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Energy Efficiency Reference for Environmental Reviewers

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Energy Efficiency Reference for Environmental Reviewers

Guidance for EPA Staff

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Acronyms and Glossary

Acronyms

ADA	Americans with Disabilities Act
APU	Auxiliary Power Units
ARRA	American Recovery and Reinvestment Act (2009)
ASHRAE	American Society of Heating, Refrigeration, and Air-conditioning Engineers
BEES	Building for Environmental and Economic Sustainability
BLM	Bureau of Land Management
BRT	Bus Rapid Transit
BTU	British Thermal Unit
C&D	Construction and Demolition debris
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CALIPER	Commercially Available LED Product Evaluation and Reporting
CAP	Clean Airport Partnership
CBECS	Commercial Building Energy Consumption Survey
CCT	Correlated Color Temperature
CEC	California Energy Commission
CEE	Consortium for Energy Efficiency
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
ChemPEP Tool	Plant Energy Profiler for the Chemical Industry
CHP	Combined Heat and Power
CMOP	Coalbed Methane Outreach Program
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COSTSAFR	Conservation Optimization Standard for Savings in Federal Residences
CRER	Conservation and Renewable Energy Reserve
CWSAT	Chilled Water System Analysis Tool
DCA	Department of Community Affairs
DDC	Direct Digital Control
DDHS	Diesel-Driven Heating System
DEMP	Departmental Energy Management Program
DoD	Department of Defense
DOE	Department of Energy
EACC	Electric Aircraft Cargo Conveyor
EAPT	Electric Aircraft PushBack Tractor
ECIP	Energy Conservation Investment Program
ECRA	Energy Conservation Reauthorization Act of 1998

EER	Energy Efficiency Ratio
EERE	Office of Energy Efficiency and Renewable Energy
EGS	Enhanced Geothermal Systems
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act of 2007
EMCS	Energy Monitoring and Control System
EMS	Environmental Management Systems
EO	Executive Order
EPA	Environmental Protection Agency
EPAct 1992	Energy Policy Act of 1992
EPAct 2005	Energy Policy Act of 2005
EPC	Environmental Performance Criteria
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contracts
EV	Electric Vehicle
FAA	Federal Aviation Administration
FAME	Fatty Acid Methyl Esters
FAR	Federal Acquisition Regulation
FAST	Federal Automotive Statistical Tool
FEMP	Federal Energy Management Program
FFV	Flexible Fuel Vehicle
FLEET	Freight Logistics and Energy Tracking
FRA	Federal Railroad Administration
FSAT	Fan System Assessment Tool
FTC	Federal Trade Commission
FY	Fiscal Year
GAI	Green Airport Initiative
GEC	Green Electronics Council
GHG	Greenhouse Gas
GHO	Green Homes Office
GSA	General Services Administration
GVWR	Gross Vehicle Weight Rating
HC	Hydrocarbons
HEV	Hybrid Electric Vehicles
HOT	High Occupant Toll
HOV	High Occupant Vehicle
HUD	Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
ICC	International Code Council
IECC	International Energy Conservation Code

IEEE	Institute of Electrical and Electronics Engineers
IES	Integrated Energy Systems
IESNA	Illuminating Engineering Society of North America
INL	Idaho National Laboratory
IRC	International Residential Code
IRS	Internal Revenue Service
ISO	International Standards Organization
ITP	Industrial Technologies Program
ITS	Intelligent Transportation Systems
kW	Kilowatts
Labs21	Laboratories for the 21st Century
LBNL	Lawrence Berkeley National Laboratory
LED	Light-Emitting Diode
LEED®	Leadership in Energy and Environmental Design
LMOP	Landfill Methane Outreach Program
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSV	Low-Speed Vehicle
MEF	Modified Energy Factor
MOU	Memorandum of Understanding
mpg	Miles Per Gallon
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NCDC	National Clean Diesel Campaign
NCPV	National Center for Photovoltaics
NECPA	National Energy Conservation Policy Act
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NGV	Natural Gas Vehicles
NHTSA	National Highway Traffic Safety Administration
NHPA	National Historic Preservation Act
NIBS	National Institute of Building Sciences
$NICE^3$	National Industrial Competitiveness Through Efficiency: Energy, Environment
NIST	National Institute for Standards and Technology
NO_x	Nitrogen Oxides
NRC	National Research Council
NREL	National Renewable Energy Laboratory
NWCC	National Wind Coordinating Committee
NxEAT	NOx and Energy Assessment Tool
OFA	Office of Federal Activities
OLED	Organic Light-Emitting Diode

ORNL	Oak Ridge National Laboratory
PAR	Parabolic Aluminized Reflector
PEM	Polymer Electrolyte Membrane
PHAST	Process Heating Assessment and Survey Tool
PLED	Polymer Light-Emitting Diode
PM	Particulate Matter
PNNL	Pacific Northwest National Laboratory
ppm	Parts Per Million
PPV	Public-Private Venture
PRV	Plant Replacement Value
PSAT	Pumping System Assessment Tool
R&D	Research and Development
SBIC	Sustainable Buildings Industry Council
SCx	Shading Coefficient
SEL	Spectrally Enhanced Lighting
SEP	State Energy Program
SHGC	Solar Heat Gain Coefficient
SOV	Single-Occupancy Vehicle Lanes
SRI	Solar Reflectance Index
SSL	Solid-State Lighting
TAT	Thermally Activated Technologies
TDM	Transportation Demand Management
TEAM	Transformational Energy Action Management
TOD	Transit Oriented Development
U^{235}	Uranium-235
UESC	Utility Energy Services Contracts
UF_6	Uranium Fluoride
ULSD	Ultra-low Sulfur Diesel
USACE	U.S. Army Corps of Engineers
USGBC	United States Green Building Council
VAV	Variable Air Volume
VFD	Variable Frequency Drives
WAP	Weatherization Assistance Program
WBDG	Whole Building Design Guide
WIP	Weatherization and Intergovernmental Program
WPA	Wind Powering America

Glossary

This glossary is compilation of terms and definitions used throughout this guidance document.

Access management – Policies, design criteria, and facilities that minimize the number of driveways and intersecting roads accessing a main thoroughfare; includes parallel service roads, shared driveways, median barriers, and curb cut limitations.

Active solar technology –Used to convert solar energy into usable light, heat, cause air-movement for ventilation or cooling, or store heat for future use. Active solar uses electrical or mechanical equipment, such as pumps and fans, to increase the usable heat in a system.

Air barriers – Systems of materials used to control airflow in building enclosures.

Biodiesel – A domestically produced, clean-burning, renewable substitute for petroleum diesel. Biodiesel is a liquid fuel made up of fatty acid alkyl esters, fatty acid methyl esters (FAME), or long-chain mono alkyl esters. It is produced from renewable sources such as new and used vegetable oils and animal fats and is a cleaner-burning replacement for petroleum-based diesel fuel.

Biofuel – Solid, liquid or gaseous fuel obtained from recently dead biological material and is different from fossil fuels, which are derived from long dead biological material. Various plants and plant-derived materials are also used for biofuel manufacturing.

Biomass – A renewable energy source that refers to living and recently dead biological material that can be used as fuel or for industrial production. In this context, biomass refers to plant matter grown or used to generate electricity or produce (for example: trash such as dead trees and branches, yard clippings and wood chips), and it also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel.

Bioswale – Vegetated buffers that slow water runoff and encourage infiltration.

Biorefineries – Facilities that integrate biomass conversion processes and equipment to produce fuels, power, and value-added chemicals from biomass.

Brownfields – Real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Building commissioning – A project management practice that formalizes review of all project expectations for facilities and their systems during planning, design, construction, and occupancy phases. It is an umbrella process that seeks to improve energy efficiency and indoor air quality by uncovering deficiencies in design or installation using peer review, inspection and functional performance testing, and by delivering preventive maintenance plans, tailored operating manuals, and training procedures.

Building envelope – Consists of all exterior components of a building.

CAFE standards – The sales weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 lbs. or less, manufactured for sale in the United States, for any given model year.

Cleanrooms – Specially constructed enclosed areas that are environmentally controlled with respect to airborne particulates, temperature, humidity, air flow patterns, air motion, and lighting. They are sealed facilities with specialized air handling and filtration systems designed to minimize static electricity or the concentrations of particles and other contaminants that may interfere with scientific research, manufacturing, medical operations and other activities.

Cogeneration/Combined Heat and Power – As discussed in this reference, cogeneration is defined as the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.

Compact fluorescent light (CFL) – A compact fluorescent light bulb is a fluorescent bulb that has been compressed into the size of a standard-issue incandescent light bulb. Modern CFLs typically last six times as long and use a quarter of the power of an equivalent incandescent bulb.

Concentrated solar power system – Systems that use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated light is then used as a heat source for a conventional power plant or is concentrated onto photovoltaic surfaces. Concentrating solar power systems are divided into concentrating solar thermal (CST) and concentrating photovoltaics (CPV).

Construction and Demolition debris (C&D) – Materials left over after a building, roadway, or other piece of infrastructure is either constructed or demolished at end of life.

Daylighting – To light an area with daylight.

Direct geothermal heating – When hot water near the Earth's surface is piped directly into facilities and used to heat buildings, grow plants in greenhouses, aquaculture, crop drying and a variety of other tasks.

Distributed Generation – The use of small-scale power generation technologies located close to the load being served and connected at the distribution level, rather than the transmission level of the electric grid.

Electronic Product Environmental Assessment Tool (EPEAT) – a system that evaluates electronic products (mainly computers and computer products) based on 51 environmental criteria.

Energy efficiency – Obtaining identical services or output with less energy input.

Energy intensity – A measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of Gross Domestic Product (GDP).

ENERGY STAR – a joint EPA/DOE program designed to identify and promote energy-efficient products, including office equipment, major appliances, lighting, home electronics, new homes, and commercial and industrial buildings.

Feedstock – Raw material required for an industrial process.

Geothermal heat pump system – A central heating and/or air conditioning system that actively pumps heat to or from the shallow ground. It uses the earth as either a source of heat in the winter or as a coolant in the summer.

Geothermal power – Power extracted from heat stored in the earth. Geothermal energy originates from the original formation of the planet, from radioactive decay of minerals, and from solar energy absorbed at the surface.

Green building – An outcome of a design which focuses on increasing the efficiency of resource use — energy, water, and materials — while reducing building impacts on human health and the environment during the building's lifecycle, through better design, construction, operation, maintenance, and removal.

Green power – Electricity produced from a subset of renewable resources, such as solar, wind, geothermal, biomass, and low-impact hydropower.

Green roof – A vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air.

Heat island effect – The phenomenon in which air temperatures above an urban area are higher than the surrounding rural areas.

Hot dry rock technology – A type of geothermal power production that uses the very high temperatures found in rocks a few kilometers below the surface. By pumping high pressure water down a borehole, the water travels through fractures in the rock and absorbs heat energy and is subsequently forced out of a second borehole as very hot water. This water is then used to run a turbine and generate electricity. The cooled water is injected back into the ground to heat up again in a closed loop.

Hybrid electric vehicles – A type of vehicle that combines the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle. The combination offers low emissions, with the power, range, and convenient fueling of conventional (gasoline and diesel) vehicles.

Hydroelectric power – Power that is derived from the force or energy of moving water, which may be harnessed for useful purposes.

Hydrokinetic technologies – Technologies capable of generating electricity from the motion of waves, tides, ocean and river currents.

Incident management systems– Technology and programs for detecting crashes, disabled vehicles, or other incidents that impede travel and resolving or removing the obstructions.

Integrated energy systems – A system design that brings together gas-fired and electrically driven equipment to provide heating, cooling, dehumidification, and electrical service to commercial and public buildings.

Intermediate Load Electricity – Power that is needed in addition to baseline power as a result of increased demand – often this comes from natural gas, solar or wind.

Intelligent transportation systems – The use of technology to improve traffic flow with respect to incident management and traveler information. The use of technology must include supporting operations and maintenance of that technology.

Life cycle cost – The investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence.

Light Emitting Diode (LED) – An electronic light source.

Low speed vehicles – Alternative means of transportation that drastically reduce the amount of petroleum used by a conventional vehicle fleet. Low-speed vehicles are commonly utility or recreational vehicles and typically powered by electric, gasoline or propane.

Military installations – A base, camp, post, station, yard, center, homeport facility or ship, or any other facility under the jurisdiction of a department, agency, or other instrument of the Department of Defense, including a leased facility.

Modal choice – The ability for one mode of transportation to be selected over another given the preferences and requirements of the commuter or goods. Mode choices are viable transportation alternatives between the same origin and destination.

Nanomanufacturing – The purposeful engineering of matter at the nano-scale, which ranges from 1 to 100 nanometers.

Passive solar technology – The technology of heating, cooling, and lighting a building naturally with sunlight rather than with mechanical systems.

Photovoltaics – The field of technology and research related to the application of solar cells for energy by converting sunlight directly into electricity. They are silicon-based devices that convert light into electricity.

Post consumer content – A material that has served its intended use and instead of being disposed of it is being reused in a different product.

Pre-consumer content – By-products generated after the manufacturing process is completed and then reconstituted into pre-consumer recycled content.

R value – a measure of thermal resistance used in the building and construction industry.

Renewable energy – Energy generated from natural resources—such as sunlight, wind, rain, tides and geothermal heat—which are renewable (naturally replenished).

Smart Grid – A shift from a centralized, producer-controlled electrical network to a less centralized, more consumer-interactive grid.

Smart growth – An approach that enhances neighborhoods and involves local residents in development decisions while creating vibrant places to live, work, and play. These approaches develop strategies that preserve natural lands, protect water and air quality, and reuse already-developed land.

Solar heat gain coefficient (SHGC)– A numerical measure of how well a window blocks heat from sunlight. The SHGC is the fraction of the heat from the sun that enters through a window. SHGC is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits.

Solar power – Energy from sunlight that is converted it into heat, electricity or supplemental lighting using photovoltaics (PV), concentrating solar power (CSP), or various experimental technologies.

Solid state lighting – Utilizes light-emitting diodes, organic light-emitting diodes, or polymer light-emitting diodes as sources of illumination rather than electrical filaments, plasma (used in arc lamps such as fluorescent lamps), or gas. The term "solid state" refers to the fact that light in an LED is emitted from a solid object—a block of semiconductor—rather than from a vacuum or gas tube, as is the case in traditional incandescent light bulbs and fluorescent lamps.

Spectrally enhanced lighting (SEL) – A technology/lighting design technique that uses existing products and technology to reduce energy use in commercial buildings. The concept behind SEL is that a significant amount of energy can be saved by using lamps that have less light output, but higher correlated color temperature.

Standby power – Refers to the electric power consumed by electronic appliances while they are switched off or in a standby mode.

Thermally activated technologies – A diverse portfolio of equipment that transforms wasted/discarded heat into useful purposes such as heating, cooling, humidity control, thermal storage, and shaft/electrical power.

Thin-film technology – A microscopically thin layer of material that is deposited onto a metal, ceramic, semiconductor or plastic base. Thin films of photovoltaic material using silicon, cadmium telluride and other elements are used to make solar panels and solar roof shingles.

Tidal power – A form of hydropower that converts the energy of tides into electricity or other useful forms of power.

Transit oriented development – The creation of compact, walkable communities centered around high quality train systems, and collector support transit systems including trolleys, streetcars, light rail, and buses.

Wave power – The transport of energy by ocean surface waves, and the capture of that energy to do useful work.

Weatherization – The practice of protecting a building and its interior from the elements, particularly from sunlight, precipitation, and wind, and of modifying a building to reduce energy consumption and optimize energy efficiency.

Whole building design – A concept that forms the entire building stakeholder community into a team at the beginning of a project. The team examines project objectives, building materials, systems, and assemblies from various perspectives, and improves the final building product by integrating the components into a more energy efficient system.

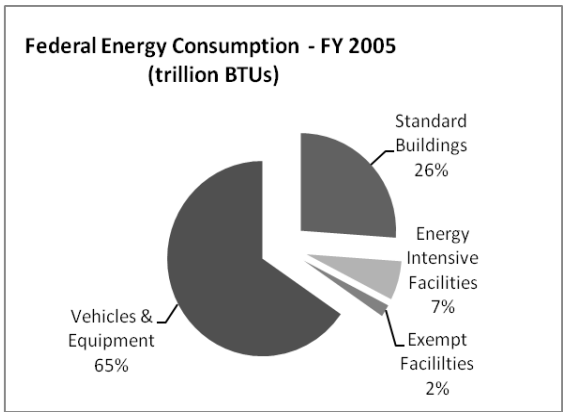
Wind power – the conversion of wind energy into a useful form, such as electricity, using wind machines and turbines.

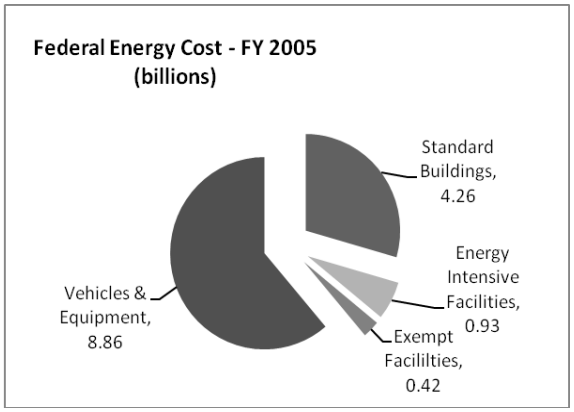
Xeriscape – Refers to landscaping and gardening in ways that reduce or eliminate the need for supplemental irrigation.

1. Introduction

1.1 Purpose and Intent of This Reference

Energy efficiency—obtaining identical services or output with less energy input—offers one of the lowest cost means of reducing U.S. energy bills, preventing pollution and addressing climate change. As one of the largest energy consumers in the United States, the federal government has taken on the responsibility to lead by example by promoting energy efficiency. By more fully integrating energy efficiency considerations throughout the actions, decisions and operations of the federal government, the U.S. could not only make substantial





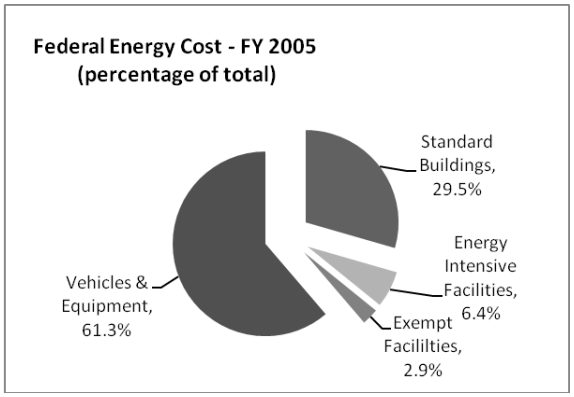


Figure 1-1.

Federal energy consumption and cost statistics for Fiscal Year 2005 derived from Annual Report to Congress on Federal Government Energy Management and Conservation Programs: Fiscal Year 2005, U.S. Department of Energy, Assistant Secretary, Energy Efficiency and Renewable Energy, Federal Energy Management Program.

The U.S. government is the single largest energy consumer in the nation. The energy consumption of the Federal government represents approximately 1.6% of the total energy consumed in the United States.

In terms of major energy use, jet fuel and electricity accounted for approximately 59.3% of total energy consumption and approximately 71.1% of total energy costs.

Note: Standard buildings include typical office and other administrative structures. Energy intensive buildings include industrial facilities, laboratories, and data centers. Exempt facilities include those that are deemed exempt from the provisions of the Energy Act of 2005, generally including leased buildings, privately-owned buildings on federal lands, and limited energy-consuming structures such as parking garages.

advances in reducing our dependence on foreign sources of energy, but could reduce many of the environmental pollutants emitted in the production and utilization of that energy.

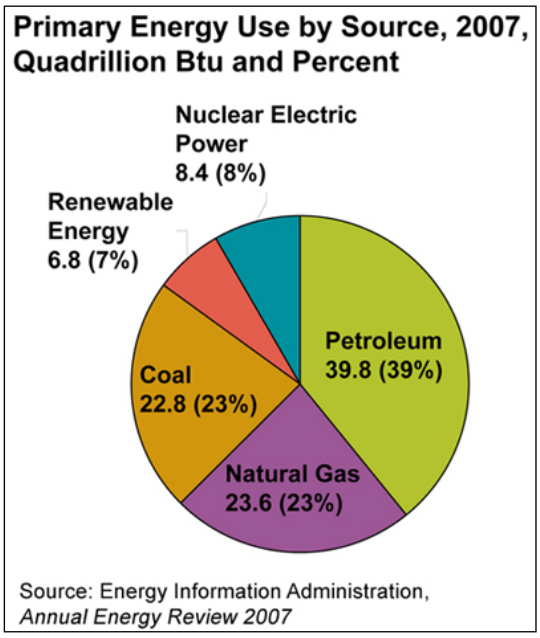
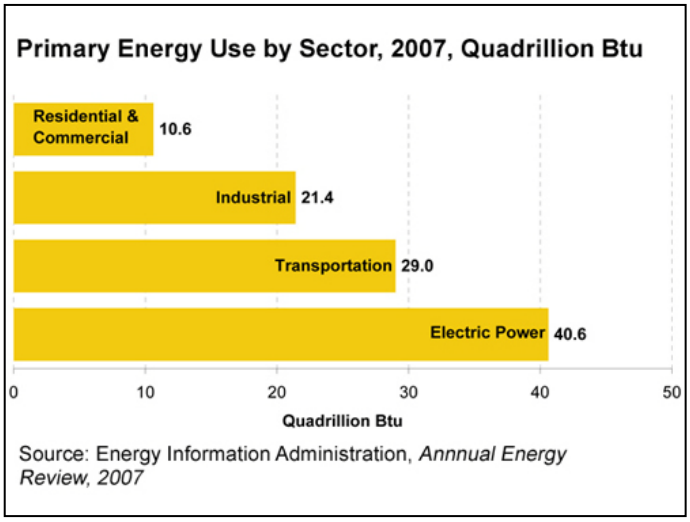


Figure 1-2. Overall U.S. Energy Consumption by Source and Sector, 2007



This reference document provides background information on federal energy efficiency legislation, policies, guidance and programs, as well as current energy efficiency technologies, standards, and products. These programs and documents have very specific requirements. For this reason, federal agencies are well aware of energy efficiency requirements for their actions and activities. 309 Reviewers should identify whether they are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

This reference is intended for reviewers within the U.S. Environmental Protection Agency (EPA) who review and comment on National Environmental Policy Act (NEPA) documents, in accordance with EPA's responsibilities for environmental review under §309 of the *Clean Air Act* (CAA).

The goal of the reference is to provide information to assist EPA reviewers to:

1. Prepare scoping comments on environmental impact statements (EISs) that address energy efficiency;
2. Consider energy efficiency issues most appropriate to a specific type of federal action presented in an EIS;
3. Support the development of EPA's comments under CAA §309.

1.2 Audience

The primary audience for this reference is EPA staff who: 1) review legislation, regulations, and NEPA documentation to meet EPA's CAA §309 responsibilities; and 2) participate in interagency coordination meetings, committees and task forces on a full range of EPA's responsibilities and initiatives.

Other audiences include staff of federal agencies and private and public individuals and groups whose environmental legislation, regulations, projects, documentation, or permit applications come under EPA review, and international, state, or local governmental staff or officials and private individuals and groups interested in energy efficiency. All audiences should consider this document as background information, not as law, regulation, policy or guidelines.

1.3 Organization of this Reference

This introductory chapter is followed by a chapter that reviews the NEPA and §309 review process and describes opportunities for including energy efficiency within the process. Chapter 3 summarizes the relevant federal legislation, policies, directives and guidance related to energy efficiency. Chapter 4 examines energy efficiency related federal programs. Chapter 5 summarizes general federal energy uses, related federal partnership programs and review considerations for each federal energy use by topic. The chapter is organized by the following topics:

- appliances and equipment
- facility siting
- construction
- buildings
- federally assisted housing
- military installations
- laboratories
- industrial facilities
- federal vehicle fleets
- transportation facilities
- other federal government operations

Chapter 6 describes renewable energy technologies and related federal programs, and Chapter 7 presents a list of training opportunities related to energy efficiency for 309 Reviewers, other federal agency employees, and the public.

2. Incorporating Energy Efficiency in the NEPA Process

2.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) was signed into law on January 1, 1970. NEPA, as amended (42 U.S.C. 4321 et seq.), requires all federal agencies to, among other things, assess the environmental impacts of major federal actions significantly affecting the quality of the human environment (e.g., issuing permits, spending federal money, or taking actions on federal lands). When an agency concludes that a proposed major federal action has the potential for causing significant environmental impacts, it is required to prepare a detailed statement, known as an environmental impact statement (EIS). The purpose of the EIS is to inform the federal decision makers and the public of the environmental impacts of the project and reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. In part, NEPA states that all federal agencies shall "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment" (42 U.S.C. 4332).

2.2 CEQ Regulations Implementing NEPA, 40 CFR Part 1500

The President's Council on Environmental Quality's (CEQ's) NEPA-implementing regulations, at 40 CFR Parts 1500 – 1508, establish minimum general procedures that assure NEPA compliance. These CEQ regulations establish a multistage process that describes how an agency is to analyze and describe any significant environmental impacts that could result from carrying out a proposed major federal action.

NEPA and the CEQ regulations require that, when a federal agency proposes legislation or another major federal action significantly affecting the quality of the human environment, the agency must prepare a detailed statement of the environmental effects and obtain comments from any other federal agency having jurisdiction by law or special expertise with respect to any environmental impact involved (42 USC 4332(C); 40 CFR 1503.1). In accordance with the CEQ regulations, each federal agency has developed its own NEPA rules and/or agency procedures.

2.3 CEQ Guidance Regarding NEPA Regulations

Since NEPA was enacted, CEQ has issued many guidance documents to assist federal agencies in complying with the CEQ regulations for implementing the Act, preparing high-quality NEPA documents, and improving the NEPA process.

One of the most widely referenced CEQ guidance documents is the 1981 memorandum to federal agencies, *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations* (CEQ 1981). This guidance provided clarification on topics including the range of alternatives, implementing actions that are the subject of an ongoing NEPA review, public involvement, cooperating agencies, and contents of specific EIS sections, among others.

Other CEQ guidance includes the following documents that are widely applicable or that may be particularly relevant to reviewing EISs for energy efficiency projects:

- *A Citizen's Guide to the NEPA: Having Your Voice Heard* (CEQ 2007a)
- *Reporting NEPA Status and Progress for Recovery Act Activities and Projects*, April 3, 2009 (CEQ 2009)
- *Aligning National Environmental Policy Act Processes with Environmental Management Systems: A Guide for NEPA and EMS Practitioners*, April 2007 (CEQ 2007b)
- *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis*, June 24, 2005 (CEQ 2005)
- *Environmental Justice: Guidance Under the National Environmental Policy Act*, December 10, 1997 (CEQ 1997a)
- *Considering Cumulative Effects Under the National Environmental Policy Act*, January 1997 (CEQ 1997c)
- *Pollution Prevention and the National Environmental Policy Act*, January 12, 1993 (CEQ 1993)
- *Guidance Regarding NEPA Regulations*, 1983 (CEQ 1983).

2.4 Section 309 of the *Clean Air Act*

Section 309 of the *Clean Air Act*, as amended in 1970 (42 U.S.C. 7609), directs EPA to review and comment in writing on the environmental impacts of, among other things, "newly authorized federal projects for construction and any major federal action (other than a project for construction) of a federal agency to which 42 USC 4332(C) . . . applies" and to make those reviews available to the public. If EPA determines that any such action is environmentally unsatisfactory, the action will be referred to CEQ.

Section 309 confers upon EPA review responsibilities for proposed major federal actions. The EPA Administrator has delegated to the Office of Federal Activities (OFA) the authority to review and comment on EISs that are multi-regional in scope and regulations proposed by other federal agencies for which there are national policy implications. The Administrator has delegated to the ten EPA Regional Administrators the authority to review and comment on region-specific EISs. EPA has developed a set of criteria for rating draft EISs. The rating system provides a consistent method for evaluating Draft EISs (EPA 2002). In the event EPA determines that:

1) the agency's action involves adverse environmental impacts that are of sufficient magnitude that EPA believes the proposed action should not proceed as proposed;
2) the draft EIS has been rated environmentally unsatisfactory;
3) the final EIS continues to be environmentally unsatisfactory;
4) and every effort has been made to resolve the environmental issues at the agency level;

EPA will determine whether the action is unsatisfactory from the standpoint of public health, welfare, or environmental quality, and, if so, refer the Final EIS to CEQ.

EPA (OFA and regional offices) reviews approximately 500 EISs and about 2,000 other actions each year. OFA also develops guidance materials, provides NEPA and §309 training courses, and promotes coordination between EPA offices and other federal agencies.

2.5 Energy Efficiency and the NEPA Process

Section 309 of the *Clean Air Act* directs the EPA to review and comment on major federal actions significantly affecting the quality of the human environment undertaken by other federal agencies, and to make the results of those reviews available to the public. In its Section 309 role, EPA ensures that federal agencies give due consideration to environmental factors and resource issues in their individual decision-making processes. EPA conducts Section 309 reviews consistent with its *Policy and Procedures for the Review of Federal Actions Impacting the Environment* (EPA 1984) and the 2007 update (EPA 2007).

While NEPA does not specifically address the subject, the promotion of energy efficiency is inherent in the overall goals of the statute which define the environmental stewardship policy of the nation and include the concepts of:

- Responsibility for the future: Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Societal prosperity: Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Sustainable practices: Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Under the CEQ regulations for implementing NEPA, consideration of energy efficiency is specifically required. Under Section 1502.16 (e) regarding the requirements for analyzing and documenting environmental consequences, agencies are required to discuss "energy requirements and conservation potential of various alternatives and mitigation measures." Section 1502.16(f) requires agencies to consider the "natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures." Energy efficiency and conservation concepts may also be interpreted as a necessary consideration in addressing the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources as required by the CEQ regulations (Section 1502.16).

Several executive orders and policies have been promulgated over the years that require or promote the consideration of energy efficiency in federal actions, including the following:

- Executive Order 13423, *Strengthening Federal Environmental, Energy and Transportation Management* (EOP 2007)
- Executive Order 13221, *Energy Efficient Standby Power Devices* (EOP 2001a)

- Executive Order 13211, *Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use* (EOP 2001b).

These executive orders are discussed in detail in Chapter 3 of this document.

The reviewer should keep in mind that questions and suggestions regarding energy efficiency should be governed by tests of reasonableness and practicality. The earlier in the NEPA process (e.g., during scoping) that suggestions are made and considered, the greater the likelihood of incorporating energy efficiency in project design. This reference is provided to help the reviewer recognize energy impacts and considerations that may be included in the NEPA process. The best time to include questions or suggestions regarding energy efficiency is during the scoping stage or, where EPA is a cooperating agency, during the preparation of the DEIS. The intent of this document is to increase awareness and understanding of federal programs and information regarding energy efficiency.

Section 2 References

Links to external web sites provided in this document may be useful or interesting and are being provided consistent with the intended purpose of this guidance document. EPA cannot attest to the accuracy of information provided by any linked site. Providing links to a non-EPA web site does not constitute an endorsement by EPA or any of its employees of the sponsors of the site or the information or products provided on the site. Also, be aware that the privacy protection provided on the epa.gov domain (see Privacy and Security Notice) may not be available at the external link.

40 CFR Part 6. Procedures for Implementing the National Environmental Policy Act and Assessing the Environmental Effects Abroad of EPA Actions. http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1 Accessed March 2009.

40 CFR Parts 1500 – 1508. CEQ regulations for implementing NEPA. http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1 Accessed March 2009.

42 U.S.C. 4321 et seq. *National Environmental Policy Act.* http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC55 Accessed March 2009.

42 U.S.C. 7609. *Clean Air Act*. http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC85 Accessed March 2009.

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Executive Office of the President. 2001b. Executive Order 13211—Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use. 66 Federal Register 99:28355-28356. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2001_register&docid=01-13116-filed.pdf Accessed March 2009.

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3. Relevant Federal Statutes, Regulations, Executive Orders, Directives and Guidance

This section provides background information on the laws, regulations, Presidential directives, and guidance relating to energy efficiency. This is not intended to be a comprehensive compilation of such documents; rather it is intended to assist the reviewer by providing background information. It is important to note that EPA does not have jurisdiction or authority to enforce these laws, regulations and directives.

3.1 Energy Policy Act of 2005

The purpose of the *Energy Policy Act* of 2005 (P.L. 109-58), the first major piece of federal energy legislation since 1992, is to "ensure jobs for our future with secure, affordable, and reliable energy." The Act contains provisions to promote energy efficiency and conservation, encourage alternative and renewable energy sources, reduce dependence on foreign sources of energy, increase domestic production, modernize the electricity grid, and encourage the expansion of nuclear energy.

Title I, Energy Efficiency, of the 18-title act addresses energy efficiency as it relates to Federal Programs (Subtitle A), Energy Assistance and State Programs (Subtitle B), Energy Efficient Products (Subtitle C), and Public Housing (Subtitle D). Of particular relevance to NEPA document review, Title I, Subtitle A, Federal Programs, amends the *National Energy Conservation Policy Act* (NECPA) of 1978 by adding:

- Requirements for energy and water savings measures in congressional buildings.
- Requirements for annual two percent reductions in energy use at federal agency buildings (including industrial and laboratory facilities) through fiscal year 2015, with DOE to complete a review of the government's performance in response to this requirement by the end of 2014 and recommend additional measures for fiscal years 2016 through 2025.

- A requirement for agencies to monitor their electricity use in all federal buildings by October 1, 2012, using advanced meters or devices that provide data at least daily and that measure consumption of electricity at least hourly.
- A requirement that, whenever an agency procures an energy-consuming product, they must purchase an ENERGY STAR or Federal Energy Management Program (FEMP)-designated product, unless such products would not be cost-effective (including consideration of energy savings) or not reasonably available. DOE published a final rule on March 13, 2009, stating that ENERGY STAR and FEMP-designated products may be assumed to be life cycle cost-effective, and identifying the applicability of NECPA Section 553 requirements related to energy efficiency to specific procurement actions (74 *Federal Register* 10830-10835, March 13, 2009, to be codified as 10 CFR 436.40-436.43).
- Extension of the energy savings performance contracts provision in NECPA Section 801 through 2016.
- Voluntary agreements between industrial energy users and federal agencies to reduce energy intensity (defined as "the primary energy consumed for each unit of physical output in an industrial process" (42 USC 15811).
- A requirement for DOE to establish a university-led Advanced Building Efficiency Testbed program to develop, test and demonstrate advanced engineering systems, components and materials to enable innovations in building technologies, for which funds were appropriated for fiscal years 2006-2008.
- Requirements for achieving greater use of recovered mineral component in cement or concrete projects.
- Requirements that DOE establish regulations revising federal building energy performance standards that require that new federal buildings (1) are designed to achieve energy consumption levels that are at least 30 percent below levels established by the American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) Standard or the International Energy Conservation Code standards, (2) incorporate sustainable design principles; and (3) apply water conservation technologies if water is used to achieve energy efficiency.
- Increasing the length of daylight savings time.
- In managing public lands, incorporating the use of energy efficient technologies in public and administrative buildings, and using energy-efficient motor vehicles to the extent practicable.

In Title II, Renewable Energy, Section 203 sets federal government renewable energy consumption requirements, and prioritizes renewables that are produced on-site or on federal or Indian lands. Section 204 promotes the establishment of a photovoltaic energy commercialization program in federal buildings, including the installation of 20,000 solar energy systems in federal buildings by 2010.

In addition to its goals for federal programs, the *Energy Policy Act* includes three major energy efficiency provisions: (1) new minimum energy efficiency standards for specific residential and commercial products (Title 1, Subtitle C, Energy Efficient Products); (2) research into energy efficiency, the Next Generation Lighting Initiative, the National Building Performance Initiative, building standards, a secondary electric vehicle battery use program, the Energy Efficiency Science Initiative, and Advanced Energy Efficiency Technology Transfer Centers (Title IX, "Research and Development," Subtitle A, "Energy Efficiency"); and (3) manufacturer and

consumer tax incentives for advanced energy savings technologies and practices (Title XIII, "Energy Policy Tax Incentives.")

The full text of the Act is available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf

3.2 National Energy Conservation Policy Act of 1978

The purpose of the National Energy Conservation Policy Act of 1978 (NECPA) is "to provide for the regulation of interstate commerce, to reduce the growth in demand for energy in the United States, and to conserve nonrenewable energy resources produced in this Nation and elsewhere, without inhibiting beneficial economic growth" (42 USC 8201(b)). On their website, DOE states that NECPA "serves as the underlying authority for federal energy management goals and requirements. . . NECPA is the foundation of most current energy requirements" (DOE 2009).

The NEPCA energy management requirements (Subchapter III, "Federal Energy Initiative," Part B, "Federal Energy Management," 42 USC 8251-8262k) are particularly relevant to NEPA analyses of agency actions. This part promotes the conservation and the efficient use of energy and water, and the use of renewable energy sources by the federal government (42 USC 8252). As currently amended, it provides for:

- Annual reductions in energy use at federal agency buildings (including industrial and laboratory facilities) through fiscal year 2015, with DOE to complete a review of the government's performance in response to this requirement by the end of 2014 and recommend additional measures for fiscal years 2016 through 2025. Installation of energy and water conservation measures in federally owned buildings.
- Metering energy use in federal buildings.
- Establishing and using life cycle cost methods and procedures.
- Authorizing agencies to offer and receive incentives for energy efficiency improvements.
- Implementing energy management programs in federal agencies, including intergovernmental energy management planning and coordination, energy management training, energy audit teams, energy cost accounting and management, procurement and identification of energy efficient products, provisions specific to the Postal Service, and government contract incentives.

The full text of the Act is available at http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC91.

3.3 Criteria for Excluding Buildings from the Energy Performance Requirements of Section 543 of the National Energy Conservation Policy Act, as Amended by the Energy Policy Act of 2005

Under Section 543 of NECPA, 42 USCA § 8353 federal agencies are required to demonstrate an annual reduction in energy usage. A building may be excluded from this requirement for one fiscal year if it meets all of the following criteria (DOE 2006a):

1. Impracticability due to energy intensiveness or national security function.
2. Completed energy management reports.
3. Compliance with all energy efficiency requirements.
4. Implementation of all cost-effective energy projects in the building.

Federal agencies are required to submit to DOE their aggregate annual costs for each fuel type consumed in its excluded buildings as well as the aggregate gross square footage of the excluded buildings. The full text of these criteria is available in paragraph (c) at: http://www1.eere.energy.gov/femp/pdfs/exclusion_criteria.pdf.

3.4 Energy Independence and Security Act of 2007

The *Energy Independence and Security Act* of 2007 (EISA) (P.L. 110-140) builds on the *Energy Policy Act* of 2005 in creating a comprehensive energy strategy for the 21st century. EISA promotes accelerated research and development of alternative energy resources, primarily focusing on solar, geothermal, and marine energy technologies, along with carbon sequestration. In addition to providing research funding, the Act directs DOE to conduct studies on integration of alternative energy technologies into regional electric transmission grids, to offer grant programs for alternative energy workforce training, and to initiate and fund demonstration programs for alternative energy technologies.

The Act raises corporate average fuel economy (CAFE) standards to 35 miles per gallon (mpg) by model year 2020. Prior to EISA, Congress had not raised the CAFE standard for passenger cars since 1975.

EISA 2007 also revises the Renewable Fuel Standard (RFS) for transportation fuels, originally created under the Energy Policy Act of 2005. The Act seeks to increase the supply of biofuel by requiring fuel producers to use in the fuel mix a progressively increasing amount of biofuel, culminating in at least 36 billion gallons of biofuel by 2022. This includes 15 billion gallons of conventional biofuel such as corn ethanol, as well as 21 billion gallons of advanced biofuels. Within advanced biofuels, new volume standards are created for cellulosic biofuel, biomass-based diesel, and other advanced biofuel. EISA also includes new definitions and criteria for both renewable fuels and the feedstocks used to produce them, including new lifecycle greenhouse gas (GHG) emission thresholds for each type of renewable fuel mandated by the Act. EISA requires a 50% reduction in lifecycle GHG emissions for fuels to be classified as biomass-based diesel or advanced biofuel, and a 60% reduction in order to be classified as cellulosic biofuel. EISA also provides some limited flexibility for EPA to adjust these GHG percentage thresholds downward by up to 10 percent under certain circumstances. EPA issued a proposed

rule on May 19, 2009 to implement these changes to the RFS program, and is now working on a final rule. Additional details can be found at:
http://www.epa.gov/otaq/renewablefuels/index.htm

The Act also authorizes EPA to define low GHG-emitting light-duty vehicles and medium-duty passenger vehicles and prohibits federal agencies from acquiring light-duty vehicles and medium-duty passenger vehicles that are not low GHG-emitting vehicles.

EISA sets the first federal mandatory efficiency standards for lighting and residential and commercial appliance equipment, including 200 percent greater efficiency from light bulbs by 2020. The array of products and appliances for which energy efficiency standards are established in the Act includes dishwashers, dehumidifiers, residential boilers, electric motors, incandescent lamps, external power supplies, and walk-in coolers and freezers. EISA also directs DOE to conduct new rulemakings on residential refrigerators and clothes washers, and on the standby power use of currently regulated appliances, and to revise all standards and test procedures on a regular basis.

The Act also establishes requirements for federal agency efficiency and renewable energy use. Key provisions include:

- All general purpose lighting in federal buildings must use ENERGY STAR or FEMP-designated products by 2013.
- All new federal buildings must be "carbon neutral" by 2030.
- New and renovated federal buildings must reduce fossil fuel use by 55 percent from 2003 levels by 2010, and 80 percent by 2020.
- The U.S. General Services Administration (GSA) will establish an Office of High-Performance Green Buildings to promote green building technology implementation in federal buildings.

The Act also permanently authorizes Energy Savings Performance Contracts, an innovative financing tool for upgrading the energy efficiency of federal buildings. EISA authorizes DOE to implement a new program, the Commercial Buildings Initiative, to be designed with input from an industry consortium. This program will combine research, development, and deployment activities designed to achieve the goal of making all new commercial buildings "zero energy" by the year 2030. Zero energy means that, on a net basis, the facility produces as much energy as it uses.

The full text of this Act is available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ140.110.pdf.

3.5 Housing and Community Development Act of 1974

The purpose of the *Housing and Community Development Act*, as amended, is development of viable urban communities, by providing decent housing and a suitable living environment and expanding economic opportunities, principally for persons of low and moderate income (42 USC

69(5301)(c)). More information on energy efficiency in federally assisted housing programs can be found in Section 5.5 of this document.

The full text of the Act is available at http://www.hud.gov/offices/cpd/communitydevelopment/rulesandregs/laws/index.cfm.

3.6 Federal Acquisition Regulation

Title 48 of the CFR contains the Federal Acquisition Regulation (FAR), which codifies uniform policies and procedures for federal agency acquisitions. FAR Subparts 23.200 through 23.206 prescribe procedures for acquiring products and services that are energy- and water-efficient and products that use renewable energy technology. To meet FAR requirements, the GSA offers products designated as energy efficient under the EPA ENERGY STAR program, U.S. Department of Energy (DOE) FEMP, and the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT).

The FAR is contained in CFR Title 48, which is available at http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1.

3.7 Federal Energy Management and Planning Programs, 10 CFR Part 436

10 CFR Part 436 "sets forth the rules for Federal energy management and planning programs to reduce Federal energy consumption and to promote life cycle cost effective investments in building energy systems, building water systems and energy and water conservation measures for Federal buildings." 10 CFR 436.1.

Subpart A of the regulation "establishes a methodology and procedures for estimating and comparing the life cycle costs of Federal buildings, for determining the life cycle cost effectiveness of energy conservation measures and water conservation measures, and for rank ordering life cycle cost effective measures in order to design a new Federal building or to retrofit an existing federal building. It also establishes the method by which efficiency shall be considered when entering into or renewing leases of federal building space" (10 CFR 436.10).

Subpart B "provide[s] procedures and methods which apply to Federal agencies with regard to the award and administration of energy savings performance contracts awarded on or before September 30, 2003." 10 CFR 436.30.

Subpart C "provides guidance to promote the procurement of energy efficient products by Federal agencies and promote procurement practices which facilitate the procurement of energy efficient products" 10 CFR 436.40.

Subpart F, Guidelines for General Operations Plans, "provide[s] guidelines for use by Federal agencies in their development of overall 10-year energy management plans to establish energy conservation goals, to reduce the rate of energy consumption, to promote the efficient use of energy, to promote switching for petroleum-based fuels and natural gas to coal and other energy sources, to provide a methodology for reporting their progress in meeting the goals of those

plans, and to promote emergency energy conservation planning to assuage the impact of a sudden disruption in the supply of oil-based fuels, natural gas or electricity. The plan is intended to provide the cornerstone for a program to conserve energy in the general operations of an agency" (10 CFR 436.100). Each federal agency must submit its plan or revision of a plan to DOE. DOE is authorized to review federal agency energy management plans and to evaluate the sufficiency of such plans. 10 CFR 436.107.

These regulations can be accessed online under CFR Title 10, Volume 3, Chapter II, Parts 200-499 at http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1.

3.8 Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management

Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy and Transportation Management* (EOP 2007), consolidates and strengthens prior energy-efficiency related executive orders by establishing new and updated goals, practices, and reporting requirements for performance and accountability. Federal agency goals listed in EO 13423 include:

- Improve energy efficiency and reduce greenhouse gas emissions by 3 percent annually by the end of fiscal year 2015 or by 30 percent by the end of fiscal year 2015 (using 2003 as the baseline). At least half of the statutorily-required renewable energy must come from new renewable sources, which are defined as sources of renewable energy placed into service after January 1, 1999. (Note: The federal government improved energy efficiency 29.6 percent between 1985 and 2005. The energy efficiency goal outlined in the EO seeks to achieve in 8 years (2007 to 2015) the same level of improvement that federal agencies achieved in the preceding 20 years, and is 50 percent more stringent than the goal in the *Energy Policy Act* of 2005 (OFEE 2009)).
- Beginning in fiscal year 2008, reduce water consumption relative to the fiscal year 2007 baseline by two percent annually through the end of fiscal year 2015. (Note: Prior executive orders related to energy efficiency did not include a water consumption goal).
- Procure green products and services (that is, environmentally sensitive, energy efficient, water efficient, and recycled content, reduce use of toxic and hazardous chemicals and materials). (Note: EO 13423 requires agencies to integrate four existing disparate purchasing requirements into an integrated federal purchasing effort that applies to all types of acquisitions of goods and services. Federal purchasing of energy efficient, recycled content, bio-based, and environmentally preferable products should increase as a result).
- Construct or renovate buildings in accordance with the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings* set forth in the *Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding* (MOU) (2006) (http://www.wbdg.org/pdfs/sustainable_mou.pdf).
- If the agency operates a fleet of at least 20 motor vehicles, increase purchase of plug-in hybrid electric vehicles when commercially available at a cost reasonably comparable, reduce the fleet's total petroleum consumption by 2 percent annually through the end of fiscal year 2015, and increase the use of alternative non-petroleum-based fuels by 10 percent annually. (Note: The *Energy Policy Act* of 2005 also set a renewable energy goal but did not require that any percentage come from new sources).

- Ensure at least 95 percent of all purchased electronic products are Electronic Product Environmental Assessment Tool (EPEAT)-registered; enable the ENERGY STAR feature on all agency computers and monitors; establish and implement policies to extend the useful life of agency electronic equipment; and use environmentally sound practices with regard to the disposition of electronic equipment that has reached the end of its useful life. (Note: This goal impacts approximately $60 billion that the federal government spends annually on information technology-related purchases (OFEE 2009)).

In addition, the EO directs each agency head to:

- Designate a senior civilian officer to be responsible for EO implementation.
- Establish programs for environmental management training, environmental compliance review and audit, and leadership awards to recognize outstanding environmental performance.
- Implement environmental management systems (EMSs) within the agency to address environmental aspects of internal agency operations and activities, including energy and transportation functions. Use EMSs to establish agency objectives and targets for EO implementation and measure performance. (Note: As a result of this directive, it is projected that by approximately 2010, there will be at least 2,500 federal operations that implement EMSs, up from about 1,000 today (OFEE 2009)).
- Establishes an Office of the Federal Environmental Executive to assist in implementation of the EO.

EO 13423 revoked several previous EOs, as follows:

- EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*.
- EO 13123, *Greening the Government through Efficient Energy Management*.
- EO 13134, *Developing and Promoting Biobased Products and Bioenergy*.
- EO 13148, *Greening the Government through Leadership in Environmental Management*.
- EO 13149, *Greening the Government through Federal Fleet and Transportation Efficiency*.

Because EO 13423 revokes the previous EOs, 309 Reviewers should reference EO 13423 when offering energy efficiency recommendations on related topics. The full text of this EO can be accessed at http://edocket.access.gpo.gov/2007/pdf/07-374.pdf.

3.9 Executive Order 13221, Energy Efficient Standby Power Devices

The EO requires that a federal agency, each time "it purchases commercially available, off-the-shelf products that use external standby power devices, or that contain an internal standby power function, shall purchase products that use no more than one watt in their standby power consuming mode" (EOP 2001a). If such products are unavailable, agencies are to purchase products with the lowest standby power wattage while in their standby power consuming mode. DOE, in consultation with the Department of Defense and the GSA, was directed to compile an annual list of products subject to these requirements.

The full text of this EO is available at http://www.ofee.gov/eo/eo13221.pdf.

3.10 Executive Order 13211, Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

When undertaking ”significant energy action,” (that is, an action by an agency normally published in the Federal Register that promulgates or is expected to lead to the promulgation of a final rule or regulation that (1) is a significant regulatory action under EO 12866 and is likely to have a significant adverse effect on the supply, distribution or use of energy; or (2) is designated by the Administrator of the Office of Information and Regulatory Affairs (OIRA) within the Office of Management and Budget, as a significant regulatory action), an agency must prepare, to the extent permitted by law, a Statement of Energy Effects. The Statement consists of a detailed statement relating to (1) any adverse effects of the regulatory action on energy supply, distribution, or use; and (2) reasonable alternatives to the action and the expected effects of such alternatives on energy supply, distribution and use (EOP 2001b). The Statement is to be submitted to the Administrator of OIRA and published in each related proposed rulemaking and in any resulting final rule.

The full text of this EO is available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2001_register&docid=01-13116-filed.pdf.

3.11 Guidance for Electric Metering in Federal Buildings

Section 103 of the *Energy Policy Act* of 2005 amended section 543 of the National Energy Conservation Policy Act (see section 3.3), 42 USC 8253, and requires agencies to measure electricity use in all federal buildings by October 1, 2012, using advanced meters or devices that provide data at least daily and that measure at least hourly consumption of electricity. Guidelines for implementing this requirement, developed by DOE (2006b), clarified that the requirement applies only to electric metering and that it applies to all electric metering at all federal buildings based on cost-effectiveness and practicability. DOE required agencies to submit implementation plans by August 3, 2006, and to begin reporting annually on their progress beginning with FY 2007. The statute requires agencies to install meters, to the maximum extent practicable, by October 1, 2012. The guidance defines “Advanced Metering,” describes the uses of metered data, identifies metering approaches and technologies, discusses how to determine cost-effectiveness of metering, presents methods for prioritizing buildings for metering applications, discusses methods of financing metering equipment, provides a template for an agency metering plan, and discusses performance measures and special considerations.

This guidance document can be accessed at http://www1.eere.energy.gov/femp/pdfs/adv_metering.pdf.

3.12 Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

The EO was issued on October 5, 2009 to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions a priority for Federal agencies. Its policy requires Federal agencies to increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve

and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which Federal facilities are located; and inform Federal employees about and involve them in the achievement of these goals.

Specific goals for each Federal agency include but are not limited to:

(a) Establish a percentage reduction target for agency-wide reductions of greenhouse gas emissions in absolute terms by fiscal year 2020. In establishing the target, each agency shall consider the following:

(i) reducing energy intensity in agency buildings;
(ii) increasing agency use of renewable energy and implementing renewable energy generation projects on agency property; and
(iii) reducing the use of fossil fuels by:
(A) using low greenhouse gas emitting vehicles including alternative fuel vehicles;
(B) optimizing the number of vehicles in the agency fleet; and
(C) reducing, if the agency operates a fleet of at least 20 motor vehicles, the agency fleet's total consumption of petroleum products by a minimum of 2 percent annually through the end of fiscal year 2020, relative to a baseline of fiscal year 2005.

(b) Improve water use efficiency and management by:

(i) reducing potable water consumption intensity by 2 percent annually through fiscal year 2020, or 26 percent by the end of fiscal year 2020, relative to a baseline of the agency's water consumption in fiscal year 2007, by implementing water management strategies including water-efficient and low-flow fixtures and efficient cooling towers;
(ii) reducing agency industrial, landscaping, and agricultural water consumption by 2 percent annually or 20 percent by the end of fiscal year 2020 relative to a baseline of the agency's industrial, landscaping, and agricultural water consumption in fiscal year 2010;
(iii) consistent with State law, identifying, promoting, and implementing water reuse strategies that reduce potable water consumption; and
(iv) implementing and achieving the objectives identified in the stormwater management guidance referenced in section 14 of this order.

(c) Implement high performance sustainable Federal building design, construction, operation and management, maintenance, and deconstruction including by:

(i) managing existing building systems to reduce the consumption of energy, water, and materials, and identifying alternatives to renovation that reduce existing assets' deferred maintenance costs;
(ii) when adding assets to the agency's real property inventory, identifying opportunities to consolidate and dispose of existing assets, optimize the performance of the agency's real-property portfolio, and reduce associated environmental impacts; and
(iii) ensuring that rehabilitation of federally owned historic buildings utilizes best practices and technologies in retrofitting to promote long-term viability of the buildings.

(d) Advance sustainable acquisition to ensure that 95 percent of new contract actions including task and delivery orders, for products and services with the exception of acquisition of weapon systems, are energy efficient (Energy Star or Federal Energy Management Program (FEMP) designated), water-efficient, biobased, environmentally preferable (e.g., Electronic Product Environmental Assessment Tool (EPEAT) certified), non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives, where such products and services meet agency performance requirements.

(e) Promote electronics stewardship by:

(i) ensuring procurement preference for EPEAT-registered electronic products;
(ii) establishing and implementing policies to enable power management, duplex printing, and other energy-efficient or environmentally preferable features on all eligible agency electronic products;
(iii) employing environmentally sound practices with respect to the agency's disposition of all agency excess or surplus electronic products;
(iv) ensuring the procurement of Energy Star and FEMP designated electronic equipment; and
(v) implementing best management practices for energy-efficient management of servers and Federal data centers.

The full text of this EO can be accessed at http://edocket.access.gpo.gov/2009/pdf/E9-24518.pdf.

Section 3 References

Links to external web sites provided in this document may be useful or interesting and are being provided consistent with the intended purpose of this guidance document. EPA cannot attest to the accuracy of information provided by any linked site. Providing links to a non-EPA web site does not constitute an endorsement by EPA or any of its employees of the sponsors of the site or the information or products provided on the site. Also, be aware that the privacy protection provided on the epa.gov domain (see Privacy and Security Notice) may not be available at the external link.

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4. Energy Efficiency Related Federal Programs

The federal government has initiated a number of programs to promote energy efficiency. This chapter summarizes the major programs offered by DOE, EPA and GSA, as well as 2009 American Recovery and Reinvestment Act programs. 309 Reviewers may be able to highlight energy efficiency opportunities provided by these programs that may have been overlooked.

A summary of voluntary energy efficiency (and climate change) related federal and state programs are provided on EPA's website: http://yosemite.epa.gov/gw/StatePolicyActions.nsf/VolProg?OpenView&count=1000. More than 150 programs are listed.

4.1 Federal Energy Management Program

The DOE Office of Energy Efficiency and Renewable Energy (EERE) manages the Federal Energy Management Program (FEMP), one of ten EERE programs dedicated to supporting efficient and renewable energy technologies. FEMP concentrates the federal government's influence as the largest energy consumer in the U.S. to promote energy efficiency and the use of renewable energy resources at federal sites. The program has also published guidance for agencies, with several documents available under each of the following topics; see DOE (2009a):

- General Guidance for Facilities
- Advanced Metering
- Energy-Efficient Products
- Fleet Management
- Sustainable Building Design and Operation
- Water Efficiency
- Renewable Energy Technologies

The program's services are broadly divided into project transaction services, applied technology services, and decision support services, as described below. The following information on program details is consolidated from the FEMP web site (DOE 2006a).

FEMP Project Transaction Services

FEMP supports federal agencies through coordinating financing assistance for energy efficiency and renewable energy projects. Alternative financing tools include:

- ***Energy Savings Performance Contracts (ESPCs)*** ESPCs allow federal agencies to accomplish energy savings projects without up-front capital costs and without special Congressional appropriations. An ESPC is a partnership between a federal agency and an

energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the federal facility and identifies improvements to save energy. In consultation with the agency, the ESCO designs and constructs a project that meets the agency's needs and arranges the necessary financing. The ESCO guarantees that the improvements will generate energy cost savings sufficient to pay for the project over the term of the contract. After the contract ends, all additional cost savings accrue to the agency. Contract terms up to 25 years are allowed.

- ***Utility Energy Services Contracts (UESCs)*** Federal agencies can enter into utility energy service contracts (UESCs) to implement energy improvements at their facilities. With a UESC, the utility typically arranges financing to cover the capital costs of the project. Then the utility is repaid over the contract term from the cost savings generated by the energy efficiency measures. Agencies can implement energy improvements with no initial capital investment, the net cost to the agency is minimal, and the agency saves time and resources by using the one-stop shopping provided by the utility. The *Energy Policy Act* of 1992 authorizes and encourages federal agencies to participate in utility energy efficiency programs offered by utilities and by other program administrators (such as state agencies). These programs range from equipment rebates (that is, utility incentives) to delivery of a complete turnkey project.

- ***Energy Efficiency and Demand Response Programs*** Most states have energy incentive programs that help offset energy costs while promoting energy efficiency and renewable energy technologies. These programs include:

    - Energy Efficiency and Renewable Energy Programs:
        - Public purpose programs administered by utilities, state agencies, or other third parties and paid for by utility ratepayers, typically through a non-bypassable system benefits charge that is instituted as part of restructuring legislation or rules. The term "non-bypassable" means that full responsibility for a distribution fee cannot be bypassed by a customer switching fuels. A system benefits charge is designed to fund certain "public benefits" that are placed at risk in a more competitive industry. These benefits include assistance for low-income consumers, renewable energy research and development, and energy efficiency.
        - Utility programs administered by the local utility and paid for by utility ratepayers through their bundled rates.
        - Programs sponsored by state agencies that are designed to promote energy efficiency and renewable energy and that are usually funded out of general tax revenues.
    - Demand Response/Load Management Programs, which are programs that provide incentives to curtail demand during peak energy usage periods in response to system reliability or market conditions.

FEMP researches these programs on a state-by-state basis to help agencies meet their energy management goals. FEMP has compiled data on the energy efficiency and renewable energy funds and demand response programs available in each of the 50 states and the District of Columbia; see DOE (2009b).

With assistance from FEMP, the federal government's commitment to improving agency energy efficiency has accelerated and grown in recent years. ESPCs under development are now in excess of $1 billion dollars for the first time in the program's history. The current value of the project pipeline is over three times the size that it was in February 2007, and continues to grow.

FEMP Applied Technology Services

FEMP lends considerable research and market experience to help federal agencies deploy technology projects, including:

- ***High-Performance Building Design, Operation, and Maintenance*** FEMP helps agencies create and implement sustainable design, operation, and maintenance practices that incorporate energy efficiency, renewable energy, and water conservation technologies. These practices span new construction, renovation, and commissioning projects. FEMP services in this area include energy audits, operations and maintenance assessments, laboratory design protocols, new technology reports, advanced metering, and guidance for purchasing energy-efficient products and renewable energy technologies. One program example is FEMP's Laboratories for the 21st Century (Labs21) partnership with the EPA, which reduces federal laboratory energy use by $18 million annually.

- ***Renewable Energy Technology Deployment*** FEMP assists federal agencies in developing and implementing solar, wind, biomass, and geothermal energy sources to meet energy management regulations and goals.

- ***Energy-Efficient Product Procurement*** FEMP provides energy efficiency requirements, guidance, and cost calculators that help agencies offset energy consumption costs through energy-efficient product implementation. Federal buyers are required by the *Energy Policy Act* of 2005 to purchase products that are ENERGY STAR®-qualified or FEMP-designated for energy efficiency and low standby power. These products are in the upper 25% of energy efficiency in their class.

- ***Managing Energy-Efficient / Alternative Fuel Vehicles*** FEMP provides guidance and assistance on implementing and managing energy-efficient and alternative-fuel vehicle fleets. This includes helping federal agencies meet new fleet management mandates, such as recent requirements for agencies to reduce petroleum consumption by 2% per year through fiscal year (FY) 2015 relative to a FY 2005 baseline and to increase alternative fuel use by 10% per year relative to the previous year. EISA 2007 (Section 141) defined low GHG-emitting vehicles as AFVs for the purposes of compliance with federal mandates.

FEMP Decision Support Services

FEMP assists federal agencies with guidance, outreach, and training programs that include:

- ***Energy Legislation and Regulation Compliance*** EO 13423 established energy efficiency goals for federal agencies, including a 30% reduction in energy intensity, a significant

increase in the use of new renewable energy resources, and a 16% reduction in water consumption by fiscal year 2015. The *Energy Independence and Security Act* of 2007 codified much of EO 13423 into statute (see Section 3.4). FEMP analyzes federal legislation to help agencies comply with energy management requirements. This assistance is delivered through interagency coordination, guidance documents, facility reporting requirements, and fleet reporting requirements.

- ***Education and Training on Energy Efficiency and Renewable Energy*** Federal agencies learn to implement energy-saving strategies, gain recognition for outstanding achievements, and keep current on the government's progress in meeting energy management goals through FEMP training, services, and outreach activities. FEMP education, training, and outreach programs include online news, ongoing training and events, awards, and outreach.

FEMP at DOE Facilities: Transformational Energy Action Management (TEAM)

At its own facilities, DOE uses the TEAM Initiative, which seeks to attain the following specific goals (DOE 2009c):

1. Reduce energy consumption by 30% and water consumption by 16% in all DOE facilities.
2. Acquire at least 7.5% of all energy from renewable sources.
3. Build alternative fueling stations on all sites by 2008, and replace all conventional fuel vehicles in the DOE fleet with alternative fuel vehicles by 2010.
4. Attain a Leadership in Energy and Environmental Design (LEED®) Gold standard on all new buildings and on all buildings that go through major renovations.
5. Attain a LEED® Gold standard on 15% of all current buildings by the end of fiscal year 2015.
6. Give preference to bio-based, environmentally-friendly sources of energy and water, while reducing the use of hazardous and toxic chemicals and managing the production of waste.
7. Develop best-practice models for the use of third-party financing for energy saving projects.
8. Improve the energy efficiency of all data centers by 10% by 2011.

From 1978 through FY 2007, DOE used the Departmental Energy Management Program (DEMP) to help rank retrofit projects, provide financial and technical support, offer counsel for leveraging appropriated funds with private sector financing, and ensure compliance with executive orders and legislation (DOE 2006b). As of FY 2008, energy management at DOE was integrated with the FEMP.

4.2 EPA Programs

Combined Heat and Power Partnership

Combined heat and power (CHP) is a proven technology that utilizes indigenous heat in buildings to generate electricity and heat either sequentially or simultaneously. In a single,

integrated system, CHP utilizes one fuel source (such as natural gas, biomass, biogas, coal, waste heat or oil) to produce both electricity and heat, thereby saving the energy that would have been necessary to produce them separately. While a CHP system consists of a number of individual components (such as heat engine, generator, heat recovery, and electrical interconnection), the type of heat engine equipment that drives the overall system, known as the prime mover, typically identifies the type of CHP system. Prime movers can include reciprocating engines, combustion or gas turbines, steam turbines, micro-turbines, and fuel cells. They are capable of burning numerous fuel types.

Utilizing CHP for at least a portion of the electric load avoids off-site power generation and the resultant significant losses realized from the production, transmission and distribution of traditional power sources. CHP provides reliable power that increases production, delivery and usage efficiencies. Because electric generation in the US contributes significantly to the emissions of air pollutants and GHG (responsible for 41% of the energy-related CO2 emissions), heightened focus has been placed on improving fuel conversion efficiencies and reducing these emissions (EIA 2009). CHP provides a unique opportunity to dramatically impact these efficiencies (up to 80% efficiencies when compared to separate heat and electricity production).

The CHP Partnership (CHPP) was established in 2001 to promote the potential energy, environmental and economic benefits of shifting traditional centralized, electric-only generation to more distributed generation of both electricity and heat. CHPP is a voluntary program aimed at heightening the awareness of the environmental, economic, and energy benefits associated with the various applications of this technology. This awareness is raised by a cadre of outreach and analytical activities including:

- *Project Assistance* including on-line qualification tools that assist facility owners/operators to assess the potential for CHP at their site (CHP Emissions Calculator), up-to-date lists of state and federal incentives for CHP, as well as information on state policies and favorable utility rates for CHP projects;
- *Technical Assistance-- Level One Feasibility Studies* determine preliminary technical and economic compatibility such as system sizing based on anticipated thermal and electric loads, and estimated turnkey costs associated with the system including equipment, construction, utility interconnection, implementation, as well as operation and maintenance costs;
- *Technical Assistance-- Level Two Feasibility Studies* is an Investment Grade Feasibility Study that produces detailed and verifiable analyses to determine technical and economic viability, replacing assumptions made in Level One analyses with actual electrical, mechanical and structural data as well as project economic analyses including utility rate analyses, life-cycle costs analyses, and operation and maintenance pricing estimates. These analyses produce verified data to identify optimal CHP system configuration and sizing, appropriate thermal applications and economic operating strategies;
- *Market Analyses* to assess potential for CHP in a variety of market sectors and applications;
- *Education and Outreach* via website (www.epa.gov/chp), webinars, conferences and meetings, fact sheets and other documentation, as well as partnership meetings; and

- *Public Recognition* via the ENERGY STAR CHP Awards provided to CHPP Partners who have achieved exemplary reductions in energy usage and emissions utilizing CHP technology.

Partners represent a cross-section of the industry including CHP manufacturers, developers, end-users, as well as non-profit and local government entities. For further information, visit: www.epa.gov/chp (EPA 2008a).

Green Power Partnership

Green power is electricity produced from a subset of renewable resources, such as solar, wind, geothermal, biomass, and low-impact hydropower (EPA 2009a). EPA's Green Power Partnership is a voluntary program that supports the organizational procurement of green power by offering expert advice, technical support, tools, and resources. The program can help an organization lower the transaction costs of buying green power, reduce its carbon footprint, and communicate its leadership to key stakeholders. To join, an organization must submit a Partnership Agreement and complete a qualifying green power purchase within six months of joining the program. After joining, the organization is required to report their green power purchase information on a yearly basis to EPA. For more information, visit www.epa.gov/greenpower.

ENERGY STAR

ENERGY STAR (EPA 2009b) is a joint EPA/DOE program designed to identify and promote energy-efficient products, including office equipment, major appliances, lighting, home electronics, new homes, and commercial and industrial buildings. Together with the complementary DOE-managed FEMP energy-efficient product designation, ENERGY STAR guides federal agencies in procuring energy-efficient products and services (see Section 5.1, Appliances and Equipment).

EPA also uses the ENERGY STAR program to support programs that improve energy use at water utilities. Water efficiency and energy efficiency are closely linked, as water requires a significant amount of energy input for treatment, pumping, heating, and process uses (EPA 2009c).

SmartWay Transport Partnership

The SmartWay Transport Partnership is an EPA program designed to reduce GHG emissions and promote low carbon use and efficiency in the freight transportation system. SmartWay provides metrics to identify more efficient transportation choices by mode and by individual transportation provider. EPA also uses the SmartWay program to reduce CO_2, NOx, and PM emissions from the transportation system. EPA also identifies the cleanest, most efficient passenger vehicles and heavy commercial tractor-trailers, with its SmartWay designation (EPA 2009f).

The SmartWay Transport Partnership is responsible for defining low GHG-emitting vehicles. Annually, the SmartWay program assesses the overall model year fleet's GHG performance to define low GHG-emitting vehicles. A list of vehicles by make and model that meet EPA's definition is found on the Federal Vehicle Acquisition page of EPA's Green Vehicle Guide found at www.epa.gov/greenvehicles.

National Action Plan for Energy Efficiency

Since 2005, EPA and DOE have sponsored the National Action Plan for Energy Efficiency. The Action Plan's Leadership Group of more than 60 leading gas and electric utilities, state utility regulators and energy offices, energy users, environmental groups, and others released five consensus policy recommendations in 2005. The five key policy recommendations of the Action Plan include recognizing energy efficiency as a high-priority energy resource, committing to the implementation of cost-effective energy over the long-term, communicating efficiency benefits and opportunities, providing sufficient and stable program funding, and modifying ratemaking policies to align utility and customer incentives with investments in energy efficiency (EPA 2009d). Over 120 organizations have endorsed these recommendations and made commitments to energy efficiency through the Action Plan.

National Action Plan Vision for 2025: A Framework for Change

The Plan was updated in 2008 with the National Action Plan Vision for 2025: A Framework for Change (EPA 2008b), which outlined ten specific implementation goals to achieve the major recommendations in the original action plan, as follows:

1. Establish cost-effective energy efficiency as a high-priority resource.
2. Develop processes to align utility and other program administrator incentives such that efficiency and supply resources are on a level playing field.
3. Establish cost-effectiveness tests.
4. Establish evaluation, measurement, and verification mechanisms.
5. Establish effective energy efficiency delivery mechanisms.
6. Develop state policies to ensure robust energy efficiency practices.
7. Align customer pricing and incentives to encourage investment in energy efficiency.
8. Establish state of the art billing systems.
9. Implement state of the art efficiency information sharing and delivery systems.
10. Implement advanced technologies.

The Action Plan offers a comprenhensive suite of best practices-based guides, papers and tools. In addition, EPA and DOE offer technical assistance to states working to advance the Action Plan Vision.

4.3 GSA Programs

Energy Management Support and Services Department

Through the General Services Administration's (GSA's) Facilities Maintenance and Management multiple award schedule contracts, the Energy Management Support and Services Department of GSA offers federal agencies access to services including (GSA 2009a):

- Energy management planning and strategies
- Training on energy management
- Metering services
- Energy program support services
- Building commissioning services
- Energy audit services ranging from cursory to comprehensive
- Resource efficiency management
- Innovations in energy
- Water conservation

Energy efficient buildings certification programs such as Leadership in Energy and Environmental Design (LEED®) (see Section 5.4) may be included in all these services.

GSA Energy Division

The GSA Energy Division offers information and programs to reduce federal utility costs and increase energy efficiency (GSA 2009b). The Center provides:

- Web-based access to energy use data, to policy information, and to programs and contacts for purchasing utilities/energy and energy-related services.
- The Public Utilities program, which develops contracting vehicles for agencies to procure utility services at the lowest cost.
- The Natural Gas Acquisition program, a new program to provide federal facilities with natural gas supply and supply management.
- The Energy and Water Management program, which is responsible for the utility use and cost data in all GSA buildings nationwide.

More information on GSA's energy contract information and guidebooks can be found at their website: www.gsa.gov/energy.

Office of Federal High-Performance Green Buildings

In 2008, GSA established an Office of Federal High-Performance Green Buildings to coordinate green building information and activities within the federal government (GSA 2008). The office works in conjunction with DOE, which has a similar responsibility for commercial buildings. The duties of the office, as outlined in EISA 2007, are to establish a Federal Green Building Advisory Committee; identify and develop technical standards for high-performance green buildings; establish green practices for operations and maintenance of facilities; provide information and disseminate research results; identify practices and tools to achieve high-performance green buildings through budgeting and contracting; identify opportunities to demonstrate innovative technologies and concepts; and, identify incentives to encourage high-

performance green buildings and technologies. The website for the office is: http://www.fedcenter.gov/programs/greenbuildings/.

4.4 Energy Audits/Surveys

As noted in Section 4.3, contractor-provided energy audit/survey services are available to federal agencies through a GSA multiple award schedule. The goal of an energy audit is usually to identify opportunities to conserve energy without affecting the building or system's intended function and desired status. GSA states that "Energy audits may range from cursory to comprehensive. At a minimum, audits shall include data collection, data analysis, benchmarking with tools such as Energy Star, and written recommendations of suggested upgrades of electrical and mechanical infrastructure, including their impact on energy consumption and pollution" (GSA 2009c).

There are many resources and no standard protocols for energy audits. An example protocol for industrial facilities was published by Bonneville Power Administration, whose *Industrial Audit Guidebook* (BPA 2004) for performing walk-through energy audits. For homeowners, both DOE and EPA provide information on do-it-yourself and professional energy audits on their websites (DOE 2009d, EPA 2009e).

4.5 American Recovery and Reinvestment Act (ARRA) programs

The 2009 American Recovery and Reinvestment Act (ARRA) provides substantial funding to improve energy efficiency at federal government facilities and within vehicle fleets, as well as research into energy efficiency technologies and improvements to the nation's energy transmission, distribution and production systems. Much of the funding provided in the legislation will be distributed through existing federal programs. For example, 20% of EPA's Clean Water and Drinking Water State Revolving Fund (SRF) grants will be spent on energy efficiency and other green projects. SRF grants provide low-cost financing to communities for the construction, repair, and rehabilitation of drinking water systems and wastewater collection and treatment facilities. SRF programs conduct an environmental review process with similarities to the NEPA process. More information on the program can be found at: http://www.epa.gov/safewater/dwsrf/index.html.

Section 4 References

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5. General Federal Energy Uses And Related Federal Partnership Programs

Chapter 5 summarizes general federal energy uses by topic. Each subsection is divided into a summary of the topic, related federal partnership programs, and review considerations for 309 Reviewers. Information on energy efficiency related federal partnership programs is consolidated from EPA and DOE websites.

5.1 Appliances and Equipment

5.1.a Summary

Appliance and equipment purchases can be a significant source of energy savings for federal agencies. Purchases of appliance and equipment are guided by several pieces of federal legislation. EPAct 2005 amended NECPA by requiring federal agencies to procure ENERGY STAR-qualified or FEMP-designated products, unless the head of the agency determines in writing that a statutory exception applies, or the product is for combat or combat-related missions. NECPA was further amended by EISA 2007 to clarify that the procurement requirement applies to the procurement of a product in a category covered by the ENERGY STAR program or the FEMP program (see Chapter 3).

ENERGY STAR is a joint EPA/DOE program designed to identify and promote energy-efficient products, including office equipment, major appliances, lighting, home electronics, new homes, and commercial and industrial buildings. FEMP is a complementary DOE program that provides an energy-efficient product designation. Products designated under ENERGY STAR and FEMP are in the upper 25% of energy efficiency in their class.

Further, each federal agency is required to incorporate into the specifications of all procurements involving energy-consuming products and systems, and into the factors for evaluation of offers received for such procurements, criteria for energy efficiency that is consistent with the criteria used for rating ENERGY STAR qualified products and for rating FEMP designated products.

FAR Subpart 23.2 prescribes procedures for acquiring products and services that are energy- and water-efficient and use renewable energy technology. To meet FAR requirements, the GSA offers products designated as energy efficient under ENERGY STAR, FEMP and the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT). These three major programs guide federal government procurement of energy-efficient products and services.

EPAct 2005 also includes new federal minimum energy efficiency standards on 16 residential and commercial products (Table 5-1).

Table 5-1 Commercial Energy Efficient Product Standards Set in the Energy Policy Act of 2005

Product	Effective Date*	Standard
Residential		
Ceiling fan light kits	2007	Packaged with ENERGY STAR v2 screw-in CFLs or meet ENERGY STAR Residential Light Fixture v4 specification. Standard for specialized products determined by DOE by 1/1/07.
Dehumidifiers	Oct. 2007	ENERGY STAR vI specification
Compact fluorescent lamps	2006	ENERGY STAR v2 specification
Torchiere lighting fixtures	2006	190 W maximum
Commercial		
Air-conditioners and heat pumps (unitary equipment 24Q-760k Btulhr)	2010	Capacity — Minimum EER (ACIHP) 65-134k Btuh — 11.2/11.0 135-239 — 11.0/10.6 240-759 — 10.0/9.5 (EER 0.2 lower for units with integrated heating that is not electric resistance) For HP, also 3.2 COP@47°F except 3.3 for 65-134k Btuh equipment.
Clothes washers	2007	MEF at least 1.26 and WF no more than 9.5
Distribution transformers (low voltage)	2007	Meet NEMA standard TP-I-2002
Exit signs	2006	ENERGY STAR v2 specification
Fluorescent lamp ballasts (F34 and F96ES types)	2009	Closes loophole in DOE regulations so that these ballasts will be electronic, like other covered ballasts.
Ice-makers (cube type, 50-2,500 Ibs/day)	2010	California Energy Commission (CEC) standard, which is almost identical to Consortium for Energy Efficiency (CEE) Tier 1.
Mercury vapor lamp ballasts	2008	Bans sale of mercury vapor lamp ballasts
Pedestrian signals	2006	ENERGY STAR v.1.1 specification
Pre-rinse spray valves	2006	Maximum 1.6 gallon/minute
Refrigerators and freezers (packaged)	2010	California Energy Commission (CEC) standard, which is almost identical to ENERGY STAR specification

Table 5-1 Commercial Energy Efficient Product Standards Set in the Energy Policy Act of 2005		
Product	**Effective Date***	**Standard**
Traffic signals	2006	ENERGY STAR v1.1 specification
Unit heaters	Aug. 2008	Must be equipped with an intermittent ignition device and have power venting or an automatic flue damper

**Effective in January unless otherwise specified.*

Table 5-2 Additional Commercial Energy Efficient Product Standards to be Set by DOE Rulemaking	
Product	**Rulemaking Completion Date**
Ceiling fan light kits (niche products candelabra base, halogen, etc.)	1/1/2007
Battery chargers	8/8/2008
External power supplies	8/8/2008
Commercial refrigeration - ice-cream freezers, packaged units without doors, remote condensation equipment	1/1/2009
Refrigerated beverage vending machines	8/8/2009
Dehumidifiers (revised standard)	10/1/2009
Commercial clothes washers (revised standards)	1/1/2010 and 1/1/2015
Commercial packaged refrigerators & freezers (revised standards)	1/1/2013 and 3 years after revised standard takes effect
Ice-makers (revised standards)	1/1/2015 and 5 years after revised standard takes effect

EPAct 2005 required a DOE rulemaking to set standards for nine additional product categories (Table 5-2). In April 2009, DOE published a final rule to promote federal procurement of energy-efficient products. The final rule establishes guidelines for federal agencies in procuring ENERGY STAR qualified and FEMP-designated products: http://edocket.access.gpo.gov/2009/E9-5459.htm.

The guidelines apply to general specifications, project specifications, and construction, renovation and service contracts that involve the procurement of covered products. Agencies should consider this requirement to apply to:

- Design, design/build, renovation, retrofit and services contracts;
- Facility maintenance and operations contracts;
- Energy savings performance contracts and utility energy service contracts; and
- If applicable, lease agreements for buildings or equipment, including build-to-lease contracts, such as those used to implement the Military Housing Privatization Initiative.

Agencies are also encouraged to use ENERGY STAR and FEMP designated products in new service contracts and other existing service contracts as they are recompeted and should, to the extent possible, incorporate such requirements and preferences into existing contracts as they are modified or extended through the exercise of contract options.

A list of product categories, which contain ENERGY STAR qualified and FEMP designed products, is located at: http://www.eere.energy.gov/femp/pdfs/eep_productfactsheet.pdf (*FEMP Energy-Efficient, Water Conserving & Low Standby Power Product Types Product Fact Sheet*). To identify actual products that are ENERGY STAR rated, potential purchasers can go to the ENERGY STAR website: http://www.energystar.gov/products. Currently, there is no companion list of FEMP designated products, but the FEMP specifications for energy efficiency products are located at: http://www.eere.energy.gov/femp/procurement/eep_requirements.html. Life-cycle cost calculators for many of the ENERGY STAR qualified and FEMP designated products can be accessed at: http://www.eere.energy.gov/femp/procurement/eep_eccalculators.html (DOE 2009).

EO 13514 (2009) establishes the goal that 95 percent of new contract actions including task and delivery orders, for products and services with the exception of acquisition of weapon systems, will be ENERGY STAR, FEMP, and/or EPEAT certified (as well as water-efficient, biobased, non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives), where such products and services meet agency performance requirements. The EO also directs federal agencies to: 1) establish and implement policies to enable power management, duplex printing, and other energy-efficient or environmentally preferable features on all eligible agency electronic products, 2) employ environmentally sound practices with respect to the agency's disposition of all agency excess or surplus electronic products, and 3) implement best management practices for energy-efficient management of servers and Federal data centers.

EO 13221 requires that federal agencies purchase products with low standby power (see Chapter 3). Standby power is electricity used by appliances and equipment while they are switched off or not performing their primary function. Most products with an external power supply, remote control, continuous display (including an LED), or charges batteries will draw power continuously. Standby mode is different than "sleep" mode. All ENERGY STAR labeled computers, monitors, copiers, printers, and fax machines will switch into a low-power "sleep" mode after a specified period of non-use. When needed, these devices return automatically to the active mode (displaying an image, copying, receiving a fax etc.) after a brief delay. Standby mode is different because the user—not the machine itself—has switched off the device and must manually turn it back on. Power use in the standby mode is usually much lower than in the sleep mode.

EO 13221 directs agencies, when feasible and cost effective, to purchase products that use 1 watt of power or less during standby mode. Both ENERGY STAR and FEMP have specifications for products that meet this standby power guideline (FEMP 2002).

The 1997 *Federal ENERGY STAR Buildings Program Partnership Memorandum of Understanding* between DOE, EPA, and DoD requires the military to survey energy-efficient building upgrades, and implement them to the maximum extent practicable using the full range

of commercially available building technologies.
http://www.afcesa.af.mil/shared/media/document/AFD-070613-038.doc

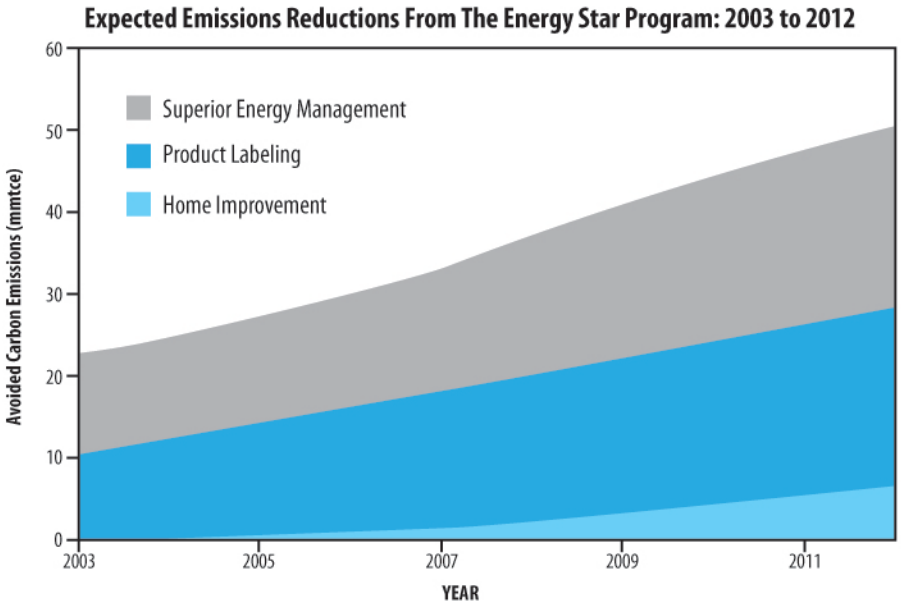
5.1.b Related Federal Partnership Programs

ENERGY STAR

EPA introduced the ENERGY STAR program in 1992 as a way to reduce greenhouse gas emissions through greater energy efficiency. Today, in partnership with DOE, the ENERGY STAR program defines energy efficiency standards for a variety of products and services, and qualifies specific products as meeting the ENERGY STAR standards (DOE 2009e). EPA oversees the ENERGY STAR Program and manages ENERGY STAR efforts to make existing homes, new homes and commercial and industrial buildings more energy efficient. The goals of the program are to provide businesses and consumers with objective information and tools to make informed decisions about equipment purchases; and to assist in reducing business investment risks for implementing energy efficiency projects. The program also provides a market-based mechanism to reduce greenhouse gas emissions.

One of the best known energy efficiency federal programs, ENERGY STAR labeling is recognized by more than 75% of the American public. Figure 5-1 shows the expected emissions reductions from the ENERGY STAR program through 2012.

Figure 5-1



Source: (DOE 2003).

The program was first introduced as a voluntary labeling program designed to identify and promote energy-efficient computers to reduce greenhouse gas emissions. The ENERGY STAR label has since been expanded to cover more than 60 product categories, including appliances, office equipment, lighting, heating and cooling equipment, home electronics, and new homes and

commercial and industrial buildings (DOE 2009e). Together with the complementary DOE Federal Energy Management Program (FEMP) energy-efficient product designation, ENERGY STAR guides federal government procurement of energy-efficient products and services.

ENERGY STAR products can be found on the ENERGY STAR website: http://www.energystar.gov. EPA routinely monitors the use of the label on products in the market place to ensure that it is used to identify only qualified products. EPA also selectively tests products to ensure that products said to qualify for the label do indeed qualify. The performance specifications for ENERGY STAR are updated as market conditions change.

EPA's ENERGY STAR Portfolio Manager is a national energy performance rating system for buildings. It functions as an interactive energy management tool that can be used to track and assess energy and water consumption. The types of buildings eligible to receive a rating include:

- Bank/Financial Institutions
- Courthouses
- Hospitals (acute care and children's)
- Hotels
- K-12 Schools
- Medical Offices
- Municipal Wastewater Treatment Plants
- Offices
- Residence Halls/Dormitories
- Retail Stores
- Supermarkets
- Warehouses (refrigerated and non-refrigerated)

Statistically representative models are used to compare each building against buildings with similar characteristics from a national survey conducted by DOE's Energy Information Administration (EIA). This national survey, known as the Commercial Building Energy Consumption Survey (CBECS), is conducted every four years, and gathers data on building characteristics and energy use from thousands of buildings across the United States. A rating of 75 indicates that the building performs better than 75% of all similar buildings nationwide. Buildings rating 75 or greater may qualify for the ENERGY STAR label. This rating can be used in key market transactions such as the assessment of a building's asset value or the lease price of building space.

For those buildings that are not eligible to receive a rating, EPA has created a list of reference energy performance targets (EPA 2009b). These are based on average energy use calculated across different types of buildings. These energy performance targets are not normalized for climate nor adjusted for activities which may affect energy use. All targets are expressed in energy use intensity and are derived from the Commercial Buildings Energy Consumption Survey.

EPA also uses the ENERGY STAR program to support programs that improve energy use at water utilities. Water efficiency and energy efficiency are closely linked, as water requires a significant amount of energy input for treatment, pumping, heating and process uses. ENERGY STAR recently added wastewater and drinking water treatment facilities to the suite of facilities addressed under its Portfolio Manager. The Portfolio Manager can help a utility to set targets for investment priorities, verify efficiency improvements, and calculate its carbon footprint.

ENERGY STAR also offers tools and information for residential homeowners and new home builders. Residential homeowners can get assistance in performing a home energy audit, and retrofitting their property for greater energy efficiency. The Home Performance with Energy Star Program offers a comprehensive, whole-house approach to improving energy efficiency, ventilation, Indoor Air Quality and comfort at home (http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_hpwes). New home builders can have properties qualified with the ENERGY STAR label. ENERGY STAR labeled new homes are at least 15% more energy efficient than homes built to the 2004 International Residential Code (IRC), and include additional energy-saving features that typically make them 20–30% more efficient than standard homes. Approximately 12% of U.S. new housing starts in 2007 were qualified as ENERGY STAR homes (EPA 2008). The U.S. Army Corps of Engineers (USACE) builds all new Army homes as ENERGY STAR properties. EPA also supports HUD in its integration of ENERGY STAR into home energy programs and other affordable housing efforts (EPA 2003).

Electronic Product Environmental Assessment Tool (EPEAT)

The Electronic Product Environmental Assessment Tool (EPEAT) is a system that evaluates electronic products (mainly computers and computer products) based on 51 environmental criteria related to the reduction/elimination of environmentally sensitive materials, materials selection, design for and management of product end of life, product longevity/life cycle extension, energy conservation, corporate performance and packaging. There are 23 required criteria and 28 optional criteria. To qualify for registration as an EPEAT product, the product must conform to all the required criteria. Table 5-3 lists the titles of each of the 51 criteria. Detailed summaries of the each of the criteria can be found at: http://www.epeat.net/Docs/Summary%20of%20EPEAT%20Criteria.pdf.

EPEAT evaluates electronic products according to three tiers of environmental performance – Bronze, Silver and Gold. To be EPEAT registered at the Bronze level, products must meet all the 51 required criteria. Products may then achieve a silver or gold level EPEAT rating by meeting all required criteria plus at least 50% or 75%, respectively, of the optional criteria that apply to the product type being registered.

EPEAT is managed and operated by staff from the Green Electronics Council (GEC). The GEC is part of the 501(c)(3) non-profit International Sustainable Development Foundation. The EPEAT system was originally developed in a two-year multi-stakeholder process that was facilitated by the Zero Waste Alliance on a EPA grant. The criteria listed in EPEAT are contained in environmental performance standard IEEE 1680. IEEE is an international organization (originally an acronym for Institute of Electrical and Electronics Engineers, Inc.) that provides technical and professional information. IEEE 1680 includes a criterion (4.5.1.1) that requires that every EPEAT registered product meet the current version of the applicable ENERGY STAR standard.

The EPEAT Registry web site: http://www.epeat.net/ lists products in conformance with EPEAT criteria. On the website, purchasers can use the EPEAT database to search for EPEAT registered products and review product-specific information, and can use the Electronics Environmental

Benefits Calculator to measure the environmental benefits of purchasing EPEAT registered products vs. conventional ones.

Table 5-3: List of Environmental Criteria Required for Registration as an EPEAT Product

4.1	**Reduction/elimination of environmentally sensitive materials**	
	R	4.1.1.1 Compliance with provisions of European RoHS Directive upon its effective date
	O	4.1.2.1 Elimination of intentionally added cadmium
	R	4.1.3.1 Reporting on amount of mercury used in light sources (mg)
	O	4.1.3.2 Low threshold for amount of mercury used in light sources
	O	4.1.3.3 Elimination of intentionally added mercury used in light sources
	O	4.1.4.1 Elimination of intentionally added lead in certain applications
	O	4.1.5.1 Elimination of intentionally added hexavalent chromium
	R	4.1.6.1 Elimination of intentionally added SCCP flame retardants and plasticizers in certain applications
	O	4.1.6.2 Large plastic parts free of certain flame retardants classified under European Council Directive 67/548/EEC
	O	4.1.7.1 Batteries free of lead, cadmium and mercury
	O	4.1.8.1 Large plastic parts free of PVC
4.2	**Materials selection**	
	R	4.2.1.1 Declaration of postconsumer recycled plastic content (%)
	O	4.2.1.2 Minimum content of postconsumer recycled plastic
	O	4.2.1.3 Higher content of postconsumer recycled plastic
	R	4.2.2.1 Declaration of renewable/bio-based plastic materials content (%)
	O	4.2.2.2 Minimum content of renewable/bio-based plastic material
	R	4.2.3.1 Declaration of product weight (lbs)
4.3	**Design for end of life**	
	R	4.3.1.1 Identification of materials with special handling needs
	R	4.3.1.2 Elimination of paints or coatings that are not compatible with recycling or reuse
	R	4.3.1.3 Easy disassembly of external enclosure
	R	4.3.1.4 Marking of plastic components
	R	4.3.1.5 Identification and removal of components containing hazardous materials
	O	4.3.1.6 Reduced number of plastic material types
	O	4.3.1.7 Molded/glued in metal eliminated or removable
	R	4.3.1.8 Minimum 65 percent reusable/recyclable
	O	4.3.1.9 Minimum 90 percent reusable/recyclable
	O	4.3.2.1 Manual separation of plastics
	O	4.3.2.2 Marking of plastics
4.4	**Product longevity/life cycle extension**	
	R	4.4.1.1 Availability of additional three year warranty or service agreement
	R	4.4.2.1 Upgradeable with common tools
	O	4.4.2.2 Modular design
	O	4.4.3.1 Availability of replacement parts
4.5	**Energy conservation**	

Table 5-3: List of Environmental Criteria Required for Registration as an EPEAT Product		
	R 4.5.1.1	ENERGY STAR®
	O 4.5.1.2	Early adoption of new ENERGY STAR® specification
	O 4.5.2.1	Renewable energy accessory available
	O 4.5.2.2	Renewable energy accessory standard
4.6	**End of life management**	
	R 4.6.1.1	Provision of product take-back service
	O 4.6.1.2	Auditing of recycling vendors
	R 4.6.2.1	Provision of rechargeable battery take-back service
4.7	**Corporate performance**	
	R 4.7.1.1	Demonstration of corporate environmental policy consistent with ISO 14001
	R 4.7.2.1	Self-certified environmental management system for design and manufacturing organizations
	O 4.7.2.2	Third-party certified environmental management system for design and manufacturing organizations
	R 4.7.3.1	Corporate report consistent with Performance Track or GRI
	O 4.7.3.2	Corporate report based on GRI
4.8	**Packaging**	
	R 4.8.1.1	Reduction/elimination of intentionally added toxics in packaging
	R 4.8.2.1	Separable packing materials
	O 4.8.2.2	Packaging 90% recyclable and plastics labeled
	R 4.8.3.1	Declaration of recycled content in packaging
	O 4.8.3.2	Minimum postconsumer content guidelines
	O 4.8.4.1	Provision of take-back program for packaging
	O 4.8.5.1	Documentation of reusable packaging

FEMP Energy Efficiency Product designation

DOE's FEMP helps federal purchasers identify products in the top 25th percentile of efficiency for their class and that use minimal standby power in accordance with EO 13221. The FEMP designation is useful for products that have yet to be assigned an ENERGY STAR certification. The FEMP also provides model language for specifying efficient products in capital projects and service contracts, and gives buyers advice on procurement decisions. FEMP publishes a series of Purchasing Specifications for Energy-Efficient Products: www.eere.energy.gov/femp/procurement/. For each product, FEMP identifies the efficiency levels needed to meet the requirements for procurement of energy-efficient products. Whenever there is a significant change in the market, FEMP revises the energy efficiency levels to a market-leading threshold and updates the specifications. To assist federal buyers in identifying qualifying products, the FEMP Procurement Web site provides links to lists of models that meet the required efficiency levels. These lists identify efficient models by brand name and model number (EPA 2009a).

Appliance and Commercial Equipment Standards Program (Equipment Standards and Analysis)

Over the past two decades, Congress, in various energy efficiency related legislation, set the initial federal energy efficiency standards for many major appliances and established schedules for DOE to review and revise these standards (DOE 2009a). The Appliance and Commercial Equipment Standards Program (Equipment Standards and Analysis), which operates within the Building Technologies Program (see Table 5-3), maintains and updates these standards and the testing procedures for appliances and equipment referenced in federal legislation. DOE is required to upgrade standards to the maximum level of energy efficiency that is technically feasible and economically justified.

The program carries out activities in three areas: 1) maintaining federal mandatory energy conservation standards to achieve national consistency; 2) outlining test procedures that manufacturers must use to certify that their appliances meet the standards (test procedures are typically maintained by industry associations and incorporated by reference into DOE rules); and 3) labeling commercial equipment, a shared responsibility with the Federal Trade Commission (FTC).

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

State Energy Program

The DOE State Energy Program (SEP) funds states to carry out their own energy efficiency and renewable energy programs. The states can tailor projects to meet individual needs, economic conditions, climate, and renewable resources. DOE technical assistance helps states develop projects and accelerate the adoption of energy efficiency technologies. DOE investment in SEP is augmented by funding from state and local governments and the private sector. SEP also directs funding from EERE technology programs to the states for specific projects to advance the adoption of emerging energy technologies (DOE 2009c).

Rural Energy for America Program

The Rural Energy for America (REAP) program was created through the 2008 Farm Bill, and provides financial assistance to agricultural producers and rural small businesses to purchase renewable energy systems or make energy efficiency improvements (e.g., replacing equipment

with more efficient units). The program is administered by USDA and more information can be found at: http://www.rurdev.usda.gov/ND/documents/REAP-Final.pdf.

5.1.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

Reviewers should look for whether discussions that address federal agency actions related to general specifications, project specifications, and construction, renovation and service contracts that involve the procurement of energy-consuming products and systems are in compliance with EPAct 2005, EISA 2007, EO 13423, EO 13514 and EO 13221:

- EPAct 2005 requires that, whenever an agency procures an energy-consuming product, they must purchase an ENERGY STAR or Federal Energy Management Program (FEMP)-designated product, unless it would not be cost-effective (including consideration of energy savings) or is not reasonably available.
- EISA 2007 sets federal mandatory efficiency standards for lighting and residential and commercial appliance equipment, including dishwashers, dehumidifiers, residential boilers, electric motors, incandescent lamps, external power supplies, walk-in coolers and freezers, residential refrigerators and clothes washers.
- EO 13423 states that at least 95 percent of all purchased electronic products must meet EPEAT standards; facilitates ENERGY STAR features on 100 percent of computers and monitors; and requires that 100 percent of electronic products must be reused, donated, sold, or recycled using environmentally sound management practices.
- EO 13514 sets the goal that 95 percent of new federal agency contract actions including task and delivery orders, for products and services with the exception of acquisition of weapon systems, will be ENERGY STAR, FEMP, and/or EPEAT certified.
- EO 13221 requires that a federal agency, each time "it purchases commercially available, off-the-shelf products that use external standby power devices, or that contain an internal standby power function, shall purchase products that use no more than one watt in their standby power consuming mode." If unavailable, products with the lowest standby power wattage while in their standby power consuming mode shall be purchased.

If a product to be purchased is not covered by an ENERGY STAR or FEMP rating, agencies could seek to purchase products in the top 25% of efficiency for their class to maximize energy efficiency. Military installations should be in compliance with the *Federal ENERGY STAR Buildings Program Partnership MOU* (http://www.wbdg.org/ccb/DOD/UDG/fedstar.pdf).

Section 5.1 References

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5.2 Facility Siting

5.2.a Summary

Separating land uses, spreading development out, and providing little or no public transportation or safe walking and biking routes foster greater reliance on motor vehicles. As development grows more dispersed, employees and residents must drive further to reach their destinations, leading to more and longer vehicle trips and greater energy expenditures. Smart Growth is an effort to create development that minimizes air and water pollution, encourage brownfields clean-up and reuse, and preserve natural lands. The EPA Smart Growth Network developed a set of ten basic principles to describe smart growth:

- Mix land uses.
- Take advantage of compact building design.
- Create a range of housing opportunities and choices.
- Create walkable neighborhoods.
- Foster distinctive, attractive communities with a strong sense of place.
- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Strengthen and direct development towards existing communities.
- Provide a variety of transportation choices.
- Make development decisions predictable, fair, and cost effective.
- Encourage community and stakeholder collaboration in development decisions (EPA 2009).

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. EPA provides information on brownfield redevelopment at: http://www.epa.gov/brownfields/index.html.

Transit oriented development, closely related to smart growth, is creation of compact, walkable communities centered around high quality train systems, and collector support transit systems including trolleys, streetcars, light rail, and buses. Pedestrian/bicycle access and the use of mass transportation have multiplier impacts on energy efficiency. Pedestrian/mass transit trips not only conserve energy by reducing automobile use, but also reduce the heat island effect. The heat island effect occurs when an area (i.e., city or industrial site) has consistently higher temperatures than surrounding areas because of a greater retention of heat by buildings, concrete, and asphalt. The heat island effect is worsened by additional paving for highway capacity expansion, local facility access streets and large parking lots. The greater the heat island effect, the more energy must be expended on cooling. In addition, increasing automobile capacity through highway expansion or new alignment is itself a significant energy expenditure. EPA's Smart Growth website provides information on transit oriented development: http://www.epa.gov/smartgrowth/index.htm.

The United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®) Green Building Rating System is a third-party certification program and a

nationally accepted benchmark for the design, construction and operation of high performance green buildings (see Section 5.4 for more information on LEED®). The LEED® for Neighborhood Development Rating System integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design. LEED® certification provides independent, third-party verification that a development's location and design meet accepted high levels of environmentally responsible, sustainable development. LEED® for Neighborhood Development is a collaboration among USGBC, the Congress for the New Urbanism and the Natural Resources Defense Council. The pilot program began in the summer of 2007.

In order to reduce the impacts of urban sprawl, or unplanned, uncontrolled spreading of urban development into areas outside of the metropolitan region, and create more livable communities, LEED® for Neighborhood Development communities are:

- Locations that are closer to existing town and city center;
- Areas with good transit access;
- Infill sites;
- Previously developed sites; and/or
- Sites adjacent to existing development (USGBC 2009)

The LEED® Green Building Rating System for New Construction and Major Renovations (http://www.usgbc.org/ShowFile.aspx?DocumentID=1095) provides guidance on site selection, brownfield redevelopment, community connectivity and transportation access. The rating system covers six major topics:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation and Design Process

Credits are received in each of the various areas. For example, sites would receive a credit as sustainable in the area of development density for constructing or renovating a building on a previously developed site and in a community with a minimum density of 60,000 square feet per acre net. Net density is calculated by dividing the total number of dwelling units existing in a community by the net area in acres.

In evaluating potential facility sites, distance to transmission lines and/or other energy sources should be considered. It may be possible to construct renewable energy projects at certain facility sites that have existing transmission capacity nearby, particularly brownfields, abandoned mines, federal Superfund sites, non-Federal Superfund sites, or other disturbed areas where previous energy use occurred and infrastructure may already exist. The EPA initiative, RE-Powering America's Lands - Siting Renewable Energy on Current and Formerly Contaminated Land and Mine Sites, contains a database of disturbed sites (http://epa.gov/renewableenergyland/index.htm), including the renewable energy potential of

these sites. In addition, EPA's Renewable Energy Interactive Mapping Tool (http://epa.gov/renewableenergyland/mapping_tool.htm) makes it possible to view EPA's information about siting renewable energy on contaminated land and mining sites, alongside other information contained in Google Earth. It enables the user to search by renewable energy type or by contaminated land type. In addition to the site's location, it also provides: site name and identification information; EPA Region and program managing the site; a link to the site's cleanup status information; and specific acreage and renewable energy resource information.

After the site is selected, the form and orientation of the building should be considered for natural energy efficient design. Climatic factors, including solar radiation and wind, impact the optimal location of the facility on the site. Specific needs will vary depending on the region of the U.S., but the basic concerns are to maximize shading and ventilation during the cooling season and to maximize solar radiation and minimize wind exposure during the heating season. The building orientation can be adjusted according the position of the sun or prevailing winds, while the building form can be designed to incorporate overhangs or other horizontal or vertical shading elements (LDNR 2009).

5.2.b Related Federal Partnership Programs

See Section 5.4 Buildings.

5.2.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

Reviewers may recommend that potential facility sites be evaluated on according to smart growth principles, such as whether a site contains a mix of land uses, a walkable neighborhood, fosters a sense of place, and preserves open space by directing development toward existing communities. The site selection process should encourage community and stakeholder collaboration in development decisions.

Reviewers may want to become familiar with the LEED® for Neighborhood Development Rating System and the LEED® for New Construction and Major Renovations Rating System, during their review of a federal facility's site selection. Both rating systems provide checklists of criteria that include energy efficiency concerns. Reviewers may want to recommend that a facility achieve LEED® certification (see Section 5.4, Buildings).

Reviewers should consider whether the alternatives analysis has included the consideration of brownfield and/or infill development sites, where feasible and practicable. In addition to other environmental benefits, both brownfield and infill development may be in closer proximity to existing transportation infrastructure than undeveloped land, and will therefore reduce transportation energy use when the site becomes operational. The adaptive reuse of existing

structures (e.g., historic school buildings) should be considered to reduce the energy used to create and transport new building materials, and demolish/dispose of old structures. 309 Reviewer suggestions related to historic properties should be consistent with the requirements of the National Historic Preservation Act (NHPA), Section 106.

When evaluating potential facility sites, reviewers should consider whether the alternatives analysis has included the consideration of sites with existing transmission capacity nearby, including disturbed sites where previous energy use occurred and infrastructure may already exist.

For each site considered, the alternatives analysis should discuss the availability of and distance to public transportation for employees. Full consideration should be given to sites with bus, rail and pedestrian routes within a 1/2 mile radius. Sites that have pedestrian/bicycle access will conserve energy, e.g., school buildings located within the community will reduce the need for buses. For industrial facilities, the distance to waste disposal should be considered.

The alternatives should include a discussion of how the facility orientation on the site, from a geothermal, wind, solar heat and shading perspective, will maximize and minimize heat gain, according to seasonal and regional needs.

Section 5.2 References

Louisiana Department of Natural Resources. 2009. *Solar Orientation.* Online. http://dnr.louisiana.gov/sec/execdiv/techasmt/ecep/drafting/d/d.htm. Accessed March 2009.

U.S. Environmental Protection Agency. 2009. Online. http://www.epa.gov/brownfields/index.html. Accessed March 2009.

U.S. Environmental Protection Agency. 2009. Smart Growth. Online. http://www.epa.gov/smartgrowth/index.htm. Accessed March 2009.

U.S. Green Building Council. 2009. LEED® for Neighborhood Development. Online. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148 Accessed March 2009.

U.S. Green Building Council. 2005. *New Construction and Major Renovations.* Online. http://www.usgbc.org/ShowFile.aspx?DocumentID=1095 Accessed March 2009.

5.3 Construction

5.3.a Summary

Green construction seeks to minimize the impacts of construction activities on the environment. This is achieved through using the principles of sustainable design and materials selection, recycling and reuse, and energy efficiency (EPA 2009). The EPA report, *Potential for Reducing Greenhouse Gas Emissions in the Construction Sector*, describes opportunities for incorporating green construction principles, and improving energy efficiency in construction (EPA 2009b). Opportunities for improving energy efficiency include:

- Fuel efficiency/Equipment idling
- Electricity use
- Equipment maintenance
- Equipment selection
- Materials recycling

To achieve improvements in fuel efficiency, contractors can make changes ranging from reducing equipment idling time and improving maintenance to replacing or repowering equipment. Unnecessary idling occurs when trucks wait for extended periods of time to load or unload, or when equipment that is not being used is left on, such as to maintain heating or cooling for driver comfort. Reduced idling reduces fuel consumption. Regulations restricting idling were in place in almost half the states as of July 2008. These regulations vary by state, county, or city, but typically restrict idling to 3-10 minutes and do not distinguish between gasoline or diesel vehicles. Most of these regulations are relatively new and many have associated information campaigns to increase awareness (EPA 2009b).

Two examples of maintenance activities that can improve energy efficiency are:

- Forklift maintenance: A recent study of forklift maintenance estimated that 50% of forklifts were not properly maintained, each of which could be wasting more than 400 gallons of propane annually.

- Improperly inflated tires and poor wheel alignment, which can adversely affect fuel efficiency of small trucks by 3-4%. Under-inflated tires increase the tires' rolling resistance, and increased rolling resistance requires more fuel to move the vehicle (EPA 2009b).

Identifying the proper equipment for a task can also provide fuel savings. Truck engines too large for an application burn more fuel by adding unnecessary weight. Longer term fuel saving solutions involve replacing older, less fuel efficient equipment with newer models. Through advances in engine technology, reduced equipment weight, and even some hybrid technologies, equipment manufacturers are offering more fuel efficient new equipment (EPA 2009b).

Reducing delivery vehicle trips to the construction site also results in lower fuel consumption. For large projects, creating a consolidated location for materials delivery may reduce energy use.

Switching transportation methods may also reduce fuel consumption. EPA's Freight Logistics and Energy Tracking (FLEET) Performance Model can help quantify the fuel use of various shipment methods. Buying locally produced lumber and other materials can reduce fuel use in transporting materials (EPA 2009b).

To improve energy efficiency, construction plans should include preserving existing vegetative growth and replanting trees that must be removed with native species. This will reduce the heat island effect (see Section 5.4, Buildings).

Wastes from new construction, renovation, and demolition projects generate about 25% of the total U.S. solid waste volume (EPA 2009b). Debris can contain asphalt, concrete, wood, dry wall gypsum, shingles, plastics, glass, and other materials. Data on reuse rates are very uncertain. Rough estimates are that only about 15% of building construction and demolition debris (C&D) is recycled, whereas up to 80% of roadway C&D (asphalt and concrete primarily) is recycled/reused. However, states vary widely in terms of roadway C&D reuse rates. When materials are reused or recycled, energy use is avoided. In addition, virgin resources are conserved and virgin mining impacts are avoided.

Debris can be difficult to segregate into reusable components. Processing is often necessary, but less often with roadway debris. Recycled asphalt pavement (RAP) is usually derived from the demolition of degraded roadways and parking lots. This material can often be processed and reused in new pavement. Both original asphalt binder and aggregate can be recycled. When just the top pavement course layer of asphalt is removed for reclamation it is called "mining." When both the pavement and base courses are reclaimed and reused in place, it is referred to as "full depth reclamation." Construction materials such as cardboard, metal, glass gypsum board and acoustical ceiling tile can be easily recycled. Some opportunities for materials recycling or reuse in construction supplies are cited in Table 5-4.

Table 5-4
Secondary Use Markets for Various Construction and Demolition Materials

Material	Generating Activity	Recycling Markets	Percent	Substitutes for:
Concrete	Building construction Building demolition Infrastructure demolition	Road Base	68%	Virgin aggregate
		Aggregate for new asphalt hot-mixes	9%	Virgin aggregate
		General Fill	7%	Virgin aggregate
		Other	7%	Virgin aggregate
		Aggregate for concrete mix	6%	Virgin aggregate
		Rip-rap	3%	Virgin aggregate
		TOTAL	100%	
Asphalt Pavement	Road, parking lot and driveway maintenance	Aggregate for new asphalt hot-mixes	66%	Virgin aggregate
		Sub-Base for paved roads	33%	Virgin aggregate

Table 5-4
Secondary Use Markets for Various Construction and Demolition Materials

Material	Generating Activity	Recycling Markets	Percent	Substitutes for:
	and reconstruction	TOTAL	100%	
Wood	Building deconstruction	Recovered lumber remilled into flooring	Not Available	Virgin lumber
	Building construction	Mulch and compost		Scrap wood from sawmills, logging debris
		Animal bedding		
	Building demolition	Feed stock for particle board		
	Land clearing	Biomass fuel for boilers		
Gypsum wallboard	Building construction	Gypsum wallboard	Not available	Virgin gypsum
	Building demolition	Portland cement		Virgin gypsum
		Land application in agriculture		Virgin gypsum
Asphalt shingles	Building construction	Asphalt mixes road base	Not available	Virgin aggregate Virgin bitumen
	Building renovation	Cement kilns		Virgin aggregate
	Building demolition			

Note: With the exception of concrete and asphalt debris, which have well-established recycling markets, data are not well documented concerning the quantities of wood, wallboard, and asphalt shingles used in various applications.
Source: U.S. EPA, *Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials – Construction and Demolition debris.* Draft in progress

Construction projects should not only recycle materials, but make use of recycled materials as well. Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process (USGBC 2009). Examples of materials with high pre-consumer and post-consumer content include: structural steel and decking, aluminum roof and wall panels, acoustical ceiling tile, certain carpeting goods, gypsum board and some ceramic tiles.

Scrap tires are another material that can be reused in construction projects. 300 million scrap tires are disposed in the U.S. every year. Reuse saves the embodied energy and impacts of tires and reduces the need for petroleum. It also saves dramatically on landfill space. Scrap tires can be reprocessed into chips or granules (crumbs), which can be used as:

- Rubberized Chip Seal – A thin top-coat sealant composed of binder and a relatively fine aggregate to rehabilitate a worn asphalt road.
- Rubberized Asphalt Concrete – A new asphalt layer on top of a worn pavement surface placed to rehabilitate a worn road.
- Rubberized Asphalt Concrete – New asphalt road construction.
- "Open-Graded" Rubberized Asphalt – A different type of asphalt similar to pervious concrete that promotes stormwater drainage to the side of the roadway and provides non-skid properties.
- Tire Derived Aggregrate – Structural fill in embankments, behind retaining and sound walls, in trenches; soil stabilization, including roadway collapse repair; and as vibration abatement along train tracks or near roadways.

Benefits of recycled tire materials can include increased strength, quieter roadway surfaces, vibration control, and increased water penetration control.

EPA offers several software tools that provide information on the recycled content of common construction materials:

- EPA Recycled Content Tool (ReCon): http://www.epa.gov/climatechange/wycd/waste/calculators/ReCon_home.html.
- EPA Waste Reduction Model (WaRM): http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html.
- National Institute for Standards and Technology (NIST) Building for Environmental and Economic Sustainability (BEES): http://www.bfrl.nist.gov/oae/software/bees/.

While these tools were designed to compare greenhouse gas impacts and overall environmental performance, they are useful for determining energy efficiency as well. They attempt to provide full life-cycle estimates of the material (acquisition, manufacture, transportation, installation, use, and waste management).

The LEED® Green Building Rating System for New Construction and Major Renovations (http://www.usgbc.org/ShowFile.aspx?DocumentID=1095) contains energy efficiency related criteria for new construction (see Section 5.4 for more information on LEED®). To score one point under the LEED® system, projects must meet the following requirements. Additional points are awarded for exceeding these requirements:

- Recycle and/or salvage at least 50% of non-hazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled. Excavated soil and land-clearing debris do not contribute to this credit.

- Use salvaged, refurbished or reused materials such that the sum of these materials constitutes at least 5%, based on cost, of the total value of materials on the project.

- Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project. Recycled content shall be defined in accordance with ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling). Reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it is excluded.

- Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% (based on cost) of the total materials value. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

- Use rapidly renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 2.5% of the total value of all building materials and products used in the project, based on cost (USGBC 2009).

5.3.b Related Federal Partnership Programs

Clean Construction USA

Clean Construction USA, part of the National Clean Diesel Campaign (NCDC), is an EPA program designed to promote the reduction of diesel emissions from construction equipment and vehicles. Many of the strategies for emissions reduction also improve energy efficiency. Information can be found at: http://www.epa.gov/otaq/diesel/construction/index.htm.

See Section 5.4, Buildings, for additional construction-related programs.

5.3.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

To minimize/mitigate the energy impact of construction activities, Reviewers should encourage federal agencies to adhere to energy efficient practices described above, including: 1) reducing idling by training drivers to turn off equipment and providing fuel-efficient auxiliary power for the heat or air conditioning; 2) using fuel efficient and size appropriate equipment that is properly maintained; and 3) minimizing delivery vehicle trips.

Reviewers may want to recommend that projects be certified using LEED® for New Construction and Major Renovations. Regardless of whether projects are LEED® certified, construction plans should document waste reduction efforts, including using recycling construction materials with significant post-consumer content, salvaged, refurbished or reused materials, rapidly renewable materials, and locally produced or on-site materials (e.g., lumber) when feasible. Reviewers may want to recommend using one of the recycled content software tools described above for material selection.

Section 5.3 References

U.S. Environmental Protection Agency. 2009. Sector Strategies Program: Construction. Online. http://www.epa.gov/ispd/construction/index.html. Accessed March 2009.

U.S. Environmental Protection Agency. February 2009b. *Potential for Reducing Greenhouse Gas Emissions in the Construction Sector*. Online. http://www.epa.gov/ispd/pdf/construction-sector-report.pdf. Accessed March 2009.

U.S. Green Building Council. 2009. LEED® for New Construction and Major Renovations. Online. http://www.usgbc.org/ShowFile.aspx?DocumentID=1095 Accessed March 2009.

5.4 Buildings

5.4.a Summary

In the United States, the best performing buildings use 75 percent less energy than the worst performing buildings. This difference cannot be accounted for by particular technologies, climate, building size, or building age (EPA 2003). The opportunity exists to significantly improve building energy efficiency by retrofitting existing buildings, and incorporating energy efficient design into new construction.

The Federal government owns approximately 445,000 buildings with total floor space of over 3.0 billion square feet, in addition to leasing an additional 57,000 buildings comprising 374 million square feet of floor space (DOE 2006). These include a large variety of building types, including offices, retail shops, hospitals, schools, housing, warehouse/storage, airports, highway rest stops, visitor centers, border inspection facilities.

Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding

In January 2006, 19 federal agencies signed a Memorandum of Understanding (MOU) to commit to federal leadership in the design, construction, and operation of high-performance and sustainable buildings. The MOU directs agencies completing new construction to reduce the energy cost budget by 30% compared to the baseline building performance rating per the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) Standard 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential. For major renovations, agencies should reduce the energy cost budget by 20 percent below pre-renovations 2003 baseline. The five guiding principles of the MOU address:

- Employing integrated design;
- Optimizing energy performance;
- Protecting and conserving water;
- Enhancing indoor environmental quality; and
- Reducing the environmental impact of materials.

The MOU can be found at: http://www.energystar.gov/ia/business/Guiding_Principles.pdf.

EO 13423 made permanent the elements of the MOU, and as directed in the EO, the Interagency Sustainability Working Group developed technical guidance in December 2008 to assist agencies in meeting the EO goals and statutory requirements. The guidance (*High Performance and Sustainable Buildings Guidance*) can be found at: http://www.wbdg.org/pdfs/hpsb_guidance.pdf and frequently asked questions based on the comment resolution summary of the draft guidance can be found at: http://www.wbdg.org/pdfs/hpsb_guidance_comment_sum.pdf.

The Buildings and Thermal Systems Center at the National Renewable Energy Laboratory provides another information source on high performance buildings.

Lessons Learned from Case Studies of Six High-Performance Buildings (2006)

The Center studied six buildings in detail over four years to understand best practices for design, construction, operation, and evaluation of low energy commercial buildings. The case studies are available at: http://www.nrel.gov/docs/fy06osti/37542.pdf.

Greening Federal Facilities: An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers (Second Edition)

DOE, in partnership with DoD, GSA, EPA and other federal agencies, authored a comprehensive resource guide designed to increase energy and resource efficiency, cut waste, and improve the performance of Federal buildings and facilities. The guide is intended primarily for Federal facility managers, and is available at: http://www.nrel.gov/docs/fy01osti/29267.pdf.

Federal Building Codes and Standards

DOE works in partnership with the International Code Council (ICC), the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), the Illuminating Engineering Society of North America, and other code user groups to develop stringent and easy-to-understand building energy codes (see Building Energy Codes program, Section 5.4.b).

Federal building codes and standards apply to buildings constructed or used by any Federal agency that is not legally subject to state or local building codes. Different federal codes exist for low rise residential buildings built before and after January 3, 2007, and for commercial and multi-family high rise buildings.

The current Federal code for low-rise residential building energy efficiency for which design for construction began on or after January 3, 2007 can be obtained in the Code of Federal Regulations in Title 10, Part 435, subpart A, sections 435.1 through 435.8 (http://www.gpoaccess.gov/cfr/retrieve.html). The new rule requires that new Federal residential low-rise (3 stories or less above grade) buildings achieve an energy consumption level of at least 30% below those set by the 2004 International Energy Conservation Code (IECC), if cost effective. The Federal agencies procuring new housing are responsible for complying with this code, including determining levels of energy efficiency that can be achieved cost effectively (DOE 2009i).

The Federal code for energy efficiency in low-rise residential buildings for which design for construction began before January 3, 2007 can be obtained at the same link as for the new rule above but in sections 435.300 through 435.306 (Subpart C). The requirements in the old Federal residential code are determined on a project-specific basis using software called COSTSAFR (Conservation Optimization Standard for Savings in Federal Residences). Federal staff must run COSTSAFR to generate a project-specific point system that accounts for factors such as local fuel costs, climate, and construction costs for energy efficiency measures. The point system is completed by the building designer and contains options for energy efficiency measures such as insulation levels. The designer selects energy efficiency measures and obtains the points for

these selections. The more points, the more energy efficient the design. A sufficient number of points must be obtained to achieve compliance with the code (DOE 2009i).

The current Federal code for energy efficiency in new commercial and multi-family high-rise residential buildings (10 CFR Part 434), can be obtained at: http://www.access.gpo.gov/nara/cfr/waisidx_05/10cfr434_05.html. This code was issued on January 1, 2002, and is based on ASHRAE/IES Standard 90.1-1989, and all addenda. It became effective on October 8, 2001. Software to assist in complying with the envelope and lighting portions of the Federal code can be downloaded at: http://www.energycodes.gov/federal/exist_fedcom.stm. Overall, the lighting requirements in the new Federal code are more stringent than those in Standard 90.1-1989.

To implement the envelope requirements for the new Federal commercial building code, individual Alternate Component Package (ACP) tables (http://www.energycodes.gov/federal/acp_tables.stm) have been developed for 234 different locations around the United States and abroad. The tables are given in terms of both shading coefficient (SCx) and solar heat gain coefficient (SHGC) and inch-pound (IP) and System International (SI) units.

DOE also provides software through its Building Energy Code program to help practitioners ensure code compliance for residential and commercial buildings: http://www.energycodes.gov/.

Building Energy Efficiency Rating Systems

Leadership in Energy and Environmental Design (LEED®)

The GSA supports the use of the USGBC LEED® Green Building Rating System, a third-party certification program for the design, construction and operation of high performance green buildings. Within LEED®, there are rating systems for:

- New Construction
- Existing Buildings: Operations and Maintenance
- Commercial Interiors
- Core and Shell
- Laboratories
- Schools
- Retail
- Healthcare
- Homes
- Neighborhood Development (pilot)

LEED® offers four levels of certification: Certified, Silver, Gold and Platinum. LEED® Version 2.2 was replaced with Version 3.0 in April 2009. Version 3.0 improved on earlier versions by aligning credit weighting and scoring between the different LEED® rating systems, and basing scoring on a 100-point scale. With revised credit weightings, LEED® now awards more points for strategies that will have greater positive impacts on energy efficiency and CO_2 reductions.

The new version also awards points to projects for addressing regional environmental issues (e.g., in urban Florida, decreased reliance on fossil fuels, reuse of existing building stock, decreased reliance on insufficient municipal wastewater plants, and utilization of abundant local sunshine). These regional issues were identified through USGBC's regional councils, chapters and affiliates (USGBC 2009).

Notably, some Federal agencies have established specific energy efficiency and building performance goals (in LEED®) for applicable projects (see Table 5-5).

Table 5-5
Federal Agency LEED® Goals for Facility Design

Agency	LEED® Goal	Goal Notes
DOE	Gold	Required for new construction and major renovations > $5M; Gold preference for leases
EPA	Gold	Required for new construction > 20,000 sq.ft.
NASA	Silver	Silver is required, strive for Gold
State	Silver	Required by 2009 for major assets, new embassies for next 10 yrs
Defense – Army	Silver	Vertical construction required; LEED® for homes adopted
Commerce – National Weather Service	Silver	"Shall strive for minimum of LEED® Silver"
Agriculture – Forest Service	Silver	Required for offices, visitor centers, research facilities >2500 sq. ft.
USDA	Silver	Design for LEED® Silver
GSA	Certified	Required for new construction/major renovation, Silver recommended (some regions require)
Defense – Navy	Certified	Required now, potentially Silver in near future
Health & Human Services	Certified	LEED® or Green Globes for projects > $3M
Defense –Pentagon	Certified	Long-term goal of LEED® rating for entire Pentagon
Smithsonian	Certified	New construction/major renovation to aim for a minimum of LEED® certification
Defense –Air Force	Certified	Required by FY '09, self-certified
Interior – National Park Service	NA	Incorporating LEED® criteria for new construction and existing buildings, not required

Source: (DOE 2008).

The EPA ENERGY STAR program also offers a certification for buildings. It functions as an interactive energy management tool that can be used to track and assess energy and water consumption (see Section 5.1, Appliances and Equipment). While buildings can be dual certified using both LEED® and ENERGY STAR, the LEED® system references ENERGY STAR requirements within its rating criteria.

The Green Building Initiative's Green Globes program is another popular third party rating and review system for sustainable design practice that contains energy efficiency related criteria. The Green Globes rating system uses a 1000 point base total scoring system and has four levels of certification with a 4 Globes rating being the highest level of certification. The Green Globes system, which originated in Great Britain, is not as widely used in the United States as LEED®.

Whole Building Design

The whole building design concept departs from the typical construction approach by forming the entire building stakeholder community into a team at the beginning of a project. The team examines project objectives, building materials, systems, and assemblies from various perspectives, and improves the final building product by integrating the components into a more energy efficient system. Lessons learned are compiled in reports and reference documents to be used by other members of the construction industry (Prowler and Vierra 2008).

The Whole Building Design Guide (WBDG) is a web-based portal providing government and industry practitioners with information on building-related guidance, criteria and technology from a 'whole buildings' perspective. The WBDG web site is offered by the National Institute of Building Sciences (NIBS) through funding support from the Department of Defense, Naval Facilities Engineering Command (NAVFAC) Engineering Innovation and Criteria Office, USACE, U.S. Air Force, GSA, Department of Veterans Affairs, National Aeronautics and Space Administration (NASA), and DOE, and the assistance of the Sustainable Buildings Industry Council (SBIC).

The Whole Building Design Guide website (http://www.wbdg.org/design/buildingtypes.php) provides extensive information on improving environmental performance for all building types. Design guidance is available by building type or use, including:

- Ammunition & Explosive Magazines
- Archives
- Aviation
- Community Services
- Educational Facilities
- Federal Courthouse
- Health Care Facilities
- Land Port of Entry
- Libraries
- Office Building
- Parking Facilities
- Research Facilities
- Warehouse

Guidance includes energy-efficiency techniques, emerging issues, and a list of relevant codes and standards. The Federal Green Construction Guide for Specifiers, available on the WBDG website (http://www.wbdg.org/design/greenspec_msl.php?s=001000) is a guidance document

that provides sample specification language to be inserted into project specifications as appropriate to a federal agency's environmental goals.

Design Guidelines for Specific Building Types

EnergySmart, part of the DOE Building Technologies Program (see Section 5.3) offers design guidelines specifically to improve energy efficiency at schools (*Advanced Energy Design Guide for K-12 School Buildings*, http://www1.eere.energy.gov/buildings/energysmartschools/design.html) and hospitals (*Advanced Energy Design Guide for Hospitals*, http://www1.eere.energy.gov/buildings/energysmarthospitals/). The ASHRAE-sponsored Energy Design Guides provide information for improving energy at K-12 School Buildings, Small Retail Buildings, Small Office Buildings, and Small Warehouses and Self-Storage Buildings. The guides are available at: http://www.ashrae.org/publications/page/1604.

Building Commissioning

Building commissioning is a project management practice that formalizes review of all project expectations for facilities and their systems during planning, design, construction, and occupancy phases. It is an umbrella process that seeks to improve energy efficiency and indoor air quality by uncovering deficiencies in design or installation using peer review, inspection and functional performance testing, and by delivering preventive maintenance plans, tailored operating manuals, and training procedures. ASHRAE defines commissioning as "…the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent… Commissioning begins with planning and includes design, construction, start-up, acceptance and training, and can be applied throughout the life of the building (WBDG 2008)."

Building commissioning is commonly used for major building systems, including electrical power and controls, HVAC, and building lighting and controls (and potentially for building envelopes). Recent case studies conducted in private sector facilities have shown that the building commissioning process can improve new building energy performance by 8% to 30%.

Currently, no building code requirements exist at a national level for building commissioning. However, GSA, NAVFAC, and the USACE have adopted formal requirements for commissioning of their construction projects. Fundamental building commissioning is also a prerequisite for obtaining certification using LEED® or Green Globes rating systems. LEED® and Green Globes require a comprehensive fundamental commissioning plan to cover the major building energy systems that must be developed by someone outside the design team prior to construction. A follow-up report must be filed after construction and prior to building occupancy noting corrective measures required. Many new facilities, such as clean rooms and data rooms with unique design challenges, are utilizing the commissioning process to achieve higher energy efficiency and indoor air quality (WBDG 2008).

The Whole Building Design guide recommends that projects employing the building commissioning process follow the procedure outlined in ASHRAE Guideline 0 – 2005

(http://specs4.ihserc.com/Results.aspx?prod=SPECS4&sess=426719263). This guideline does not focus on specific systems or assemblies, but presents a standard process that can be used to commission any building system. DOE also provides a resource guide, *Continuous Commissioning Guidebook for Federal Energy Managers (2002),* available at: http://www1.eere.energy.gov/femp/operations_maintenance/om_ccguide.html.

Life cycle costing

When selecting materials and components for buildings, designers can employ life cycle costing to maximize energy efficiency. The National Institute for Standards and Technology (NIST) Building for Environmental and Economic Sustainability (BEES) model (http://www.bfrl.nist.gov/oae/software/bees/) uses the life-cycle assessment approach specified in the ISO 14040 series of standards to measure the environmental performance of building products. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Environmental and economic performance are combined into an overall performance measure. BEES has been supported in part by the U.S. EPA Environmentally Preferable Purchasing (EPP) Program. The EPP program is charged with carrying out EO 13423 (See Chapter 3).

Building Envelope

The building envelope consists of all exterior components of a building. The building envelope concept seeks to improve the energy efficiency and thermal performance of materials for windows, doors, walls, roof and foundation materials, including how they work together as a system. To improve energy efficiency, building designers/managers can control heat loss and solar gain through windows and doors, provide better insulation and air barrier design. Air barriers are systems of materials used to control airflow in building enclosures. They typically completely enclose the air within a building. The physical properties which distinguish air barriers from other materials are the ability to resist air flow and air pressure (Lstiburek 2004). The National Institute for Standards and Technology provides recommendations to maximize the energy efficiency of air barriers (http://www.nist.gov/index.html).

The International Energy Conservation Code (IECC) and ASHRAE 90.1 provide guidance on energy efficient insulation levels, and door and window R values. Both of these codes govern minimum building envelope standards for commercial buildings. The IECC also covers window glazing sizes, configuration, and using glass with the proper attributes for optimum solar heat gain coefficients (SHGC) suitable for the climate region. Building siting and window placements can be tested and optimized by utilizing computerized energy modeling programs that input building orientation, building envelope thermal insulation values, heating and cooling energy loads, lighting and power loads for three or more seasons.

Indoor Air Quality

One potential risk associated with implementation of green building standards and energy efficiency measures is unintended indoor air quality impacts. For example, if buildings are sealed tightly, ventilation rates are reduced and re-circulated air is used, indoor pollutants coming from

building materials, furnishings, and occupant activities may be retained. Reduced drying of buildings can also result, which promotes moisture accumulation and mold growth problems. Green building and energy conservation strategies can avoid these problems through proper design. EPA's Indoor airPLUS is a comprehensive program that promotes professional best practices for minimizing IAQ problems (http://www.epa.gov/indoorairplus/). Specific indoor air quality measures for energy efficiency programs can include: a) radon testing and mitigation; b) whole-building and local exhaust ventilation systems per ASHRAE Standard 62.2; c) mold/moisture control measures; d) combustion safety and house pressure diagnostics; and e) integrated pest management.

Lighting

Energy consumption for all lighting in the United States is estimated to be about 22% of the total electricity generated in the country. More than half of the energy is consumed in the commercial sector, where lighting coincides with peak electrical demand and contributes to a building's internal heat generation, increasing air-conditioning load.
The conversion of electricity into useful light is one of the least efficient energy conversion processes in buildings today. Lighting accounts for 35-45% of an office building's energy use, and is a significant energy user in all types of buildings. Advanced lighting technologies can significantly improve the energy efficiency of lighting and reduce building energy consumption and costs (DOE 2009k).

High efficiency lighting alternatives exist for new construction and for retrofitting existing lighting systems. The California Energy Commission offers the following recommendations for increasing the energy efficiency of lighting systems:

- Advanced fluorescent lighting: In most interior spaces, facilities can replace or upgrade existing fixtures to include high-efficiency fluorescent lamps, electronic ballasts, custom designed reflectors, and appropriate lenses or louvers.

- High-intensity discharge lighting: In outdoor applications and in warehouses and indoor areas with ceilings over 15 feet, facilities can replace highly inefficient incandescent or mercury vapor lamps with metal halide and high-pressure sodium lamps. High-intensity discharge lamps generate high lighting output, use a fraction of the energy required for incandescent or mercury vapor equivalents, and have substantially longer lamp life than incandescents.

- Lighting controls: Simple controls can eliminate unnecessary lighting in the many facility areas that do not require continuous lighting. Occupancy sensors detect the presence of personnel within an area and turn lights on and off accordingly. Time switches that turn lighting systems on and off are useful for outdoor signs, security lighting, and corridors. Dimming systems take advantage of daylight to further reduce energy use and costs. Photocell controls provide easy, effective on/off switching of outdoor lighting. In addition, photocells can be combined with time switch controls for areas that don't require lighting all night.

- Maintenance: A program of regular cleaning, replacement, and maintenance of lamps and luminaries can significantly save energy. A typical lamp, as it reaches 80% of its useful life, produces 15-35% less light due to lamp degradation. Dust, dirt, and other materials on lamps, reflectors, and lenses can decrease lighting output by 30% or more. Photocells used to activate outdoor lights should also be cleaned regularly (CEC 2009).

The DOE Lighting Development and Research program provides information on high efficiency lighting. Mandatory federal building codes require high efficiency lighting and lighting controls in new construction. In addition, LEED® criteria include designing buildings with occupant controls for lighting, (e.g., task lighting).

To maximize daylight in the building interior, building designers can select office systems furniture with 54 inch panels or less that will allow natural daylight from the exterior walls to permeate into the building core and reduce artificial light during daylight hours. Designing light shelves and light colored or reflective surfaces near the building perimeter will also bounce the light further into the building space. The WBDG contains specifications for office systems furniture (including recycled material content): http://www.wbdg.org/design/greenspec_msl.php?s=125900.

Heating, Ventilation, and Air Conditioning (HVAC)

Underfloor HVAC Systems Traditional air conditioning uses overhead variable air volume (VAV), which supplies air through metal ductwork to boxes in the ceiling. The VAV boxes respond to space thermostats to provide cooling. Air is generally returned to the mechanical room through the space above the ceiling. This traditional system has two inefficiencies. First, because the air supply and return are located in the ceiling, some amount of air short cycles, or returns without having done any cooling work in the room. Second is the high cost for renovations after the building is occupied. With the cooling system located in the ceiling and constructed from sheet metal, renovations routinely require the energy intensive removal of ceiling systems and installation of new ductwork (Spinazzola 2005).

Underfloor HVAC systems supply air through floor air devices that are either manually adjusted or controlled automatically by thermostats. Air is generally returned through the ceiling. Underfloor HVAC is more efficient (no short cycling of air), provides more effective ventilation by introducing supply at the floor and returning it at the ceiling, and results in easier and less energy intensive renovations (Spinazzola 2005).

Integrated Energy Systems (IES) Integrated systems bring together gas-fired and electrically driven equipment to provide heating, cooling, dehumidification, and electrical service to commercial and public buildings. The three principal configurations are (1) hybrid chiller plants incorporating gas-fired and electrically driven chillers, (2) desiccant dehumidifiers using waste heat from combustion of natural gas to regenerate the desiccant, and (3) combined heating, cooling, and power systems (cogeneration) that include on-site electrical power generation with heating and cooling space conditioning and/or potable hot water production. System energy efficiency is increased significantly in these applications when waste heat from one component of the integrated system is used by a second component (e.g., waste heat from power generation

used to provide hot water for laundry facilities or for space heating, heat from engine-driven chiller used to regenerate desiccant in desiccant dehumidifier) (ORNL 2000).

Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source, such as natural gas, biomass, biogas, coal, waste heat, or oil. CHP is an IES that can be modified depending upon the needs of the energy end user. CHP requires less fuel to produce a given energy output, and avoids transmission and distribution losses that occur when electricity travels over power lines. CHP can greatly increase the facility's operational efficiency and decrease energy costs (EPA 2009a). On average, CHP facilities improve energy efficiency by up to 80% when compared to both heat and electricity generation. This dramatic energy savings potential significantly reduces carbon dioxide emissions as well as decreases operating costs and improves economic viability (See Chapter 4 for additional information on EPA's CHP Partnership).

Thermally activated technologies (TAT) are another IES which would typically be designed for smaller office buildings where packaged rather than custom designed units are better utilized. These technologies vary depending on the system used and are still being tested for commercial use (*TAT: Integrated Energy Systems Brief*, http://www.eere.energy.gov/de/pdfs/thermally_activated_ies_tech_brief.pdf). Current TAT designs may supplement up to 40% of power needs for a particular facility under optimum conditions.

Researchers at Oak Ridge National Laboratory (ORNL) evaluated various IES technologies, as well as efficiency concepts, based on actual performance testing from the ORNL IES Laboratory in a research paper: *Evaluation of Difference Efficiency Concepts of an Integrated Energy System*, http://www.ornl.gov/~webworks/cppr/y2001/pres/121706.pdf. The paper concludes that standard guidelines for efficiency calculations are needed for IES manufacturers and end users. At a minimum, manufacturers and users should indicate and/or be aware of the basis for efficiency calculations.

Other technologies that are less power dependent and re-emerging due to their energy efficiency include absorption chillers and desiccant humidifiers. Absorption chillers provide cooling by using a heat source (instead of mechanical energy) and converting the source into cooling. Detailed information on absorption chillers can be found at: http://www.newbuildings.org/downloads/guidelines/AbsorptionChillerGuideline.pdf.

Desiccant dehumidifiers rely on absorption media to provide evaporative cooling and dehumidification. Both absorption chillers and desiccant humidifiers are used occasionally when indoor air quality issues are a major concern and both use less power than their conventional counterparts.

Oak Ridge National Laboratory produced a report with detailed descriptions of various integrated systems, *Integrated Systems, DOE/EE 0234*, available at: http://www.ornl.gov/sci/femp/pdfs/FTA_IntSys.pdf.

Passive Cooling.

The term "heat island" describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C). Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality (EPA 2009b). More information is available at: http://www.epa.gov/heatisland.

The heat island effect can be reduced using four main strategies: 1) increasing tree and vegetative cover, 2) using cool pavements, 3) installing green roofs (also called "rooftop gardens" or "eco-roofs"), and 4) installing cool—mainly reflective—roofs.

Using shading devices or tall native trees around the parking and other paved areas, as well as using paving materials with a higher Solar Reflectance Index (SRI) (typically with an SRI at 30 and above) will reduce the heat island effect and subsequent need for additional energy use to cool the facility. Open grid paving is another technique that allows grass or plants to help reduce the heat island effect. More information on cool pavements can be found at: http://www.epa.gov/heatisland/mitigation/pavements.htm.

A green roof, or rooftop garden, is a vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F (50°C) warmer.

Green roofs can be installed on a wide range of buildings, from industrial facilities to private residences. They can be as simple as a 2-inch covering of hardy groundcover or as complex as a fully accessible park complete with trees (EPA 2009). More information can be found at: http://www.epa.gov/heatisland/mitigation/greenroofs.htm.

Energy-efficient cool roofing systems can reduce roof temperatures significantly during the summer, and thus reduce the energy requirements for air conditioning. A Cool Roofing Materials Database was compiled by the Berkeley Laboratory's Heat Island Project to assist with the selection of roofing materials which reflect, or otherwise reject, the sun's radiant energy, before it penetrates into the interior of the building. More information can be found at: http://eetd.lbl.gov/CoolRoof/ and http://www.epa.gov/heatisland/mitigation/coolroofs.htm.

Stormwater management

EISA 2007, Title IV, Subtitle C, Sec. 438, states, "The sponsor of any development or redevelopment project involving a federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." This

provision requires federal sites to achieve/maintain the predevelopment hydrology to the "maximum extent technically feasible."

To reduce the amount of energy required to construct and maintain stormwater management infrastructure, projects can manage water onsite by the use of site developed wetlands and "bioswales," vegetated buffers that slow water runoff and encourage infiltration. To comply with EISA 2007, projects larger than 5,000 square feet must retain a site's natural hydrology, but smaller projects can improve efficiency by adopting this goal as well. Porous paving and permeable pavements can also be used for paving where light traffic and automotive vehicles are the main use vehicles. Infiltration can be encouraged on the building itself through the construction of green roofs, vegetated planters and tree boxes. These and other approaches to infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies are collectively known as green infrastructure. Specific site practices can be found at: http://cfpub.epa.gov/npdes/home.cfm?program_id=298 and in the EPA publication: Using Smart Growth Techniques as Stormwater Best Management Practices (http://www.epa.gov/smartgrowth/pdf/sg_stormwater_BMP.pdf).

Water Efficiency

EO 13514 sets goals for federal agencies to improve water use efficiency and management by:

- reducing potable water consumption intensity by 2 percent annually through fiscal year 2020, or 26 percent by the end of fiscal year 2020, relative to a baseline of the agency's water consumption in fiscal year 2007, by implementing water management strategies including water-efficient and low-flow fixtures and efficient cooling towers;
- reducing agency industrial, landscaping, and agricultural water consumption by 2 percent annually or 20 percent by the end of fiscal year 2020 relative to a baseline of the agency's industrial, landscaping, and agricultural water consumption in fiscal year 2010;
- consistent with State law, identifying, promoting, and implementing water reuse strategies that reduce potable water consumption; and
- implementing and achieving the objectives identified in the stormwater management guidance referenced in section 14 of this order.

A variety of water saving strategies exist for new construction and existing buildings. A major source of water savings for most building projects is the design of water efficient landscaping. Xeriscaping is landscaping where supplemental irrigation is not required. It includes the reduction of lawn grass and planting of hardy native plant species.

Pressure management, or reducing excessive pressures in the distribution system, can save a significant quantity of water. Reducing water pressure can decrease leakage, amount of flow through open faucets, and stresses on pipes and joints which may result in leaks. Lower water pressure may also decrease system deterioration, reducing the need for repairs and extending the life of existing facilities. Furthermore, lower pressures can help reduce wear on end-use fixtures and appliances. More information can be found in the *EPA Water Conservation Plan Guidelines, Appendix A*: http://www.epa.gov/watersense/docs/app_a508.pdf.

Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a ground water basin (referred to as ground water recharge). Examples of water recycling opportunities include:

- Harvesting rainwater from the building roof (in appropriate climates) for use as graywater in flushing toilets or to provide on site watering for landscaping.
- Using washing machine graywater for landscape irrigation.
- Installing toilets that have handwashing basin above toilet tank so used water flushes toilet.

The EPA Region 9 website provides further detail on water recycling opportunities (http://www.epa.gov/region09/water/recycling/) and the EPA Office of Water published the 2004 report, *Guidelines on Water Reuse* (www.epa.gov/ord/NRMRL/pubs/625r04108/625r04108.pdf) (EPA 2004).

Other strategies to improve water efficiency include:

- Establish a monitoring system and maintenance program to replace leaking pipes as they deteriorate.
- Install hot water on demand heaters to reduce potable water waste while waiting for hot water.
- Install solar hot water heaters.

WaterSense, a partnership program sponsored by EPA, identifies and labels high efficiency water-related products for consumers (http://www.epa.gov/WaterSense). The installation of high efficiency "Water Sense" labeled plumbing fixtures, including automatic or self-closing faucets reduces water use and wastewater volumes for all types of buildings. Examples of high efficiency plumbing fixtures include: dual flush toilets, composting toilets, waterless or pint flush urinals and gray water collected and filtered from sink and shower drains to flush toilets. Currently there are multiple efficient plumbing fixtures available that have reduced volumes below the 1.6 gal per flush mandated in the Energy Policy Act of 1995.

The WaterSense program also provides technical assistance for different groups of water consumers, including:

- Guidelines and strategies for communities to implement water conservation plans (http://www.epa.gov/watersense/pubs/guide.htm).
- Water Use Audits that provide water systems and their customers with information about how water is used and how usage might be reduced through specific conservation strategies (http://www.epa.gov/watersense/docs/app_a508.pdf).
- Assistance to utilities with new technologies for leak detection equipment and water loss control (http://www.epa.gov/WaterSense/docs/utilityconservation_508.pdf).
- Assistance to utilities with designing rebate programs for customers to replace older fixtures (http://www.epa.gov/watersense/docs/app_a508.pdf).
- Assistance to utilities with designing water standards and regulations that maximize conservation (http://www.epa.gov/watersense/docs/app_a508.pdf).
- Assistance to communities to achieve universal metering, or installing meters at unmetered households, replacing meters, improving meters to help track and analyze

community water use, and developing an accurate meter reading and system map (http://www.epa.gov/WaterSense/docs/utilityconservation_508.pdf).

- Model ordinances/building codes for allowing graywater reuse: (www.oasisdesign.net/downloads/ModelGreywaterOrdinance.doc).
- Model ordinances/building codes for allowing rainwater catchment: (www.cbs.state.or.us/bcd/programs/plumbing/alt_methods/Rainwater_Harvesting_Potable.pdf (potable). www.cbs.state.or.us/bcd/programs/plumbing/alt_methods/Rainwater_Harvesting_Non-potable.pdf (non-potable)).

DOE's Office of Energy Efficiency and Renewable Energy sponsored research that resulted in a technical report, *Consumptive Water Use for U.S. Power Production* (http://www.nrel.gov/docs/fy04osti/33905.pdf). The 309 reviewer may use this report as a reference to federal agencies for determining water efficiency in building cooling systems. The report focuses on water consumption at power plants to provide the data needed to make accurate comparisons between water uses of building cooling systems. While it does not answer the question of which system consumes more water, it does provide the metric for determining the amount of water used at the power plant when the amount of energy consumed at the site is known. If used, the reviewer should be clear that a thorough understanding of local conditions is necessary to properly interpret the data in the report.

The 2009 GovEnergy presentation, "EPA – A Leader in Water Conservation," details EPA's internal strategies for reducing water use at their own facilities (http://www.govenergy.com/pdfs/presentations/Water-Session05/Water-Session05-Johnson_Sieber.pdf) (Green et al. 2009). The presentation provides ideas that may be useful for other federal facilities in reducing water consumption.

5.4.b Related Federal Partnership Programs

Building Technologies Program

The DOE Building Technologies program, supported by DOE national laboratories, was established to improve the efficiency of buildings and the equipment, components, and systems within them through partnerships with the private sector, state and local governments, and universities (DOE 2009e). The Building Technologies Program's strategic goal is to create technologies and design approaches that lead to marketable zero energy homes by 2020 and zero energy commercial buildings by 2025. A net-zero energy building is a residential or commercial building with greatly reduced energy needs due to efficiency gains of greater than 60% to 70% compared to conventional practice, with the balance of energy needs supplied by renewable technologies.

The Building Technologies Program has three main focuses: researching building designs, materials and construction techniques; applying them to residential and commercial buildings; and helping to develop ways to encourage implementation of these improvements. The primary research involves partnerships with industry to examine "whole building design" and "building

envelope" concepts. The building envelope concept is part of whole building design, and involves focused research into materials and thermal performance for windows, doors, walls, roof and foundation materials, including how they work together as a system. Research focuses on controlling heat loss and solar gain through windows and doors, insulation materials research, or moisture control technologies. This section of the Building Technologies program is also developing test methodologies to measure material properties. The program uses program outreach, cooperative industry projects, and contributions to standards-setting organizations to transfer technical information and expertise to the building materials industry, industry associations, and federal/state agencies (DOE 2009d).

The Building Technologies Program applies these whole building and building envelope concepts through two programs: "Building America" program for residential applications, and the "High Performance Buildings" program (Commercial Buildings Integration) for commercial applications (see following Energy Star section).

The Building Technologies Program website: <http://www1.eere.energy.gov/buildings/about.html>, provides information and resources on the program. The program operates a database: http://eere.buildinggreen.com/, which collects data on various factors that affect a building's performance (e.g., energy, materials, and land use) from buildings around the world, ranging from homes and commercial interiors to large buildings, campuses and neighborhoods (DOE 2009f).

Several other websites and reference materials provide useful information regarding whole building design. The Whole Building Design Guide website: <http://www.wbdg.org/index.php> is a portal run by the National Institute of Building Sciences and provides government and industry practitioners with current building-related guidance, criteria and technology from a whole building design perspective. The Whole-Building and Community Integration Group website: <http://www.ornl.gov/sci/btc/integration.shtml, run by the Oak Ridge National Laboratory, Building Technologies Research and Integration Center, also provides information on sustainable whole-building and community integration.

Building America Program (Rebuild America Residential Buildings Integration Research and Development)

The research into whole building design and building envelope concepts are directly applied in the Building America program for residential building integration. Building America is an industry-driven research program designed to accelerate the development and adoption of advanced building energy technologies in new and existing homes (DOE 2009a). It involves research teams from the DOE national laboratories, the National Renewable Energy Laboratory (NREL), the Oak Ridge National Laboratory (ORNL) and the Pacific Northwest National Laboratory partnering with the following industry alliances:

- Building Industry Research Alliance
- Building Science Consortium
- Consortium for Advanced Residential Buildings
- Industrialized Housing Partnership

- Integrated Building and Construction Solutions
- National Association of Home Builders Research Center

Residential building construction techniques are refined in this program, and are then published in a six-volume set of Best Practices Handbooks (DOE 2009b). The first five volumes are divided by climate zones and the sixth volume focuses on solar thermal and photovoltaic systems for all climates. Each volume contains information and instructions in separate sections written for seven specific stakeholders: homeowners, managers, marketers, site planners and developers, designers, site supervisors, and trades and crafts.

The Building America Program and Best Practices handbooks are located at: http://www1.eere.energy.gov/buildings/building_america/about.html.

ENERGY STAR

See 5.1.b for a description of EPA's ENERGY STAR program for commercial buildings, including the online Portfolio Manager energy performance rating system. More information is also available at: www.energystar.gov/buildings.

High Performance Commercial Buildings Program

The High Performance Commercial Buildings Program directly applies whole building design research for commercial buildings (DOE 2009j). The program consists of government and industry research partnerships and information dissemination. Government/industry partnerships include the Retailer Energy Alliance, Commercial Real Estate Energy Alliance, and the Institutional Energy Alliance (DOE 2009g). The technologies promoted within the program have the potential to result in substantial energy savings as commercial buildings constitute 17% of U.S. energy use.

The High Performance Buildings program disseminates information from its website, which takes the form of energy simulation software: <http://www.eere.energy.gov/buildings/highperformance/simulation_software.html> links to energy efficiency and solar power technologies: <http://www.eere.energy.gov/buildings/highperformance/technologies.html>, and research reports: <http://www.eere.energy.gov/buildings/highperformance/research_reports.html>.

Building Energy Codes

Building energy codes directly impact energy efficiency by setting the lowest acceptable building practice. To be effective, they are supported through education, implementation, and enforcement. The Building Energy Codes program is an information resource on national model energy codes. The program works with government agencies, state and local jurisdictions, national code organizations, and industry to promote stronger building energy codes and help states adopt, implement, and enforce those codes (DOE 2009c). The program also develops and promulgates Federal energy codes for government residential and commercial buildings.

Through its website: <http://www.energycodes.gov/>, the program provides resource materials, training and education opportunities, and code compliance tools, such as residential and commercial code checking software, and special climate-related prescriptive packages for contractors to quickly build and renovate code-compliant structures. The program website contains an extensive Building Energy Codes Glossary as a reference for practitioners and the public.

Lighting Research and Development Program

The Lighting Research and Development Program, which operates within the DOE Building Technologies Program, conducts and collaborates on research on energy efficient lighting technologies and practices. The program focuses mainly on two areas: spectrally enhanced lighting (SEL) and solid-state lighting (SSL). SEL is a simple strategy that uses existing products and technology to reduce energy use in commercial buildings. The concept behind SEL is that a significant amount of energy can be saved by using lamps that have less light output, but higher correlated color temperature (CCT). Lamps with higher CCT appear brighter than those with lower CCT, so the actual light output of higher CCT lamps can be decreased, while maintaining equivalent perceived brightness and visual acuity. Unlike other energy efficiency strategies, SEL is not a technology — it's a different way to quantify light that can be used with any type of lighting design to improve energy performance. Energy savings are achieved by using high performance and high CCT lamps coupled with lower ballast factor, extra efficient electronic ballasts (DOE 2009l).

SSL utilizes light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma (used in arc lamps such as fluorescent lamps), or gas. The term "solid state" refers to the fact that light in an LED is emitted from a solid object—a block of semiconductor—rather than from a vacuum or gas tube, as is the case in traditional incandescent light bulbs and fluorescent lamps.

The program's SSL research aims to accelerate market introduction of high efficiency, high-performance SSL products. DOE's plan features two concurrent, interactive pathways. Core technology research is conducted primarily by academia, national laboratories, and research institutions. Product development is conducted primarily by industry on commercially viable materials, devices, or systems. DOE and its SSL partners have developed a multi-year R&D plan to ensure that DOE is funding the appropriate R&D topics. The R&D roadmap is updated annually with input from industry partners and workshop attendees, and guides the development of annual SSL R&D solicitations.

DOE supports various programs to encourage the latest SSL technology to successfully enter the market, one of which is the Commercially Available LED Product Evaluation and Reporting (CALIPER) program. CALIPER supports testing of a wide array of SSL products available for general illumination. DOE allows its test results to be distributed in the public interest for noncommercial, educational purposes. Over 120 products have been tested through the CALIPER program to date (DOE 2009m). Test reports and benchmark reports comparing LED products to conventional technology are available at the program website: <http://www1.eere.energy.gov/buildings/ssl/caliper.html>.

The Lighting Research and Development Program can be found at: http://www1.eere.energy.gov/buildings/lighting.html. Information on LED basics, applications, and measurement can be found at: <http://www1.eere.energy.gov/buildings/ssl/using_leds.html>.

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

EPA Combined Heat and Power Partnership

See Section 4.2.

EPA Green Power Partnership

See Section 4.2.

5.4.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

Reviewers should assess federal actions related to buildings and where appropriate encourage compliance with requirements of the Energy Policy Act of 2005 and EO 13423-Strengthening Federal Environmental, Energy, and Transportation Management. The Act requires annual two percent reductions in energy use at federal agency buildings (including industrial and laboratory facilities) through 2015, with DOE to complete a review of the government's performance in response to this requirement by the end of 2014 and recommend additional measures for 2016 through 2025. Agencies must apply water conservation technologies if water is used to achieve energy efficiency. EO 13423 strengthens this requirement by 50% to compel the reduction of greenhouse gas emissions by three percent annually by 2015 or by 30 percent by the end of 2015 (using 2003 as the baseline). EO 13423 also requires an annual two percent reduction in water consumption through 2015. Existing facilities should provide documentation of their annual energy and water consumption reduction, and new facilities should include a plan for meeting

the federal requirements. Facilities may be exempt from the energy reduction requirements if they meet all of the following requirements:

- Impracticability due to energy intensiveness or national security function;
- Completed energy management reports;
- Compliance with all energy efficiency requirements; and
- Implementation of all cost-effective energy projects in the building.

The Energy Policy Act of 2005 also requires federal agencies to monitor electricity use in all federal buildings by 2012, using advanced meters or devices that provide data at least daily. DOE's Guidance for Electric Metering in Federal Buildings required implementation plans by August 2006, and the meters must be installed, to the extent practicable, by October 1, 2012. Reviewers should determine whether federal actions that involve existing buildings and new construction have sufficiently addressed the electricity metering requirements of EPAct 2005 and any implementing guidance.

Reviewers should determine whether any actions involving new construction meet EPAct 2005 requirements. This includes the requirement for new federal buildings to be designed 30 percent below ASHRAE or International Energy Code standards and to incorporate sustainable design principles. Reviewers could cite *Greening Federal Facilities* and the *Federal Green Construction Guide for Specifiers*, among other resource guides, for sustainable and energy efficient design. EO 13423 additionally requires that buildings be constructed or renovated in accordance with the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings* set forth in the Federal Leadership in High Performance and Sustainable Buildings MOU.

Reviewers should, where appropriate, encourage compliance with requirements of EO 13514. The EO sets goals for federal agencies, including:

- managing existing building systems to reduce the consumption of energy, water, and materials, and identifying alternatives to renovation that reduce existing assets' deferred maintenance costs;
- when adding assets to the agency's real property inventory, identifying opportunities to consolidate and dispose of existing assets, optimize the performance of the agency's real-property portfolio, and reduce associated environmental impacts; and
- ensuring that rehabilitation of federally owned historic buildings utilizes best practices and technologies in retrofitting to promote long-term viability of the buildings.

Reviewers may want to recommend that buildings achieve LEED® and/or ENERGY STAR certification. Both rating systems provide checklists of criteria that include energy efficiency concerns. New federal construction should document the use of building commissioning (a prerequisite for LEED® certification) and may want to frame the design and construction process using the whole building design concept. Reviewers may want to recommend that projects make use of specific building type energy and environmental design guidance offered by WBDG and ASHRAE. More information on ASHRAE's initiatives to encourage energy efficiency in existing buildings can be found in the 2009 GovEnergy presentation, "Sustaining our Future by Rebuilding our Past: ASHRAE's Sustainability Goals: The Path Towards Net Zero Energy

Buildings" (http://www.govenergy.com/pdfs/presentations/Sustainability-Session05/Sustainability-Session05-Holness.pdf) (Holness 2009).

Federal buildings should comply with all federal building energy codes. Reviewers can suggest the use of DOE Building Energy Codes software to determine compliance. Building envelope (windows, doors, walls, roof and foundation materials) design should follow IECC and ASHRAE 90.1 to maximize energy efficiency through appropriate insulation levels, window glazing and optimized configuration.

Advanced HVAC technology, including Integrated Energy Systems should be considered for new construction and retrofitting existing buildings. Buildings should also employ passive cooling methods, including tree and vegetative cover, cool pavements, and green or cool roofs.

10 CFR Part 436, Subpart A of Federal Energy Management and Planning Programs promotes the use of and establishes a methodology and procedures for life cycle costing. Reviewers may want to recommend the NIST BEES model, which uses the life-cycle assessment approach to measure the environmental performance of building products.

The Energy Independence and Security Act of 2007 requires all general purpose lighting in federal buildings must use ENERGY STAR or FEMP-designated products by 2013. In addition, Reviewers can recommend the use of advanced fluorescent lighting, high intensity discharge lighting, and LEDs where appropriate, and recommend occupancy sensors, time switches, dimming systems and regular maintenance to retain lighting output over the life of the product. Buildings should be designed to maximize interior daylighting.

Reviewers should, where appropriate, encourage compliance with the water efficiency-related requirements of EO 13514. Reviewers can recommend that buildings develop a plan to manage stormwater onsite, potentially recycle graywater for use within the building, use EPA WaterSense labeled plumbing fixtures and xeriscape to reduce water use for landscaping. For new multi-building facilities, Reviewers can recommend that the design minimize the energy required for water supply by:

- Locating areas that will receive water close and downhill to the sources of water and reclaimed water.
- Identify the end users of potable water and locate them near potable water sources.
- Locate wastewater treatment facilities near users of potable water.
- Locate sites to receive recycled wastewater near the wastewater treatment plant.
- Lay out pipes first, before the facilities, to eliminate the number of turns and bends required because these increase the need for energy and pumping.
- Increase the size of pipes and select pipe material to reduce the amount of friction which will reduce energy and pumping.
- Install solar hot water heaters.

Reviewers may recommend that indoor air quality be considered when implementing energy efficiency measures. Additional potential indoor air quality-related safety measures include: a) radon testing and mitigation; b) whole-building and local exhaust ventilation systems (ASHRAE

Standard 62.2); c) mold/moisture control measures; d) combustion safety and house pressure diagnostics; and e) integrated pest management.

Sections 5.5, 5.6 and 5.7 and 5.8 discuss energy efficiency at specialized building types, including federally assisted housing, military installations, laboratories and industrial facilities. For information on more specialized High-Performance Buildings for High-Tech Industries (laboratories, cleanrooms, data centers), 309 Reviewers may want to encourage the use of information provided by LBNL on High-Performance Buildings for High-Tech Industries. DOE also has a website which addresses this subject. It is located at: http://hightech.lbl.gov/mission.html.

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5.5 Federally Assisted Housing

5.5.a Summary

As early as 1974, the *Housing and Community Development Act* cited energy efficiency as a specific objective in the development of affordable housing. Today, the U.S. Department of Housing and Urban Development's (HUD) Office of Environment and Energy oversees HUD energy initiatives and policies. The *2002 HUD Energy Action Plan* outlines HUD energy initiatives, including promotion of ENERGY STAR products, improved monitoring of energy efficiency in public and assisted housing, weatherization and other programs to improve residential energy efficiency, internal training and technical assistance, and strengthening of incentive programs for ESPCs (http://www.hud.gov/energy/energyactionplan.pdf). An ESPC is an agreement with a utility company which, after performing an energy audit, provides financing for recommended energy efficiency measures, oversees the installation of these measures, and provides long-term services such as monitoring of energy use, training of maintenance staff, and energy education of residents (see Section 4.1).

The HUD Energy Action Plan also calls for increasing partnership efforts with EPA and DOE to develop programs such as the CHP Screening Tool (which evaluates combined cooling, heating and power in multi-family housing). The 2006 HUD report to Congress, *Promoting Energy Efficiency at HUD in a Time of Change*, summarizes HUD's continuing efforts to implement the Energy Action Plan (http://www.huduser.org/publications/destech/energyefficiency.html).

HUD would prepare EISs for projects that meet the following criteria (24 CFR 58.37):

- The project would provide a site or sites for, or result in the construction of, hospitals or nursing homes containing a total of 2,500 or more beds.
- The project would remove, demolish, convert or substantially rehabilitate 2,500 or more existing housing units (but not including rehabilitation projects categorically excluded under § 58.35), or would result in the construction or installation of 2,500 or more housing units, or would provide sites for 2,500 or more housing units.
- The project would provide enough additional water and sewer capacity to support 2,500 or more additional housing units. The project does not have to be specifically intended for residential use nor does it have to be totally new construction. If the project is designed to provide upgraded service to existing development as well as to serve new development, only that portion of the increased capacity which is intended to serve new development should be counted.

5.5.b Related Federal Partnership Programs

Weatherization Assistance Program

The Weatherization Assistance Program (WAP), managed by the DOE Weatherization and Intergovernmental Program (WIP), assists low-income families to permanently reduce their energy bills by making their homes more energy efficient. The WIP awards annual grants to state weatherization programs and works in partnership with states and more than 900 local

agencies to provide weatherization services. DOE provides approximately 40% of weatherization funding, while states, the U. S. Department of Health and Human Services Low-Income Home Energy Assistance Program, and utilities contribute the remaining funds.

During the last 30 years, the Weatherization Assistance Program has provided weatherization services to more than 5.6 million low-income families. On average, weatherization reduces heating bills by 32% and overall energy bills by $358 per year at 2008 prices. Cost-effective measures to increase energy efficiency are tailored to the specific home and climate. Reducing spending on energy bills can have positive secondary effects on low-income communities by freeing up funds for other pressing needs (DOE 2009). Weatherization not only helps low-income families save money, but it also lowers energy consumption as a whole.

The program is supported by the Weatherization Assistance Program Technical Assistance Center website, http://www.waptac.org/, run by the Oak Ridge National Laboratory. This site provides weatherization practitioners and other energy conservation professionals with program-related information. The Center offers the Weatherization Assistant software, an energy audit software tool developed for the WAP, containing the National Energy Audit Tool for site-built single-family houses and the Manufactured Home Energy Audit for mobile homes.

The WIP program has begun providing grants under the Energy Efficiency and Conservation Block Grant (EECBG) Program, funded for the first time under the American Recovery and Reinvestment Act of 2009. This Program, authorized in Title V, Subtitle E of EISA 2007, provides funds to units of local and state government, Indian tribes, and territories to develop and implement projects to improve energy efficiency and reduce energy use and fossil fuel emissions in their communities. More information can be found at: http://www.eecbg.energy.gov/.

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

5.5.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these

documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

Many of HUD's programs that support energy efficiency, such as subsidizing utility expenses in assisted housing or energy assistance for low-income households, are not likely to be the subject of assessment in EISs reviewed by EPA. However, community redevelopment and similar projects are often partially or fully funded by HUD, requiring NEPA compliance. EPA has reviewed EISs for eight projects proposed, or proposed to be funded, by HUD that met these criteria in the period January 2004 through March 2009. On one of these EISs (LMDC 2004), energy efficiency-related comments by EPA and other commenters included requests for clarification, revision, additional contingency planning, or mitigation related to the following issues, which serve as a useful checklist for reviewing future EISs:

- Water use in fountains and planning for drought emergencies.
- Total demand on the electrical supply grid.
- Means to reduce power use burdens on environmental justice communities.
- Potential to add onsite energy generation.
- Water conservation.
- Commitment to sustainable design guidelines.
- Stormwater capture and reuse.
- Use of electric-powered construction equipment.

In addition to these issues, EPA reviewers may request that HUD EISs consider reporting the results of a screening assessment as to the feasibility of incorporating cogeneration (CHP) into the project (EPA 2008). Promoting CHP in public or assisted housing is one of the action items in HUD's Energy Action Plan (HUD 2003).

The increase in the per facility allocation available under the new ARRA funding allows for additional treatments beyond the traditional weatherization program energy efficiency measures. The convergence of available monies with the emergence of new micro CHP technologies, could proffer additional opportunities to improve economic, energy and environmental benefits. This opportunity is particularly acute in the multifamily sector, which serves a significant portion of public or assisted housing.

The following elements that would support the attainment of energy conservation could be considered by HUD for incorporation into its proposed actions and alternatives, particularly the actions related to public and assisted housing. These items are drawn from the department's Energy Action Plan (HUD 2003):

- Take advantage of opportunities for weatherization in multifamily housing.
- Improve monitoring and maintenance of existing equipment through energy efficiency training for multifamily housing managers and maintenance staff.
- Incorporate use of ESPCs.
- Procure ENERGY STAR-rated equipment.

Section 5.5 References

Links to external web sites provided in this document may be useful or interesting and are being provided consistent with the intended purpose of this guidance document. EPA cannot attest to the accuracy of information provided by any linked site. Providing links to a non-EPA web site does not constitute an endorsement by EPA or any of its employees of the sponsors of the site or the information or products provided on the site. Also, be aware that the privacy protection provided on the epa.gov domain (see Privacy and Security Notice) may not be available at the external link.

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5.6 Military Installations

5.6.a Summary

The U.S. Department of Defense (DoD), including the military branches of the U.S. Army (Army), U.S. Navy (Navy), U.S. Marine Corps (Marines) and U.S. Air Force (Air Force), occupy and operate more than 5,400 sites comprising over 316,200 individual buildings and 229,400 other structures in the U.S. and abroad (valued at more than $455 billion dollars). These facilities cover approximately 29.8 million acres, with more than 98% located within the United States and its territories (DoD 2008). The DoD operates from over 2.2 million square feet of building space. Buildings and facilities account for approximately 25% of total DoD energy use.

In FY 2008, the DoD spent $3.95 billion on facility energy, and an additional $16 billion on fuel for non-fleet and fleet vehicles, including automotive gasoline, LPG-propane, aviation gasoline, jet fuel, diesel-distillate, and other Navy-specific fuel. Accordingly, the DoD is the largest single energy consumer in the country, representing approximately 78% of the entire energy consumed by the federal government (DoD 2009a). Within DoD, the Air Force is the largest energy consumer, accounting for 64% of total DoD energy use with aviation fuel the major component. The Navy/Marines and Army account for 19% and 17%, respectively, of DoD energy consumption.

The term 'military installation' means a base, camp, post, station, shipyard, center, homeport facility, or any other activity under the jurisdiction of a department, agency, or other instrument of the Department of Defense, including a leased facility (GlobalSecurity.Org 2005). The term military installation does not include facilities used primarily for civil works, rivers and harbor projects, or flood control projects (i.e. those activities commonly under the management of the U.S. Army Corps of Engineers).

Conserving energy and investing in energy reduction measures makes good business sense and allows limited resources to be applied to readiness and modernization. The DoD has already reduced its installation energy consumption significantly; by FY 2005 the DoD achieved a reduction in energy consumption by 28.3 percent as compared to a FY 1985 baseline. The Energy Policy Act of 2005 changed the baseline to FY 2003. DoD achieved a 10.1% reduction in goal facilities energy intensity for FY 2007. Despite this success, the DoD must make greater strides in energy efficiency and consumption reduction in order to meet the vision of providing reliable and cost effective utility services to the warfighter. Dramatic fluctuations in the cost of energy significantly impact already constrained operating budgets, providing even greater incentives to conserve and seek ways to lower energy consumption. These include investments in cost-effective renewable energy sources, energy efficient construction designs, and aggregating bargaining power among regions and services to procure the most favorable energy contracts (DoD 2009b).

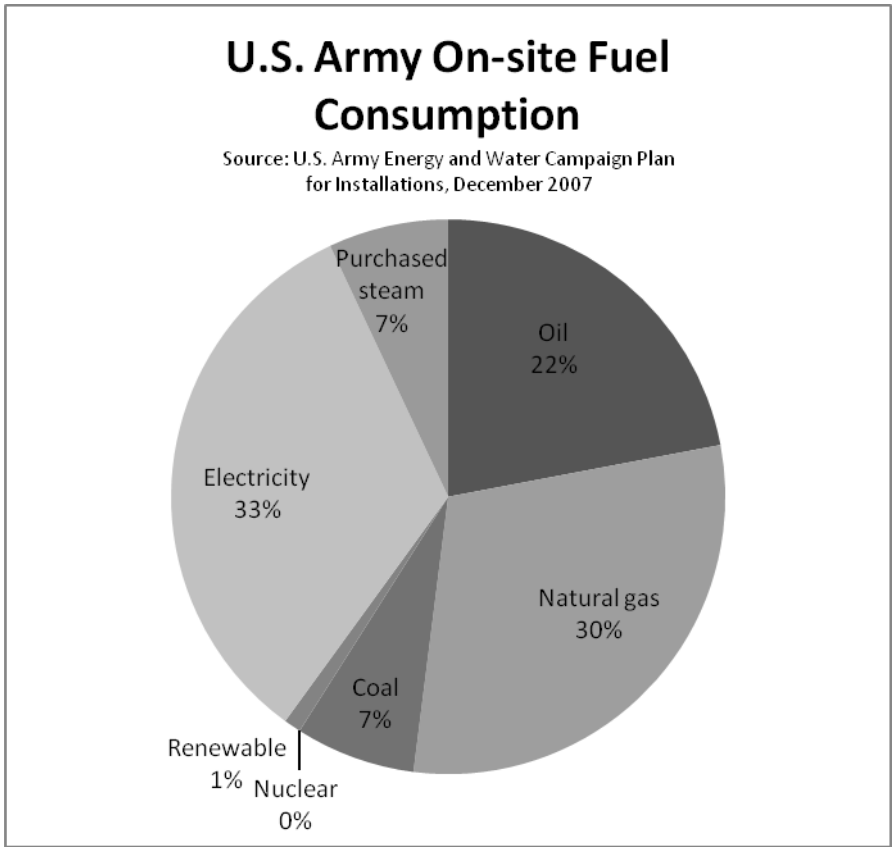
U.S. Army

The U.S. Army is comprised of almost 1.3 million personnel, including active, guard, reserve and civilian employees, at over 2,200 locations worldwide. The Army operates from over

143,000 buildings covering 955 million square feet, and is also responsible for 71,315 other structures. The Army manages approximately 52% of DoD lands, over 15.4 million acres (DoD 2008).

Energy consumption in Army facilities consists of approximately 1/3 electrical energy, with the remainder being thermal energy supplied primarily by natural gas and increasingly less fuel oil (Figure 5-2).

Figure 5-2



Energy Strategy

The U.S. Army developed the "Army Energy Security Implementation Strategy" to address energy use and efficiency efforts across the Army enterprise. This document presents the Army's overall energy security vision, mission, and goals, with direction on the development of objectives and metrics to gauge progress toward such goals. The Army's energy security mission is to make energy a consideration in all Army activities in an effort to reduce demand, increase efficiency, seek alternative sources, and create a culture of energy accountability, while sustaining or enhancing operational capabilities.

Army Energy Security Implementation Strategy

Surety, Survivability, Supply, Sufficiency, Sustainability – these are the core characteristics defining the energy security necessary for the full range of Army missions. Energy security for the Army means preventing loss of access to power and fuel sources (surety), ensuring resilience in energy systems (survivability), accessing alternative and renewable energy sources available on installations (supply), providing adequate power for critical missions (sufficiency), and promoting support for the Army's mission, its community, and the environment (sustainability).

The strategy outlines the five Strategic Energy Security Goals to improve the Army's overall energy security posture and assure access to critical power across the full spectrum of Army missions:

- Reduced Energy Consumption: Reduce the amounts of power and fuel consumed by the Army at home and in theatre. This goal will assist in minimizing the logistical fuel tail in tactical situations by improving fuel inventory management and focusing installation consumption on critical functions.
- Increased Energy Efficiency Across Platforms and Facilities: Raise the energy efficiency for generation, distribution, storage and end-use of electricity and fuel for system platforms, facilities, units and individual Soldiers and Civilians. This goal also relates to the productivity of a system based on energy requirements and supports the ability to make informed trade-offs in development, engineering and deployment of weapon systems.
- Increased Use of Renewable / Alternative Energy: Raise the share of renewable/alternative resources for power and fuel use, which can provide a decreased dependence upon conventional fuel sources. This goal also supports national goals related to renewable/alternative energy.
- Assured Access to Sufficient Energy Supplies: Improve and maintain the Army's access to sufficient power and fuel supplies when and where needed. Energy is a critical resource in conducting Army missions. Vulnerabilities to external disruption of power and fuel sources should be minimized and the potential for industry partnerships to enhance energy security and generate net revenues for the Army should be considered.
- Reduced Adverse Impacts on the Environment: Reduce harmful emissions and discharges from energy and fuel use. Conduct energy security activities in a manner consistent with Army environmental and sustainability policies.

Army Energy and Water Campaign Plan for Installations

As a major component of the U.S. Army's energy posture, the "Army Energy and Water Campaign Plan for Installations" specifically addresses energy efficiency and water use at Army installations. The goal of this plan is to assist the Army in providing safe, secure, reliable, environmentally compliant, and cost-effective energy and water services to soldiers, families, civilians, and contractors on Army installations. The plan sets the general direction for Army installations with five major initiatives:

- Eliminate energy waste in existing facilities.

- Increase energy efficiency in new construction and renovations.
- Reduce dependence on fossil fuels.
- Conserve water resources.
- Improve energy security.

Since energy demand is predicted to increase based on on-going and potential military operations globally, energy efficiency and increased use of renewable resources are the critical to meeting future Army energy needs.

Eliminate Energy Waste

Major actions associated with this initiative include:

- A centralized review of Army energy operations.
- Development of long range energy management plans for installations.
- Improving training for energy managers, creation of energy management decisions and accountability standards.
- Implement data management systems including enhanced utility metering.
- Expand knowledge through awareness initiatives, energy management guide, and awards program.
- Development of a dedicated funding stream for energy projects.
- Improve effectiveness of utility contracting.
- Expand procurement of energy-efficient equipment and products.

Increase Energy Efficiency in New Construction

Major actions associated with this initiative include:

- Develop facility energy performance requirements for specific climate zones.
- Develop energy design standards which meet or exceed federal energy performance requirements, including standards for use of Energy Star products, HVAC systems, and lighting.
- Create LEED® certification standards for all new and major construction activities: LEED® Silver by FY08, LEED® Gold byFY15, and LEED® Platinum by FY20.
- Expand training in building design and renovations with energy efficiency technologies.
- Use of advanced, automated and remote metering technology for data collection and accountability monitoring.
- Reduce effects of energy price volatility through maximization of fuel flexible technologies, use of high-efficiency electric components, and increased use and on-site generation of renewable fuels.
- Development of utility source evaluation program to maximize use of alternative energy sources.
- Allow installations to control funds saved through utility savings via efficiency improvements.

- Increase performance validation of the use of alternative financing and contracting agreements.

Reduce Dependence on Fossil Fuels

Major actions associated with this initiative include:

- Increase purchase of renewable resource generated electricity.
- Develop cost-effective on-site renewable energy generation and create a Zero Energy initiative program which benefits installations which produce more energy than they consume.
- Modernize central energy systems to reduce fossil fuel consumption.
- Reduce use of fossil fuel oil for building space heating and domestic hot water.
- Increase the use of Alternative Fuel Vehicles for non-tactical purposes.

Conserve Water Resources

Major actions associated with this initiative include:

- Prioritize sites for water conservation opportunities through use/cost/availability assessments.
- Improve water storage and distribution system integrity.
- Increase efficiency of plumbing fixtures, using Energy Star criteria and promoting low-flow and no-flow water-using appliances and fixtures.
- Limit use of potable water for irrigation and increase use of native plants in landscapes.
- Increase efficiency and reduce losses in process water use (cooling towers, steam systems, vehicle wash stations).
- Use water audits to prioritize project and implementation strategies.
- Develop new technical standards and training for design guides, LEED® implementation and technical assistance/design review.
- Identify availability of water resources to meet mission critical future demands.

Improve Energy Security

Major actions associated with this initiative include:

- Conduct energy security vulnerability assessments and response plans.
- Implement energy security plans and necessary remedial actions.
- Use current and projected energy sources with greatest potential for availability and economy, based on periodic review of energy supply trends.

Army specifications for implementing energy efficiency are found in *Army Regulation 420-1, Army Facilities Management* http://www.army.mil/USAPA/epubs/pdf/r420_1.pdf. These regulations apply to the management of Army installations, specifically providing guidance on

construction, master planning, utilities services and energy management, and fire and emergency services.

Guidance on the use of energy savings performance contracting (ESPC) for Army installations are provided in *Department of the Army Policy Guidance for Implementation of an Energy Savings Performance Contract, Version 3, November 2008* http://army-energy.hqda.pentagon.mil/docs/ESPC_policy_hdbk_v3_1108.pdf. Use of ESPC and these guidelines are intended to help Army installation mangers save energy and reduce costs, help meet environmental requirements, reduce equipment breakdowns and emergency repair requests, provide more productive living and working conditions, and enhance energy security.

U.S. Navy/U.S. Marine Corps

For FY2005, the Navy and Marine Corps were supported by a combined personnel group of approximately 860,000, with about 544,000 active personnel, 123,000 reserve personnel, and 193,000 civilian employees. These services collectively manage over 91,000 buildings comprising over 600 million square feet and 88,700 other structures. The services manage over 4.5 million acres of land.

U.S. Marine Corps Energy Strategy

The Marine Corps Facilities Energy and Water Management Program authored the energy strategy campaign plan, "Ten x 10: Top 10 Things To Do by 2010 to Reduce USMC Energy Risks." The plan focuses on three long-term energy goals:

- Reduce energy intensity 30% by 2015 relative to 2003 baseline.
- Reduce water consumption intensity 16% by 2015 relative to 2007 baseline.
- Increase the percentage of renewable electrical energy consumed to 25% by FY 2025.

The plan also lists ten strategies for achieiving these long term goals:

- Create an organizational structure that maintains a command committed to the efficient use of energy and water resources.
- Provide management and resources for the execution of facilities energy and water management programs.
- Use an integrated approach to optimize energy performance to meet Federal building performance requirements and achieve a Leadership in Energy & Environmental Design (LEED) rating of Silver for new construction and major renovation projects.
- Demonstrate leadership in implementing cost-effective technology and management practices.
- Procure energy-efficient equipment and products.
- Phase out use of incandescent bulbs.
- Evaluate viability of power purchase and leasing agreements to implement large-scale renewable energy projects and develop geothermal energy resources in a manner that protects the operational mission.
- Manage utility costs through demand-shedding and peak-shaving strategies.

- Use Geospatial Information System (GIS) capabilities to manage metered data.
- Implement training and awareness programs to emphasize user-controlled reductions.

The plan can be found at: http://www.marines.mil/units/hqmc/logistics/Documents/Conferences/USMCEnergySummit/USMC_Energy_Water_Campaign_Plan.pdf.

Department of the Navy Energy Strategy

While the Navy does not currently have a specific energy management or energy efficiency strategy for installation management, a number of policies and instructions relate specifically to energy-related considerations in the renovation and construction of Navy facilities.

The operational impacts of a volatile energy market resulted in the Chief of Naval Operations (CNO) establishing Task Force Energy (TFE) to transform the disparate and decentralized Navy energy programs through top-down commitment and centralized governance, and emphasizing a need for further energy efficiency as a strategic imperative in the CNO 2009 guidance.

The TFE is developing a Navy Energy Strategy to formulate an overarching governance to reduce demand, increase alternative/renewable power generation, and provide secure energy for critical infrastructure and operations. It establishes the shore and tactical community pillars with functional platforms to optimize energy security, investments and policy/doctrine. Upon full implementation, the Navy strategy will: enable a culture where energy is valued as a strategic resource; be a leader in environmental stewardship; make energy an operational advantage; and minimize the impacts of energy market volatility.

Department of the Navy Environmental Strategy

The Department of the Navy Environmental Strategy empowers every sailor, marine and civilian employee to take a proactive role in protecting the environment, helping the Navy to meet mission requirements, protect and enhance the environment, build equity with internal and external stakeholders, manage and reduce costs, and enhance the commitment to environmental stewardship. A goal of the strategy related to energy efficiency states "Personnel shall incorporate pollution prevention principles, adopt a "green procurement" philosophy, and employ technology to meet DoD environmental stewardship objectives where efficiency and economics warrant with an overall objective of reducing the department's environmental footprint. Energy efficiency, use of alternative energy sources including sustainable energy sources, and energy conservation initiatives shall be considered in every acquisition program consistent with warfighting requirements."

Secretary of the Navy Instruction 4100.9A, Department of the Navy Shore Energy Management, October 2001

Navy shore energy will be managed to minimize consumption, minimize costs, utilize renewable energy resources, and use environmentally friendly technologies whenever feasible. Accordingly, the Navy shall:

- Promote programs in energy conservation awareness that stress the importance of energy conservation and educate all personnel in prudent and appropriate energy conservation techniques.
- Utilize government funds and financing tools to attain Navy shore energy goals established by the National Environmental Policy Act, Executive Order 13123, and DoD Instruction 5126.47, DoD Energy Policy Council. Government fund sources include Federal Energy Management Program, Navy (FEMP), Energy Conservation Investment Program (ECIP), geothermal revenues and other appropriated funding sources. Financing tools include Energy Savings Performance Contracts (ESPC), Public-Private Venture (PPV) Capital Contracts, and Utility Energy-Efficiency Service Contracts (UESC).
- Aggressively develop energy-related natural resources in a manner that protects the military mission of shore activities and provides cost savings or other benefits to the Navy.
- Fund energy efforts from savings and revenue generated from the development of energy-related natural resources whenever feasible.
- Participate with other (DoD) agencies in the acquisition of natural gas, water, electricity and other energy commodities, when appropriate and cost effective.

Navy Facilities Engineering Command (NAVFAC) Instruction 9830.1, Sustainable Development Policy, June 2003

The purpose of this policy is to reduce the total cost of ownership of shore facilities by implementing sustainable development concepts and principles. Major components of the policy are:

- Reduce the life-cycle cost of shore facilities by incorporating sustainable development concepts and principles in the planning, programming, design, construction, operation and maintenance, sustainment, restoration, and modernization of all facilities and infrastructure projects to the fullest extent possible, consistent with mission, budget, and client requirements.
- NAVFAC shall use the LEED® Green Building Rating System as a tool in applying sustainable development principles and as a metric to measure the sustainability achieved through the planning, design, and construction process.

NAVFAC Engineering and Construction Bulletin 2008-01, Energy Policy Act of 2005 Implementation and USGBC LEED® Certification, December 2007

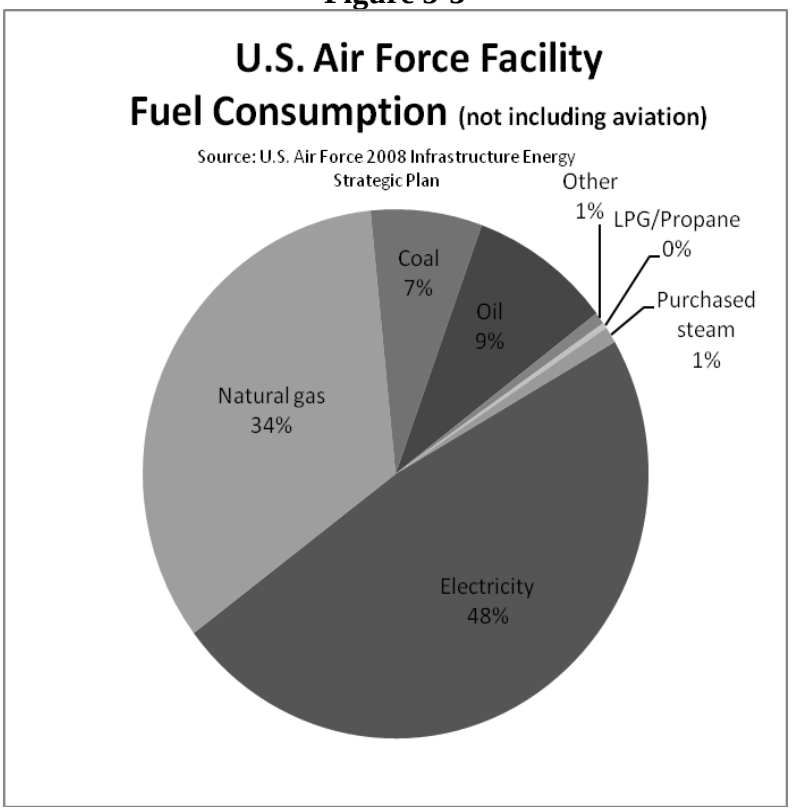
This bulletin establishes policy related to meeting the requirements of the Energy Policy Act of 2005 and Executive Order 13423. All projects for new buildings and major renovations where the work exceeds 50 percent of the building's plant replacement value (PRV) must comply with EPAct 2005 requirements as codified under US Code 10 CFR 433 & 435, regardless of fund source, building size, location or temporary nature. Projects must also comply with the Executive Order 13423. All projects must be registered with USGBC and have the required LEED® submittal documentation certified by USGBC to meet the required LEED® Silver-level rating.

U.S. Air Force

The U.S. Air Force operates throughout the world at 84 major and 82 minor installations, on over 9.8 million acres. The service is supported by an estimated 700,000 employees, including active military, civilian, guard and reserve personnel. The Air Force operates from 81,900 buildings covering 655 million square feet. The service is also responsible for over 56,000 structures.

The Air Force is the largest energy consumer in the federal government. Aviation is the largest energy user, accounting for 81% of the total energy consumption of the Air Force. Facilities and installations account for approximately 15% of energy use, with vehicles and other ground equipment consuming about 4%. In FY 2007, the Air Force spent over $7 billion in energy costs (Figure 5-3).

Figure 5-3



Energy Strategy

To address energy sustainability concerns, the Air Force has developed a strategic vision to provide leadership in utilizing new energy options that include secure and reliable energy alternatives and increased energy-use efficiency. The three major strategies are:

- Reduce demand: The Air Force is committed to increasing energy efficiency and awareness of the need to reduce energy consumption. This has led to a more than 16% reduction in facility energy usage in FY 2008 compared to FY 2003, equating to a

savings of 6 trillion BTUs and $90 million in savings —making the Air Force one of the biggest energy savers in the country.

- Increase supply: The Air Force is committed to research, testing, and certifying new technologies, as well as renewable and sustainable resources in order to create new domestic sources of supply. This includes leveraging advances in renewable energy sources such as geo-thermal, wind, biomass and solar power and alternative synthetic fuels derived from coal, natural gas, and biomass.
- Culture change: The Air Force is seeking to increase awareness of energy concerns, creating a culture where personnel make energy a consideration in every action and decision. By focusing on leadership efforts, training, curricula, and communication, the Air Force is building the foundation for a culture that will continuously reduce energy consumption. This strategy seeks to create a cultural change similar to previous awareness and behavioral changes created by safety and environmental programs.

In concert with these broad strategies, the Air Force has identified the following major statutory and policy goals to achieve a more secure and reliable energy portfolio:

- Reduce facility energy intensity 3% annually.
- Reduce base water use 2% annually.
- Increase use of renewable energy at annual targets, culminating in 25% goal by 2025.
- Reduce ground vehicle fossil fuel use 2% annually.
- Increase alternative fuel use 10% annually.
- Obtain 50% of domestic aviation fuel blend from “green sources” by 2016.

Air Force Installations and Infrastructure

In order to implement the components and meet the goals of the Air Force energy strategy, installation programs and actions are focused in four major areas: improving current infrastructure; improving future infrastructure; expanding use of renewable energy; and managing costs.

Improving Current Infrastructure

Efforts in this area focus on increasing energy efficiency in current facilities, vehicles, and equipment, and actively conserving water through actions such as improving building envelope thermal resistance; installing energy efficient lighting; recommissioning building systems; maximizing space utilization; rightsizing vehicle fleet; and replacing inefficient system machinery with high-efficiency components.

Some of the major actions to improve current infrastructure include:

- Develop policy/guidance for considering life-cycle costs for purchases of replacement machinery and parts related to energy and water consumption.
- Develop a strategic consolidation and demolition plan that considers requirements, utility savings, and financial savings targeted toward facilities with poor energy performance.

- Increase use of water meters to document use and expand use of water distribution system leak detection and repair.
- Actively seek to improve overall fleet average miles per gallon while achieving 2% annual reduction in fossil fuel consumption.
- Increase awareness and consideration of low-speed vehicles for replacing medium-to-heavy duty vehicles, such as utility pickup trucks, vans and maintenance vehicles.
- Continue testing hydrogen vehicles and infrastructure at select installations.

Improve Future Infrastructure

Air Force actions for better future infrastructure involve improving processes and applying sustainable energy-efficiency standards to accelerate the delivery of high-performance buildings, alternative-fuel vehicles, and supporting infrastructure.

Some of the major actions to improve future infrastructure include:

- Starting in FY 2009, ensure that 100% of new construction is capable of achieving LEED® Silver certification, 5% is certified LEED® Silver, and 10% is certified LEED® Silver in FY 2010 and beyond.
- Develop metrics and measurement capabilities to track energy performance.
- Convert 30% of fleet to low-speed vehicles.
- Procure/construct/sustain alternate fuel stations, including installation of at least 1 renewable fuel pump at each refueling center handling more than 100,000 gallons of fuel annually (Department of the Air Force 2008).

Expand Renewables

By promoting the development of renewable and alternative energy of use in facilities and ground vehicles and equipment, the Air Force seeks to have 25% of base energy consumption in FY 2025 be derived from on-base renewable generation. These efforts will increase energy supply, decrease stress on the national electrical grid, and provide security benefits to ensure the sustainability of military operations.

Some of the major actions to expand the use of renewable energy include:

- Construct on-base renewable energy production to achieve 1% of total Air Force consumption by FY 2012.
- Expand testing and deployment of hydrogen vehicles and fuel infrastructure where cost-effective.

Manage Costs

As the major energy user in the DoD, measures to reduce Air Force costs through utility terms, service and contract are of utmost importance. Cost planning, negotiation and litigation of utility rates, accounting management, timely bill payment, and cost-avoidance education are each important components of the Air Force cost management strategy.

Some of the major actions to address energy cost efficiency include:

- Perform utility acquisition evaluations at 10 bases annually to determine the best rate schedule and most favorable contract terms.
- Develop and implement a utility contract training program.
- Partner with DoD to advertise current rebates, incentives and credits for utilities and renewable energy to maximize use on Air Force installations.

Air Force Aviation

Efforts to improve the energy efficiency of Air Force aviation operations involve actions to meet the three major energy strategy components of reducing demand, increasing supply and changing culture.

Reducing Demand

To reduce demand, Air Force efforts are concentrated on improving aircraft design and operations. Optimized aerodynamic research into new aircraft wing and body configurations seek to reduce drag and associated fuel demand. The use of lighter and stronger alloy and composite materials in aircraft construction can reduce structural weight and improve fuel efficiency. Advancements in propulsion and engine technologies can result in improvements in the amount of thrust derived from each gallon of fuel, thereby improving fuel economy. Improvements in mission and route planning can reduce unnecessary flight time and fuel use. Increased use of flight simulators for training programs directly reduces fuel consumption while reducing the stress and maintenance fleet costs. Finally, the Air Force is seeking to maximize the use of advanced avionics and stealth unmanned aerial systems to accomplish missions with greater success at reduced energy consumption.

Increasing Supply

This component is mainly focused on developing implementation of alternative fuel sources. Currently, the Air Force has certified its entire B-52 fleet to operate on a 50/50 blend of synthetic fuel and JP-8 aviation fuel. This synthetic fuel is derived from coal, natural gas or biomass feedstocks. Testing with other Air Force aircraft is underway to evaluate the performance of this blend for wider use. This synthetic blend burns cleaner than conventional petroleum products and produces fewer particulates and no sulfur dioxide.

5.6.b Related Federal Partnership Programs

See Section 5.4, Buildings.

5.6.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will

most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

In reviewing DoD and service installation projects, Section 309 reviewers should consider highlighting energy efficiency commitments and project components against applicable DoD and service policies and guidance.

As installations routinely involve a variety of buildings and equipment, reviewers should consult other sections of this reference document specific to the components of the proposed action. Specific considerations to determine compliance with EPAct 2005 and EO 13423 include:

- Confirming applicable LEED® design and certification.
- Evaluation of results of energy audits, as applicable.
- Review of alternative fuel vehicle commitments. A good source of information is the annual AFV reports produced by each service found at: https://www.denix.osd.mil/portal/page/portal/denix/environment/AFV.
- Commitments to use of alternative and/or renewable sources of energy either generated on-site or procured from an outside energy provider.
- For an assessment of compliance with applicable building standards, reviewers should consult the DoD Unified Facilities Criteria program at http://www.wbdg.org/references/pa_DoD.php.

Under EISA 2007, agencies must identify all “covered facilities” that constitute at least 75% of the agency's facility energy use. A covered facility may be defined as "a group of facilities at a single location or multiple locations managed as an integrated operation." Section 431 of EISA requires that total energy use in federal buildings, relative to the 2005 level, be reduced 30% by 2015. DoD has identified “covered facilities” relative to EISA. Projects involving these facilities should receive additional scrutiny in terms of documentation of energy reduction and efficiency components. A list of EISA facilities is provided in the DoD Annual Energy Report at http://www.acq.osd.mil/ie/energy/energymgmt_report/main.shtml.

Section 5.6 References

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5.7 Laboratories

5.7.a Summary

Laboratories can be defined as buildings that contain areas where isolated operations are performed with hazardous/toxic or precious/delicate materials. This isolation is accomplished through the air balance/pressure relationship to adjacent areas. The pressure relationship is either negative for hazardous isolation for handling hazardous/toxic operations, or positive for protective isolation for handling precious/ delicate operations. Characteristics of the laboratory environment that are coupled tightly with energy use include ventilation rates, temperature requirements, humidity requirements, filtration efficiency, and fume hoods (LBNL 1996).

Cleanrooms are specially constructed enclosed areas that are environmentally controlled with respect to airborne particulates, temperature, humidity, air flow patterns, air motion, and lighting. They are sealed facilities with specialized air handling and filtration systems designed to minimize static electricity or the concentrations of particles and other contaminants that may interfere with scientific research, manufacturing, medical operations and other activities. (LBNL 1996).

Laboratories are sophisticated and complex environments that are designed to meet the special demands of experimental study, testing, and analysis and to provide safe environments for workers. This double mission means that laboratories must provide levels of safety, space conditioning, and indoor air quality not usually maintained in conventional office buildings. To this end, designs of research laboratories typically use far more energy and water per square foot than an office building (EPA 2009a). A study by Lawrence Berkeley National Laboratory (LBNL) noted that energy intensities are four to five times higher than those found in ordinary buildings in California. In the case of cleanrooms, intensities are 10-100 times higher, depending on the cleanliness classification (LBNL 1996).

Laboratories intended for research and those intended for production differ from an energy standpoint. Research laboratories (especially those located in university settings) have very irregular operating patterns, seasonally as well as diurnally. Because of this, the diversity of loads is of critical importance in design of HVAC systems. Energy management strategies based on control (of lighting, ventilation, etc.) offer particular promise in research laboratories where occupancy varies or the need for certain processes is sporadic (LBNL 1996).

Production laboratories, on the other hand, tend to be used very intensively. As a result, loads are relatively level. Around-the-clock operation is not uncommon, especially for cleanrooms where the importance of maintaining high-quality environmental conditions means that the ventilation is turned off only when absolutely necessary (even if there is a pause in the production process). Interruptions of production for the sake of energy-management interventions are far less acceptable in a (commercial) production laboratory where downtime is extremely costly. Lastly, in production laboratories energy costs are very small in proportion to the value of production, while in research laboratories they can represent a relatively high share of total costs (LBNL 1996).

DOE's National Laboratories and other facilities represent major laboratory-type facilities in many parts of the country, and represent the full range of laboratory functions. Energy data for the National Laboratories is compiled by DOE, and is reported annually according to FEMP requirements.

Recognition of load diversity is a key factor in energy-efficient laboratory design. Each laboratory facility will be operated in a unique manner commonly referred to as the "Profile of Use." Laboratory designers/operators must determine the potential variation of energy loads on hourly, daily, annual, and life-cycle bases and take steps to minimize these loads. The main energy loads that need to be minimized are:

- Thermal (sensible), e.g., heating and cooling;
- Latent, e.g., humidification or de-humidification;
- Air movement, e.g., fans and motors/drives;
- Circulation, e.g., pumps and motors/drives; and
- Miscellaneous support and peripheral equipment.

LBNL offers a list of barriers to energy efficient design. Barriers include:

- Using standard design practices that are based on old technologies or inaccurate assumptions.
- Conservative facility building culture, short supply of designers who are familiar with energy-efficiency concerns in laboratory facilities, and a risk of legal consequences if the laboratory's operation does not meet design specifications/design basis documents.
- Emphasizing initial cost of systems, instead of life-cycle costing.
- Lack of benchmarking of energy costs.
- Size limitations for code requirements that may adversely affect environmental conditioning system designs.
- Inadequate space may be available for energy-efficient equipment. Currently, the architect often designs the facility and then tells the engineers how much space they have. Early cooperation between the design team members is necessary to devise optimum configurations.
- Performance envelope specifications may limit possibilities for energy efficiency. When the performance envelope, i.e. operating range of the facility, can be expanded—for example, increasing the allowable relative humidity—lower initial costs and operational energy costs may result.

LBNL authored *A Design Guide for Energy-Efficient Research Laboratories* (http://ateam.lbl.gov/Design-Guide/), which uses a comprehensive systems design approach to improving energy efficiency. The guide emphasizes "right sizing," choosing the most efficient and cost effective combinations of equipment and equipment sizes as well as managing the laboratory load, to reduce energy consumption and operating costs. The guide also recommends building commissioning (see Section 5.4, Buildings) to maximize efficiency.

The guide also recommends:

- An energy monitoring and control system (EMCS) that incorporates direct digital control (DDC).
- Variable Frequency Drives (VFD). The VFD's lower air velocity reduces pressure loss and increases operating efficiency of a heat recovery device. When the laboratory is unoccupied, the air flow rate could be reduced by 50%, decreasing the energy consumption of the entire air handling system to less than 25% of that required for a conventional system.
- Modularized Plant Devices. Conditioning equipment can be designed in modules that can operate singly or together to meet part or full loads. Modules include multiple boilers and chillers that can have their operation staged to meet the load. Devices whose operation can be modulated include: variable air volume (VAV) supply and fume hood exhaust systems and variable frequency drives (VFDs) on fans and pumps.
- Segregating Tasks with Mini-Environments. Laboratory temperature and humidity design conditions are typically specified to satisfy both process and human comfort needs. Segregating critical areas with narrow environmental tolerances from other non-critical areas saves energy. One method is to subdivide systems and zones into mini-environments.
- Indirect-Direct Evaporative Cooling. The higher the allowable humidity, the greater the energy savings. As the allowable humidity range increases, the use of energy-efficient indirect-direct evaporative cooling becomes more appropriate. Laboratories in warmer climates benefit from raising the allowable relative humidity; laboratories in colder climates benefit most from lower minimum relative humidity specifications, as well as a wider range.
- Efficient Lighting. Lighting should be designed to incorporate both dedicated task illumination and general ambient lighting. High-efficiency lighting components, such as fluorescent lamps and solid state lighting, should be used. Lighting energy consumption can also be reduced by control systems that turn off lights based on occupancy or adjusts lighting in response to available natural light. In some laboratories, a remote lighting system provides the benefit of isolating a large portion of the lighting system from the laboratory space.
- Efficient Duct Systems. Small ductwork in laboratories is often routed circuitously, resulting in significant energy waste. The design of an energy-efficient air distribution system should be an iterative process which incorporates life-cycle cost. A key to saving energy is to reduce the friction loss of the air distribution system by using large-diameter, round ductwork, efficient fittings, lower coil and filter face velocities, and energy-efficient noise attenuators.
- Heat Recovery Ventilation. Energy recovery systems typically incorporate heat exchange equipment to reduce energy costs by extracting heat from the facility's exhaust air stream before it is vented outside. Energy recovery from the laboratory's exhaust should be considered when significant portions of operating hours are at ambient temperature of 50°F (10°C) and below. Another recoverable energy source is provided by chiller/DX condensers. Water cooled condensers can be piped to reject waste back into the lab's HVAC system to provide reheat capacity, to augment run-around coil systems, and to dry regenerative heat wheels. The four major energy recovery systems include run-around coil systems, regenerative heat wheels, heat pipes, and fixed-plate exchangers.

- Economizer Cooling. Laboratories, research facilities, clean rooms, and hospitals require large amounts of outside make-up air. These facilities can only benefit from economizers when the facility does not require 100 percent outside make-up air. Exhaust air from the facility may be added into this outside make-up air stream with an economizer to save energy. Inadequate mixing of the make-up air stream and the exhaust (return) air will defeat the function of economizer. Consequently, errors made by the mixed-air temperature sensor can increase annual energy consumption by as much as 30 to 50 percent. To maximize the savings from economizer system, proper blending and sensing of the air streams must occur.
- Demand-controlled ventilation. During periods of non-occupancy or low level of process activity in research laboratory or cleanroom facilities, recirculation ventilation rates can be reduced. Sensors can monitor and control ventilation rates, meeting occupant safety and process requirements and minimizing energy consumption. A great amount of "free" cooling can be realized by using a demand-controlled ventilation scheme the takes advantage of cooler evening temperatures.

Another reference for laboratories is the 2002 *Los Alamos National Laboratory Sustainable Design Guide* (http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/sustainable_guide_ch1.pdf), which focuses on issues and design processes for energy efficient buildings at LANL, and how these processes can be used for other laboratories.

5.7.b Related Federal Partnership Programs

Labs21

Laboratories for the 21st Century (Labs21) is a voluntary partnership program co-sponsored by EPA and DOE to improve the environmental performance of U.S. laboratories. It is open to all U.S. public and private sector laboratories, and provides training and technical assistance, including the *Design Guide for Energy Efficient Research Labs*, Best Practice Guides and Technical Bulletins on design, construction, and operation of specific energy efficiency and sustainable technologies for laboratories. The primary guiding principle of the Labs21 approach is that improving the energy efficiency and environmental performance requires examining the entire facility from a whole building perspective.

The program also offers a web-based Energy Benchmarking Tool (http://labs21.lbl.gov/) that allows laboratory owners to compare the performance of their laboratories to similar facilities and help identify potential energy cost savings opportunities.

The Labs21 Design Intent Tool (http://www.labs21century.gov/toolkit/intent_tool.htm) is a database that records design decisions that impact a lab's energy efficiency. Designers can plan, monitor, and verify that a facility's design intent is being met during each stage of the design process. Additionally, the tool gives commissioning agents, facility operators, and future renovators an understanding of how the building, and its subsystems, were, and are, intended to operate. Thus, tracking and benchmarking energy efficiency performance is enhanced.

The *Labs21 Design Process Manual* (http://www.labs21century.gov/toolkit/process_manual.htm) is a web-based tool that provides step-by-step guidance of the design process for a high-performance laboratory, leveraging all of the other Labs21 tools. Highlights include a checklist of action items for each stage of the building design and delivery process, with links to relevant Labs21 tools, and a quick-reference list of sustainable design strategies, with links to Labs21 EPC credits, Best Practice Guides, Design Guide, and case studies.

The Labs21 Environmental Performance Criteria (EPC) is a rating system specifically designed for laboratory facilities. It builds on the LEED® Green Building Rating System. The EPC was produced by a series of working groups that included architects, engineers, facility managers, and health and safety professionals. The EPC has been recently updated to version 2.2 and is available at: http://www.labs21century.gov/toolkit/epc.htm.

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

5.7.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

See Section 5.4, Buildings for Review Considerations for new construction and retrofitting of federal buildings.

The first step for reviewers will be to understand the purpose of the proposed laboratory or proposed changes to an existing laboratory. Reviewers should be aware of the different energy needs/issues related to research and production laboratories. Research laboratories will need to account for irregular operating patterns in planning to minimize energy use, while production laboratories will have an intensive, and more constant energy load.

Reviewers may want to suggest that laboratories achieve certification under LEED® for Laboratories, and/or complete the checklist for the related Labs21 Environmental Performance Criteria (EPC) rating system.

Reviewers should review the LBNL list of barriers to energy efficiency at laboratories listed above, and identify any barriers present in the proposed project. The LBNL Labs 21 *Design Guide for Energy-Efficient Research Laboratories* (http://ateam.lbl.gov/Design-Guide/)(as well as Best Practice Guides and Technical Bulletins) offer comprehensive, specific recommendations for reviewing proposed projects from an energy efficiency standpoint.

The Labs21 federal partnership program also offers a number of tools that Reviewers can recommend, including the Energy Benchmarking Tool, Design Intent Tool, and Design Process Manual.

Section 5.7 References

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5.8 Industrial Facilities

5.8.a Summary

Industry is a large and diverse energy-consuming sector in the United States. As of 2007, industry was responsible for more than one-fifth of U.S. energy consumption (see Figure 1-2) (EIA 2007, DOE 2003). Approximately 8 percent of this energy is lost during power generation and transmission before electricity arrives at industrial plants. Natural gas, petroleum products, and electricity comprise the major energy sources used to heat and power U.S. factories, farms, mining, and construction operations. In addition to heat and power, industry uses fossil fuels as feedstock to produce industrial materials and products such as chemicals and plastics (DOE 2003).

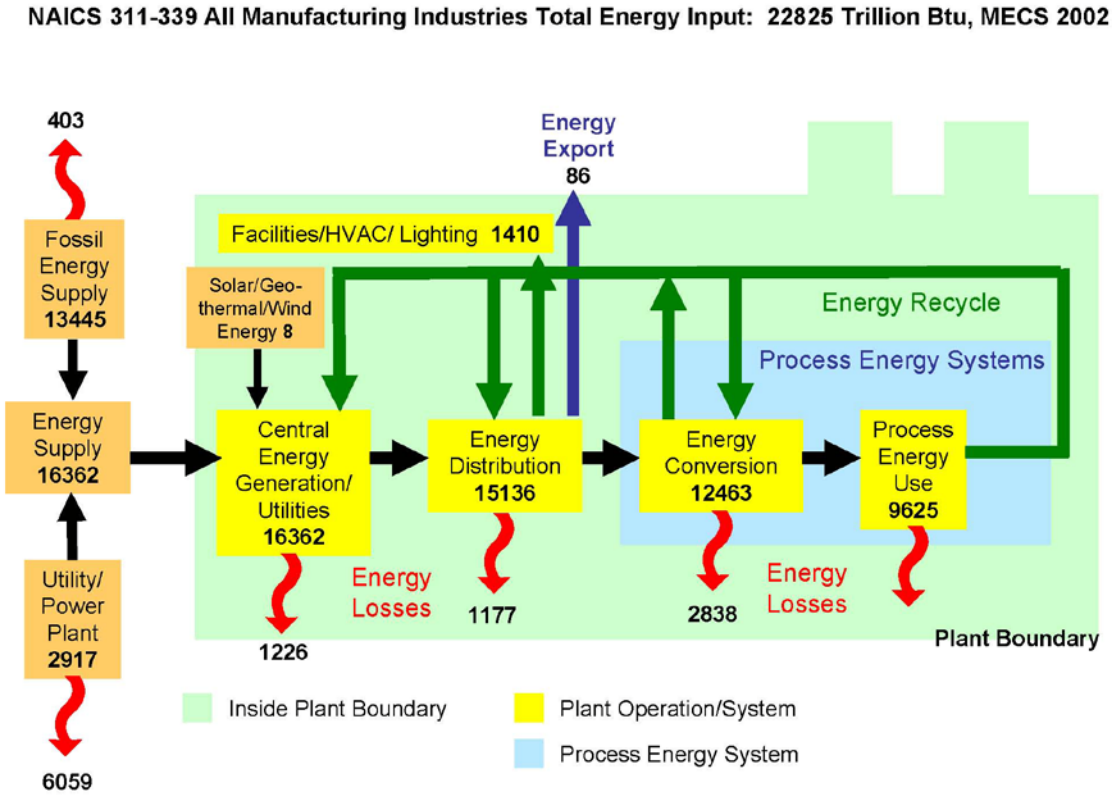
Unlike other sectors, energy use in industry is often determined by the specific industrial process in use. These inherent variations inhibit a "one-size-fits-all" approach to energy efficiency. However, some important energy applications are common across industry. As a result, industrial energy efficiency opportunities exist in both process-specific and crosscutting energy systems (DOE 2003).

As part of its Industrial Technologies Program (see 5.8.b Related Federal Partnership Programs), DOE creates energy footprints that map the flow of energy supply, demand, and losses in U.S. manufacturing industries. Identifying the sources and end uses of energy helps to pinpoint areas of energy-saving opportunities, and provides a baseline to calculate the benefits of improving energy efficiency. Each footprint represents an average picture of energy use for each industry and illustrates:

- The portion of energy that is purchased from utilities, generated onsite, and transported to the local grid.
- Where and how energy is used within a typical plant.
- Where energy is lost due to inefficiencies, both inside and outside the plant.

Energy losses shown on the footprints indicate immediate opportunities to improve efficiency and lower energy consumption by implementing best energy management practices, improved energy systems, and new technology (DOE 2009m). Figures 5-4 through 5-6 show the energy footprints in three levels of detail for the manufacturing sector as a whole. Footprints are also available for specific industries at:
http://www1.eere.energy.gov/industry/program_areas/footprints.html.

Figure 5-4



Source: (DOE 2009m).

Figure 5-5

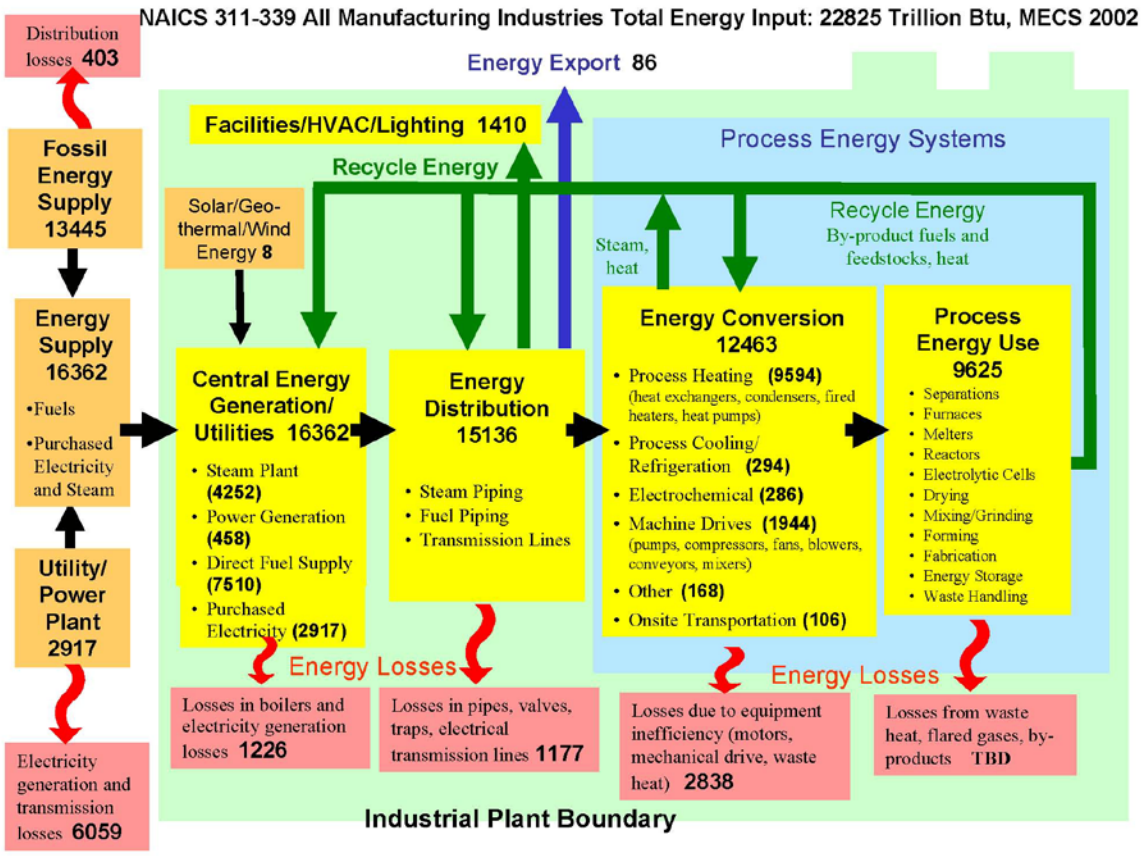
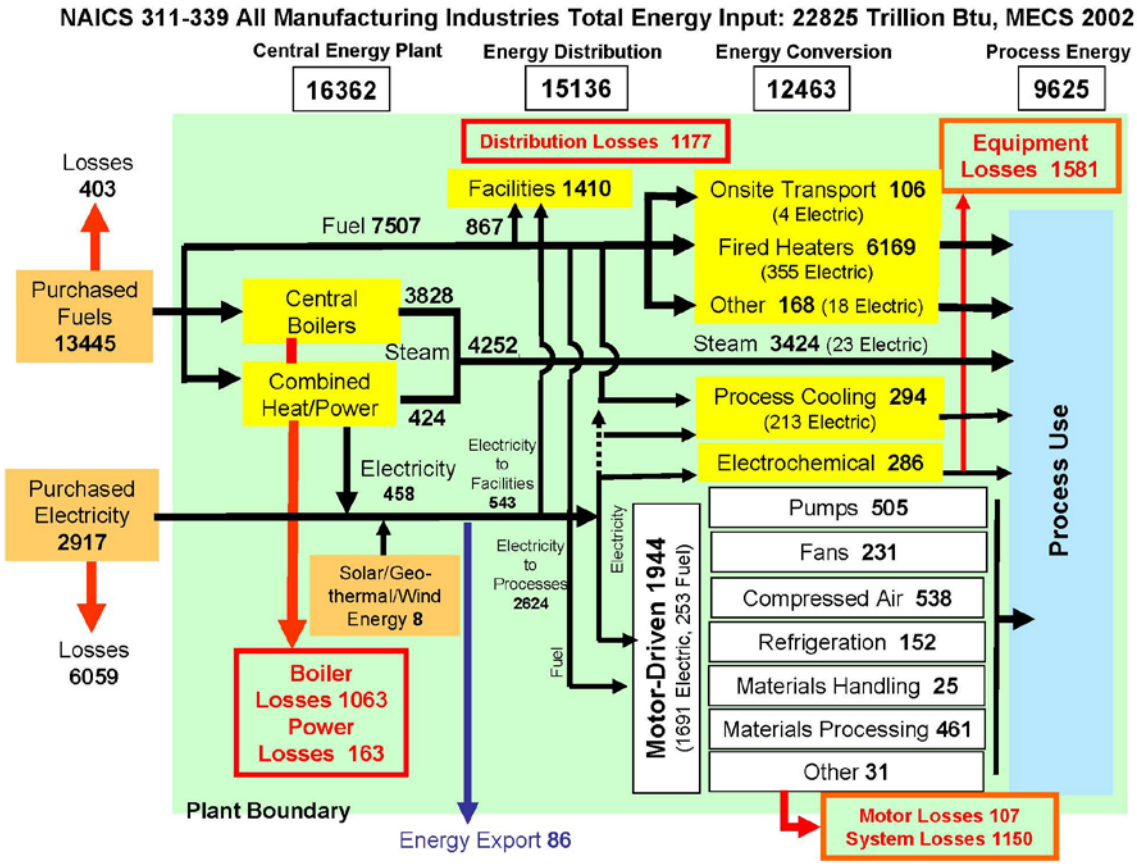

NAICS 311-339 All Manufacturing Industries Total Energy Input: 22825 Trillion Btu, MECS 2002
Distribution losses 403
Energy Export 86
Fossil Energy Supply 13445
Facilities/HVAC/Lighting 1410
Recycle Energy
Process Energy Systems
Solar/Geo-thermal/Wind Energy 8
Steam, heat
Recycle Energy
By-product fuels and feedstocks, heat
Energy Supply 16362
•Fuels
•Purchased Electricity and Steam
Central Energy Generation/ Utilities 16362
• Steam Plant (4252)
• Power Generation (458)
• Direct Fuel Supply (7510)
• Purchased Electricity (2917)
Energy Distribution 15136
• Steam Piping
• Fuel Piping
• Transmission Lines
Energy Conversion 12463
• Process Heating (9594) (heat exchangers, condensers, fired heaters, heat pumps)
• Process Cooling/ Refrigeration (294)
• Electrochemical (286)
• Machine Drives (1944) (pumps, compressors, fans, blowers, conveyors, mixers)
• Other (168)
• Onsite Transportation (106)
Process Energy Use 9625
• Separations
• Furnaces
• Melters
• Reactors
• Electrolytic Cells
• Drying
• Mixing/Grinding
• Forming
• Fabrication
• Energy Storage
• Waste Handling
Utility/ Power Plant 2917
Energy Losses
Energy Losses
Losses in boilers and electricity generation losses 1226
Losses in pipes, valves, traps, electrical transmission lines 1177
Losses due to equipment inefficiency (motors, mechanical drive, waste heat) 2838
Losses from waste heat, flared gases, by-products TBD
Electricity generation and transmission losses 6059
Industrial Plant Boundary

Figure 5-6



Many industrial waste products can be recycled. When materials are reused or recycled, energy use is avoided. In addition, virgin resources are conserved and virgin mining impacts are avoided. Table 5-6 lists secondary use markets for common industrial waste products.

Table 5.6 Secondary Use Markets for Various Industrial Waste Products

REUSE / RECYCLED MATERIAL	BENEFICIAL USE	
	Product / Function	**Infrastructure Application**
Coal Fly Ash *Mostly inorganic material left after combustion of coal to produce electricity. 75 million tons are produced per year. About 45% is reused.* *Exhibits pozzolanic properties and can serve as supplementary cementitious material (SCM). Particles are fine and spherical which modifies the handling*	**SCM Binder** *Substitute for some Portland cement binder. Reduces CO2 footprint of PC calcination; conserves resources and reduces impacts of mining limestone (CaCo3)* *Benefits can include increased strength, resistance to deterioration, higher durability, less water use, greater water*	Portland Cement Concrete (PCC) Pavement Cement-stabilized Road Base Portland cement concrete (PCC) Highway Support Structures & Bridges Flowable Fill

Table 5.6 Secondary Use Markets for Various Industrial Waste Products		
REUSE / RECYCLED MATERIAL	**BENEFICIAL USE**	
	Product / Function	**Infrastructure Application**
properties of products in which it is contained. *Air scrubbing byproducts, such as gypsum from flue gas desulphurization, are produced by coal plants independently of and in addition to fly ash. About 40 million tons of scrubber byproducts are produced in the U.S. each year.*	*impermeability, better plasticity/handling, and lower cost.*	
	Encapsulated Aggregate *The bulk, graded material held together by binder in concrete. Conserves virgin resources and reduces virgin mining impacts*	PCC Pavement
		Cement stabilized Road Base
		Portland cement concrete (PCC) Highway Support Structures & Bridges
		Asphalt Concrete Pavement
		Flowable Fill
	Unencapsulated Aggregate or Fill *Unbound earthen material used to fill, support, stabilize, or condition soils. Reuse conserves virgin resources and reduces virgin mining impacts*	Roadway Base or Subbase
		Flowable fill
		Structural fill
		Soil stabilization
		Landscaping
Iron Blast Furnace or Steel Slag *The inorganic material removed when iron ore is purified to iron metal. Involves calcinations of calcium carbonate. Exhibits pozzolanic properties and can serve as a supplementary cementitious material (SCM)* *Almost all slag is reused (95%) in the U.S.*	**SCM Binder** *Substitute for some Portland cement binder. Reduces CO2 footprint of PC calcination; conserves resources and reduces impacts of mining limestone (CaCo3)* *Benefits can include increased strength, resistance to deterioration, higher durability, less water use, and lower cost.* *Only the quick-quench, or water-cooled form of slag has SCM properties, once ground and granulated. It has a highly spherical shape. Air cooled slag does not have these qualities.*	Portland Cement Concrete (PCC) Pavement
		Cement-stabilized Road Base
		Portland cement concrete (PCC) Highway Support Structures & Bridges
		Flowable Fill
	Encapsulated Aggregate *The bulk, graded material held together by binder in concrete. Conserves virgin resources and reduces virgin mining impacts* *The slag for this purpose is generally aircooled, and angular in shape.*	PCC Pavement
		Cement stabilized Road Base
		Portland cement concrete (PCC) Highway Support Structures & Bridges
		Asphalt Concrete Pavement
		Flowable Fill
	Unencapsulated Aggregate or Fill *Unbound earthen material used to fill, support, stabilize, or condition. Reuse conserves virgin resources and reduces virgin*	Roadway Base or Subbase
		Flowable fill
		Structural fill in embankments, behind walls, in trenches, etc.
		Soil stabilization
		Landscaping

Table 5.6 Secondary Use Markets for Various Industrial Waste Products		
REUSE / RECYCLED MATERIAL	**BENEFICIAL USE**	
	Product / Function	**Infrastructure Application**
	mining impacts. *The slag for this purpose is generally aircooled, and angular in shape.*	Anti-Skid Surfaces
Silica Fume *A very finely powdered material produced by condensing smoke generated by electric arc furnaces in the metallurgical industry. Exhibits pozzolanic properties and can serve as a supplementary cementitious material (SCM)*	**SCM Binder** *Substitute for some Portland cement binder. Reduces CO2 footprint of PC calcination; conserves resources and reduces impacts of mining limestone (CaCo3)* *Benefits can include increased strength, resistance to deterioration, higher durability, less water use, and lower cost.*	Portland Cement Concrete (PCC) Pavement Cement-stabilized Road Base Portland cement concrete (PCC) Highway Support Structures & Bridges Flowable Fill
Foundry Casting Sand *Foundries cast metal parts by pouring molten metal into casting molds composed of sands that are held together with binders such as clay+ coal or isocyanate. They can be reused for up to 100 casts, but then loose critical properties. The sands have very uniform grain size.* *About 10 million tons of foundry spent casting sands are generated in the U.S. each year. About 30% are reused.*	**Encapsulated Aggregate** *The bulk, graded material held together by binder in concrete. Conserves virgin resources and reduces virgin mining impacts*	PCC Pavement Cement stabilized Road Base Portland cement concrete (PCC) Highway Support Structures & Bridges Asphalt Concrete Pavement Flowable Fill
	Unencapsulated Aggregate and Fill *Unbound earthen material used to fill, support, stabilize, or condition. Reuse conserves virgin resources and reduces virgin mining impacts.*	Roadway Base or Subbase Flowable Fill Structural fill Soil stabilization Landscaping
Glass *Some data suggests that very finely pulverized colored waste glass may possess pozzolanic properties so that it can be used as a supplementary cementitious material.* *It may be usable as an aggregate, as well. There is some question as to whether this is its highest and best use, however.*	**SCM Binder (Potential)** *Only very finely pulverized glass with good quality control can potentially be used for this purpose.* *Substitute for some Portland cement binder. Reduces CO2 footprint of PC calcination; conserves resources and reduces impacts of mining limestone (CaCo3)* *Benefits can include increased strength, resistance to deterioration, higher durability, less water use, greater water impermeability, better plasticity/handling, and lower cost.*	Portland Cement Concrete (PCC) Pavement Cement-stabilized Road Base Portland cement concrete (PCC) Highway Support Structures & Bridges Flowable Fill

Table 5.6 Secondary Use Markets for Various Industrial Waste Products		
REUSE / RECYCLED MATERIAL	**BENEFICIAL USE**	
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	Encapsulated Aggregate *The bulk, graded material held together by binder in concrete. Conserves virgin resources and reduces virgin mining impacts*	PCC Pavement
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		Portland cement concrete (PCC) Highway Support Structures & Bridges
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		Flowable Fill
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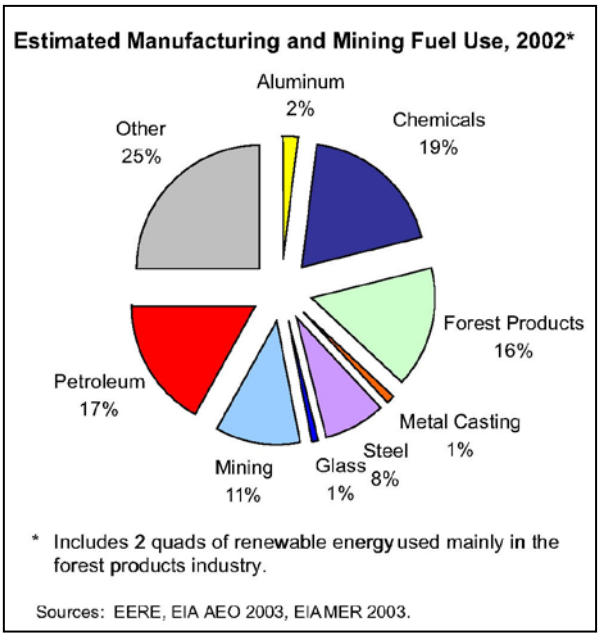
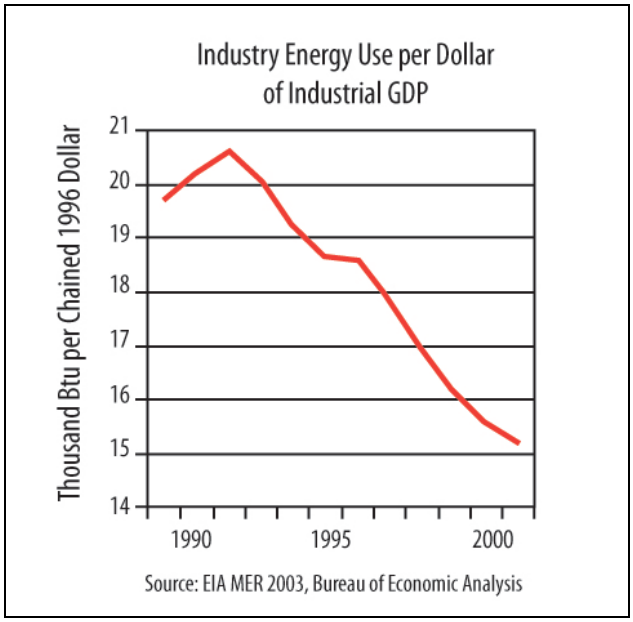
		Flowable fill
		Structural fill
		Soil stabilization
		Landscaping

Within manufacturing, 8 of the 21 major U.S. industries (including mining) account for more than 85% of all energy use. These industries also tend to be energy-intensive, using large amounts of energy per dollar of product output. Energy intensity is the single most important indicator of energy efficiency in industry. The DOE Policy Office determined that more efficient manufacturing delivered the largest component of total U.S. energy savings from 1970 to 1988 (Figure 5-7) (DOE 2003).

Figure 5-7





A brief overview of the eight major energy intensive U.S. industries follows, with links to current industry-specific energy efficiency research and development.

Aluminum

The aluminum industry is responsible for approximately 2.8 percent of the total manufacturing energy consumed in the United States and 1.6 percent of all U.S. electricity consumption. Energy-intensive operations consist of the primary aluminum production from ore, secondary aluminum production from scrap, shape casting, rolling, and extrusion (DOE 2005a). The melting and thermal operations used in primary and secondary metal production provide large opportunities for energy efficiency improvement. More information on the aluminum industry's energy efficiency vision, roadmap, and current energy efficiency research and development projects can be found at: http://www1.eere.energy.gov/industry/aluminum/.

Chemicals

The U.S. chemical industry is the largest in the world. It converts raw materials (oil, natural gas, air, water, metals, and minerals) into more than 70,000 different products. Chemicals are used to make a wide variety of consumer goods, as well as thousands of inputs to agriculture, manufacturing, construction, and service industries. Major industrial customers include rubber and plastic products, textiles, apparel, petroleum refining, pulp and paper, and primary metals (EIA 2009a).

While the U.S. chemical industry has significantly reduced energy consumption in the past several decades, it still consumes close to 25 percent of all manufacturing energy use (EIA 2009a). The chemicals industry is energy intensive because processes involve a series of

reactions, followed by the separation of the desired product. Currently, most industrial chemical reactions have low conversion and selectivities – and thus low product output. Higher quantities of product require more reactions, which makes processes very energy- and capital-intensive. Current R&D strategy in the chemical industry focuses heavily on improving reaction conversion and selectivities, and investigating ways to improve the efficiency of separation processes.

In 1996, chemical industry leaders articulated a long-term vision for the industry in the *Technology Vision 2020—The U.S. Chemical Industry*. This vision, along with the DOE Industrial Technologies Program (ITP) roadmap, is used to guide energy efficiency research (DOE 2009c). More information can be found at: http://www1.eere.energy.gov/industry/chemicals/index.html.

Forest Products

In the forest products industry, transforming whole trees into lumber and wood products or into pulp and paper products requires physical and chemical processes that are often highly energy-intensive. Pulp and paper mills account for the largest share of energy use in the industry, mainly due to the amount of energy required to evaporate the large quantities of water used to form the pulp slurry and the paper web. Although the industry self-generated close to 40% of its energy needs by 1998, it is still the third largest user of fossil energy in the U.S. manufacturing sector (DOE 2009g).

The forest products industry roadmap states that the industry will use emerging technologies, such as biotechnology and nanotechnology, as well as advances in manufacturing process technologies improve efficiency. The industry has focused research efforts into converting existing mills into "biorefineries" that are energy self-sufficient and produce biomass-derived products—including traditional wood and paper products, wholesale electricity, fuels, and chemicals—using manufacturing by-products, forest residues, and/or agriculture residues as feedstock (DOE 2006). More information on energy efficiency research and development in the forest products industry can be found at: http://www1.eere.energy.gov/industry/forest/index.html.

Glassmaking

Glass products are used in food and beverage packaging, lighting, communications, transportation, and building construction. The four sectors of the glass industry – container, flat, specialty, and fiberglass – produce over 20 million tons of glass annually. Glassmaking is a relatively energy-intensive industry, primarily due to the large amount of energy required to melt and refine glass. ITP is currently sponsoring cost-shared research and development of alternative methods for melting and refining glass. In addition, some air emissions from glassmaking processes are hazardous or toxic and must be controlled through energy-intensive incineration.

In January 1996, the glass industry published *Glass: A Clear Vision for a Bright Future*, which articulated the industry's future vision, and in 2002 the industry and ITP published the *Glass*

Industry Technology Roadmap. More information can be found at: http://www1.eere.energy.gov/industry/glass/index.html.

Metal Casting

More than 90 percent of all manufactured goods and capital equipment use metal castings as engineered components or rely on castings for their manufacture. The metal casting industry produces both simple and complex components of numerous varieties. In addition to producing components of larger products, foundries may also do machining, assembling, and coating of the castings. As of 2009, there were nearly 3,000 metal casting foundries operating in all 50 states (EIA 2009b). Major end-use applications for castings include power generation equipment, defense systems and machinery, motor vehicles, transportation equipment, oil field machinery, pipelines, industrial machinery, construction materials, and other products (DOE 2005c).

The basic metal casting process consists of pouring or injecting molten metal into a mold or die containing a cavity of the desired shape. The most commonly used method for small- and medium-sized castings is green sand molding, accounting for approximately 60 percent of castings produced. Other methods include die casting, shell molding, permanent molding, investment casting, lost foam casting, and squeeze casting (DOE 2005c). The major energy-consuming processes in the metal casting industry include melting of metal, coremaking, moldmaking, heat treatment, and post-cast activities (DOE 2009j).

DOE and the metal casting industry have grouped energy efficiency research into three categories:

- Advanced Melting: Research that establishes new melting practices, and/or new design methodologies to significantly improve the energy efficiency of melting and save costs for metal casters. Research in this area will improve melt efficiency, reduce metal transfer heat loss, reduce scrap/revert, and improve mold yield.

- Innovative Casting: Research that advances energy-efficient casting processes and practices that will increase yield and reduce scrap. Research in this area is developing accurate simulation tools, the ability to produce thin-wall, high-performance castings, real-time sensors and controls, improvements in rapid prototyping, and expanding the knowledge base of various material properties and performances.

- R&D Integration and System Analysis: Integration of applicable ITP technologies for improving energy efficiency and reducing emissions in metal casting practices. This includes other ITP portfolios and ITP's Best Practices program for energy demand management (DOE 2005c).

The metal casting industry vision and roadmap, along with analysis of energy use in the industry, can be found at: http://www1.eere.energy.gov/industry/metalcasting/index.html.

Mining

Materials mined in the U.S. mining industry include:

- Coal: defined as a combustible rock containing more than 50 percent by weight and more than 70 percent by value of carbon materials, including inherent moisture.
- Metals: defined as opaque lustrous elemental substances that are good conductors of heat and electricity. Metals are also malleable and ductile, have high melting and boiling points, and tend to form positive ions and chemical compounds.
- Industrial Minerals: defined as rocks and minerals not produced as sources of metals. Industrial minerals include stone, sand and gravel (DOE 2005d).

Surface and underground mining are the two extraction methods used by the mining industry. The method selected depends on a variety of factors, including the nature and location of the deposit, as well as the size, depth and grade of the minerals. Both surface and underground mining are used widely in the extraction of coal. Most of the industrial minerals in the United States are extracted by surface mining.

Energy-intensive processes in the mining industry include materials handling, ore crushing and separation, processing, and extraction. Energy requirements include electricity for ventilation systems, water pumping, and crushing and grinding operations. Diesel fuel is used for hauling and other transportation needs.

Several analytical studies provide the basis for energy efficiency research and development decision making in the mining industry's partnership with DOE, including the 1999 *Crosscutting Technologies Roadmap*, the 2000 *Mineral Processing Technologies Roadmap*, and the 2002 *Exploration and Mining Technologies Roadmap*. In addition, the DOE Industry of the Future vision, Energy and Environmental Profile, Bandwidth and Energy Footprint studies have focused R&D efforts. These studies were developed using both government and industry data and information, and are available at the DOE website: http://www1.eere.energy.gov/industry/mining/index.html.

In 2003, a mining industry energy analysis was completed in partnership with DOE. This analysis demonstrated that the largest opportunities for energy savings in mining were materials handling, beneficiation and processing, and extraction. Diesel technologies consumed the highest amount of energy in materials handling, accounting for 87 percent of the energy used. Comminution activities – or crushing and grinding – were the largest energy consumers in beneficiation and processing, accounting for 75 percent of the energy used. Finally, pumping consumed the most energy in extraction, accounting for 41 percent. Although materials handling, and beneficiation and processing consume the largest amount of energy, improvements in extraction could reduce downstream materials handling and processing, reducing energy needs (DOE 2005d). More information on the energy analysis can be found at: http://www1.eere.energy.gov/industry/mining/analysis.html.

Petroleum Refining

Petroleum refining is the largest industrial user of energy in the United States. It is both the country's single largest source of energy products, supplying 39% of total U.S. energy demand and 97% of transportation fuels, and the largest industrial consumer, representing about 7.5 percent of total U.S. energy consumption (DOE 2009l). The U.S. uses two times more petroleum than either coal or natural gas and four times more than nuclear power or renewable energy sources.

Before petroleum can be used, it is sent to a refinery where it is physically, thermally, and chemically separated into fractions and then converted into finished products. About 90 percent of these products are fuels such as gasoline, aviation fuels, distillate and residual oil, liquefied petroleum gas (LPG), coke, and kerosene. Refineries also produce non-fuel products, including petrochemicals, asphalt, road oil, lubricants, solvents, and wax. Petrochemicals (ethylene, propylene, benzene, and others) are shipped to chemical plants, where they are used to manufacture chemicals and plastics (EIA 2009c). The United States has nearly 150 refineries that can process anywhere between 5,000 and 500,000 barrels of oil per day.

Although the industry relies heavily on refining process by-products as energy sources, energy expenditures still represent a significant portion of manufacturing costs for petroleum refiners. The DOE Petroleum Refining Industries of the Future program is currently not funding any active projects and has no solicitations planned for the near future. ITP funding has been redirected to areas that are less inclined to attract private investment without federal leadership. However, as a former participant in the program, the U.S. petroleum refining industry set a vision and roadmap to define its R&D priorities, and developed a portfolio of energy efficiency related projects. Currently, the petroleum refining industry is pursuing its own R&D portfolio. Many of the collaborative R&D projects completed through its Industry of the Future partnership continue to yield benefits to the industry. In addition, many of the publications, tip sheets, software tools, and other resources developed through the partnership are in active use at U.S. refineries (DOE 2009l). More information can be found at: http://www1.eere.energy.gov/industry/petroleum_refining/index.html.

Steel

The steel industry accounts for 2-3% of total U.S. energy consumption. Steel is produced via two different routes, both of which are energy-intensive: using blast furnaces or electric arc furnaces. Integrated or blast furnace facilities are ore-based, and electric arc furnace facilities are primarily scrap-based. Ohio, Indiana, Pennsylvania, Illinois, and Michigan have the highest concentration of steel industry facilities (EIA 2009d). About half of steel industry facilities currently conduct energy-management activities (DOE 2009n).

The U.S. iron and steel industry relies heavily on coal and natural gas for fuel. In 1998 the industry used approximately 7% of all U.S. manufacturing energy use and 2% of domestic energy use. The industry has made significant improvements in energy efficiency, reducing energy use per unit of output by over 45% since 1975. Additionally, steel is now the most recycled material in North America, with an overall recycling rate of 67% (DOE 2009n).

The steel industry has created a vision and roadmap for energy efficiency research and development, in partnership with DOE. Technologies that improve the efficiency of furnaces and other process heating systems have significant potential to reduce overall steel industry energy use. The three major R&D focus areas are:

- Cokeless Ironmaking
- Next Generation Steelmaking
- Advanced Process Development

More information on these research areas, as well as the steel industry's energy analysis and related publications, can be found at: http://www1.eere.energy.gov/industry/steel/index.html.

5.8.b Related Federal Partnership Programs

Industrial Technologies Program (ITP)

The DOE Industrial Technologies Program (ITP) supports public/private partnerships to improve industrial energy efficiency and environmental performance. The program has four major elements: Energy Intensive Industries R&D, Crosscutting Technologies R&D, Best Practices, and Industrial Assessment Centers.

Energy Intensive Industries

Energy Intensive Industries supports research partnerships to reduce energy consumption for the country's most energy-intensive industries: aluminum, chemicals, forest products, glass, metal casting, mining, petroleum refining, and steel. These industries participate in the DOE Industries of the Future process, which helps an entire industry articulate its long-term goals and publish them in a unified vision for the future. To achieve that vision, industry leaders jointly define detailed R&D agendas known as roadmaps. Roadmaps are used to identify opportunities for industry collaboration and to guide Federal R&D spending. ITP relies on roadmap-defined priorities to target cost-shared solicitations and guide development of an R&D portfolio that yields results in the near-, mid-, and long-term.

As part of the Energy Intensive Industries area, ITP regularly conducts energy analyses for each of the eight Industries of the Future to identify energy savings opportunities. These analyses include Energy and Environmental Profiles, as well as Energy Footprints, for each industry. Energy Footprints map the flow of energy supply, demand, and losses in U.S. manufacturing industries. Identifying the sources and end uses of energy helps to pinpoint areas of energy-saving opportunities, and provides a baseline to calculate the benefits of improving energy efficiency. Although actual energy use in a plant will vary, each footprint represents an average picture of energy use for each industry and illustrates:

- The portion of energy that is purchased from utilities, generated onsite, and transported to the local grid.
- Where and how energy is used within a typical plant.

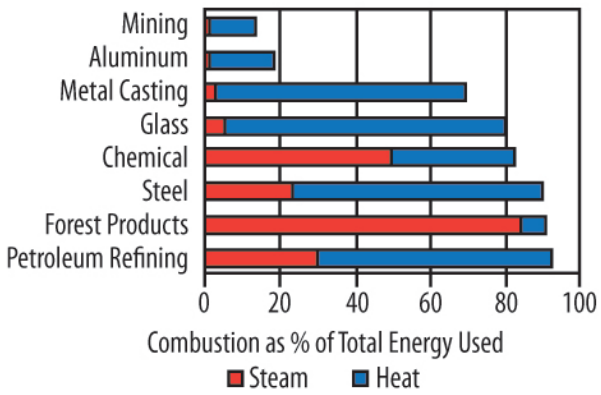
- Where energy is lost due to inefficiencies, both inside and outside the plant. Energy losses shown on the footprints indicate immediate opportunities to improve efficiency and lower energy consumption by implementing best energy management practices, improved energy systems, and new technology. Links to the energy analyses pages for each industry are:
    - Aluminum: http://www1.eere.energy.gov/industry/aluminum/analysis.html
    - Chemicals: http://www1.eere.energy.gov/industry/chemicals/analysis.html
    - Forest products: http://www1.eere.energy.gov/industry/forest/analysis.html
    - Glass: http://www1.eere.energy.gov/industry/glass/analysis.html
    - Metal Casting: http://www1.eere.energy.gov/industry/metalcasting/analysis.html
    - Mining: http://www1.eere.energy.gov/industry/mining/analysis.html
    - Petroleum Refining: http://www1.eere.energy.gov/industry/petroleum_refining/analysis.html
    - Steel: http://www1.eere.energy.gov/industry/steel/analysis.html.

Crosscutting Technologies

ITP conducts R&D to improve efficiency of technologies that are common to many industrial processes and can benefit multiple industries. Because of the widespread application of these crosscutting systems, even small improvements in their efficiency can yield large energy savings. In addition to research, ITP provides cost-shared funding for related projects identified as priorities by specific industries. DOE is currently conducting research on the following crosscutting technologies:

Combustion. U.S. industries rely on combustion systems for heat and steam generation. Combustion systems account for nearly three-quarters of all energy used in U.S. manufacturing. Combustion components and systems offer opportunities for significant energy and emissions savings in almost every industry (Figure 5-8) (DOE 2009d).

Figure 5-8



Source: (DOE 2009).

Manufacturers and users of burners, boilers, furnaces, and other process heating equipment partnered with DOE to create a vision and roadmap for improving the energy efficiency of combustion technology, and many subsequent demonstration projects have achieved substantial energy savings. More information on these projects can be found at: http://www1.eere.energy.gov/industry/combustion/index.html.

Distributed Energy

Combined Heat and Power (CHP) involves the sequential process of producing and utilizing electricity and thermal energy from a single fuel. CHP is widely recognized to save energy and costs, while reducing carbon dioxide and other pollutants. CHP is a realistic, near-term option for large energy efficiency improvements and significant CO_2 reductions.

While CHP is a well-established practice in large industrial processes with sizable electricity and thermal loads, DOE analyses indicate a largely untapped potential exists for applications less than 50 megawatts in electrical demand. Increased CHP deployment could help contribute to a 25% reduction in U.S. industrial energy intensity by 2017 and an 18% reduction in U.S. carbon intensity by 2012 (DOE 2009e).

CHP technology uses several distinct names (e.g., cogeneration, Combined Cooling, Heating and Power (CCHP), Building Combined Heat and Power (BCHP), Distributed Energy Resources (DER), and Integrated Energy Systems (IES)). CHP and cogeneration are basically the same thing, although cogeneration has been identified with district heating and large utility owned power plants or industrial power production and plant operation. CHP is generally a smaller scale, privately owned operation. CCHP stresses that combined cooling, heating, and power production occur, whereas combined heating and power in CHP may or may not use the recovered heat for cooling purposes. BCHP is just CHP applied to a building as opposed to a district heating system or industrial process. DER is distributed energy resources, the use of small generating facilities distributed close to the consumers either with or without heat recovery. IES is an integrated energy system that recovers waste heat from on-site or near-site power generation to provide hot water, steam, heating, cooling, or dehumidifying air for buildings (DOE 2009e).

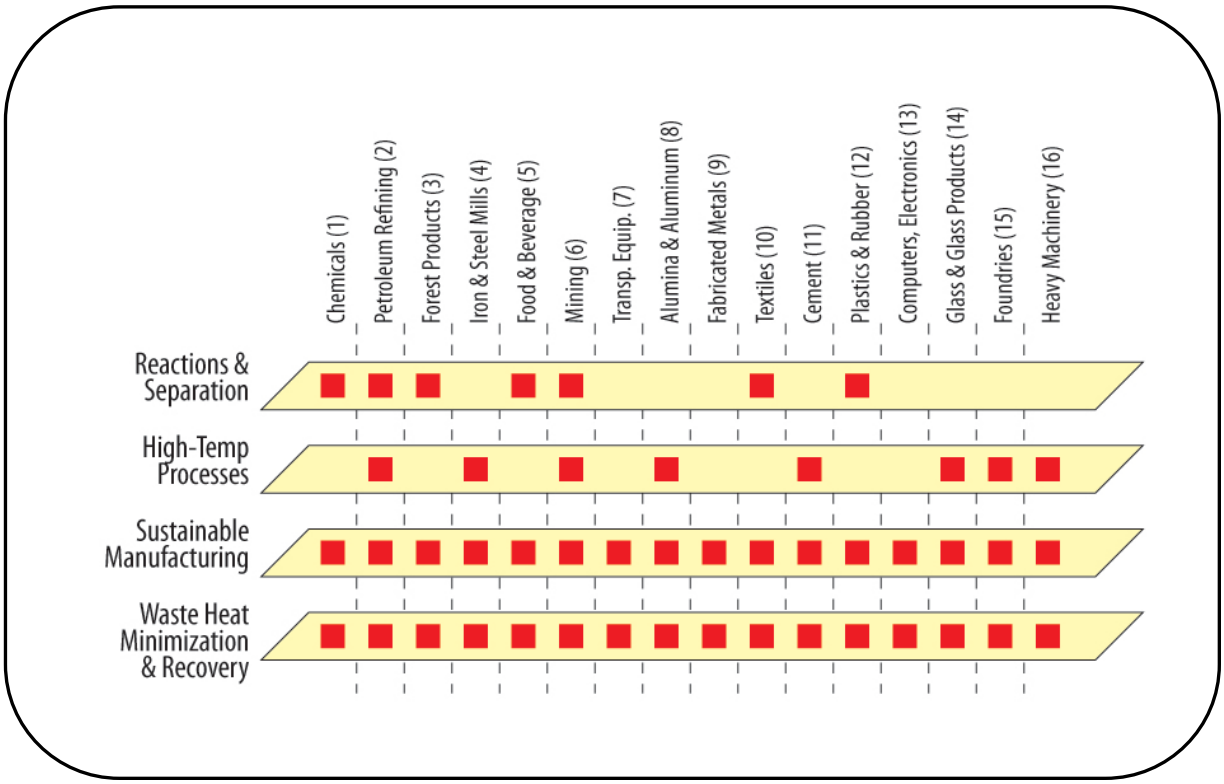
DOE provides support for conducting CHP market assessments, including market analyses of CHP potential in supermarkets, restaurants, health care facilities, industrial sites, hotels and motels, and new commercial and institutional buildings and facilities used for infrastructure resiliency. Many of these assessments have led to the installation of CHP components and systems in hospitals, schools, university campuses, commercial and industrial sites, and at military installations, wastewater treatment facilities, office buildings, and farms.

The Oak Ridge National Laboratory 2008 report on CHP, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future*, summarizes the latest technological advances. The report and more information on CHP can be found at: http://www1.eere.energy.gov/industry/distributedenergy/index.html.

Energy Intensive Processes

This crosscutting research area focuses on the four top energy consuming technology platforms: industrial reactions and separation, high-temperature processing, waste heat minimization and recovery, and sustainable manufacturing. Figure 5-9 shows the four technology platforms and their relationship with all industrial sectors (ranked by fuel and electricity use) (DOE 2009f).

Figure 5-9



Source: (DOE 2009).

Focus areas for industrial reactions and separations include advanced water removal, gas separations, hybrid distillation, and energy-intensive conversions. High-temperature processing focuses on the development of new materials, material processing, and process monitoring technologies that increase energy efficiency during high-temperature processing. Waste heat minimization and recovery reduces fuel demands of steam boilers and furnaces by utilizing waste heat recovery. Sustainable manufacturing advances materials and technologies to improve yields per unit energy cost for multiple elements of the manufacturing chain. More information on these platforms can be found at: http://www1.eere.energy.gov/industry/intensiveprocesses/profile.html.

Fuel and Feedstock Flexibility

U.S. industry is principally dependent on natural gas as a single major source of fuel or feedstock. ITP's Fuel and Feedstock Flexibility subprogram focuses on various methods to reduce natural gas use in industrial applications, including research to develop fuel flexible hardware, and demonstration of fuel flexible technologies. ITP aims to accelerate the market adoption of emerging technology options for industry, such as the utilization of gasified fuels, landfill gas, and electro-technologies (DOE 2009h). More information can be found at: http://www1.eere.energy.gov/industry/fuelflexibility/index.html.

Industrial Materials for the Future

New and advanced materials are key crosscutting technologies necessary for efficiency improvements in processes using furnaces, boilers, gasifiers, steam systems, recuperators and heat exchangers. This ITP activity conducts R&D to develop and test new advanced industrial materials and material processing methods.

Material properties play a central role in determining the operating parameters and efficiencies of almost all industrial processes. However, materials also cause many planned and unplanned process interruptions in which productivity and energy are lost, and safety is compromised. Operating efficiency is also lost as materials corrode, wear, foul or otherwise degrade. Improved materials that perform better under corrosive, high-temperature and high-pressure conditions will enable new technologies to save more energy. In addition, longer lifetime saves the energy and raw materials needed to produce and install replacement materials (DOE 2005b). Detailed information on technological developments in industrial materials can be found at: http://www1.eere.energy.gov/industry/imf/index.html.

Nanomanufacturing

Nanotechnology is the purposeful engineering of matter at the nano-scale, which ranges from 1 to 100 nanometers. A typical human hair is around 80,000 nanometers wide (DOE 2008). Nanomanufacturing is the cost-competitive, large-scale production of uniform nanomaterials and the integration of these nanomaterials in intermediate and finished products while maintaining their unique properties. Nanotechnology can improve the energy efficiency and specificity of chemical reactions, thereby increasing productivity. It can produce new and improved materials (e.g., lighter, stronger, harder, more ductile, and high-temperature resistant) that provide superior life-cycle benefits. Initial R&D efforts are focusing on:

- Nanocoatings and thin-films for heat, wear, corrosion, and scratch resistance;
- Nanocatalysts for applications in chemical, petroleum, pulp and paper, and energy production;
- Membranes and sorbents for more energy-efficient industrial separations; and
- Nanocomposites for industrial and automotive applications (DOE 2009k).

More information on nanomanufacturing can be found at: http://www1.eere.energy.gov/industry/nanomanufacturing/index.html.

Sensors and automation

Sensor and automation technologies are vital, yet often unseen, components of virtually every industrial process. Acting as part of a plant's "nervous system," these technologies - along with next generation controls, information processing, robotics, and wireless technology - improve process efficiency. ITP is working with industry to develop advanced sensor and automation technologies that can be applied across industries. Industry specific information on commercialized and emerging technologies can be found at: http://www1.eere.energy.gov/industry/sensors_automation/index.html.

Best Practices

The Best Practices program area implements and disseminates best practices in energy management. The program provides technical assistance to help industries identify energy savings opportunities in manufacturing plants. Best Practices offers a range of software tools and databases for plant self-assessment of steam, compressed air, motor, and process heating systems. The Quick Energy Profiler is an online software tool that helps industrial plant personnel quickly diagnose how energy is being used at their plant and find the largest opportunities to save energy and money. The Integrated Tool Suite is another software tool to help plants find the best opportunities to reduce energy use in major energy-consuming systems (DOE 2009b). Other software tools offered by Best Practices include:

- AIRMaster+ LogTool
- AIRMaster+ Version
- Chilled Water System Analysis Tool (CWSAT)
- Combined Heat and Power Application Tool (CHP)
- Fan System Assessment Tool (FSAT)
- MotorMaster+
- MotorMaster+ International
- NOx and Energy Assessment Tool (NxEAT)
- Plant Energy Profiler for the Chemical Industry (ChemPEP Tool) (http://www.fedcenter.gov/Bookmarks/index.cfm?id=1885&pge_prg_id=8595&pge_id=1857)
- Process Heating Assessment and Survey Tool (PHAST) Version 2.0
- Pumping System Assessment Tool (PSAT) 2008
- Steam System Tool Suite

Links to these tools can be found at: http://www1.eere.energy.gov/industry/bestpractices/software.html. The program also provides a library of publications covering the various aspects of energy management across the eight Industries of the Future.

Industrial Assessment Centers

The Industrial Assessment Centers program enables eligible small and medium-sized manufacturers to have comprehensive industrial assessments performed at no cost to the manufacturer. These assessments examine an industrial plant's site, its facilities, services and manufacturing operations to identify energy efficiency improvements, waste minimization and pollution prevention, and productivity improvement. Assessments are performed by local teams of engineering faculty and students from the centers, which are located at 26 universities around the country (DOE 2009i). More information can be found at: http://www1.eere.energy.gov/industry/bestpractices/iacs.html.

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

5.8.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

For federal actions related to industrial facilities, Reviewers should encourage federal agencies to comply with Energy Policy Act of 2005 and E.O. 13423-Strengthening Federal Environmental, Energy, and Transportation Management as appropriate. The Act requires annual two percent reductions in energy use at federal agency buildings (including industrial and laboratory facilities) through 2015, with DOE to complete a review of the government's performance in response to this requirement by the end of 2014 and recommend additional measures for 2016 through 2025. E.O. 13423 strengthens this requirement by 50% to compel the reduction of greenhouse gas emissions by three percent annually by 2015 or by 30 percent by the end of 2015 (using 2003 as the baseline). Existing facilities should provide documentation of their annual energy reduction, and new facilities should include a plan for meeting the federal requirement.

The Act also promotes the use of voluntary agreements between industrial energy users and federal agencies to reduce energy intensity (defined as "the primary energy consumed for each

unit of physical output in an industrial process" (P.L. 109–58, Sec. 106(a)). The agreements are to have as a goal the reduction of energy intensity by at least 2.5 percent each year from 2007 through 2016. Existing and new facilities should consider entering a voluntary agreement to reduce energy efficiency, which includes eligibility for grants and technical assistance.

For new industrial facilities, energy efficient facility siting, construction, and building design should be documented within the EIS. These topics are covered in Sections 5.2, 5.3 and 5.4, including federal energy efficiency requirements for buildings. Section 5.4 also discusses energy efficiency associated with water use, often a substantial factor in an industrial facility's energy use. Section 5.9, Federal Vehicle Fleets, may also have relevant information for industrial facilities that transport raw materials into, and dispose of waste outside the facility. Minimizing transportation energy use is another significant factor in an industrial facility's overall energy use.

For operation of industrial facilities, opportunities exist to reduce energy use in both process-specific operations and cross-cutting energy systems. As discussed above, DOE provides extensive information on improving energy efficiency for the eight most energy-intensive U.S. industries: aluminum, chemicals, forest products, glass, metal casting, mining, petroleum refining, and steel. Many of the technological advances in the links provided above are market ready and/or already in use. Reviewers should encourage facilities to incorporate industry-specific advanced technology as feasible and practicable.

In addition, the DOE ITP has identified combustion, distributed energy, energy intensive processes, fuel and feedstock flexibility, industrial materials of the future, nanomanufacturing, sensors and automation as cross-cutting technologies that improve energy efficiency across industries. Reviewers may want to ask whether the industrial facility has utilized appropriate ITP software tools described above to identify energy savings opportunities.

Reviewers may want to become familiar with the Bonneville Power Administration's *Industrial Audit Guidebook*: http://www.bpa.gov/energy/n/Projects/industrial/pdf/audit_guide.pdf. The guidebook was created for performing walk through energy audits of industrial facilities. Its purpose is to introduce the user, both technical and non-technical, to common opportunities that may be found in an industrial facility to reduce electrical energy consumption. Topics include:

- Lighting Systems
- Motors, Belts and Drives
- Fans and Pumps
- Compressed Air systems
- Steam Systems
- Refrigeration Systems
- Material Handling Systems
- Hydraulic Systems
- Injection Molding or Extrusion
- Veneer Dryers
- Kiln Drying
- Energy Management

Each topic has a series of questions about the efficiency level of the specific system, as well as general notes and useful tips on each topic.

Section 5.8 References

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5.9 Federal Vehicle Fleets

5.9.a Summary

The federal vehicle fleet consists of more than 650,000 vehicles, approximately 20 percent of which are alternative fuel vehicles (AFVs) (FEMP 2009). Technological advances in transportation equipment, vehicle design, and alternative fuels offer significant energy efficiency improvements that can be applied to federal vehicle fleets.

Vehicles are categorized and regulated based on weight. Federal agencies acquire light-duty vehicles, medium-duty vehicles and heavy-duty vehicles. Typically medium-duty vehicles are a subset of heavy-duty vehicles. Federal agencies are subject to vehicle acquisition requirements that define the light-duty vehicles and medium-duty passenger vehicles they can acquire, and fuel use requirements.

EPAct 1992, as amended by EISA, requires that federal agencies acquire low GHG-emitting light-duty and medium duty passenger vehicles and alternative fuel vehicles as 75% of their light-duty vehicle acquisitions. The requirement to purchase only low GHG-emitting vehicles applies to all vehicle acquisitions. The AFV requirement applies to fleets. The Energy Policy Act of 2005 requires that AFVs only be operated with alternative fuel. Agencies must receive a fuel waiver from DOE to operate an AFV with gasoline. Executive Order 13423 and section 142 of EPAct 1992 require that federal agencies increase their alternative fuel consumption 10% from the previous year, reduce their petroleum consumption 2% per year, and acquire plug-in hybrid electric vehicles when commercially available. Section 246 of EISA, requires that federal agencies install renewable fuel pumps at all fleet refueling centers.

Under EISA 2007 section 141, EPA is required to provide guidance to federal fleets for the acquisition of low GHG-emitting vehicles. EPA's definition of a low GHG-emitting vehicle is technology and fuel neutral. All vehicles are weighted equally. EPA believes the acquisition of low GHG-emitting vehicles will expedite achievement of an agency's petroleum consumption reduction requirement and reduce an agency's GHG emissions.

EO 13514 establishes a percentage reduction target for agency-wide reductions of GHG emissions in absolute terms by fiscal year 2020. In establishing the target, each agency shall consider reducing the use of fossil fuels by:

- using low greenhouse gas emitting vehicles including alternative fuel vehicles;
- optimizing the number of vehicles in the agency fleet; and
- reducing, if the agency operates a fleet of at least 20 motor vehicles, the agency fleet's total consumption of petroleum products by a minimum of 2 percent annually through the end of fiscal year 2020, relative to a baseline of fiscal year 2005.

In fiscal year 2005, U.S. government spent approximately $708.2 million for gasoline, $377.2 million for diesel fuel, and $0.6 million for propane to operate governmental surface vehicles. Utilizing advanced fuel and vehicle technology to gradually improve the energy efficiency of federal fleets can reduce energy consumption and costs for fuels.

Light duty vehicles (passenger cars, sport utility vehicles, vans and pick-up trucks with a gross vehicle weight of less than 8,500 pounds) consume approximately 40% of all U.S. oil consumption. These same vehicles account for approximately 20% of total U.S. emissions of carbon dioxide (US EPA 2008).

Since 1975, nationwide fuel efficiency has seen four basic trends: a rapid increase from 1975 through the early 1980s as a reaction to the oil shortages of the 1970s; a slower increase until reaching peak fuel efficiency in 1987; a gradual decline from 1987 to 2004 (the year in which the U.S. had the lowest fuel economy standard since 1980), and a steady increase beginning in 2005 (US EPA 2008).

For model year 2008, passenger cars are projected to average 24.1 mpg and light trucks are estimated to average 18.1 mpg – representing a fleet wide light-duty fuel economy adjusted average of 20.8 mpg. Since 2004, light truck fuel economy has increased 1.4 mpg, while car fuel economy has increased by 1.0 mpg. Overall fuel efficiency has increased approximately 1.8% since 2004, from 19.3 mpg to 20.8 mpg. Changes in vehicle weight and advanced transmission and engine design, along with increases in use of front-wheel drive, variable valve timing and cylinder deactivation, have all contributed to a general increase in fuel efficiency since 2004 (US EPA 2008).

Fleet-wide fuel economy standards are required under the Energy Policy Act of 1975. The National Highway Traffic Safety Administration (NHTSA), in cooperation with EPA, promulgates such standards and implements the Corporate Average Fuel Economy (CAFE) program. CAFE is the sales weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 lbs. or less, manufactured for sale in the United States, for any given model year. A passenger car CAFE standard of 27.5 mpg has been in effect since model year 1990. Light-duty truck CAFE standards have recently evolved from a standard of 21.0 mpg for model year 2005, to 21.6 mpg for model year 2006, to 22.2 mpg for model year 2007, and to 22.5 mpg for model year 2008 (US EPA 2008).

EPA and DOT are working together on light-duty vehicle GHG/fuel economy standards that will increase average fuel economy and establish, for the first time, a GHG-emission standard for passenger vehicles. Under EISA 2007, a CAFE goal has been set of 35 mpg for 2020 – a fuel economy increase of 40%. To reach this goal, manufacture of fuel-efficient vehicles will need to increase substantially.

Alternative Fuels

Biodiesel

Biodiesel is a clean-burning, renewable substitute for petroleum diesel. Biodiesel is a liquid fuel made up of fatty acid alkyl esters, fatty acid methyl esters (FAME), or long-chain mono alkyl esters. It is produced from renewable sources such as new and used vegetable oils and animal fats and is a cleaner-burning replacement for petroleum-based diesel fuel. It is nontoxic and biodegradable. Biodiesel can be produced domestically and used in conventional diesel engines,

directly substituting for or extending supplies of traditional petroleum diesel. It also has an excellent energy balance: biodiesel contains 3.2 times the amount of energy it takes to produce it (DOE 2009a). Compared with using petroleum diesel, using biodiesel in a conventional diesel engine substantially reduces emissions of unburned hydrocarbons (HC), carbon monoxide (CO), sulfates, polycyclic aromatic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and particulate matter (PM). The reductions increase as the amount of biodiesel blended into diesel fuel increases. Using biodiesel also reduces greenhouse gas emissions because carbon dioxide released from biodiesel combustion is offset by the carbon dioxide sequestered while growing the soybeans or other feedstock. Biodiesel is nontoxic, so it causes far less damage than petroleum diesel if spilled or otherwise released to the environment. It is also safer than petroleum diesel because it is less combustible (DOE 2009a). There are uncertainties over the average effect the use of biodiesel has on NOx emissions. Some studies have shown an increase in NOx emissions with biodiesel use, but insufficient data exists for a definite conclusion (NREL 2005).

Biodiesel production in the U.S. has risen dramatically since 2001 (Table 5-6). Concurrently, the number of biodiesel fueling stations has risen from 16 in year 2001 to approximately 645 in 2008. As a direct replacement for conventional petroleum based diesel, biodiesel has the potential to have a dramatic impact on a reduction in the dependency on foreign oil sources, as well as some environmental benefits (DOE 2009a).

Table 5-7
U.S. Biodiesel Production

Year	Thousand Gallons	Thousand GGEs
2001	8,568	8,823
2002	10,500	10,813
2003	18,060	18,598
2004	27,972	28,806
2005	90,804	93,510
2006	250,000	257,451
2007	491,000	505,634

GGE = gallon of gasoline equivalent
Source: (EIA 2008).

Electricity

Electricity can be used to power electric and plug-in hybrid electric vehicles (EVs). EVs store electricity in an energy storage device, such as a battery. The electricity powers the vehicle's wheels via an electric motor. The only emissions that can be attributed to electricity as a vehicle fuel are those generated in the electricity production process. Home recharging of EVs is as simple as plugging them into an electric outlet. Electricity fueling costs for electric vehicles are reasonable compared to gasoline, especially if consumers take advantage of off-peak rates. However, electricity costs vary across the U.S. depending on location, type of generation, and time of use. Additionally, EVs have limited energy storage capacity, which must be replenished by plugging into an electrical source (DOE 2009b).

Use of electricity as a transportation fuel has some environmental and operation drawbacks. While electric vehicles themselves may not produce carbon-based emissions, increased electric generation and its inherent emissions would be needed to supply the fuel. Electric batteries used to store energy in a vehicle must be manufactured and will ultimately need to be disposed, and these batteries often contain high levels of toxic materials which poses a disposal issue. When a federal agency is acquiring electric vehicles, it should consider two key factors: the Ev's rate of energy consumption, typically measured in kWh/mi, and the emissions from the generation of the electricity that is used to charge the Ev's batteries.

Use of electricity as a transportation fuel has increased from approximately 1 million gasoline gallon equivalents in 1997 to about 5.1 million gasoline gallon equivalents, with a peak usage of 7.3 million gasoline gallon equivalents in 2002. Electric fueling stations have increased from 188 in 1995 to around 430 today. While this is a reduction in available stations since the early 2000s, much of this reduction is due to an increase in travel range from technological advancements in battery performance (DOE 2009b).

Ethanol

Ethanol, also known as ethyl alcohol, grain alcohol, is a clear, colorless liquid that can be produced from various plant materials, which collectively are called "biomass." Today, nearly half of U.S. gasoline contains ethanol in a low-level blend to oxygenate the fuel and reduce air pollution. E85, which is typically 83% ethanol, is increasingly becoming available and is an alternative fuel that can be used in "flexible fuel" vehicles. Studies have estimated that ethanol and other biofuels could replace 30% or more of U.S. gasoline demand by 2030. Biomass for ethanol production can be generated from starch and sugar based plants (such as corn or sugar cane) or from cellulosic feedstocks which include certain types of grass or woody plants or crop or wood residues. Ethanol is derived from feedstocks primarily via fermentation. Cellulosic feedstocks are also increasingly being converted to ethanol using heat and chemicals in a process called thermochemical conversion. Today, most ethanol in the U.S. is derived from corn grain, which has experienced increased production and substantial use in ethanol over the last several years (DOE 2009c).

Ethanol is a high-octane fuel, which increases engine performance. Low-level blends of ethanol, such as E10 (10% ethanol, 90% gasoline), generally have a higher octane rating than unleaded gasoline. Low-octane gasoline can be blended with 10% ethanol to attain the standard 87 octane requirement. Ethanol is the main component in E85, a high-level blend of 83% ethanol and gasoline. Ethanol is a renewable, largely domestic transportation fuel which helps reduce imported oil dependence and greenhouse gas emissions. The carbon dioxide released when ethanol is burned is balanced by the carbon dioxide captured when the crops are grown to make ethanol. According to Argonne National Laboratory, on a life-cycle analysis basis, corn-based ethanol production and use reduces greenhouse gas emissions (GHGs) by up to 52% compared to gasoline production and use (DOE 2009c).

Ethanol use and availability has increased significantly since around 2004 (Table 5-7 and 5-8). Domestic consumption of ethanol has increased 445% between 1997 and 2007. In 1997, E85

ethanol fuel was available at 71 fueling stations in the U.S. mostly confined to the midwest. In 2008, E85 fuel was available at 1,644 stations across the country (DOE 2009c).

Table 5-8
U.S. Total Corn Grain Production and Corn Used for Fuel Ethanol (million bushels)

Year	Production	Used for Ethanol
1994	10,051	533
1995	7,400	396
1996	9,233	429
1997	9,207	481
1998	9,759	526
1999	9,431	566
2000	9,915	628
2001	9,503	706
2002	8,967	996
2003	10,089	1,168
2004	11,807	1,323
2005	11,114	1,603
2006	10,535	2,117
2007	13,074	3,200

Source**:** Corn Production: USDA National Agricultural Statistics Service.
Corn Used for Ethanol: USDA Economic Research Service

Table 5-9
U.S. Total Production and Consumption of Fuel Ethanol (million gallons)

Year	Production	Net Increase through Imports and Stock Change [1]	Consumption
1994	1,289	0	1,289
1995	1,358	25	1,383
1996	973	18	992
1997	1,288	-33	1,256
1998	1,405	-17	1,388
1999	1,465	-22	1,443
2000	1,622	31	1,653
2001	1,765	-24	1,741
2002	2,140	-67	2,073
2003	2,804	22	2,826
2004	3,404	148	3,552
2005	3,904	154	4,059
2006	4,884	597	5,481
2007	6,485	361	6,846

Source**:** EIA Annual Energy Review, Table 10.3 (http://www.eia.doe.gov/emeu/aer/renew.html)

Notes:
[1] Negative numbers indicate decrease, assumed to be zero for years where values not given.
2007 numbers are preliminary.
Ethanol consumption values are close to, but sometimes less than the EIA aggregates of ethanol used in blends + ethanol used in E85.

Environmental issues with ethanol center around several potential problems. First, pure ethanol has less energy by volume, about 34% less energy, than conventional gasoline, meaning that overall more ethanol is needed than conventional gasoline. Secondly, increased use of cropland to support ethanol production would increase water consumption for irrigation, decrease land available for food stocks and potentially raise food production costs worldwide. Finally, increased ethanol production has resulted in increased conversion of rainforest to agriculture. Therefore, much effort and research is being devoted to use of cellulosic feedstocks (DOE 2009c).

Hydrogen

The interest in hydrogen as an alternative transportation fuel stems from its clean-burning qualities, its potential for domestic production, and the fuel cell vehicle's potential for high efficiency (two to three times more efficient than gasoline vehicles). Currently, steam reforming of methane (natural gas) accounts for about 95% of the hydrogen produced in the United States. Hydrogen can be produced domestically from resources such as natural gas, coal, solar energy, wind, biomass, and nuclear energy, with the potential for near-zero greenhouse gas emissions. Because the transportation sector accounts for about one third of U.S. carbon dioxide emissions, which contribute to climate change, using these sources to produce hydrogen for transportation can slash greenhouse gas emissions. Once produced, hydrogen generates power without exhaust emissions in fuel cells. It holds promise for economic growth in both the stationary and transportation energy sectors (DOE 2009d).

Utilization of hydrogen in alternative fuel vehicles has increased from essentially zero to 41,000 gasoline gallon equivalents in 2006 (DOE 2009d). According to the National Hydrogen Association, hydrogen fuel is currently available at 61 fuel stations in the U.S., with approximately 45% of those sites in California (NHA 2009). A national network of 284 hydrogen refueling stations is proposed to be in place by 2018 when hydrogen vehicles are projected to be commercially available in the U.S. in substantial numbers (NREL 2006).

Natural Gas

Natural gas is a domestically available, inherently clean-burning fuel, mostly extracted from gas and oil wells. Natural gas has a high octane rating and excellent properties for spark-ignited internal combustion engines. It is non-toxic, non-corrosive, and non-carcinogenic. It generally presents a reduced threat to soil, surface water, or groundwater in comparison to traditional fuel sources, although methane emissions from gas drilling have been associated with contaminated groundwater, drinking water and methane releases inside buildings and homes. Natural gas accounts for approximately one quarter of the energy used in the United States. Of this, about one third goes to residential and commercial uses, one third to industrial uses, and one third to

electric power production. Only about one tenth of one percent is currently used for transportation fuel (DOE 2009e).

Natural gas vehicle and infrastructure development can facilitate the transition to hydrogen-fuel cell technology. With the highest hydrogen-to-carbon ratio of any energy source, natural gas is an efficient source of hydrogen—in fact, it is the number one source of commercial hydrogen used in the United States. The vast U.S. network of natural gas transmission lines offers the potential for convenient transportation of natural gas to future refueling stations that reform hydrogen from the gas (DOE 2009e).

Natural gas, as either compressed natural gas (CNG) or liquefied natural gas (LNG) is the second most utilized alternative fuel today, behind only liquefied petroleum gas (LPG). Together, CNG and LNG have increased in utilization by 1,000 %, from 17,575,000 gasoline gallon equivalents in 1992 to 195,485,000 gasoline gallon equivalents in 2006. CNG is the most popular form of natural gas fuel, available at over 750 fueling stations across the country (DOE 2009e). Historically, LNG has been less utilized in the United States; between 1% and 3% of U.S. demand for natural gas was met by LNG from 2004-2009. However, U.S. LNG import capacity is expanding and is expected to be more than six times greater in 2009 than it was at the beginning of the decade. Growth in LNG imports remains uneven, due to a high sensitivity to the volatile prices of the natural gas market (EIA 2009).

Propane

Propane, or liquefied petroleum gas (LPG), is the most prevalent alternative transportation fuel in use today. Propane is produced as a by-product of natural gas processing and crude oil refining and accounts for about 2% of the energy used in the United States. Propane vehicle technology is well established, and propane fueling stations are widely distributed with more than 2,000 locations in the U.S. Propane has one of the highest energy densities of all alternative fuels, so propane vehicles go farther on a tank of fuel in comparison to gasoline vehicles. It is also an exceptionally safe fuel, as propane tanks are 20 times more puncture resistant than gasoline tanks, and propane has the lowest flammability range of all alternative fuels. LPG's generally have cleaner combustion properties. Propane engines can be calibrated to chose between pollutants, making the engine additionally useful in achieving pollution-reduction targets. A rich calibration reduces NO_x at the expense of increasing CO and non-methane hydrocarbons and a lean calibration does just the opposite (DOE 2009f).

Ultra-low sulfur diesel

Ultra-low sulfur diesel (ULSD) is classified as diesel fuel containing 15 parts per million (ppm) or less in sulfur content. Most highway diesel fuel meets this requirement and it is mandated for all diesel sold in the U.S. by 2010. Previously, typical highway diesel fuel contained up to 500 ppm of sulfur. Use of ULSD in light-heavy duty vehicles enables the use of catalytic converters and particulate traps routinely used in gasoline vehicles. These components help to reduce emissions of nitrogen oxides (NO_x) and particulate matter (PM), issues which were particularly troublesome with previous diesel engine applications using standard diesel fuel. Additionally, since diesel engines are typically 20-40% more efficient than comparable gasoline engines,

increased use of ULSD (especially sources produced from non-petroleum and renewable resources) will reduce dependence on foreign petroleum sources and may reduce emission of greenhouse gases (DOE 2009g).

Passenger Vehicles

For all types of passenger vehicles, energy efficiency can be improved through proper maintenance. Improperly inflated tires and poor wheel alignment adversely affect fuel efficiency. Under-inflated tires increase the tires' rolling resistance, and increased rolling resistance requires more fuel to move the vehicle.

As the U.S. moves toward the increased use of alternative fuels, vehicle applications continue to mature. Since 1995, alternative fuel vehicles (not counting hybrid vehicles) in use in the U.S have increased from 246,855 to 634,559 in year 2006. In fiscal year 2008, federal agencies acquired 27,925 alternative fuel vehicles. Greater than 99% of these acquisitions were flexible fuel vehicles capable of operating with E85. Electric/battery powered vehicles use the energy stored in a battery (or series of batteries) for vehicle propulsion, resulting in vehicles with fast acceleration but limited distance before recharge. Combustion-based and electrochemical hydrogen vehicles are emerging along with compressed natural gas; both becoming viable fuel energy alternatives. Vehicle technology is quickly emerging, and will be highly impacted by consumer preferences, costs, and the availability of support infrastructure.

Electric

In an electric vehicle (EV), a battery or other energy storage device is used to store the electricity that powers the motor. EV batteries must be replenished by plugging in the vehicle to a power source. Some electric vehicles have onboard chargers; others plug into a charger located outside the vehicle. Both types, however, use electricity that comes from the power grid. Although electricity production may contribute to air pollution, EVs are considered zero-emission vehicles because their motors produce no exhaust or emissions. No purely electric vehicles are currently available from the major automotive manufactures (DOE 2009h).

Natural Gas

Dedicated natural gas vehicles (NGVs) are designed to run only on natural gas; some NGVs have two separate fueling systems that enable the vehicle to use either natural gas or a conventional fuel (gasoline or diesel). In general, dedicated NGVs demonstrate better performance and have lower emissions than bi-fuel vehicles because their engines are optimized to run on natural gas. In addition, the vehicle does not have to carry two types of fuel, thereby increasing cargo capacity and reducing weight. For model year 2008, the only commercially available natural gas light-duty vehicle is the Honda Civic GX. Prior to model year 2006, CNG technology vehicles were also commercially available from GM and Ford, mainly large trucks and vans (DOE 2009i).

Propane

Today, most propane vehicles are conversions from gasoline vehicles. Dedicated propane vehicles are designed to run only on propane; bi-fuel propane vehicles have two separate fueling systems that enable the vehicle to use either propane or gasoline. No light-duty propane vehicles are currently for sale in the U.S. Conversions are more popular in medium and heavy-duty vehicle applications, especially for school buses (DOE 2009j).

Flex Fuel

Flexible fuel vehicles (FFVs) are capable of operating on gasoline, E85 , or a mixture of both. Flexible fuel vehicles contain one fueling system, which is made up of ethanol compatible components and is set to accommodate the higher oxygen content of E85. Other than fueling capability and ethanol compatible components, FFVs are similar to their conventional gasoline counterparts. Their power, acceleration, payload, and cruise speed are comparable whether running on ethanol or gasoline. The only noticeable difference: fuel economy is lower when FFVs run on ethanol. Flex fuel vehicles are available from each of the major automotive producers, but the technology is mostly used in larger passenger automobiles, SUVs and pick-up trucks (DOE 2009k).

Hybrid

Hybrid electric vehicles (HEVs) typically combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle. The combination offers low emissions, with the power, range, and convenient fueling of conventional (gasoline and diesel) vehicles. Hybrid electric vehicles have the potential to be two to three times more fuel-efficient than conventional vehicles. For model year 2009, there are 28 vehicle types available for sale which utilize hybrid technology. By model year 2010, there are plans for at least two commercially available plug-in hybrid vehicles – the Chevrolet Volt and the Toyota Prius – which have the potential to provide even greater fuel efficiency than current hybrid vehicles (DOE 2009l).

International surveys have shown that battery electric cars can meet the mobility needs of many urban households, but they usually do not meet consumer expectations. There is a growing focus on the role electric vehicles can play in sustainable transportation. There is a Hybrid and Electric Vehicles Implementing Agreement (HEVIA) which outlines the following objectives:

- provide governments, local authorities, large users and industries with objective information on electric and hybrid vehicles and their effects on energy efficiency and the environment;
- collaborate on pre-competitive research projects and related topics and to investigate the need for further research in promising areas; and
- collaborate with other transport-related Implementing Agreements and to collaborate with specific groups or committees with an interest in transportation, vehicles, and fuels (IEA 2009).

Fuel Cell

Fuel cell vehicles use a completely different propulsion system than conventional vehicles, which can be two to three times more efficient. Unlike conventional vehicles, they produce no harmful exhaust emissions—their only emission is water. Fuel cell vehicles are fueled with hydrogen, which is considered an alternative fuel under the Energy Policy Act of 1992. Like electric vehicles, fuel cell vehicles use electricity to power motors located near the vehicle's wheels. In contrast to electric vehicles, fuel cell vehicles produce their primary electricity using a fuel cell. The fuel cell is powered by filling the fuel tank with hydrogen. Fuel cell vehicles can be fueled with pure hydrogen gas stored directly on the vehicle or extracted from a secondary fuel—such as methanol, ethanol, or natural gas—that carries hydrogen. These secondary fuels must first be converted into hydrogen gas by an onboard device called a reformer. Fuel cell vehicles fueled with pure hydrogen emit no pollutants, only water and heat. Vehicles that use secondary fuels and a reformer produce only small amounts of air pollutants.

No fuel cell vehicles are commercially available to consumers today. They generally are only available in limited numbers to select organizations with access to hydrogen refueling stations. (DOE 2009m). Fuel cell vehicles will be listed in the DOE Alternative Fuels and Advanced Vehicles Data Center (AFDC) Vehicle Make and Model Search when they become commercially available (http://www.afdc.energy.gov/afdc/progs/vehicles_search.php).

Light Duty Ultra-low Sulfur Diesel

Light-duty diesel vehicles (passenger cars, light trucks and SUVs) are already available in the U.S. with demand expected to double over the next 10 years. Vehicles using ULSD must meet the same CAFE standards as gasoline-powered vehicles, but generally are more fuel efficient and less polluting. Passenger car models from Audi, BMW, Mercedes-Benz and Volkswagen are currently available, as are truck and SUV models from BMW, Chevrolet, Dodge, Ford, GMC, Jeep, and Mercedes Benz (DOE 2009n).

Other Vehicles

There are a variety of strategies that EPA is promoting which addresses the sectors of freight, construction, agriculture, ports, and school buses vehicles. The programs include switching to cleaner fuels, retrofitting, repairing, re-powering, replacing equipment, and reducing idling. EPA has promoted these changes by fostering partnerships, supporting innovative technologies, and providing grants to accelerate clean diesel technologies.

Low-speed Vehicles

The National Highway Traffic Safety Administration (NHTSA) defines a low-speed vehicle (LSV) as "…a 4-wheeled motor vehicle, other than a truck, whose speed attainable in 1.6 km (1 mile) is more than 32 kilometers per hour (20 miles per hour) and not more than 40 kilometers per hour (25 miles per hour) on a paved level surface.

LSVs (low speed vehicles) are alternative means of transportation that drastically reduce the amount of petroleum used by a conventional vehicle fleet. LSVs are suitable on roads with speed limits of less than 35 mph, which makes them an excellent application for on-site use. LSVs are prohibited for use on federal highways and their use may also be restricted by state and local laws.

Low-speed vehicles are commonly utility or recreational vehicles and typically powered by electric, gasoline or propane. Examples include airport baggage vehicles, small passenger vehicles, golf carts, and small utility trucks. These vehicles are increasingly becoming more important components of federal fleets, in response to fleet rightsizing requirements of EO 13423, energy savings, and the flexibility these vehicles provide. With an annual requirement of a 2 percent reduction in petroleum fuel use for federal agencies, the impact of expanded use of low speed vehicles is a key strategic component for compliance.

As an example, the Air Force has completed an assessment of plug-in electric pick-up trucks. These vehicles were compared to the performance of a conventional pick-up truck and evaluated for doing various types of work. Advantages of using a plug-in electric vehicle truck include:

- Excellent for tasks that require short, moderately light load hauling.
- Serve well as personnel taxi vehicles and enable access to tight, closed-in areas.
- Batteries prove to hold their charge for an adequate time before needing to be recharged.

Disadvantages include:

- Not multi-passenger pick-ups.
- Limited off-road use.
- Does not accommodate heavy loads.
- Not suitable for 24 hour continual use due to battery recharging.

Medium –to-Heavy-duty Trucks

Medium-duty diesel vehicles serve a wide array of applications. With gross vehicle weight ratings (GVWR) of about 8,500 to 26,000 pounds, they include everything from large pick-up trucks and SUVs, to small school and transit buses, to cargo vans and “short-haul” trucks. They are the backbone of many fleets and consume large quantities of fuel because of intensive use.

Heavy-duty diesel vehicles include long-haul trucks, large buses, and other vehicles that are heavier than 26,000 lb GVWR.

Currently as much as 80% of U.S. goods by value of shipment are transported by trucks; therefore, it is critical to improve truck transport energy efficiency in the movement of goods and for services. Within the U.S. transportation sector, truck energy use has been increasing at a faster rate than that of automobiles. Since 1973, all of the increase in highway transportation fuel use has been due to trucks, mainly because of their extensive use in trade and commerce. Heavy truck fuel efficiency is influenced by several factors, including basic vehicle design, zone of operation, driver technique, and weather factors. Engine power losses and road losses

(aerodynamic, tire-rolling resistence, drive train friction, auxiliaries) account for approximately 94% of the energy used to sustain vehicle speed at 65 mph (DOE 2006).

Truck design and performance

The 21st Century Partnership Truck Partnership is a collaborative effort of the DOE, DOT, DoD, EPA and fifteen industrial partners supporting the development and implementation of commercially viable technologies to reduce dependence on imported oil and improve air quality. Through this program, the federal government and the trucking industry are working together to develop prototype production heavy-duty trucks and buses with improved fuel efficiency, reduced emissions, enhanced safety and performance, and lower operating costs. More information can be found in *The 21st Century Truck Partnership Roadmap and Technical White Papers* (http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ctp_roadmap_2007.pdf).

Focus areas of research and testing include:

- Diesel engine efficiency.
- Advanced cylinder combustion, emission recirculation, and emission after-treatment.
- Non-petroleum based diesel fuels.
- Lightweight materials with required strength and stability.
- Advanced heavy duty hybrid propulsion systems.
- Aerodynamic improvements.
- Auxiliary power management using electric, fuel cells, and waste heat recovery.
- Input into idle reduction technologies and policies.
- Advances in vehicle safety using video, improved crashworthiness, and improved braking, stability, and collision-avoidance technologies.

Another area of research into truck design is the potential use of hydraulic transmissions for heavy-duty highway trucks. Hydraulic transmissions are routinely used for low-speed, heavy duty applications such as off-road earth moving equipment, but have not been used for highway use applications. New technology development allows the use of SuperDrive hydraulic transmissions for highway use which uncouple the transmission from engine speed and then use an electronic control module to seek the lowest engine rpm for needed torque. Use of this technology is anticipated to result in a 20-25% increase in fuel economy for heavy-duty trucks and a 50-55% efficiency increase for light-to-medium duty vehicles. More information can be found in *An Innovative Approach to Improved Fuel Economy in Heavy-Duty Trucks, Project Fact Sheet* (http://www.e3energy.org/fleming.pdf).

EPA established the National Clean Diesel Campaign (NCDC) to promote diesel emission reduction strategies. NCDC includes regulatory programs to address new diesel engines as well as voluntary programs.

NCDC regulatory programs for new diesel engines include the following:

- 2007 Heavy-Duty Highway Engine Rule: This rule will cut harmful pollutants from highway engines by more than 90 percent, resulting in an annual reduction of 2.6 million tons of NO_x and 110,000 tons of PM when fully implemented.
- The Clean Air Non-road Diesel Rule: This rule will cut emissions from new construction and agricultural and industrial engines by more than 90 percent.

Anti-idling measures

Historically, most idling activity occurs at truck stops, rail yards, and with government fleet vehicles. Efforts to reduce idling have many benefits including:

- Reduction in the emission of harmful air pollutants.
- Reductions in fuel consumption, decreased maintenance costs, and longer engine life which results in cost savings.
- Reductions in noise levels.
- Decreased dependency on fuel import.

Idling longer than ten seconds uses more fuel and produces more CO_2 compared to restarting the engine. Unnecessary idling wastes money and fuel and produces greenhouse gases that contribute to climate change.

The GSA's Federal Acquisition Service offers the following facts and tips to help reduce fuel consumption and idling.

- Idling an engine for more than 30 seconds uses 2/10 of a gallon of fuel.
- Idling a diesel engine does not warm it up.
- A diesel engine retains more heat longer when it is shut off instead of idling.
- Driving the vehicle is the only way to properly warm it up.
- Idling will cause a diesel to go into regeneration more frequently.
- Implementing and enforcing anti-idling policies can cut your fuel consumption by 8% or more.
- Frequently restarting of your engine increases wear by $10 per year.
- Anti-Idle timers have been standard on GSA buses since 2006.
- Diesel engines with High Horsepower improve fuel economy.
- Automated manual transmissions can improve fuel economy by 19%.
- Alternative lighting saves fuel, reduces down time, and improves safety.

Unnecessary idling occurs when trucks wait for extended periods of time to load or unload, or when equipment that is not being used is left on. Long haul truck drivers idle their engines during their rest periods to provide heat or air conditioning for the sleeper compartment, keep the engine warm during cold weather, and to maintain adequate battery voltage while using electrical appliances such as a microwave oven or television set. Other reasons cited by truck drivers for idling include safety (i.e., keeping the windows closed, thereby needing cooling or heating) and habit (i.e., protecting the engine by not turning it off). The EPA report, *Study of Exhaust*

Emissions from Idling Heavy-Duty Diesel Trucks and Commercially Available Idle-Reducing Devices provides more information: *http://www.epa.gov/otaq/retrofit/documents/r02025.pdf*.

Reduced idling reduces fuel consumption. Regulations restricting idling were in place in almost half the states as of July 2008. These regulations vary by state, county, or city, but typically restrict idling to 3-10 minutes and do not distinguish between gasoline or diesel vehicles. Most of these regulations are relatively new and many have associated information campaigns to increase awareness.

In May 2001, President Bush issued the National Energy Policy directing EPA and DOT to work with the trucking industry to establish a program to reduce emissions and fuel consumption from long-haul trucks. Responding to this directive, EPA initiated a comprehensive program aimed at reducing idling. This includes organizing workshops, issuing grants, implementing demonstration projects, and most importantly, closely examining idling fuel consumption and exhaust emissions. The EPA SmartWay program (see Section 5.9.b) published a model "state idling law" and EPA issued guidance on how states can incorporate projects to reduce long-duration truck and locomotive idling into their air quality plans.

Several types of technologies exist that will effectively reduce long-duration idling. EPA maintains a list of idle reduction technologies that can be accessed at the following website: http://www.epa.gov/otaq/retrofit/.

Over the past seven years, EPA has evaluated idle reduction technologies as part of grants, cooperative agreements, emissions testing, engineering analysis, modeling, and external peer reviewed reports. More information can be found at: http://epa.gov/diesel/idle-ncdc.htm. To date, EPA has verified the following idle reduction technology categories:

- Electrified Parking Spaces (truck stop electrification)
- Shore Connection Systems and Alternative Maritime Power
- Auxiliary Power Units and Generator Sets
- Fuel Operated Heaters
- Battery Air Conditioning Systems
- Thermal Storage Systems

EPA, in collaboration with FHWA, developed the DrayFLEET model and four supporting case studies, to assess truck emissions, and various technical and management options for reducing emissions and fuel consumption from truck drayage activity (http://www.epa.gov/otaq/smartway/transport/partner-resources/resources-drayage.htm). To reduce truck queuing at terminal gates and associated vehicle emissions, operations tactics such as gate time expansion and gate appointment systems can be used (*A Glance at Clean Freight Strategies: Terminal Appointment Systems for Drayage,* http://www.epa.gov/smartway/transport/documents/drayage/420f06005.pdf). Gate time expansion allows trucks to access port and freight facilities for a longer period of the day (up to 24 hour access) to reduce peak hour demand. The use of computerized inventorying, automated gate controls and security devices, and other intelligent freight handling methods provides

efficient freight handling with reduced personnel needs. Gate appointment systems rely on improved logistics whereby carriers are provided numerous reserved time slots during gate hours when they can be assured of being handled efficiently. Both of these options allow the peak truck demand periods at terminals to be spread out over longer periods and help reduce air quality concerns due to less truck idle time.

Boats and Vessels

Green Vessel Design

Green vessel design is a growing area of interest in the marine sector, driven by rising fuel prices. In addition to environmental benefits, maximizing the application of recycled and renewable materials and minimizing discharges to water can help to increase efficiency. Duel-fuel engines, which can use either diesel or liquefied natural gas, have been common on large vessels for many years and are now being increasingly used in other higher speed vessels (DHS 2008). More information can be found in *Green Vessel Design: Environmental Best Practices*, http://www.uscg.mil/proceedings/articles/7_King,%20Payne,%20Roberts,%20Villiott_Green%20Vessel%20Design.pdf.

An area of interest in vessel design is the development of new materials which are lightweight but provide the stability needed for use in marine environments. Advances in fiberglass technology is a promising area which may have many applications for ship design and manufacturing (*DOE Glass Project Fact Sheet: Low Energy Alternative to Commerical Silica-based Glass Fibers*http://www1.eere.energy.gov/inventions/pdfs/mosci.pdf).

Vessel Building and Repair

Improvements in energy efficiency related to ship building and ship repair are mainly focused on implementation of energy efficient compressed air systems, HVAC systems, lighting and motors (EPA 2007).

Marine Remanufacture Program

EPA has adopted a new emission control program for marine diesel engines that includes emission standards for certain engines already in operation. The program is called the Marine Remanufacture Program. Marine diesel engines are significant contributors to ambient levels of ozone and particulate matter (PM) pollution in our nation's ports and along our rivers and coastal waterways. EPA's latest emission standards for new engines will result in substantial reductions of nitrogen oxides (NO_X) and PM emissions from marine vessels. More information can be found at EPA's website for frequently asked questions about the program: http://www.epa.gov/OMS/regs/nonroad/marine/ci/420f09003.htm.

Engines built before the new-engine standards take effect, however, will continue operating with higher emissions for a long time. The service life of many marine engines can be 30 years or more. The Marine Remanufacture Program will provide early air quality benefits by reducing

PM emissions from this legacy fleet sooner than would be the case through the normal turnover of the fleet to vessels with new engines.

A marine diesel engine is covered by the Marine Remanufacture Program if it meets all of the following criteria:

- It is a commercial marine diesel engine.
- It was manufactured between 1973 and the last Tier 2 model year.
- It has power at or above 600 kilowatts (kW).
- It has a displacement of less than 30 liters per cylinder.
- It is installed on a vessel that is flagged or registered in the United States.

EPA is promoting a remanufacture system, commonly referred to as a "remanufacture kit," which is a process for making an engine meet certain emission criteria – in this case, a 25 percent reduction in PM emissions. The kit consists of instructions, specifications, limitations and/or engine components. In most cases, a kit is expected to consist of "better" versions of parts normally replaced or rebuilt and should not adversely affect engine reliability, durability, or power.

Clean Ports USA

Clean Ports USA is an incentive-based, innovative program designed to reduce emissions from existing diesel engines and non-road equipment at ports. The program is for ports and fleet owners who voluntarily engage in emission reduction strategies, including improvements in cargo handling equipment, trucks, vessels, and other support machinery. The focus of the program is promoting the implementation of clean fuels; retrofit, repair and rebuild of existing equipment; changes to and replacement of equipment to utilize more efficient and less petroleum-based power sources; and operational strategies. Operational strategies include truck idling measures and improved management of intermodal containers. More information can be found at EPA's Clean Ports USA website: http://www.epa.gov/otaq/diesel/ports/basicinfo.htm.

Passenger Buses

Bus technology has, for several years, used compressed natural gas and liquefied natural gas to power large passenger vehicles. Transit agencies, schools, airports, and large parks are a few of the users who have implemented the use of alternative fuel buses in the U.S. Today, all plug-in electric hybrids and all electric buses are commercially available and are beginning to be put into use.

Fuel Cell Bus Benefits

The benefits of fuel cell buses includes being more efficient, clean, quiet, low emissions, less maintenance, and they reduce dependence on imported oil. Transit buses are good candidates for fuel cell technology for the following reasons:

- Their weight and volume constraints are compatible for fuel cells.

- Central fueling stations minimize fuel logistic issues, which would apply to a bus system.
- Fuel cell power requires no operational concessions.
- Buses provide immediate environmental benefits to urban air quality if they reduce their emissions.
- They allow the public an opportunity to learn, first-hand, about fuel cell technology.

Generation I and Generation II Fuel Cell Buses have been developed with plans for Generation III fuel cell buses that will provide quick first start capabilities. The Generation III bus will be a non-hybrid fuel cell power system that will operate on methanol, and it will be built upon a 40-ft low floor bus platform for Americans with Disabilities Act (ADA) compliance, and have a low curb weight.

Plug-In Hybrid-Electric School Buses

Another example of a bus using alternative energies is being followed in North Carolina's Wake and Mecklenburg County school system, which is piloting plug-in hybrid electric school buses. They cost two to three times more than a regular bus yet are expected to pay for themselves through fuel efficiency within six years. They are expected to reduce fuel consumption by 40-50% and reduce emissions by 90%. More information can be found at the DOE website: http://apps1.eere.energy.gov/state_energy_program/project_brief_detail.cfm/pb_id=1230.

Electric Drive Lightweight Buses

Advances in electric battery technology and use of state of the art steel materials have been used to develop a commercially-adaptable all electric bus. While originally designed using battery technology, the vehicle could be alerted to eventually utilize a plug-in hybrid system using a small diesel generator. More information can be found at the DOE website: http://www1.eere.energy.gov/vehiclesandfuels/pdfs/success/lightweight_buses.pdf.

Hydrogen Buses

The state of Florida established a "hydrogen highway" for hydrogen powered buses. The Florida Department of Environmental Protection (DEP) launched a "H2 Florida" statewide initiative to accelerate the commercialization of hydrogen technologies and stimulate consumer interest. More information can be found at the DOE website: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=8782.

Clean School Bus USA

The goals of Clean School Bus USA are to reduce children's exposure to diesel exhaust and the amount of air pollution created by diesel school buses. Clean School Bus USA brings together partners from business, education, transportation, and public-health organizations to work towards the following goals:

- Encouraging policies and practices to eliminate unnecessary public school bus idling.

- Upgrading ("retrofitting") buses that will remain in the fleet with better emission-control technologies and/or fueling them with cleaner fuels.
- Replacing the oldest buses in the fleet with new, less-polluting buses.

More information can be found at the DOE website:
http://apps1.eere.energy.gov/state_energy_program/project_brief_detail.cfm/pb_id=852.

Locomotives

During normal railroad operations, locomotives sometimes must wait for freight cars to be switched and/or picked up, for another train to clear track on which the locomotive is to proceed, or for mechanical service. Historically, locomotives have been left idling while they are waiting. In some cases, there are practical or safety reasons why locomotives need to be left idling. In other cases, locomotive operators might simply idle the engines due to custom, habit, or misunderstandings about diesel engines (EPA 2008b).

The reasons why current locomotives may need to be left idling can be technological or related to worker and passenger needs. First, diesel engines can be difficult to start in extremely cold temperatures, especially larger diesel engines such as those used in locomotives. Also, locomotive engines are typically designed to use water without antifreeze because water is more efficient at cooling the engine. However, the water can freeze in cold weather and crack the engine block. As a result, shutting locomotives off in cold weather has historically been avoided as much as possible (EPA 2008b).

Locomotive engines may also need to idle in order to maintain critical functions such as air pressure for the braking and starting systems and battery charge. Maintaining air pressure for braking is especially important since it can directly affect safety. Finally, in some cases, locomotives will idle to supply air-conditioning or heat to its crew and/or passengers, in part to comply with regulations and contractual requirements related to working conditions for the crew (EPA 2008b).

EPA's regulatory efforts to reduce emissions from idling locomotives focus on requiring the application of automatic idle reduction technologies to the locomotives themselves rather than directly regulating when railroads may allow locomotives to idle. EPA issued emission standards for locomotives in 1998, and updated these standards with a 2008 rulemaking. The 2008 rulemaking requires technology that reduces the amount of time a locomotive spends idling (as well as applying tighter emission standards to new locomotives generally). EPA is requiring that all newly manufactured and nearly all remanufactured locomotives be equipped with idle reduction technology that will automatically shut locomotives down if they are left idling unnecessarily (EPA 2008b).

Several other technological developments that improve locomotive energy efficiency are summarized below.

Gen Set Locomotives

A Gen Set Locomotive has three separate smaller engines instead of the one large engine found in a conventional locomotive. The three smaller engines can provide horsepower on demand, which is the ability to tailor horsepower output to the train weight and the territory the train will travel over. A Gen Set Locomotive is 25 percent more fuel efficient than a conventional locomotive.

Advanced Fuel Saving Control System for Freight Locomotives

General Electric is now commercializing the first planned advanced control system called "Consist Manager". The device can be installed new or retrofit on GE Dash9 and AC-4400 class locomotives. Two Class 1 US railroads are in the process of field evaluation. The product can achieve fuel savings of 1-2%. The product also lends itself to quiet operation of a lead unit at part power operation.

Energy Efficient Coal Mining Locomotives

Battery vehicles have been introduced in coal mining locomotives to help overcome mobility limitations of tethered vehicles. A fuel cell vehicle provides mobility and energy capacity of a diesel unit and provides environmental benefits of electric vehicles.

Shore power plug-in unit

Plug-in units are relatively inexpensive and heat and circulate water and oil. They have an optional battery charger. Minimal equipment is required and they are ideal for commuter trains. They can also be used for yard units. A locomotive must be at an equipped location. There are no local impacts. They are quiet and pollution-free.

Hybrid switching locomotives

Hybrid locomotives are in the demonstration stage. They can replace a 2000 hp switcher. They use 125 hp diesel and 60,000 lb of sealed Pb-acid batteries. Small diesel charges batteries and it runs when the switcher is in use. The batteries are expected to last 10-15 years, yet the lifetime is unproved at this point in time. A hybrid switcher costs much more than add-ons.

Aircraft

Aircraft design

Blended wing design is an alternative airframe design which incorporates features from both a traditional fuselage and wing design and flying wing design. This design provides improved lift and weight savings, resulting in better fuel utilization. NASA and the Air Force are currently developing and testing prototype planes for potential future application in military and commercial aviation. More information can be found at the NASA website: http://www.nasa.gov/topics/aeronautics/features/bwb_main.html.

Alternative propulsion planes

In April of 2008, Boeing completed the world's first manned flight using hydrogen fuel cells. Similar fuel cell technology potentially could power small manned and unmanned air vehicles. Over the longer term, solid oxide fuel cells could be applied to secondary power-generating systems, such as auxiliary power units for large commercial airplanes. Small, single-person planes have also been developed using electric battery and solar power. As with fuel cells, it is unlikely that these technologies would have major impact on commercial aviation, but could serve as auxiliary power sources in the future.

Biofuels

The Air Force has certified, or is in the process of certifying, much of its fleet to operate on a 50/50 blend of synthetic fuel (derived from coal and biomass feedstocks) and JP-8 aviation fuel. Commercial airlines are experimenting with synthetics, but they are currently unproven and not available in adequate quantity to support commercial operations.

Transport and assisting equipment

The following are various assisting transportation equipment and devices that have been noted through research, which can assist with creating more energy efficient transport.

- Electric Aircraft PushBack Tractor (EAPT) - a propulsion and energy management system for a battery-powered, electric aircraft pushback tractor.
- Electric Aircraft Cargo Conveyor (EACC) - a battery-powered, self propelled belt conveyor for handling baggage and cargo at aircraft bulk cargo holds.
- Limiting use of escalators and elevators – Limiting use times and not running escalators, elevators and moving walks when volumes are low.
- Tractors and Trailers - EPA has certified SmartWay tractors and trailers. These tractors and trailers are outfitted with equipment that significantly reduces fuel use and emissions. There are criteria for carriers to earn the privilege to label their vehicles with the SmartWay brand.
- Monitoring GPS Devices - Onboard wireless location and performance monitoring GPS devices can help reduce idling and fuel costs. The device identifies if the vehicle is consuming fuel as efficiently and cleanly as possible and identifies engines requiring maintenance.
- Cabin video/audio Monitoring Devices - A cabin video/audio monitoring devices records and identifies when a vehicle exceeds a specific level. They help identify and limit aggressive behavior.

5.9.b Related Federal Partnership Programs

SmartWay Transport Partnership

EPA introduced SmartWay in 2004 to reduce greenhouse gases from the transportation sector. Information on SmartWay can be found at http://www.epa.gov/smartway. SmartWay identifies

passenger vehicles with low greenhouse gas and air pollutant emissions (vehicles which are also more efficient) for both consumers and for federal agencies. Light duty vehicles certified as SmartWay can be found at: http://epa.gov/smartway/vehicles/smartway-certified.htm or through EPA's Green Vehicle Guide: http://www.epa.gov/greenvehicles/Aboutratings.do#aboutsmartway. SmartWay's "green leaf" mark allows consumers to easily identify environmentally friendly vehicles in the Green Vehicle Guide. Trucking companies can also search for the most fuel efficient commercial vehicles for purchase using the SmartWay certification for heavy duty vehicles: http://www.epa.gov/otaq/smartway/transport/what-smartway/tractor-trailer.htm.

SmartWay designates a federal partnership - The SmartWay Transport Partnership. This is a voluntary collaboration between EPA and the goods movement industry, designed to increase energy efficiency while significantly reducing greenhouse gases and air pollution in the ground freight transportation sector. The program promotes innovative financing mechanisms for energy efficiency upgrades, as well as the deployment of idle reduction technology, low-rolling resistance tires, fairings (products to reduce aerodynamic drag) and other strategies.

The partnership currently includes over 2,200 participating transportation providers that supply efficiency and emissions performance data to EPA through SmartWay emission models. EPA uses individual company emissions and efficiency data to identify more efficient transportation providers to purchasers of freight services. SmartWay assesses the freight practices of shipping and logistics companies, based in part upon the environmental performance of the freight carriers they use, to determine if these shippers can earn the SmartWay mark. SmartWay Partners – carriers and shippers -- with low greenhouse gas and high efficiencies are recognized with the use of the SmartWay logo, an established mark of clean transportation.

Although initially targeted for commercial fleets, government agencies employing any freight transportation services can utilize SmartWay to determine their freight related CO_2, NO_x, and PM emissions and energy use for both inventories and efficiencies. Using SmartWay will allow Federal agencies to track and improve their freight transportation energy efficiency over time, and will contribute toward providing market pressure on the industry to improve its efficiency.

Federal green purchasing programs have included a provision that federal agencies should seek out freight providers that belong to the SmartWay partnership, which is focused on reducing greenhouse gas and other emissions from goods movement including delivery of products to and from federal buildings. Federal fleets can also join SmartWay.

To assist trucking companies in reducing their emissions and improving efficiency, SmartWay has identified a group of fuel saving technologies and has bundled them into a package known as an "Upgrade Kit". They are highly fuel-efficient technologies with emission control devices to reduce fuel consumption, idling, and emissions of greenhouse gases. Companies should experience a full payback within one to three years. More information can be found at: http://www.epa.gov/smartway/transport/what-smartway/upgrade-kits.htm.

Vehicle Technologies Program

The DOE Vehicle Technologies Program (http://www1.eere.energy.gov/vehiclesandfuels/index.html) works with industry to develop and deploy advanced transportation technologies that can improve vehicle fuel efficiency and increase the use of alternative fuels. The program has two major components:

FreedomCAR and Fuel Partnership. These subprograms seek to develop emission- and petroleum-free cars and light trucks and the infrastructure to support them. The Partnership focuses on the research needed to develop the necessary technologies, such as fuel cells and advanced hybrid propulsion systems.

21st Century Truck Partnership. This program is a large public-private R&D partnership with multiple federal partners including EPA, DOT, Commerce and DOE, along with several federal laboratories, and private industry. The program addresses the research needs of commercial vehicles (trucks and buses) with the aim to reduce pollution and dependence on fossil fuels. The technical goals of the program include developing more efficient engine systems and heavy-duty hybrids, reducing parasitic losses that use up fuel (e.g., aerodynamic drag resistance, rolling resistance, drivetrain losses, and auxiliary load losses), reducing idle time and improving safety.

The Vehicle Technologies Program also supports implementation programs that help to transition alternative fuels and vehicles into the marketplace through its Clean Cities subprogram.

Clean Cities Program

The DOE Clean Cities program (http://www1.eere.energy.gov/cleancities/) is a government-industry partnership designed to reduce petroleum consumption in the transportation sector by advancing the use of alternative fuels and vehicles, idle reduction technologies, hybrid electric vehicles, fuel blends, and fuel economy measures. Clean Cities has a network of 90 or more volunteer coalitions, which develop public-private partnerships to promote petroleum reduction. Clean Cities provides equipment manufacturers, trade associations and other federal agencies with access to strategies and resources, and DOE incentives to fund petroleum reduction projects.

Clean Cities sponsors the Alternative Fuels and Advanced Vehicles Data Center (AFDC), which provides online technical data about fuels, vehicles, fueling station and truck-stop electrification locations, infrastructure development, state and federal incentives and laws, technical and outreach. AFDC tools include the Petroleum Reduction Planning Tool (https://www.afdc.energy.gov/afdc/prep/index.php), which calculates petroleum reductions by choosing one or a combination of the following methods:

- Alternative Fuels
- Hybrid Electric Vehicles
- Biodiesel Blends
- Fuel Economy
- Vehicle Miles Traveled Reduction
- Truck Stop Electrification
- Idling Time Reduction
- Onboard Idle Reduction

Hydrogen, Fuel Cells & Infrastructure Technologies Program

The DOE Hydrogen, Fuel Cells & Infrastructure Technologies Program (http://www1.eere.energy.gov/hydrogenandfuelcells/about.html) works in partnership with industry, academia, and national laboratories to research hydrogen production, delivery, and storage technologies, as well as fuel cell technologies for transportation, distributed stationary power, and portable power applications. The program focuses on addressing safety issues and facilitating the development of model codes and standards, as well as demonstrating hydrogen and fuel cell technology in real-world conditions.

Delivery technology for hydrogen infrastructure is currently available commercially, and several U.S. companies deliver bulk hydrogen. Some infrastructure is already in place because hydrogen has long been used in industrial applications, but is not sufficient to support widespread consumer use. There are very few hydrogen filling stations, and a limited number of hydrogen pipelines throughout the country. The program promotes the construction of more filling stations and seeks other methods for hydrogen distribution, such as converting to hybrid natural gas/hydrogen pipelines and using trucks, railcars, ships and barges (DOE 2009).

On-board hydrogen storage for transportation applications continues to be one of the most technically challenging barriers to the widespread commercialization of hydrogen-fueled vehicles. Although hydrogen has nearly three times the energy content of gasoline by weight, it has four times less energy content by volume. The program's research and development is working on compression technologies to make widespread commercial hydrogen use more feasible (DOE 2009).

Fuel cell research and development is aimed at reducing fuel cell system cost and size and improving the performance and durability of fuel cell systems for transportation and for small stationary and portable applications. Most of this research focuses on advancing polymer electrolyte membrane (PEM) fuel cell systems.

EPA Sector Notebooks

The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

5.9.c Review considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

309 Reviewers should encourage agencies with federal actions involving federal vehicle fleets to incorporate federal policies that include petroleum reduction and energy efficiency. The Energy Policy Act of 1992 (EPAct 1992), as amended by EISA, prohibits federal agencies from acquiring light-duty vehicles and medium-duty passenger vehicles that are not low GHG-emitting vehicles with exceptions, and further requires that 75% of all covered light-duty vehicles acquired for Federal fleets must be AFVs (where the fleets have 20 or more vehicles, are capable of being centrally fueled, and are operated in a metropolitan statistical area with a population of more than 250,000 based on the 1980 census). In FY 2005, 58% of Federal vehicle purchases were considered exempt from EPAct 1992 requirements. Exemptions were granted for fleet size, geographic location and use for emergency, law enforcement and national defense.

EPAct 1992 also set a goal of using replacement fuels to displace at least 30 percent of the projected consumption of motor fuel in the United States annually by the year 2010. The Energy Conservation Reauthorization Act of 1998 (P.L. 105-388) (ECRA) amended EPAct 1992 to allow one AFV acquisition credit for every 450 gallons of pure biodiesel fuel consumed in vehicles over 8,500 pounds gross vehicle weight rating. "Biodiesel credits" may fulfill up to 50 percent of an agency's EPAct 1992 requirements. The head of each Federal agency must also prepare and submit a report to Congress outlining the agency's AFV acquisitions and future plans by February 15th each year.

E.O. 13149, *Greening the Government through Federal Fleet and Transportation Efficiency*, amended EPAct 1992 to direct Federal agencies operating a fleet of 20 or more vehicles within the United States to reduce their annual petroleum consumption by at least 20 percent by the end of FY 2006 (compared to FY 1999 levels) by using alternative fuels in AFVs more than 50 percent of the time, improving the average fuel economy of new light-duty petroleum-fueled vehicle acquisitions by one mpg by FY 2002, and 3 mpg by FY 2006, and using other fleet efficiency measures. E.O. 13149 was supplanted in 2007 by E.O. 13423, which requires Federal agencies to decrease their fleets' petroleum consumption by two percent annually and increase non-petroleum consumption by 10 percent annually by 2015, using FY 2005 as a baseline. Every federal agency is required to develop and implement a plan to meet this requirement. Also, by 2010 each agency is to install at least one renewable fuel pump at each federal fleet fueling center. Agencies must purchase plug-in hybrids when they are commercially available at a reasonable cost.

EO 13514 expands the requirements of EO 13423 to establish a percentage reduction target for agency-wide reductions of GHG emissions in absolute terms by fiscal year 2020. In establishing the target, each agency shall consider reducing the use of fossil fuels by:

- using low greenhouse gas emitting vehicles including alternative fuel vehicles;

- optimizing the number of vehicles in the agency fleet; and
- reducing, if the agency operates a fleet of at least 20 motor vehicles, the agency fleet's total consumption of petroleum products by a minimum of 2 percent annually through the end of fiscal year 2020, relative to a baseline of fiscal year 2005.

Section 701 of EPACT 2005 amends EPAct 1992 to require Federal agencies to use alternative fuels in fleet dual-fuel vehicles (flexible or bi-fuel) if the fuel is available within five miles or 15 minutes and does not cost more than gasoline on a per-gallon basis (FEMP 2008).

EISA 2007 created new and enhanced conservation requirements for federal vehicle fleets. The Act raises corporate average fuel economy (CAFE) standards to 35 miles per gallon (mpg) by 2020. EISA also sets a renewable fuels standard for gasoline. The Act seeks to increase the supply of biofuel by requiring fuel producers to use in the fuel mix a progressively increasing amount of biofuel, culminating in at least 36 billion gallons of biofuel by 2022. EISA differentiates between "conventional biofuel" (corn-based ethanol) and "advanced biofuel." Advanced biofuel is renewable fuel, other than corn-based ethanol, with lifecycle greenhouse gas emissions that are at least 50 percent less than greenhouse gas emissions produced by gasoline or diesel. Beginning in 2016, a progressively increasing portion of renewable fuels must be advanced biofuels, such as cellulosic ethanol. Under EISA, EPA is required to revise its regulations to ensure that transportation fuel sold in or imported into the U.S. contains at least the applicable quantity of renewable fuels.

Section 2862 of the National Defense Authorization Act of 2008 amends EPAct92 by expanding the definition of a qualifying AFV for Federal fleets. Newly defined alternative fueled vehicles include the following four types of vehicles:

- a new qualified fuel cell motor vehicle (as defined in section 30B(b)(3) of the Internal Revenue Code of 1986);
- a new advanced lean burn technology motor vehicle (as defined in section 30B(c)(3) of that Code);
- a new qualified hybrid motor vehicle (as defined in section 30B(d)(3) of that Code); and
- any other type of vehicle that the Administrator of EPA demonstrates to the Secretary of Energy would achieve a significant reduction in petroleum consumption.

Section 30.B of the Internal Revenue Service (IRS) Code (U.S. Code Title 26, Subtitle A, Chapter 1, Subchapter A, Part IV, Subpart B, Section 30.B) provides definitions of new qualified fuel cell motor vehicle, new advanced lean burn technology motor vehicle and new qualified hybrid motor vehicle. (DOE 2008f). In a December 21, 2008 letter to DOE, EPA demonstrated that operating a low GHG-emitting vehicle, as defined by EPA, would achieve a significant reduction in petroleum consumption consistent with NDAA2008 section 2862 qualifying low GHG-emitting vehicles as AFVs.

To help record progress in meeting the federal legislative requirements, the Office of Management and Budget issues "Transportation Scorecards" for Federal agencies to document status and progress for each agency in the areas of energy, transportation, and environment.

January 2009 scorecards for each agency are available at: http://www.fedcenter.gov/Documents/index.cfm?id=11768&pge_id=1854.

Through its Federal Acquisition Service and Federal Vehicle Standards program, GSA offers services for fleet managers looking to improve energy efficiency. GSA's website (http://www.gsa.gov/Portal/gsa/ep/programView.do?pageTypeId=17110&ooid=8060&programPage=%2Fep%2Fprogram%2FgsaDocument.jsp&programId=15263&channelId=-24545) contains Alternative Fuel Vehicles and Biodiesel Product Guides & Manuals that have pricing and technical information to assist managers in selecting efficient vehicles and fuels.

EPA provides the Green Vehicle Guide, an interactive tool to compare the environmental performance of vehicles (http://www.epa.gov/greenvehicles/Index.do). The tool also includes an EISA 141 low GHG federal fleet calculator. The EPA/DOE fuel economy website, http://www.fueleconomy.gov/ provides a tool for fleets to use for comparing the fuel economy of various vehicles including hybrids, AFVs, and conventional vehicles. FEMP and GSA also offer the Federal Automotive Statistical Tool (FAST), a Web-based tracking tool that allows agencies to input fleet data for many data collection requirements (http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_BASIC&contentId=23302&noc=T).

FEMP assists federal agencies with implementing the vehicle fleet mandates. A few strategies and resources discussed in the Winter 2009 FEMP Focus newsletter include:

Acquire the right number and type of AFVs in the correct location. Placing AFVs where alternative fuel is not available will not reduce petroleum consumption, and may make it more difficult to reduce agencies' petroleum use if the AFV uses petroleum and gets fewer miles per gallon than the non-AFV equivalent. Acquisition of AFVs should be part of an integrated plan for petroleum reduction that takes advantage of available alternative fuel infrastructure, and uses other types of vehicles where alternative fuel infrastructure is not available. In geographical areas where there is alternative fuel available, AFVs should be acquired, and fleet managers should ensure alternative fuel is used in those AFVs to the greatest extent practicable. If a subfleet has access to alternative fuel, an agency might consider composing the entire fleet of AFVs.

Biodiesel. Using biodiesel in diesel vehicles is another important option for fleets that have limited access to alternative fuels for light-duty vehicles. Agencies can use B20 (a mixture of 20 percent biodiesel and 80 percent diesel fuel) to meet up to half of their AFV acquisition requirements.

Develop an alternative fuel infrastructure. Public refueling stations are often willing to install E85 pumps at no cost in areas with high concentrations of Federal vehicles. A publicly accessible list of Federal fleet E85-fueled AFVs without access to E85 is available at: www.afdc.energy.gov/afdc/data/fleets.html.

Update agency-specific polices and procedures. Agencies must develop and encourage policies that ensure AFVs use alternative fuel to the greatest extent possible. Agencies may consider fleet

site visits or internal audits. Some agencies have instituted a key card system that allows E85-fueled vehicles to only refuel with E85 when refueling on site at an agency (FEMP 2009b).

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5.10 Transportation Facilities

5.10.a Summary

A complete transportation system includes a variety of modes that seamlessly transport goods and people. As a system, each mode is used to its maximum advantage and beneficial choices are made with respect to the best movement of people and goods. Transportation mode choices should maximize energy efficiency and effectiveness and form the core of a complete transportation system. This system may include (but is not limited to) the following modes:

- Aviation
- Highway
- Rail
- Water-based transportation
- Public transit
- Bicycle/Pedestrian

Modal choice

Modal choice is the ability for one mode of transportation to be selected over another given the preferences and requirements of the commuter or goods. Mode choices are viable transportation alternatives between the same origin and destination. Differences in energy efficiency between various transportation modes should be a consideration when planners are designing, maintaining and upgrading transportation facilities.

The SmartWay Transport Partnership has tools and information to assist shippers and carriers better understand the environmental and fuel consumption impacts of different modal choices and other operational strategies for freight goods movement (www.epa.gov/smartway).

Intermodal Connectivity

The various modes are only one measure of a complete transportation system. A more important measure is how the modes interact and ultimately perform with regard to the movement of people and goods. Each mode has unique considerations that must be addressed to ensure a seamless transfer of goods and people between modes.

When transportation improvements are contemplated, the following are design considerations for each mode:

Highway

Highways typically form the spine, or backbone, of any community's transportation system. Highways can provide both the accessibility of a local street to a specific destination, to the mobility provided by an interstate highway. From a freight perspective, shippers and receivers who use highway modes of transportation rely on the just-in-time delivery and door-to-door convenience that motor carrier modes can offer.

There are a number of design considerations to be made when evaluating the energy efficiency of a proposed highway or improvements to an existing facility, including the ones bulleted below:

- **High Occupant Vehicle (HOV) lanes** – HOV lanes are dedicated to vehicles containing two or more passengers. Implementation of HOV can increase the overall throughput and efficiency of the highway facility by incentivizing carpooling and ridesharing.
- **High Occupant Toll (HOT) lanes** – This is a form of road pricing where drivers of single-occupant vehicles must pay a toll for use of lanes or roadways that have been designated for use of high occupancy vehicles. While HOT lanes may not reduce overall demand, they do affect the *redistribution* of demand, allowing for the roadway to operate more efficiently.
- **Truck-only lanes** – These lanes improve the operating efficiency of the roadway by removing slower-moving vehicles such as trucks from the mixed-flow of the overall vehicle stream. This contributes to the stabilization of traffic flow, and reduces congestion.
- **Design speeds** – A roadway may be designed for a higher speed, but posted at a lower one to improve fuel efficiency as well as safety.
- **Grades** – Grade considerations are particularly important for trucks, as lower gradients result in improved operation and greater fuel efficiency.
- **Energy efficient lighting**–Older style mercury vapor lamps are inefficient. Converting from mercury vapor lamps to more efficient options, such as metal halide, can reduce energy consumption.
- **Upgrades to LED signals** – LED signals (light emitting diode) can provide electricity savings of up to 90 percent over incandescent lamps and can last up to six times longer. While somewhat expensive to install, the energy cost savings can quickly eclipse the costs of installation. LED signals improve signal visibility and safety while reducing energy costs. They also produce more light per watt than the traditional incandescent bulb.
- **Signal interconnection and coordination** –Interconnection and coordination can allow a platoon of traffic to "pulse" through a corridor, producing a short term reduction in congestion and decreasing the fuel use caused by wasted "green time," or unnecessary idling of vehicles.
- **Transit-friendly features** (bus pulloffs, signal pre-emption, etc.) – these features should be considered during the design of a roadway. Accommodating larger transit vehicles can remove them from the cartway. Signal pre-emption also reduces wasted green time and unnecessary vehicle idling.
- **Smart Toll Collection –** For toll facilities, advances in technology now make it possible to collect tolls more efficiently than through traditional toll booths. A variety of electronic systems and devices such as transponders and "Smart Cards" make the collection of tolls technically feasible and more efficient.

Parking Facilities

Every vehicular trip begins and ends in a parking place. Some studies have suggested that there are four parking spaces for every car in the U.S. (Shoup 2005). Municipal zoning ordinances typically establish off-street parking requirements to accommodate the busiest of shopping days,

leaving an overcapacity of parking spaces throughout the rest of the year. This contributes to the urban heat island effect, among other undesirable conditions. A secondary issue involves the cost of parking itself. With the exception on urban on-street parking and parking structures, a majority of parking facilities are either free or underpriced. This incentivizes single occupant vehicle travel and its resultant energy use. On-street parking that is underpriced also contributes to a process known as "cruising," where motorists searching for parking must mix with other traffic, creating congestion and delay. Constructing an appropriate inventory of parking spaces, coupled with proper pricing, would encourage the use of more efficient modes of transportation, such as bicycle/pedestrian, or public transportation.

Public Transportation

Transit can help communities operate more energy efficiently by reducing the need for single occupancy vehicle roadway and parking investments. Transit can operate most effectively when it is operated with complementary facilities such as the ones bulleted below:

- **Transit Oriented Development (TOD)** – Orienting development or higher density, mixed-use developments around key transit nodes and activity centers can help make transit operate more efficiently. Pedestrian/bicycle access and the use of public transportation have multiplier impacts on energy efficiency. Pedestrian/public transportation trips not only conserve energy by reducing automobile use, but also reduce the heat island effect. Higher development densities, complementary land uses, and pedestrian-oriented design all help to promote transit. EPA's Smart Growth website provides information on transit oriented development: http://www.epa.gov/smartgrowth/index.htm.
- **Park and Ride facilities** – These complementary facilities can expand the catchment area of a transit operator. Park and rides should be located at areas within a defined travel shed (between major origins and activity centers) and should include parking for both vehicles and bicycles.
- **Bus Rapid Transit (BRT) and/or Bus-only lanes** – This service attempts to match the service quality of passenger rail while still realizing the fuel efficiency savings of bus transit. Since it is segregated from other roadway lanes, it provides a higher level of operating efficiency, even though additional right-of-way may initially need to be acquired for its construction.
- **Bike racks on buses** – The availability of bicycle racks on buses also expands the potential service area of the transit operator and can lessen demand for other, less energy efficient forms of transportation such as the single occupant vehicle.

Passenger Rail

Passenger rail service can relieve congestion (and reduce fuel consumption) at a fraction of the cost of building extra highway capacity. The availability of other intermodal facilities and services such as park and ride lots and provisions for bicycles on trains can increase the capture rate of passenger rail. Passenger rail stations should be located within the center of the community where they can be easily accessed by multiple modes (i.e., bicycle, pedestrian, inter- and intra-city bus, etc.) and provide easy access to destinations such as employment,

entertainment, and shopping. Transit oriented development around stations makes rail more accessible as an energy efficient mode of travel.

Rail Freight

Rail freight has been an important element of the U.S. transportation system for over 150 years. Because they are not as flexible as highway/motor carrier modes, freight railroads have historically been dominated by lower value bulk shipments with flexible shipment timetables (e.g., coal), . and have been most effective in delivering goods in excess of 300 miles. With major growth occurring in intermodal shipping, and advent of double stack trains, rail now has increased ability to facilitate the movement of relatively high value materials, including materials shipped in ocean containers, trailers, and automobile rail car carriers. Inbound containers are often higher value finished products (e.g., retail goods for Wal-Mart.) In addition, short line rail roads can serve as feeders for larger rail lines in moving freight to distribution centers.

Rail freight should be evaluated as an energy-efficient means of transporting goods, depending on the type (value) of product being shipped, and the distance involved. A typical rail car can remove as many as four trucks from the highway. Removing trucks from state highways and local roadways around ports and congested communities heightens rail freight's environmental benefits. A few methods to consider in planning for the effectiveness of rail freight modes include:

- **Train make-up/block management** – More than any other train type, intermodal trains suffer from their equipment design and loading pattern. Large gaps between the cars directly affect the aerodynamic drag of the train. Matching intermodal loads with cars of an appropriate length reduces the gap length between loads and improves air flow. Filling empty slots with empty containers or trailers also reduces aerodynamic resistance and improves energy efficiency, despite the additional weight penalty and rolling resistance. Depending on particular train configuration, train resistance can be lowered by as much as 27 percent and fuel savings by 1 gal/mi per train (TRB 2005). These techniques can be applied to manifest trains (trains which carry almost any kind of freight) as well.
- **Electrification of lines** – Electrification has a significant initial cost, but can provide long-term energy savings over diesel engines, particularly on high-volume lines.
- **Double stack container accommodation** – Moving freight via double-stacked rail freight containers can significantly reduce the amount of locomotive power needed to move the same freight under more conventional methods. The application and accommodation of double-stack rail facilities (e.g., raising bridges and lowering tunnels, etc.) has a significant initial cost, but can improve the fuel efficiency of the rail freight operator.
- **Sealed corridors –** One of the most significant concerns for railroads involves right of way crossings. Grade separation at crossings or elimination of crossings improves train speeds, and saves energy by precluding vehicles idling at crossings.
- **Lighter vehicles –** Use of composites and other materials that would reduce car weight and efforts to reduce friction/rolling resistance would require less energy and improve overall system performance.

- **Improve rail logistics** – Adding rail capacity (e.g., double-tracking, etc.) can improve train scheduling and tracking and lessen dwell times in rail sidings. It also reduces total hours of service (and energy consumption) by increasing throughput.
- **Train yards and facilities** – energy efficiency review may be undertaken at train yards and facilities, many of which have been in operation for decades. Recommendations on insulation, HVAC, lighting, etc. and the resultant energy savings should be examined. See Section 5.4 for recommendations on improving energy efficiency for buildings and lighting. Reduction of truck and locomotive idling can also improve energy efficiency at rail facilities (see Section 5.9.b Federal Vehicle Fleets for a discussion of idle reduction strategies).

Airports

Airports transport both people and freight. In the case of the former, the Federal Aviation Administration (FAA) reports that passenger traffic has tripled since 1970 and is expected to double again by 2025. In the case of the latter, aviation is used to transport a mix of high and low value products. The schedule flexibility of air travel permits time sensitive product delivery, an increasingly important aspect for manufacturers seeking to optimize the efficiency of their supply chains. However, airports can also be voracious energy consumers, and the opportunity exists for substantial energy efficiency improvements.

The Clean Airport Partnership (CAP), a U.S. non-profit corporation, works to improve environmental quality and energy efficiency at airports. Recently, CAP's primary focus has been implementation of the Green Airport Initiative (GAI), which is a comprehensive, streamlined approach for helping airports shrink their environmental footprint while creating a blueprint for sustainable development. The GAI was designed and implemented with financial support from DOE, EPA, the Rockefeller Foundation, and the U.S. Congress. More information on the GAI can be found at: http://www.cleanairports.com/.

Airport systems that are among the largest electricity consumers include:

- Lighting systems
- Heating, ventilation, and air conditioning
- Motors and machine drives
- Office equipment like computers, copiers, and printers
- Tenant facilities like concessionaire kitchens (Sea-Tac 2007)

Many of the strategies listed in Section 5.4 Buildings, can be applied to airports. In addition the airport building(s) itself, there are a variety of ways in which airport operations can improve energy efficiency, such as those outlined below:

- **Intermodal Approaches** – Provide intermodal connections for employees and travelers to access the airport while using other modes, such as public transportation, passenger rail or ride-sharing. Employees can be provided with transit vouchers or similar benefit to encourage commuting by these energy-saving modes.

- **Signing** – an effective signing program can help travelers find available parking and airline check-in facilities more quickly, thus reducing the amount of time and fuel visitors spend in re-circulating through airport facilities.
- **Congestion pricing -** Charging commercial vehicles for each time they enter the airport can promote energy conservation by discouraging needless travel and reducing the total number of trips made. These systems can reduce shuttle trips by 25-40% (Sea-Tac 2007).
- **Reduced vehicle idling** – Airports can mandate the length of time that authority vehicles idle, thus saving on energy costs. Some airports such as the Port of Seattle have constructed cell phone lots to discourage drivers who are awaiting passengers from re-circulating through the airport or from idling their vehicles on adjacent access roads.
- **Pay on Foot Parking** - Pay-on-Foot parking speeds egress from parking garages (and reduces idling) by enabling motorists to pay their fees in the terminal and to submit their receipt through an automated system upon exiting.
- **Escalators** - Most escalators consume full power constantly. Turn off escalators when not in use and retrofit escalators with energy efficiency kits (e.g., Ecostart, which allocates power "in direct proportion to the required workload, eliminating wasted energy") (Sea-Tac 2007).
- **Rental facilities** – Airports can locate all rental car facilities at one location. This reduces number of shuttle buses that operate to move passengers between terminals and the rental car facility.

Energy efficiency strategies that can be applied to aircraft and ground support equipment can be found in Section 5.9, Federal Vehicle Fleets.

Water-based transportation

The emergence of containerization over the past 50-60 years has allowed for the transport of virtually any type of consumer product. Water-based transportation specializes in containerized, bulk and breakbulk cargo and can carry commodities over long distances. With water-based transportation, goods must be transferred unless a shipper or receiver is located along a waterway. This makes the efficiency of intermodal transfer to highway and rail vitally important for energy efficiency. Some considerations for improving the energy efficiency of water ports include:

- **Draft Depth** – In taking advantage of economies of scale, vessel size has been continually increasing through the years for improved cost effectiveness and overall energy efficiency. As such, adequate channel depth and wider locks are needed to accommodate larger vessels and facilitate efficient movement between terminals. Vessels that cannot be accommodated at smaller ports must offload a portion or all of their cargo to other modes of transportation in shipping to a final destination. The land bridge portion of the intermodal move may often be more energy intensive than water-based transport. Where possible, increasing channel depth and lock width to accommodate larger vessels can facilitate increases in efficiency.

- **Port facilities** – water ports that have rail freight sidings with direct access to terminals and docks minimize the amount of drayage involved in moving cargo from the ship to its final destination.

Considerations for congestion mitigation

The broad area of congestion mitigation can be important to the efficient use of energy on the highway system. Efforts to reduce congestion and improve traffic flow can reduce fuel consumption for all transportation modes at least in the short term. Long-term strategies for improving energy efficiency may require a more comprehensive evaluation of the transportation system.The range of possible mitigation strategies should be applied to address specific corridor needs. These potential strategies generally fall into three categories:

1. Additional capacity
2. Operational improvements
3. Demand management

FHWA has identified numerous mitigation techniques associated with each category. In reality, the most successful approach may be to implement a combination of appropriate strategies from all three categories.

Figure 5-10

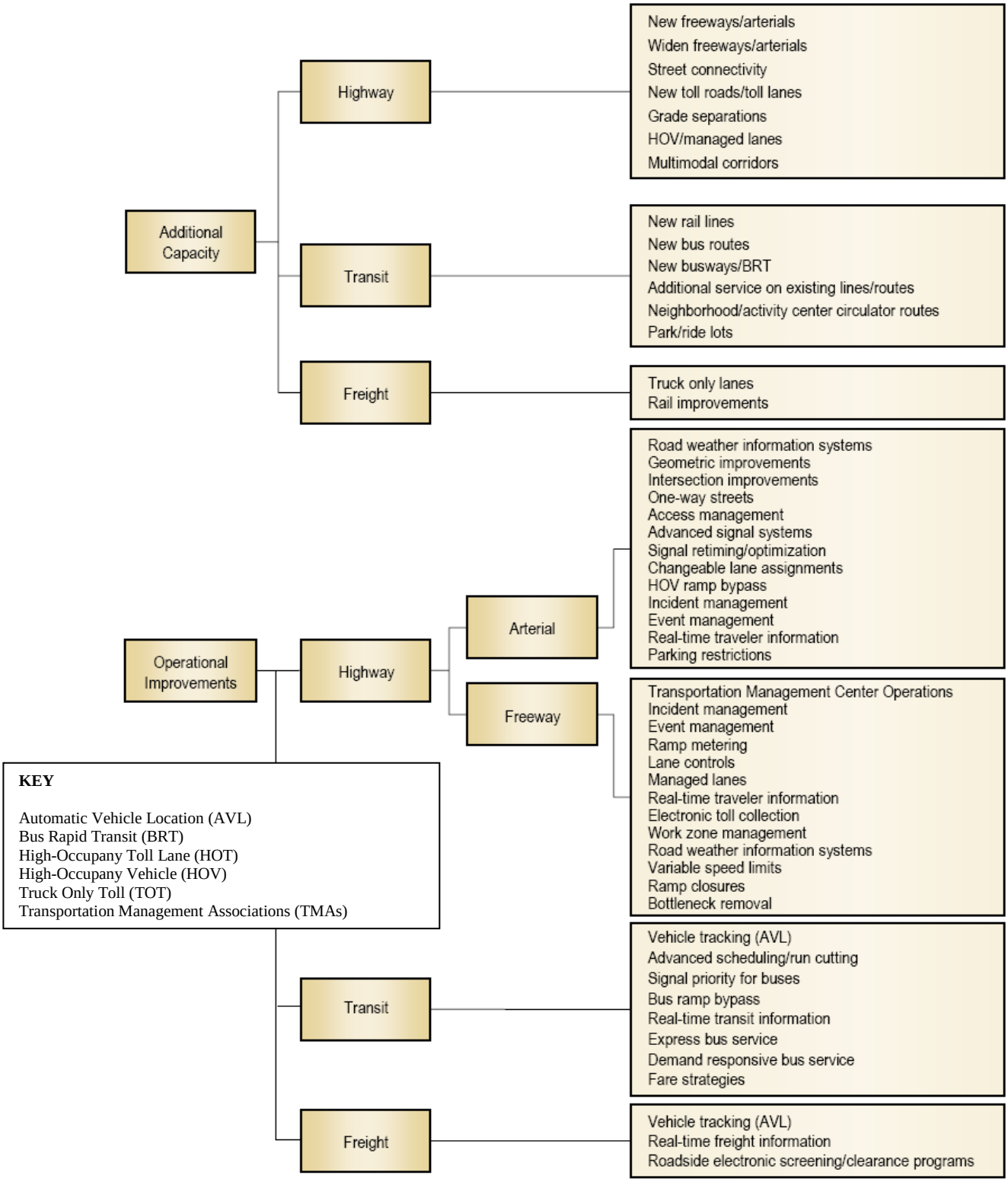
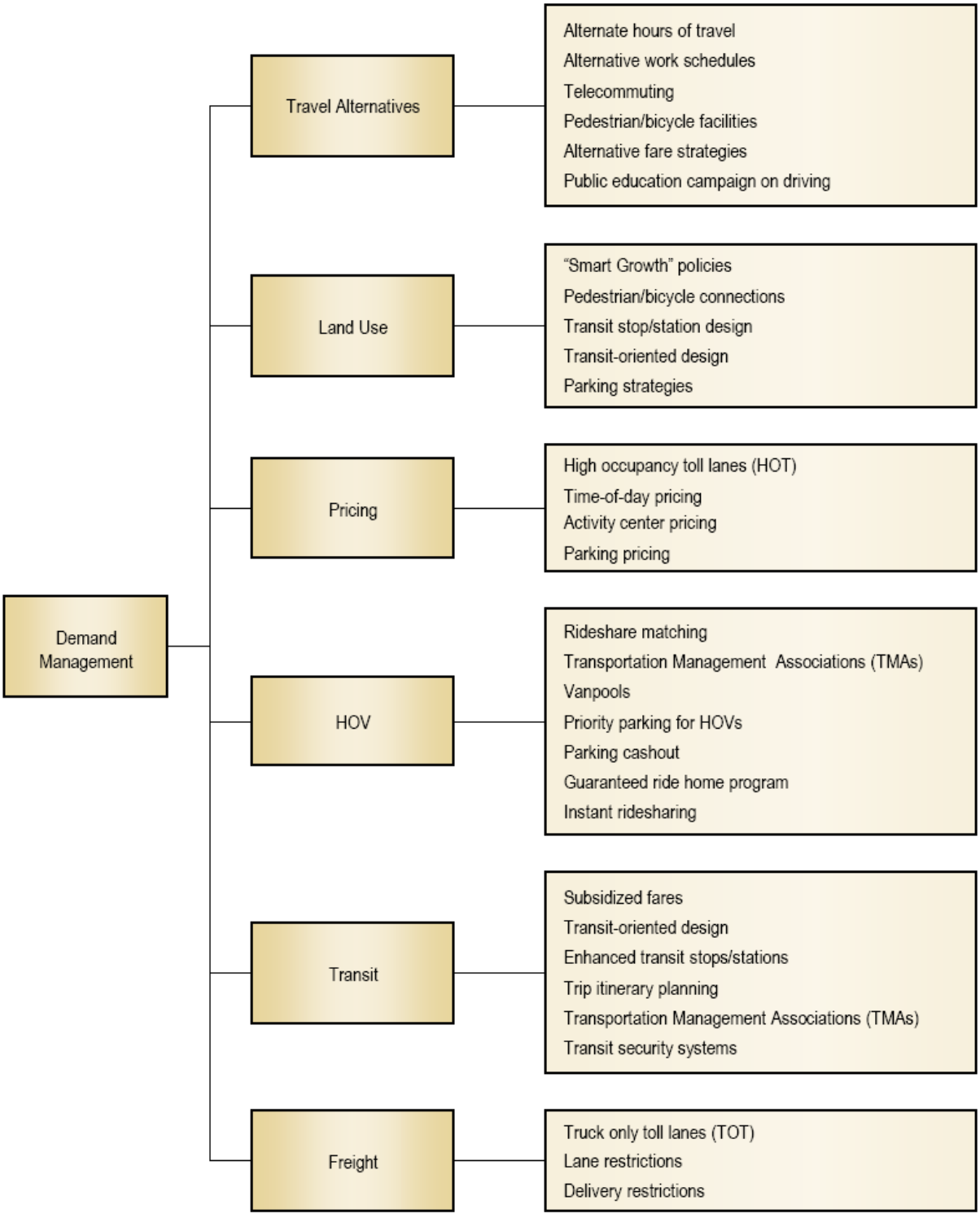

Additional Capacity
Highway
New freeways/arterials
Widen freeways/arterials
Street connectivity
New toll roads/toll lanes
Grade separations
HOV/managed lanes
Multimodal corridors
Transit
New rail lines
New bus routes
New busways/BRT
Additional service on existing lines/routes
Neighborhood/activity center circulator routes
Park/ride lots
Freight
Truck only lanes
Rail improvements
Operational Improvements
Highway
Arterial
Road weather information systems
Geometric improvements
Intersection improvements
One-way streets
Access management
Advanced signal systems
Signal retiming/optimization
Changeable lane assignments
HOV ramp bypass
Incident management
Event management
Real-time traveler information
Parking restrictions
Freeway
Transportation Management Center Operations
Incident management
Event management
Ramp metering
Lane controls
Managed lanes
Real-time traveler information
Electronic toll collection
Work zone management
Road weather information systems
Variable speed limits
Ramp closures
Bottleneck removal
KEY
Automatic Vehicle Location (AVL)
Bus Rapid Transit (BRT)
High-Occupany Toll Lane (HOT)
High-Occupany Vehicle (HOV)
Truck Only Toll (TOT)
Transportation Management Associations (TMAs)
Transit
Vehicle tracking (AVL)
Advanced scheduling/run cutting
Signal priority for buses
Bus ramp bypass
Real-time transit information
Express bus service
Demand responsive bus service
Fare strategies
Freight
Vehicle tracking (AVL)
Real-time freight information
Roadside electronic screening/clearance programs

Figure 5-10



Note: Improvements in italics are those enabled by Intelligent Transportation Systems technology.

Source: FHWA - http://www.ops.fhwa.dot.gov/congestion_report/congestion_report_05.pdf.

A situation-appropriate selection of FHWA's suggested mitigation techniques can be implemented through consideration of this framework for responding to congestion and identifying potential solutions. While it is appropriate to segregate improvements by *Capacity Enhancement*, *Operational Improvements* and *Demand Management*, it may be also be beneficial to segregate *Modal Options* into their own classification.

Capacity Enhancements can include new roadways and roadway widening for additional single-occupancy vehicle lanes (SOV), but may also include minor geometric enhancements and the elimination of bottlenecks. Large-scale capacity enhancements are typically the last measures transportation professionals consider, because they are often the most expensive and can have adverse environmental impacts, such as environmental and right-of-way impacts. Large-scale capacity enhancements can also have the effect of inducing additional travel, which may result in the roadway becoming congested again in the future; however, strategic capacity enhancements can alleviate existing congestion and may accommodate some future growth if properly considered. Capacity enhancements that can be considered include:

- New SOV Facilities – new roadways, interchanges, or ramps that increase single-occupancy vehicle lane-mileage on the transportation network.
- Lane Additions – new travel lanes on an existing roadway designed to increase the capacity of the facility; does not including turning lanes, acceleration/deceleration lanes, climbing lanes, or specialized lanes for use by modes other than single-occupancy vehicles.
- Elimination of Bottlenecks – removal of a physical constriction which delays travel, such as widening an underpass, providing lane continuity (i.e. replacing a two-lane bridge that connects pieces of four-lane roadway), or eliminating a sight barrier. FHWA's publication, *Traffic Bottlenecks: A Primer Focus on Low-Cost Operational Improvements* (http://ops.fhwa.dot.gov/publications/bnprimer/index.htm) provides low-cost strategies for the elimination of bottlenecks.
- Intersection/Geometric Improvements – addition or reconfiguration of turning lanes, lane widening, realignment of intersecting streets, improved acceleration or deceleration lanes at interchange ramps.

Operational Improvements are geared toward improving the "supply side" of the transportation system. These efforts are intended to enhance the operation of the transportation system and make it as efficient as possible. Operational improvements include things such as intersection upgrades, access management, reversible lanes, traffic signal improvements, and Intelligent Transportation Systems.

Operations represent technologies and institutional arrangements that allow transportation systems to operate more closely to their maximum design intent. Operational improvement include:

- Traffic Signal Improvements – signal hardware upgrades, signal software upgrades, signal timing, multi-jurisdictional signal coordination, or (in conjunction with intersection improvements) channelization of turning movements.
- One-way Streets/Circulation Adjustments – establishing, or removing, pairs of one-way streets in place of a standard two-way street.

- Incident Management Systems – technology and programs for detecting crashes, disabled vehicles, or other incidents that impede travel and resolving or removing the obstructions.
- Intelligent Transportation Systems (ITS) – the use of technology (Closed Circuit Television (CCTV), Dynamic Message Sign (DMS), Highway Advisory Radio (HAR), etc.) to improve traffic flow with respect to incident management and traveler information. The use of technology must include supporting operations and maintenance of that technology.
- Institutional Programs and Procedures – establishing institutional relationships to address congestion, especially non-recurring congestion. These relationships may include special events management, incident management and traveler information as well as traffic signal operations. The partnerships can be used to develop inter-agency procedures to address certain congestion issues.
- Special Events Management – establishing coordinated management of special events.

Demand Management programs attempt to address congestion at the root of the problem by reducing the number of vehicles on the road. These initiatives work to modify driver behavior by encouraging people to make fewer single-occupancy trips, travel in off-peak hours when possible, and support land use policies that reduce the demand for automobile transportation. Examples include:

- Growth Management – public policies to manage the location and nature of development in a way that optimizes transportation efficiency. These include "Smart Growth" initiatives.
- Access Management – policies, design criteria, and facilities that minimize the number of driveways and intersecting roads accessing a main thoroughfare; includes parallel service roads, shared driveways, median barriers, and curb cut limitations. While many consider access management an operational improvement, the policies associated with them lend themselves to demand reduction on arterials and some collectors.
- Transit-Oriented Development (TOD) Policies – public policies that encourage concentrated development adjacent to transit stops or stations and easy access to these transit facilities.
- Employer-Based Programs – encouraging telecommuting, flexible or staggered work schedules, company-run carpool/vanpool programs, promotion of transit usage, and parking management at the job site.
- Public Relations & Education for TDM – education and publicity that discourages single-occupancy vehicle travel during peak hours and provides information on alternate modes of travel and ways to minimize travel.
- Public Relations & Education for Transportation-Supportive Development – educational programs for policy makers and the general public about the impact of development decisions on transportation systems in order to promote informed decision-making.

Modal Options include techniques to give people transportation choices beyond just driving alone in their cars. These include initiatives to encourage carpooling, vanpooling, transit, bicycle and pedestrian modes of travel.

- Improved Transit Service – new routes and/or expanded schedules, but not including new facilities. Where possible, coordination should take place such that planning and transit activities are coordinated to support existing and future service needs.

- Transit Capital Improvements – new transit facilities such as busways, dedicated bus lanes, and bus pull-off to increase transit accessibility and usage.
- Park-n-Ride & Other Intermodal Facilities – outlying parking lots that encourage transit use, carpooling and vanpooling or other facilities that facilitate transfer from one mode of travel to another.
- Rideshare Programs – programs to facilitate carpooling and vanpooling.
- Pedestrian Facilities & Information – sidewalks, crosswalks, paths, pedestrian signals, pedestrian bridges, maps and signage to promote walking as a viable mode of transportation.
- Bicycle Facilities & Information – bike lanes, paths, signals, lockers, maps and signage to promote bicycling as a viable mode of transportation.

During the preliminary screening process, congestion strategies can be subjectively evaluated for suitability and potential benefit. The rating of suitability and potential benefit can result in a matrix that helps determine which strategies should be high, medium and low priorities. The preliminary screening provides some context as to the range and magnitude of possible mitigation techniques. Ultimately, it is likely that additional detailed evaluation may be required. Additional guidance and strategies from FHWA include:

- FHWA Congestion Reduction Toolbox:
  http://www.fhwa.dot.gov/congestion/toolbox/index.htmFacilities & Information

- FHWA Traffic Congestion and Reliability: *Trends and Advanced Strategies for Congestion Mitigation, Final Report*
  http://www.ops.fhwa.dot.gov/congestion_report/congestion_report_05.pdf

In July 2009, the Urban Land Institute published the report, *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*. The report was prepared for a steering committee that included FHWA, FTA and EPA. A broad variety of transportation strategies are evaluated. Strategies relevant to improving energy efficiency included:

- Travel Activity—Reducing the number of miles traveled by transportation vehicles, or shifting those miles to more efficient modes of transportation.
- Vehicle and System Operations—Improving the efficiency of the transportation network so that a larger share of vehicle operations occur in favorable conditions, with respect to speed and smoothness of traffic flow, resulting in more fuel efficient vehicle operations.

The report advocates for an integrated multi-strategy approach, and emphasizes that measures that reinforce efficient driving — either through regulation (speed limit reductions) or education (eco-driving) are especially effective. Integrated land use strategies and transit capital investments, such as urban transit expansion and intercity and high-speed rail, were also found to reduce fuel consumption. More information can be found at: http://movingcooler.info/.

5.10.b Related Federal Partnership Programs

See Section 5.9, Federal Vehicle Fleets.

5.10.c Review Considerations

309 Reviewers should identify whether energy efficiency requirements are addressed in EISs. It is understood that rather than repeating a lengthy discussion on these requirements, the EISs will most likely incorporate them by reference by citing the appropriate document. Many times these documents are made available via a link to a web site in the EIS. In most cases, this should suffice.

When considering energy efficiency within transportation facility related EISs, 309 Reviewers will need to consider the individual purpose and need for each project. The purpose and need should clearly state the transportation needs that exist, and the alternatives analysis should thoroughly document the reasons for the selected modal choice.

In terms of operation, proposed capacity improvements projects should document the changes in energy use or efficiency. Capacity improvements could have differing impacts on proposed energy use depending upon the mode and the nature of the planning improvements. An EIS should also quantitatively document the congestion mitigation benefits of the proposed action, via analysis such as changes in delay, level of service, vehicle miles traveled, vehicles hours traveled, travel time savings, etc. To fully appreciate the benefits of congestion mitigation, EIS reviewers could suggest that the agency relate congestion mitigation to energy savings via improved travel efficiency, reduction of idling, etc.

The construction of new transportation facilities, or upgrades of existing facilities, should consider the energy efficiency of construction methods and materials. Mitigation commitments documented in the EIS should include efforts to improve energy efficiency of construction. See Section 5.4, Buildings, for recommendations on reducing energy use in construction. For highway construction, reviewers can consult the EPA Green Highways Partnership website http://www.greenhighways.org/index.cfm for additional recommendations on applicable energy efficiency strategies (click on Resources for green highways technologies and case studies). For other suggestions on construction techniques, the Low Impact Development Center http://www.lowimpactdevelopment.org/ provides innovative approaches to “green” construction techniques.

Section 5.10 References

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5.11 Other Operations

5.11.a Summary

Energy efficiency can be evaluated as an issue in EISs for other operations, including research and development (R&D) programs, operation of uranium enrichment facilities and power plants, nuclear power plants, dredging, development of water and wastewater infrastructure, mining and other resource extraction projects, and electricity transmission and distribution.

5.11.b Related Federal Partnership Programs

Federal agencies, particularly DOE and EPA, offer a range of programs to support energy efficiency improvements. They include the following:

- Energy Conservation and Renewable Energy Reserve (CRER): As an incentive to conserve energy and to use renewable energy resources (such as biomass, solar, geothermal, or wind), the Energy Reserve (58 FR 3618-3701) was established as part of the Acid Rain Program. CRER has a pool of 300,000 air emission allowances. Utilities that meet standards by implementing demand-side conservation measures or by using renewable energy resources will be awarded the allowances by the CRER. These allowances can be banked for future use as part of a compliance plan or sold.

- Coalbed Methane Outreach Program (CMOP): CMOP is an EPA program with the goal of reducing methane emissions from coal mining. CMOP promotes the profitable recovery and use of coal mine methane, a greenhouse gas (EPA 2009a).

- The Coal Combustion Products Partnership (C^2P^2): The C^2P^2 program is a cooperative effort between EPA and the American Coal Ash Association (ACAA), Utility Solid Waste Activities Group (USWAG), DOE, FHWA, the Electric Power Research Institute (EPRI), USDA Agricultural Research Service (ARS) to promote the beneficial use of coal combustion products (CCPs) (EPA 2009f).

- Landfill Methane Outreach Program (LMOP): LMOP is an EPA program to promote use of landfill gas as a renewable, green energy source. Landfill gas (mainly carbon dioxide and methane) is the natural by-product of the decomposition of solid waste in landfills. Landfill gas energy projects also provide the benefit of preventing emissions of methane (a powerful greenhouse gas) (EPA 2009b).

- AgStar: This joint effort of EPA, USDA, and DOE "encourages the use of methane recovery (biogas) technologies at the confined animal feeding operations that manage manure as liquids or slurries. These technologies reduce methane emissions while achieving other environmental benefits" (EPA 2009c).

- Methane to Markets Partnership: An international initiative that advances cost-effective, near-term methane recovery and use as a clean energy source. The Partnership acts as a

mechanism to bring together interested parties from governments and the private sector to facilitate methane project development and implementation around the world (EPA 2009d).

- Natural Gas Star: EPA partners with oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce methane emissions (EPA 2009e).

- National Industrial Competitiveness Through Efficiency: Energy, Environment and Economics (NICE^3): DOE's Office of Industrial Technology's NICE^3 program "provides grants to state and private sector partnerships to demonstrate emerging, energy efficient technologies that will benefit the Industries of the Future. The program provides up to $525,000 (50% cost sharing is required) for the first commercial demonstration of innovative industrial technologies that reduce energy consumption, waste generation, and operating costs. Applications must be submitted by an authorized state agency with an appropriate industrial partner" (DOE 2001).

- Power Marketing Administrations: DOE's Power Marketing Administrations market and deliver through transmission systems the power produced at federal water projects in excess of project needs in such a manner as to encourage its most widespread use at the lowest possible rates to consumers consistent with sound business principles. The four regional Power Marketing Administrations are Western Area, Bonneville, Southeastern, and Southern (DOE 2009a).

- EPA Sector Notebooks: The Sector Notebook series is a unique set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water, and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environmental information. There are 33 Industry Sector Notebooks and 3 Government Series that provide government officials with information they need to comply with the environmental regulations that apply to their activities. Many of them may provide useful information for the NEPA reviewer. More information about the Sector Notebooks can be found in the Sector Notebook Factsheet located at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/sector-notebooks-factsheet.pdf. The notebooks can be accessed at: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/.

5.11.c Review Considerations

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Research and Development Programs

The possibilities for introducing energy efficiency into R&D programs range as wide as the subjects of the R&D activities themselves. Many review considerations identified in other sections of this document could be relevant, depending on the details of the proposed action, including the following:

- Procurement of appliances and equipment (Section 5.1)
- Facility siting (Section 5.2)
- Construction and buildings (Sections 5.3 and 5.4)
- Laboratories (Section 5.7)

Other activities that could present opportunities for energy efficiency include water conservation measures in agricultural R&D projects, and teleconferencing, videoconferencing, online reporting, and use of electronic data in management activities for large research programs.

Uranium Enrichment Facilities

Nuclear reactor fuel requires a higher concentration of the uranium-235 (U^{235}) isotope than exists in natural uranium ore. Normally, the amount of U^{235} is enriched from 0.7% of the uranium mass to about 5%. Gaseous diffusion is the only process currently used in the U.S. to enrich uranium for use as nuclear reactor fuel (NRC 2008). Gaseous diffusion involves heating the solid form of uranium fluoride (UF_6) that was received by the facility until its gaseous form is reached. In gaseous form, lighter U^{234} and U^{235} atoms are separated from the heavier U^{238} though diffusion barriers. The resulting UF_6 gas, enriched with the U^{235} isotope, is condensed into a liquid, solidified, and transported to a fuel fabrication facility where it can be manufactured into reactor fuel (NRC 2007).

NRC has issued licenses for facilities to enrich uranium in the U.S. via gas centrifuge processing, and two such facilities are currently under construction (NRC 2008). In this process, centrifugal force generated in a rotating cylinder containing UF_6 gas separates the lighter from the heavier uranium isotopes. A series (or "cascade") of centrifuges repeatedly spins the products of the previous step, resulting in a progressively greater concentration of U^{235} (NRC 2008).

Laser enrichment is another technology that can be used to enrich uranium for use as nuclear fuel, but it is a more difficult process, though more efficient. This technology is still in development, and it may be available in the future in the U.S. (NRC 2008).

The NRC is a regulatory agency and does not build or operate uranium enrichment facilities. The NRC issues licenses for these facilities. The NRC's regulatory authority under the Atomic Energy Act does not extend to the energy efficiency of the facility. The NRC's implementing regulations for NEPA are found in 10 CFR Part 51. If a license from NRC is requested to build a new uranium enrichment facility, an appropriate NEPA assessment would be prepared, including an EIS subject to EPA review and comment. Since the industrial processes described above have high energy demands, both the construction and operation of the facility would present numerous

opportunities to incorporate energy efficiency principles into the proposed action. Many review considerations identified in other sections of this document could be relevant, including the following:

- Procurement of appliances and equipment (Section 5.1)
- Facility siting (Section 5.2)
- Construction and buildings (Sections 5.3 and 5.4)
- Laboratories (Section 5.7)
- Industrial facilities (Section 5.8)

Power Plants

Thousands of generators in the U.S. produce electrical power for public consumption using sources that include coal, petroleum, natural gas, other gases, nuclear, conventional hydroelectric, wind, solar thermal and photovoltaic, wood and wood-derived fuels, geothermal, other biomass, pumped storage, and other sources (such as batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, and miscellaneous technologies). New sources are added frequently, while others are retired. EISs may be prepared when a federal agency is involved in funding or licensing a power plant.

Many review considerations identified in other sections of this document could be relevant, depending on the details of the proposed action, including the following:

- Procurement of appliances and equipment (Section 5.1)
- Facility siting (Section 5.2)
- Construction and buildings (Sections 5.3 and 5.4)
- Laboratories (Section 5.7)
- Industrial facilities (Section 5.8)

In addition, power plant and supporting operations design presents many opportunities to conserve water resources and increase energy efficiency. Cooling systems for thermal (conventional and nuclear) power plants, in particular, can have large water requirements, amenable to implementation of water conservation measures. EPA reviewers identify language indicating that water consumption has been quantified, and whether inclusion of conservation measures has been considered.

For coal powered plants, the beneficial reuse of fly-ash and other coal combustion products can improve energy efficiency. See 5.11.b for information on the EPA/DOE/USDA Coal Combustion Products Partnership.

Several states also require that the energy resource planning used to determine the need for a new power plant fully integrate cost-effective energy efficiency. By integrating energy efficiency resources, the need for a power plant may be deferred.

Nuclear Power Plants

The NRC is a regulatory agency and does not build or operate nuclear power plants. The NRC issues permits and licenses for these facilities. The NRC's regulatory authority under the Atomic Energy Act does not extend to the energy efficiency of the facility. The Nuclear Regulatory Commission (NRC) has specific guidance (NUREG-1555, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1555/sr1555.pdf) for its staff regarding energy reviews for EISs. NUREG-1555 contains environmental standard review plans comprised of a series of instructions developed for NRC staff to use when conducting environmental reviews of applications related to nuclear power plants. The efficiency, conservation and demand side management discussed in the ESRP refers to the service area to which the applicant will be supplying electricity. It does not refer to the efficiency of the nuclear power plant or the buildings associated with the nuclear power plant.

Chapter 8, Need for Power, Sections 8.2.1- "Power and Energy Requirements" and 8.2.2- "Factors Affecting Growth of Demand" specifically addresses energy efficiency. They direct the staff to analyze and evaluate the historic (15 years preceding the date of the application) and projected (3rd year of commercial operation of proposed units) electricity consumption and peakload demands in the relevant service area or market. In performing the review, NRC may rely on the analysis in the applicant's environmental report and/or State or regional authorities' or Independent System Operators' analyses concerning the need for power and energy supply alternatives after ensuring that the analysis of the need for power and alternatives is reasonable and meets high quality standards. Many of the applicants for a license for a nuclear power plant are regulated utilities and as such their State public service commission may have required the utility to implement conservation, efficiency measures and demand side management. The NRC considers these measures in its analysis of the "need for power" in the EIS.

According to this guidance, a qualitative assessment as to the effectiveness of energy efficiency improvements in the last several years given industry restructuring, price changes, recession, and weather should be included. Successful efforts undertaken within the relevant region to promote energy efficiency on the part of customers and with respect to internal use of power transmission and distribution efficiency and demand side management should also be included.

The guidance states that the EIS should include the following:

1. public disclosure of the applicant's forecasts of peakload and electrical energy demand and
2. presentation of the staff's evaluation regarding the completeness and adequacy of these forecasts.

Chapter 9, "Alternatives to the Proposed Action", Section 9.2.1 "Alternatives Not Requiring New Generating Capacity" also includes a brief discussion on energy efficiency. The discussion is in terms of an analysis of conservation as an alternative to construction of the proposed plant. This discussion indicates that the EIS should include the bases for rejecting or accepting the alternative and supporting data such as:

1. the amount of (or lack of) excess generating capacity available for purchase,

2. the plants within the regional system, if any, available for reactivation or extended service life and their operating costs and availability factors, and
3. the effects of conservation on reducing the need for electrical generating capacity.

Dredging

Options for improving the energy efficiency of dredging are not well-documented. One option that was identified, however, is to reduce the water content of the dredged material, which reduces the amount of dredge waste. This reduces the amount of energy needed to process dredged material, improving the energy efficiency of the dredge removal process (Black Sea Coast Association 2001).

Equipment choices, such as newer dredge pump designs, can also improve the energy efficiency of dredging.

Water and Wastewater Infrastructure

Energy efficiency and water conservation can be increased by improvements in several aspects of water and wastewater systems (Alliance to Save Energy (2007), as follows:

- Pumps: efficient pumps of the right size (trim impellers when pumps already in place are too large), variable speed drives, maintenance, re-wind pump motors when insufficient funds to replace them.
- Leaks: detect and repair, manage network pressure, measure minimum night flow to gauge leakiness of system.
- System automation.
- Metering and monitoring: process for regular system monitoring, water meters, performance metrics, monitor the pump system (such as valves, flow, pressure, rotating speed, energy used, volume pumped, and velocity in the main headers).

EPA (2008a) stated that the water sector's energy efficiency can be supported by the Agency by "promoting benchmarking by utilities so that they better understand how their actions yield results; promoting use of energy efficient products/practices; and evaluating the life cycle energy costs associated with proposed projects so that alternatives can be appropriately considered." Examples include:

- Designing and implementing an environmental management system (EMS). An EMS is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency. More information can be found on the EPA website: http://www.epa.gov/ems/.
- Use of the ENERGY STAR Portfolio Manager tool to track and assess energy and water consumption; this tool includes drinking water and wastewater treatment facilities in its suite of facilities.
- Performing an energy audit. Information and examples can be found at the EPA Region 9 website: http://www.epa.gov/region09/waterinfrastructure/audit.html. Links to energy

efficient technologies for water and wastewater infrastructure can be found at: http://www.epa.gov/region09/waterinfrastructure/technology.html.

- Use of CHP systems in waste water treatment facilities that have anaerobic digesters. Biogas flow from these digesters can be used in a CHP system as "free" fuel to generate reliable electricity and power for the facility (EPA 2008b).
- Use of alternative energy sources for utility operations, including solar cells, fuel cells, and wind turbines.
- Use of EPA technical assistance in asset management (http://www.epa.gov/OWM/assetmanage/index.htm). Asset management can be defined as managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service levels customer's desire. It is successfully practiced in urban centers and large and small sewer collection systems to improve operational, environmental, and financial performance (includes such measures as modified flow and energy demand programs and software).

For new facilities and upgrades to existing facilities, design concepts to improve energy efficiency include:

- Lay out the pipes first within the treatment facility so water is moved the shortest and most direct distances with the least amount of turns and bends.
- Reduce friction by using large diameter pipe.
- Remove solids at the beginning of treatment to reduce the need for extra energy to move the solids within the facility.
- Incorporate a drying process with the solids removal process to reduce extra energy needed to move the extra moisture content in the solids.
- Increase residence time for additional treatment instead of adding more aeration.
- Reduce hydraulic head to reduce pumping capacity.
- Codigest biosolids and biowaste to reduce the volume of sludge trucked to a landfill.
- Consider using a high-density diffuser as opposed to an aeration system, which uses more energy. The energy savings from the diffuser can offset the greater capital cost within 3 to 5 years.
- Use more efficient single stage blowers that save power and require less space, saving building and operating costs.
- Use variable speed pumps and motors to match capacity with variable demand.
- Do not use materials that corrode and keep materials and structures such as ceilings, roofs, and walls away from treatment processes that emit vapors that are corrosive.
- Design system in multiple units that can be added or deleted to expand or contract treatment facility without the need to replace an entire component.
- Reduce the amount of chemicals required to treat and maintain treatment facilities by using biological or physical processes.
- Design systems and equipment so less items are needed, so there are fewer replacement parts.
- Design systems to reduce building height and amount of covers to save on materials, lighting, heating.
- Establish pumping frequencies and software management programs.
- Regrade site as appropriate to reduce height of walls and pumping grades.

- Use codigestion of biosolid wastes (e.g., sludge, fats, oils, grease, food waste, manure) onsite anaerobically to generate biogas and add it to cogeneration equipment to create electricity and heat for use onsite or to sell to the power company.
- Compost sludge and sell it.
- Sell excess recycled water to local farmers or businesses or use it to grow canola seeds to create biodiesel or food.
- Enter into purchase power agreement to construct solar photovoltaic energy and utilize net metering programs. Install emergency generators to provide alternative energy source during periods of peak demand and high cost.

In 2008, EPA (2008c) published *Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities*. The introduction states that "If drinking water and wastewater systems reduce energy use by just 10% through cost-effective investments, collectively they could save approximately $400 million and 5 billion kWh annually." This 113-page guide offers tools, links, technology suggestions, and management strategies to assist utilities at all points on the energy efficiency spectrum make improvements, using a "Plan-Do-Check-Act" approach that is cross-referenced to other programs including ENERGY STAR, asset management, ISO 14001 environmental management systems, and the American National Standards Institute's Management System for Energy. The guide sets out the steps that a facility would take to understand their energy use and set reduction goals, take actions, and make progress on achieving energy reduction targets.

The Water Environment Research Foundation is coordinating a project funded by the Global Water Research Coalition to develop "Energy Efficiency in the Water Industry: A Compendium of Tools, Best Practices and Case Studies." When complete (projected for spring 2010), this document should serve as a useful tool for EPA Section 309 reviewers of EISs for water and wastewater infrastructure projects. Updates can be found at www.werf.org/operations.

Mining and Other Resource Extraction Projects

The Southwest Energy Efficiency Project (2003) identified a comprehensive set of possibilities for improving energy efficiency in the mining sector, as follows:

- Improving exploration techniques: minimize exploratory digging and drilling by deploying non-invasive technologies such as remote sensing and ground-based technologies; advanced techniques for assaying mineral content at exploratory sites to prioritize follow-up.
- Raising the efficiency of the drilling, excavation, extraction, and ventilation processes: using efficient and correctly sized excavation motors and pumps; using insulated pipes and pumps and fan/coil heat exchangers located in the mine itself for ventilation ("[t]he closed loop used to pipe chilled water takes advantage of gravity to move water into and out of the mine, and water can contain 55 times more energy per unit of volume than can air. In addition, it is simpler and more efficient to insulate pipe than ducts.")
- Ore processing: use of correctly sized and properly maintained motors, along with adjustable speed drives for applications with varying load requirements; for smelting, use oxygen-fueled burners rather than air-fueled burners to reduce energy use and emissions.

DOE (2007) published case studies from the mining industry that demonstrate the savings associated with improvements in mining, some of which are included in the list above:

- mining fan system optimization;
- retrofitting smelting applications from air-fuel to oxy-fuel burners;
- modernizing an electrolysis system; and
- optimizing pump systems.

EPA reviewers can look for inclusion of technologies such as these in the alternatives evaluated in an EIS.

Electricity Transmission and Distribution

"The electric grid delivers electricity from points of generation to consumers, and the electricity delivery network functions via two primary systems: the transmission system and the distribution system. The transmission system delivers electricity from power plants to distribution substations, while the distribution system delivers electricity from distribution substations to consumers. The grid also encompasses myriads of local area networks that use distributed energy resources to serve local loads and/or to meet specific application requirements for remote power, village or district power, premium power, and critical loads protection (DOE 2009b)."

Given the state of our electricity grid, EPA is likely to review EISs addressing the expansion and/or modernization of our electricity grid over the coming years. Grid expansions are expected to extend electricity transmission to new generators, particularly in the case of renewable resources, such as wind, which are available in areas currently not served or connected to the transmission grid. Increases in electricity demand, particularly during peak hours of the day, is likely to lead to expansions in our transmission and distribution systems. Demand-side options, including energy efficiency and demand response programs, may defer the need for such expansions to load growth.

Title XIII of the Energy Independence and Security Act of 2007 (EISA) states, "It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid.

1. Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid;
2. Dynamic optimization of grid operations and resources, with full cyber-security;
3. Deployment and integration of distributed resources and generation, including renewable resources;
4. Development and incorporation of demand response, demand-side resources, and energy efficiency resources;
5. Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer

devices) for metering, communications concerning grid operations and status, and distribution automation;
6. Integration of "smart" appliances and consumer devices;
7. Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal storage air conditioning;
8. Provision to consumers of timely information and control options;
9. Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid; and
10. Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services."

EISA established the Federal Smart Grid Task Force (http://www.oe.energy.gov/smartgrid_taskforce.htm) to coordinate smart grid activities across the Federal Government. Task Force activities include coordinating security issues and advancing interoperability standards so that technologies across the grid can better communicate with one another. The Task Force has also commissioned a report on understanding the potential CO_2 benefits from smart gird technologies. It includes experts from several Federal agencies, including DOE (Office of Electricity Delivery and Energy Reliability and Office of Energy Efficiency and Renewable Energy), FERC, Department of Commerce (DOC), EPA, Department of Homeland Security (DHS), Department of Agriculture (USDA), Federal Communications Commission (FCC), and DoD.

The DOE OE office has the lead role on federal efforts to modernize the electricity grid. This includes both the federal Smart Grid Task Force and a national Electricity Advisory Committee. DOE also sponsors research and development on smart grid technologies, as well as grid modernization strategy tools for industry and broad educational offerings for states, customers and others. The American Recovery and Reinvestment Act of 2009 (ARRA) provided approximately $4.5B to smart grid investment projects and regional demonstration projects. DOE is responsible for awarding these funds and reporting on the results. Based on DOE's selections announced on October 27, 2009, ARRA smart grid investment grant program funding is being considered in the following categories: advanced metering infrastructure, customer systems, electricity distribution systems, electric transmission systems, equipment manufacturers, and integrated and/or cross cutting systems.

At the federal level, FERC has authority over electricity rates and terms and conditions of transmission and wholesale sales in interstate commerce. FERC also has responsibility for approving and enforcing mandatory reliability standards for the bulk power system and adopting smart grid interoperability standards for the interstate transmission of electric power (http://www.ferc.gov/industries/electric/indus-act/smart-grid.asp). It is important to highlight that FERC has jurisdiction over hydropower projects but has no authority over the construction or maintenance of power generating plants and has significant limited jurisdiction over transmission line siting, electricity distribution systems, and retail sales. The responsibility over the construction and maintenance of power generating plants and transmission lines primarily resides with the state Public Utility Commissions (PUC). State PUCs also have authority over

electricity distribution systems and the rates paid and services received by retail customers. Links to all the PUCs are located at http://www.naruc.org/.

Under EISA, the National Institute of Standards and Technology (NIST), (a non-regulatory federal agency within DOC) has responsibility to coordinate development of interoperability standards and protocols for a smart grid (http://www.nist.gov/smartgrid/). Interoperability standards will help generators, transmission, distribution, consumer products, and buildings communications to facilitate a desired action. For example, "smart" appliances and products may tell consumers how much power they are using and at what cost, providing additional information and feedback to help lower their power consumption and energy bills. In addition, smart grid technologies may help the electricity system manage large penetration (higher than 20%) of renewable generation that provides varying levels of power throughout the day (DOE 2009c).

Efforts are also underway to engage states, consumers, environmental groups and others in the deployment of the smart grid. For example, DOE and EPA facilitate a Smart Grid Stakeholder Group, which released a Perspective for Utilities and Others Implementing Smart Grids document in September 2009. This document was developed to provide general guiding principles for utilities and other smart grid project developers as they begin to plan and implement upgrades to their metering infrastructures, transmission and distribution networks. It is located at http://www.epa.gov/cleanenergy/documents/stakeholder_roundtable_sept09.pdf. Key findings include but are not limited to:

- More information on smart grid demonstrations and deployments is needed, particularly from the perspectives of utility regulators, consumers and those with expertise about the environmental impacts or benefits.
- Technology investment is important, but thorough evaluations and possibly the adoption of additional policies are needed to ensure that the potential environmental and consumer benefits from smart grid investments exceed the costs.
- Pioneers of smart grid deployments need to learn from each other and help to inform further technology and policy development.

309 Reviewers may be interested in a particular section of this report, "Smart Grid and Its Link to The Environment." It discusses both the environmental benefits and potential disadvantages/concerns that may be affiliated with the smart grid. This stakeholder dialogue revealed the following potential environmental benefits from a smart grid:

1. Reduced integration costs for variable renewable technologies and plug-in electric vehicles
2. Greater use of clean distributed general on options by all consumers (such as solar rooftops)
3. Enhanced load control capabilities that can provide sustainable energy efficiency savings for utilities and therefore help to avoid new generation
4. Reduction in energy losses across the transmission and distribution grids

Environmental participants' concerns about a smart grid included whether smart grid technologies would enable greater use of diesel back-up generators or encourage a shift of energy usage from peak load periods during the day to greater reliance on base load fossil plants and their effect on total emissions. Further, smart grid technologies themselves use electricity (computing, network equipment, sensors) and contribute to data center load. For these reasons, in order to address this issue an EIS may include a utility's holistic approach to meeting emission reduction goals that may rely on clean demand response (such as load curtailment), increased deployment of various renewables, smart grid technologies that are themselves energy efficient, data center energy efficiency efforts, and other measures.

The following are other issues that were highlighted in the report that 309 Reviewers may consider while reviewing an EIS that addresses a smart grid:

1. What are the anticipated environmental benefits of the smart grid deployment and how will these be measured, including enabling greater penetration of renewable generation and peak and total energy use reductions.
2. Are any risks being shifted from the utility to customers, or within customer classes? In particular, will additional risks be transferred to environmental justice communities?
3. If upgrades are intended to reduce peak load, how much load will be avoided over what period? Are these savings being captured in energy and air planning?
4. How much consumer interaction is required? Will all customers, including environmental justice communities, have access to benefits?
    a. Will customers have access to their energy use, price and bill information? What will be done with this information to help make it actionable for consumers to reduce their total energy use?
    b. Will customers be required to purchase a new technology or service (such as grid-connected appliances, a home area network, or energy management system) in order to reduce their total energy bills? How will that purchase be incented through rates and other programs to address the additional market barriers?
    c. Will all customers have access to the enabling technology? For example, will Internet connections be required in homes to obtain information feedback? Will information also be available to customers in low or no tech formats?
    d. Has the utility performed any customer research to fully understand what different customers want and will respond to? How does this vary by different customer segments (i.e. low-income residential, commercial buildings with existing energy management systems, etc).
    e. What is being done to ensure the utilities' smart grid technologies will be interoperable with available technologies within homes and buildings?
5. Has the utility considered the broad environmental impacts as well as benefits from smart grid deployment? For instance, data storage associated with smart grid technology will undoubtedly increase. Data storage centers are huge energy users. Has the utility evaluated the broad spectrum of savings offset by the potential increases of electric use from its smart grid additions?
6. Will building managers have access to consumption data and information to better manage energy use by ensuring that installed equipment are maintained and operating as designed to meet forecasted loads and to allow for changes in operational requirements?

Another challenge is the integration of renewable energy into the existing grid where there is the tendency of large-scale renewable energy facilities to be located far from population centers; additional expense is required for property acquisition, transmission lines and road construction. To overcome this challenge, one solution is to construct renewable energy projects on brownfields, abandoned mines, federal Superfund sites, non-federal Superfund sites, or other disturbed areas. Many of these locations have transmission capacity on-site and/or may be closer to population centers. Another alternative which limits the need for new transmission is the possibility of locating solar facilities near substations, where only short-interconnections are needed.

Smart Grid technology deployments may increase energy efficiency by reducing line losses and controlling voltage levels on the electricity system and supporting greater energy efficiency and clean distributed generation in homes, buildings and industry. The technologies alone will not provide the end-use energy efficiency benefits directly. EPA reviewers may also look to resources of the National Action Plan for Energy Efficiency (Section 4.2) for information on policy and program options to support achieving energy efficiency savings. As smart grid deployments are still under development, EPA reviewers can request that smart grid projects share information on the energy savings realized through the investment. This can help better inform EPA on the efficiency opportunity for future reviews.

EPA reviewers may also consider whether federal actions related directly (siting of new transmission lines and power plants) or programmatically to electricity transmission and distribution have considered technologies and policies, including those considered Smart Grid, that could help increase energy efficiency benefits from the investment. In the case of new long-distance transmission lines, EPA reviewers may consider not only the line, but potential for environmental effects from the power generator that will now be generating power due to the line.

Many review considerations identified in other sections of this document could be relevant, depending on the details of the proposed action, including the following:

- Procurement of appliances and equipment (Section 5.1)
- Construction and buildings (Sections 5.3 and 5.4)
- Laboratories (Section 5.7)
- Industrial facilities (Section 5.8)

In a related matter, EPA entered into a Memorandum of Understanding (MOU) with the Department of the Interior (DOI), USDA, DOC, DoD, DOE, the Advisory Council on Historic Preservation, CEQ, and FERC. Its intent is to expedite the siting and construction of qualified electric transmission infrastructure in the United States. It also improves coordination among project applicants, federal agencies, and states and tribes that are involved in the siting and permitting process. The MOU assigns the lead agency for NEPA and other environmental reviews. It is located at:
http://www.whitehouse.gov/files/documents/ceq/Transmission%20Siting%20on%20Federal%20Lands%20MOU.pdf.

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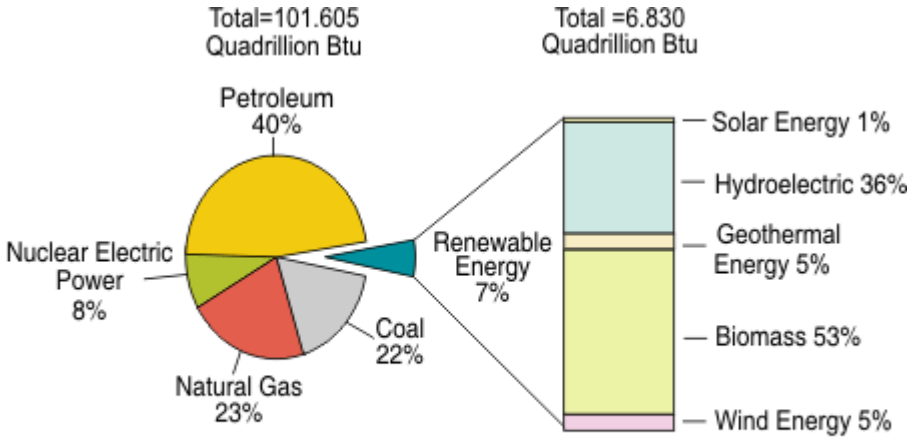
6. Renewable Energy Technologies

Renewable energy and energy efficiency technologies are closely related in that both seek to increase energy sustainability and reduce pollution caused by energy use. This chapter presents information on current and developing renewable energy technologies and federal renewable energy programs. Section 309 reviewers can use the information provided in this chapter to make informed recommendations to federal agencies for incorporating renewable energy technology in the actions, decisions and operations of the Federal government (see Section 5.11 Other Operations, for information on the related topic of electricity transmission and distribution).

The figure below shows U.S. energy consumption by production type. In 2007, renewable energy supplied about 7% of the nation's energy needs. Hydroelectric and biomass together provide 89% of the U.S. renewable energy supply.

Renewable Energy Plays a Role in the Nation's Energy Supply (2007)



Note: Sum of components may not equal 100 percent due to independent rounding.
Source: EIA, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics*, Table 1: U.S. Energy Consumption by Energy Source, 2003-2007 (May 2008).

As of 2007, the majority of renewable energy consumption (51%) was for the production of electricity. Most of the remaining 49% of renewable energy consumed was biomass for industrial applications (principally paper-making) by plants producing only heat and steam. Biomass is also used for transportation fuels (ethanol) and to provide residential and commercial space heating.

Table 6-1 shows the electricity generated from various renewable sources. The largest share of the renewable-generated electricity comes from hydroelectric energy (71%), followed by biomass (16%), wind (9%), geothermal (4%), and solar (0.2%) (EIA 2009b).

Table 6-1
Electricity Net Generation From Renewable Energy by Energy Use Sector and Energy Source, 2003-2007 (thousand-kilowatt hours)

Sector/Source	2002	2004	2005	2006	2007
Biomass	53,341,092	53,073,722	54,160,152	54,758,512	55,400,235
Geothermal	14,424,231	14,810,975	14,691,745	14,568,029	14,838,636
Hydroelectric Conventional	275,806,329	268,417,308	270,321,255	289,246,416	248,312,395
Solar/PV	534,001	575,155	550,294	507,706	606,082
Wind	11,187,466	14,143,741	17,810,549	26,589,137	32,143,244
Total	355,293,119	351,020,900	357,533,995	385,669,799	351,300,592

Sources: Energy Information Administration, Form EIA-906, "Power Plant Report," and Form EIA-920, "Combined Heat and Power Plant Report." (EIA 2009a).

Several federal agencies have conducted comprehensive assessments evaluating the potential for increased renewable energy development. These reports can aid federal and military decision makers in prioritizing activities that will increase the federal government's use of renewable energy technologies. Reports include:

- *Assessing the Potential for Renewable Energy on National Forest System Lands* (http://www.nrel.gov/docs/fy05osti/36759.pdf). This U.S. Forest Service technical report evaluates the potential for renewable energy resource development (wind and solar) on National Forest System lands.

- *Assessing the Potential for Renewable Energy on Public Lands* (http://www.nrel.gov/docs/fy03osti/33530.pdf). This Department of Interior Bureau of Land Management (BLM) report is intended to assist federal land managers with increasing development of renewable energy resources on public lands in the West (except Alaska). The report studied resources on BLM, Tribal, and Forest Service lands.

- *Department of Defense Renewable Energy Assessment* (http://www.acq.osd.mil/ie/energy/renew_energy/renewable.shtml). This Department of Defense assessment provides an evaluation of wind, solar and geothermal energy use at U.S. military installations, and considers resource availability, electricity purchasing, mission compatibility, energy security, and short- and long-term perspectives.

- *RE-Powering America's Land: Renewable Energy on Contaminated Land and Mining Sites* (http://www.epa.gov/renewableenergyland/). EPA is encouraging the development of renewable energy by identifying currently and formerly contaminated lands and mining sites that present opportunities for renewable energy development. The website contains maps showing renewable energy development potential on EPA-tracked sites (linked to Google Earth), as well as incentive sheets describing renewable energy development and contaminated lands redevelopment incentives in each state.

- DOE *Geothermal Resource Maps* (http://www1.eere.energy.gov/geothermal/maps.html).
- DOE *Wind Resource Maps* (http://www.windpoweringamerica.gov/wind_maps.asp).
- NREL *U.S. Solar Resource Maps* (http://www.nrel.gov/gis/solar.html).
- NREL *Dynamic Maps, GIS Data and Analysis Tools* (http://www.nrel.gov/gis/) provides dynamically-generated maps of renewable energy resources that determine which energy technologies are viable solutions in national and international regions.

Federal agencies have also prepared several programmatic EIS's related to renewable energy development:

- *West-wide Energy Corridor Programmatic EIS* (http://corridoreis.anl.gov/). This DOE, BLM and DOD Programmatic Environmental Impact Statement (PEIS) evaluates issues associated with the designation of energy corridors on federal lands in 11Western states. EPAct 2005 directs the Secretaries of Agriculture, Commerce, Defense, Energy, and the Interior to designate corridors on federal land in 11 Western States (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) for oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities (energy corridors).
- *Solar Energy Development Programmatic EIS* (http://www.solareis.anl.gov/). See Section 6.1, Solar Power.
- *BLM: Wind Energy Development Programmatic EIS* (http://windeis.anl.gov/). See Section 6.2, Wind Power.
- *Geothermal Resources Leasing Programmatic EIS* (http://www.blm.gov/wo/st/en/prog/energy/geothermal/geothermal_nationwide.html). See Section 6.3, Geothermal Power.

The Database of State Incentives for Renewables and Efficiency (DSIRE) (http://www.dsireusa.org/) is a comprehensive source of information on state, local, utility, and federal incentives and policies that promote renewable energy and energy efficiency. Funded by DOE, DSIRE is an ongoing project of the North Carolina Solar Center and the Interstate Renewable Energy Council. DSIRE tracks energy efficiency financial incentives and rules, regulations and policies established by the federal government, state governments, larger local governments and larger electric utilities.

The DOE EERE has renewable energy research and development partnership programs and conducts research related to these renewable energies with the Solar Energy Technologies Program, the Wind and Hydropower Technologies Program, the Geothermal Technologies Program, and the Biomass Program. Information in the following sections is adapted from DOE websites.

6.1 Solar Power

Solar power involves collecting energy from sunlight and converting it into heat, electricity or supplemental lighting. Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight. Active solar techniques use technology such as photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the sun.

Passive Solar Design

Passive solar design is the technology of heating, cooling, and lighting a building naturally with sunlight rather than with mechanical systems. Basic design principles are large south-facing windows with proper overhangs, as well as tile, brick, or other thermal mass material used in flooring or walls to store the sun's heat during the day and release it back into the building at night or when the temperature drops. Passive solar can also use energy efficient materials, improved insulation, airtight construction, natural landscaping, and proper building orientation to take advantage of the sun, shade, and wind. Passive solar designs can include natural ventilation for cooling (DOE 2009c).

Solar Water Heating

Solar water-heating systems use collectors, generally mounted on a south-facing roof, to heat either water or nontoxic antifreeze that is circulated from the collector to the water storage tanks. The heated water is then stored in a water tank similar to one used in a conventional gas or electric water-heating system.

Collectors heat water either "passively" or "actively." *Passive* solar water-heating systems use natural convection or water pressure to circulate water through a solar collector to a storage tank. They have no electric components that could break, a

Hybrid Solar Lighting Illuminates Energy Savings for Government Facilities
http://www1.eere.energy.gov/femp/pdfs/tf_hybridsolar.pdf
Electric lighting is the greatest consumer of electricity in U.S. commercial buildings and generating this electricity by conventional power plants is the building sector's most significant cause of air pollution. Hybrid solar lighting provides a new means of reducing energy consumption in federal buildings while delivering benefits associated with natural lighting. The technology could be particularly useful in the Sunbelt where cooling is a significant source of energy use.

Hybrid solar lighting contributes to meeting the requirements set by EPAct 2005 for federal renewable energy consumption The technology was originally developed for fluorescent lighting applications but has been enhanced to work with incandescent accent-lighting sources, such as the parabolic aluminized reflector (PAR) lamps commonly used in retail spaces. Commercial building owners—specifically retailers—use the low-efficiency PAR lamps because of their desirable optical properties and positive impact on sales. Yet the use of this inefficient lighting results in some retailers' spending 55–70% of their energy budgets on lighting and lighting-related energy costs.

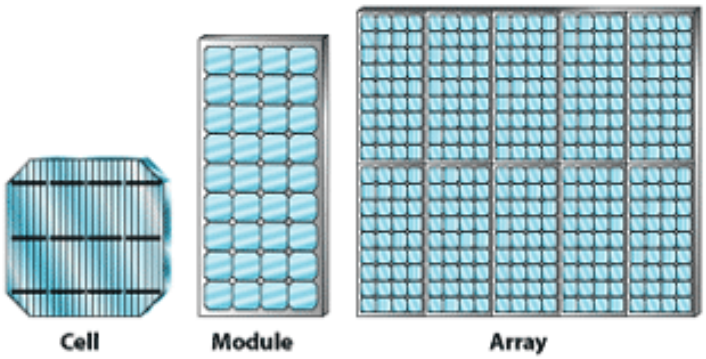
Solar lighting can significantly reduce artificial lighting requirements and energy costs in many commercial and industrial buildings and in institutional facilities Future R&D is aimed at enhancing the performance and reliability of the technology as well as extending the application of the system to work with newly emerging solid-state lighting sources.

feature that generally makes them more reliable, easier to maintain, and possibly longer lasting than active systems. An *active* system uses an electric pump to circulate water or nontoxic antifreeze through the system. Active systems are usually more expensive than passive systems, but they are also more efficient. Active systems are easier to retrofit than passive systems because their storage tanks do not need to be installed above or close to the collectors. In addition, the moving water in the system will not freeze in cold climates. However, because these systems use electricity, they will not function in a power outage. For this reason, many active systems are now combined with a small solar-electric panel to power the pump.

The amount of hot water a solar water heater produces depends on the type and size of the system, the amount of sun available at the site, proper installation, and the tilt angle and orientation of the collectors (DOE 2009c).

Photovoltaics and Thin Film Technology

Photovoltaics are silicon-based devices that convert light into electricity. These devices are grouped together into photovoltaic modules and either used to provide power for individual structures or for large-scale grid-connected power generation. The larger photovoltaic installations, called solar farms, can encompass numerous acres and many interconnected photovoltaic modules. Because of this modularity, PV systems can be designed to meet any electrical requirement, no matter how large or how small. Thin-film, a more recent development in PV technology, uses microscopically thin layers of material deposited onto a metal, ceramic, semiconductor or plastic base. Thin films of photovoltaic material using silicon, cadmium telluride and other elements are used to make solar panels and solar roof shingles.



Source: DOE 2009.

Concentrated Solar Power

Concentrated solar power is a solar thermal technique that uses reflective surfaces from dish/engine systems, parabolic troughs, and central power towers that focus or concentrate the sun's heat energy. This concentrated solar energy then drives a generator to produce electricity. Concentrated solar power systems are divided into concentrated solar thermal and concentrated photovoltaics. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated light is then used as heat or as a heat source for a conventional power plant. Concentrated photovoltaics is a term used when sunlight is concentrated onto photovoltaic surfaces for the purpose of direct electrical power production. Compared to conventional flat panel solar cells, concentrated photovoltaics are advantageous because the solar collector is less expensive than an equivalent area of solar cells.

The DOE Report to Congress, *Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation* (http://www1.eere.energy.gov/solar/pdfs/csp_water_study.pdf discusses potential methods to reduce water consumption associated with concentrated solar power. The DOE fact sheet, Concentrated Solar Power (http://www1.eere.energy.gov/solar/pdfs/43685.pdf), and Solar Energy Technologies Program website provide more information on concentrated solar power.

Other solar heating technologies make use of low-temperature solar collectors that absorb the sun's heat energy, allowing that heat to be used directly for water or space heating in residential, commercial, and industrial buildings. Solar lighting technologies rely on roof-mounted solar concentrators to collect sunlight; this is then distributed through optical fibers to special lighting fixtures in the building's interior that combine natural light with electric light to illuminate interior spaces.

Distributed Generation

Solar power increases the potential for distributed energy generation. Distributed generation is the production of energy close to where it will be used, and power capacity usually ranges from 1 kilowatt to 5 megawatts (MW). In contrast, central generation ranges from 10 to 1,000 MW and supplies power to locations much farther away through transmission lines. Electric utilities often tap into solar electricity for distributed applications, such as near substations or at the end of overloaded distribution lines, to avoid or defer costly upgrades of transmission lines (DOE 2009d). Several reports published in February 2008 by NREL and DOE's EERE discuss the mechanics and challenges of distributed generation, including:

- *Distribution System Voltage Performance Analysis for High-Penetration Photovoltaics* (http://www1.eere.energy.gov/solar/pdfs/42298.pdf)
- *Renewable Systems Interconnection* (http://www1.eere.energy.gov/solar/pdfs/42292.pdf
- *Power System Planning: Emerging Practices Suitable for Evaluating the Impact of High-Penetration Photovoltaics* (http://www1.eere.energy.gov/solar/pdfs/42297.pdf)

Solar Energy Development Programmatic EIS
DOE and BLM are preparing (as of 2009) a PEIS to evaluate utility-scale solar energy development, to develop and implement Agency-specific programs that would establish environmental policies and mitigation strategies for solar energy projects, and to amend relevant BLM land use plans with the consideration of establishing a new BLM solar energy development program. Information about the PEIS can be found here: http://www.solareis.anl.gov/.

Solar Energy Technologies Program

Solar energy capacity has more than doubled between 2000 and 2007, but still represents a very small part of U.S. electricity generation (DOE 2009). The DOE EERE Solar Energy Technologies Program focuses on developing cost-effective solar-energy technologies that have the greatest potential for incorporation into the market place. Along with technology research and development, the program works to remove non-technical market barriers (e.g., updating codes and

standards that are not applicable to new technologies, and improving interconnection agreements among utilities and consumers). The program works with the National Renewable Energy Laboratory, Sandia National Laboratories, Oak Ridge National Laboratory, and Brookhaven National Laboratory to perform research support program management. These laboratories are organized into two virtual labs, the National Center for Photovoltaics (NCPV) and the SunLab (for Concentrating Solar Power research).

There are four subprograms in the Solar Energy Technologies Program: Photovoltaics, Concentrating Solar Power, Systems Integration and Market Transformation. The Photovoltaics subprogram funds PV technologies that have potential for significant advances in solar energy efficiency. The Concentrating Solar Power subprogram pursues research and development activities in concentrating solar power to lower technology and manufacturing costs, increase conversion efficiencies, and improve the reliability of components and systems. The Systems Integration subprogram focuses on reducing the regulatory, technical, and economic barriers to integrate solar electricity into the electric grid. The Market Transformation subprogram works with external partners to address non-R&D issues that are barriers to the widespread adoption of solar technologies. Through this subprogram the DOE provides financial and technical assistance, information, and training related to solar technology. The program also presents case studies (e.g., http://www1.eere.energy.gov/solar/cs_ca_substation.html) of successful solar power implementation. More information on the program can be found at: http://www1.eere.energy.gov/solar/.

6.2 Wind Power

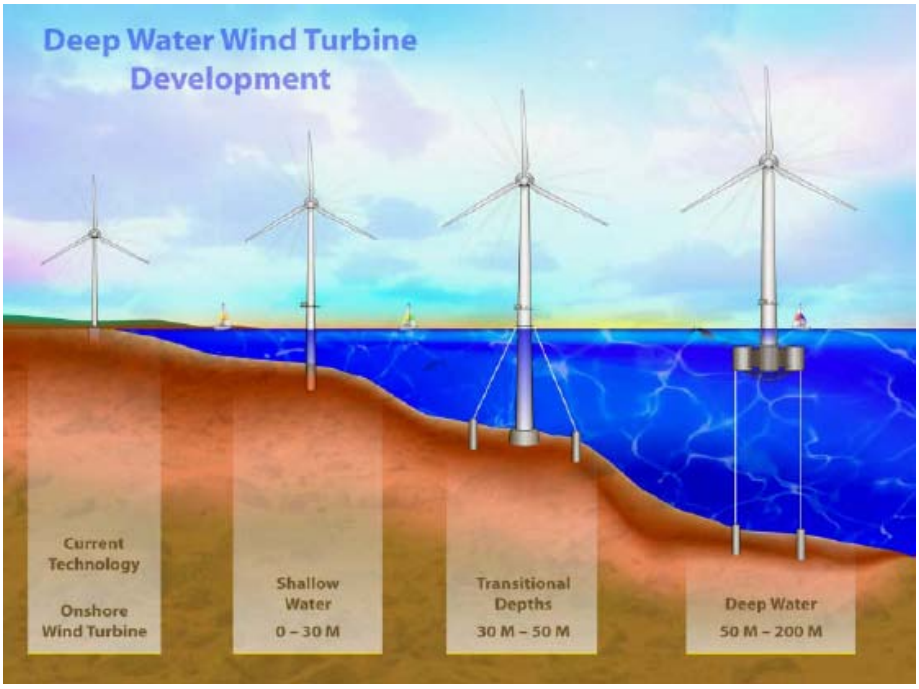
Wind power is the conversion of wind energy into a useful form, such as electricity, using wind machines and turbines. Wind machines can be large individual structures with a small number of sizable blades, or numerous smaller structures with many relatively tiny blades. Specially-designed blades are constructed to capture as much wind as possible; this turns a drive shaft connected to a turbine, generating electricity. Modern wind turbines fall into two basic groups: the horizontal-axis and the vertical-axis design (DOE 2009e).

Larger turbines are grouped together into wind farms, which provide bulk power to the electrical grid. Utility-scale turbines range in size from 100 kilowatts to as large as several megawatts. Single small turbines, below 100 kilowatts, are used for homes, telecommunications dishes, or water pumping. Utility companies increasingly buy back surplus electricity produced by small domestic turbines. Wind energy is one of the lowest-priced renewable energy technologies available today, costing between 4 and 6 cents per kilowatt-hour (DOE 2009e).

BLM: Wind Energy Development Programmatic EIS.
In June 2005, BLM prepared a Final PEIS to evaluate issues associated with wind energy development on Western public lands (excluding Alaska) administered by the BLM. The PEIS, along with the *Revised BLM Wind Energy Policy Instruction Memorandum* is available here: http://windeis.anl.gov/.

Electricity generated from wind power can be highly variable at several different timescales: from hour to hour, daily, and seasonally. Annual variation also exists, but is not as significant. Because instantaneous electrical generation and consumption must remain in balance to maintain grid stability, this variability can present substantial challenges to incorporating large amounts of wind power into a grid system. In particular geographic regions, peak wind speeds may not coincide with peak demand for electrical power. In California and Texas, for example, hot days in summer may have low wind speed and high electrical demand due to air conditioning.

Proper selection of a wind turbine site is critical to economic development of wind power. Aside from the availability of wind itself, other factors include the availability of transmission lines, value of energy to be produced, cost of land acquisition, land use considerations, and environmental impact of construction and operations. Although wind power plants have fewer impacts on the environment compared to conventional power plants, impacts include noise produced by the rotor blades, aesthetic (visual) impacts, and danger to migratory birds from the spinning blades. Many potential sites for wind farms are far from demand centers, requiring substantially more money to construct new transmission lines and substations.



Offshore winds tend to flow at higher speeds than onshore winds, thus allowing turbines at offshore locations to produce more electricity. Because the potential energy produced from the wind is directly proportional to the cube of the wind speed, increased wind speeds of only a few miles per hour can produce a significantly larger amount of electricity. Much of this potential energy is near major population (and energy load) centers where energy costs are high and land-based wind development opportunities are limited (MMS 2009). For this reason, interest in wind project located off the U.S. coast is increasing.

In offshore facilities, undersea collection cables connect multiple turbines in the wind facility and transport the electricity from them to a transformer where the combined electricity is converted to a high voltage for transmission via undersea cables to a substation. There the electricity is connected to the onshore electricity grid (MMS 2009).

Offshore turbines have technical needs not required of onshore turbines due to the more demanding climatic environmental exposure offshore. U.S. waters are generally deeper than those on the European coast where offshore wind projects are more common, and will require new technology. Off-shore locations also have higher construction costs, but may offset these costs with higher annual power generation, thereby reducing the cost of energy produced. The National Renewable Energy Laboratory (NREL) published two recent reports on offshore wind power potential, *Future for Offshore Wind Energy in the United States* in June 2004 (http://www.nrel.gov/docs/fy04osti/36313.pdf) and an April 2009 *Outer Continental Shelf* report (http://www.doi.gov/ocs/). The October 2007 MMS OCS Alternative Energy and Alternate Use Programmatic EIS also contains information on offshore wind energy development (http://ocsenergy.anl.gov/guide/wind/index.cfm).

With a current annual growth rate of 30% to 40%, the nation's wind energy capacity increased from 2,500 MW in 1996 to more than 21,000 MW at the end of 2008. However, wind energy still comprises less than 2% of U.S. energy generation (DOE 2009e).

Wind and Hydropower Technologies Program

The DOE Wind and Hydropower Technologies Program (http://www1.eere.energy.gov/windandhydro/about.html) focuses research on increasing the technical viability of wind systems, and increasing the use of wind power in the marketplace. DOE assesses market barriers for various turbine size ranges (Table 6-2):

Table 6-2
Wind Turbine Market Segmentation
Source: MMS 2009.

Turbine Size Range	Applications	Barriers
Small (<10 kW)	Residential, off-grid	Zoning
Intermediate (10 kW - 500 kW)	Wind/diesel, industrial	Zoning
Large (500 kW - 5 MW)	Grid interconnect	Transmission and access; operational impacts
Very Large (>5 MW)	Offshore grid interconnect	Cables to shore, viewshed, new regulatory

DOE uses a state-focused strategy for build acceptance for wind energy technology. DOE uses several subprograms to promote wind power, including:

- Wind Powering America (WPA) (http://www.windpoweringamerica.gov/). WPA identifies barriers at the state level, and provides technical assistance and outreach to key user communities - farmers and ranchers, Native Americans, federal facility managers, rural electric cooperatives, and consumer-owned utilities.

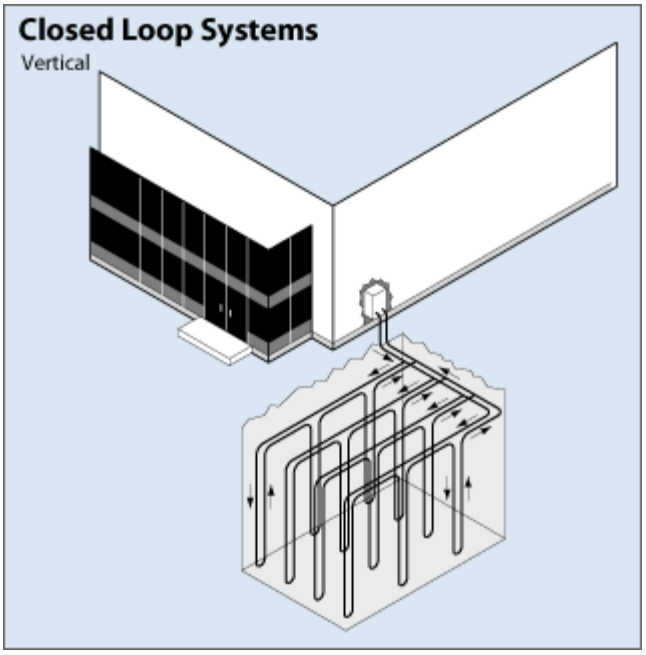
- National Wind Coordinating Committee (NWCC) (http://www.nationalwind.org/). NWCC is a collaborative among representatives from electric utilities and support organizations, state legislatures, state utility commissions, consumer advocacy offices, wind equipment suppliers and developers, green power marketers, environmental organizations, agriculture and economic development organizations, and state and federal agencies.

- Federal Wind Siting Information Center (http://www1.eere.energy.gov/windandhydro/federalwindsiting/). The Center provides information on the siting of wind turbines and on federal activities to support the increased deployment of wind energy facilities on public, private, and tribal lands, airspace, and offshore.

6.3 Geothermal Power

Geothermal power comes from energy generated by heat stored in the earth. Geothermal energy is available 24 hours a day, 365 days a year. Geothermal power plants have average availabilities of 90% or higher, compared to about 75% for coal plants. In the U.S., most geothermal reservoirs are located in the western states, Alaska, and Hawaii. Geothermal resources range from shallow ground to hot water and rock several miles below the Earth's surface, and even further down to the extremely hot molten rock called magma (DOE 2009b). Wells over a mile deep can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface for use in a variety of applications. Geothermal systems are recognized as one of the most efficient heating and cooling systems available. Geothermal technologies include collecting energy through heat pumps, hot dry rock processes, and direct heating.

In most areas, the upper 10 feet of Earth's surface maintains a nearly constant temperature between 50 and 60°F. A geothermal heat pump system consists of pipes buried in the shallow ground near a building. In winter, heat from the relatively warmer ground is collected in the pipes and brought into building, while in summer hot air from the building is pulled out into the relatively cooler ground. Heat removed during the summer can be used as no-cost energy to heat water (DOE 2009b).



Source: DOE 2009b.

The initial cost of installing a geothermal heat pump system can be two to three times that of a conventional heating system in most residential applications, new construction or existing buildings. There are four basic types of heat pump systems. Three

of these—horizontal, vertical, and pond/lake—are closed-loop systems. The fourth type of system is the open-loop option. Which one of these is best depends on the climate, soil conditions, available land, and local installation costs at the site.

More information on heat pump systems can be found at: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12650.

Hot dry rock technology is a type of geothermal power production that uses the very high temperatures found in rocks a few kilometers below the surface. By pumping high pressure water down a borehole, the water travels through fractures in the rock and absorbs heat energy and is subsequently forced out of a second borehole as very hot water. This water is then used to run a turbine and generate electricity. The cooled water is injected back into the ground to heat up again in a closed loop. Higher permeability of the rock is important, as it allows for the greater energy production. Although natural fractures may provide adequate flow rates, systems can be enhanced through hydraulic stimulation which involves pumping cold water with acid additives into the rock to open the fractures. Three types of geothermal power plants are operating today:

- Dry steam plants, which directly use geothermal steam to turn turbines;
- Flash steam plants, which pull deep, high-pressure hot water into lower-pressure tanks and use the resulting flashed steam to drive turbines; and
- Binary-cycle plants, which pass moderately hot geothermal water by a secondary fluid with a much lower boiling point than water. This causes the secondary fluid to flash to vapor, which then drives the turbines (DOE 2009b).

In direct geothermal heating, hot water near Earth's surface is piped directly into facilities and used to heat buildings, grow plants in greenhouses, aquaculture, crop drying and a variety of other tasks. Some cities pipe the hot water under roads and sidewalks to melt snow. District heating applications use networks of piped hot water to heat buildings in whole communities (DOE 2009b). Direct-use systems typically include three components:

- A production facility — usually a well — to bring the hot water to the surface;
- A mechanical system — piping, heat exchanger, controls — to deliver the heat to the space or process; and
- A disposal system — injection well or storage pond — to receive the cooled geothermal fluid.

Geothermal Resources Leasing Programmatic EIS

In 2008, BLM and the USDA Forest Service (FS) prepared a joint PEIS to analyze and expedite the leasing of BLM-and FS-administered lands with high potential for renewable geothermal resources in 11 Western states and Alaska. The PEIS is available here: http://www.blm.gov/wo/st/en/prog/energy/geothermal/geothermal_nationwide.html.

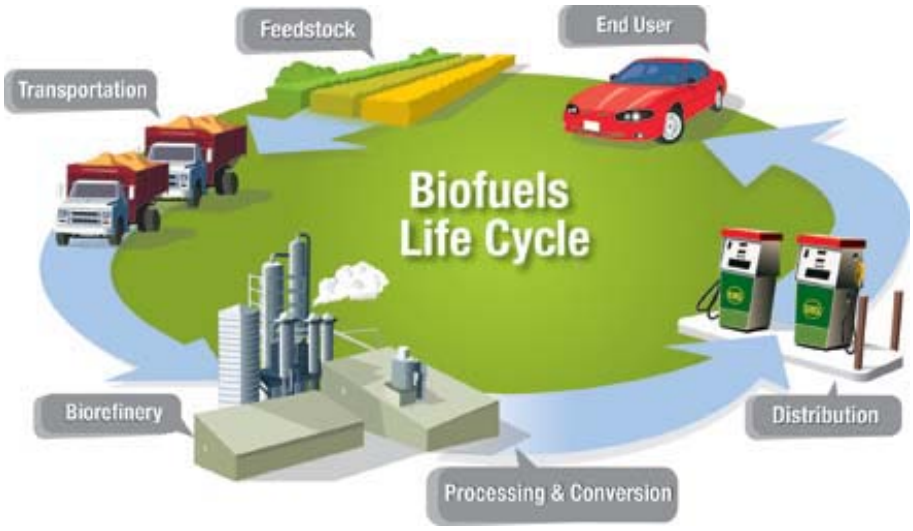
Geothermal Technologies Program

The DOE Geothermal Technologies Program partners with industry, academia and the national laboratories to conduct research, development and

demonstration projects on geothermal heat systems. Among other areas, the program focuses research on enhanced geothermal systems (EGS), which are engineered reservoirs created to produce energy from geothermal resources that are otherwise not economical due to lack of water and/or permeability. EGS technology has the potential for accessing the Earth's vast resources of heat located at depth. The program provides technical information on geothermal heat, including geothermal resource maps (http://www1.eere.energy.gov/geothermal/maps.html), research reports on the status of the industry (http://www1.eere.energy.gov/geothermal/publications.html) and software programs that model geothermal systems and economics (http://www1.eere.energy.gov/geothermal/software_data.html).

6.4 Biomass

Biomass power is solar energy stored in organic matter. Sources of biomass energy include agricultural and forestry residues, manure, municipal solid wastes, industrial wastes, and terrestrial and aquatic crops grown solely for energy purposes. Biomass can be grown from numerous types of plants, including miscanthus, switchgrass, hemp, corn, poplar, willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm (DOE 2009a).



Biomass resources are used to generate electricity and power, and to produce liquid transportation fuels, such as ethanol and biodiesel. There are generally two ways to release the energy stored in biomass: burning and fermentation. Biomass can be burned as a direct heat source, or to heat water and create steam to power turbines which generate electricity. Burning biomass to produce energy can circumvent waste management problems by removing it from the waste stream. Burning biomass does generate carbon dioxide and particulate matter. However, biomass energy recycles carbon dioxide during the plant photosynthesis process (DOE 2009a).

Biomass can also be fermented and made into liquid fuels, which are easily transportable. Many car manufacturers are now producing flexible-fuel vehicles, which can safely run on blends of ethanol, biodiesel and gasoline. Biologically produced alcohols, most commonly ethanol, and less commonly propanol and butanol, are produced by the action of microorganisms and enzymes through the fermentation of sugars or starches or cellulose. The distillation process requires significant energy input for heat, which often comes from the burning of natural gas, as

well as tremendous amounts of water. The burning of biomass itself can be used to increase biomass sustainability (and reduce lifecycle CO_2 emissions), albeit with the accompanying carbon dioxide and particulate matter.

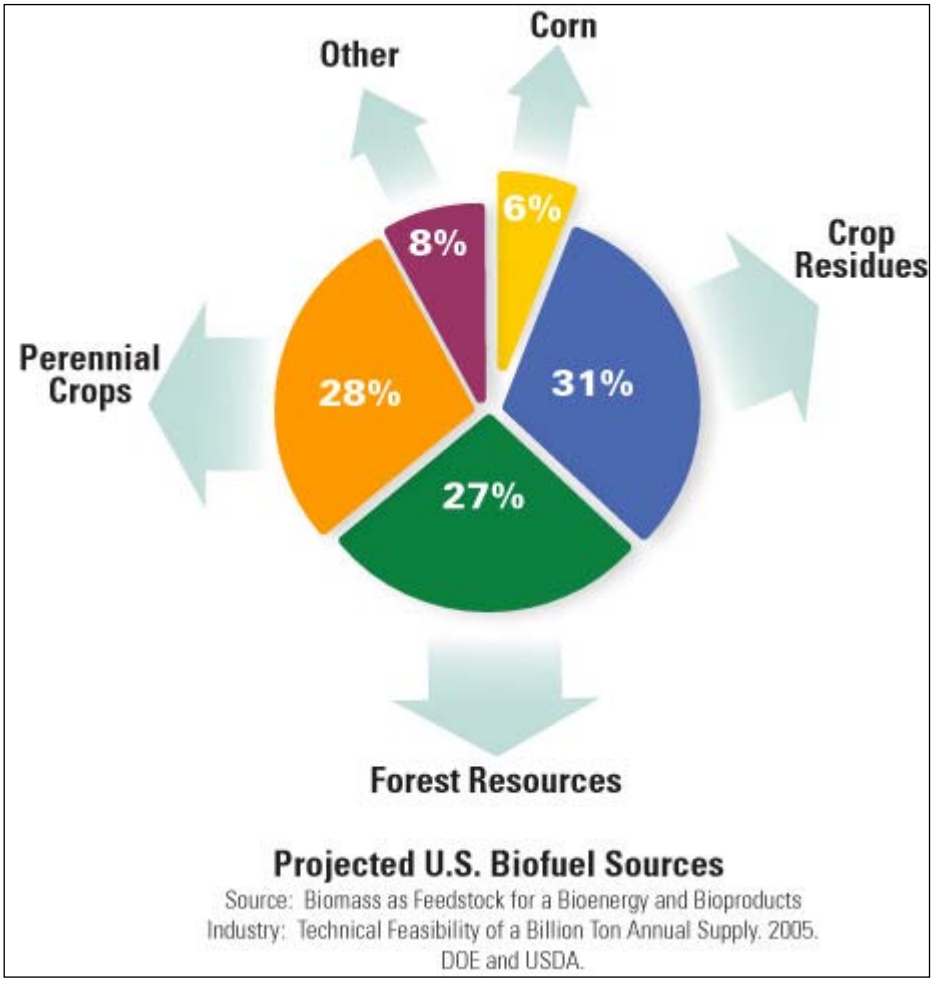
The burning and fermentation processes create co-products that can be used for other purposes, such as ash for use in construction material, and dried distiller grains, corn gluten feed, corn oil and other ingredients that can be used in plastics and chemicals. The generation and use of these co-products help offset some of the energy-intensive nature of producing energy from biomass (DOE 2009a).

EISA 2007 revises the Renewable Fuel Standard (RFS) for transportation fuels, originally created under the Energy Policy Act of 2005. The Act seeks to increase the supply of biofuel by requiring fuel producers to use in the fuel mix a progressively increasing amount of biofuel, culminating in at least 36 billion gallons of biofuel by 2022. Within these total volumes, new volume standards are also created for cellulosic biofuel, biomass-based diesel, and other advanced biofuel. EISA also includes new definitions and criteria for both renewable fuels and the feedstocks used to produce them, including new lifecycle greenhouse gas (GHG) emission thresholds for renewable fuels. EISA requires a 50% reduction in lifecycle GHG emissions for fuels to be classified as biomass-based diesel or advanced biofuel, and a 60% reduction in order to be classified as cellulosic biofuel. EISA also provides some limited flexibility for EPA to adjust these GHG percentage thresholds downward by up to 10 percent under certain circumstances. EPA issued a proposed rule on May 19, 2009 to implement these changes to the RFS program, and is now working on a final rule. Additional details can be found at: http://www.epa.gov/otaq/renewablefuels/index.htm

Biomass Program

The DOE Biomass Program partners with industry, academia and the national laboratories to conduct research, development and demonstration projects on biomass feedstocks and conversion technologies. Two major focuses of the program are ensuring that cellulosic ethanol is cost competitive by 2012, and developing infrastructure and opportunities to bring biobased fuels and products to market. Figure 6-1 shows projected U.S. biofuel sources.

Figure 6-1



The NREL has developed (with EPA Region 6 funding) a new biomass assessment tool. While it does not take the place of an on-the-ground detailed assessment, it can serve as an initial screening tool to identify and evaluate sites for potential sources of biomass. It is a mapping application that allows users to explore the potential of biomass-to-power conversions at different locations and scales. It also allows for visualization and analysis of biomass resources on a local basis. This tool is located at: http://rpm.nrel.gov/biopower/biopower/launch.

The 309 Reviewer should be aware that unlike oil and gas, the U.S. does not have a biomass fuel commodity market. For this reason, each biomass project would have to locate and/or acquire its own supply of quality fuel.

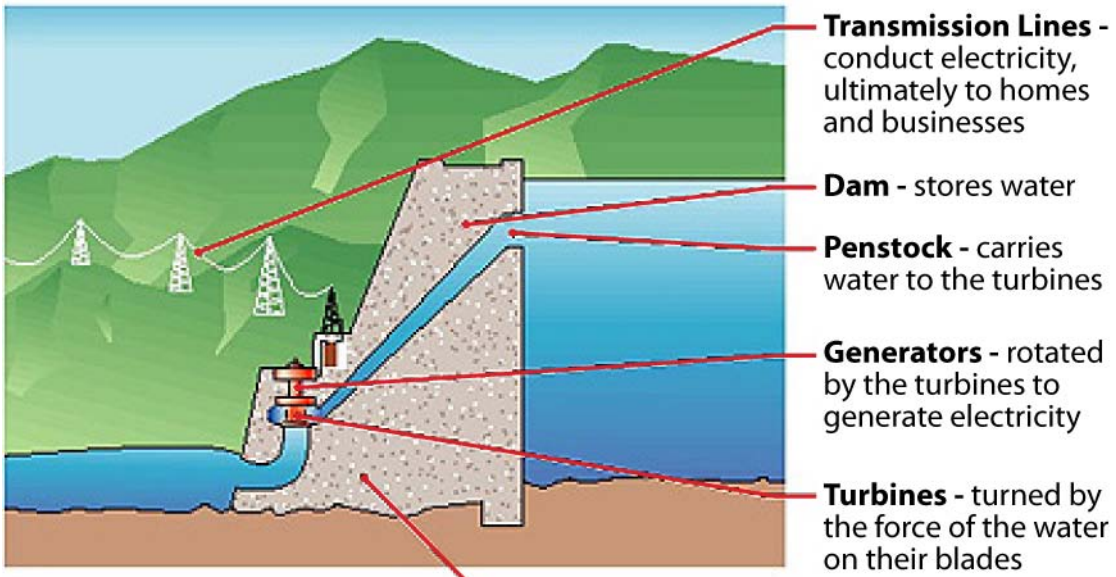
More information about the DOE Biomass program can be found at: http://www1.eere.energy.gov/biomass/about.html. Technical resources can also be found at The

National Renewable Energy Laboratory, the lead national laboratory of the virtual National Bioenergy Center (http://www.nrel.gov/biomass/).

6.5 Hydropower

Hydropower is derived from the force or energy of moving water. Today, the largest use of hydropower is for the creation of hydroelectricity, currently the leading renewable energy source used by electric utilities to generate electric power. Conventional hydropower is a key component of the U.S. energy portfolio, representing approximately 7% of total U.S. electricity generation and between 71-75% of U.S. renewable energy electricity generation (DOE 2009f, EIA 2009b). There are significant opportunities to increase the nation's incremental hydroelectric generation, to quantify and maximize the ancillary benefits to the U.S. electric grid, and to improve the environmental performance of the U.S. hydroelectric industry.

There are three types of hydropower facilities: impoundment, diversion, and pumped storage. The most common type of hydroelectric power plant is an impoundment facility. An impoundment facility, typically a large hydropower system, uses a dam to store river water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity. The water may be released either to meet changing electricity needs or to maintain a constant reservoir level (DOE 2009e). There are not many locations in the United States where dam installation is currently feasible, as many of the best locations have already been acquired and built upon. In addition, the potential environmental impacts to riverine systems associated with dam installation render many projects infeasible.



Source: DOE 2009e.

In a diversion hydroelectric facility, sometimes called run-of-river, a portion of a river is channeled through a canal or penstock. A diversion facility may not require the use of a dam. When the demand for electricity is low, a pumped storage facility stores energy by pumping water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir to generate electricity.

Generating electricity using water has several advantages, including: 1) low cost, 2) little air pollution compared with fossil fuel plants, and 3) limited thermal pollution compared with nuclear plants. Like other energy sources, the use of water for generation also has limitations, including environmental impacts caused by damming rivers and streams (EIA 2009c). Current DOE research focuses on reducing the environmental impacts of hydropower facilities through improved design of turbines in existing facilities.

Hydrokinetic Technologies

DOE research also focuses on new marine and hydrokinetic technologies – technologies capable of generating electricity from waves, tidal, ocean, and river currents, and ocean thermal energy/temperature gradients. Tidal power converts the energy of tides into electricity. Because tides are caused by the forces related to the gravitational interaction with the moon, the sun and the Earth's rotation, tidal power is predictable and practically inexhaustible. Tidal power can be classified into two main types: kinetic and potential. Tidal stream systems make use of the kinetic energy of moving water to power turbines, in a similar way to windmills that use moving air. Some tidal stream systems use propellers or aerofoils, while others involve placing obstacles in rivers in order to cause the formation of vortices which can then be tapped for energy. The higher density of water means that a single generator can provide significant power at low tidal flow velocities when compared to wind velocities.

Potential energy can be tapped by barrages (structures built across rivers and estuaries to manage water) by taking advantage of the difference in water height between high and low tides. Turbines installed in the barrage wall generate power as water flows in and out of the estuary basin, bay, or river.

Wave power is the transport of energy by ocean surface waves. Waves are generated by wind passing over the sea, and there is an energy transfer from the wind to the most energetic waves. Devices can be used to take advantage of the wave swells: the rising and falling of the waves can move a buoy-like structure, creating mechanical energy which is converted into electricity and transmitted to shore over a submerged transmission line. Other wave power devices consist of a single piston pump attached to the sea floor, with a float tethered to the piston. Waves cause the float to rise and fall, generating pressurized water, which is piped to an onshore facility to drive hydraulic generators or run reverse osmosis desalination.

The U.S. market for marine and hydrokinetic energy is still in the early stages of development, with a few technologies ready for demonstration or deployment. These technologies can be deployed near densely populated load centers as well as for remote power applications.

Renewable Energy Development on the Outer Continental Shelf

In May 2009, the Federal Energy Regulatory Commission (FERC) and the U.S. Department of Interior, Minerals Management Service (MMS) signed a Memorandum of Understanding (MOU) regarding renewable energy development activities on the Outer Continental Shelf, including hydrokinetic sources such as wave, tidal and ocean current. According the MOU:

- "MMS has exclusive jurisdiction with regard to the production, transportation or transmission of energy from non-hydrokinetic renewable energy projects including wind and solar. MMS also has jurisdiction to issue leases, easements and rights-of-way regarding Outer Continental Shelf lands for hydrokinetic projects. MMS will conduct any necessary environmental reviews, including those under the National Environmental Policy Act, related to those actions.
- FERC has exclusive jurisdiction to issue licenses and exemptions from licensing for the construction and operation of hydrokinetic projects on the Outer Continental Shelf and will conduct any necessary analyses, including those under the National Environmental Policy Act related to those actions. FERC's licensing process will involve relevant federal land and resource agencies including DOI.
- FERC will not issue a license or exemption for an Outer Continental Shelf hydrokinetic project until the applicant first obtained a lease, easement or right-of-way from MMS for the site. FERC will not issue preliminary permits for hydrokinetic projects on the Outer Continental Shelf. In all leases, easements and rights-of-way for hydrokinetic projects, MMS will require that construction and operation cannot begin without a license or exemption from FERC, except when FERC notifies MMS that a license or exemption is not required (FERC 2009)."

The MOU also states that, "at its discretion, FERC may choose to become a cooperating agency with MMS in the latter's preparation of an environmental document for the lease, easement and right-of-way for any Outer Continental Shelf hydrokinetic project. Likewise, MMS may choose to be a cooperating agency with FERC in the preparation of FERC's environmental documents for the license or exemption of any Outer Continental Shelf hydrokinetic project (FERC 2009)."

The agencies also will coordinate to ensure that any licenses or exemptions issued by FERC and all operations regulated by FERC, with respect to a lease, easement or right-of-way, are consistent with the provisions of the Outer Continental Shelf Lands Act, the Federal Power Act and other applicable laws (FERC 2009). A copy of the MOU can be accessed at: http://www.ferc.gov/legal/maj-ord-reg/mou/mou-doi.pdf.

Wind and Hydropower Technologies Program

The mission of DOE's Wind and Hydropower Technologies Program is to conduct research and development that will improve the technical, societal, and environmental benefits of hydropower and provide cost-competitive technologies that enable the development of new and incremental hydropower capacity. Three of DOE's National Laboratories with experience in hydropower issues provide technical support to the Program: Idaho National Laboratory (INL), Oak Ridge

National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). The lead laboratory for engineering and program management support is INL. ORNL is the lead laboratory for environmental and computational support. PNNL is involved in biological testing and technology development studies, taking advantage of their experience with fish and test facilities. A combination of industry, universities, and federal facilities conduct research activities for the Hydropower Program. More information can be found at: http://www1.eere.energy.gov/windandhydro/about.html and http://hydropower.id.doe.gov/.

In 2008, DOE, through the Water Power Program (a subprogram within DOE's Wind and Hydropower Technologies Program), initiated advanced water power activities to research, test, and develop innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water. These include marine and hydrokinetic technologies, a new suite of renewable technologies that harness the energy from untapped wave, tidal, current and ocean thermal resources.

The Water Program's activities with marine and hydrokinetic technologies include:

- Research and development funding for components and devices to optimize these technologies and help industry reduce costs and technical risks. In 2008, the program initiated the development of two new National Marine Renewable Energy Centers, and began technology characterization efforts that included the development of a marine and hydrokinetic technology and project database (http://www.eere.energy.gov/windandhydro/hydrokinetic/default.aspx), which includes a technology glossary.
- Higher-resolution resource assessments to quantify and validate estimates of extractable energy quantity by location. Results from assessments will improve the quality of device and component testing by providing fundamental resource characteristic data and fill essential information gaps needed to reduce technical and project risk for the investment community.
- Environmental effects studies to better assess potential impacts that hinder technology deployment, to aid the regulatory process, and to reduce project development costs.

In addition, the Water Power Program works to develop technologies and processes to improve the efficiency, flexibility, and environmental performance of hydroelectric generation. The Water Power Program's activities with conventional hydropower include:

- Assessing the current state of the U.S. hydroelectric infrastructure and identifying opportunities for increased and more valuable generation. This includes increasing incremental generation through efficiency and capacity gain at existing power stations, placement of power stations at existing non-powered dams and in constructed waterways such as canals, and supporting the development of the small hydropower industry.
- Developing and deploying technologies, including pumped storage, that increase stability and operational flexibility of the U.S. electric grid and support the integration of variable renewable energy resources.
- Addressing environmental impacts through the development of new technologies and methods to improve environmental performance, which will mitigate such impacts as fish passage, water quality in reservoirs and downstream from dams, and altered flow regimes

that may degrade physical habitat for fish below dams. DOE published the *Draft Report to Congress on the Environmental Effects of Marine and Hydrokinetic Energy Projects* in December 2008, with the final report scheduled for publication in 2009. The report, prepared pursuant to EISA 2007, describes options to mitigate and prevent adverse environmental impacts from marine and hydrokinetic energy technologies (http://www.lawofrenewableenergy.com/2008/12/articles/renewable/doe-issues-draft-report-on-environmental-effects-of-marine-and-hydrokinetic-energy-projects/).

More information can be found at http://www1.eere.energy.gov/windandhydro/hydro_about.html.

6.6 Benefits and Limitations

There are substantial benefits to pursuing renewable energy technologies: a relatively unlimited supply, with little greenhouse gas or particulate matter generation. Renewable energy would also help reduce the nation's dependence on foreign oil, protect against rising utility rates, reduce operating costs, and provide jobs. There are some technical, economic, operational, and regional concerns regarding renewable energy, which are summarized in Table 6-3.

Table 6-3
Renewable Energy

Issues & Concerns	Solar	Wind	Geothermal	Biomass	Hydropower
Variability	Power generated only during daylight hours	Power generated only when wind is blowing	Earth provides constant heat source	Variability between organic matter sources	Seasonal fluctuations in flow rates
Regional Issues & Efficiency	Highest efficiency achieved in areas with fewest cloudy days and most direct sunlight; only achieve ~10-40% efficiency with current technology	Highest efficiency achieved in areas with stronger winds; strong development potential in Midwest	Most activity in western U.S., Alaska and Hawaii	Production of some sources not energy efficient; energy use from agricultural production and transportation can exceed energy created	Pacific coast has the most potential for wave power; tidal influence required for tidal power
Transmission	Large-scale facilities for these types of renewable energy typically located far from population centers; additional expense required for property acquisition, transmission lines and road construction. Feasible to construct RE projects on brownfields, abandoned mines, federal Superfund sites, non-Federal Superfund sites, or other disturbed areas; many of these locations have transmission capacity on-site.				
Land Use	Requires substantial tracts of land for large scale production	Requires substantial tracts of land for large scale production	90% of all significant geothermal activity located on federal land	Many organic matter sources require large scale farm production	Locations limited to streams, rivers and oceans, many sites already in use

Table 6-3
Renewable Energy

Issues & Concerns	Solar	Wind	Geothermal	Biomass	Hydropower
Natural Resource Impacts	Large-scale facilities are typically located in arid regions; potential water quantity impacts due to heavy water use (wet cooling plants use 10x more water than dry cooling plants); potential water quality/ habitat impacts from herbicides used to prevent sunlight-blocking vegetation growth	Birds and bats can be injured by swiftly spinning blades; newer designs attempt to prevent roosting and decrease potential mortality	Potential impact to groundwater aquifers from leaks of acid used in production. Potential impact to surface water quantity/quality from heavy water use in production	Potential surface water quantity/quality impacts due to heavy water use for fermentation, filtration, and extraction and fertilizer/ pesticides use; potential climate change impacts (CO_2, particulate matter) from burning	Changes the natural flow of streams/rivers causing sedimentation/ erosion, surface water quantity/quality impacts; potential aquatic and terrestrial habitat impacts
Social Impacts	Perceived to cause visual blight to landscape	Perceived to cause visual blight to landscape; potential noise impacts from wind machines	Potential noise impacts from drilling and blasting for temperature gradient wells, seismic exploration, and core drilling	Increase/ decrease in demand has economic impacts on agricultural industry	Viewshed impacts from dams and surface-related wave devices

Section 6 References

Links to external web sites provided in this document may be useful or interesting and are being provided consistent with the intended purpose of this guidance document. EPA cannot attest to the accuracy of information provided by any linked site. Providing links to a non-EPA web site does not constitute an endorsement by EPA or any of its employees of the sponsors of the site or the information or products provided on the site. Also, be aware that the privacy protection provided on the epa.gov domain (see Privacy and Security Notice) may not be available at the external link.

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7. Energy Efficiency-Related Training Opportunities

There are many training opportunities available to increase familiarity with both general and specific aspects of energy efficiency. A "snapshot in time" of the training that is available as of spring 2009 is summarized in Table 7-1.

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
Energy Efficiency Training - General							
FedCenter Training Fed Center is a web-based portal for federal agencies and federal facilities managers and provides comprehensive information resources and data management capabilities to enhance the effectiveness and efficiency of environmental compliance and stewardship programs, in addition to opportunities for interagency collaborative self-management on environmental issues across the federal government. It allows real-time access to recognized best management practices on compliance, environmental management systems, green procurement, energy management, sustainable construction, chemical management, restoration and reuse, NEPA, and natural resources. In addition it provides a significant instrument for tracking and reporting of common environmental metrics across the federal government. Current Energy efficiency related training: Basics of Daylighting in a Green Environment (Online) ENERGY STAR Online Trainings and Presentations (Online) FEMP Lights Online Training (Online) Integrating Energy Conservation into the Capital Planning Process (Webinar)	Many no cost, some have fees.	Most one day, several 2-3 days	http://www.fedcenter.gov/	X			X
FEMP Training Variety of training opportunities on energy efficiency topics, including UESCs/ESPCs, alternative financing tools for implementing energy efficiency projects.	Many no cost, some have fees.	Most one day, several 2-3 days	http://www1.eere.energy.gov/femp/news/events.html	X	X	X	X
GovEnergy Co-Sponsors: DOE, GSA, VA, DoD, DHS, EPA *Training conference where participants will have the opportunity to :* *Obtain insight on reducing Federal agency energy usage and cost, as mandated by the Energy Policy Act, Executive Order 13423, EISA 2007 and additional Federal guidance.* *Access the tools, techniques and best practices needed for meeting both day-to-day and long-term energy management goals.* *Develop effective partnerships amongst Federal energy professionals.*	$495	4 days	1-800-343-2171 govenergy@govenergy.gov www.govenergy.com	X	X	X	X

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
Comprehensive 5-Day Training Program for Energy Managers (preparation for CEM certification) Association of Energy Engineers *Provides in-depth, comprehensive learning and problem-solving forum for those who want a broader understanding of the latest energy cost reduction techniques and strategies.*	$1595 – govt price	5 days	(770) 925-9633 valerie@aeecenter.org https://www.aeecenter.org/store/detail.cfm?id=745&category_id=4	X	X	X	X
Pacific Gas and Electric Company, Spring 2009 Energy Efficiency Classes, sponsored by the Pacific Energy Center (PEC) and the Energy Training Center - Stockton (ETC) *ETC offers continuing education for businesses, construction professionals and participants of energy efficiency education programs. PEC offers educational programs, design tools, advice, and support to create energy efficient buildings and comfortable indoor environments, with most efforts focused around commercial buildings.*	Many no cost, some have fees	Most one day or less	Customer Service: 1-800-468-4743 http://www.pge.com/mybusiness/edusafety/training/pec/classes/index.jsp	X	X		X

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
ENERGY STAR Training U.S. EPA *Provides free online training to help improve the energy performance of organizations.*	No cost	1-2 hours for live web sessions, or download pre-recorded lessons	1-866-229-3239 http://www.energystar.gov/index.cfm?c=business.bus_internet_presentations	X	X	X	X
Seminars for Professionals Association of Energy Engineers *Includes a range of topics including energy efficiency-related offerings.*	$245 - $1595	1-5 days	https://www.aeecenter.org/seminars/	X	X	X	X
Timing Is Everything: Moving Investment Decisions to Energy-Efficient Solutions American Council for an Energy-Efficient Economy *The 2009 ACEEE Summer Study on Energy Efficiency in Industry offers opportunities to learn about approaches to securing boss' support for energy efficiency, financing mechanisms to pay for projects, regulatory aspects affecting energy efficiency projects, commercially-available technologies that work, and emerging technologies likely destined to be the next big thing.*	$775	4 days	Rebecca Lunetta Director of Conferences (302) 292-3966 fax (302) 292-3965 rlunetta@verizon.net http://aceee.org/conf/09ss/09ssindex.htm	X	X		X

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
Information Center DOE Office of Energy Efficiency and Renewable Energy (EERE) *Information about residential, commercial, industrial, and transportation energy efficiency, as well as the use of solar, wind, biofuels, and other renewable energy sources.*	NA	NA	1-877-EERE-INF 1-877-337-3463 EERE Office of Business Admin., Program Execution Support EE-3A 1000 Independence Avenue, SW Washington, DC http://www1.eere.energy.gov/informationcenter/	X	X	X	X
Energy Efficiency Global Forum and Exposition Alliance to Save Energy *Showcases new technologies and ideas for growing an energy efficient economy.*	$600	May 10-12, 2010	http://eeglobalforum.org/	X	X	X	X
Facilities/Green Building							

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
BOC Level I Training Building Operator Certification *Course series consists of Building Systems Overview, Energy Conservation Techniques, HVAC Systems and Controls, Efficient Lighting Fundamentals, Operation & Maintenance Practices For Sustainable Buildings, Indoor Air Quality, and Facility Electrical Systems.*	$1275	74 hours in seven 1-2 day sessions	206-292-4793, ext. 2 BOCinfo@theBOC.info www.theBOC.info	X			
BOC Level II Training Building Operator Certification *Course series consists of Preventive Maintenance & Troubleshooting Principles, Advanced Electrical Diagnostics, HVAC Troubleshooting & Maintenance, HVAC Controls & Optimization, plus two supplemental classes (choices include Water Efficiency for Energy Operators, Commercial Energy Audits).*	$1275	61 hours in six 1-2 day sessions	206-292-4793, ext. 2 BOCinfo@theBOC.info www.theBOC.info	X			
Green Building for Building Professionals National Association of Home Builders *Includes strategies for incorporating green-building principles into homes without driving up the cost of construction.*	$325 for non-members	2 days	Mr. Ashley Burnette HBA of Greater Knoxville 221 Clark Street, NW Knoxville, TN 37921 http://www.nahb.org/meeting_details.aspx?meetingID=17160&sectionID=116	X			X

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	Cost	Duration	Contact / More Information	Facilities / Green Buildings	Industrial Activities	Trans-portation	Construc-tion
Building Science Fundamentals Building Science Corporation *Seminar about optimizing building performance. Fundamental building science principles (such as the control of heat, air and moisture and IAQ) as well as applications in disaster management, building investigations and sustainability.*	$795	2 days	http://www.buildingsciencesseminars.com/seminars/fundamentals/2008/index.html	X			
Residential Green Building Workshop Series Building for Social Responsibility *Participants learn about key green building topics, including health, quality and durability; preserving the natural ecosystem on the building lot; locating homes efficiently; reducing potable water use;reducing environmental impacts of building materials; reducing emissions through energy efficiency and renewable energy; and educating homeowners about green building features.*	$250	1 day	http://www.bsr-vt.org/contactus.html	X			
Designing Low Energy Buildings: Tools, Techniques and Technologies Building Science Corporation *This seminar examines challenging techniques for heating, cooling and ventilation low energy buildings, including: natural ventilation, radiant heating and cooling, and passive design approaches for commercial building enclosures.*	$395	1 day	http://www.buildingsciencesseminars.com/	X			
Green Building Basics and LEED® U.S. Green Building Council *Inlcudes an introduction to USGBC, green building principles, and the fundamentals of the LEED® Rating System.™*	$225	1 day	(800) 795-1747 (202) 742-3792 www.usgbc.org	X			X
Green Building Operations And Maintenance U.S. Green Building Council *Walks through the phases of a typical project, using case examples and implementation strategies throughout to reinforce learning and encourage students to apply knowledge to real-life situations. Prior Knowledge: Familiarity with the LEED® Rating System is a must and USGBC's " LEED® Core Concepts & Strategies" workshop is strongly recommended.*	$445	1 day	http://www.usgbc.org/DisplayPage.aspx?CMSPageID=283	X			

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
Achieving Zero Energy Green Homes Florida Solar Energy Center *A 12-course series on implementing strategies to achieve zero energy use.*	$69 for each course in the series	1 day each	Mable Flumm 1679 Clearlake Road Cocoa, Florida 32922 (321) 638-1401 Fax: (321) 638-1010 mable@fsec.ucf.edu http://www.fsec.ucf.edu/en/education/conted/schedule.php	X			
Save Energy Now in Federal Data Centers Energetics, Inc. *Provides information on state-of-the-art strategies to improve data center energy performance. While it will be targeted towards facility engineers, managers, and operators, information technology (IT) professionals and project managers will also benefit from attending.*	No cost	1 day	AYoung@energetics.com http://www.govenergy.com/events_related.php	X			
High-Performance Buildings for High-Tech Industries - Data Centers Lawrence Berkeley National Laboratory *Provides training resources for data center energy management. Includes workshop developed by DOE and ASHRAE, which provides information, tools, and environmental best practices for data center/telecom power and cooling facilities.*	unlisted	1 day	http://hightech.lbl.gov/training/training.html	X			

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	Cost	Duration	Contact / More Information	Facilities / Green Buildings	Industrial Activities	Trans-portation	Construc-tion
Green Workplace Auditor Midwest Renewable Energy Association *Basic "green practices" that can be applied to most businesses. Emphasis will be placed on how these practices can help save money, improve employee health, and reduce the carbon footprint of the company.*	$240	1 day	7558 Deer Road Custer, WI 54481 (715) 592-6595 Fax: (715) 592-6596 greta@the-mrea.org	X	X		
LEED							
LEED® Core Concepts and Strategies U.S. Green Building Council *Provides essential knowledge of the LEED® Rating Systems and sustainable building concepts for those seeking a better understanding of LEED® or pursuing GBCI's LEED® Green Associate (Tier I) credential.*	$445	1 day		X	X		X
LEED® for Commercial Interiors Technical Review U.S. Green Building Council *Provides technologies and strategies for achieving LEED® credits to optimize the performance of leased spaces.*	$445	1 day		X			
LEED® For General Contractors And Construction Managers U.S. Green Building Council *Will help general contractors and construction managers understand LEED® as it relates to their project role, with a focus on technical requirements. Includes strategies for general contractor and subcontractor documentation and cost tracking.*	$225	1/2 day		X			
LEED® for Homes Program Review U.S. Green Building Council *Provides key concepts needed for successful participation in the LEED® for Homes initiative.*	$225	1 day		X			

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	Cost	Duration	Contact / More Information	Facilities / Green Buildings	Industrial Activities	Trans-portation	Construc-tion
LEED® For New Construction Technical Review U.S. Green Building Council *Designed for those who have a basic knowledge of LEED® and want to delve deeper into the technical requirements of the rating, the building certification process and other implementation strategies.*	$445	1 day		X			X
LEED® For Schools Technical Review U.S. Green Building Council *Provides a complete review of the LEED® for Schools Rating System™ and how to apply it on school projects including the tools and insights needed to incorporate green building practices into projects. Case studies of certified school projects illustrate successful strategies and practices for improving school design and performance.*	$445	1 day		X			
Managing LEED® Documentation U.S. Green Building Council *Provides in-depth instruction on LEED® documentation. Attendees should have completed a technical review workshop or have equivalent knowledge of a LEED® Rating System.*	$225	1/2 day		X			
Using Energy Modeling On LEED® Projects U.S. Green Building Council *Coveres application of the LEED® for New Construction energy modeling protocol and the use of ASHRAE Standard 90.1 for LEED® Energy and Atmosphere credit compliance.*	$225	1/2 day		X	X		X
Renewable Energy/Alternative Fuels							
Law of Renewable Energy: Regulatory and Transmission Issues for Renewable Energy Projects Electric Utility Consultants, Inc. *Briefly addresses the requirements and applicable exemptions of the Federal Power Act and other applicable federal and state statutes and regulations related to power sales, transmission, and interconnection, as well as important differences in transmission and interconnection requirements in the different regional transmission organization areas.*	$295	Web conference or CD 1.5 hours	(303) 770-8800 www.euci.com		X		

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	Cost	Duration	Contact / More Information	Facilities / Green Buildings	Industrial Activities	Trans-portation	Construc-tion
Renewable Energy and Energy Efficiency for Tribal Community and Project Development DOE, Energy Efficiency and Renewable Energy, Tribal Energy Program *This unique course will help tribal leaders and staff understand the range of energy efficiency and renewable energy opportunities that exist within their communities.*	No cost for tribal members and BIA employees	5 days	David Glickson fax: (303-384-6568) david_glickson@nrel.gov http://www.certredearth.com/documents/DOE-TEPRegionalTrainingFlyer.pdf	X	X		
Demand Response & Energy Efficiency World Electric Utility Consultants, Inc. *Hear from commissioners, utilities and brilliant leaders within the power community. Inquire about specific case studies and learn first-hand results of different pilot programs and their effectiveness.*	$1,295	2 days	(303) 770-8800 www.euci.com	X	X		
Alternative Fuels and Vehicles National Conference Alternative Fuel Vehicle Institute *Presents alternative fuels, vehicles and technologies. Showcases natural gas, ethanol, biodiesel, propane, electricity, and hydrogen, and their companion vehicles. The conference embraces advanced technologies that result in fuel efficiency, petroleum displacement and emissions improvements. Included are hybrid-electric and plug-in hybrid technologies; blends, including hydrogen; fuel cells; and, idle-reduction devices.*	$799	May 9-12, 2010	http://www.afv2010.com/			X	

Table 7-1. Energy Efficiency Training Opportunities							
				Topic			
Title / Source/ Description	**Cost**	**Duration**	**Contact / More Information**	**Facilities / Green Buildings**	**Industrial Activities**	**Trans-portation**	**Construc-tion**
Electric Vehicles for Utilities: Impact, Opportunities and Challenges for a Smart Grid Electric Utility Consultants, Inc. Learning outcomes include, but not limited to: • *Evaluate the impact of electric vehicles on electric utilities* • *Identify when and where wide scale deployment is projected to take place* • *Analyze the effect that electric vehicles will have on the Electricity T&D system at certain stages of implementation* • *Examine strategies to provide electric vehicle charging to those who do not have in-home access to an outlet* • *Examine how renewable energy can be used to charge electric vehicles* • *Discuss the implications of GHG legislation and management of RECs for utilities in terms of electric vehicles* • *Review how electric vehicles fit into a utility's greater smart grid strategy* • *Experience PHEV and smart grid technology with hands on demonstrations*	$1195 Govt: no cost	2 days	(303) 770-8800 www.euci.com			X	
Construction							
Energy Efficient and Environmentally Friendly Construction Midwest Renewable Energy Association *Provides the basics of energy efficient and environmentally friendly construction, including: site analysis, passive solar design strategies, superinsulated frame construction techniques, sustainable building materials, renewable heating systems and mechanical systems.*	$110	1 day	7558 Deer Road Custer, WI 54481 (715) 592-6595 Fax: (715) 592-6596 greta@the-mrea.org	X			X

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