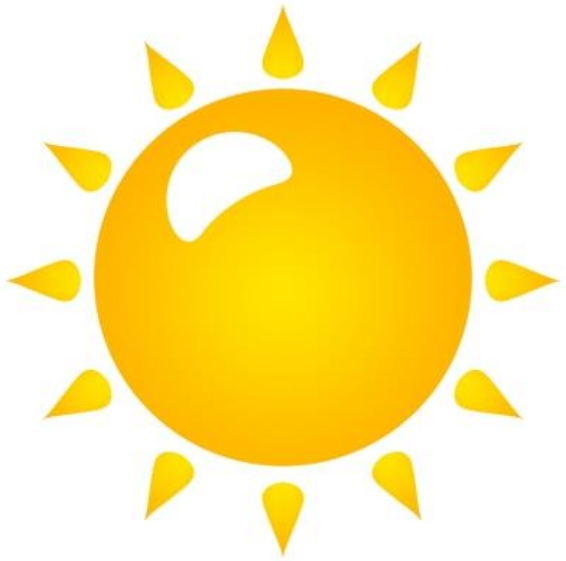


Solar Panel Design

Team Croatia

Andrew Hassel, Emma Schmitz, and Marshall Grady

Introduction of Group

- Green Engineering students at The Ohio State University
- Majors: Aerospace, Biomedical, and Electrical Engineering

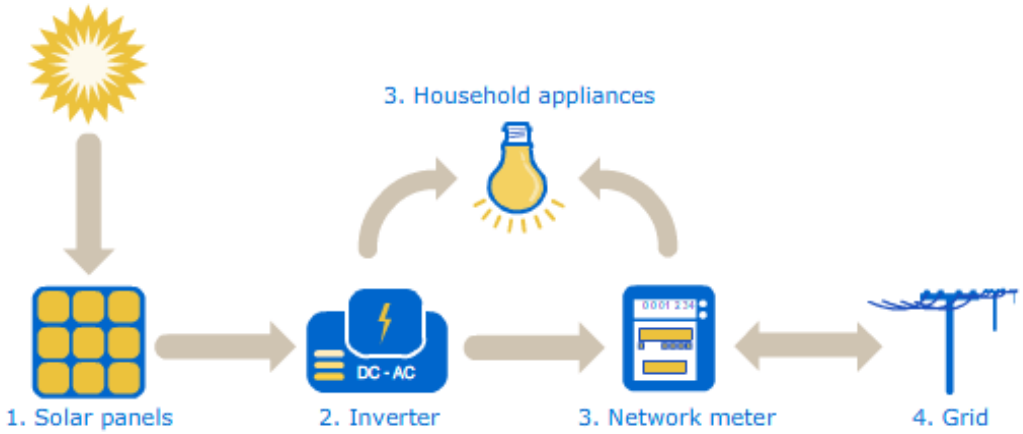
Description of Topic

- Solar panels main goal is to find a way to collect the most energy at the lowest cost
  - The main factor is currently cost
- Current efficiency of most solar panels are below 29%
- Theoretical efficiency is 86.8% (3)

What this means for future solar farms

- Making Solar farms more efficient means making the world one step closer to preserving the environment

- If solar technology can advance enough it can become a very viable option to reduce the amount of fossil fuels and emissions that the world produces

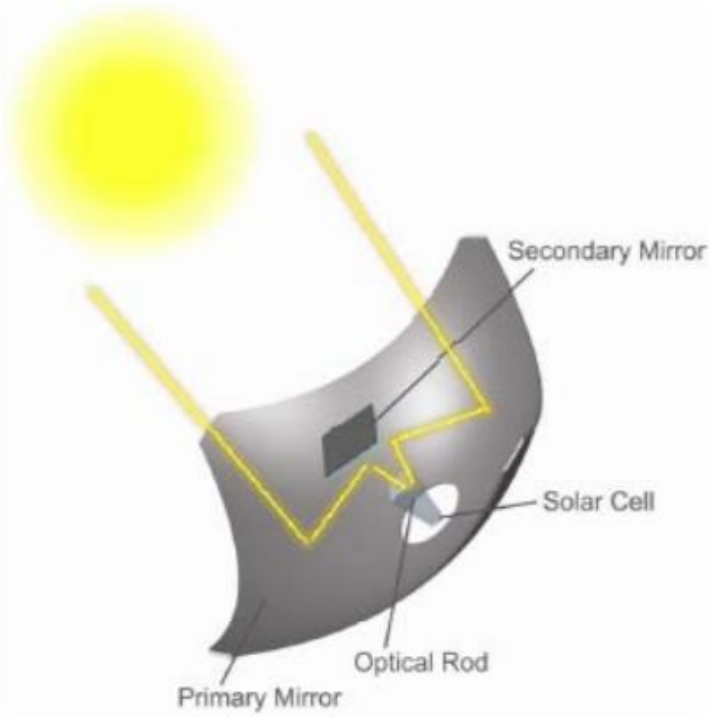


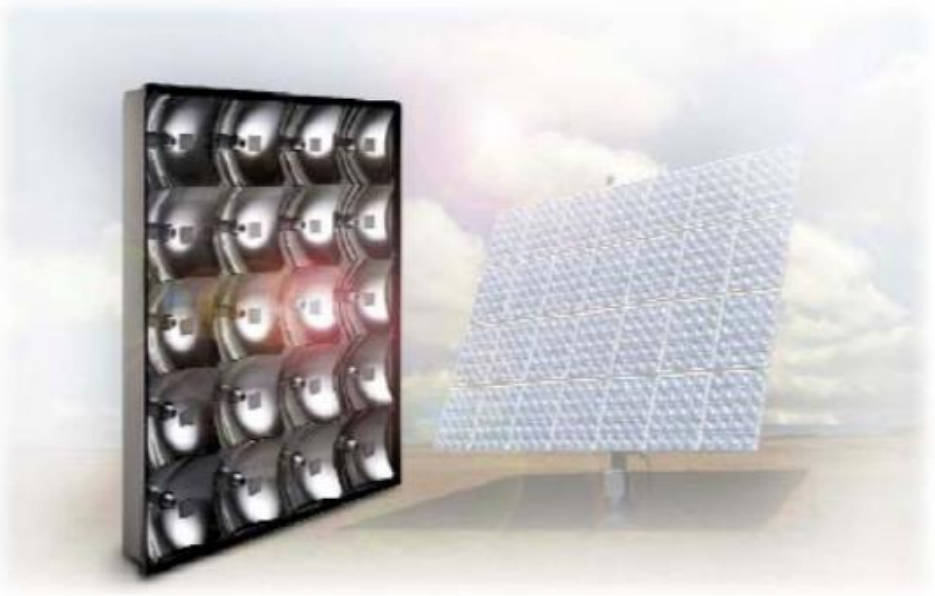
Relevance of topic

- Push for affordable renewable energy
  - An 5 Kw systems costs about $25,000 to $35,000 (1)
- Solar technology is making great advancements
- Helping the environment through the application of improved solar panel technology
  - Solar panels have considerably lower CO2 emissions than its fossil fuel competitors

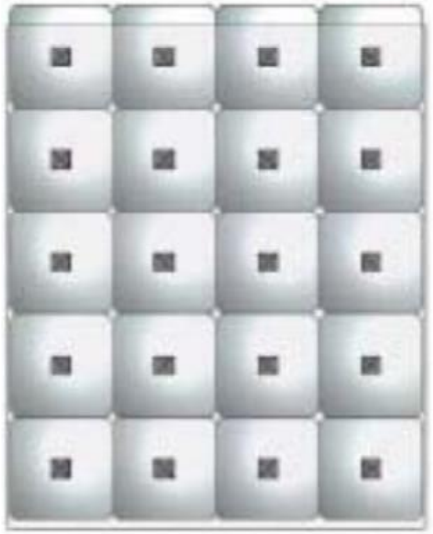
History of research and/or Implementation

- The National Renewable Energy Laboratory subcontracted an 18 month project to Solfocus to improve panel efficiency, reliability, and overall module performance
- Many improvements such as the redesigning and automating the fabrication of the primary mirrors were looked into and implemented.
- The contract was split into two phases. Phase 1 was the work they did to improve CPV panels and phase 2 was the work they did on the efficiency of production of the panels
- The company was able to exceed their goals in improvements to the panel of 22 percent efficiency and 3 megawatt run rate capacity (1)



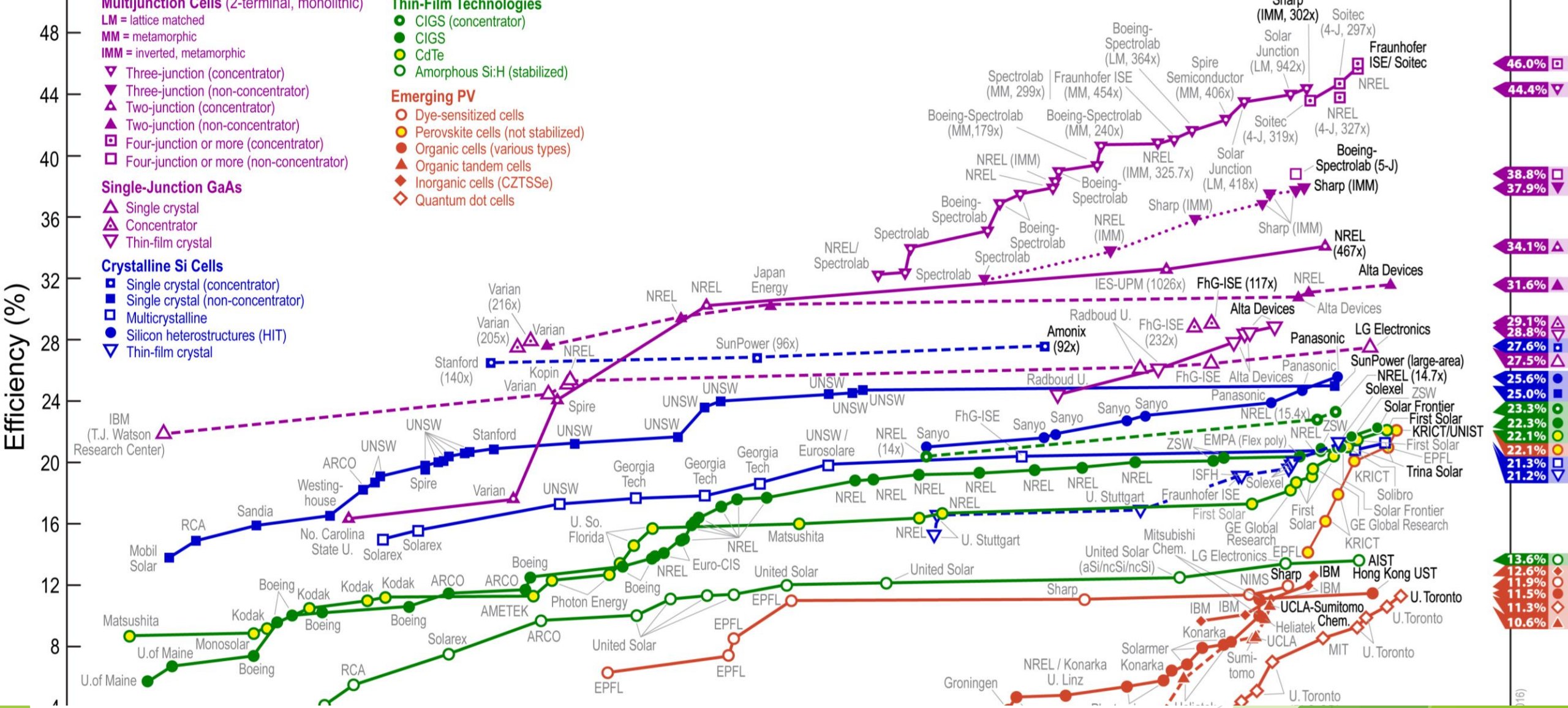


Shown to left: SolFocus SF-1100 optical system utilizing primary and secondary mirrors and optical rod are combined with high-efficiency multi-junction PV cells to form a power unit. Twenty power units are integrated into a panel, and then 28 panels are integrated on a dual axis tracker for field deployment.



Optical architecture redesign from hexagonal to quadrangle shaped optics

Left: Secondary mirror with dark adhesive. Right: Secondary mirror using adhesive with increased reflectivity.

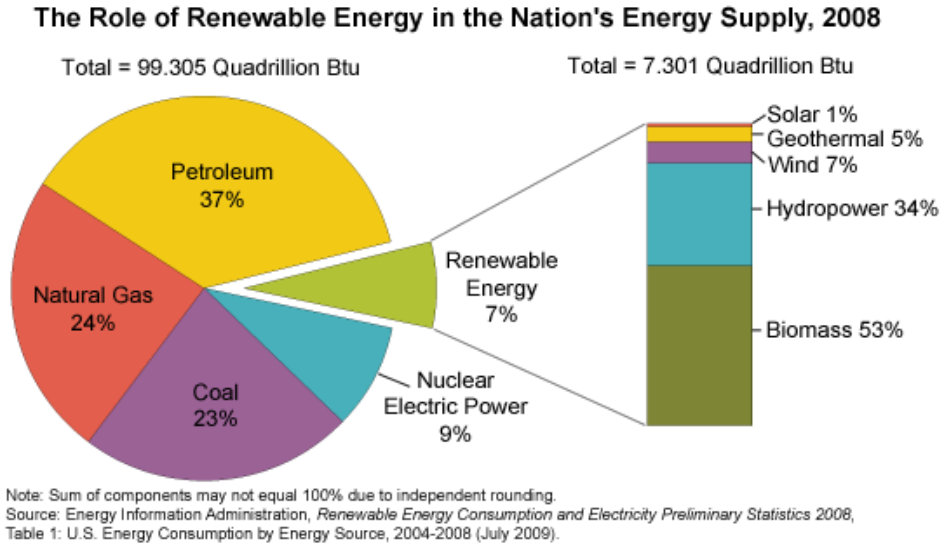

Multijunction Cells (2-terminal, monolithic)
LM = lattice matched
MM = metamorphic
IMM = inverted, metamorphic
Three-junction (concentrator)
Three-junction (non-concentrator)
Two-junction (concentrator)
Two-junction (non-concentrator)
Four-junction or more (concentrator)
Four-junction or more (non-concentrator)
Single-Junction GaAs
Single crystal
Concentrator
Thin-film crystal
Crystalline Si Cells
Single crystal (concentrator)
Single crystal (non-concentrator)
Multicrystalline
Silicon heterostructures (HIT)
Thin-film crystal
Thin-Film Technologies
CIGS (concentrator)
CIGS
CdTe
Amorphous Si:H (stabilized)
Emerging PV
Dye-sensitized cells
Perovskite cells (not stabilized)
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells
Efficiency (%)
48
44
40
36
32
28
24
20
16
12
8
IBM (T.J. Watson Research Center)
RCA
Sandia
Mobil Solar
Westing-house
ARCO
UNSW
Stanford
Spire
No. Carolina State U.
Solarex
Varian
Varian (216x)
Varian (205x)
NREL
Japan Energy
Stanford (140x)
Kopin
SunPower (96x)
Amonix (92x)
Georgia Tech
U. So. Florida
UNSW / Eurosolare
Sanyo
Matsushita
Euro-CIS
Boeing
Kodak
AMETEK
Photon Energy
United Solar
EPFL
U.of Maine
Monosolar
Solarex
Spectrolab
NREL/ Spectrolab
Boeing-Spectrolab
Boeing-Spectrolab (MM,179x)
Boeing-Spectrolab (MM, 240x)
Spectrolab (MM, 299x)
Fraunhofer ISE (MM, 454x)
Spire Semiconductor (MM, 406x)
Boeing-Spectrolab (LM, 364x)
Solar Junction (LM, 942x)
Soitec (4-J, 297x)
Fraunhofer ISE/ Soitec
NREL
NREL (4-J, 327x)
Soitec (4-J, 319x)
NREL (IMM)
NREL (IMM, 325.7x)
Solar Junction (LM, 418x)
Boeing-Spectrolab (5-J)
Sharp (IMM)
Sharp (IMM, 302x)
NREL (467x)
IES-UPM (1026x)
FhG-ISE (117x)
Alta Devices
FhG-ISE (232x)
Radboud U.
Panasonic
LG Electronics
SunPower (large-area)
NREL (14.7x)
Solexel
ZSW
Solar Frontier
First Solar
KRICT/UNIST
EPFL
Trina Solar
NREL (15.4x)
EMPA (Flex poly)
ISFH
U. Stuttgart
Fraunhofer ISE
GE Global Research
KRICT
Solibro
Mitsubishi
United Solar Chem. (aSi/ncSi/ncSi)
LG Electronics
AIST
Hong Kong UST
NIMS
Sharp
IBM
U. Toronto
UCLA-Sumitomo Chem.
Heliatek
UCLA
MIT
Konarka
Solarmer
Sumi-tomo
NREL / Konarka
U. Linz
Groningen
46.0%
44.4%
38.8%
37.9%
34.1%
31.6%
29.1%
28.8%
27.6%
27.5%
25.6%
25.0%
23.3%
22.3%
22.1%
22.1%
21.3%
21.2%
13.6%
12.6%
11.9%
11.5%
11.3%
10.6%

Future Research

- Soitec and CEA-Leti, France, together with the Fraunhofer Institute for Solar Energy Systems ISE, Germany developed a four junction concentrator solar cell with a record breaking efficiency of 46% (3)

- Most solar research is primarily happening at universities and government organizations

- Materials used in high efficiency cells are much more expensive, cheaper materials with the same effectiveness need to be found for solar to grow to be a primary source of energy (5)



Video on Solar Research

- http://fod.infobase.com.proxy.lib.ohio-state.edu/p_ViewVideo.aspx?xtid=40295 (2)

Closing

- Current solar technology has come a long way since it was develop
- As it stands now solar technology is very useful for many applications where the demand of power is not at its peak
- However, the world of solar technology still needs a lot of improvement if it is to become a viable source of renewable energy in the future to replace fossil fuels entirely

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