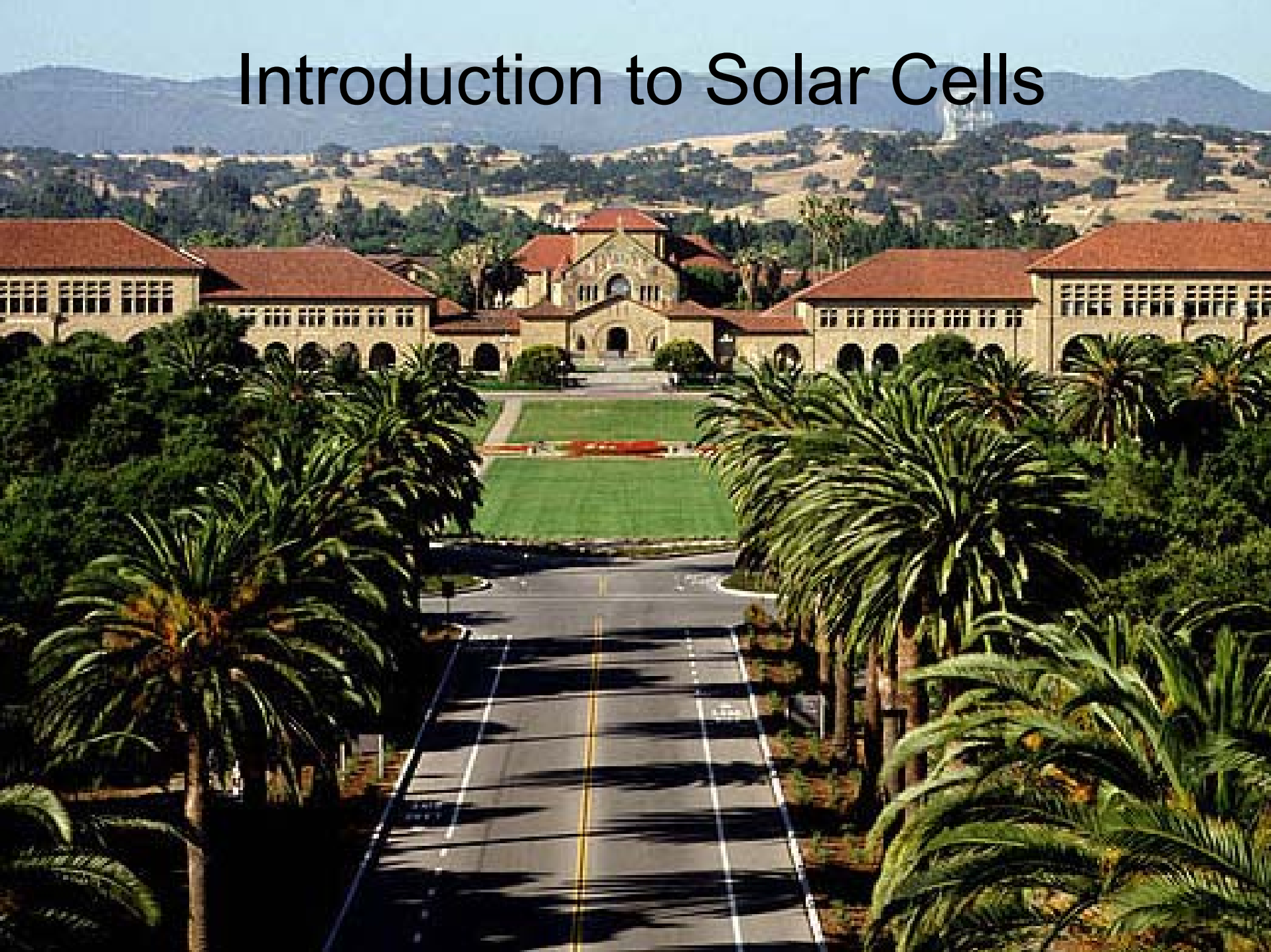
Introduction to Solar Cells



The energy problem

- The world uses about 13 TW of power today.

- We probably need to generate ~ 30 TW of power in 2050.

- Within the next 10 years, the amount of oil we can extract each year will probably start to decline.

- If we do not dramatically reduce our emissions of carbon dioxide, the average temperature of the planet will probably rise by several degrees.

Our options

- Burn fossil fuels and sequester the carbon
- Nuclear
- Renewable energy

Why solar cells are likely to provide a significant fraction of our power

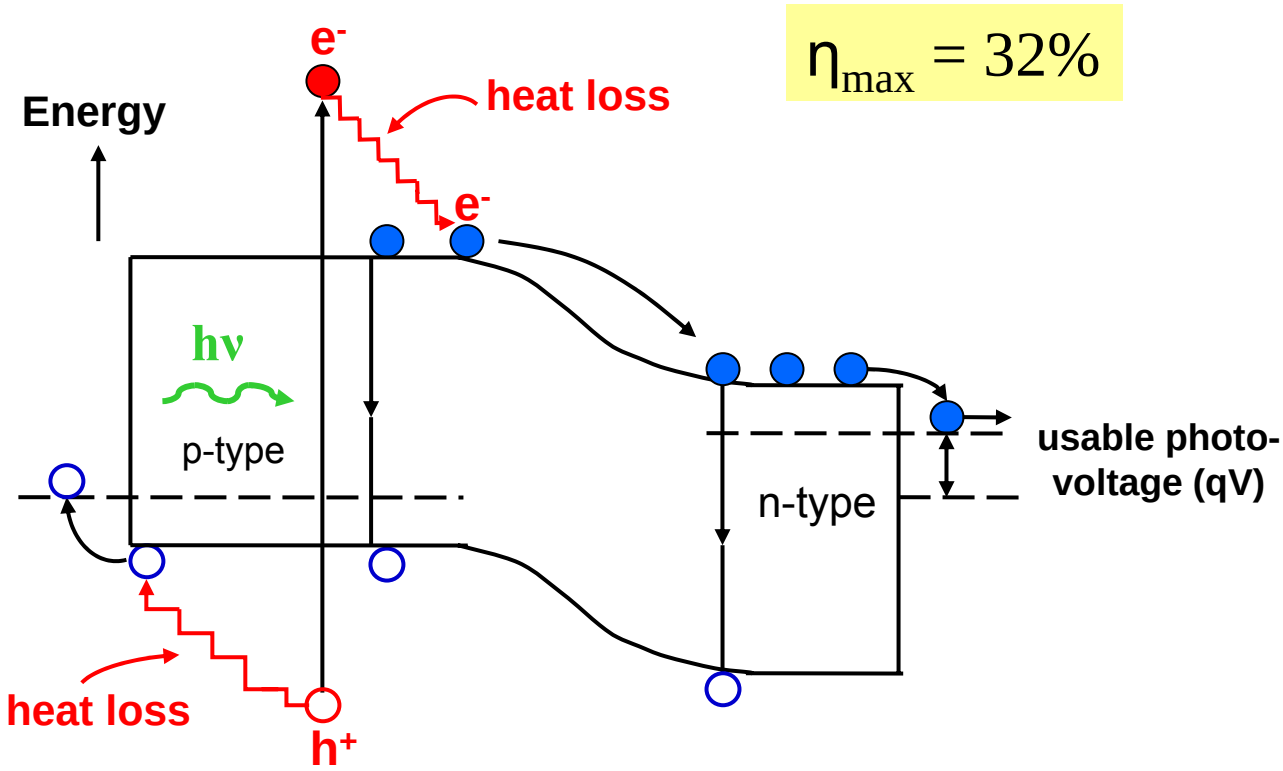
- We need ~ 30 TW of power, the sun gives us 120,000 TW.

- Solar cells are safe and have few non-desirable environmental impacts.

- Using solar cells instead of burning coal to generate electricity is a much easier way to reduce carbon emissions than replacing gasoline in vehicles.

- Solar cells provide electricity exactly when we need it the most.

Conventional p-n junction photovoltaic (solar) cell



Jenny Nelson, *The Physics of Solar Cells*, 2003.

Polycrystalline silicon solar cells

12 % efficiency
$350/m^2$

	Cost ($/W)
Cell	$2.50
Making the module	$1.00
Inverter	$0.50
Installation	$4-5.00
TOTAL	$8-9.00

DOE numbers

Average cost of PV cell electricity: $.27/kW-hr

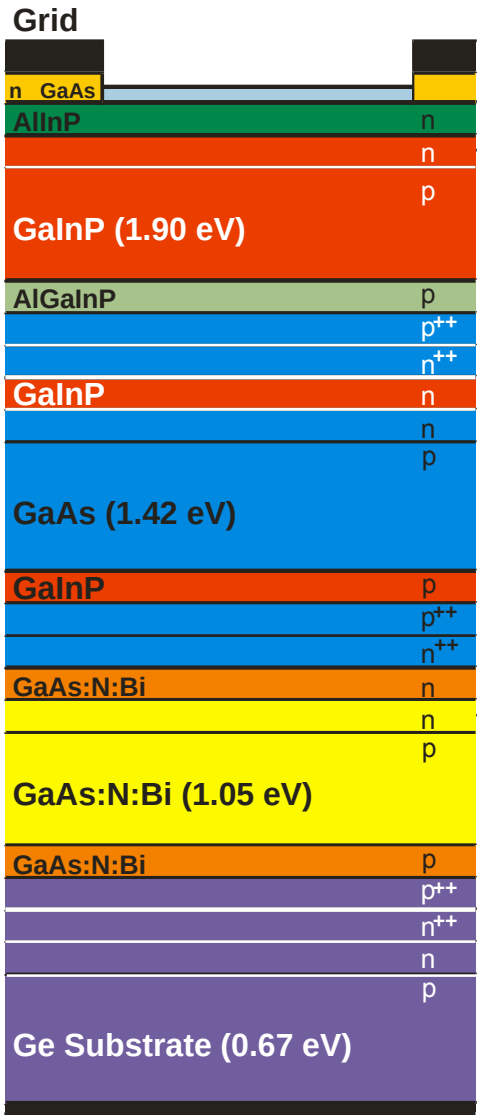
Today's grid electricity: $0.06/kW-hr

Single crystal cells

Dick Swanson will show you how SunPower makes 21 % efficient cells.

What is the potential for using less silicon and reducing the costs?

Multijunction cells

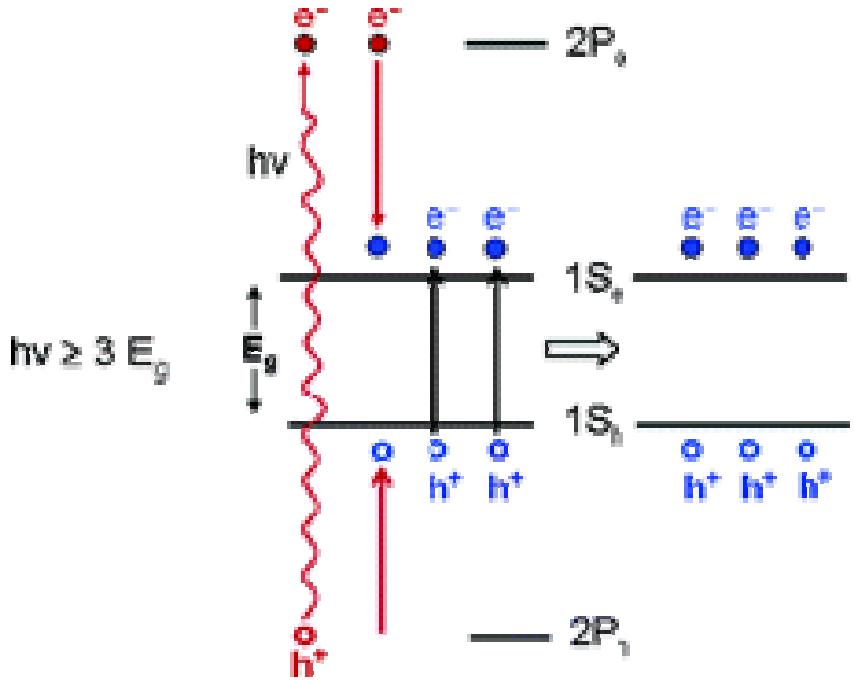


SpectroLab has achieved 37 % efficiency

Costs are estimated at $50,000/m^2, so concentrators must be used.

Quantum Dot Solar Cells

- Energy levels are quantized.
- Electrons do not rapidly give up there energy to phonons.



Art Nozik, *Inorganic Chemistry*, 44 (2005) p. 6893.

The cheapest option

Efficiency: 0.3 %

We don't have the land and water to provide the world with energy this way.

Can we artificially improve the efficiency?

Thin Film Cells

A thin film of semiconductor is deposited by low cost methods.

Less material is used.

Cells can be flexible.

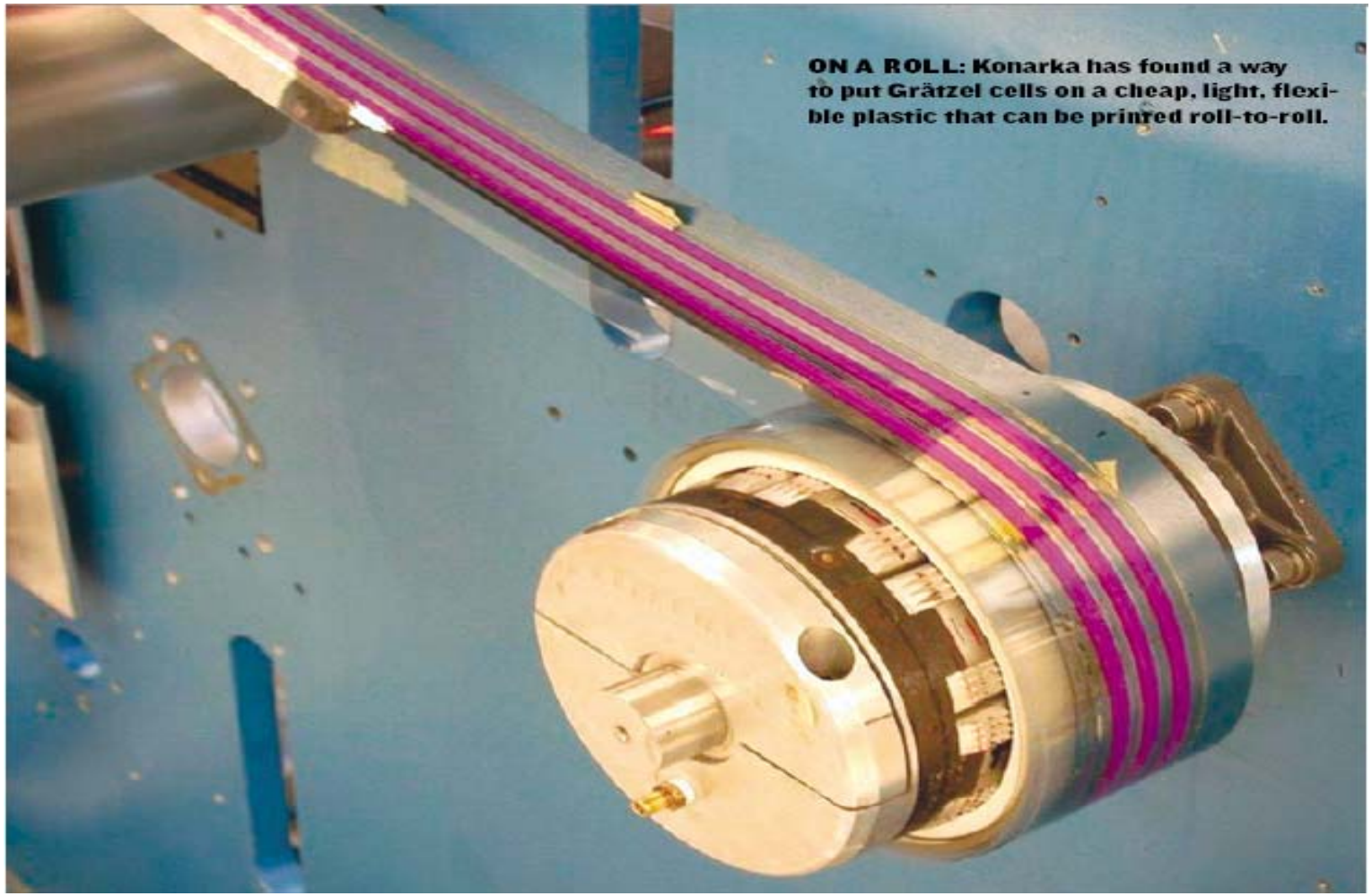
CIGS ($CuInGaSe_2$)
World record: 19.5 %
Stable
Is there enough In available?

amorphous Si
World record: 12.1 %
not completely stable

CdTe
World record: 16.5 %
Stable
Cd is toxic

Chris Eberspacher will tell you how Nanosolar prints CIGS cells.

5 % efficient organic cells can be deposited from solution



P. Fairley, *IEEE Spectrum.* Jan. 2004 p.28