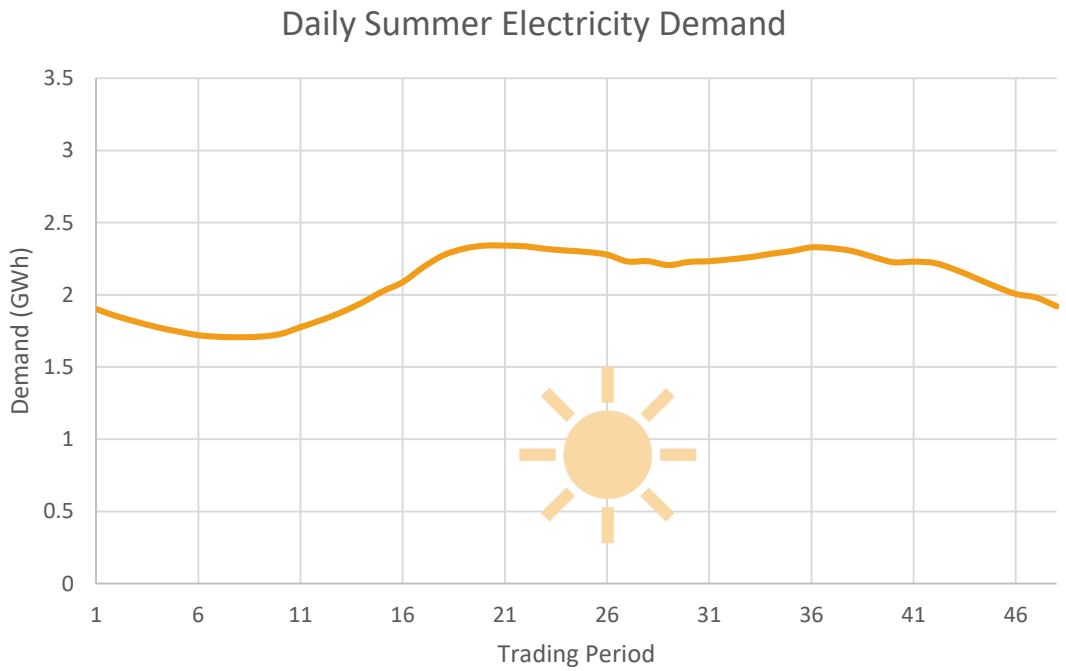
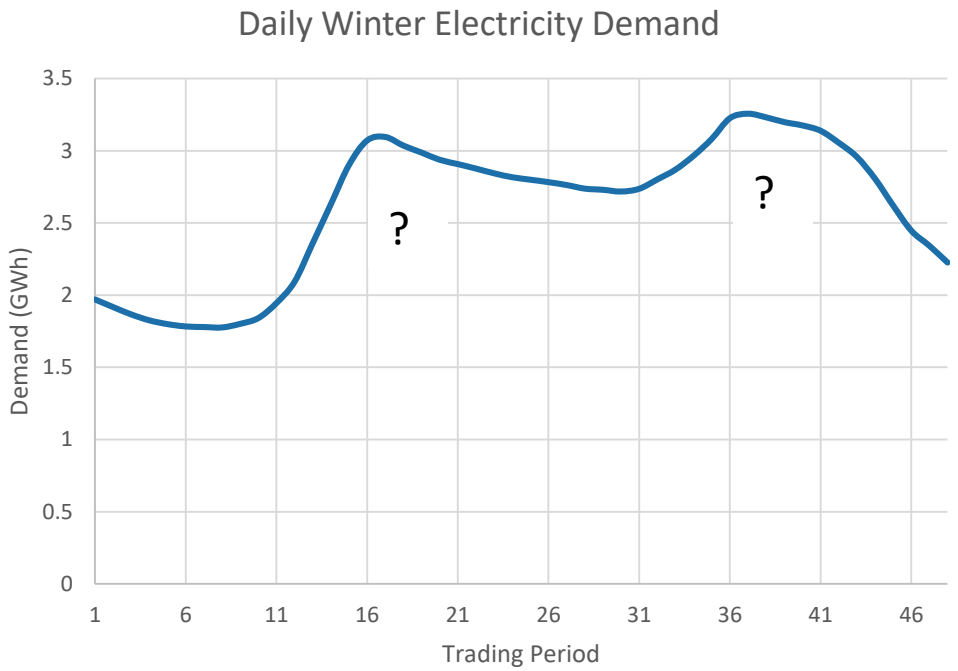
Night-time Photovoltaics: An answer to the renewable energy supply-demand mismatch

Electricity Demand Curves





Source: Electricity Authority

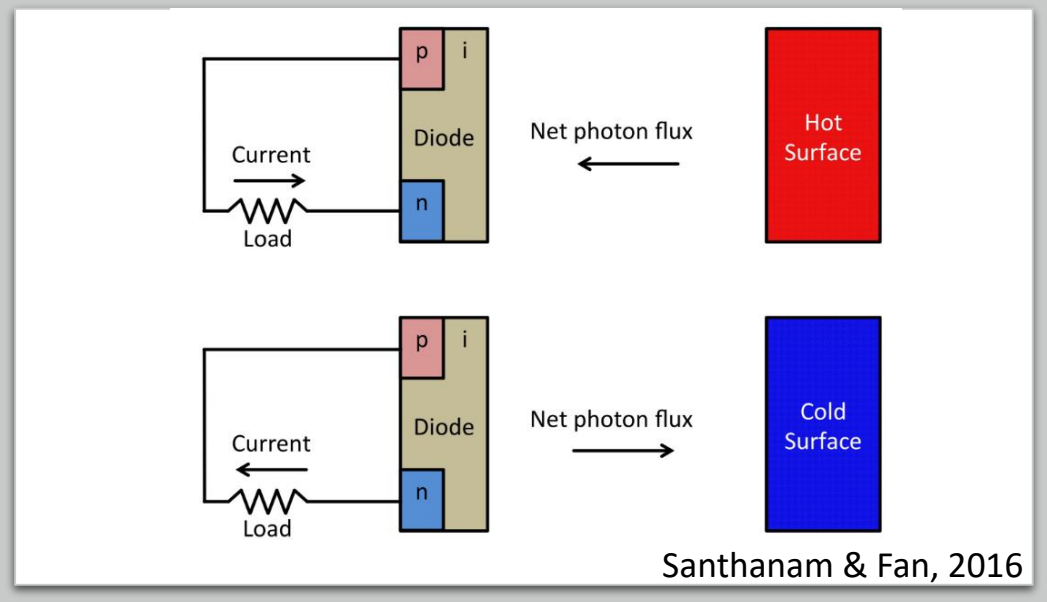
- Is there a renewable technology that can efficiently meet these winter peaks?

Night-time Photovoltaics

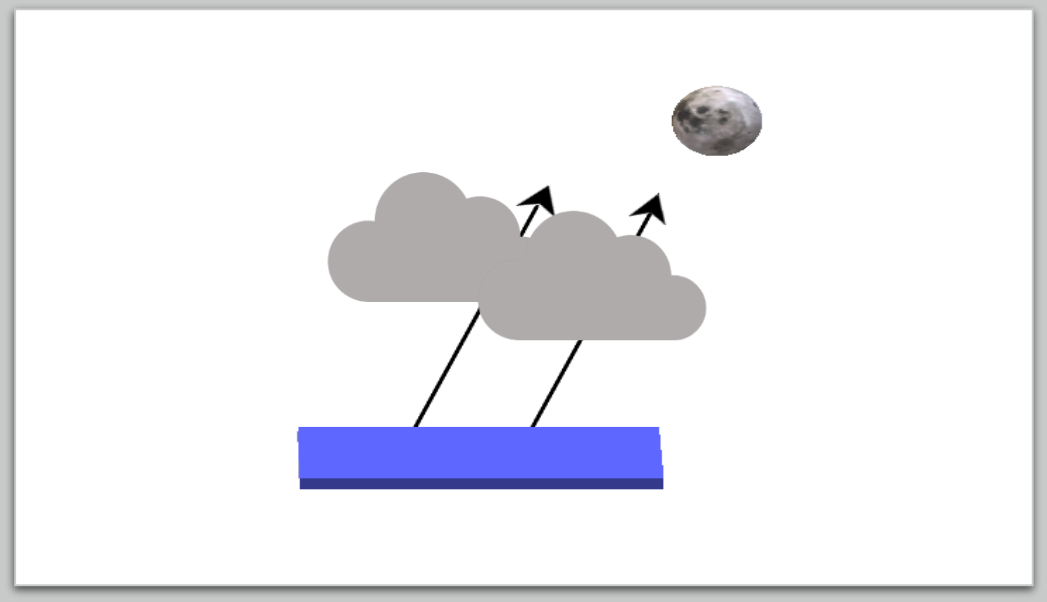
- Solar power is possible due to heat transfer from sun to earth.

- Night-time PV (Emissive Energy Harvester) is similarly possible due to heat transfer from the earth's surface towards outer-space.

- Project determined how atmospheric conditions (clouds, humidity) impact the power output of these devices.



Santhanam & Fan, 2016



Limits of Emissive Energy Harvesters

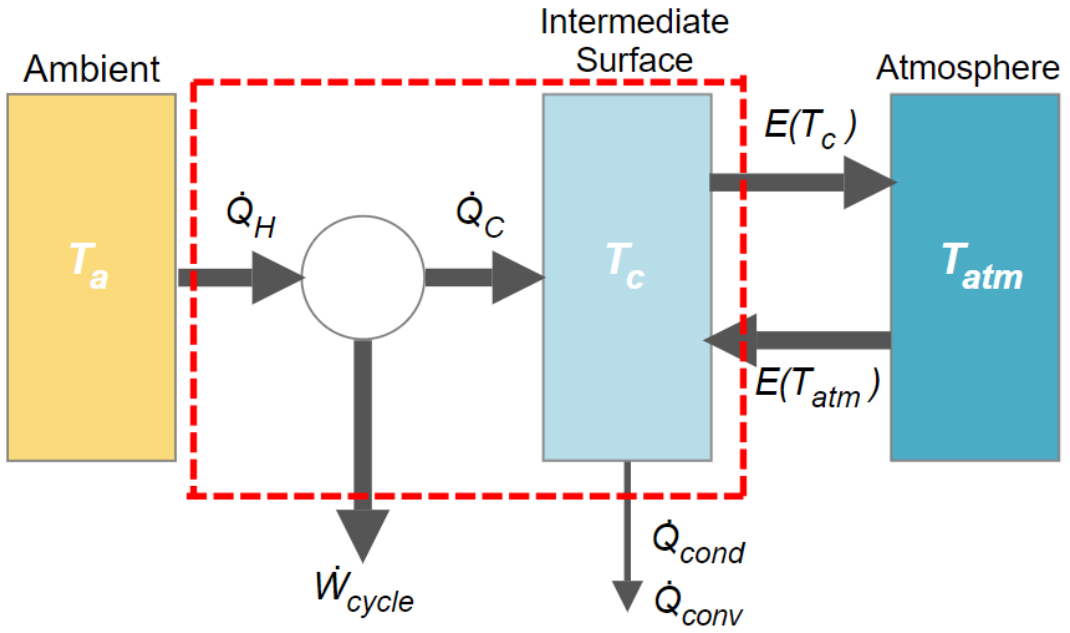
- Well known limits used in Solar energy conversion efficiency;

- <u>Blackbody Limit & Multicolour Limit:</u>

Heat transfer between blackbody surfaces and power produced by a heat engine at the Carnot efficiency.

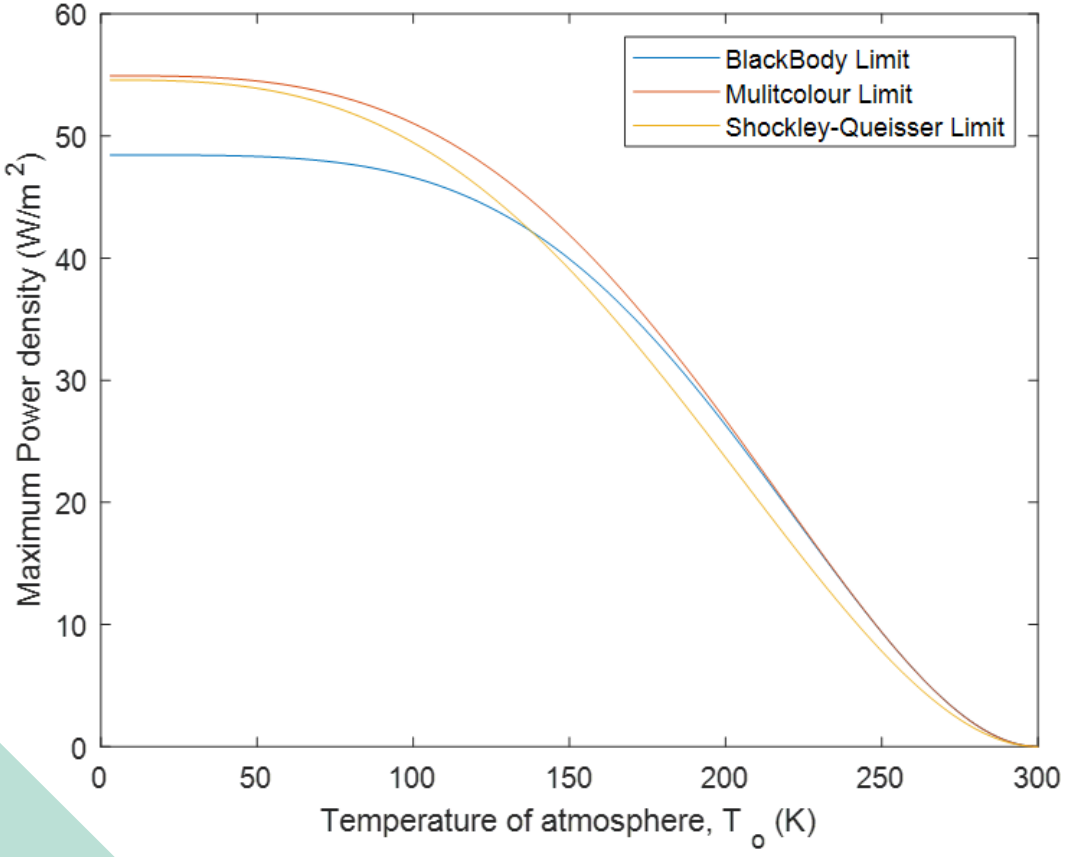
- <u>Shockley Queisser Limit:</u>

Thermo-Photovoltaic Cell facing cooler surroundings.



Schematic of Blackbody Limit for an emissive energy harvester

Results



- Significant generation available under theoretical conditions.
- Results suggest that the maximum power densities are greatly reduced by atmospheric conditions.
- Power densities in realistic conditions unable to compete with solar PV

Limit	Night-time, T_o = 3K (W/m^2)	Night-time, T_o = 270K (W/m^2)
Blackbody	48.4	3.8
Multicolour	54.9	3.8
Shockley Queisser	54.6	3.11