What If Your Footsteps Could Power Your City Sustainably?

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Author
Urban Times @urbantimes
Pavegen Tiles in a Hallway
A while back our Sci & Tech Correspondent Nathan Liu wrote a piece entitled "iPavement Connects People with Cities" about how a paving slab can make cities more intelligent, through making the ground you walk on connect with you. Sticking with this seemingly science fiction theme of smart pavements, take a look at one of the more – potentially – awesome inventions that you'll come across in a while; Pavegen Systems' Paving Slabs. Simply put, they turn your footsteps into an energy source.
In a world where novel and clean energy solutions are few and far between, Pavegen have received a lot of coverage in mainstream media in the previous two tears and have already won several awards, including the Observer Ethical Award and the Shell LiveWIRE Grand Idea Award. At first, the smart slabs are a stroke of genius, but one must wonder; is this enticing technology the efficient, cost-effective energy harvester it claims to be, or are the gains simply insufficient to make it worthwhile?

How do Pavegen Tiles Work?

Pavegen Tiles Instructional Visual. Courtesy Pavegen.

These paving slabs, made from 100% recycled rubber, are designed to generate renewable energy by converting the kinetic energy of footsteps to electric off the grid. In theory, wherever there is a high footfall Pavegen's technology harvests the wasted energy for such applications as street lighting, advertising billboards and information displays.

According to a report from the University of British Columbia, Pavegen claims that each tile is capable of generating 4-8 watts of electricity per footstep. 5% of this is used to power the tiles' LED lighting – designed to engage the walker – and the remaining 95% is left over as useable electricity. The cost of the eight Pavegen tiles is, for the moment, $30,800 – excluding installation, shipping, maintenance and disposal.
Furthermore Pavegen Systems, their system is particularly useful in circumstances where grid connections are unfeasible. It is rather obvious that the system is appropriate as a means to minimise carbon footprint. The technologies' effectiveness is maximised on bustling streets like Oxford Street or underground stations where footfall is extremely high; the system might then be used in combination with high-efficiency built infrastructure to power beyond the applications mentioned above.
Pavegen's entrepreneurial founder and chief executive Laurence Kemball-Cook, 26, explained to the BBC:

> "When you stand on a tile it flexes just 5mm in the centre, which is actually imperceptible to users. Through our technology we convert that into electrical power and seven watts per footstep is created. The heavier you are, the more energy is created."

The technology actually mirrors that which has been used in self-winding wristwatches for many decades. It involves utilising an electromagnetic system (a magnet inside a coil) to drive a current. This current is stored as energy in a battery housed within the paving slab itself. The concept of utilising otherwise wasted energy to power small, low-power electronic devices is known as "energy harvesting."
Pavegen Tile lighting Up – a form of interactive gamification which engages the walker.

Working Examples of Pavegen's Technology

The technologies' potential has been demonstrated through the installation of just four tiles at the Simon Langton Grammar School, where the Headmaster Ken Moffat told the BBC:

> "We've got 1,100 students in the school and you can imagine 1,100 young men running around the place. That's about as robust as you get. If you could put something like this in a London Underground station, that would be very exciting."

The system has also been implemented in Westham Tube Station, where the company claims that during the Olympics they captured nearly 1 million footsteps. Pavegen even took a leaf out of iPavement's book and incorporated wireless communication technology into their tiles, in order to stream live data to their website on how much renewable energy is being generated by the visitors using the walkway.

In the Ted Talk below, Kemball-Cook describes how by implementing an interactive aspect to the pathegen experience – by having the tiles illuminate as you step or encouraging people to dance and jump – it acts as a form of "gamification of energy production".

See source for video of that Ted Talk.

Do the Numbers Add Up?

According to GizMag, "each tile is claimed to have a life of approximately 20 million steps or 5 years." This is actually pretty decent, so no complaints here. At the end of the last year, Kemball-Cook told CNN;

> "We recently came back from a big outdoor festival where we got over 250,000 footsteps — that was enough to charge 10,000 mobile phones".

As stated by Pavegen, the pressure of a single footstep creates 4 to 8 watts. It was also calculated that assuming 8 watts is created per step, "during peak hours, one tile produces 12kWh ideally [and] during the off hours, it produces 5kWh ideally" and that "floor tiles, during peak hours will be stepped on 926-1889 times per hour… and 0-719 times during off hours… which works out to about 56 kWh per weekday".

So let's put this in perspective. We measure the amount of energy a house uses daily in kilowatt hours (kWh) and according to eHow, the average American home (in 2008) saw a daily usage of just over 30 kWh. This translates to over one billion joules, or is equivalent to the amount of energy released by burning 100 cubic feet of natural gas. In case you're interested, according to City of Westminster's 2010 estimations, Oxford Street sees a footfall of 4.3 million people each week. So, what would 10 tiles during one day of activity on say Oxford Street look like? It would be enough to provide 560 kWh by Pavegen's standards. This would power over 18 average American homes for one day.

Model of Pavegen tiles used on stairway. Via Pavegen.

These numbers do sound extremely promising. However according to Professor Markys Cain, a science area leader at the UK National Physical Laboratory specialising in scientific measurement, who spoke to the BBC, the limitations to this technology are rather evident and his conclusions tell a very different story.

> "It's delivering milliwatts – 1,000 times less than is required," he said. "I think a really good example of how energy harvesting can be used in the consumer environment is to extend the life of batteries so your mobile phone will last three days between charges rather than one, for example."

According to the BBC, "the average person will walk 150 million steps in their lifetime (other sources put this at 200 million) and even this footfall would only be enough to power the average family home for three weeks." This is actually rather low for such a huge number of steps, and despite the variation between an average family home in the Uk or Us, the disparity between the BBC's statement and Pavegen's projections is really, really huge. And as I am no expert, it is hardly for me to say who is right.

Looking forward, I am encouraged by Pavegen's brilliant idea, but sceptical of its efficiency unless the product can be scaled up to dramatically greater proportions.