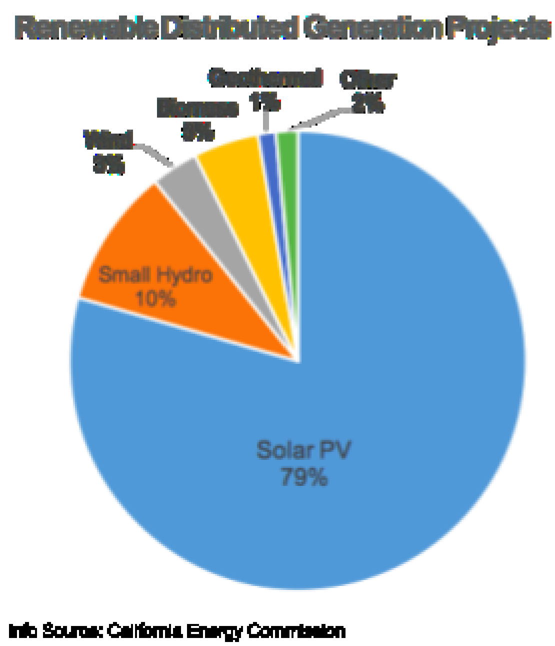
Shining Light on an Issue with Solar Energy

Imagine a world where charging your home was as simple as placing your phone under the sunlight or parking your car outdoors. As the extraction of fossil fuels becomes increasingly harmful to our environment, there has risen a dire need for sources of renewable, environmentally-friendly energy. As solar energy becomes more prevalent in California in 2017 and beyond, its efficiency has presented itself as a taxing problem – one that can be solved with implementable, cost-effective spray-on perovskite solar technology.

I. Why Solar Energy?

Solar power is a well-established, widespread form of renewable energy in California. With various statewide energy programs and a rapid-growing solar industry, the state leads the nation in solar power. Established in 2002, California's Renewable Portfolio Standard Program requires that 50% of California's electricity be generated from renewable resources by 2030.



The establishment of the Energy Commission's New Solar Homes Partnership (NSHP) and the California Solar Initiative (CSI) have significantly expanded the use of solar energy by providing monetary incentives for installation of solar energy systems. Successful implementations of these programs have displayed remarkable progress – California has already far exceeded its 3,000 MW solar generation goal as of December 2016; more than 75 builders and 30 installers participate in the NSHP. As of October 2016, solar PV energy has produced 13,000 MW, over 50% of California's renewable energy capacity. In 2017, the Multifamily Affordable Housing Solar Roofs program will install solar generation for low-income multifamily buildings. Solar energy is estimated to contribute towards over 85% of California's renewable energy capacity.

New Renewable Capacity Expected Online in 2017

Resource/Technology	Capacity (MW)	Percent of Total
Solar PV	785	85.2%
Small Hydro	4	<0.1%
Wind	132	14.3%
Biomass	0	0%
Geothermal	0	0%
Total	**920**	**100%**

Info Source: California Energy Commission

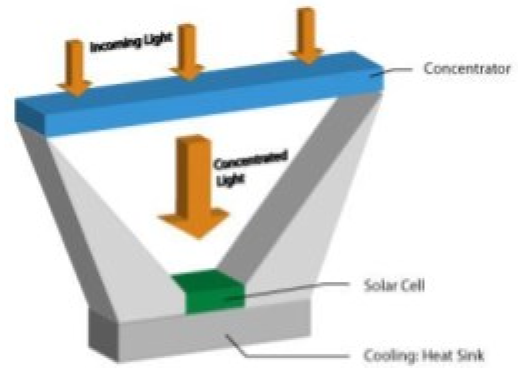
II. Solar Energy Inefficiency

Although solar power has its advantages – no pollution, practically inexhaustible, and widely available, solar energy is ultimately inefficient at generating the electricity needed in the densely populated state of California throughout the year.

The solmobile. Model A will run for 1 day after standing in the sun for 1 month. Model B, with 660 square feet of collecting area, will run whenever the sun is out. Both models assume unlimited progress of technology. With present technology, model A would have to stand in the sun for a whole year to do one day's driving.

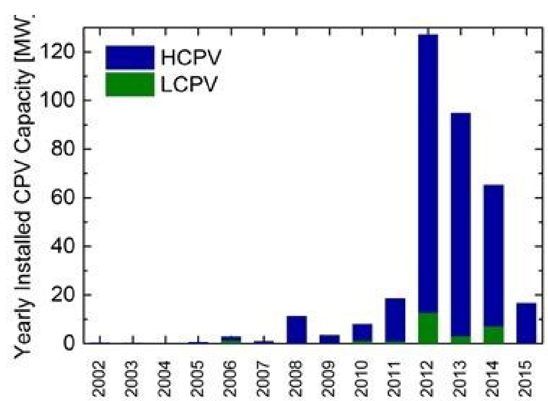
The above diagram, produced 30 years ago by Petr Beckmann, professor of electrical engineering, clearly demonstrates the inefficiency of traditional silicon-panelled solar power. The time that has passed since the creation of this diagram has not changed the situation – it is simply not possible based on immutable laws of physics and mathematics. The only way to harness more power from existing silicon solar panel technology is to cover more surface area.

In ideal conditions of sunlight (when the sun shines completely unobstructed and perpendicular onto the panel), solar energy can be generated at around 1 kW per square meter. Out of this 1 kW, only 33.7% can be harnessed into photovoltaic solar energy. According to Professor Beckmann's estimations, the sun would have to shine ideally on a 1 square-foot solar panel for 9,596.93 hours (399 days) to generate 1 kWh of electricity. To put that into perspective, in 2015, the average energy consumption for a residential utility customer was 901 kWh per month.



CPV involves concentrating a large area of sunlight into a small solar cell, thereby increasing panel efficiency in given surface area.

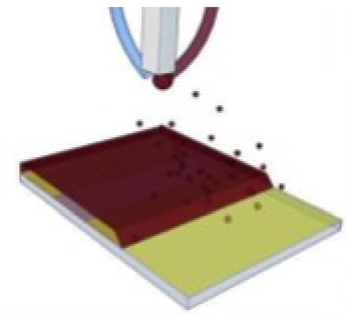
The current solution to solar panel inefficiency is concentrated PV (CPV), which involves concentrating a large area of sunlight onto the solar cell with an optical device that boosts efficiency. However, the multi-junction cells are expensive due to the elaborate extra material required – these clunky panels are often 10-11 inches thick.



III. Our Solution: Spray-On Solar Technology

As California pursues an increasing number of solar energy projects, it is crucial to improve efficiency in order to generate sufficient electricity – maximum surface area must be utilized for solar energy conversion and covered with solar cell technology. Solution-processed cells (solar cells with increased efficiency) have undergone remarkable research at several universities. As they gain more attention, spray-on solar technology has presented itself as a practical, cost-efficient solution.

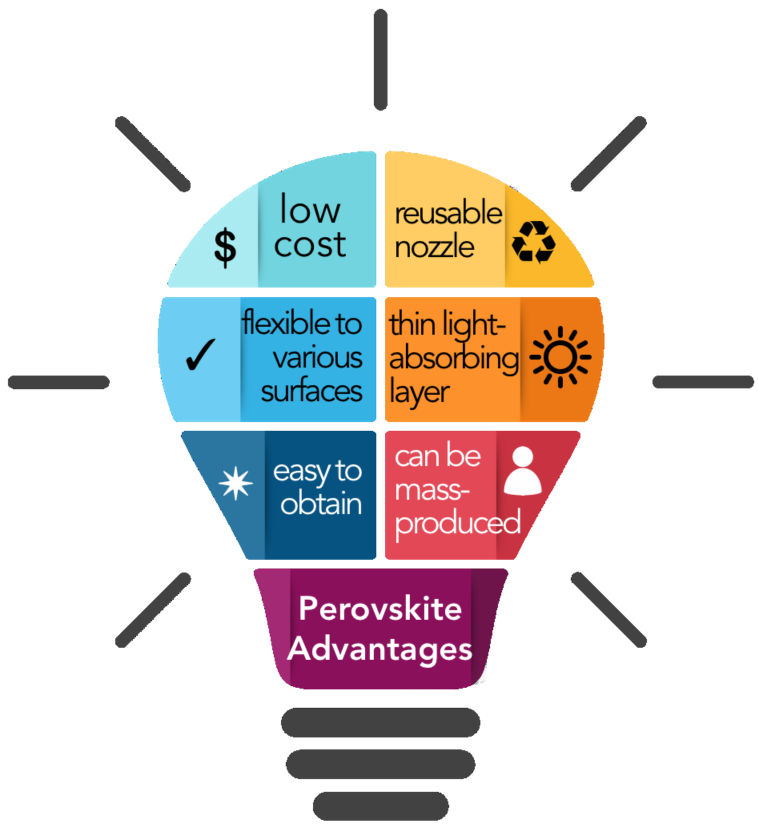
One class of solution-processed solar cell, the inorganic-organic hybrid perovskite solar-cells have shown promising results. Research has shown that the addition of perovskite, a calcium titanium oxide mineral, can boost solar cell efficiency by 20%. Cambridge University's experimental physicist Sam Stranks claims that maximum efficiency of a solar cell could increase from 30% to around 50% with the addition of a perovskite layer.



Spray-coating methods, coupled with perovskite film cells, can be used to produce cheap solar panels.

Perovskite is a mineral often used in solar cells.

University of Sheffield studies have demonstrated the feasibility of perovskite as a real-world lone-standing solar energy converter. Perovskite is not only easy and inexpensive to obtain but also has a light-absorbing layer with a thickness of 1 micrometer (compared to180 micrometers for silicon). When applied in a thin uniform layer, perovskite can turn any surface (even curved surfaces that cannot be mounted with traditional silicon panels) into solar energy generating surfaces. The application process is simple – the same spray nozzle can be used in various scenarios.



IV. Implementation Details

Perovskite spray-on coating is a versatile solar energy technique that can be applied to nearly all surfaces and significantly increase solar cell surface area. The reusability of the nozzle allows application to be cost-effective and easy-to-use in residential and commercial settings.

Although spray-on perovskite is currently not on-market, we can estimate its cost based on the price of perovskite solar cells. An average perovskite solar-cell construction kit, which consists of titania paste, an absorber precursor, and hole transport, cost around $305 retail. This price can be easily decreased when kits and materials are packaged into small spray-bottle units and purchased on a bulk scale. At the same efficiency, the at-most $305 installation compares well to the $35k installation of a 5kW silicon solar panel system.

V. Conclusion

In the modern day, the need for a more cost-effective, efficient method of garnering solar energy has never been more urgent. Our solution of spray-on perovskite will not only decrease commercial solar panel costs but also significantly improve solar efficiency by covering vast surface area. The potential is tremendous – solar energy could be harnessed from a surface as small as the back of a smartphone or as large as the body of an airplane. With spray-on perovskite, the possibilities are endless.

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