Solar Climber

A Project Oriented Approach for Teaching Power Electronics

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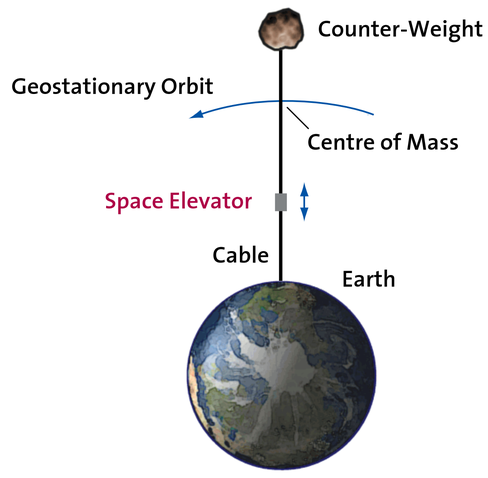
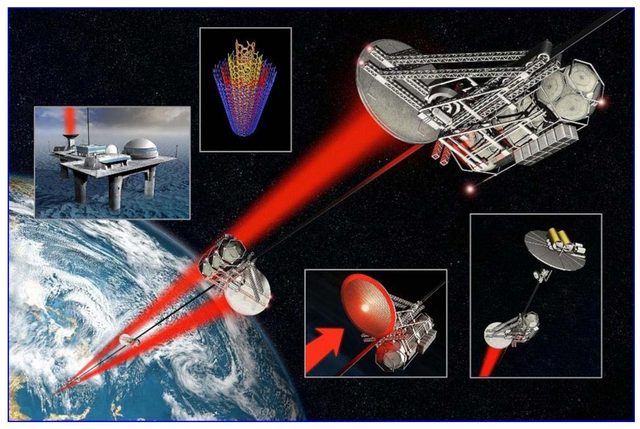
Introduction

The "Solar Climber", a model version of the space elevator, is a great project to introduce students to power electronics. The students are faced with the engineering problem of powering a vehicle from a solar panel.

Apart from learning about and building a simple buck converter as their first power electronics system, they must also identify the interdependences between a limited energy source, energy conversion efficiency, weight and climbing speed. E-Learning Tools such as JAVA applets are provided to deepen their understanding.

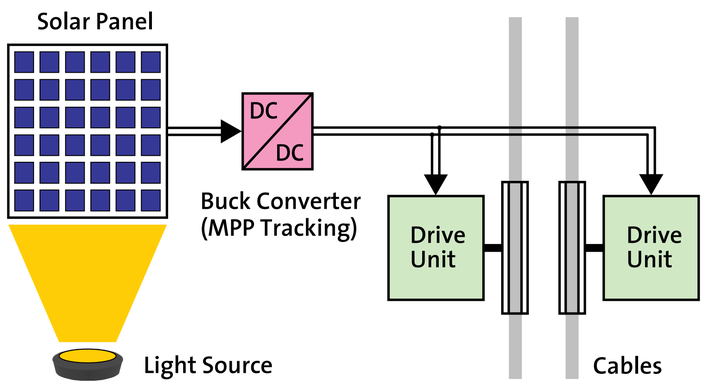
Space Elevator Concept and Possible Realization





Cost Reduction (?) – Rocket: 22´000 $/kg, Space Elevator: 220 $/kg

Energy Conversion



Key problem: Powering a system from a limited energy source

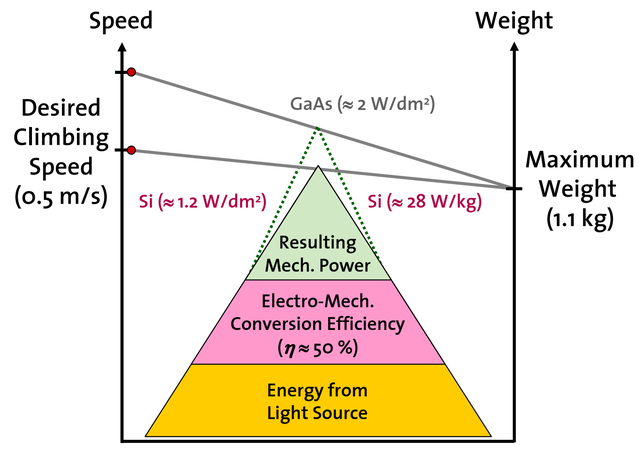
Learning Outcomes

Main Focus of Education

- Understanding of energy conversion
- Need for power electronic interface
- Use of modern design tools
- Experience in practical and team work

Challenges

- Power source to weight trade-off
- Weight to climbing speed trade-off
- Energy conversion efficiency

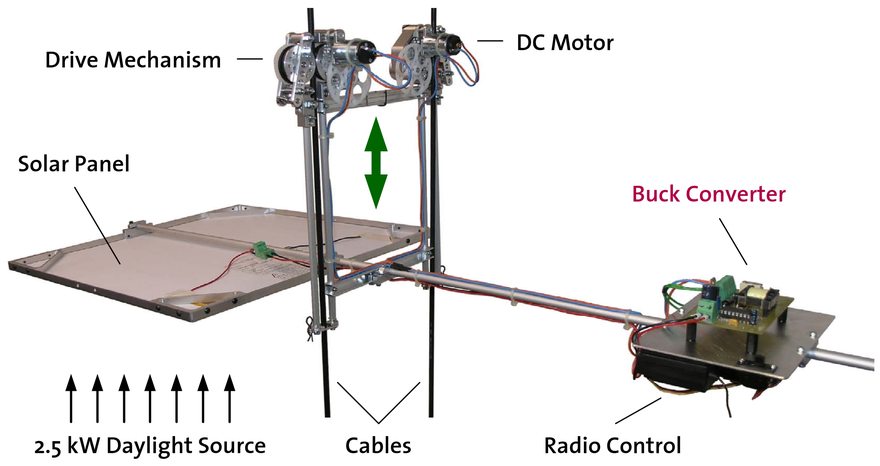


Project Schedule and Implementation

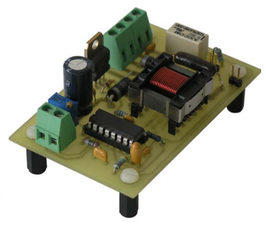
- Kick-off meeting, introduction, project plan
- Measurement of solar panel
- Providing theoretical basics
- Use of JAVA applets and simulations
- Dimensioning of the electronics
- Testing and optimization
- Solar Climber Race
- Final report, feedback

■ Theoretical
■ Practical
■ Holistic

Solar Climber – Model Space Elevator

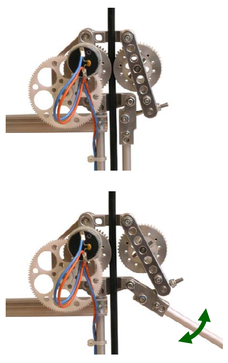


Buck Converter



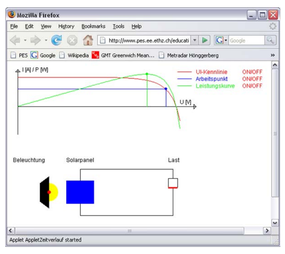
Converter Constructed by the Students

Drive Mechanism

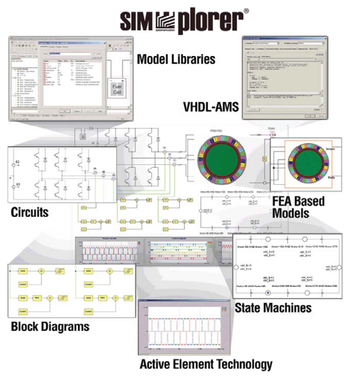


Solar Panel	Cristalline silicon, 36 cells, 11 W, 17.5 V_{MPP}
Drive Units	2 x 12 V DC motor, Maxon RE-max 21
Power Electronics	Buck converter with Maximum Power Point tracking
Overall Dimensions	95 cm x 33 cm x 28 cm
Total Weight	1.1 kg (solar panel 400 g)
Climbing Speed	≈ 0.5 m/s (averaged over 10 m climbing height)
Light Source	Arrisun, 2.5 kW daylight xenon lamp

E-Learning Tools



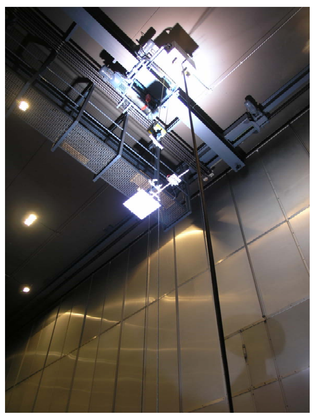
JAVA Applet to Visualize the Light and Load Dependent I-U Characteristic of a Panel



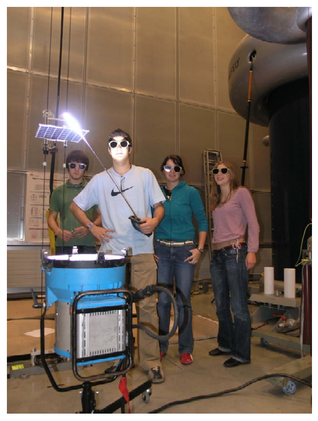
Ansoft Circuit Simulator

Solar Climber Race in the High Voltage Laboratory

Adjustment of the Maximum Power Point Tracking Controller



Solar Climber and Cable System Connected to the Crane



Commercially Available Daylight 2.5 kW Xenon Lamp (Arrisun)

Conclusions

- Incorporates different aspects of electrical engineering
- Successfull application of E-Learning Tools
- Wide variety of modification possibilites
- Project work on an entire system
- Popularity of enrolement and positive feedback
- Reduced complexity project successfully applicable for college students

Further Information

Modeling the Space Elevator – A Project Oriented Approach for Teaching Experimental Power Electronics

http://www.epeec.ethz.ch/pdf/friedli_EPE07.pdf

Thomas Friedli, PES
ETH Zurich, 24.01.08