Solar Energy Driven Charging Station
Project Code: TCY4-09

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If you have taken a stroll through the HKUST campus, you may have noticed the many green campaigns the students are participating in. There is a great urge to press towards a greener HKUST campus, amidst energy concerns rising from global shortage of non-renewable energy sources. The aim of this project is to build a portable charging dock that is simple to use and makes use of solar energy. The device serves the purpose of charging low-power consumer electronics products such as mobile phones or music players.

Device Components
1. Solar Electric Module
2. Battery
3. Charge Controller
4. Inverter
5. Microcontroller

Solar Module Sizing Methodology

Step 1: First step is to determine the daily load AH requirement. Typical usage of the iphone will yield a value of 0.5625 AH per day.

Step 2: The second step is to set a safety factor that can range from 10% - 30%. This value accounts for the variables and the losses of the system.

Step 3: Multiply the result in Step 1 by 1 and add the result in Step 2.

Step 4: Use appropriate multiplier, based on the location of the system, to multiply the result in Step 3 to get the array size in watts. For Hong Kong, the value of this multiplier is 6.90.

Step 5: Calculate the battery storage capacity by multiplying the result from Step 1 by 9.6. In calculating 9.6, it is assumed that there is 8 "no sun" days of capacity in 5 years' time. It is also assumed that 20% of battery capacity will degrade in a period of 5 years.

Results
The charger will need 0.5625 AH per day. The calculation would be 0.75 x 1500mA over 2 days. The results also yield a safety factor of around 15% (rounded to the nearest integer) and hence the array size in watts is equal to 4.46 watts. The battery capacity is estimated to be 5.4 AH (0.5625 AH/day x 9.6 days).

Solar Radiation Variability in Hong Kong
Solar Radiation can be characterized into two components, direct-normal component and diffuse component. Global solar radiation is a measure of the overall solar radiation available at a particular site and is the sum of direct-normal multiplied by the cosine of the incidence angle, \( \cos(i) \), and the diffuse (sky) radiation.

Simplified Relationship between global and direct-beam radiation:

\[ \text{Global (total)} = \text{direct normal} \times \cos(i) \times 1 \]

Figure 1: Solio Portable Solar Charger
Figure 2: Overall System Block Diagram
Figure 3: System Wiring Diagram
Figure 4: A typical silicon solar module
Figure 5: Digital Lux Meter used to measure solar radiation
Figure 6: A typical silicon solar module
Figure 7: Solar radiation readings on a cloudy day
Figure 8: Solar radiation readings on a clear day