Solyndra: Pushing innovation at any price

▲▲ »We are controlling every step during production with really high quality equipment,« underscored Kelly Truman at PHOTON's 1st Thin-Film Conference.

▲ The PV system on Solyndra's white rooftop looks like solar thermal evacuated-tube collectors.

It's just an hour's train ride from San Francisco to the barren, industrial area on the outskirts of the Californian city of Fremont. Here's where Solyndra Inc. manufactures its copper-indium-gallium-diselenide (CIGS) thin-film modules at its nearly 28,000 m² facility. That alone is not really noteworthy, since there are literally as many start-up companies with CIGS module production as there are grains of sand. The unique factor is the shape of Solyndra's module: the US company doesn't produce traditional flat modules like the ones typically seen on roofs and in PV parks. Solyndra's product consists of cylindrical glass tubes – and one tube is one module. The white surface on the company's flat roof is covered with 50 kW of these modules. They aren't directly installed on the roof, but rather attached to low, flat racks. The whole installation looks like evacuated-tube thermal collectors mounted on some kind of laundry rack.

After climbing down from the roof, the next surprise is the highly automated nature of the individual production stations inside the factory. The facility has a capacity of 110 MW and began operation last year. The company intends to produce 50 MW this year.

The production line isn't constructed optimally, yet. The machinery for the individual production steps isn't in chronological order, so the carrier has to move the glass tubes manually between the various stations. But Kelly Truman, VP of marketing, sales and business development, underscores that what they have is a production line with room for process optimization and that the systems had to be adapted to the existing building. »We've developed all the machines ourselves,« adds Truman, who together with Solyndra's CEO Chris Gronet once worked at leading US production equipment manufacturer Applied Materials Inc.

If you ignore the form of the substrate – that being the glass tubes described above – and the specific demands required by the use of such tubes, the process for producing Solyndra's CIGS solar cells is very similar to the methods used by other manufacturers. Four layers that comprise the photovoltaic active layer of the solar cell are deposited onto the glass tube, which has a diameter of around 1.5 cm. The cells are protected from atmospheric conditions by encapsulation with a second glass tube, into which the first is completely inserted after all the layers have been deposited and the laser process is complete. The space between the inner and outer tube is filled with a viscous material. The company won't provide any additional information about this non-toxic fluid, but it apparently matches the refraction index between the glass and solar cells, and provides good heat exchange. An additional positive effect of this fluid is a 1.5× concentration of incidental sunlight. Finally, the two glass tubes are sealed with metal caps and welded together like a fluorescent lamp.

A Solyndra system consists of 40 parallel-connected tubes placed in a type of frame, measuring 1 × 1.8 m, with a gap in between on a flat, even mounting system. A system like this weighs 16 kg per m². It's own weight keeps it on the roof; the system can even withstand winds of more than 200 km/h, ensures Truman. This type of system is best suited for installation on flat roofs, although it also tolerates slight slopes. These modules, which like other thin-film modules absorb direct and indirect sunlight for electricity production have more advantages, says Kelly Truman, as they are able to capture sunlight across a 360° surface, thus converting direct, diffuse and reflected sunlight. Nevertheless, it only makes sense to install these modules on bright, highly reflective flat roofs. The simple installation of these horizontally positioned systems, which are

Ronald Frommann / photon-pictures.com [3]

▲ Solyndra's fully-automated production line uses robots to move cylindrical substrates into a mounting.

easily clicked together, promises significant potential for cost reduction.

And cutting costs is essential. The American manufacturer offers its modules with powers between 150 and 200 W, and an average module efficiency of between 7.6 and 10 percent. Chalcopyrite-based solar cells, like the ones Solyndra uses in its modules, are also used by German manufacturers Würth Solar GmbH and Sulfurcell Solartechnik GmbH, Japanese manufacturers Honda Soltec Co. Ltd. and Showa Shell Solar KK, as well as US producer Global Solar Energy Inc. Unlike Solyndra, these module manufacturers use flat glass panes as substrates for their solar cells and efficiencies for commercially available CIGS modules vary between 8 and 12 percent.

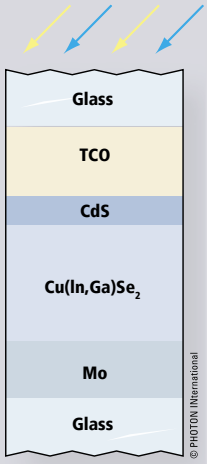
Thus, CIGS modules on flat glass not only have higher efficiencies, they are also less expensive to produce. Inside the thin-film scene, the word is that production costs for Solyndra's modules are four-times higher than conventional CIGS modules. Solyndra will not comment on current costs. Still, when asked, CEO Chris Gronet said that the second factory would result in system costs of between $3.50 and $4 per W, with a reasonable profit margin. Solyndra's current production costs are rumored to be twice that amount. In any case, homogenously depositing PV layers on glass cylinders is certainly a challenge. During production, we noticed that after all the layers were deposited, around 10 cm of material on each side of the inner tube was removed. Nevertheless, Solyndra appears to be well-prepared to tackle the challenges it faces. The majority of the company's 450 employees are highly qualified engineers and physicists that not only ensure production operates smoothly, but have developed the machinery themselves.

The US Department of Energy (DOE) is certainly impressed with the Californian company. Solyndra has made it to the final round in the DOE's Loan Guarantee Program, the only PV company among 15 other candidates. The goal of the competition is to support innovative projects in the area of clean energy. In the first half of 2009, the DOE will inform the companies whether they are to receive an 80-percent credit guarantee from the department. If so, Solyndra will use it for the construction of a second factory with an annual capacity of 420 MW. Gronet is confident that his company will be one of the competition's winners. Even if Solyndra doesn't win, the company still intends to build its second factory at the same business park in Fremont where its first factory is located. »We would involve partners. We are open to leverage,« says Gronet. A second production line could help Solyndra reduce costs considerably. Gronet seems very confident: »We will be at grid parity in just a couple of years.«

Text: Olga Papathanasiou

Solyndra

Solyndra
module structure



Founded: January 2005
Location: Fremont, California, USA
Technology: CIGS on glass cylinders
After the tubes are cleaned, molybdenum is sputtered onto the substrate. Then the absorber, which consists of a compound made of copper, indium, gallium and selenium, is deposited in a selenium atmosphere by physical vapor deposition (PVD) at temperatures above 500 °C. This is followed by the application of a razor-thin buffer layer made of cadmium sulfide and a transparent conductive oxide layer (TCO). Four laser processes separate the cells and connect them in series. The completed glass tube is then inserted into a second tube with a larger diameter and a non-toxic liquid is inserted between the two tubes. Metal caps seal both ends of the tube-in-tube laminated module.
Production equipment:
Proprietary development
Module efficiency: 7.6 to 10 percent
Cell efficiency: 12 to 14 percent
Costs: $3.50 to $4 per W after finishing the second factory
Capacity 2008: 110 MW
Employees: 450
Expansion goal: 520 MW in the next few years
Certification: IEC and UL
Finances: Solyndra is in the final round of the US Department of Energy's Loan Guarantee Program. If Solyndra wins the competition, the company's second factory will be financed for the most part through program funds. If it loses, the company will look for financially powerful partners.

»Second Solar« factor:
Solyndra's concept is without a doubt unique and innovative. By focusing on flat roofs, the company is concentrating its efforts on a niche with great potential. Last year alone, so-called commercial PV systems comprised the lion's share of the US market. On the other hand, the limitation of installations on flat roofs, and above all the currently high production costs, means that Solyndra, at least for now, is not a serious candidate for the position of »Second Solar.«