Hybrid Concentrating Solar Panels

Dr. Shawn Buckley
Focused Sun, Las Cruces, NM 88007 USA, bshawnbuckley@gmail.com

ABSTRACT

Hybrid solar panels can extract 3-4 times as much energy from the sun as conventional panels. A particular hybrid panel – a linear Fresnel collector – can also be made very inexpensively using modern sandwich fabrication techniques. The paper explores the product space of how hybrid panels can represent an alternative having both low costs and fast payback.

INTRODUCTION

Hybrid solar panels are those which capture both electricity and heat. A hybrid concentrating solar panel is one which concentrates solar energy while capturing both electricity usually through photovoltaic (PV) cells and low grade heat. Concentrating solar panels have been investigated for decades where mirrors reflect sunlight onto an absorber.

METHODOLOGY

Concentration necessarily implies sun-tracking since the mirrors must adjust to let their reflected sunlight fall on the PV absorber throughout the day. The simplest is a passive or "zero-axis" concentrator where sun-tracking is done optically. These have a high PV cost but low tracking and structure cost. In two-axis tracking, disk shaped reflectors are positioned in two axes. They have a low PV cost, but high tracking and structure costs. Between the two is one-axis tracking where linear mirrors move around a single axis. With proper design, these have a low PV cost and low tracking and structure cost.

Of the one-axis systems, reflectors come in either parabolic troughs or linear Fresnel mirrors. Trough reflectors have deep parabola with a large depth to width ratio. They can be difficult to fabricate, adding to their costs. Linear Fresnel mirrors don't have this drawback: they are nearly flat and easily produced using sandwich fabrication methods developed for aircraft manufacturing. In sandwich fabrication, a light-weight core is bonded to higher strength face sheets. The core holds the face sheets apart where they can carry structural loads required of solar panels.

More important than ease of fabrication is cost. Even in a conventional solar panel, the panel's structure is 75% of its cost. Sandwich fabrication has the highest strength per unit weight of any structure taking distributed loads. In high volume products, strength is nearly proportional to weight giving sandwich fabrication the highest strength per unit cost.

How strong must a solar panel be? Loads on solar panels are predominantly wind loads: anything mounted on a roof is required by most global jurisdictions to withstand a 150 mph wind, or a 50 lb/ft2 surface loading. By contrast, dead loads (the load of a structure due to its weight) is typically a tenth of the wind load. With proper design, sandwich fabrication can make the lowest cost structure.

But costs are only one aspect. The other important aspect is efficiency – what portion of the incoming solar flux is captured. In a conventional panel, efficiency is typically between 15% and 20%. The remaining 80% or more is discarded as heat. In a hybrid panel, that heat can be captured by pumping coolant through the absorber. The coolant also cools the PV wafers making them more efficient at converting solar energy to electricity.

SUMMARY

Hybrid concentrating panels have costs and strength comparable to conventional PV panels while capturing much more of the available solar energy: 15% to 20% electricity and 60% to 70% heat. Heat can be used immediately or stored for later use.

Authorization and Disclaimer

Authors authorize LACCEI to publish the paper in the conference proceedings. Neither LACCEI nor the editors are responsible either for the content or for the implications of what is expressed in the paper.