mercial demonstration fusion power plant, named DEMO, is proposed to follow on from the ITER project.

New, environmentally sustainable forms of electricity will be required to meet the aspirations of a growing world population. By 2050, an expected rise in global population from six billion to nine billion and better living standards could lead to a two to threefold increase in energy consumption. No single technology will fulfil this demand. Each has strengths and weaknesses, and a mix of power sources will be needed to meet the challenges of energy security, sustainable development and environmental protection. Future energy supply options may comprise fossil fuels, nuclear fission, fusion, and renewables. At present, 80% of the developed world's energy comes from fossil fuels. Environmental problems – the greenhouse effect and the effects of acidic pollution – and diminishing fuel supplies mean that reliance on coal, gas and oil will have to be severely constrained. Nuclear fission will continue to make a major contribution to electricity. Fusion and alternative sources of energy offer a secure, long-term source of supply, with important advantages. These include: no production of greenhouse gases from the fusion process; no long-lived radioactive waste (all waste will be recyclable within 100 years); inherent safety features; and almost unlimited fuel supplies. On current estimates, the cost of fusion-generated electricity is predicted to be broadly comparable to that obtained from fission, renewables and fossil fuels. Fusion and alternative energy, therefore, could have a key role to play in the energy market of the future, with the potential to produce at least 70% of the world's electricity by 2100.

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PRACTICAL USE OF PIEZOELECTRIC EFFECT

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The piezoelectric effect converts mechanical strain into electric current or voltage. This strain can come from many different sources. Human motion, low-frequency seismic vibrations, and acoustic noise are everyday examples. Except in rare instances the piezoelectric effect operates in AC requiring time-varying inputs at mechanical resonance to be efficient.

The piezoelectric effect occurs in certain compounds when pressure is applied to them. The mechanisms behind how it works are still not fully understood, but this hasn’t stopped scientists from starting to explore ways to use it in our everyday lives. Although we don’t understand the entire process, this is what we do know. When particular arrangements of molecules are pressed together, the proximity of one atom to another changes enough that there is a change in the configuration of the valance electrons. When the pressure is released, the electrons return to their previous places. When piezoelectric compounds are fitted with an auxiliary circuit, these electrons can be captured and used to create a micro circuit.

Piezoelectricity from Dancing

One of the most intriguing applications of piezoelectric technology is championed by the company Sustainable Dance Club, whose Rotterdam nightclub Watt generates part of its power from the dance moves of its patrons. The dance floor is suspended on a series of springs and piezoelectric crystals, and as dancers move, the crystals compress, generating electricity.

According to the manufacturers of Watt's dance floor, each module generates 20 W of power while an adult dances on it. A maximum of 160 of these modules can be wired together, giving an entire dance floor 3200 W of energy-generating capacity as people dance. For a typical night (say, four hours of dancing), this means the floor will generate approximately 4.6×10^7 J of energy.

To test this claim, the dance floor will be modeled with 700 dancers (the club has a capacity of 1400, so the assumption here is that half of the people at any given time are enjoying the bar, lounge, or any other stationary facility). Assuming the dancers are moving vigorously, each will be jumping approximately 10 cm in the air with a frequency of 1 Hz (a standard techno song will have around 120 beats per minute; here the dancers move every other beat). With an average weight of 70 kg, this gives each dancer a kinetic energy upon impact of approximately 70 J. If each person compresses ten spring/crystal systems - not unreasonable given the small size of the crystals examined, this translates to a generated electrical energy per person per jump of 781.5 microjoules.

Assuming all of this energy can be stored, a typical night in the club (four hours of dancing) would generate a total of only 7800 J of energy - much less than the manufacturers claims. However, it is worth noting that these numbers come from a 3 mm thick sample of PZT, and the nightclub would presumably use larger crystals to increase power generation. In addition, if modeled using Xu *et al.*'s data for slowly applied stress, the total energy generated jumps up five orders of magnitude, so that the total electrical energy made is around 4×10^7 J - just as claimed.

Energy from Human Motion

Piezoelectric systems can convert motion from the human body into electrical power. On average, a human consumes about 3,300 watt-hours of energy every day but has the potential to produce more than 3 times that amount — up to 11,000 watt-hours of power — from normal bodily functions such as motion and the production of body heat. Walking, for example, produces 163 watts of power, while sprinting generates more than 1,600 watts. DARPA has funded efforts to harness energy from leg and arm motion, shoe impacts, and blood pressure for low level power to implantable or wearable sensors. They can be integrated into clothing.

In 2007, two MIT graduate students proposed the idea of installing piezoelectric flooring in urban areas. The idea was to install a flooring system that would take advantage of piezoelectric principles by harvesting power from footsteps in crowded places such as train stations, malls, concerts and anywhere where large groups of people move. The key is the crowd: One footstep can only provide enough electrical current to light two 60-watt bulbs for one second, but the greater the number of people walking across the piezoelectric floor, the greater amounts of power produced. It's not beyond the realm of possibility — approximately 28,500 footsteps generate energy to power a train for one second.

Everywhere you look, teens have their heads down, texting sms away. Americans sent 12.5 billion text messages in just one month, and phone users in the United Kingdom send out one billion a week. What if each of those finger taps could generate power?

The Push-to-Charge cell phone would feature plastic buttons sitting atop a layer of hard metal. The bottommost layer would be made out of piezoelectric crystals, so that each time you pressed a button, the hard metal directly underneath it would hit the underlying crystal like a hammer, creating a small amount of voltage. Small wires located between the layers would convey the charge to a battery for storage.

The same technology could be used in any other product that features buttons, including computer keyboards and video games. If all the office workers had their computers hooked up to such a device, the office probably wouldn't need to pay any power bills.

A new class of devices aims to convert energy created from body movement, the stretching of muscles or the flow of water to power future nanoscale components. These so-called "nanogenerators" would be less bulky than traditional energy sources such as batteries.

Rainfall as an Energy Source

One of the latest energy harvesting techniques is converting the mechanical energy from falling raindrops into electricity that can be used to power sensors and other electronics devices.

Scientists from CEA/Leti-Minatec, an R&D institute in Grenoble, France, specializing in microelectronics, have recently developed a system that recovers the vibration energy from a piezoelectric structure impacted by a falling raindrop. The system works with raindrops ranging in diameter from 1 to 5 mm, and simulations show that it's possible to recover up to 12 milliwatts from one of the larger "downpour" drops.

This work could be considered as a good alternative to power systems in raining outdoor environments where solar energy is difficult to exploit. The system could be used for both mobile outdoor devices as well as indoor power. The scientists intend to develop remote sensor nodes in cooling towers, but abandoned sensor networks are also one of the foreseen applications for this type of system.

The physics of how a raindrop impacts a surface is not fully understood. However, to build a rain energy harvesting system, the important part is to estimate the recoverable energy during the impact.

When a raindrop impacts a surface, it produces a perfectly inelastic shock. The amount of energy generated by the impact can then be estimated using a mechanical-electric model.

To capture the raindrops' mechanical energy, the scientists used a PVDF (polyvinylidene fluoride) polymer, a piezoelectric material that converts mechanical energy into electrical energy. When a raindrop impacts the 25-micrometer-thick PVDF, the polymer starts to vibrate. Electrodes embedded in the PVDF are used to recover the electrical charges generated by the vibrations.

The group experimented with raindrops of different sizes, falling heights, and speeds. They found that slow falling raindrops generate the most energy because raindrops falling at high speeds often lose some energy due to splash. By using a micropump to generate and test the properties of raindrops, the researchers demonstrated that, for low drop heights, the electrical energy is proportional to the square of the drop's mechanical energy, while voltage and mechanical energy are directly proportional.

In the future, the scientists plan to develop a method to store the electrical power to provide a steady current for practical use.

Even if the planet doubled the amount of solar and wind power available tomorrow, there would still be a shortage of clean electricity. We need to grab energy from wherever we can find it, that is why piezoelectricity — the charge that gathers in solid materials like crystal and ceramic in response to strain—has recently begun to pique the interest of entrepreneurs and scientists alike.

A number of materials are piezoelectric, including topaz, quartz, cane sugar, and tourmaline. That means a charge begins accumulating inside these materials when pressure is applied. Piezoelectrics is already commonly used in a number of applications. Quartz clocks, for example, rely on piezoelectricity for power, as do many sensors, lighters, and actuators. But these are the old uses for piezoelectricity. Scientists today have much more interesting piezoelectric plans in mind.

One of the most popular uses for piezoelectricity in the past few years relies on roads and sidewalks. It all started in 2008 with Club Watt, a dance spot in the Netherlands dubbed the world's first sustainable dance club. The club installed piezoelectric materials in its dance floor to turn patrons' moves into electricity that is used to change the color of the floor's surface.

After Club Watt, the piezoelectric floors kept coming. A Tokyo railway station installed a piezoelectric floor that uses kinetic energy to generate 1,400 kW of energy per day—enough to power ticket gates and displays. Toulouse, France, recently became the first city to put pressure-sensitive piezoelectric modules on the sidewalk, generating enough energy to power streetlamps. And the United Kingdom plans to install power-generating tiles on London streets to light up bus stops and pedestrian crossings.

Piezoelectrics is also increasingly becoming common on roads. In 2009, a British supermarket installed kinetic road plates that collect energy from customers driving over road bumps in the store parking lot. The road plates are pushed down by vehicle weight, which creates a rocking motion that turns generators. The system is used to power the supermarket's checkout lines.

In Israel, a company called Innowattech is installing strips of asphalt embedded with piezo-electric materials. According to the company, the generators could produce 1 MWh of electricity from a four lane highway, or enough to power 2,500 homes.

The technology just keeps getting better, too. Last year, Princeton University researchers combined silicone and nanoribbons of lead zirconate titanate to create PZT, an ultra-efficient piezo-electric material that can convert up to 80 percent of mechanical energy into electricity. PZT is 100 times more efficient than quartz. It's so efficient, in fact, that the material could be used to harness energy from the minute vibrations found in items like shoes and clothing. That means a piezoelectric-equipped shirt could potentially charge up your cell phone after a day of activity. Piezoelectric sidewalks, roads, and clothing items haven't taken off in a big way quite yet, but they probably will soon. As we become more reliant on having fully-charged gadgets with us at all times, a shirt or pair of shoes that can prevent a device from dying will be incredibly valuable.

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THE MODERN OLYMPIC GAMES

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The modern Olympic Games are the leading international sporting event featuring summer and winter sports competitions where thousands of athletes variously compete. The Olympic Games are considered the world's foremost sports competition with more than 200 nations participating. The Olympic Games are held every four years, with the Summer and Winter Games alternating by occurring every four years but two years apart. Their creation was inspired by the ancient Olympic Games, which were held in Olympia, Greece, from the 8th century BC to the 4th century AD. Baron Pierre de Coubertin founded the International Olympic Committee (IOC) in 1894. The IOC is the governing body of the Olympic Movement.

Ancient Olympics

The Ancient Olympic Games were religious and athletic festivals. Competition was among representatives of several city-states and kingdoms of Ancient Greece. These Games featured mainly athletic but also combat sports such as wrestling, pentathlon and boxing, horse and chariot racing events. According to legend, it was Heracles who first called the Games "Olympic" and established the custom of holding them every four years. The myth continues that after Heracles completed his twelve labors, he built the Olympic Stadium as an honor to Zeus. Following its completion, he walked in a straight line for 200 steps and called this distance a "stadion" which later became a unit of distance. The winners of the events were admired and immortalized in poems and statues.

Revival

The first Games held under the auspices of the IOC were hosted in Athens in 1896. The Games brought together 14 nations and 241 athletes who competed in 43 events. Zappas had left the Greek government a trust to fund future Olympic Games. This trust was used to help finance the