Simulation of CubeSat energy systems for evaluation of power interfaces

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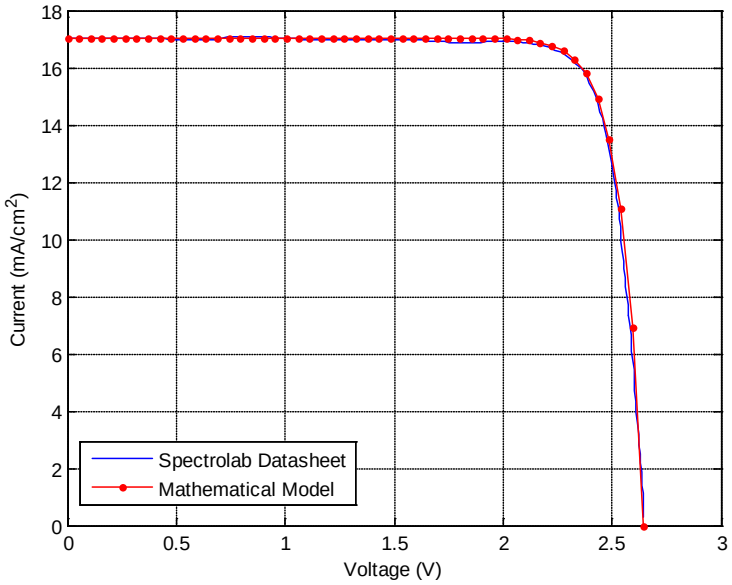
CubeSat Electrical Power System (EPS)

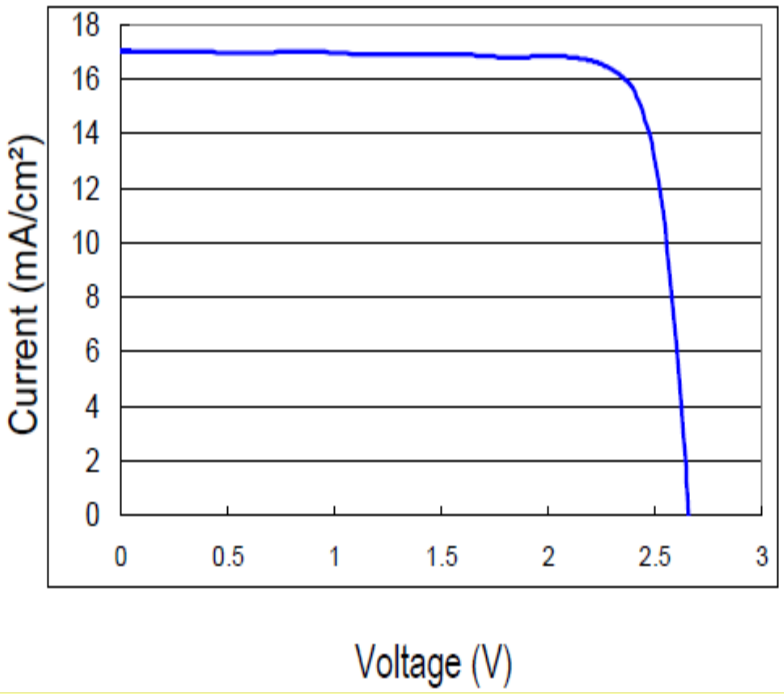
- The Electrical Power System (EPS) is a critical subsystem for all CubeSats
- The EPS must satisfy the specific requirements for each CubeSat
- Either a custom or a commercial EPS must provide reliable and safe power to the CubeSat
- it is important to evaluate the behavior of the EPS for the analysis and the design, considering the power sources

Modeling EPS component

- Photovoltaic cell model (Ortiz-Rivera)

$$I = \frac{I_x}{1 - \exp\left(-\frac{1}{b}\right)}\left[1 - exp\left(\frac{V}{bV_x} - \frac{1}{b}\right)\right]$$



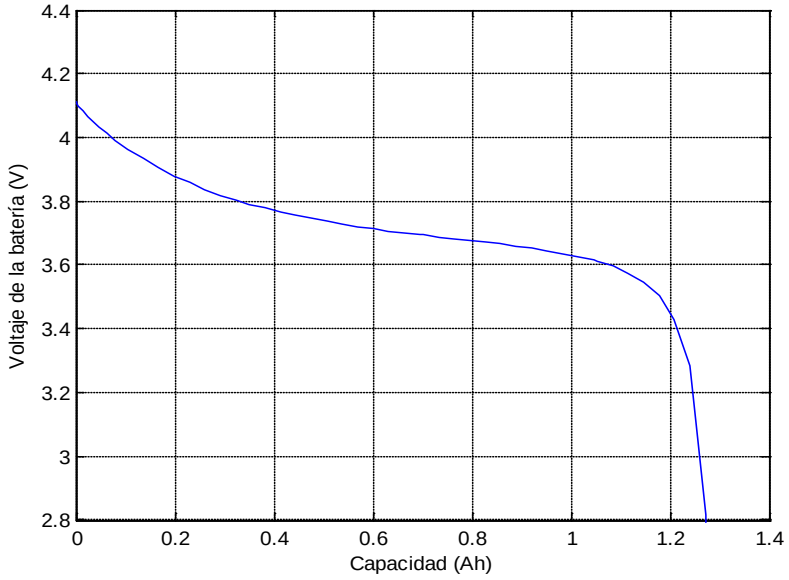


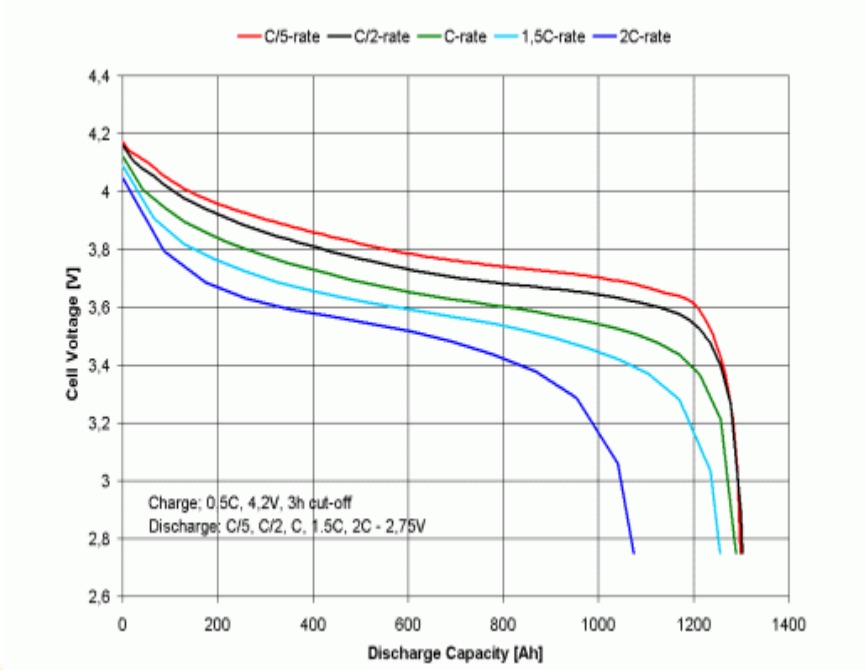
Modeling EPS component

- Battery model (Tremblay)

$$V_{bat} = E_0 - R \cdot i - K\frac{Q}{\int_0^t i\,dt + 0.1Q} i^* - K\frac{Q}{Q - \int_0^t i\,dt}\int_0^t i\,dt + Ab \cdot exp\left(-Bb \cdot \int_0^t i\,dt\right)$$

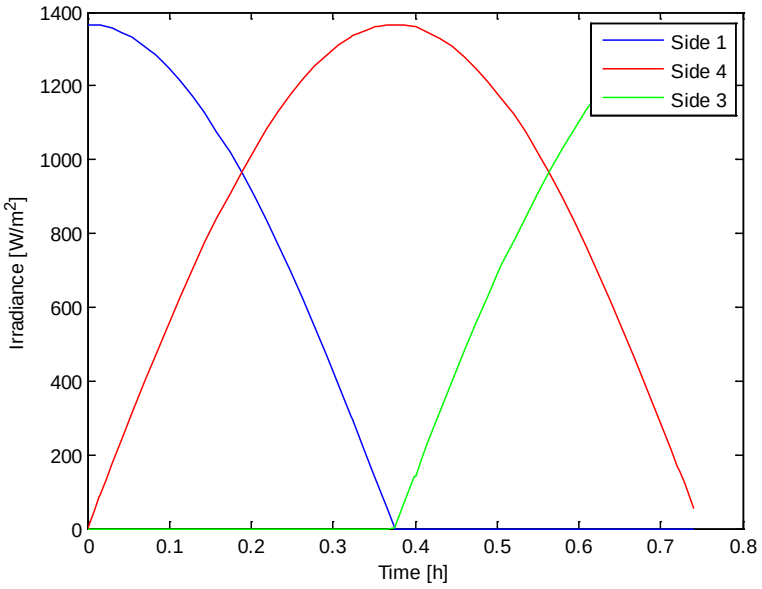
$$V_{bat} = E_0 - R \cdot i - K\frac{Q}{Q - \int_0^t i\,dt}\left(\int_0^t i\,dt + i^*\right) + Ab \cdot exp\left(-Bb \cdot \int_0^t i\,dt\right)$$



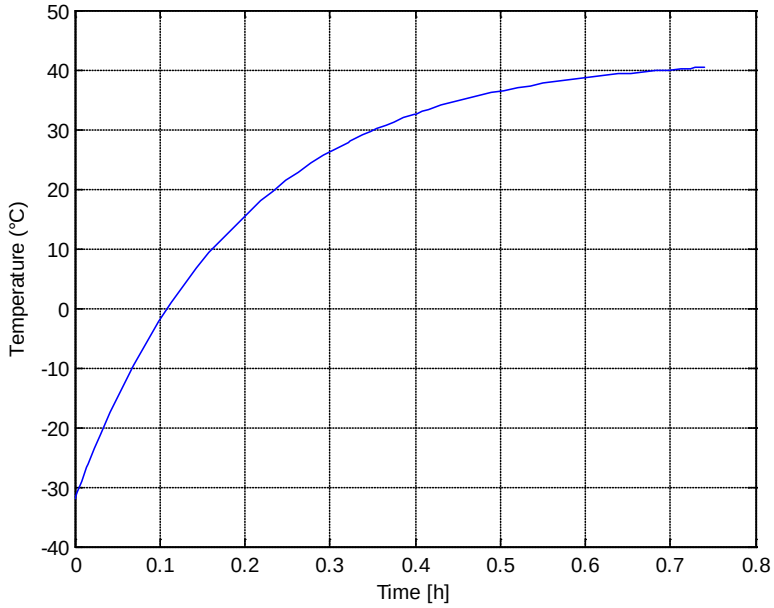


Orbit environment

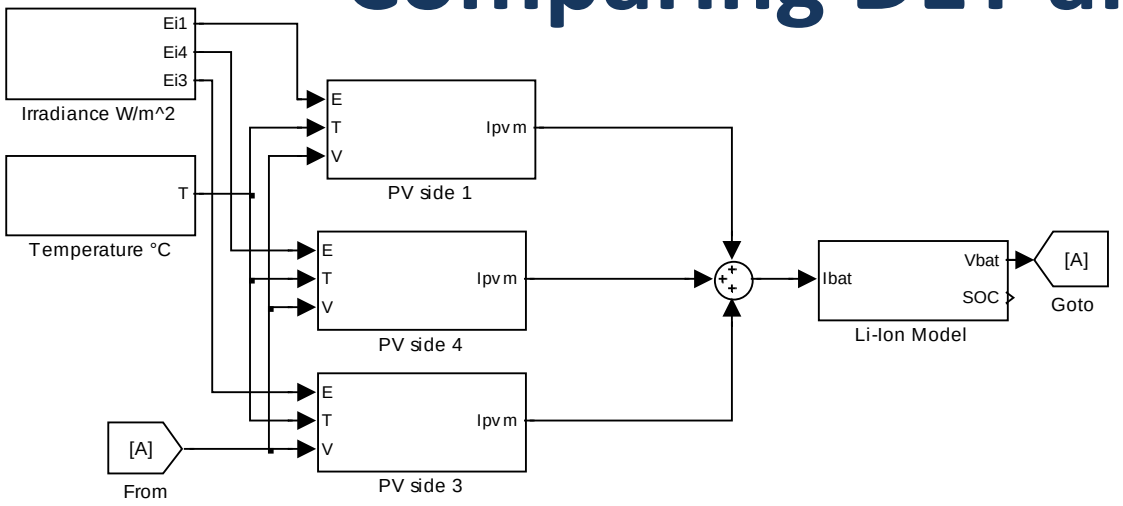
Irradiance

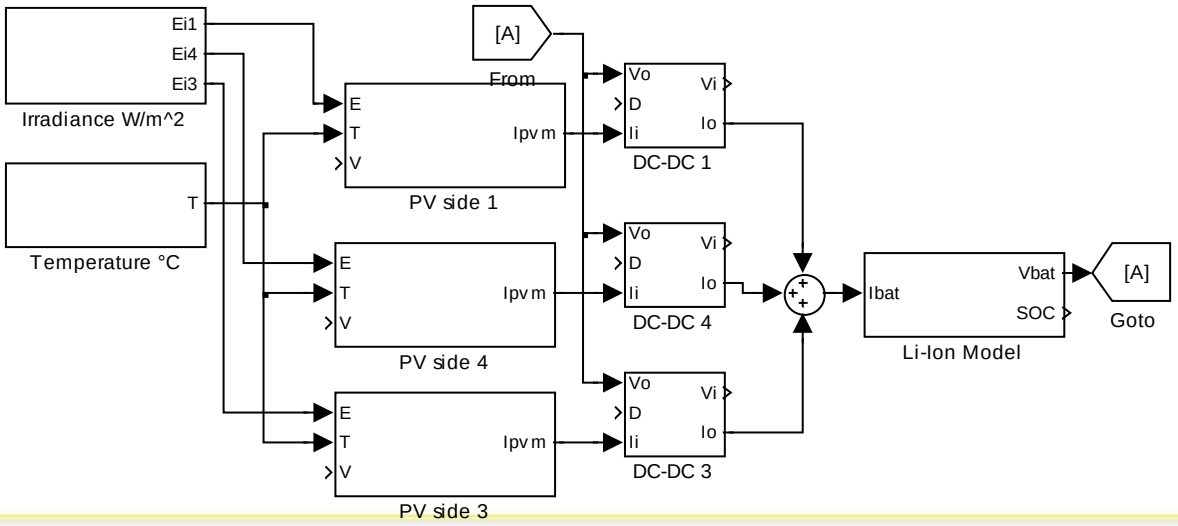


Temperature (Erb,2011)



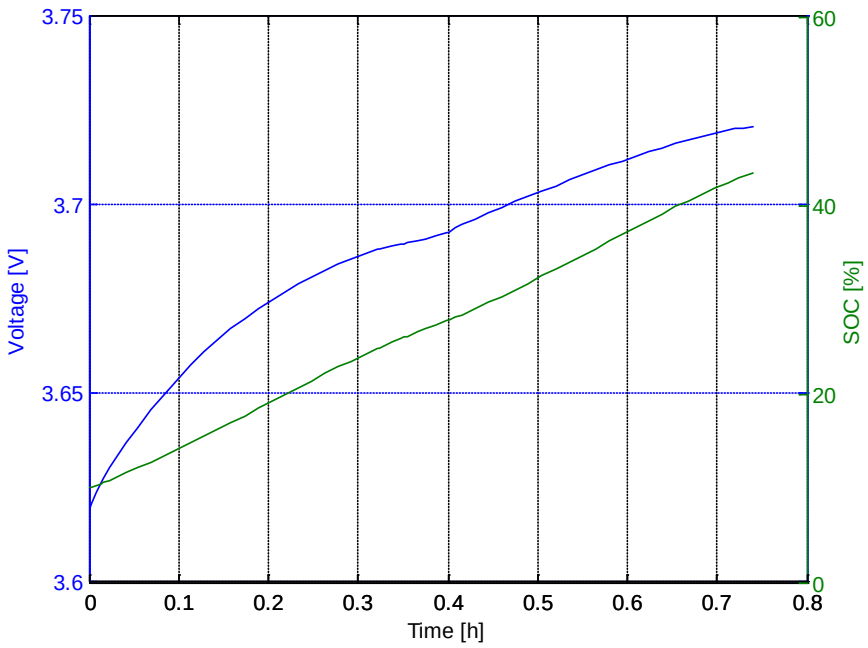
Comparing DET and MPPT



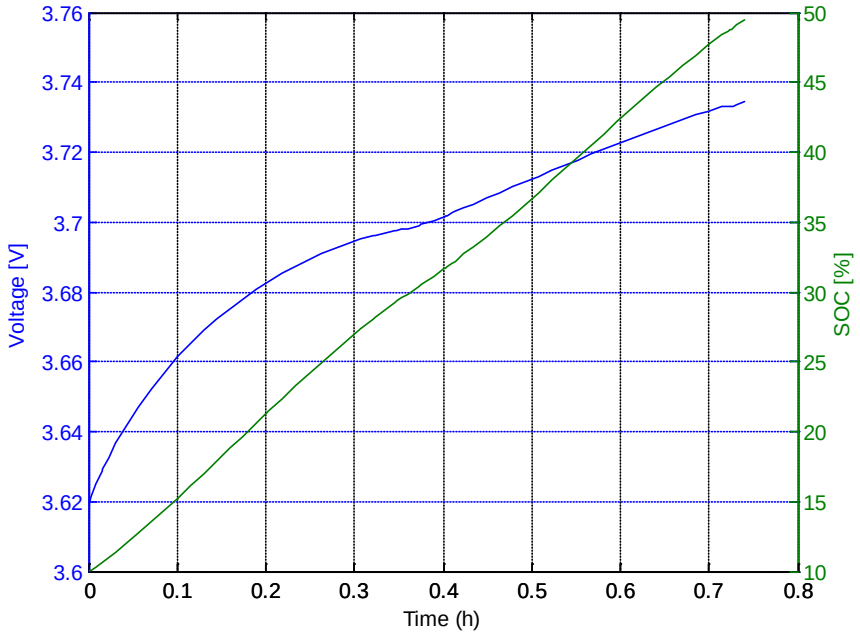


Results of Comparison

DET



MPPT



Conclusions

- Behavioral models for photovoltaic cell and Li-Ion batteries were described and used for CubeSat power system simulation
- In DET photovoltaic cells does not operate at maximum power point, the voltage is determined by the battery
- Using power converter the photovoltaic cells operate at maximum power point, thus the battery reaches a greater state of charge (7%).
- Future work must consider efficiency of power converter, as well as, a trade off between complexity and energy increment.

References

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Question?, Suggestions!
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