The best of both worlds: Solar electricity generation and sound barriers for MRT tracks

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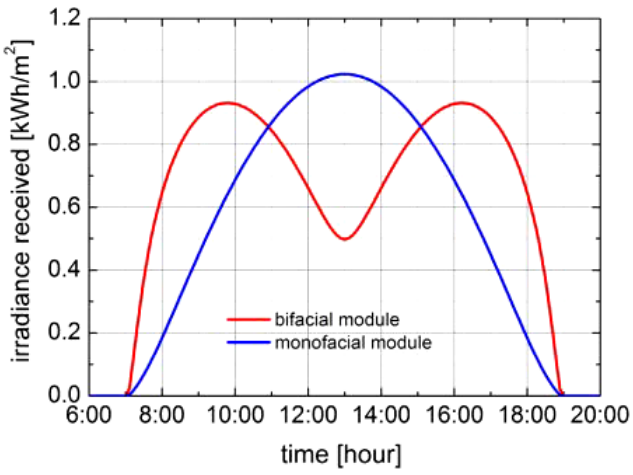
Did you already notice the long stretches of sound barrier walls along MRT tracks that are popping up everywhere? Wouldn't it be great if they could also perform other functions such as generate electricity? This is possible! Let's see how this can be done and why we should do it.

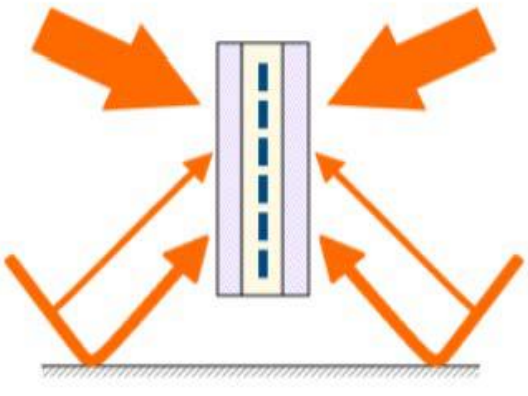
The main energy source for Singapore's electricity grid is natural gas (approx. 95%), which is imported. But solar energy has a huge potential. Even though it is currently covering only a small part of the total energy consumption in Singapore, solar energy generation is expected to grow rapidly in the near future. Through the SolarNova program, an initiative by government agencies to solarise public buildings, Singapore aims to have 350 MW_p of installed solar capacity by 2020 [1], which would be approximately 5% of Singapore's peak demand. The government has also set a new target of raising the adoption of solar power in Singapore to 1 gigawatt peak after 2020 [2]. In the coming decades, this fraction will increase to 30% and beyond. To achieve this target, novel solar photovoltaic (PV) deployment methods are needed.

Rooftops of HDBs and business park buildings are the most obvious locations when it comes to PV installations. However, such installations are often difficult as these buildings were not designed to have large PV systems on their rooftops. Another possible area for consideration is the extensive MRT network above ground. Singapore's MRT network presently covers almost 200 km of tracks (above and underground). Currently, sound barriers are erected at strategic locations of the MRT network to reduce noise pollution. A great way to enhance their functionality is to make noise barriers with active materials such as PV modules to generate electricity while also reducing traffic noise.

In view of this need, SERIS has developed a combination of PV and a new digital ceramic printing technology, to integrate vertical double-sided (bifacial) PV modules in a sound barrier. Double-sided PV modules can convert light to electricity from both sides.

A study on vertically mounted bifacial PV modules showed that such modules receive more solar irradiation per day compared to conventionally mounted modules in Singapore, thanks to their double-sided light absorption.





(Left) Simulated solar radiation received by a vertically mounted bifacial module and a conventionally mounted single-sided (monofacial) module during a cloudfree day in Singapore. The radiation received by the double-sided module over the whole day is more than 15% higher than the radiation received by the roof mounted single-sided module. (Right) Schematic representation of the solar illumination of a vertically installed bifacial PV module.

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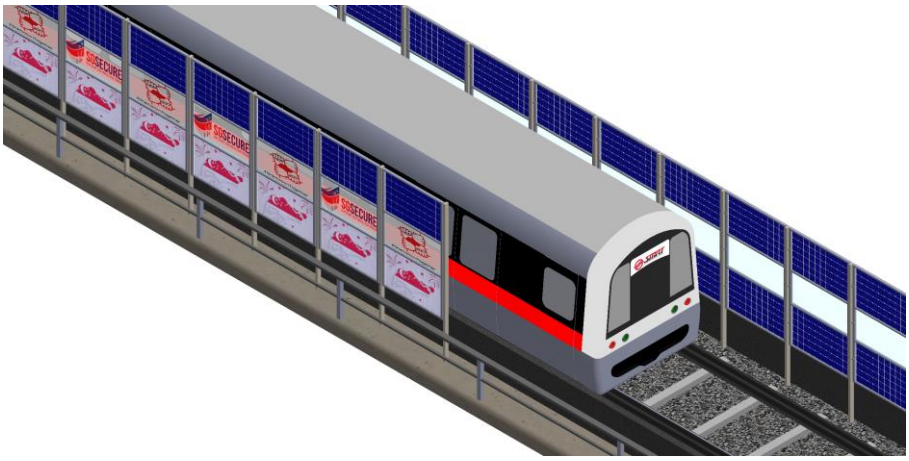
Specially designed PV sound barriers can be produced in a transparent way to avoid blocking the view, or even be printed in colours to improve the aesthetic aspect of the sound barrier.



Artist's impression of the proposed solar sound barrier along MRT tracks.

According to an estimation by SERIS researchers, if 20% (~36 km) of Singapore's MRT lines are equipped with PV sound barriers, an additional 25 MW_p of PV panels can be installed in Singapore, enough to power up to 4,900 four-bedroom HDB flats. Generating power from PV is an important step towards achieving energy security and reducing the reliance on imported natural gas. The novel way of mounting PV modules as MRT sound barriers is a space-efficient functional integration perfectly suited for urban environments such as Singapore. The technology developed by SERIS can be easily exported to other countries.

References:

[1] "HDB launches first tender under EDB-led programme, SolarNova", 5 June 2015.

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[2] "Singapore scales up floating solar PV ambitions", 30 Sep 2017, The Business Times, Singapore

http://www.businesstimes.com.sg/energy-commodities/singapore-scales-up-floating-solar-pv-ambitions

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