Solar-Reports:

PV production: The dawn of the "gigawatt" fab

by Mark Osborne
08/11/2008

Rapid growth in the demand for photovoltaics has enabled an aggressive ramp of production not just on the part of the leading PV manufacturers, but also by many new entrants in only the last few years. Continued robust demand is resulting in larger economies of scale production that, when combined primarily with a steady improvement in conversion efficiencies, is leading the industry towards a cost-per-watt level that could finally reach grid parity at peak usage levels by the 2012 timeframe. However, this may not in itself lead to the claimed industry goal without a shift to large-scale gigawatt manufacturing facilities. We discuss the opportunities for scaling PV manufacturing with Robert Gattereder, Managing Director of M+W Zander FE GmbH after a detailed study challenges the current mindset and forces manufacturers to consider scaling manufacturing to new heights.

Solar-Report as PDF-Document

Solar Magazine

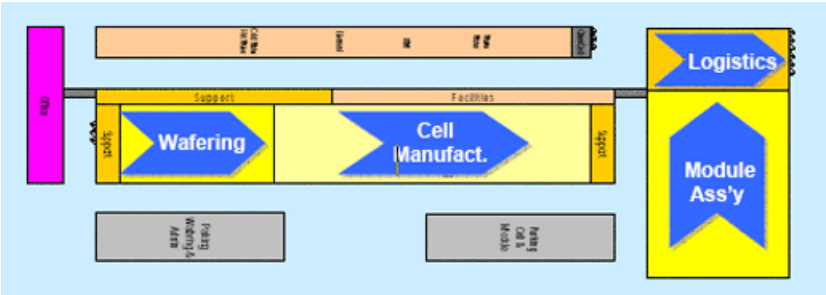
- Solar Report
- Solar News
- Solar Interviews
- Solar News Archive
- Solar Links
- Solar Energy System of the Month
- Solar Archive:
  - Photovoltaics
  - Solar heating
  - Solar Building
  - Fuel Cell
  - Solar News Archive
- Your Suggestion

search

Top 50 Solar

Wafer-based PV manufacturing: design and integrated layout concept. Source: M+W Zander FE GmbH

The vast majority of fabrication facilities are small and under 25MW annual production levels. Simply multiplying such conventional facilities in the race to grid parity is seen as insufficient for continued cost-per-watt reductions. Fully integrated and highly automated facilities will be required, and the scaling of single-site facilities to the gigawatt level is a strategic move that both conventional crystalline cell and emerging thin film producers would be wise to adopt.



The need for scale

After a detailed study undertaken in 2006/7 with involvement from equipment suppliers and PV manufacturers from both cell and thin film camps, M+W Zander FE GmbH, a leading high-technology cleanroom, design and construction company with many years' experience in major projects around the world, realized that significant changes would be required in the building and operating of largescale PV manufacturing plants if the cost reductions required to meet grid parity were to be achieved.

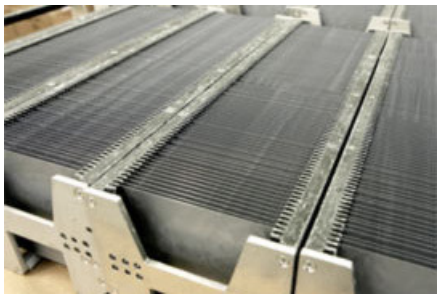
Wafer-based Manufacturing			60 MWp		200 MWp (Benchmark)		400 MWp		1000 MWp	
Area Category	Short Cut	Unit								
Administration Area	AA	m²	600	6%	1,500	6%	2,250	6%	3,375	4%
Facility Area	FA	m²	2,500	23%	5,200	22%	7,280	18%	11,648	13%
Logistics Area	LA	m²	600	6%	1,600	7%	2,880	7%	7,200	8%
Support Area	SA	m²	400	4%	800	3%	1,440	4%	2,880	3%
Manufacturing Area	MA	m²	6,600	62%	15,000	62%	27,000	66%	67,500	73%
Total Area	TA	m²	10,700	100%	24,100	100%	40,850	100%	92,603	100%
MWp/m²			0.009		0.013		0.015		0.015	
TA/MA			1.6		1.6		1.5		1.4	

Table 1. Wafer-based manufacturing: scaling and productivity considerations.

Source: M+W Zander FE GmbH

"I think the industry has to understand now and hopefully accept is that to reach its potential it needs to scale facilities to the gigawatt level" noted Robert Gattereder, Managing Director of M+W Zander FE GmbH. "Such levels cannot be achieved by 10X at 100MW lines. The costs will not come down sufficiently and the environmental issues are there in relation

to chemical usage based on current facility designs without a fresh approach in achieving real economies of scale." Gattereder highlighted that conventional PV manufacturing lines are based on a linear process flow arrangement according to their process function, typically employing manual Wafer In Process (WIP) transportation. Capacity is simply increased by adding further new lines in adjacent space.

Left: wafer production at Deutsche Solar AG. Source: SolarWorld AG. Right: production for solar cells. Source: M+W Zander FE GmbH

Though this is the typical approach taken by PV manufacturers, Gattereder believes that improvements to these conventional 'Farm' cell line facilities is still possible. He noted that improvements to equipment utilization can be realized that in turn reduce the number of tools required and reduce the manufacturing area required. Further savings could be achieved in regard to cutting labor costs, but as labor only accounts for a mere 3 to 5 percent of total operating costs, according to Gattereder, such improvements do not meet the required reductions in manufacturing costs to reach grid parity.

In the M+W Zander analysis (see table 1), the focus on scaling waferbased PV manufacturing highlighted that manufacturing cost savings in the region of 15 percent were possible when production reached the gigawatt level. The largerscaled facility could have a more efficient line and tool layout that actually delivers the true cost savings required. (see table 2).

"Manufacturing cost savings in the region of 15 percent were possible when production reached the gigawatt level"

M+W Zander believes that the waferbased gigawatt fab will need to be highly integrated and scalable. Due to capital costs and manufacturing ramp timescales, a gigawatt fab could be established in two major steps. The plant (see Figure 1, overleaf) would consist of approximately two 450MW modules with each module having a dedicated wafering , cell manufacturing and module assembly area.

A key manufacturing cost reduction aspect of this design, M+W Zander believes, is that the main facilities area positioned between each module would service and support both modules' requirements, thus making savings for considerable facilities with such large-scale manufacturing.

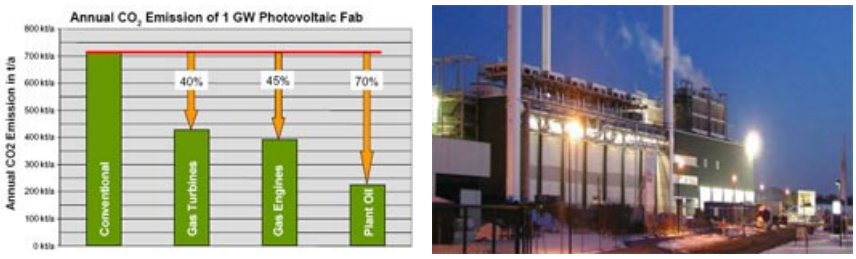
"When we talk about the gigawatt fab we are also talking about the production capacity which is 750,000 wafers a day.Then one thinks of the usage level of something like UPW and it's enormous, something in the range of 250-300 cubic meters an hour. This, we feel, creates the need for solutions not only in recycling but in usage. What we do not consume we don't have to recycle", said Gattereder. Gattereder noted that water recycling, for example, is not a general practice, as historically PV production levels have been low. The mindset therefore needs to change for megawatt manufacturing in the form of a bottom-up approach.

"What we found out was that cost improvements are possible in regard to

the consumption of water, process chemicals and energy. These all have high potential for reducing costs."

"When we talk about the gigawatt fab we are also talking about the production capacity which is 750,000 wafers a day"

Gattereder quickly added that, "Just a focus on chemical usage – our assumption is that we need to achieve a 50 percent recycling of HF chemicals in the facility and at least a 60 percent plus level of recycling of Ultra Pure Water (UPW). This should bring us a several percent reduction in cost, excluding the wafer."



"Green Energy" – high efficiency and reduced CO2 footprint. Source: M+W Zander FE GmbH

For a fully utilized gigawatt facility, Gattereder also expects the need for 25-30 megawatts of required energy. This would necessitate a co-generation or tri-generation solution, something similar to that used by semiconductor microprocessor manufacturer AMD in Dresden, Germany, whose co-generation plant M+W Zander project managed. The challenge is to combine the reduction of cost-per-watt, but also to reduce the carbon footprint while providing greater energy efficiency as shown in Figure 2.

This will become an important issue later as many experts expect carbon tariffs on industries to be implemented across several countries in the not too distant future.

Area Category	Short Cut	Unit	20 MWp		60 MWp (Benchmark)		200 MWp		1 GWp	
Administration	AA	m²	570	7%	1,000	6%	1,800	6%	4,000	5%
Facility	FA	m²	1,780	22%	2,500	14%	3,500	11%	8,000	11%
Support	PS/GS	m²	1,130	14%	1,530	9%	2,000	6%	5,000	7%
Logistics	LA	m²	1,032	13%	2,500	14%	4,000	13%	10,000	13%
Manufacturing	MA	m²	3,400	43%	10,000	57%	20,000	64%	48,000	64%
Total Area	TA	m²	7,912		17,530		31,300		75,000	100%
Capacity	C	MWp	20		60		200		1000	
MWp/m²			0.006		0.006		0.010		0.021	
TA/MA			2.3		1.8		1.6		1.6	

Table 2 Thin film manufacturing: scaling and productivity considerations. Source: M+W Zander FE GmbH

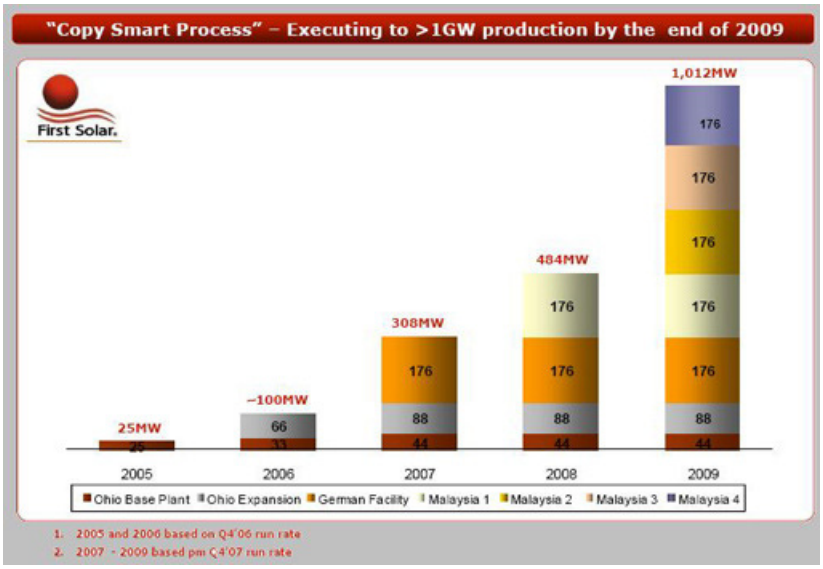
"Overall, there is no low-hanging fruit, so we have to combine a variety of factors to gain the cost advantages. The important message is that there is a productivity gain of 15 percent when considering the scaling of the facilities", commented Gattereder.

Thin film scaling

As part of the study, M+W Zander also looked at the thin film manufacturing area, which has gained considerable interest from new entrants. For example, major equipment suppliers such as Applied Materials, Oerlikon Solar and Ulvac can offer turnkey manufacturing solutions, while side-stepping the persistent polysilicon supply shortages and intrinsic higher raw material costs associated with supply constraints. Thin film therefore offers the ability-based available capital to ramp production to larger scales without the silicon hindrance.

Left: Thin film production with technology by Oerlikon. Source: Oerlikon Solar. Right: Applied SunFab: Production linie for thin film modules. Source: Applied Materials.

However, there are few current examples of companies proving that rapid scaling of thin film plants is achievable at levels greater than those of crystalline wafers. The only clear example of this is First Solar. In its February 2008 financial conference call, the company revealed that it expects annual capacity to reach approximately 1 gigawatt by the end of 2009 with the expected full ramp of all four plants in Malaysia going to plan. Capital spending in 2008 has been put at US$500 million to expand capacity towards that goal.



First Solar – 1 GW production schedule by end of 2009. Source: First Solar Inc.;M+W Zander FE GmbH

However, it should be noted that First Solar's capacity ramp is based on multiple facilities, some of which are not centred in Malaysia. But what it does highlight is that First Solar has been able to ramp thin film production towards the 1 gigawatt scale faster than the top five wafer-based PV manufacturers (see Figure 3), few of which expect to reach the 1 gigawatt level in the same period.

According to M+W Zander, thin film fabs could benefit from an area ratio improvement of as much as 12 percent when scaled to the gigawatt production level, as shown in Table 2. Another revealing aspect of the M+W Zander study is the ability for thin film facilities to be even more cost-competitive at the gigawatt scale. With overall utility cost savings as highlighted earlier, a comparison between wafer-based and thin film manufacturing (see Table 3) shows that thin film utility demands are significantly less than those for wafers.

Facility System	Wafer-based (Wafer, Cell, Module)	ThinFilm (CIS)	Unit
Make-Up Air	1.200.000	190.000	m³/h
Total Exhaust	1.100.000	170.000	m³/h
Electrical (Total on Site)	80	60	MW
Process Cooling Water	1.600	2.100	m³/h
Ultra Pure Water (Consumption)	220	300	m³/h
Compressed Dry Air	9.400	2.500	Nm³/h
N2	1.600	50	Nm³/h
HF	140	n.a.	l/h

Table 3. Sample Utility requirements: Giga fab manufacturing. Source: M+W Zander FE GmbH

Conclusion

Gattereder believes that the economies of scale that a gigawatt fab can provide for wafer-based PV manufacturers offer a reduction in investment outlay of approximately 25 percent in total. The potential reduction in capital outlay for large size thin film PV manufacturers is even higher. According to Gattereder, increased glass substrate sizes would see even further reductions. Scale, it would seem, is everything, but is there really an interest on the part of the major PV manufacturers to significantly scale facilities to the gigawatt level? "There are three serious players in the market where we have undertaken conceptual design work" said Gattereder. "To meet continued growth and drive towards grid-parity in the 2010-2012 timeframe, I believe the industry will need these gigawatt fabs."

Author: Mark Osborne is the Editor-in-Chief of Photovoltaics International the only journal specifically designed for the PV supply chain, including materials, components, equipment, manufacturing and large-scale utility installation.

Free issue of Photovoltaics International Journal

Solarserver.de has negotiated a special offer for newsletter subscribers to receive the inaugural issue of Photovoltaics International Journal for free (normally $59 USD). There is no obligation to purchase a subscription after receiving the initial promotional copy: www.pv-tech.org

Additional Solar-Reports:

- Building integrated Photovoltaics (BIPV): Solar electric power systems conquer large roofs and façades
- Solar thermal in Europe: expanding markets, state-of-the-art technical solutions
- Photovoltaic investments outside Germany? Looking into the southern EU states
- Solar power from the desert rather than desert in Germany
  New Study: Renewable Energy can replace abandoned Nuclear Energy in Germany
- BBC Interview with Dr. Knies (TREC): The energy source of the future is solar
- Photovoltaic industry achieves record profits, discussion over high module prices continues
- Chinese solar modules penetrating the German market
- Solar Roof Tile Exhibition shows developments in photovoltaic roofing
- Intersolar 2006: Solar technology and demand at an all-time high
- New Photovoltaic Factories and Capacities in Germany
- Renewable Energy in Australia
- Cooling with Solar Heat: Growing Interest in Solar Air Conditioning

- Building Solar: The Prospects and Costs of Living with the Sun
- Fuel Cell Research and Development in Southern Germany
- The Photovoltaic Market in Japan: Unquestioned Leadership of World Market
- The National Energy Plan
- Trade Fair Intersolar 2001 Presents World Wide Solar Technology for the First Time
- Solar Thermal Technologies in the United States
- An Overview of Photovoltaics in the USA
- The Year 2000: Breakthrough for Solar Technology in Germany
- Fuel Cells and Solar Hydrogen-A Power Package for the Future?

Banner Advertising | Bulletin Board | Events | Solar Magazine | Funding for Solar Energy | Companies | Solarstore (G) | Non-Profit Organizations | Lexicon | Basic Knowledge | Educational Institutions | Imprint | Contact Us | Home

up

Last modified: 08/11/2008 13:44:17
Webdesign Heindl Internet AG