

Inconvenient Truth or Incorrect Conclusion?

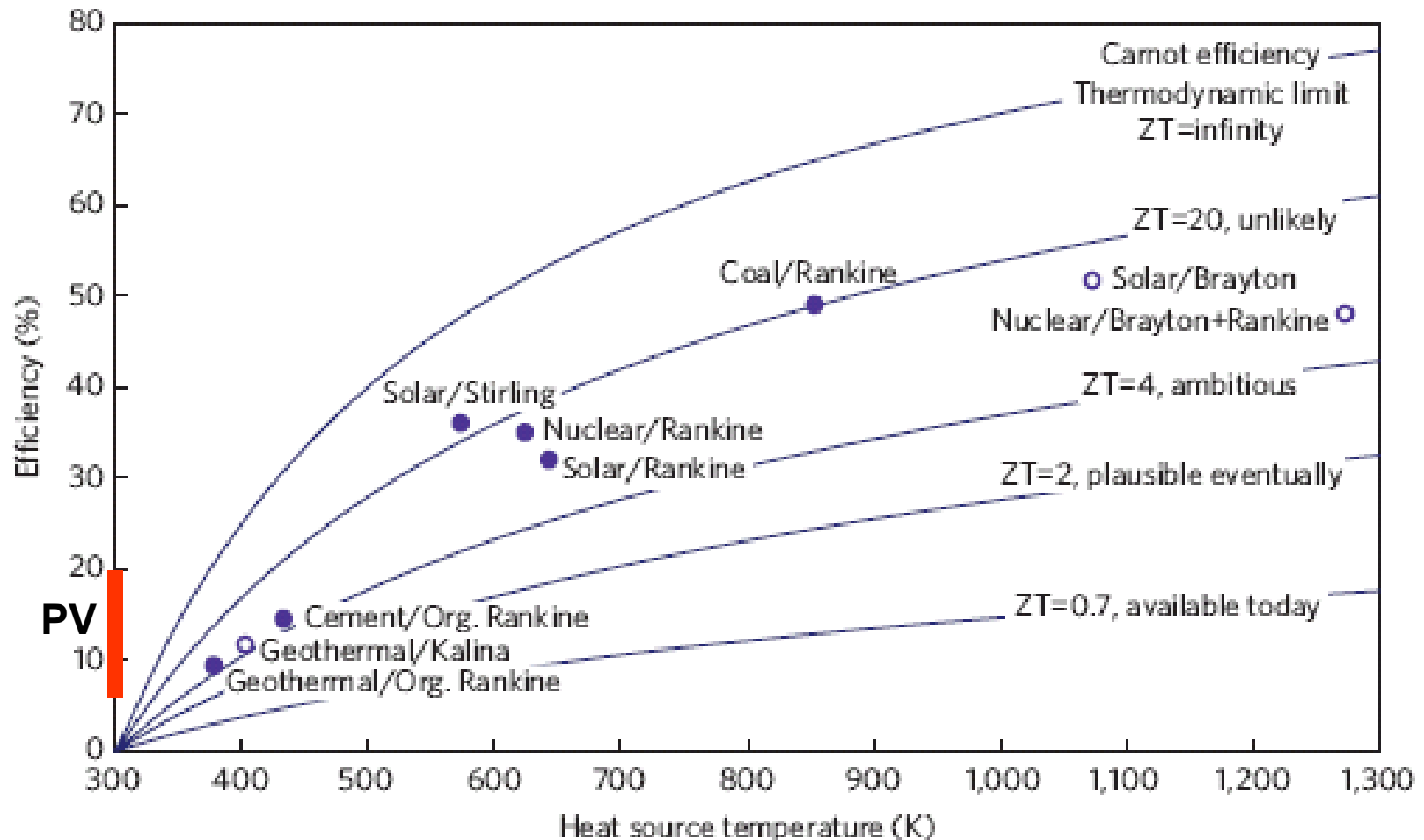
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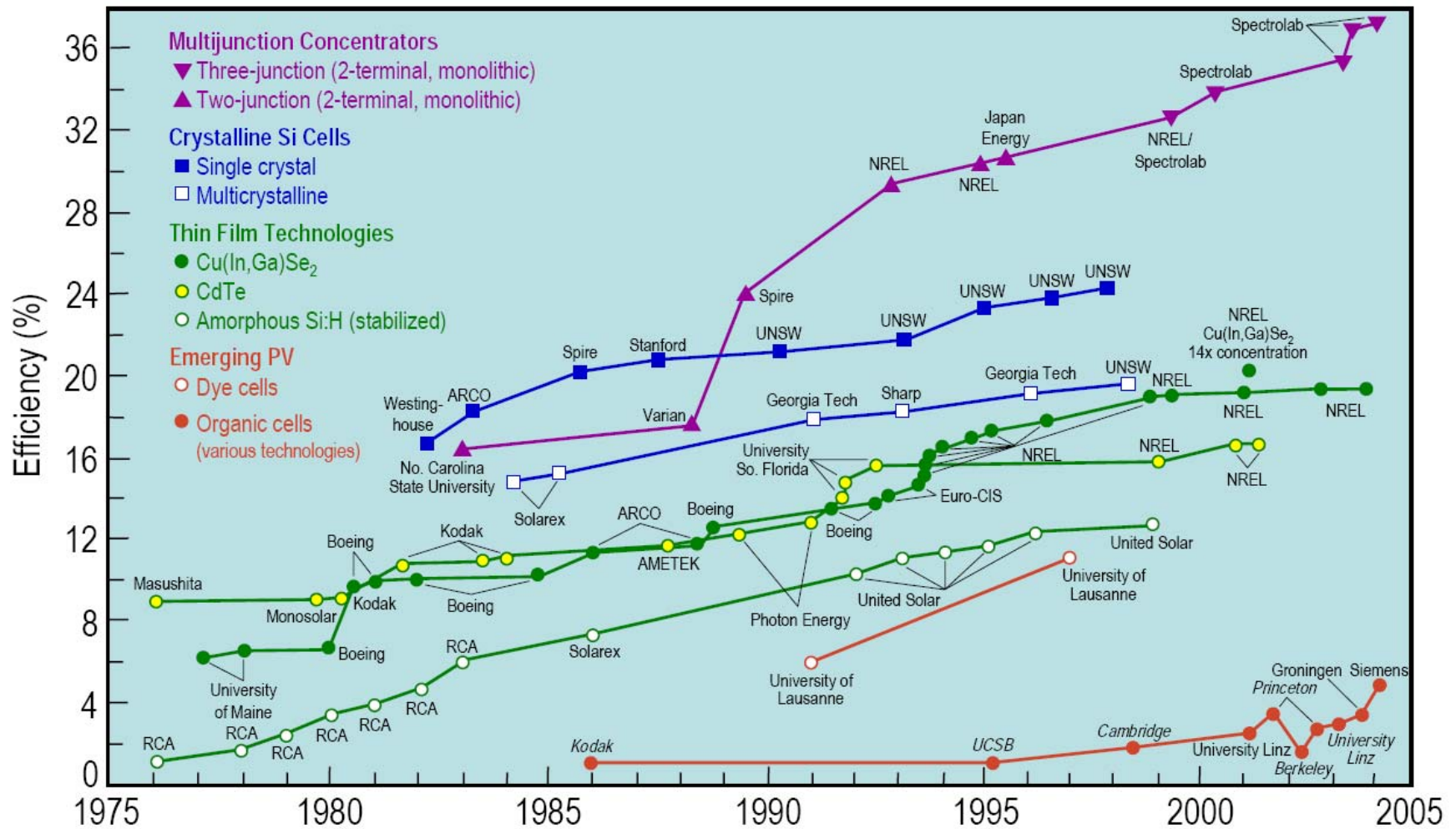
**Email: gchen2@mit.edu
<http://web.mit.edu/nanoengineering>**

An Inconvenient Truth Told by Croning Vining



C.B. Vining, Nature Materials, 8, 83, 2009

PV Cell Efficiency



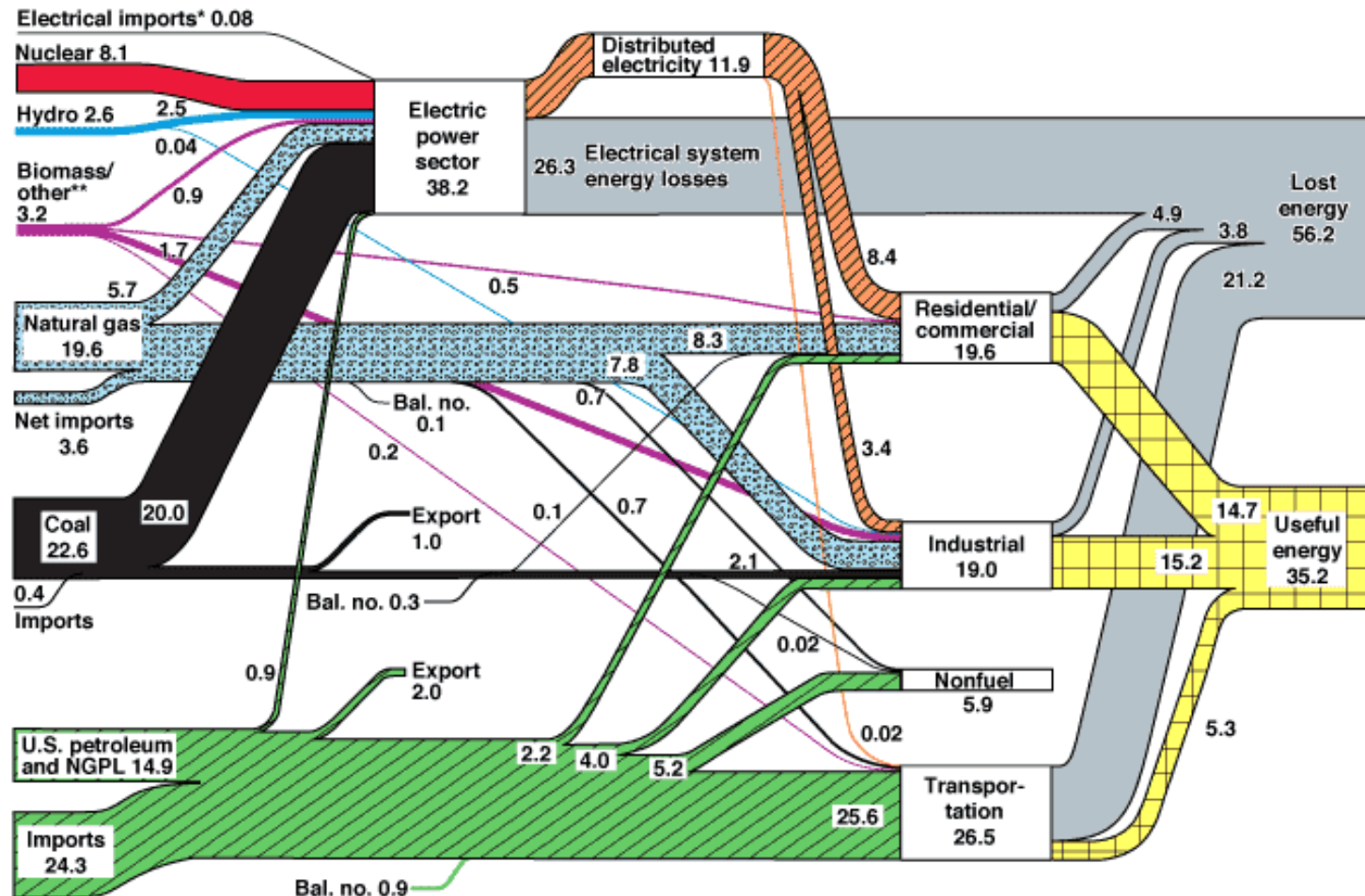
Source: National Renewable Energy Laboratory

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EPR

Usage of Heat

U.S. Energy Flow Trends – 2002 Net Primary Resource Consumption ~97 Quads



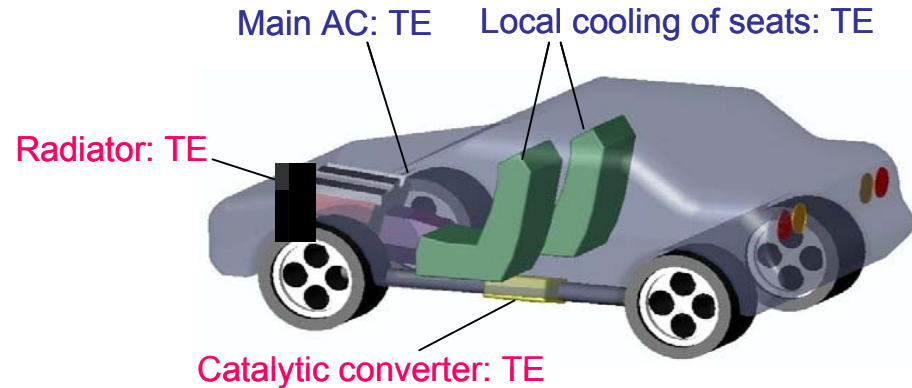
Source: Production and end-use data from Energy Information Administration, *Annual Energy Review 2002*.

*Net fossil-fuel electrical imports.

**Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

June 2004
Lawrence Livermore
National Laboratory
<http://eed.llnl.gov/flow>

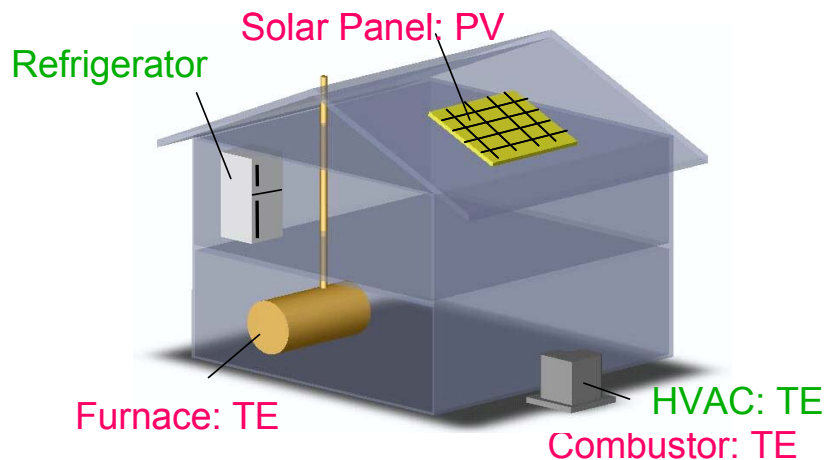
Where Heat is Free?



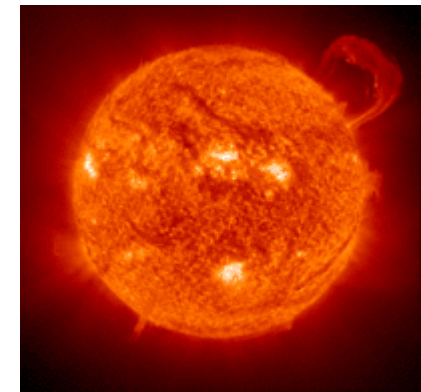
Transportation



Industrial Waste Heat (DOE/ITP)



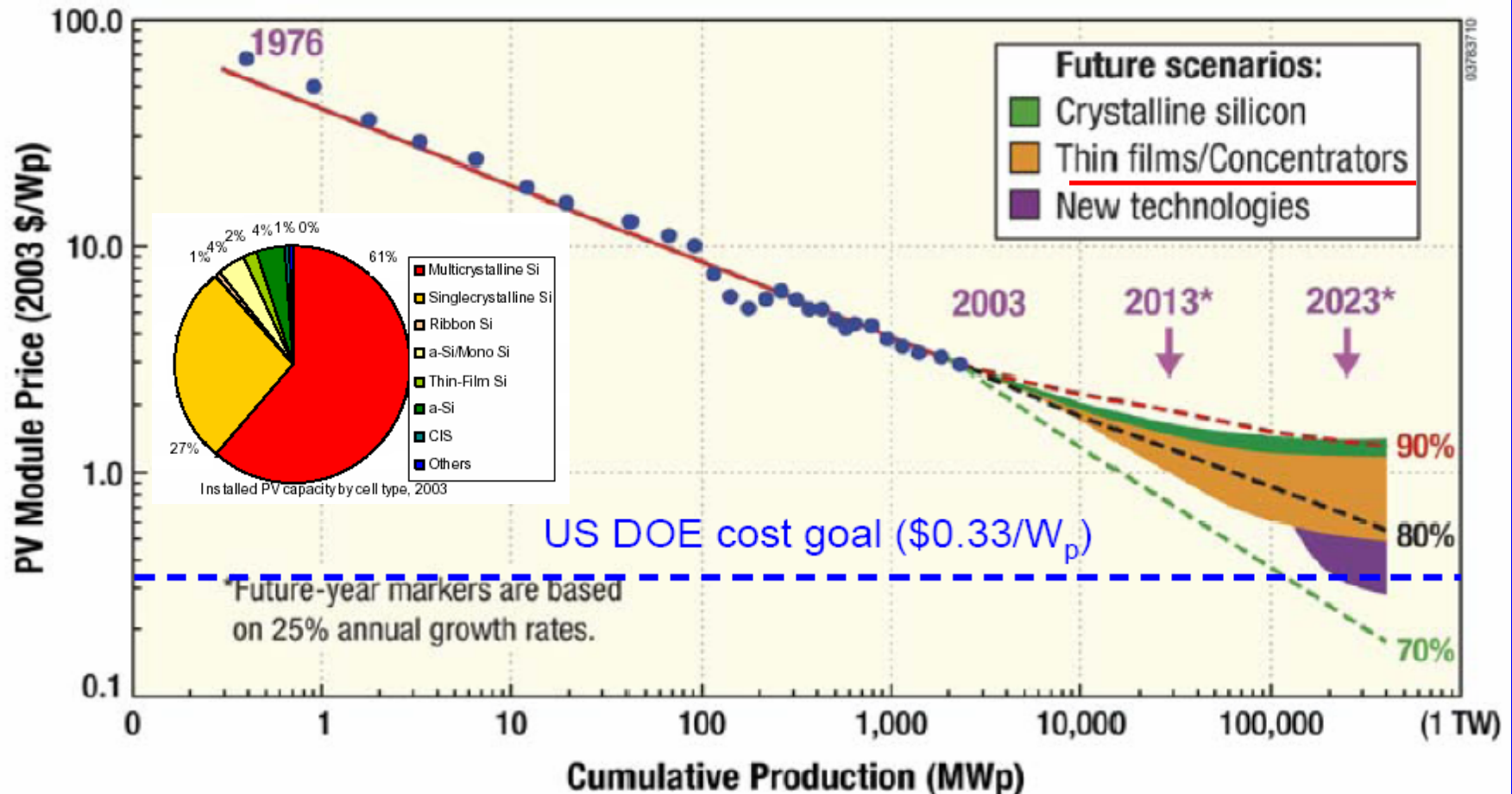
Buildings



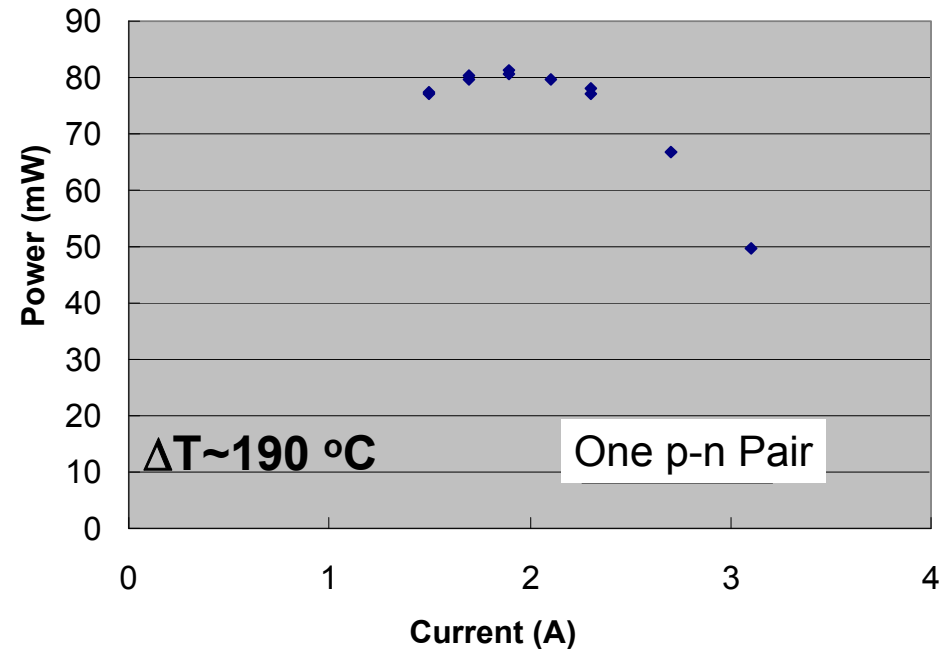
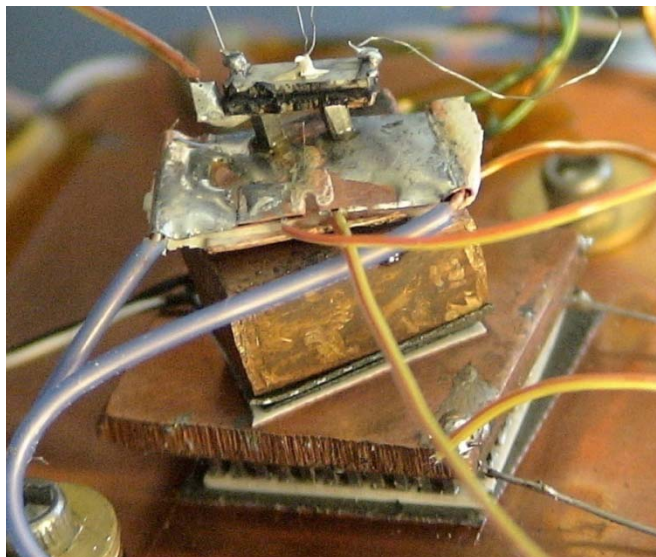
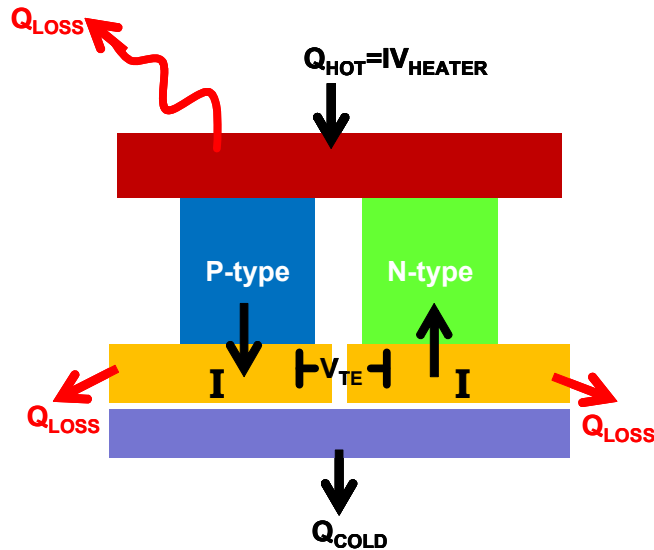
Renewables

And Entropy is Generated

PV Industry Trend & Market Requirements



Device Performance and Materials Cost



- One pair of legs 26 mg of materials
- Cost of materials \$300/kg
- Cost of 80 mW of power, \$0.0078
- Materials cost for 1 W electrical power 10c.
- Even cheaper materials are possible
- But other system components' cost can be high