Alternative energy hits the road

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Anyone who has walked barefoot across a parking lot on a hot summer day knows that blacktop is exceptionally good at soaking up the sun's warmth. Now, a research team at Worcester Polytechnic Institute (WPI) has found a way to use that heat-soaking property for an alternative energy source.

Through asphalt, the researchers are developing a solar collector that could turn roads and parking lots into ubiquitous—and inexpensive–sources of electricity and hot water.

The research project, which was undertaken at the request of Michael Hulen, president of Novotech Inc. in Acton, Mass, which holds a patent on the concept of using the heat absorbed by pavements, is being directed by Rajib Mallick, associate professor of civil and environmental engineering.

On Monday, Aug. 18, 2008, team member Bao-Liang Chen, a PhD candidate at WPI, will present the results of research aimed at evaluating the potential for transforming stretches of asphalt into a cost-effective energy source at the annual symposium of the International Society for Asphalt Pavements in Zurich, Switzerland. The study looks not only at how well asphalt can collect solar energy, but at the best way to construct roads and parking lots to maximize their heat-absorbing qualities.

"Asphalt has a lot of advantages as a solar collector," Mallick says. "For one, blacktop stays hot and could continue to generate energy after the sun goes down, unlike traditional solar-electric cells. In addition, there is already a massive acreage of installed roads and parking lots that could be retrofitted for energy generation, so there is no need to find additional land for solar farms. Roads and lots are typically resurfaced every 10 to 12 years and the retrofit could be built into that cycle. Extracting heat from asphalt could cool it, reducing the urban 'heat island' effect. Finally, unlike roof-top solar arrays, which some find unattractive, the solar collectors in roads and parking lots would be invisible."

Mallick and his research team, which also includes Sankha Bhowmick of UMass, Dartmouth, studied the energy-generating potential of asphalt using computer models and by conducting small- and large-scale tests. The tests were conducted on slabs of asphalt in which were imbedded thermocouples, to measure heat penetration, and copper pipes, to gauge how well that heat could be transferred to flowing water. Hot water flowing from an asphalt energy system could be used "as is" for heating buildings or in industrial processes, or could be passed through a thermoelectric generator to produce electricity.

In the lab, small slabs were exposed to halogen lamps, simulating sunlight. Larger slabs were set up outdoors and exposed to more realistic environmental conditions, including direct sunlight and wind. The tests showed that asphalt absorbs a considerable amount of heat and that the highest temperatures are found a few centimeters below the surface. This is where a heat exchanger would be located to extract the maximum amount of energy. Experimenting with various asphalt compositions, they found that the addition of highly conductive aggregates, like quartzite, can significantly increase heat absorption, as can the application of a special paint that reduces reflection.

Finally, Mallick says the team concluded that the key to successfully turning asphalt into an effective energy generator will replacing the copper pipes used in the tests with a specially designed, highly efficient heat exchanger that soaks up the maximum amount of the heat absorbed by asphalt. "Our preliminary results provide a promising proof of concept for what could be a very important future source of renewable, pollution-free energy for our nation. And it has been there all along, right under our feet."

Source: Worcester Polytechnic Institute