SOLAR THERMAL AND ELECTRICITY GENERATION

Dr David Ferrari
Project Lead, Sustainability Victoria

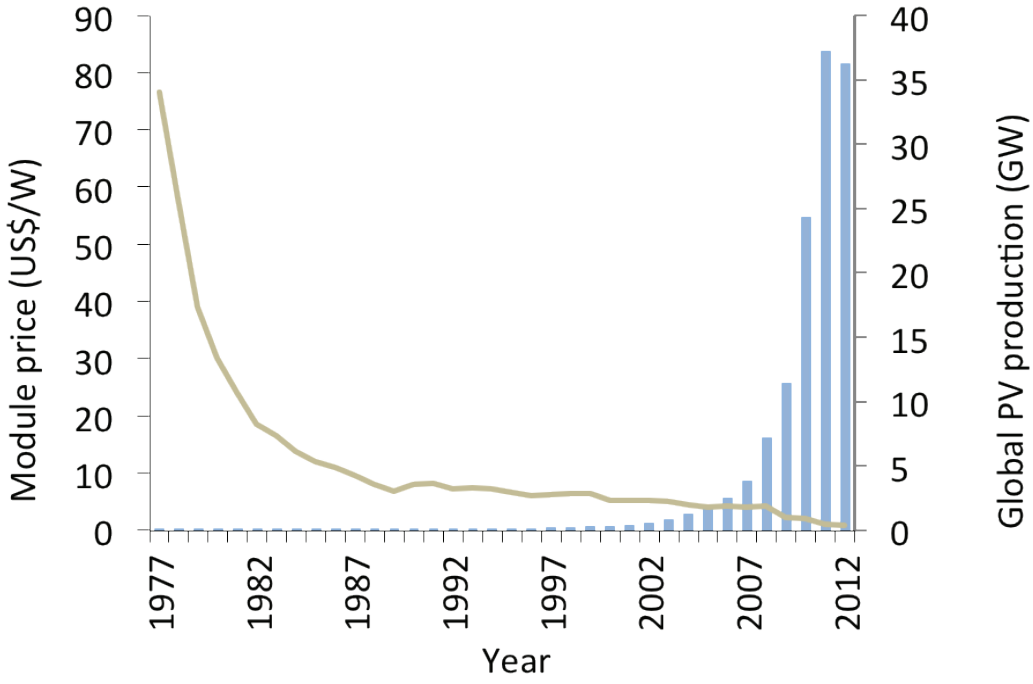
We have available to us an abundant, free energy resource: the sun delivers more energy to the Earth in one hour than humanity uses in an entire year. However, solar power only accounts for about 0.7% of the world's energy supply (US Energy Information Administration, 2013). Even in Victoria the solar resource is world class, with average annual irradiance on par with the sunniest parts of Europe. The north-west of the state has a solar resource as good as Arizona, California and Nevada, but in 2012 solar electricity only provided 1.1% of our electricity demand (Clean Energy Council 2013, *Renewable Electricity in Victoria Report 2012*).

There is substantial opportunity to expand on our use of solar energy, and rooftop solar photovoltaic (PV) generation is now one of the fastest growing industries worldwide. The technology is cheap, scalable, and has output with good alignment to electricity demand. A combination of government support and the ability of PV to hedge against rising electricity prices has encouraged uptake: more than one in ten Australian households now has a rooftop PV system (Clean Energy Council 2013, *Clean Energy Australia Report 2012*).

Recent technical advances, improvements in manufacturing processes, and enormous economies of scale have combined to drive the price of PV modules well below US$1 per Watt (Figure 1). The price of solar PV generation is now competitive with the price paid for large businesses and industrial electricity consumers, and the practice of using rooftop PV to offset electricity use is becoming commonplace.

Meanwhile, the feasibility of providing solar electricity, with storage, at utility scale has been proven in another branch of solar technology: high temperature solar thermal electricity. Large plants in Spain and the USA totalling over 1 GW of generation capacity are now operating with around eight hours of thermal storage. These plants are providing solar electricity throughout the day and into the peak demand hours of the evening and night.

Figure 1: Change in price of PV modules over time



Data source: Earth Policy Institute and Bloomberg New Energy Finance

Solar technologies are drawing attention from investors worldwide. Large-scale solar electricity generating farms are being looked upon as a potential major contributor to the world's energy supply. Technically feasible proposals have been considered for huge solar arrays exporting energy from North Africa to Europe, and from Australia to Asia.

At more moderate temperatures, advances in solar thermal technology are delivering novel designs to produce solar heat for industrial processes, and Australian research is leading the way. A collaborative project involving two major manufacturing businesses and seven universities in Australia and the USA is being led by RMIT to develop innovative lightweight, thin, concentrating collector platforms for the delivery of thermal energy at up to 400°C (Gary Rosengarten 2013, *Micro Urban Solar Integrated Concentrators project*, RMIT). Similarly, the Chromasun microconcentrator is an Australian-owned (but California-developed) product which has been demonstrated on facilities in California and Abu Dhabi. Chromasun's compact linear Fresnel collector is planned for installations in Echuca (Vic) and Fremantle (WA) (Giles Parkinson 2012, *Made in Australia: Bringing local solar technology home*, Renew Economy).

Meanwhile, the relatively simple concept of heating water to low temperatures using sunlight is finally, albeit slowly, becoming mainstream. About 600,000 Australian houses are now equipped with a solar water heater, reducing demand for grid electricity and gas. Globally, less than 0.05% of industrial process heat currently comes from solar thermal, but more than 50% of Victorian commercial and industrial energy demand is for process heat that could be delivered by solar thermal technology (Sustainability Victoria 2005, *Application of Solar Process Heat to the Commercial & Industrial Sectors*).

Low temperature solar thermal supply is the technical equivalent of putting a hose in the sun: a solar water heater does not need a cleanroom for its manufacture; it integrates simply into most applications demanding water up to about 100°C; and it does not involve the movement and processing of superheated steam at extraordinary temperatures and pressure. But it currently costs more for a household to install a solar hot water system than it does to install rooftop PV!

There are substantial opportunities to simplify solar water heater manufacturing processes, to increase the efficiency of products, and to reduce the 'balance of systems' costs of installation, plumbing and pumping. Without improvements, the solar thermal industry is facing a crisis of irrelevance. If these problems can be overcome, the outlook is tremendous.