Solar Impulse 2

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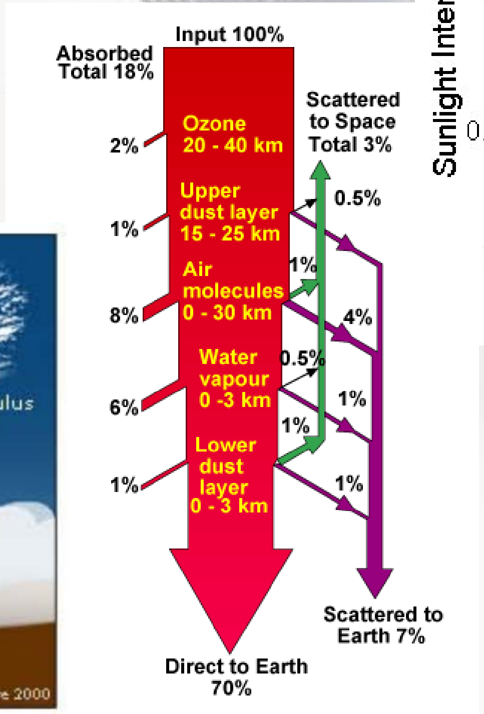
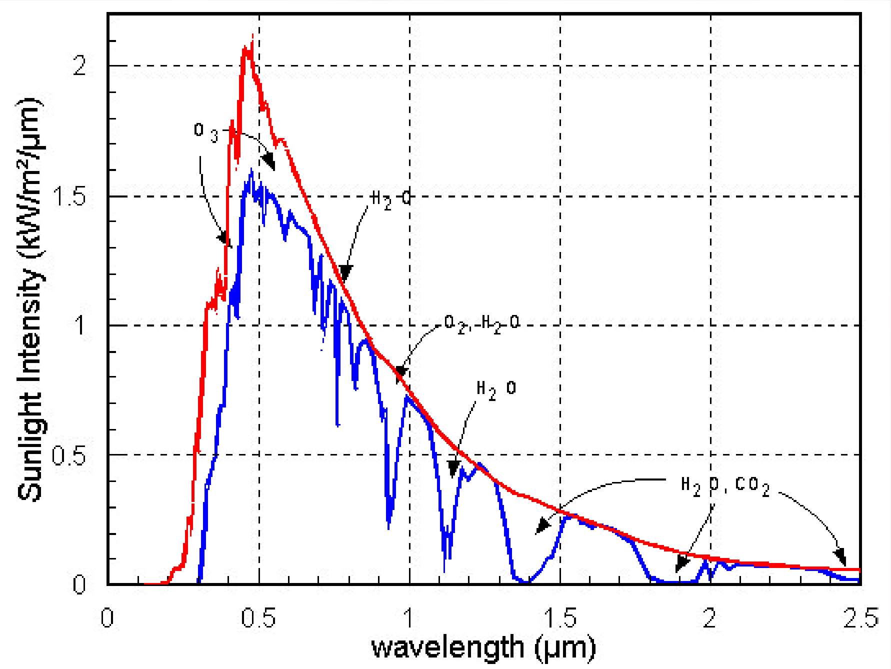
What is the solar impulse 2?

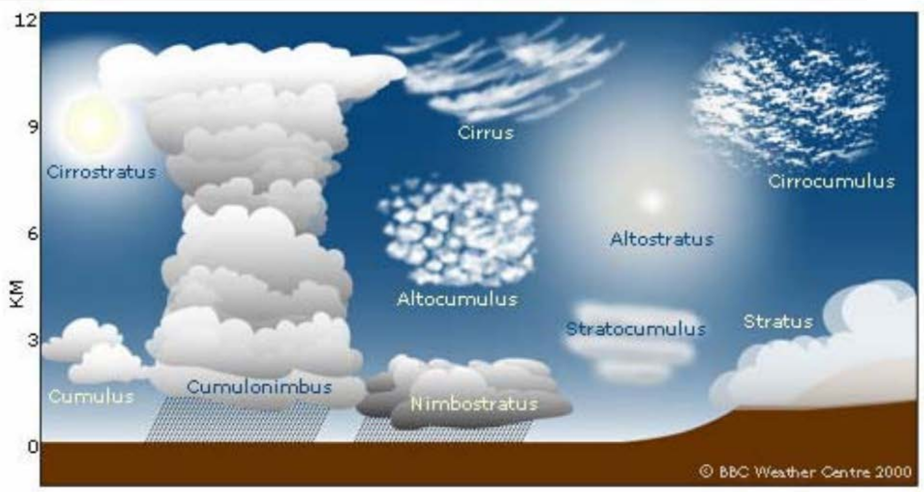
- Piloted by Bertrard Piccard and Andre Borschberg
- Weighs only 2300 kg
- Has 17248 solar cells
- Top speed of 140 kph (87 mph)
- Generates peak of 340 kWh/day
- Wingspan of 72 m
- Cruising altitude of 8500 m during day, 1500 m at night

Effects at cruising altitude of 8500 m

- No water vapor, lower dust layer, 72% of air molecules
- Flies weather permitting
- 1.536 kW/m² input
- 1.316 kw/m² at 8500 m



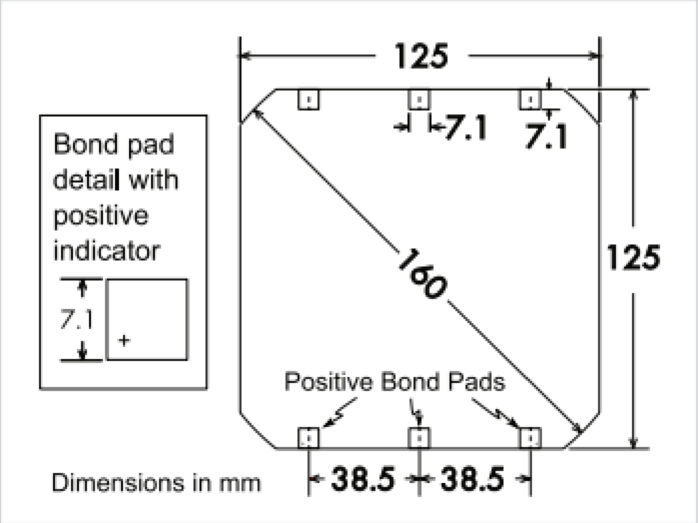




Solar Cells Used

- 17248 SunPower Maxeon C-60
- Monocrystalline Silicon
- Copper backed
- No silver metal paste
- Area of cell: 0.015625 m^2
- Total area of cells: 269.5 m^2
- Efficiency of 23%

Cell and Bond Pad Dimensions



Bond pad area dimensions are 7.1mm x 7.1mm
Positive pole bond pad side has "+" indicator on leftmost and rightmost bond pads.

Differences in kinds solar cells

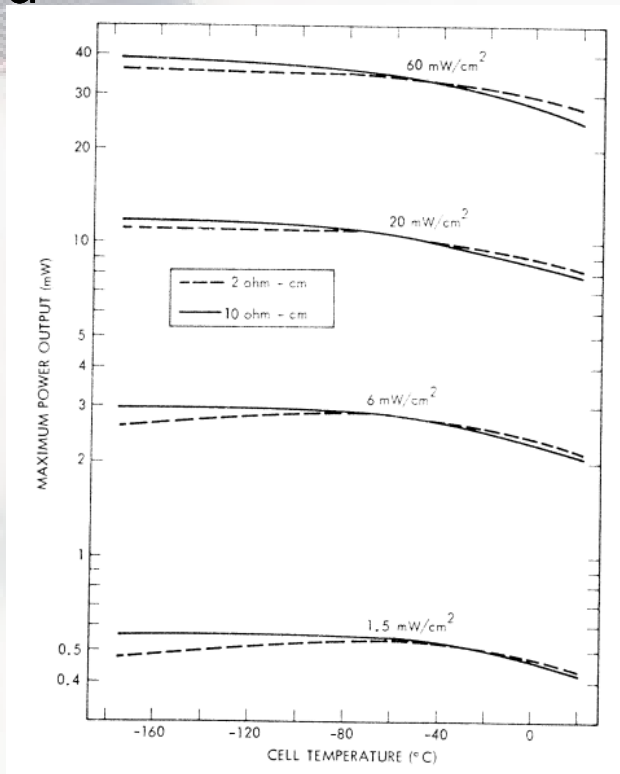
- Monocrystalline, polycrystalline, amorphous, thin film.
- Monocrystalline grown by seed crystal. Exhibits same properties as seed crystal.
- Polycrystalline has various properties due to different seed crystals.
- More recombination in polycrystalline cells, due to more trap sites.
- Polycrystalline cells are less efficient than monocrystalline cells.
- Monocrystalline cells are lighter, thinner than polycrystalline.
- Thinner cells, less absorption but more voltage. Therefore, more voltage.

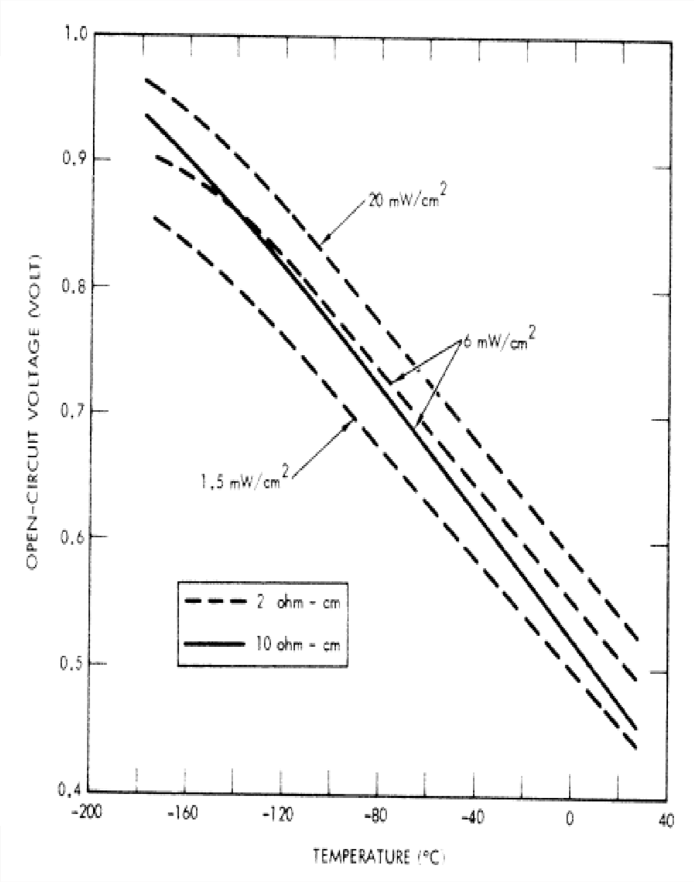
Batteries

- Lithium Ion have low energy to weight (180Wh/kg) and power to weight ratios (1500W/kg)
- 633 kg of batteries on board
- Used to enable flight at night
- Lower temperatures decrease ionic conductivity (Kd^{eff}), which decreases the specific surface area current ($S_{a,i}j_{loc}$)
- $S_{a,i}j_{loc} = \nabla\left\{K^{eff}\left[-\nabla\emptyset_2 + Kd^{eff}\frac{\nabla C_2}{C_2}\right]\right\}$
- $Kd^{eff} = \frac{2RT}{F}\left[1 + \frac{\delta \ln f}{\delta \ln c_2}\right](1 - t_+)$
- At -20 °C, only 50% of battery storage remains. But, lower temperatures allow for longer battery lifetimes.
- Heavy insolation is required

Solar cells at low temperatures

- Graph shows power outlet and voltage generally increase
- $E_g(T) = E_g(0) - \frac{\alpha T^2}{T+\beta}$
- Silicon E_g(233K) = 1.134 eV compared to 1.12 eV at room temperature
- $n_i = \sqrt{N_C N_V e^{-Eg/kT}}$
- $n_i^2 = BT^3 e^{\frac{-Eg(0)}{kt}}$
- $V_{bi} = \frac{kT}{q} \ln\left[\frac{N_A N_D}{n_i^2}\right]$





Solar cells at low temperatures cont.

- $W = \ x_p + x_n = \sqrt{\frac{2k_{si}\varepsilon_0(N_A+N_D)(V_{bi}-V_A)}{qN_AN_D}}$
- $I = I_{Dark} + I_{Light} = I_0(e^{\frac{qV_A}{kT}} - 1) - qAG_L(L_N + L_P + W)$
- $I_0 = qA\frac{Dn_i^2}{LN_D} = \ B'T^{\gamma}e^{\frac{-E_{G0}}{kT}}$
- $V_{OC} = \frac{kT}{q}(\ln I_{SC} - \ln B' - \gamma \ln T + \frac{qV_{G0}}{kT}) = \frac{kT}{q}\ln(\frac{I_{SC}}{I_0})$

MPPT technology

- Resonant power converter with Photon MPPT used
- Photon MPPT are lightweight. Would account for 16 kg for the plane, whereas normal MPPT would account for 80 kg
- Efficiency of 87%
- Closed loop feedback allows tracking without input from user

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Questions?