International Copper Association, Ltd.

Frequently Asked Questions – Sustainable Energy

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This Q&A introduces readers to the concept of sustainable energy and how copper could contribute. This document is not a press release or an official position paper of the ICA.

Sustainable Energy

1. What is sustainable energy?

Sustainability is defined as the responsible use of limited natural resources by the present generation so as to not endanger their use by future generations. Energy drawn from fossil fuels is a scarce resource. Efficiencies in the use of electrical and thermal power, and the increasing use of renewable energy are essential components of a sustainable energy (SE) system. SE addresses pressing concerns in our global society, such as how to secure energy supply, and improve the environmental performance of our energy systems, while maintaining economic efficiency. It is estimated that the world marketed energy consumption will grow by 53 percent from 2008 to 2035[1], without incorporating prospective legislation or policies that might affect energy markets.

Efficient products consume less energy than standard products. This benefit is often described in terms of a product's "energy efficiency."

2. Why is sustainable energy important?

Sustainable energy offers stakeholders opportunities to achieve desirable financial, environmental, and health-related benefits. These benefits can be realized throughout the entire chain of electrical systems – from electrical power generation to the transmission, distribution, and end use of electricity.

3. What are the financial benefits of sustainable electrical energy?

Products that are energy efficient yield a strong positive financial impact over their lifetime. The reasons are as follows:

- Lower Operating Cost: Users benefit from lower electrical bills and lower maintenance costs;
- Increased Reliability: Energy-efficient electrical products are more reliable than standard products. Users of energy-efficient products benefit from a lower frequency of maintenance;
- Longer Life: Energy-efficient products typically outlast standard products. Users do not need to replace energy-efficient products as frequently;

1 U.S Energy Information Administration/ International Energy Outlook 2011

- Lower Risk of Brownouts: Energy-efficient products have a lower peak demand for power. This helps to lower the risk of brownouts and blackouts, as well as extraordinary costs that may result from power interruptions;
- More Capital for Business Investments: By using energy-efficient products, financial savings from lower electricity bills, lower maintenance costs, longer product lifetimes, and lower risks of power failures can be used for strategic business investments that enable companies to grow and prosper.

4. What are the environmental and health-related benefits of sustainable electrical energy?

By delivering and using electricity efficiently, power plants burn less coal and emit less greenhouse gases and mercury into the environment.

Less Greenhouse Gases: Power plants that burn fossil fuels are among the largest sources of pollutant emissions in our society. These plants emit greenhouse gases (i.e., sulfur dioxide, carbon dioxide, nitrogen oxides, particulate matter, and ground level ozone) that are responsible for increased incidences of asthma and bronchitis, and they are believed to be factors in global warming, rising sea levels, and increases in the frequency and severity of extreme weather.

Less Toxic Mercury: Some coals that fuel coal-fired power plants contain elevated levels of mercury, a toxic substance. Mercury from burned coal is released into the atmosphere where it subsequently enters the food chain and becomes a health risk. For example, mercury from power plant emissions is responsible for elevated levels of the toxic metal in tuna, which has prompted NGOs in certain regions to advise the public against excessive consumption of tuna fish by humans.

5. What can be done to encourage the use of energy-efficient electrical and thermal systems?

Efforts are underway to educate stakeholders and encourage users to reap economic, environmental, and health-related benefits by using energy-efficient electrical systems. To promote the sustainable development of society, initiatives are being implemented to support the formulation and execution of regulations, accelerate the introduction and implementation of the latest energy efficient technologies, and assist customers in wise selection of viable low carbon energy products and solutions.

Why Copper?

6. Why is copper important in promoting sustainable energy?

Every piece of electrical equipment wastes energy in the form of heat. However, those made with copper wiring (and those made with thicker gauges of copper wiring) waste considerably less heat. The reason for this is that copper has an exceptionally high electrical conductivity – and this factor has a direct positive impact on enhancing the

energy efficiency of electrical equipment.

Electricity flowing through copper wires meets far less resistance than it would in aluminum or steel wires of the same diameter. In fact, copper is a better electrical conductor than any other metal except silver, which make copper conductors the most cost-efficient solution available.

For example, copper conducts electricity 60% better than aluminum, 500% better than iron, 1,000% better than steel, and eighteen times better than titanium. Silver is the only metal that has a higher electrical conductivity than copper (about 5% better), but silver is much more expensive and is therefore not considered for most electrical applications.

Similarly, Copper is the best conductor of heat and is therefore the preferred material for heat exchange applications such as air-conditioners, refrigerators etc. Larger heat exchange surfaces contribute to an improved efficiency of these equipments.

7. How does increasing the thickness of copper wire enhance electrical energy efficiency?

As the thickness of the copper wire increases, the resistance of electrons flowing through the wire decreases. Increasing the thickness of copper wire reduces heat loss and increases its electrical energy efficiency.

Experts have found that installing copper wire just one size thicker than required by national codes or standards often has dramatic positive effects on electrical energy efficiencies. This simple technique can yield quick paybacks while increasing the flexibility of the installation. Wire thicker than required by standards also enhances the reliability of electrical products, thereby reducing downtimes due to overheating and voltage drops. In addition, when less heat is generated the result is reduced energy requirements for fans and air conditioning systems.

Of course, there are many factors that must be considered in any installation. But for most new applications, where the cost of labor and conduit for the installation outweigh the cost of wire, the increased size of the wire can pay for itself in a reasonable period of time. At the same time, increased wire size is insurance against changing future needs and assures lower voltage drops. Some companies, as a matter of course, specify wire two or three sizes larger than minimum requirements in neutrals, which are often overloaded due to harmonics.

Key elements that affect the payback, and thus the economic incentive, to install larger wire gage, are the duty cycle, load factor and electricity price. When using the same size conduit, the increased cost of wire is minimal.

Energy Efficient Solutions

8. What types of energy-efficient products offer the most sustainable benefits?

Electrical products that run continuously, such as power generators, motors, power transformers, and magnetic ballasts, offer the most substantial benefits.

Motors

9. What are the sustainable benefits of energy-efficient motors?

An electric motor converts electrical energy into mechanical energy or to put it more simply, motion. Motion is the single biggest end use of electricity, more than twice the size of lighting.

Electric motors are everywhere. They are used in household appliances like washing machines, refrigerators, mixers, hair dryers even in computer fans and toys. In buildings, motors are used in elevators, escalators, water pumps, and HVAC systems. And their principal uses are in industry in conveyors, fans, pumps and in every conceivable machine.

Motors are always used as a part of an electro- mechanical system e.g. a fan or a pump or a conveyor etc and a variable speed drive.

According to a report published by the International Energy Agency, Motors and motor driven systems consume 43-46% of electricity world wide.

By 2030, this is expected to become 13,360 Tera Watt hours of energy per annum. To put this figure in perspective, it would be more than three times the present electricity consumption of the USA. Motor systems would then be responsible for 8.6 Gt of CO2 emissions, between one-fourth and one-fifth of all global emissions.

Motors that use more copper are much more energy efficient than low-efficiency motors that uses the minimum amount of copper. The increased amount of copper in motor windings of an energy-efficient motor reduces resistant current losses, thereby saving electrical energy and reducing electricity requirements.

If the entire world were to adopt a least life cycle approach to motor systems, there is a savings potential of 3890 billion kWh p.a. by 2030, nearly 30% of the total. As a corollary, the savings potential in terms of CO2 emissions is also nearly 30% at 2.5 Gt

Of this savings potential, if just the industrial electric motors were to be brought to current best practice levels in all countries, the savings potential is 322 billion kWH p.a. or 8% of current US electricity consumption and the CO2 emission savings potential is 0.2 Gt p.a.

10. What is the payback period for buying energy efficient motors?

Energy-efficient motors often pay for themselves in a few years or less. Though, motors that operate intermittently may or may not save enough to justify replacement except in cases where utility rates are especially high. But, in evaluating motors that operate at a high duty cycle, or continuously, replacement with energy-efficient motors can usually result in very rapid payback, and save many times their initial cost. After the payback period, energy-efficient motors continue to provide savings in terms of lower energy bills, reduced maintenance, and longer life.

11. How are the benefits of energy-efficient motors determined?

Software is available to help users calculate energy usage and cost savings from energy-efficient motors. Users around the world can load local motor and market data into these software programs to determine environmental and financial benefits of using energy-efficient motors.

12. What are governments and industrial groups doing to encourage the use of energy-efficient motors?

Governments have implemented policies to use energy-efficient motors. These policies are designed to reduce environmental impacts and conserve precious energy resources.

Industrial organizations are beginning to make energy efficiency recommendations that go beyond existing government standards. The development of premium-efficiency motors and the promise of mass commercialization of super premium-efficiency motors (with die cast rotors) is helping to spur these recommendations.

13. What are the potential energy efficiency benefits of the new copper die-cast rotor technology for motors?

Electric motors with copper rotors offer several advantages over motor with aluminum rotors, including increased efficiency, smaller size, and lower operating costs.

Due to copper’s excellent conductivity, replacing aluminum rotors with copper rotors can reduce electric motor losses by 15%-25%, while increasing the energy efficiency of motors by 2%-5%. The electric conductivity of copper is 40% higher than that of aluminum. As such, the replacement of cast aluminum rotors by cast copper rotors could result in a significant decrease of total motor losses and an overall improvement in the efficiency of motors. Apart from reducing motor losses, copper rotors can also reduce the temperatures of rotors and stators due to less heat generated during conversion. The lower temperature means a smaller fan can be used or even no fan at all - thereby further reducing losses incurred from motor abrasion and air resistance, while enhancing motor efficiency.

Furthermore, due to the low resistance of copper, the current flow in copper rotors is stronger than that in cast aluminum rotors under the same induced voltage, so cooper rotor motors cost less in materials, are lighter and smaller, and possess higher energy density compared with conventional motors given the same power and efficiency. This provides

design and manufacturing companies with more space to pursue efficient convenience and flexible mechanical design.

Transformers

14. What are the sustainable benefits of energy-efficient power transformers?

Energy losses produced by the electrical current flowing in transformer coils include heat losses from the material used for windings. Selecting a material that has a lower electrical resistance can reduce these losses.

When weight, size, cost, and resistance are considered, most transformer designers have found copper to be the best electrical conductor; energy efficient transformers rely on high conductivity copper windings. As a general rule, the electrical energy efficiency rating of a transformer increases as the amount of copper is increased. This means that copper, and more of it, enables transformers to run cooler with higher overload capacities - and therefore to run more efficiently. Also, cooler-running energy efficient transformers are expected to have a longer service life.

Energy efficient transformers are somewhat more expensive to buy than the standard transformers, but their operating costs are usually much lower, especially when energy prices are high and the transformers run at high loads for long periods of time.

Since transformers have a typical service life of 20-40 years or even more, the lower operating cost of energy efficient transformers can result in substantially lower total owning costs.

15. Why are energy-efficient transformers not as prevalent as they should be?

Because the sticker price (i.e., “first cost”) of an energy-efficient transformer is somewhat higher than a standard transformer, buyers often do not realize the short payback period and long- term benefits of energy-efficient transformers.

For further information, please refer to the following websites:
http://www.copper.org/
http://www.copperinfo.com
http://www.leonardo-energy.org/energy-efficiency