



## **POSITION STATEMENT**

# **ENERGY EFFICIENCY**

#### Adopted by the IEEE-USA Board of Directors, 20 June 2008

Increasing efficiency in the conversion, delivery and utilization of energy is an essential part of a comprehensive national energy policy. Through improved energy efficiency, the United States can grow the economy, improve balance of payments, strengthen national security, and mitigate the environmental impacts of energy use by reducing emission of both air pollutants that reduce air quality and impact public health, and greenhouse gases that affect climate change. Increased energy efficiency will help to decrease our vulnerability to oil supply disruptions.

IEEE-USA urges federal legislators to promote aggressive policies and legislation and to supply the necessary funding to support research and development, commercialization and promotion of existing and new technologies for more energy efficient products and processes. Specifically the federal government can help facilitate energy efficiency by:

- Promoting user awareness of economical energy efficiency opportunities
- Promulgating minimum efficiency standards for products consistent with life cycle analysis and internalization of environmental costs
- Providing incentives for capital investment in energy efficient technologies and processes in all sectors, such as residential, commercial, industrial and transportation
- Developing technologies to further reduce energy losses in electric power generation, transmission and distribution
- Developing, commercializing and using more efficient electric-drive technologies in public transit, freight, truck and personal transportation, such as plug-in hybrid electric vehicles
- Improving and upgrading transportation systems to reduce energy consumption, and adopting "smart growth" policies that reduce distances traveled

- Using communications and information technologies, such as teleconferencing and the Internet, to reduce the need for business travel, such as in telecommuting
- Using demand management programs to reduce peak demand, in lieu of building new generation.

This statement was developed by the IEEE-USA Energy Policy Committee and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good and promotes the careers and public-policy interests of the more than 215,000 engineers, scientists and allied professionals who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of the IEEE or its other organizational units.

## BACKGROUND

#### **Purpose of Energy Conservation and Efficiency**

With the continuing trend of increasing energy demand and rising energy costs, energy efficiency is becoming extremely important. Through energy conservation, the United States will have greater resources available to compete in the global market while improving energy cost and security, saving energy resources, and reducing greenhouse gases. While energy conservation is clearly a sound general policy objective, achieving broad agreement on specific conservation measures is an exceedingly complex political and societal challenge. *Energy conservation* has different meanings for different interest groups, and includes efforts to reduce and eliminate imprudent and wasteful energy use, as well as efforts to increase energy efficiency. As a consequence, this position statement focuses on improvements in energy efficiency that are more easily agreed upon by diverse interests and falls more clearly into expertise area of IEEE members. Energy-efficient technologies and processes have the additional benefits of optimizing processes, improving reliabilities, and decreasing maintenance costs. Improving energy efficiency and utilization systems.

#### **Energy User Awareness and Incentives**

Strong user awareness programs on energy efficiency are of great value in reducing energy use. Government, utilities and other public/private organizations can sponsor such programs, which will be very useful in preventing energy waste due to bad consumer habits; improving energyuser knowledge; and encouraging capital investment in energy-efficient technologies. Programs on education, training and the financial benefits of efficiency will help users realize the benefits and cost effectiveness of energy efficient technologies and processes.

#### **Generation, Transmission and Distribution**

Energy losses in power generation and delivery are small compared to those in end consumption. However, improving existing technologies and applying new technologies, such as new conductors and transformer materials, high-voltage direct current (HVDC), FACTS (Flexible AC Transmission System), energy storage, improved information, communication, and global optimization will help reduce systems losses. Emerging renewable energy systems should be planned and designed to optimize energy efficiency. Additionally, good power quality is essential for improving energy efficiency.

#### **Importance of Power Electronics**

Essential for converting and controlling electrical power at high efficiency, power electronics is now playing a significant role in energy efficiency. Electric motors, introduced more than one hundred years ago, resulted in enormous efficiency improvements in energy use and revolutionized the very nature of work. Presently, motors consume approximately 65 percent of generated electrical energy and lighting consumes another 20 percent.

Today, power electronic controls and variable speed motor drives offer another step forward in energy efficiency. For example, fluid flow control at variable speed (with fully open throttle) can give up to 30 percent savings in energy at light load, compared to traditional throttle control at constant motor speed. Since motors operate most of the time at light load, and light-load efficiency is normally poor because of excessive iron loss, flux programming at light load can improve motor efficiency up to 15 percent.

Other examples of energy efficiency include: Variable speed air conditioning and heat pump units can save up to 25 percent efficiency, compared to traditional thermostat controlled systems. Power electronics-based, high-frequency fluorescent lamps are typically four times more efficient than incandescent lamps. Similarly, LED lighting can also save energy. High frequency induction cooking and using microwave ovens can achieve efficiency improvements over traditional electric resistive sources. High-efficiency, power electronics-based power conversion in renewable energy systems and variable speed wind turbine drives have significantly increased energy produced from wind turbines. Power electronics-based EV/HV drives are also very important in energy saving. Overall, widespread but economical use of power electronics can save 15% of U.S. grid energy.

#### **Industrial Processes**

In the industrial sector, proper evaluation of energy efficient systems is very important. Productivity, product quality, cost and energy consumption should be given due consideration in designing energy efficient systems.

The following opportunities are present for energy savings:

- Electric motor efficiency improvement Replacing older, less efficient motors with new, high-efficiency motors can save energy by a few percent. Similarly, using synchronous motors, instead of induction motors, will save additional energy
- Plant electrical distribution correction Unbalanced or low-voltage (less than rated) power supplies with harmonic rich and/or non-unity power factor loads cause energy waste. Similarly, improperly sized distribution equipment also wastes energy, because part-load efficiency of equipment is generally low. When the power supply, load and distribution equipment are corrected or upgraded, considerable energy can be saved

- Improved matching of mechanical systems with drive motor Substantial energy savings is possible by this matching. This opportunity may be accomplished by using power electronics-based variable frequency drive and load cycling
- Process optimization Can substantially reduce shaft energy of electrical motors. The examples are regenerative braking and light-load motor flux weakening

#### **Residential, Commercial and Government**

Energy efficiency programs in the residential, commercial and government sectors are strongly recommended. Areas of opportunity include, but are not limited to:

- Improvements in lighting Replacing incandescent bulbs by power electronics-based, high-frequency fluorescent lamps can reduce power consumption by 75 percent. In addition, controlling lighting with ambient light to maintain a constant luminous intensity can also save energy
- Improvements in the building envelope and insulation
- Improvements in heating, ventilating, refrigerating and air conditioning system technologies; power electronics-based, variable speed air- conditioning/refrigeration
- Improvements in hot water systems technologies
- Increased use of energy efficient appliances and other equipment, such as computers, washers and dryers, blenders, entertainment systems, etc.
- Implementing building and equipment energy efficiency standards

#### **Transportation Systems**

Continued development of more energy efficient devices and systems in the transportation sector offer great opportunity for efficiency improvements. Examples of advancement in this area include, but are not limited to:

- Electric, hybrid and fuel cell vehicles
- Mass transit, such as light rail, mainline electrification, Maglev, and trolley buses
- Smart cars and highway systems
- Diesel-electric ship propulsion
- Fuel efficiency improvements in automobiles, trucks, aircraft and locomotives
- Truck-stop electrification to reduce truck idling losses
- Port electrification to reduce emissions and fuel use on ships

### **Communication Systems**

With innovative and advanced communications systems, required business travel can be reduced. Promoting the two-fold effect of energy savings and increased productivity, several areas of opportunity include, but are not limited to:

- Personal communication systems, including the Internet
- Videoconferencing and teleconferencing
- Computer information systems and the *Information Superhighway*;

- Fax
- Local- and Wide-Area Networks
- Satellite communications, including GPS systems

#### **Energy Storage**

Energy storage technologies are very important for improving a power system's energy efficiency. The primary purpose of energy storage is to store energy during off-peak hours to be used during peak hours. Operating generating plants and fuel delivery systems at more constant loads can conserve energy. Renewable energy systems like wind and photovoltaics generate power sporadically, so storing surplus energy and supplying to load when there is no generation may improve energy efficiency and eliminate the need for other back-up.

These energy storage methods may include:

- Battery storage
- Flywheel storage
- Ultra-capacitor storage
- Pumped hydro storage or compressed air
- Hydrogen gas (zero emission) generation and storage from wind, photovoltaics, nuclear or coal gasification (with CO<sub>2</sub> sequestration and underground storage)
- Superconducting magnet energy storage (SMES)

#### **Energy Management**

Through improvements to the processes of monitoring and coordinating the generation, transmission and distribution of energy, opportunities for reducing energy loss may be found in all areas of energy use (industrial, commercial, residential, utility, aerospace, military and transportation). Areas of opportunity include, but are not limited to:

- Power system data acquisition and control
- Generation control
- Load and energy management
- End-user distribution systems
- Co-generation
- FACTS (Flexible AC Transmission) System
- Real-time energy pricing and de-regulation.

#### **Maintenance and Repair**

Proper maintenance and repair of energy efficient apparatus and systems will result in longer life cycles. And energy efficiency improves its competitiveness in industry.

#### Conclusion

Through energy efficiency improvements, the United States can reduce energy costs; reduce the depletion of fuel resources; increase energy security; enhance international competitiveness, and reduce environmental impacts and substantially reduce the greenhouse gas emissions. Significant improvements in energy efficiency can also be made by applying currently available and cost-effective technologies and processes. As the demand of energy continues to grow, developing new, energy-efficient technologies can play an increasingly important role in increasing the productivity of the nation's energy system.