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Solar Systems

<http://www.solarsystems.com.au/>

Solar Concentration with Solar PV Panels

This summary is based on notes taken at the meeting by Paul Fritze. Slides from this meeting are not available.

Solar Systems is a Melbourne-based company with 165 employees. The company has five solar power stations operating in central Australia and consider themselves a world leader in concentrated Photo Voltaic technology. It was established in 1990 by John Lasich who started off experimenting with concentrating the sun onto solar panels. The fundamental principle is that “mirrors are a lot cheaper than PVs”.

Solar Systems is currently in a rapid growth phase and has just moved into a new factory in Abbotsford. It is a privately owned company with mainly low profile investors. Their first institutional investor, TRUenergy² became a 20% shareholder in 2008. The commercial side has been growing since 2000, with the current generation product first deployed in 2003.

The core product today is the CS500 dish. This has a 500x sun concentrated on the receiver generating about 38kW DC or around 31kW AC. The basic technology used is the ‘Multi-junction III-V PV which originates from space applications, where efficiency is more important than cost. Any single PV junction receives only a particular band of light, so if you use multiple junctions tuned to different bands stacked on top of each other, a much more efficient solar cell is obtained – although at a price. Efficiency of these cells is progressively increasing, from 35% last year, 38% this year and predicted to be 42% by 2012. In time it should reach 50%. The individual PV cells are manufactured by a Boeing subsidiary (Spectrolab) for the aerospace industry, tweaked for terrestrial application where they operate at 500 suns rather than one. The company has lots of unique and strong IP behind everything they do, for example, special techniques are required to take power out the back and to minimise cell spacing. While the efficiencies of different types of PV are increasing over time, the Spectrolab cells achieve world record efficiency.

The core component of the company is the multi-cell cell ‘module’, which is about 50mm square. Its output of 650W compares with a standard rooftop panel, but is about 1500 times the output/m². The modules operate at an efficiency of 35% running at 500 suns compared with 12-18% for panels. They generate about 1kW of heat, so water cooling is used to maintain the temperature at about 15°C above ambient. 64 modules are assembled in a close-packed array; water run through to take the power away; ‘flux modifier’ mirrors added around the outside do final narrowing of the beam and the resulting receiver can then generate 36kW DC of power. Solar Systems is yet to see any degradation in performance over the four years of operation – the active cooling prevents negative effects on output and life. Concentrating mirrors increase radiation from 1000W/m² to 500kW/m², but cell efficiency actually increases with number of suns, so cooling requirements are mediated.

CPV challenges

The concentrated sun takes only 12 seconds to burn a hole in a 6mm copper plate, so tight tracking systems and efficient cooling are required. A closed loop cooling system is used with a radiator to transfer heat to the air. In the past, this heat has been used in sewerage farms where possible, although it is only low grade heat at 15°C above ambient. In earlier systems, fail-safe protection

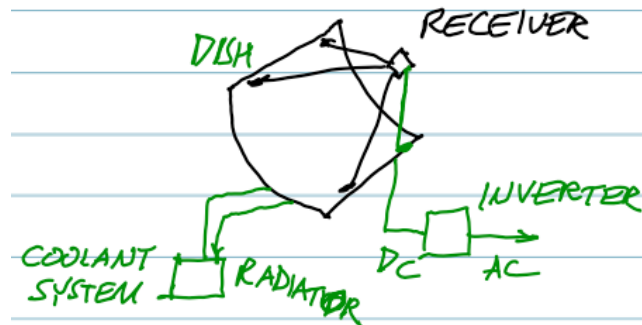
¹ Australian and New Zealand Solar Energy Society <http://www.anzsos.org/>

² TRUenergy partnership <http://www.truenergy.com.au/About/News/News.xhtml?newsitem=194>

involved a water tower that could provide enough water to all receivers in the event of a tracking failure until the sun could move away. A heat resistant shutter from space shuttle technology is now used.

CS500 dish

The current CS500 dish is 13m in diameter and provides 36.5kW DC output. The Mark V version is now going into high volume manufacture, with international supply chains being established to supply a world market. Manufacturing capacity will be 500MW of systems per year – equivalent to about 40 dishes per day.



Five operating plants are currently located in isolated off-grid communities. One in Hermansburg is a popular stopping point for tours to Kings Canyon. Whitecliffs was an early research prototype that has now been decommissioned. Off-grid installations in remote settings are challenging and they supplement rather than replace diesel generators, which must take over if a shadow blocks the sun. Such system integration is challenging. A battery bank is now used to cover while the diesel plant is fired up. Accurate tracking is achieved by control systems with alignment based on dynamic feedback from the receiver or computed when the sun is hidden.

The stated dish lifespan is 20 years, not considering possible system upgrades. Receivers, for example, are readily replaceable. The dish is designed to handle 160km/hr winds, but locations are generally out of cyclone areas. Maintenance requirements are low, with a mirrors being washed every 3-6 months (can lead to 3-4% degradation) and the gearbox serviced every 5 years.

Because of the challenges and limited market for off-grid systems, the current business model is now focused on *grid connect* systems. An 800kW ‘repeatable unit’ of 24 dishes is built around one step-up transformer. This means that standard components can be rolled off the assembly line.

The dish today is going into large-scale production, but while the cost is coming down and grid electricity prices are going up, there is still a price gap at this point. Government subsidies are necessary until parity can be reached.

Solar Systems is now developing *heliostat concentrated PV systems*. A *heliostat* is a mirror mounted on a stick that focuses the sun onto a receiver on a stationary tower. A field of such smaller mirrors is a cheaper way to achieve 500 sun concentration and a long term lower LCOE. Many tradeoffs must be made and the company is now working on these with the 150MW large-scale heliostat project at Mildura.

The NW Victoria/Mildura project

This project is contributing to the overall development and deployment of the heliostat – no one has done this before. It is being developed in stages and will eventually produce 154MW and cost ~ \$420M. The company is now buying about 1000 hectares of land and will start building in about two years. A proof of concept demonstration facility has been established on the highway at Bridgewater where the “world’s first grid-connected Heliostat concentrating PV system” was completed on time and on budget, exceeding its design specifications. This is an R&D facility with over-engineered components that has provided an enormous amount of experience running the system. The design is well progressed and the company is now preparing to build a first prototype HCPV production unit.

The factory in the old Weston Biscuit building will be primarily for making solar modules for receivers at a rate of 500MW per year - the automated production line is to be commissioned soon. Modules can be used in either heliostat or dish systems. Other system components, such as steel work, electronics and mirrors, are relatively low technology and are contacted out. The mirrors are made by a Bendigo automotive component company.

Future

The company has been researching dual mode PV/thermal systems. In these, a beam splitter in front of the PV cells redirects IR light away through a guide to a high temperature (1000°C) electrolysis cell which produces hydrogen that can be stored for energy on demand generation. It will be at least seven years before this will be commercialised.

Most new company projects are now being done overseas where commercial opportunities are best. Subsidies are currently required for this technology and places like the US have strong government support with tax incentives and aggressive renewable energy targets.

Questions

- Quality control in an international market is particularly important for these early projects – the world is watching. The key is to work with good partners and have good processes in place.
- Preliminary analysis of carbon payback period for the dish is under 2 years. Work is also being done on reducing foundations.
- Cells are overall fully recyclable and use a low volume of resources compared with flat plates.

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