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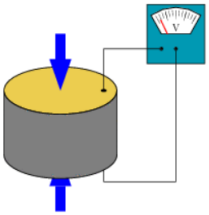
Monich K., Nikitin Y., Matusevich O.

Piezoelectricity

Belarusian National Technical University
Minsk, Belarus

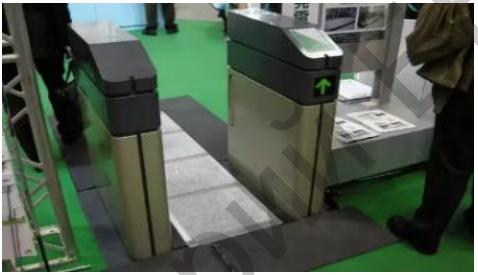
What is the future of the energy industry? Firstly, and perhaps most important, we are in danger of ruining the planet's climate through carbon dioxide emissions. If we continue to use fossil fuels, we may increase the temperature of the planet in ways that will harm our entire ecosystem and us. Secondly, we cannot keep using fossil fuels forever. They will eventually run out, even as the population of Earth grows. For both these reasons, we need to find other sources of energy that do not emit carbon dioxide when used. What is a piezo and how does it work? *Piezo* derived from the Greek piezein, which means to squeeze or press, is a prefix in piezoelectricity [1]. This term means the charge that accumulates in a solid material (often ceramic) in response to applied mechanical strain. A piezoelectric material has electromechanical interaction between its mechanical and electrical state.

When a piezoelectric material is compressed, it creates an electrical field.



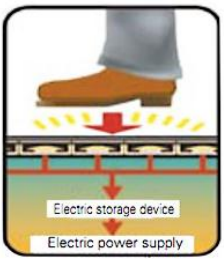
A piezoelectric disk generates a voltage when deformed

The inverse is also true. When a piezoelectric material is subjected to an electrical field, it will change dimensions [1]. In two of Tokyo's busiest stations scientists are using passengers to generate more energy with special flooring tiles installed in front of ticket turnstiles. An average person, weighing 60 kg, will generate only 0.1 W in the single second. When they are covering a large area of floor space and thousands of people are stepping or jumping on them, significant amounts of power are generated [2].



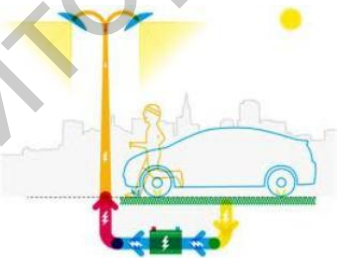
Demonstration experiment at Tokyo Station

The English company *Pavegen* is the global leader in harvesting energy and data from footfall. Its vision is for smarter, more sustainable built environments which empower and connect people. The technology enables people to directly engage with clean energy, to increase their understanding of sustainability issues, and to connect purposefully with brands. *Pavegen* uses what it calls a hybrid black box technology to convert the energy of a footstep into electricity, which is either stored in a battery or fed directly to devices. These tiles generate electricity with a hybrid solution of mechanisms that include the piezoelectric effect and induction, which uses copper coils and magnets. The marathon runners generated 4.7 kWh of energy, enough to power a five-watt LED bulb for 940 hours, or 40 days.



Mechanism of the power-generating floor

The company *Innowattech* demonstrates how Israeil technology can produce electricity from generators installed beneath a road's asphalt layer. This innovation is based on piezoelectric materials that enable the conversion of mechanical energy exerted by the weight of passing vehicles into electrical energy, without stealing any energy whatsoever from the vehicles. The technology does not increase the vehicle's fuel intake or affect the road infrastructure [3].



Electro-Kinetic Road Ramp

The accumulated energy can be used to power traffic lights or street lamps and in the future could be routed into the grid. The company observes that, *Innowattech's solution is capable of producing significant amounts of electricity, about 400 kWh from a 1 km stretch of generators along the dual*

carriageway [3]. According to official statistics, the current cost for fitting a kilometer (half-mile) of one lane of highway is about $650,000, with a cost of $6,500 per 1 kW. With mass production the price can drop by two thirds, making the system even cheaper than solar energy systems [3]. *Innowattech* has broadened their energy harvesting designs to generate energy from railways as well as roads. The company has performed a project with the National Railway Company of Israel. Last year preliminary results suggested that areas of railway track that get between 10 and 20 ten-car trains an hour, can produce 120 kW per hour. This is electricity that could be used on the railway itself, or to power the signaling, measure the speed and weight of trains, as well as to transfer it to the grid.

The technology of piezoelectricity enables the supply of electricity to various road-side applications, such as traffic lights, billboards, police speed cameras, communication systems, road signs, etc., as well as transfer of the harvested electricity into the electric grid, to supply electricity to households.

References:

1. Piezoelectricity [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Piezoelectricity. – Date of access: 23.01.2018.
2. Energy-Generating Floors to Power Tokyo Subways [Electronic resource]. – Mode of access: https://inhabitat.com/tokyo-subway-stations-get-piezoelectric-floors. – Date of access: 15.03.2018.
3. Energy harvesting roads in Israel [Electronic resource]. – Mode of access: https://www.offgridenergyindependence.com/articles/1589/energy-harvesting-roads-in-israel. – Date of access: 14.02.2018.