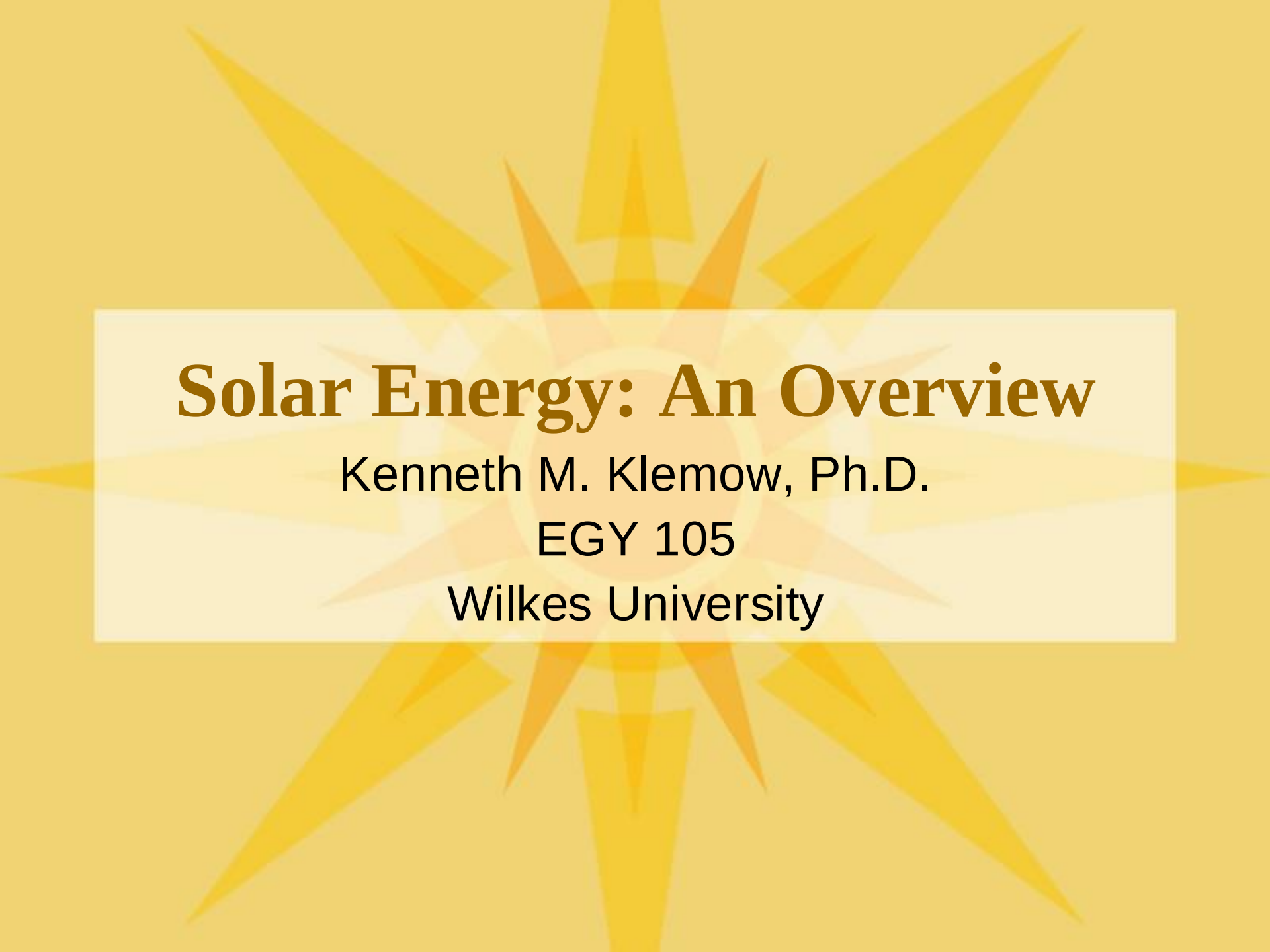


A stylized sunburst or starburst graphic in shades of yellow and orange, centered behind the text. The rays are long and pointed, creating a bright, energetic background.

Solar Energy: An Overview

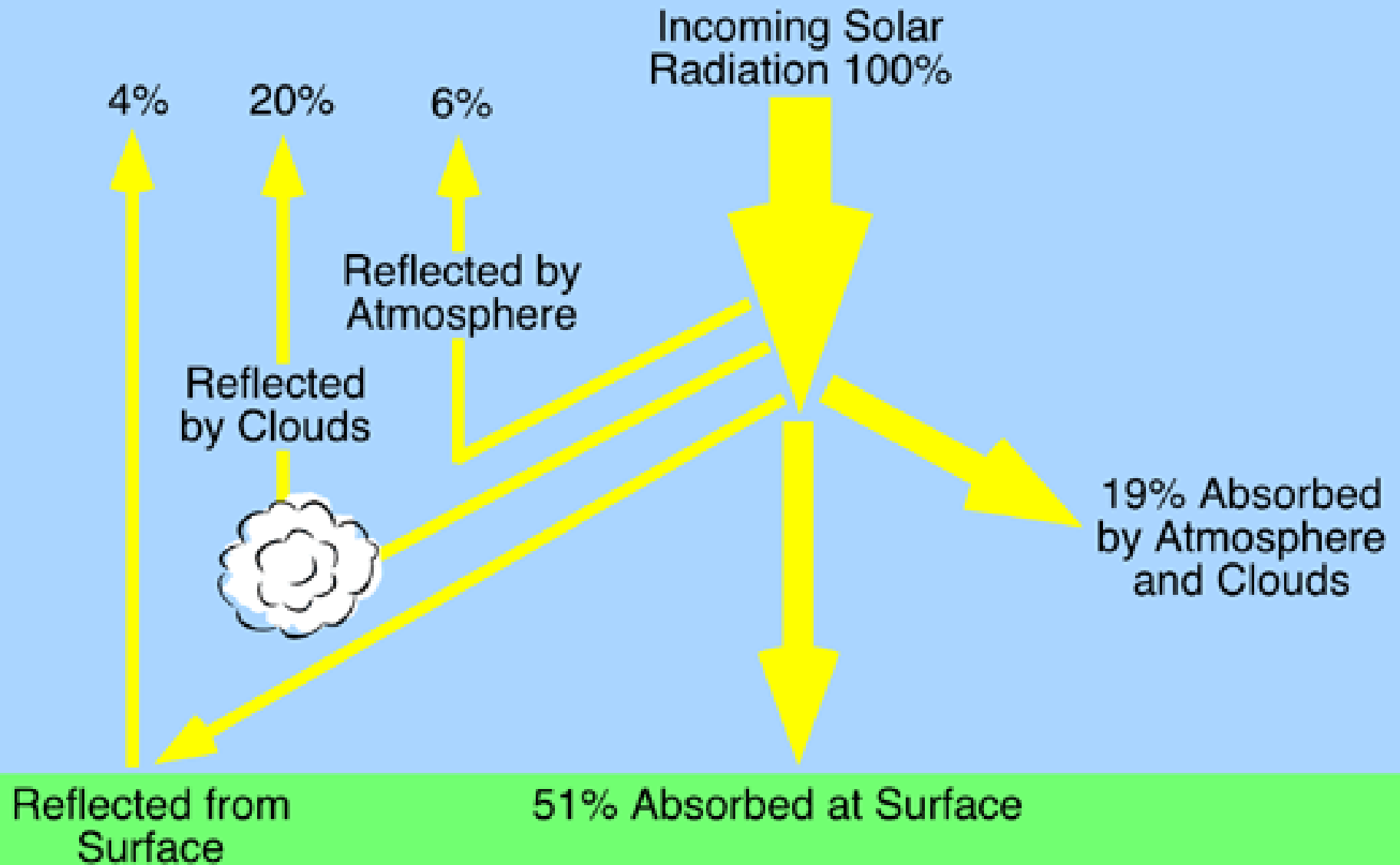
Kenneth M. Klemow, Ph.D.

EGY 105

Wilkes University

Points to be covered

- Energetics of sunlight at the earth's surface
- Direct uses of solar energy
- Types of solar electrical generation
- Current levels of solar electrical generation capacity worldwide and US.
- Benefits of solar power generation
- Disadvantages of solar
- Community solar



Solar energy vs. demand

- Total solar = 3850 zettajoules (ZJ) per year
 - 1 ZJ = 10^{21} J
- Oceans absorb approximately 285 ZJ of solar energy per year.
- Winds can theoretically supply 6 ZJ of energy per year.
- Biomass captures approximately 1.8 ZJ of solar energy per year.
- Worldwide energy consumption was 0.620 ZJ in 2023.

Solar energy vs. demand

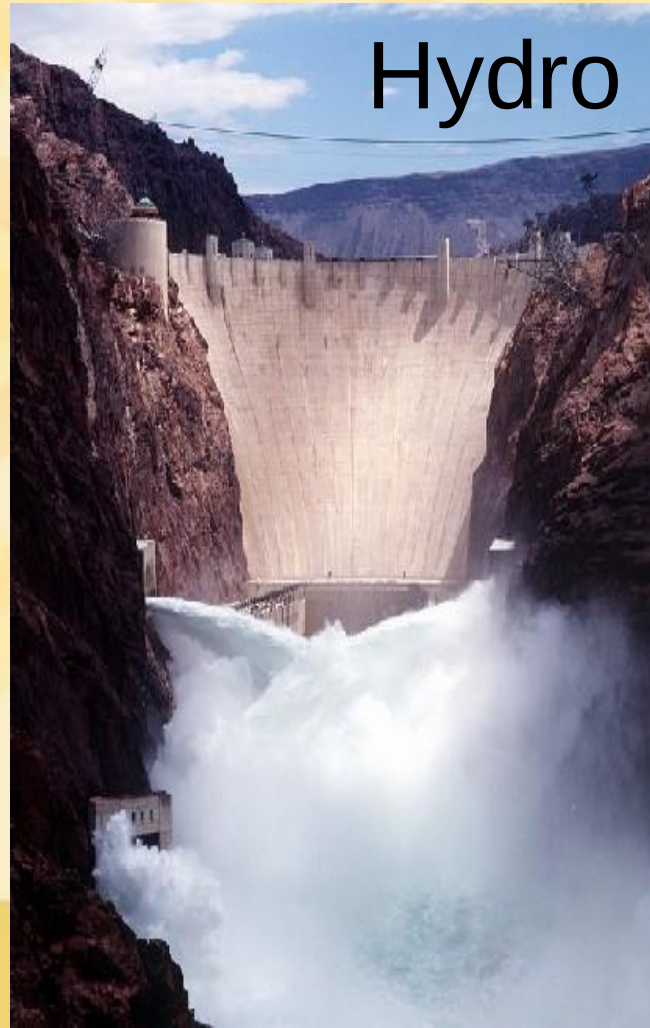
Total available	3850 ZJ
Worldwide energy consumption	0.62 ZJ

Indirect uses of solar energy

Wind



Hydro



Biomass



Solar energy is used in two ways

Direct



www.bestbuypoolsupply.com

Electrical generation

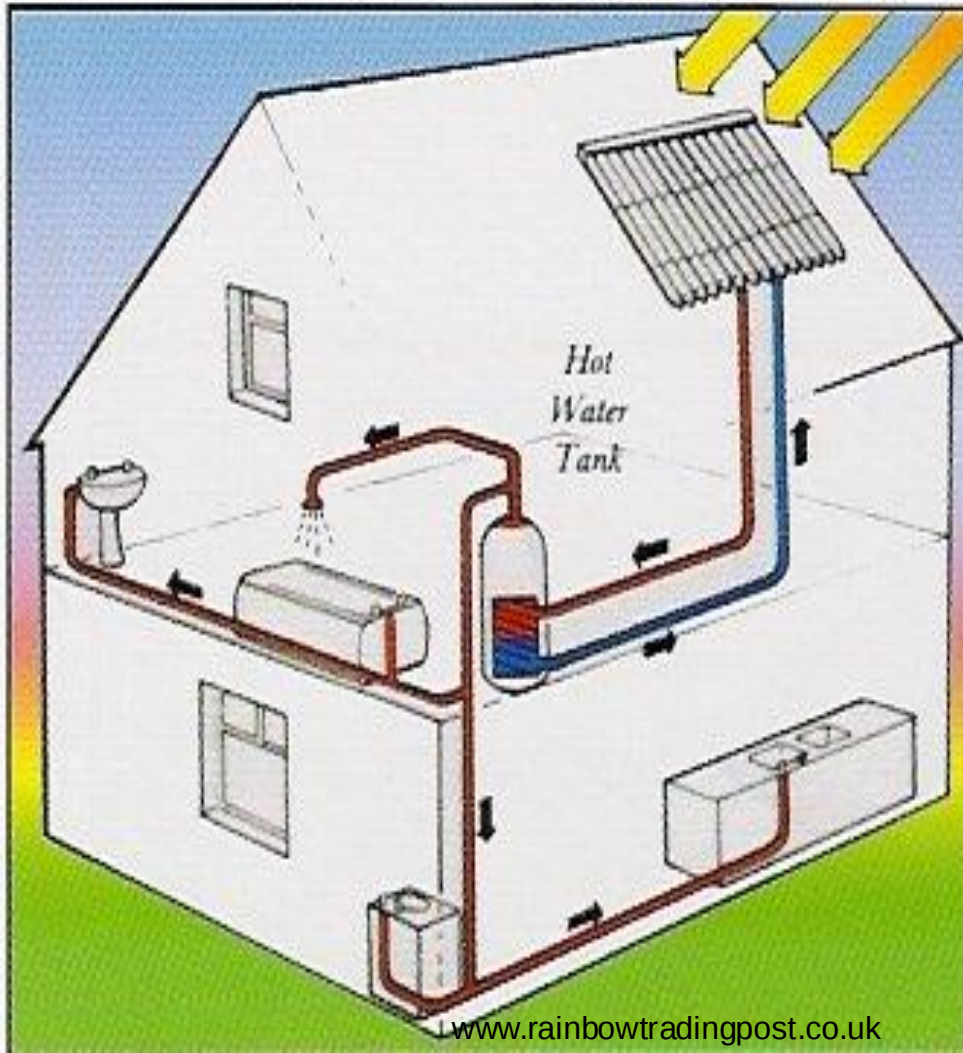


http://static.flickr.com/28/95708914_9c915fb6f1.jpg

Direct uses of solar energy

- Home heating and cooling
- Cooking
- Lighting

Home heating and cooling



Rooftop solar heating unit at California College of Arts San Francisco Campus



Cooking



www.cookwiththesun.com



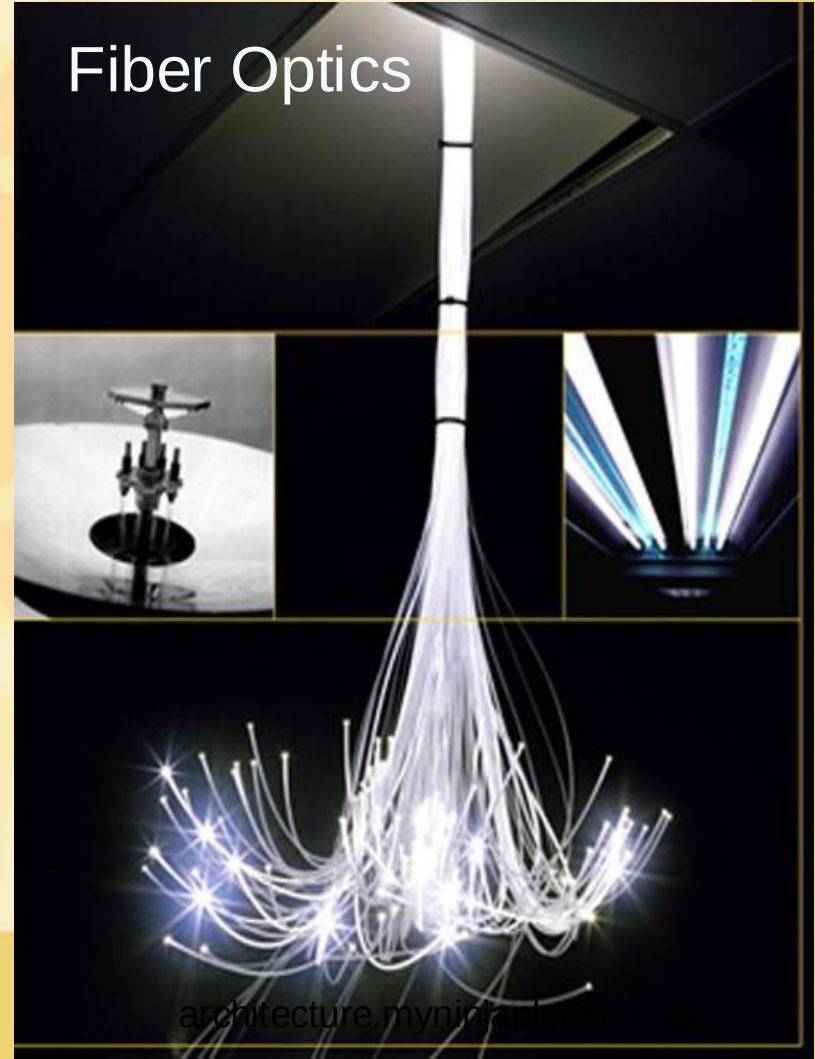
home.att.net/~cleardomesolar

Solar Lighting (Daylighting)

Clerestories



Fiber Optics



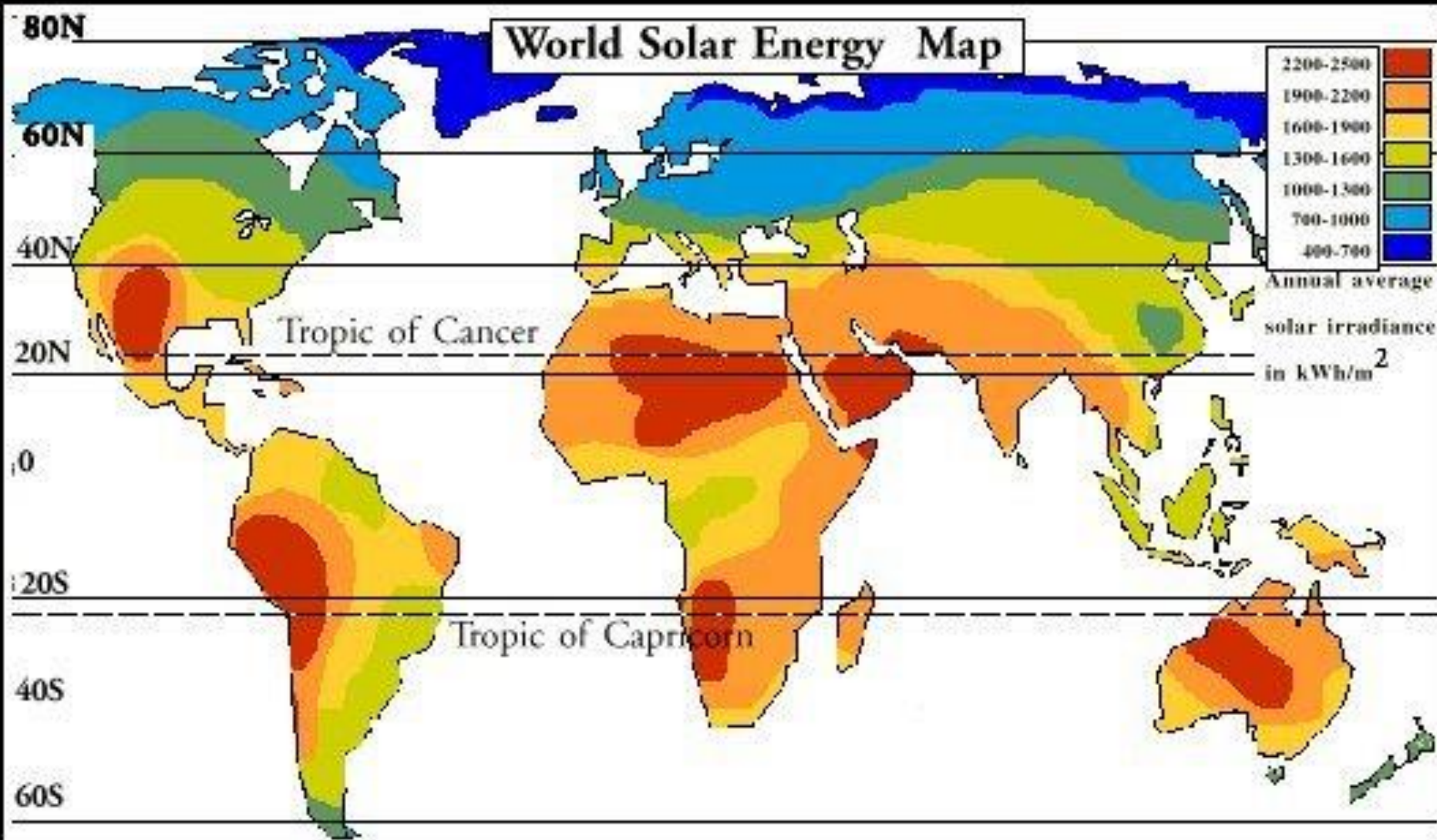
Skylights



Solar Tubes



World Solar Energy Map

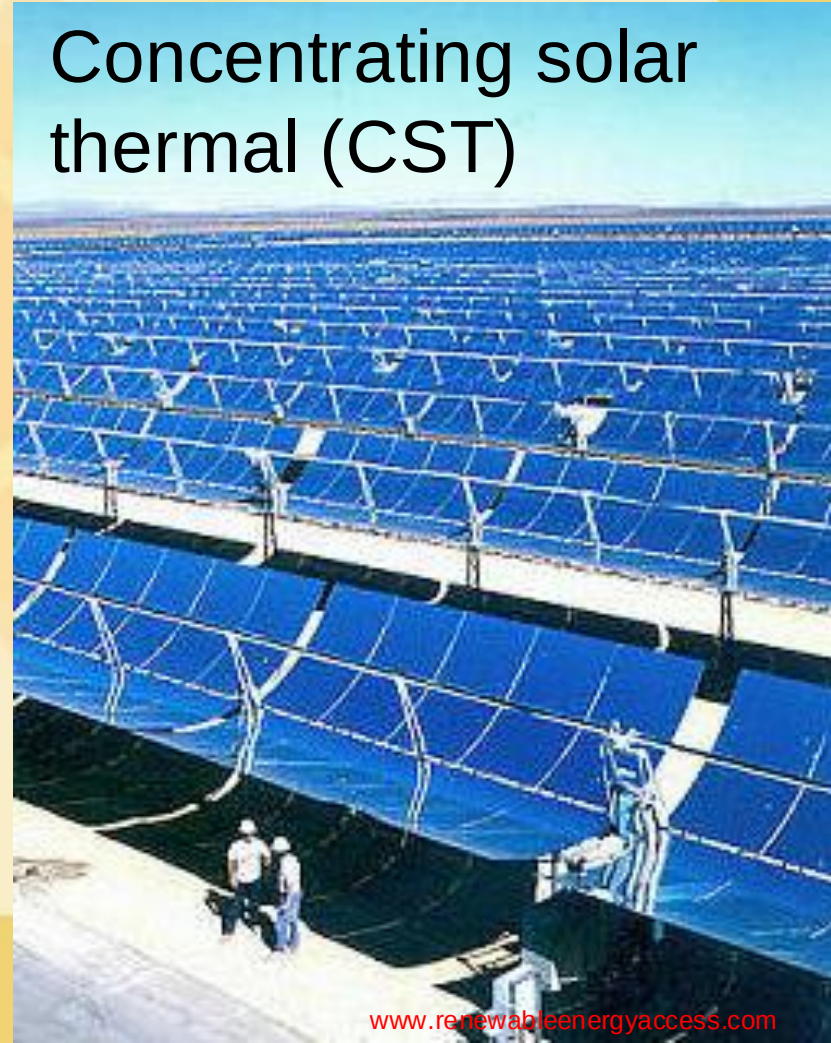


Types of solar electrical generation

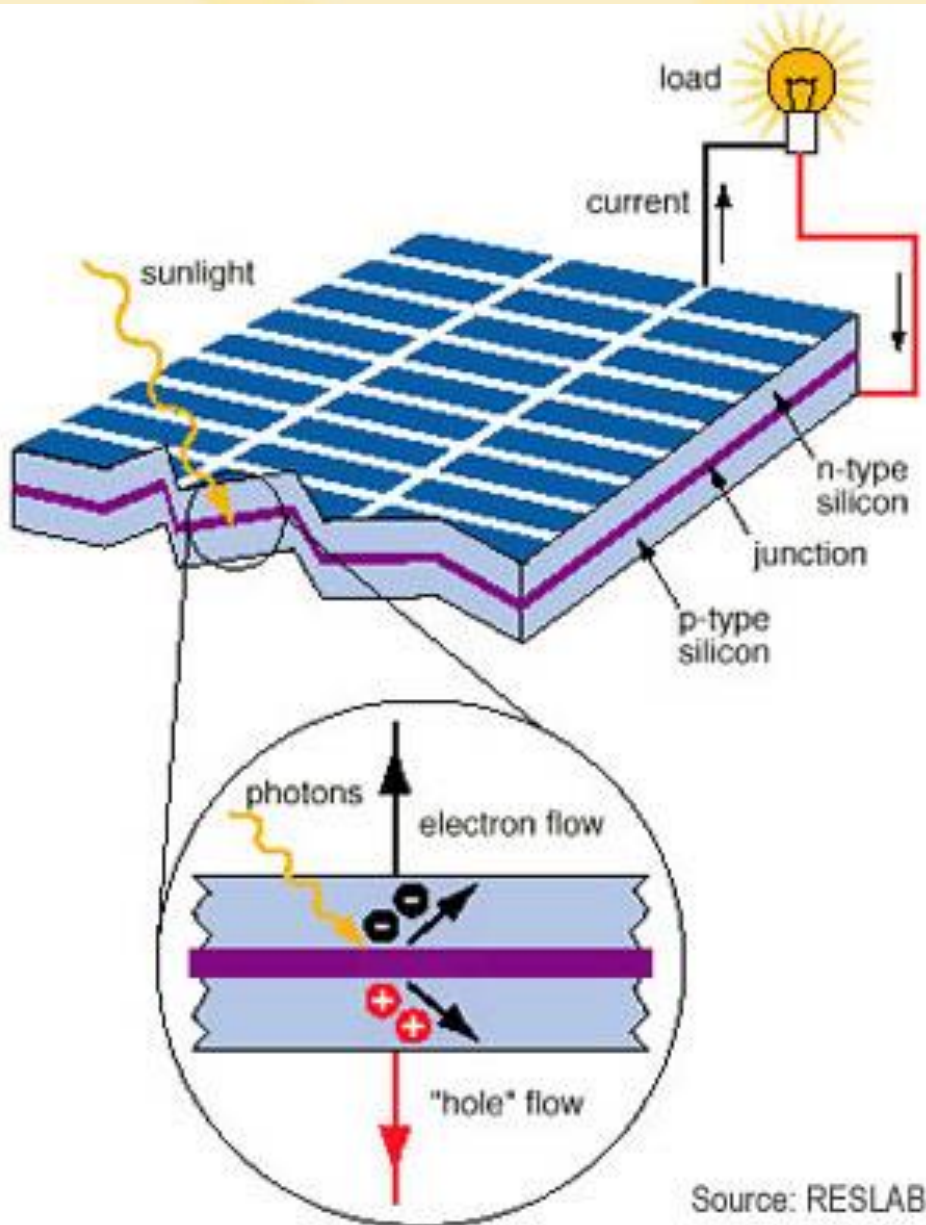
Photovoltaic (PV)



Concentrating solar thermal (CST)



Photovoltaic cell



Check out this
YouTube video
for more
information on
PV cells.

Forms of solar thermal electrical generation

Concentrating Solar Power Tower



www.trec-uk.org.uk

See DOE Video on Concentrating Solar Energy

Forms of solar thermal electrical generation

Solar parabolic collectors



Solar powered transportation

Zephyr - solar airplane



Solar powered car from Durham University

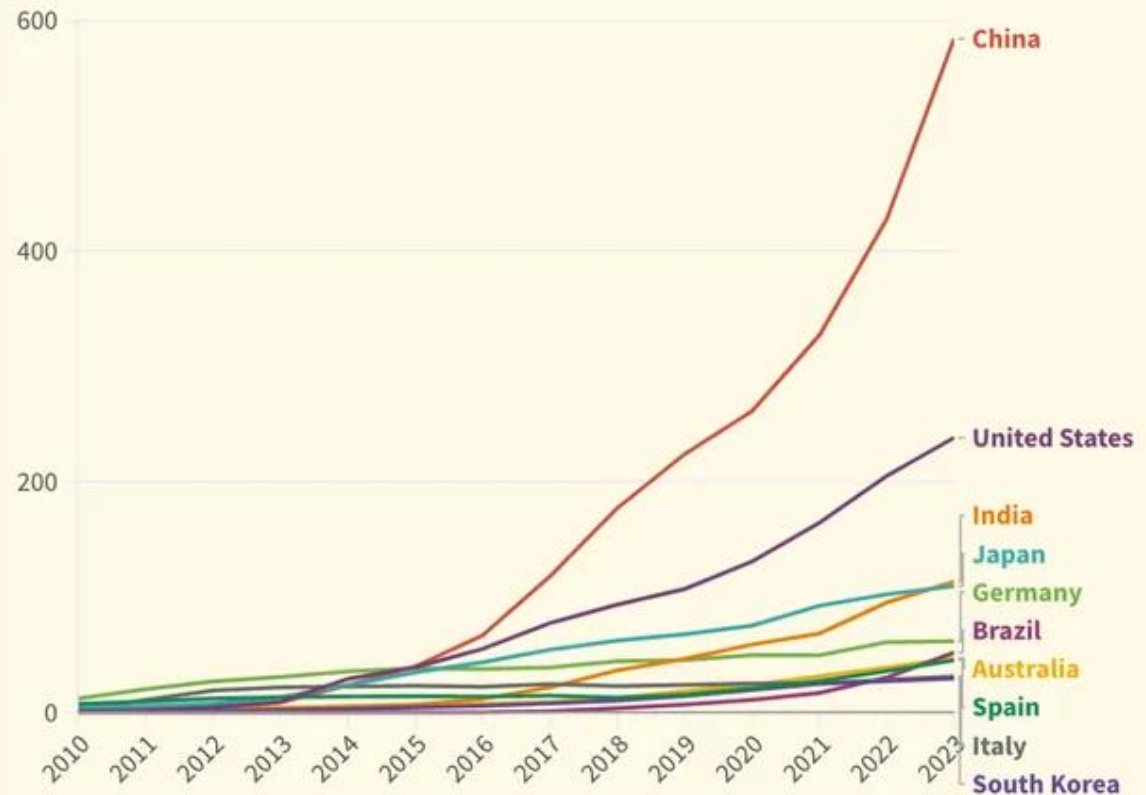


Solar Thermal vs PV

- Advantages for thermal
 - No need to generate electricity
 - Higher efficiency / energy density
 - Can last for decades
- Disadvantages for thermal
 - High weight associated with water
 - Freezing water expand, can burst pipes
 - Minor failure can totally destroy system
 - Pose hazards to migratory birds

Leading solar countries

Top 10 solar-producing countries in 2023

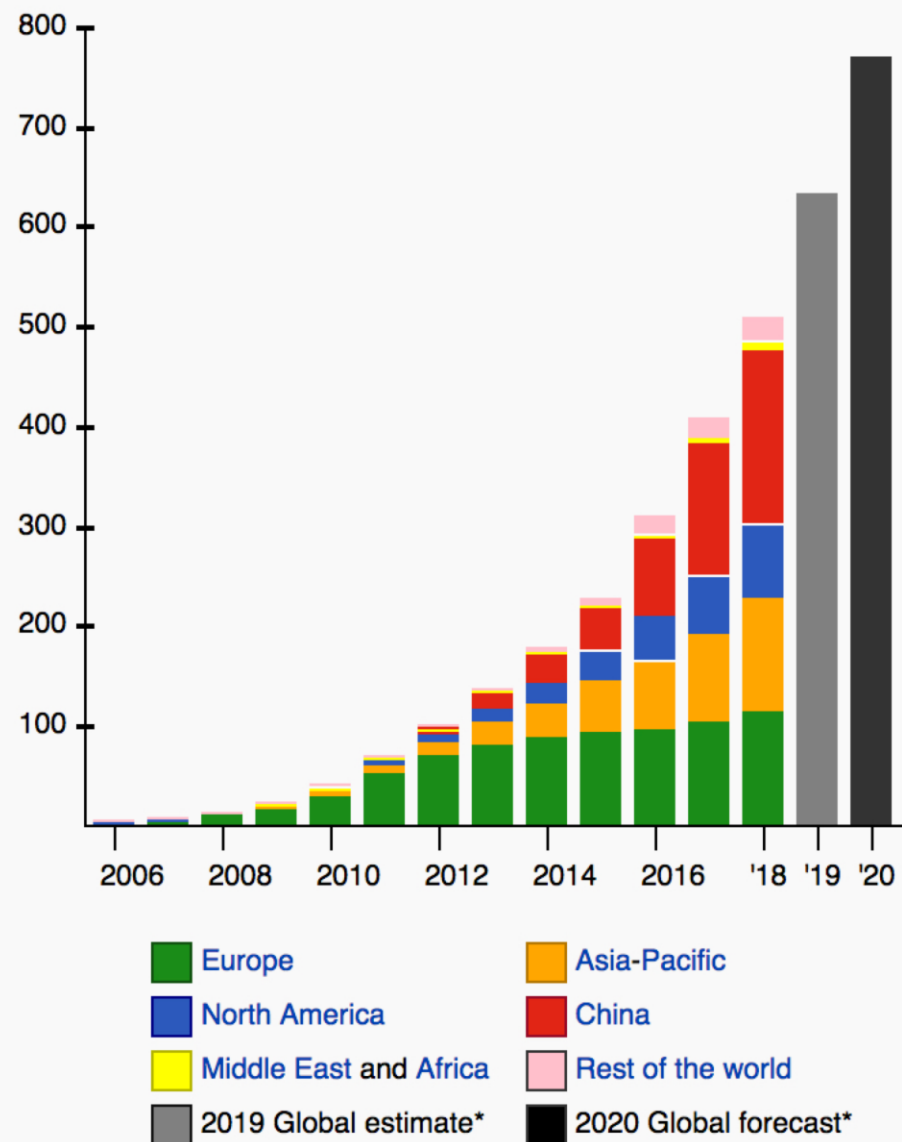


CANARY MEDIA | CHART OF THE WEEK

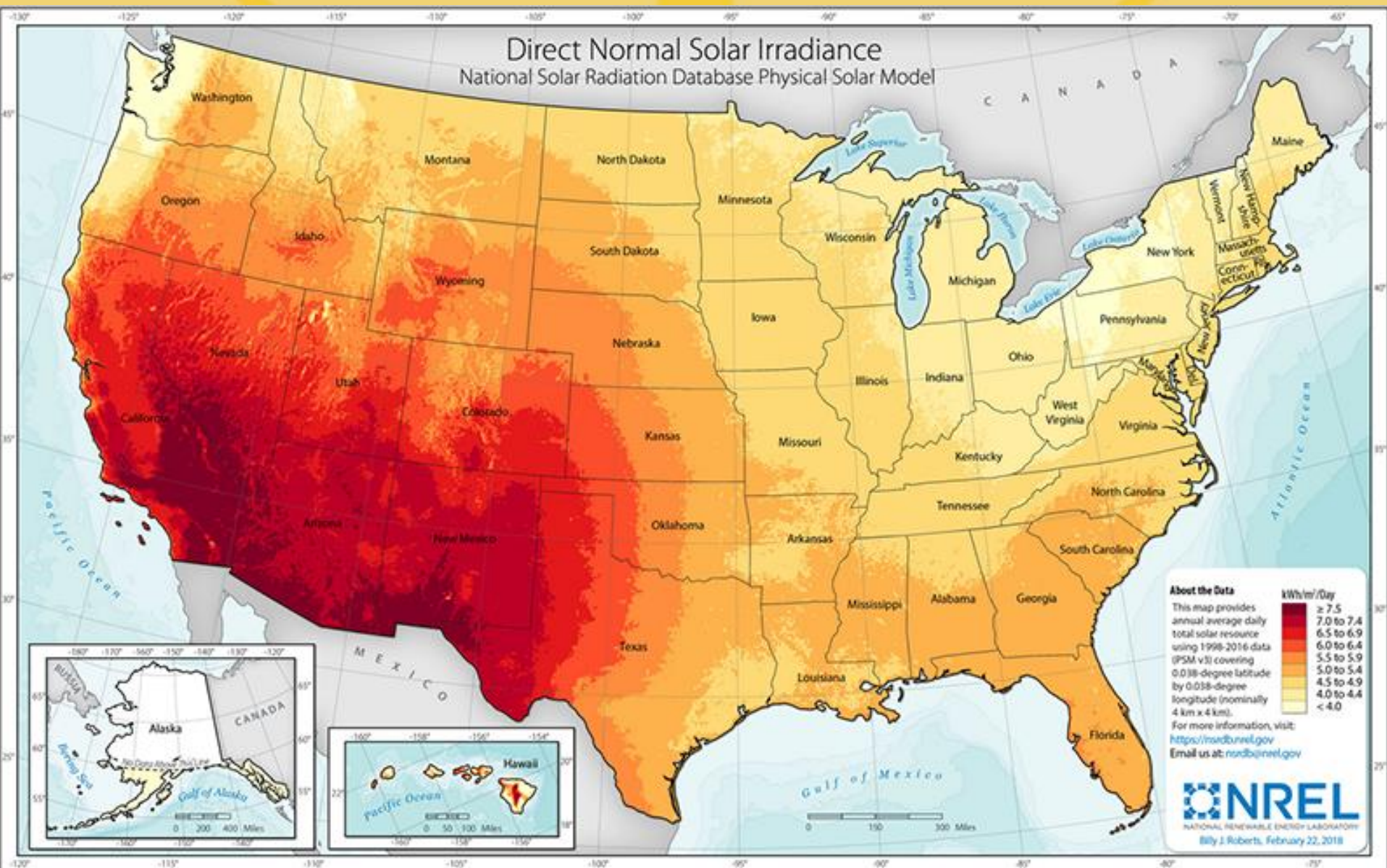
Trends in Global PV Solar

Worldwide growth of photovoltaics

Global growth of cumulative PV capacity in gigawatts (GW_p)^{[1][2][3][4][5]} with regional shares (IEA estimates).^[6]



*(2019/20 tentative figures, no regional split-up)^[7]



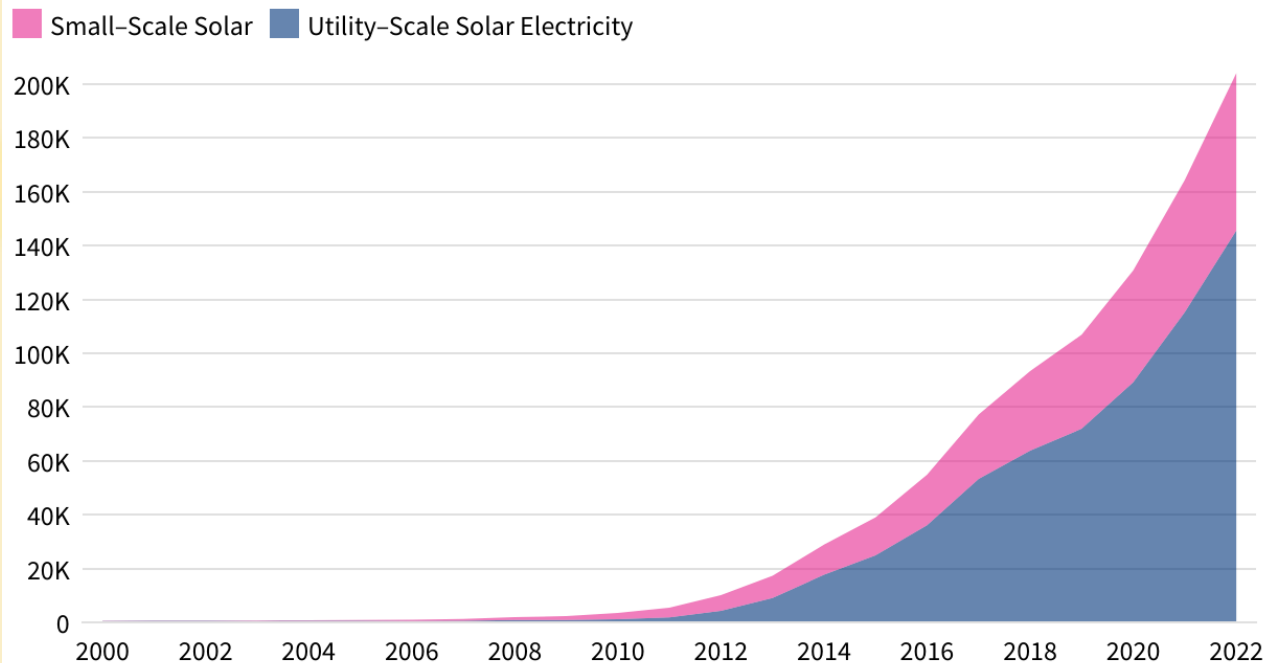
Small-scale vs large-scale solar



U.S. solar electricity by scale

Over the past five years, solar electricity generation has nearly tripled.

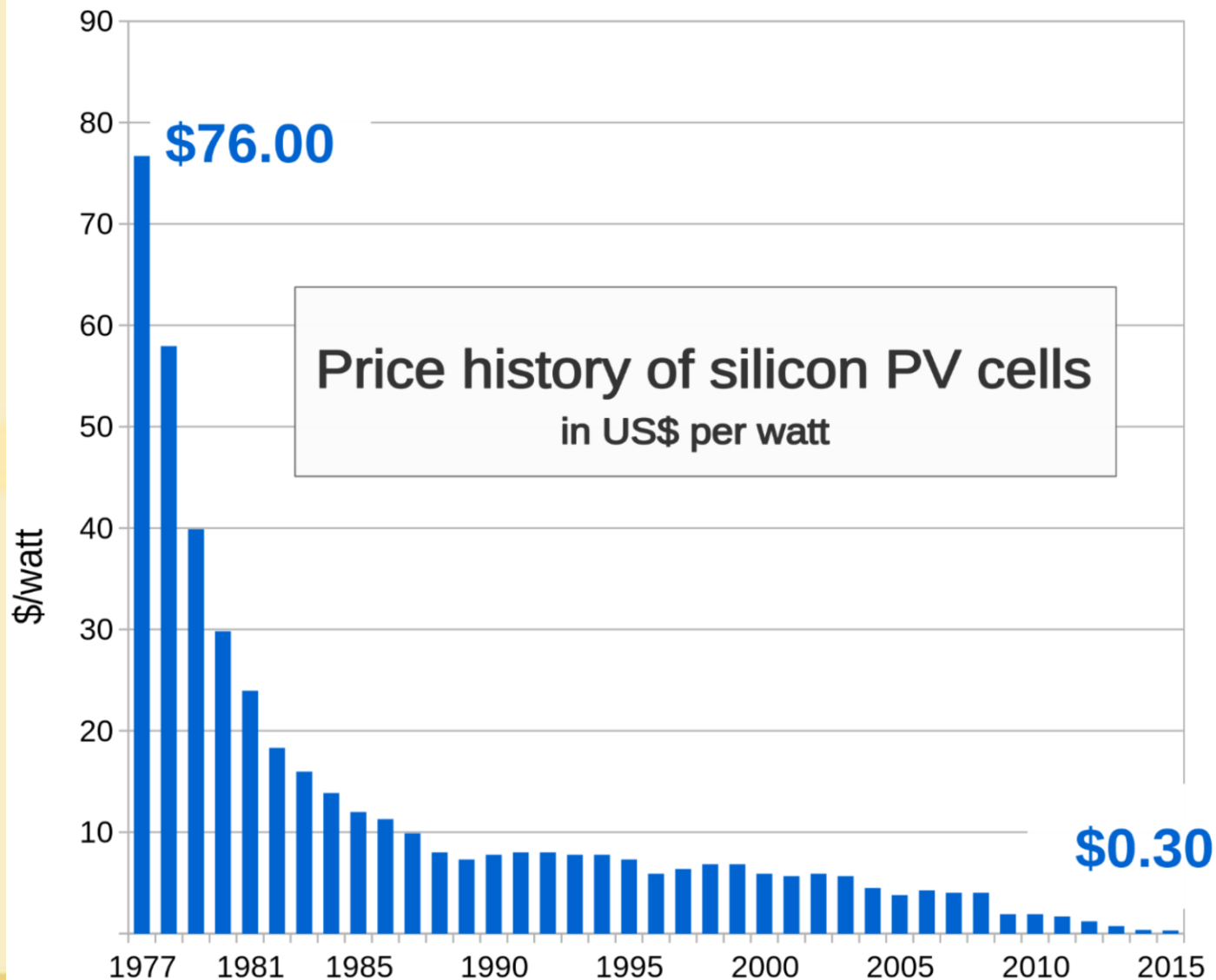
Solar electricity generation in million kilowatt-hours by scale, 2000–2022



Small-scale solar installations include ones found at homes, businesses, and non-utility industrial sites. Small-scale estimates are from small-scale PV units less than 1 MW and utility-scale are from units with 1 MW or more. 2022 data is preliminary.

Source: [Energy Information Administration](#)

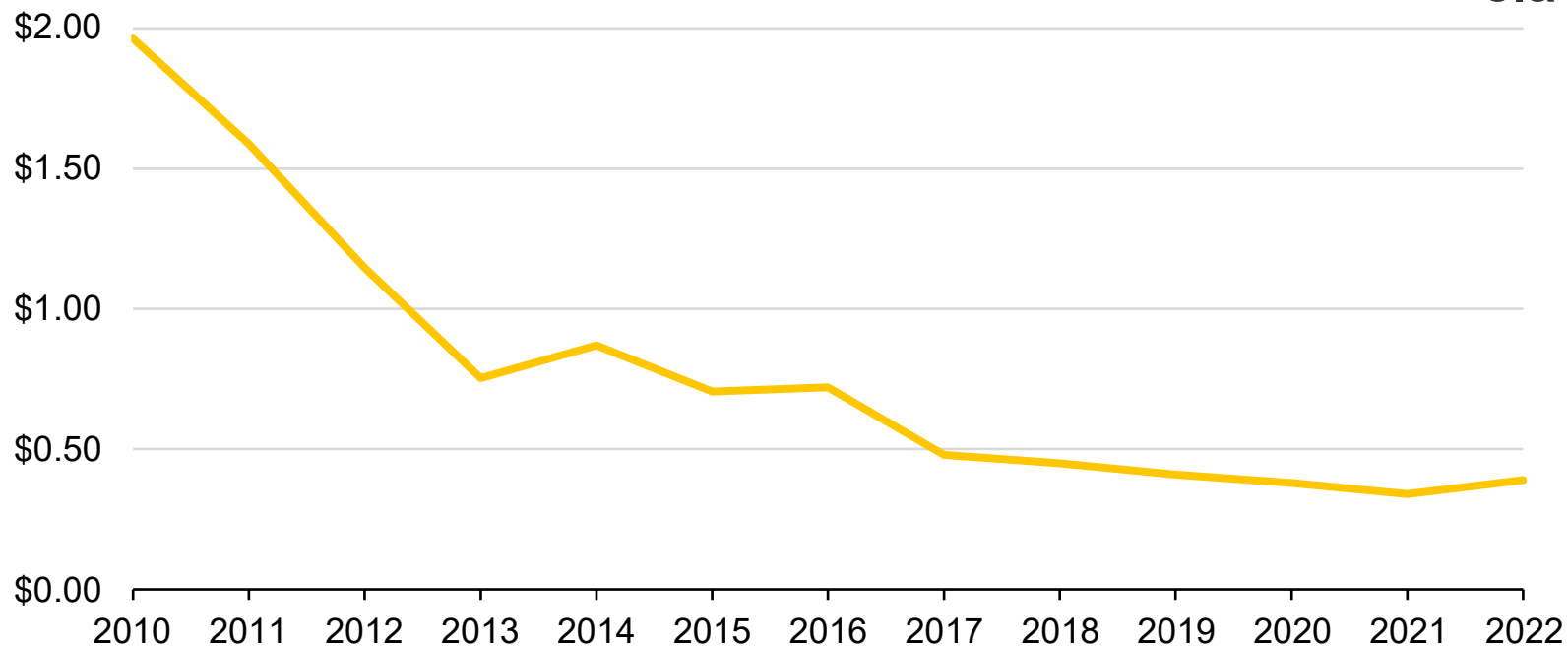
Price of solar cells (to 2015)



Price of solar cells (to 2022)

Average value of solar photovoltaic panel shipments, United States (2010–2022)

dollars per peak watt



<https://www.eia.gov/todayinenergy/detail.php?id=60261>

Costs to consider if switching to solar power

- Purchasing / leasing land
- Installation labor
- Cost of hardware
- Battery costs

Benefits of solar power

- Renewable and sustainable
- Generally quiet to operate
- Conserves fossil fuels
- Can be implemented remotely
- Can be scaled from tiny applications (solar calculators) to very large (solar powered communities)
- Can prevent pollution caused by fossil fuels
- Jobs in solar industry
 - 264,000 jobs in U.S. in 2022
 - 3.5% annual growth
 - Various job categories

Comparative life-cycle CO₂ emissions

Energy source	CO ₂ / kWe
Coal	1.4 – 3.6
Natural gas	0.6 – 2.0
PV solar	0.07 – 0.18
Thermal solar	0.08 – 0.20

Existing and potential solar energy development

- >1 million Americans use solar water heaters
- >4.2 million homes use photovoltaic systems.
- Enough electrical power could be generated in 100 mi² area of desert southwest to supply US energy needs.

Drawbacks to solar power

- Heavy investment.
- High-latitude areas receive relatively little sunshine.
- Solar unreliable at night, during winter, and during cloudy periods.
- Storage difficult; relies on batteries that may leak chemicals.
- Some PV cells use heavy metals - toxic and difficult to recycle.
- Solar farms require much land, currently between 5 and 10 acres / megawatt.
 - Is it wise to use farmland or productive forest for solar?

Community Resistance to Solar

- Some community solar power in rural areas criticized on basis of:
 - Destroying habitat
 - Industrializing rural areas
 - Enhanced fire risk
- Locally, proposed solar projects in Lehman and Nanticoke defeated.
- See Reference 1 and Reference 2
- One proposed solution: Brightfields on grayfields