



Renewable Energy overview

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Theme evening "energy issues in developing countries" 10 November 2017



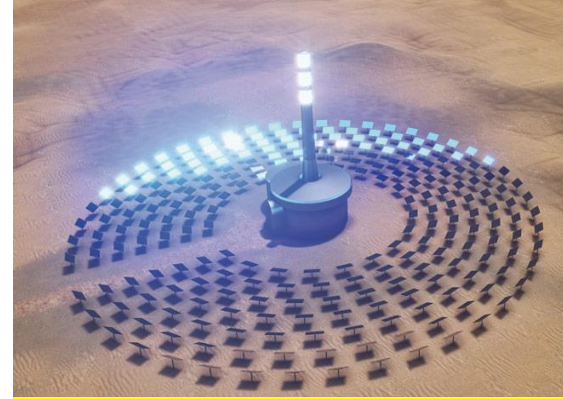
Renewable energy sources



Wind



Solar PV



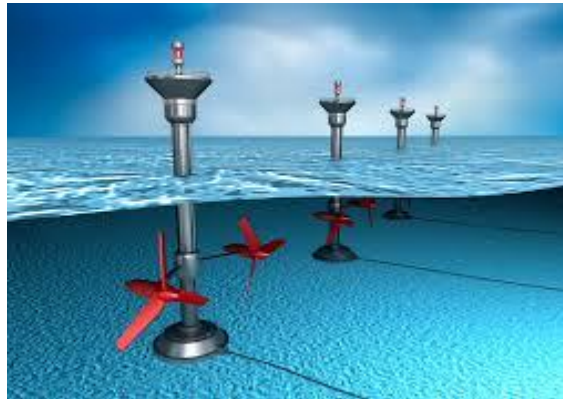
Solar CSP



Biomass



Hydro



Tidal



Wave



Geothermal



Energy in the Western world

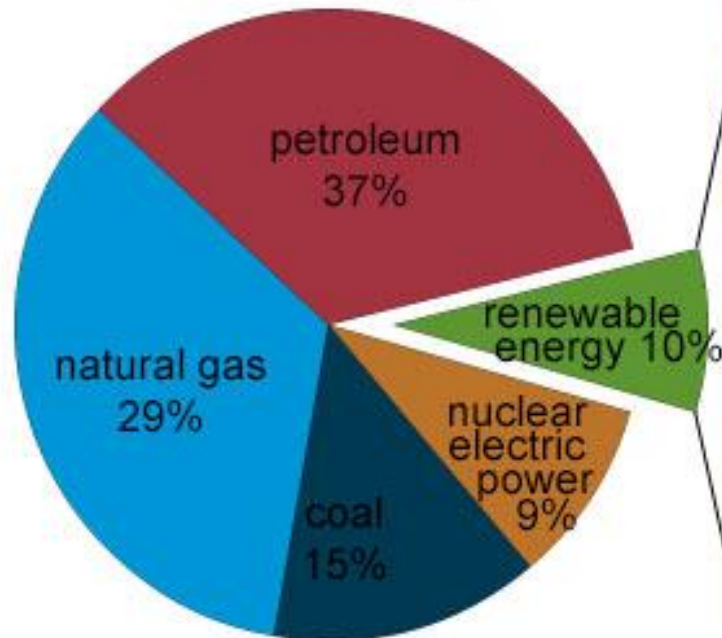
- Energy needs (residential and industrial)
 - Electricity (light, appliances, machines, electronics, ...)
 - Heat (heating, cooking, industrial processes, ...)
 - Transport (oil for cars, trucks, planes, ships, heavy equipment, ...)
- Electrical infrastructure
 - large power plants (coal, natural gas, nuclear)
 - electric grid (high tension, medium tension, low tension; transport + distribution)
 - some renewables (e.g. solar panels, wind energy)
- No "electrical" storage (except some pumped water storage)
 - electricity production is constantly matched to the demand



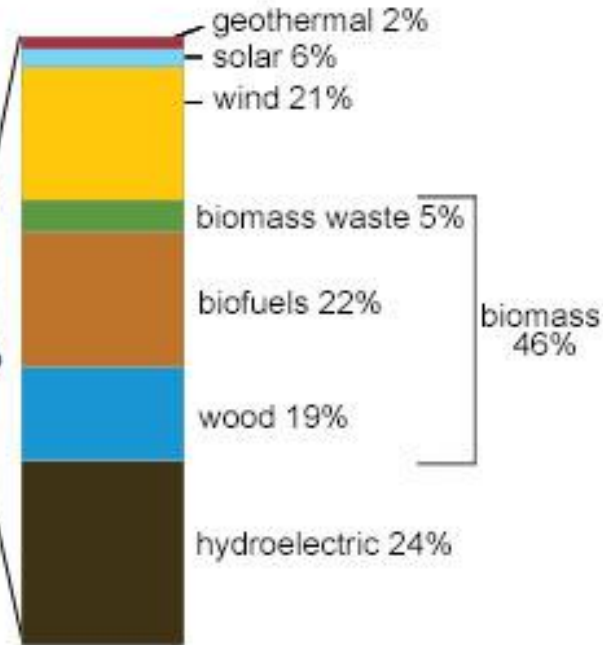
USA energy percentage by source

U.S. energy consumption by energy source, 2016

Total = 97.4 quadrillion
British thermal units (Btu)



Total = 10.2 quadrillion Btu



Note: Sum of components may not equal 100% because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2017, preliminary data





Energy in developing countries

- Problems

- power plants and/or electrical grid unreliable, even in big cities
- in many places not available, especially in rural areas
- very large countries and distances
- investments too big for "Western" solution (power plants + nation wide grid)
- rapidly growing population
- rapidly growing energy demand



Energy in developing countries

- Opportunities

- electricity consumption still very low compared to the Western world
- in many developing countries quite high solar irradiation
- renewables same price or cheaper than fossil fuels
- less demand for heat than in the Western world
- leapfrogging
 - skip large power stations, grid and fossil fuels: "jump" directly to local production with renewables
 - just like phone use: no fixed land lines, but direct jump to mobile phones



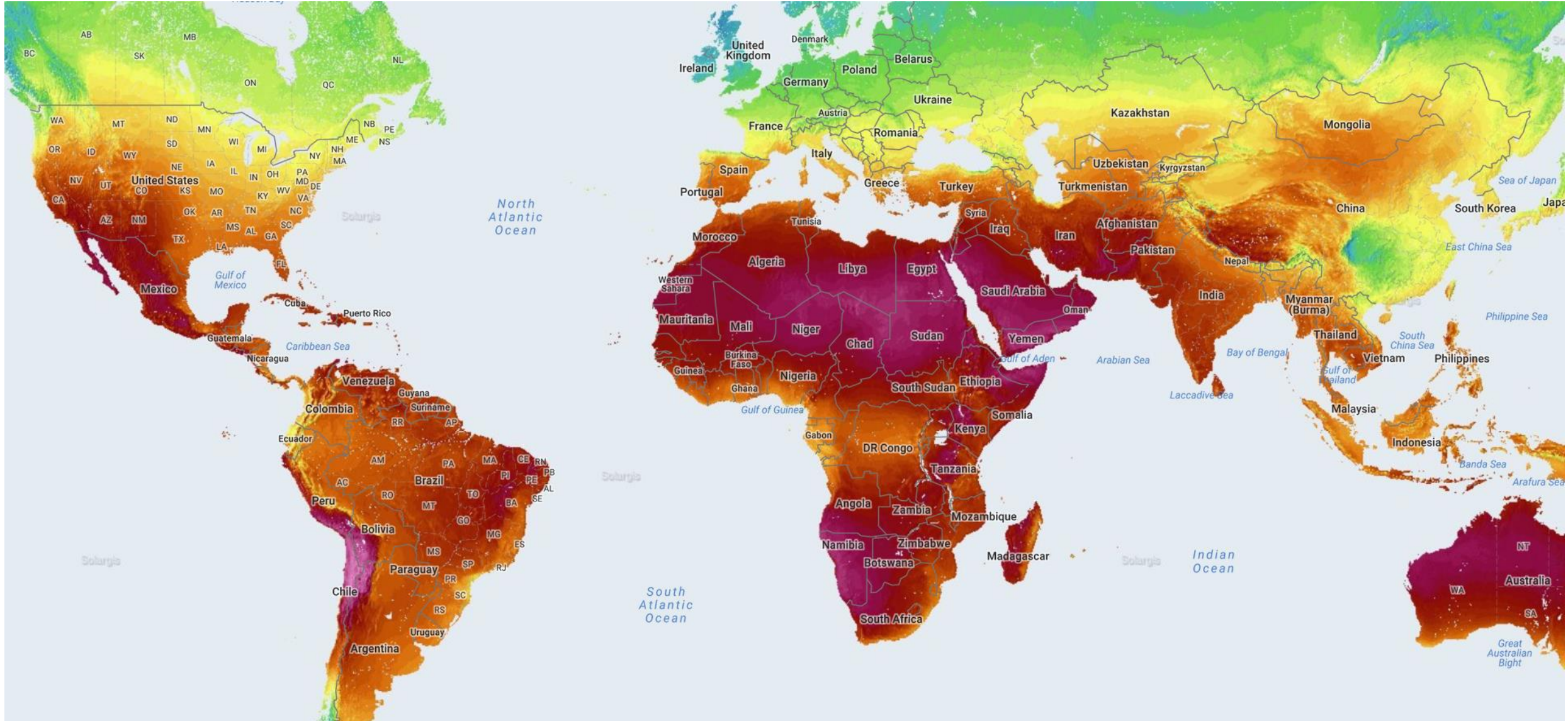
IzG energy projects in developing countries

- Small scale (household, small village)
- Focus on electricity (not on heating or transport)
 - light (12 hours of darkness each day, year round around equator)
 - appliances e.g. fridge for medicines
 - electronics e.g. computer, phone
- Energy consumption
 - e.g. 0,2 kWh/day for some LED lights and phone charging
 - house hold in Belgium 10 kWh/day
- Goal: convenient for the user
 - on demand
 - no effort of the user required
- In many cases: PV solar panels



Solar irradiation

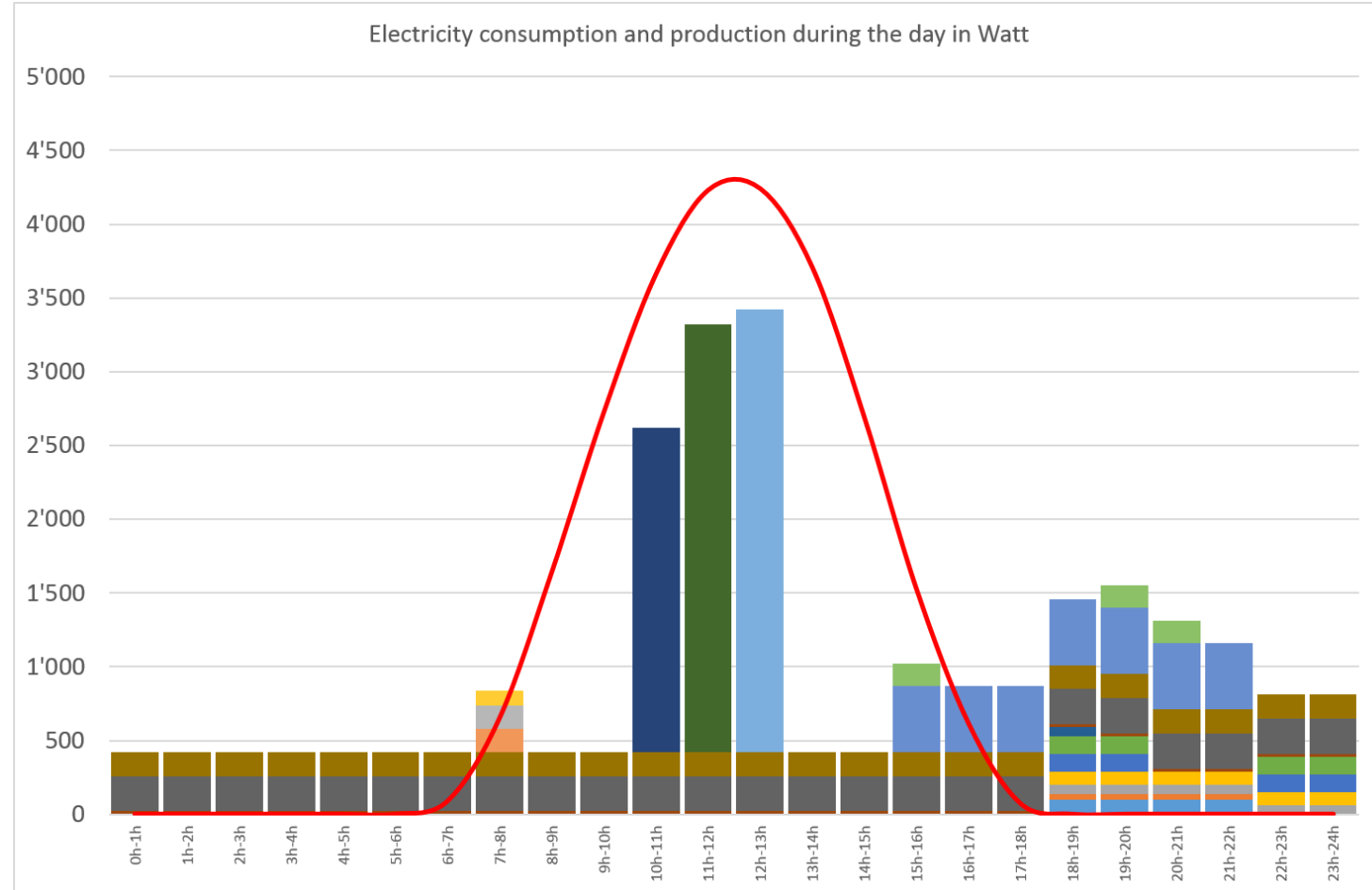
www.solargis.info





Design goal: matching production to demand

Solar irradiation	Daily irradiation
Month	kWh/m ² /j
January	5,68
February	5,55
March	5,15
April	4,7
May	4,24
June	3,86
July	3,82
August	3,82
September	4,18
October	4,24
November	4,61
December	5,36



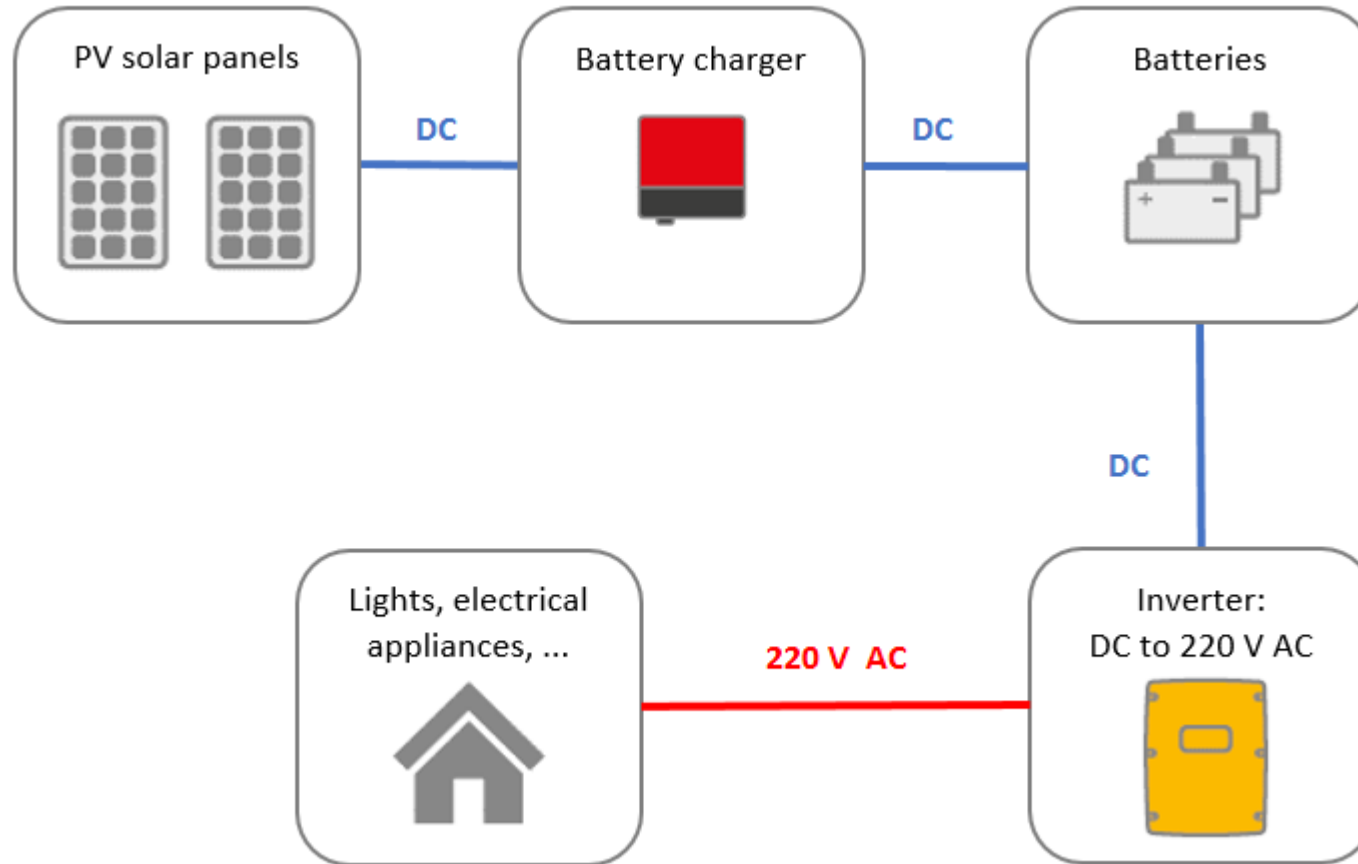


Energy storage

- Storage in most cases mandatory because grid not available or unreliable
- Common solution
 - PV solar panels
 - batteries
 - battery charger
 - inverter
- Still a rather high cost
- Hydro electricity might work without storage



Energy storage needed in most cases



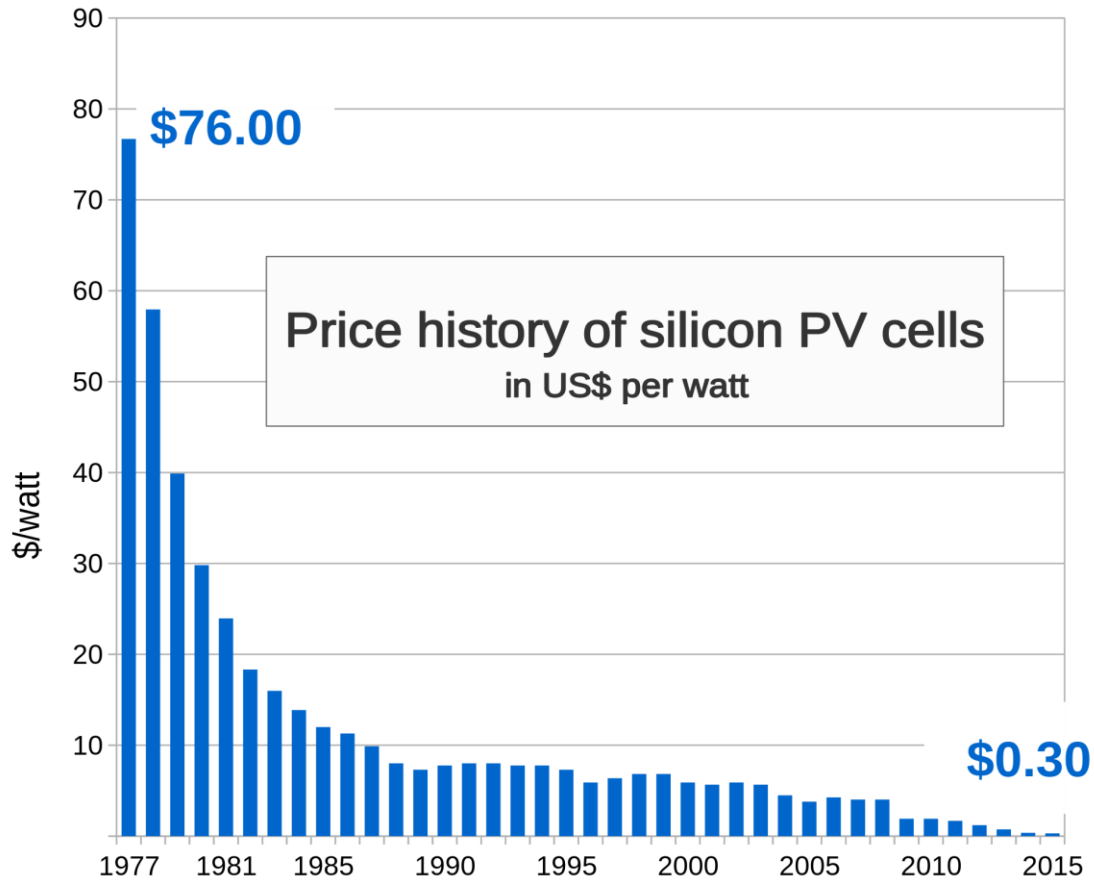


The future

- Price drops expected for currently available technology
 - solar panels
 - batteries (even Lithium batteries)
- New technologies expected
 - new types of solar panels
 - new types of storage
- Large scale benefits
 - the whole world is changing to renewables and storage
 - this will create more availability and significant price drops worldwide



The future



Source: Bloomberg New Energy Finance & pv.energytrend.com

