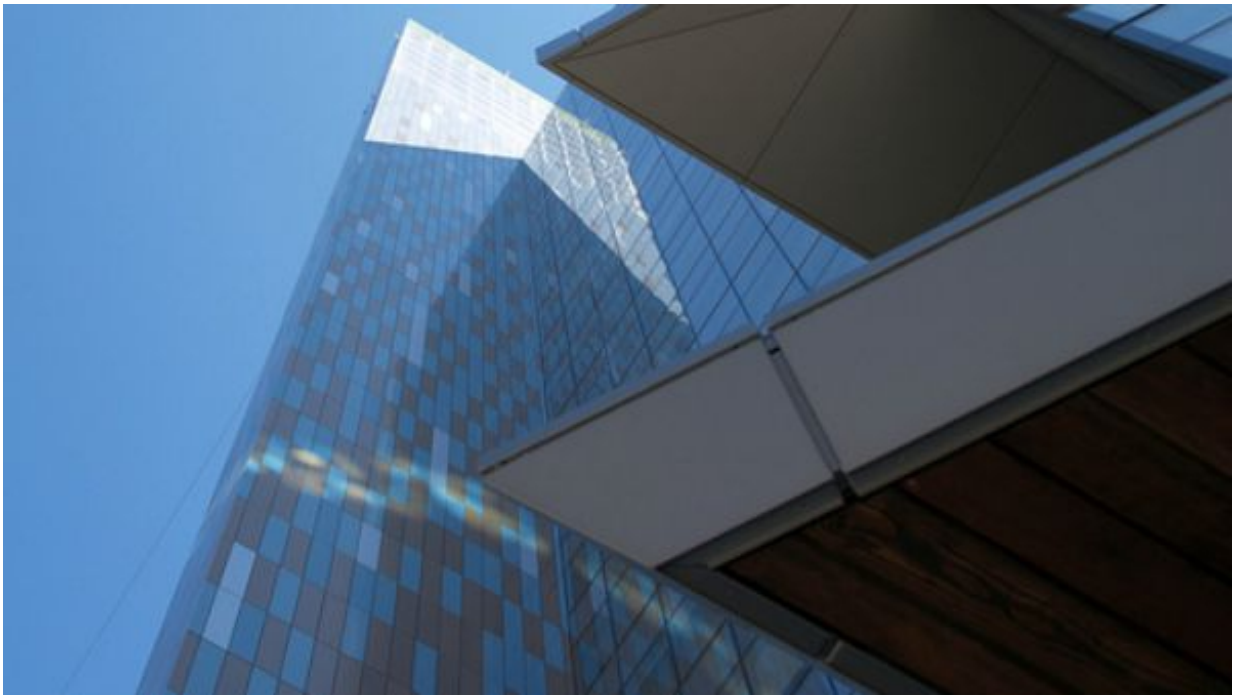
Solar chimneys meet fuel cells for power generation

September 4 2015, by Cristy Burne, Sciencenetwork Wa



The solar chimney by the Portage doors of Manitoba Hydro Place. Credit: Craig Bennett

Solar chimneys can be teamed with fuel cells to provide more electricity more economically and all year round, according to mathematical analysis.

Solar chimneys work best on hot, sunny days, relying on differences in

air temperature to generate energy.

They use solar collectors at their base to heat the air inside the chimney, then this hot air rises, according to Curtin University engineer Omid Joneydi.

As hot air flows up the chimney, cool air is sucked in at the base of the chimney, driving turbines that generate electricity.

A challenge with solar chimneys, however, is supplying energy demands on cool days, or overnight.

"We wanted to analyse how solar chimneys could be used in combination with fuel cells to generate extra electricity, to supply electricity more economically," he says.

"Our primary aim was to minimise costs."

Solar by day, fuel cells by night, electrolysis in between

Fuel cells produce clean energy by combining hydrogen gas with oxygen from the air to produce electricity and water.

The fuel cells Mr Joneydi used in his mathematical iterations were solid oxide fuel cells, distinguished by their use of a solid rather than liquid electrolyte, and their need for high operating temperatures.

But how to operate a fuel cell without hydrogen gas? Simple. Make some.

On those hot, sunny days when the solar chimney is supplying more than

demand, any extra energy can be diverted to power electrolysis.

This process would split water into hydrogen gas and oxygen gas, and generate a fuel that can be stored until needed.

Mr Joneydi's team considered the desert city of El Paso, in Texas, and determined how much of the city's power the hypothetical plant could provide, for every hour of a typical year.

"We used a genetic algorithm, trialling different calculation 'parents' to optimise outputs or 'children' over multiple cycles," Mr Joneydi says.

He found the plant could theoretically provide all of El Paso's electrical needs between 9am and 3pm during the winter month of January, stretching to 6am to 6pm over summer.

Calculating that the system can optimally produce 0.28kg of hydrogen fuel every second, Mr Joneydi determined the plant could supply nearly 80 per cent of El Paso's summer energy requirements, and 37 per cent of its winter demand.

Another bonus, he says, is that heat of the fuel cell reaction can be used to drive turbines or a steam generator.

More information: "Modeling and optimization of a novel solar chimney cogeneration power plant combined with solid oxide electrolysis/fuel cell," *Energy Conversion and Management*, Volume 105, 15 November 2015, Pages 423-432, ISSN 0196-8904, dx.doi.org/10.1016/j.enconman.2015.07.054

This article first appeared on ScienceNetwork Western Australia *a science news website based at Scitech.*