# SOLAR ENERGY: ILLUMINATING THE PATH TO A SUSTAINABLE FUTURE

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*ACS GCI GREEN AND SUSTAINABLE CHEMISTRY SUMMER SCHOOL*

## INTRODUCTION

Renewable energy- Energy derived from unlimited, naturally replenished resources.

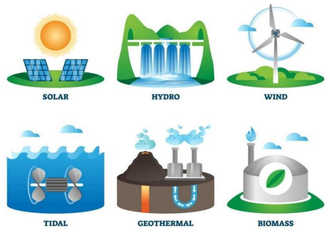


**Figure 1. Sources for renewable energy [1]**

The sun fuses about 620 million metric tons of hydrogen every second producing enormous amounts of energy. Solar energy is necessary for life on Earth and can be harvested for human uses such as electricity, heat or other forms of energy[2,3]

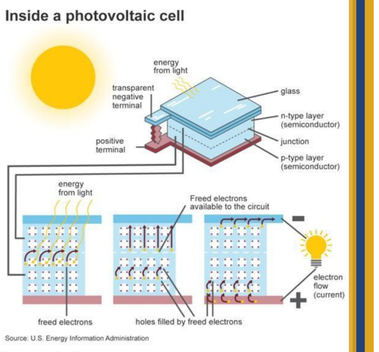


**Figure 2. Basics of photovoltaic cells [4]**

## HISTORY

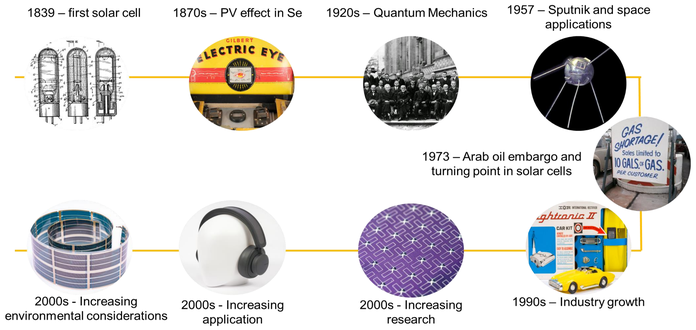


**Figure 3. Brief timeline of solar cell development and application [5,6]**

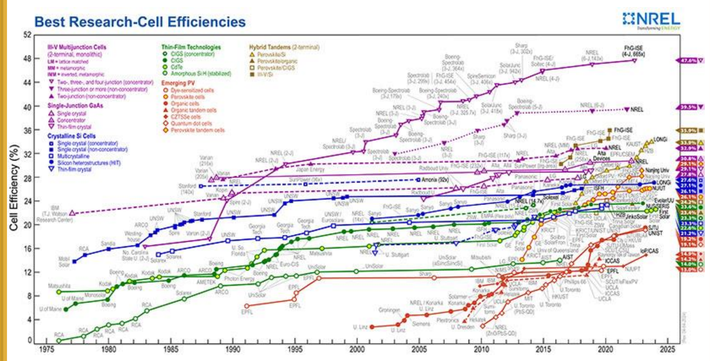


**Figure 4. Solar cell efficiencies and development from 1975 to present [7]**

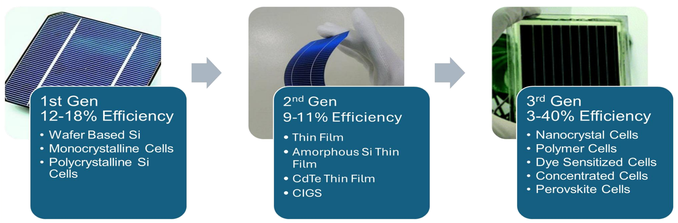


**Figure 5. Summary of solar cell generations and overall efficiencies [8]**

## CONNECTIONS TO GREEN AND SUSTAINABLE CHEMISTRY

Solar energy contributes significantly to green and sustainable chemistry by providing a clean energy source, enabling innovative chemical processes, and supporting the development of sustainable materials and chemicals. The integration of solar energy with the green chemistry principles promotes a sustainable future.[9,10]

### WASTE PREVENTION

Green principles guide the design of solar panels to be long lasting, recyclable or biodegradable thus reducing environmental impact.[11]

### DESIGN FOR ENERGY EFFICIENCY

Designing solar cells to operate efficiently at ambient temperatures. Solar irradiation can also be used to drive chemical reactions (photochemistry and thermochemistry) thus reducing the dependence on fossil fuels.[10]

### USE OF RENEWABLE FEEDSTOCKS

Solar energy is a renewable and an infinite resource and readily available. This eliminates the dependency on fossil fuels and minimizes pollution. [10]

### REAL TIME POLLUTION PREVENTION

Energy produced from solar cells is done in a clean way thus there is no emission of greenhouse gases.[10]

### CATALYST

Photocatalysis involves using light to accelerate chemical reactions. Solar energy can drive photochemical processes to produce chemicals and fuels e.g. water splitting and $CO_2$ reduction.[12]

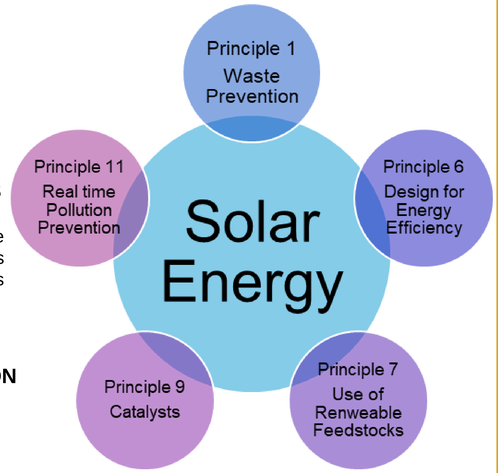


**Figure 6. Solar energy advances green and sustainable chemistry**

## ADVANTAGES AND DISADVANTAGES

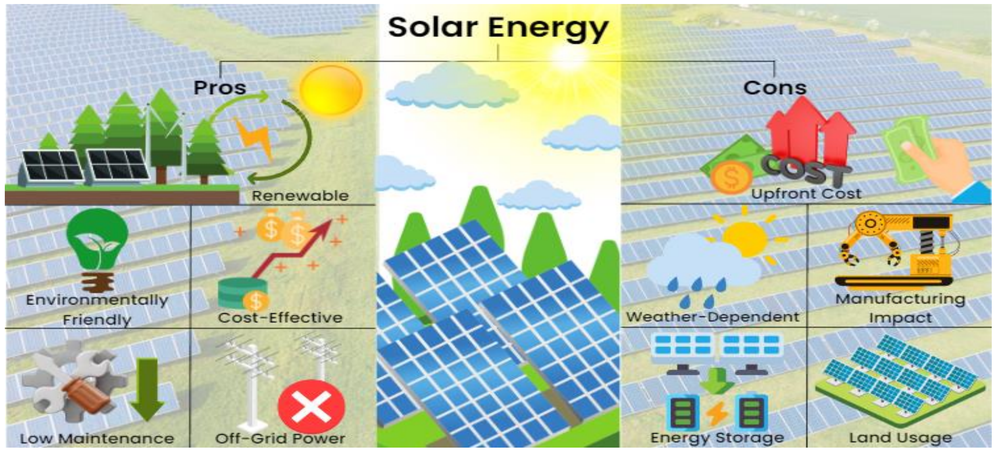


**Figure 7. Advantages and disadvantages of solar energy [13]**

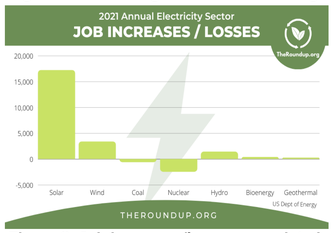


**Figure 8. Job increases/losses associated with energy sources (2021) [14]**

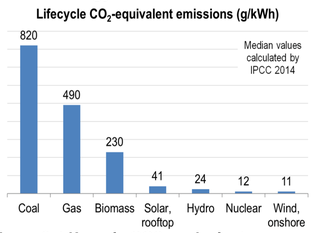


**Figure 9. Lifecycle CO2-equivalent emissions by energy source [15]**

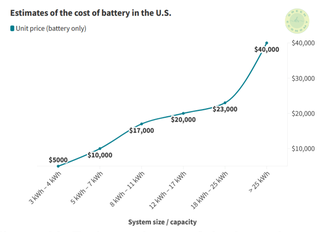


**Figure 10. Estimated cost of the batteries for solar energy in the U.S. [15]**

## APPLICATIONS [16]

**Figure 11. Solar-powered pump**

**Figure 12. Solar water heating for swimming pools**

**Figure 13. Solar chargers**

**Figure 14. Solar cookers**

**Figure 15. Solar outdoor lighting**

**Figure 16. Solar-powered exhaust fans**

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