Accelerating Innovation in Solar Energy Technologies

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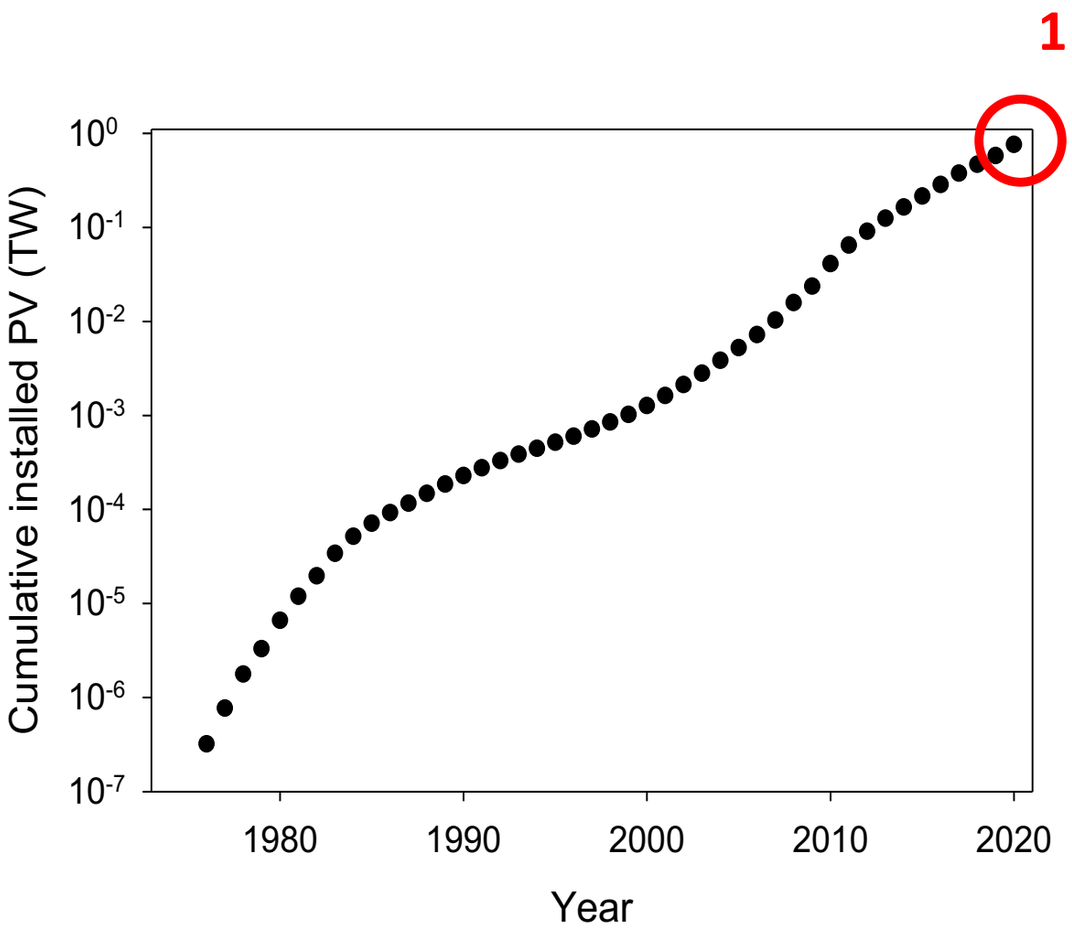
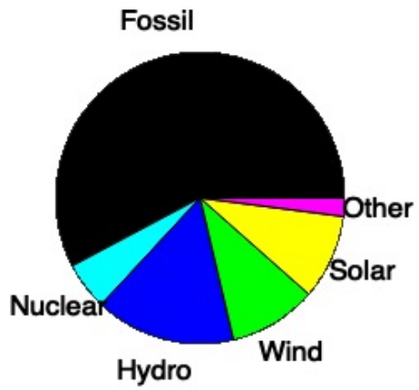
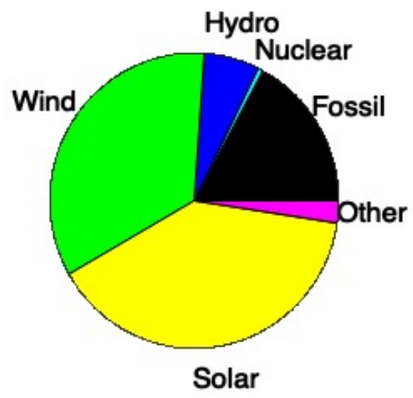
Global Installed Solar PV Capacity Likely to Reach 1 TW in 2022-3





2020
Electricity
generating
capacity
(GW)



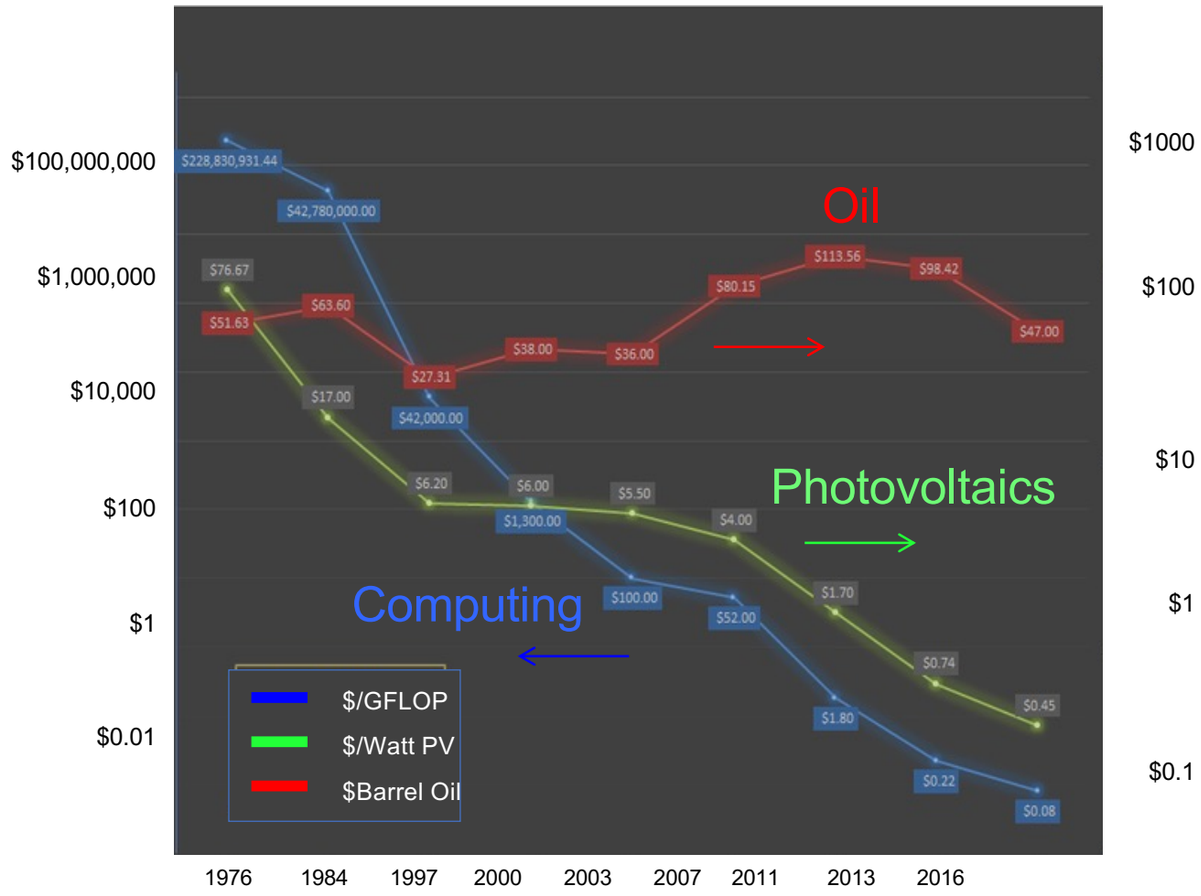
2020
Added electricity
generating
capacity
(GW)

N. M. Haegel and S. R. Kurtz, IEEE J. Photovoltaics, 2021.

In Technology, Change is Exponential

New energy technologies, like IT, follow exponential 'experience' curves:

- solar photovoltaic deployment
  - 1 MW in 1976
  - 760 GW in 2020
- >500x cost/Watt reduction
- Module cost/area: $50/m^2 → less than a window!



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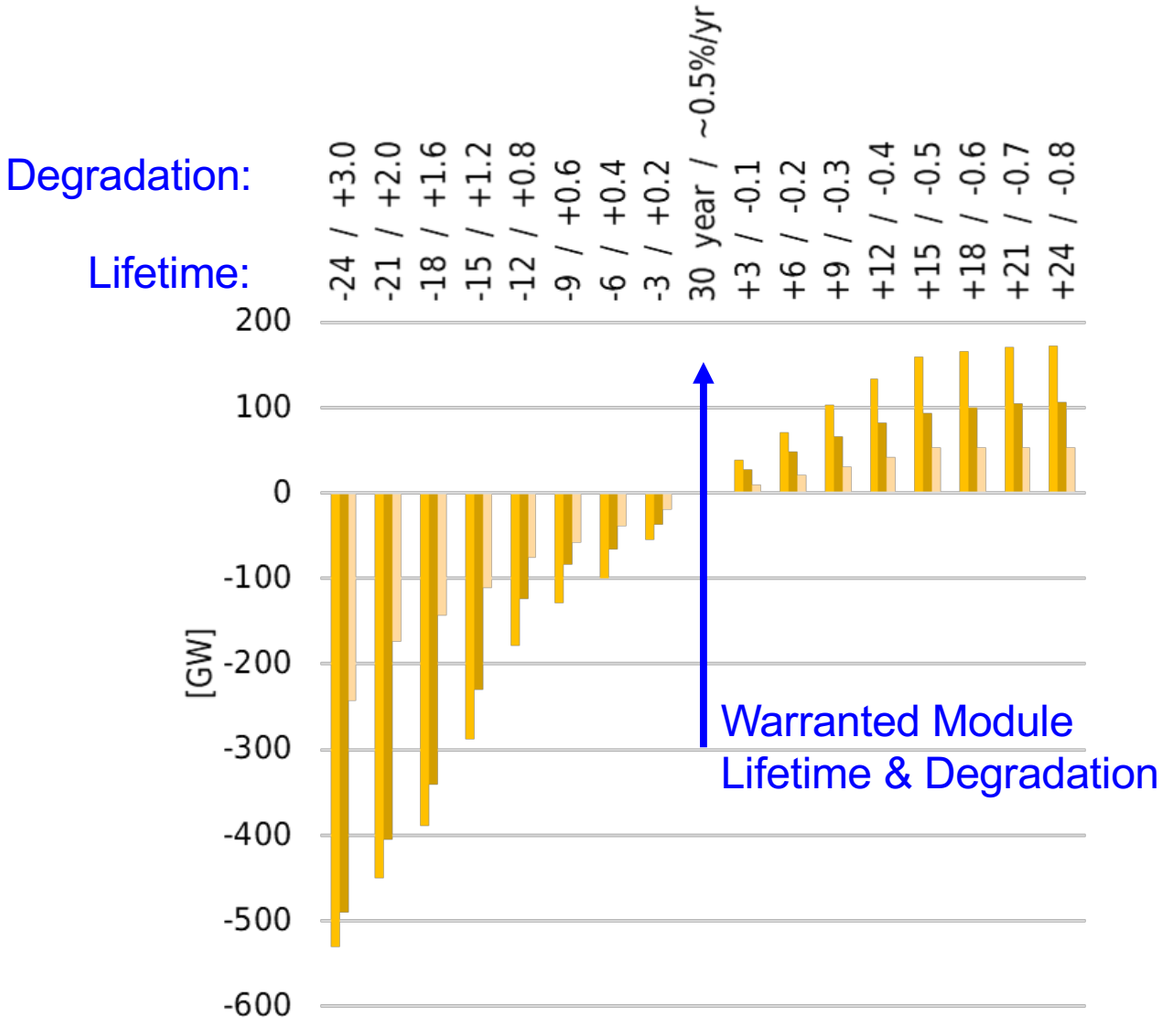
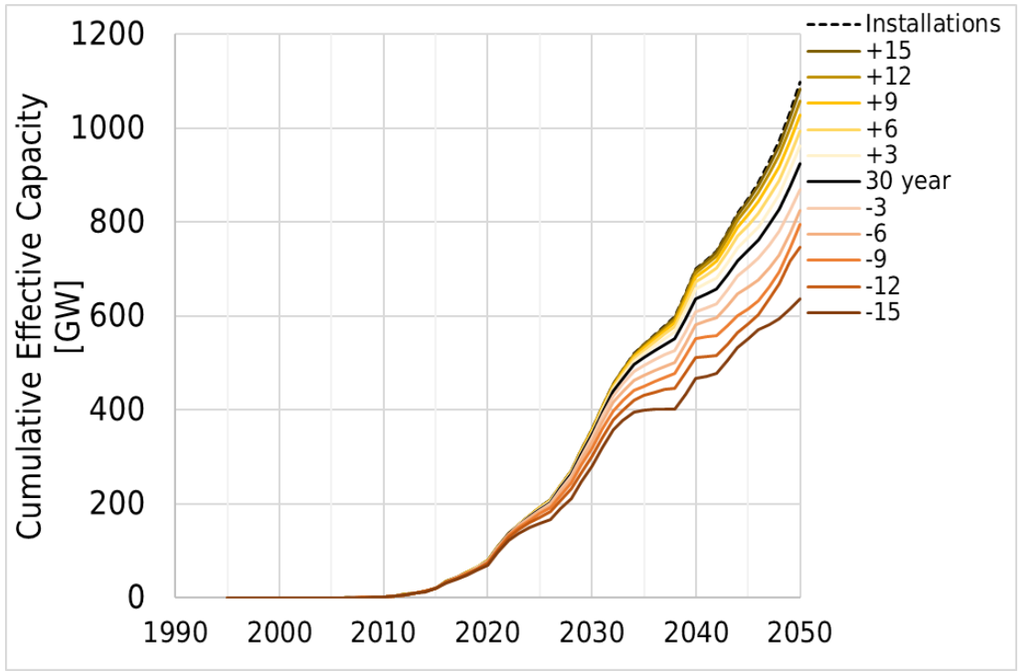
Status of Solar Photovoltaic Electricity

- Solar PV is here, at scale, growing
- Growing consensus among modelers: PV will be world's majority energy source by 2050 if we prioritize decarbonization.
- As a majority energy source, operators must increasingly prioritize reliability and resilience
- Governments will have a stronger interest in global manufacturing and supply. Cost will become a multifaceted
- Si and CdTe PV technologies can complement to meet US needs to 2035.
- Perovskite thin film PV is promising; too early to really know if the technology can meet ***cost, performance and reliability*** demands. This "value triad" has allowed PV to grow rapidly in recent years.
- US should invest to accelerate the required knowledge and experience about *cost, performance and reliability*.

Solar PV Generating Capacity by 2050 Strongly Affected by Lifetime, Degradation





T.M. Barnes, NREL Terawatt Worshop 6/28/21

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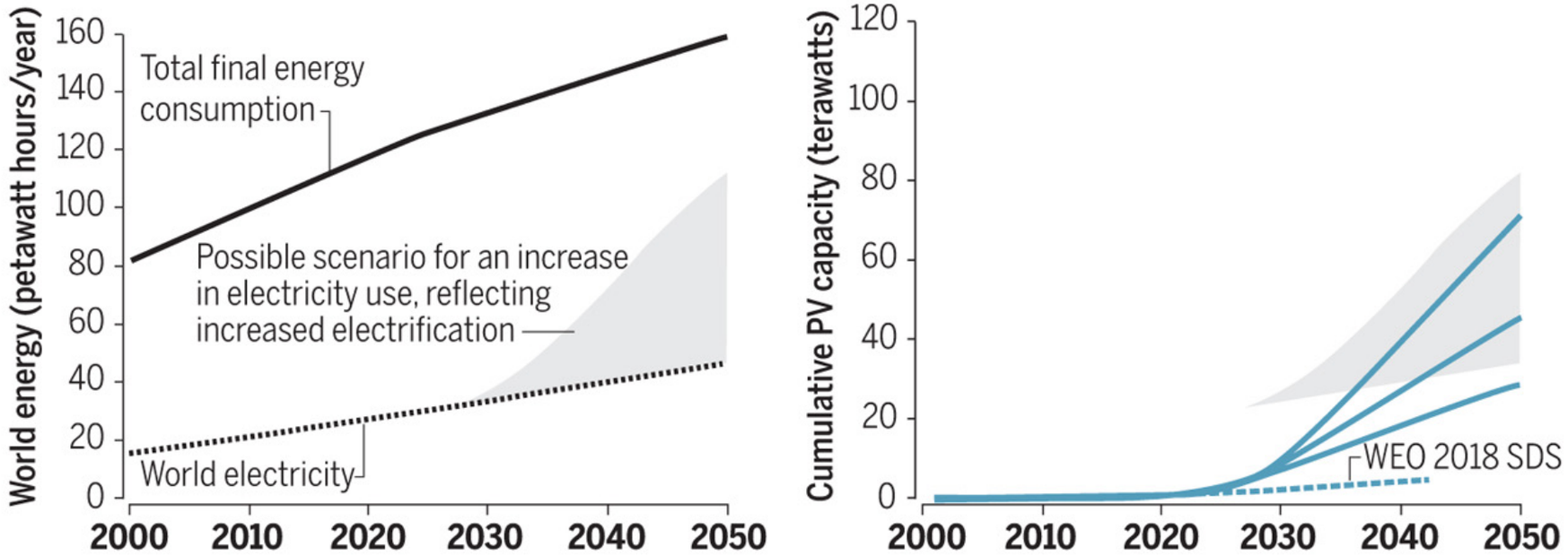
Solar Photovoltaic Electricity Outlook: 2022-2050

Scenarios for growth of PV

Total final consumption and world electricity, according to the 2018 World Energy Outlook (WEO) New Policies Scenario. The three solid blue curves provide possible scenarios for growth of PV cumulative capacity and electricity generation. A global average energy yield of 1370 kWh/kWp was used to correlate the axes for the left and right figures. See supplementary materials for details.



Haegel et. al. Science **364**, 839 (2019).

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Solar PV Technology and Current US Manufacturing

First Solar has built a new factory in Ohio that will produce 1.2 GW of panels annually and are building another.

They are forecast to deploy about 8% of solar energy in 2020 & install 25 GW in the next few years

First Solar
Series 6 module

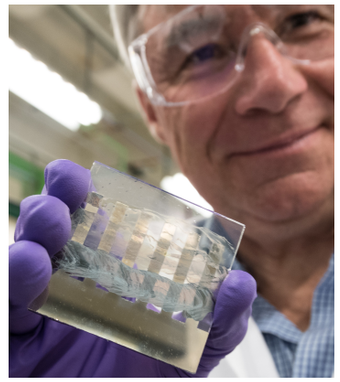
Photo: First Solar

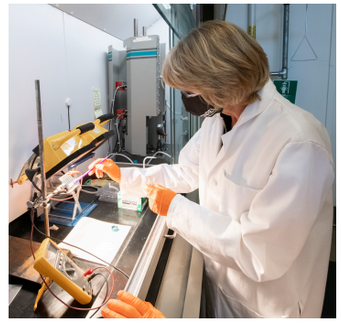
550 MW CdTe solar farm in the Mojave desert

Accelerating US Solar PV Innovation

- Perovskite PV: disruptive new technology with high efficiency and low cost of manufacturing
- Leverages US expertise in advanced scalable high deposition rate technologies and domestic manufacturing know-how (jobs)
- Thin film, high-rate production to create low cost enables economic decarbonatization (capital efficiency).
- Opportunity to establish US based manufacture and supply chain ecosystem

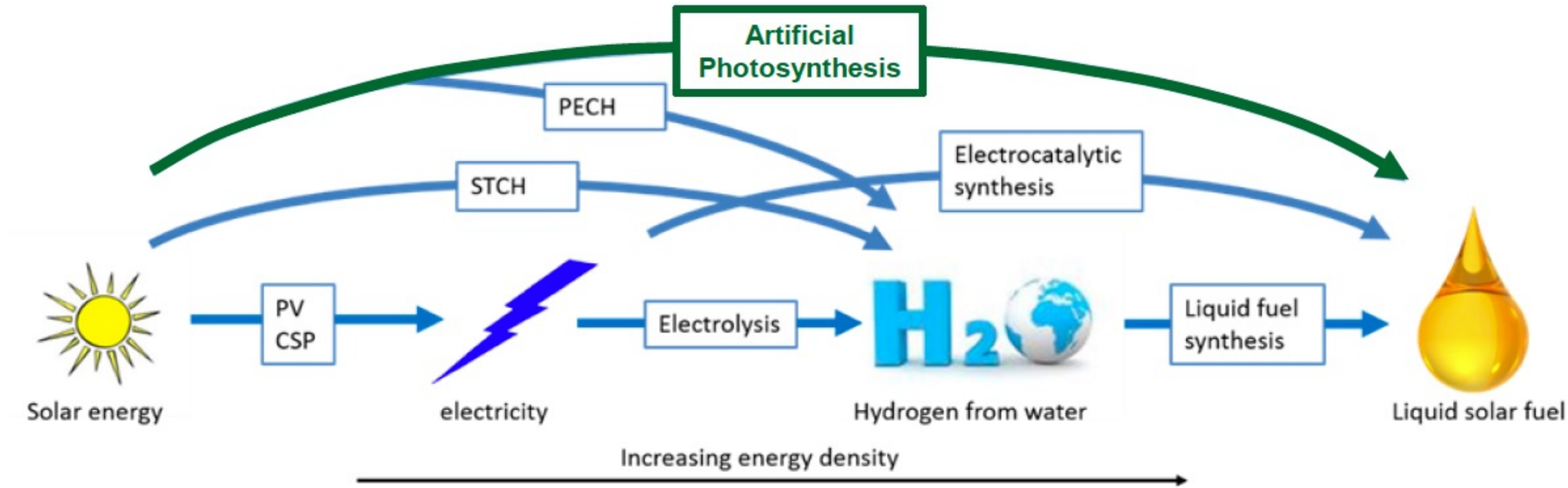
Government investment opportunity: establish a US perovskite foundry for evaluating scalable manufacturing methods and reliability/lifetime





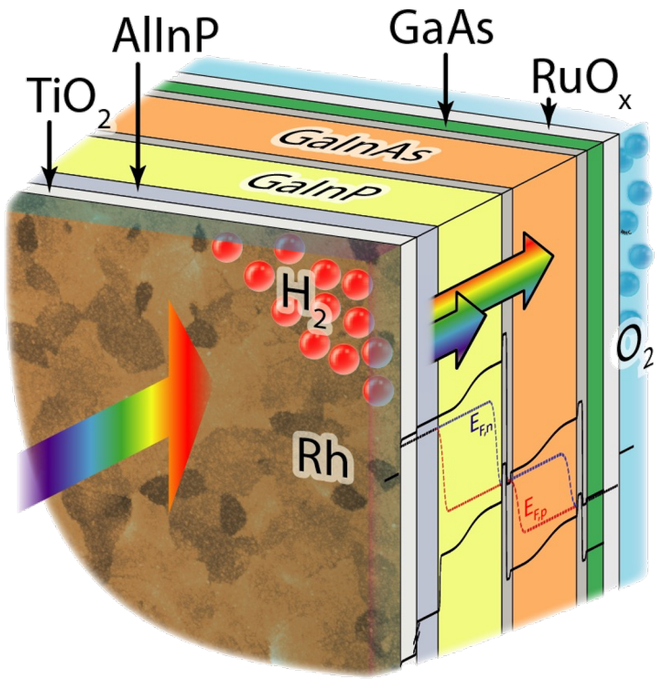
U.S. Senator Sheldon Whitehouse and US Senator Lisa Murkowski paint perovskite solar cells during visits to NREL

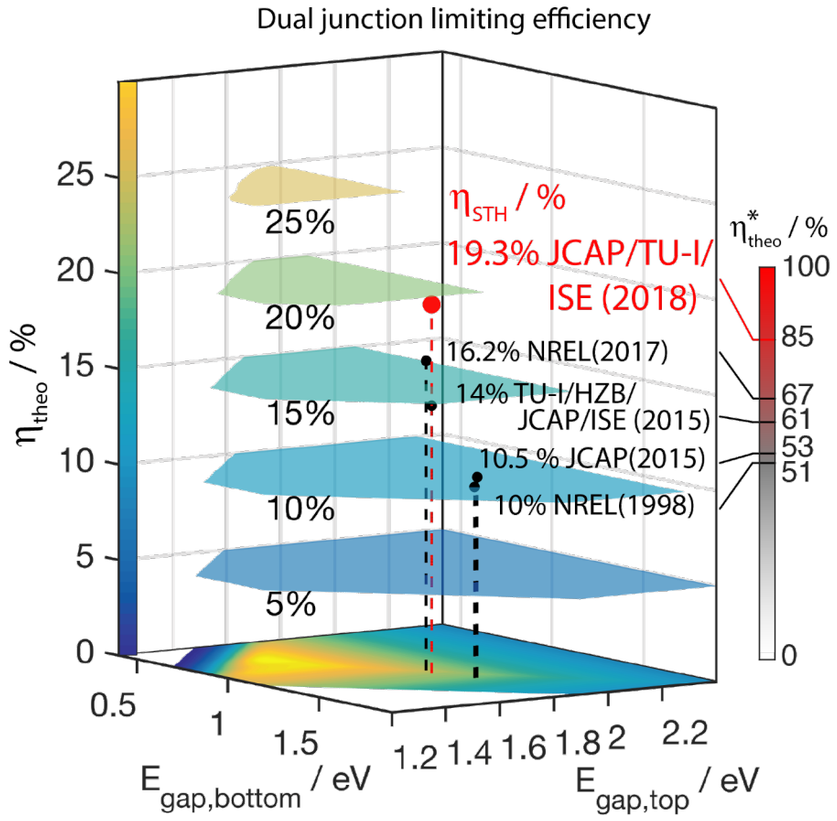
Artificial Photosynthesis: Direct Solar-to-Fuels



Artificial Photosynthesis: Direct Solar-to-Fuels

solar-to-hydrogen efficiency = 19.3%





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[1] Nat. Energy, 2017, 2, 17028. [2] Nat. Commun., 2015, 6, 8286.
[3] Energy Environ. Sci., 2015, 8, 3166. [4] Science, 1998, 280, 425.