

Investment Opportunities in the PV Industry in Taiwan

I. Top five reasons to invest in the PV industry in Taiwan

1. Number two PV exporting country in the world
2. Complete PV industrial chain from the upstream to the downstream
3. Industrial environment of semiconductor and panel industries
4. Competitive advantages of Taiwan and China are complementary to one another
5. Diverse cluster development systems for related industrial clusters

II. Current Status and Future Development Trends of the PV industry in Taiwan

For the semiconductor industry, TFT-LCD industry, LED industry, and IT power electronics industry in Taiwan, their industry clusters are complete and involve not only suppliers, but also academic community, industrial research institutes and related industrial associations. If classified in a deep level, then the entire industry can be divided into the upstream and downstream of silicon materials, silicon wafer manufacturing, solar cells, solar modules, peripheral equipment and back-end system integrators. There are about 30 domestic suppliers in this industry, and the total investment is more than NTD\$100 million.

Table 1 Output Value of Taiwan's New Energy Sectors (Unit: NT\$ million)

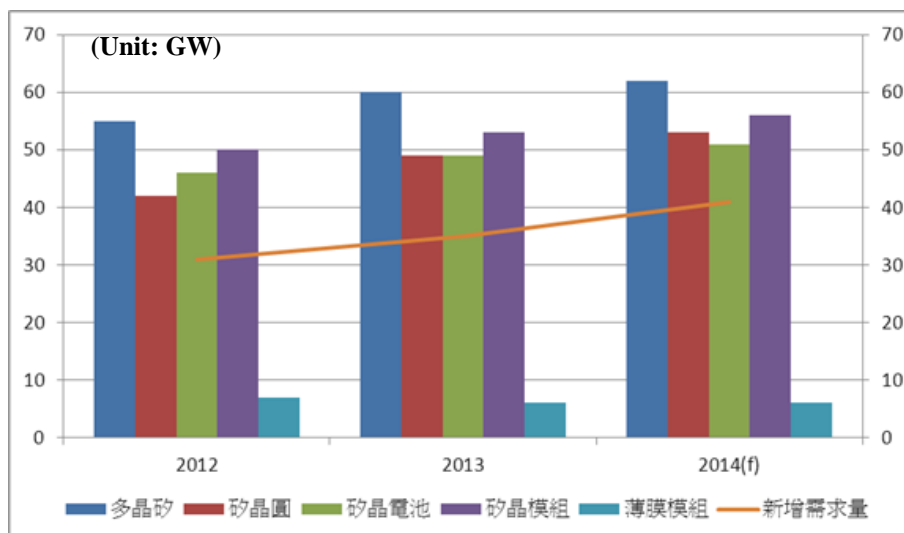
	2010	2011	2012	2013	2014	Percentage (%)	2013 Growth (%)	2014 Growth (%)
PV	206,200	164,043	94,386	135,644	169,516	93.23%	43.71%	24.97%
Wind Power	5,700	6,610	7,190	8,530	9,500	5.23%	18.64%	11.37%
Biofuel	1,400	1,914	3,197	2,870	2,800	1.54%	-10.23%	-2.44%
Total	213,300	172,567	104,773	147,044	181,816	100.00%	40.35%	23.65%

Note: PV industry includes polysilicon, silicon wafers, silicon cells, silicon modules, thin-film solar photovoltaic modules and concentrator

Source: IEK-ITIS (2014/02)

Output value of Taiwan's PV industry reached its peak, NT\$206.2 billion in 2010. Since 2011, the price competition from cheap Chinese PV products resulted in the collapse of many European manufacturers. Also, European countries significantly reduced or suspended subsidies which shrunk the global market. Therefore, the output value of Taiwan's PV industry declined to only NT\$94.39 billion in 2012. After two years of industry re-structuring globally, survival of the fittest, the market started to recover and moved to China, Japan and the United States. The output value of Taiwan's PV industry was NT\$ 135.6 billion in 2013. Because of the continuous demand growth in Japan and increasing domestic consumption in China, Taiwan's PV manufacturers begin to turn profit and make new investments.

Looking at 2014, the demands are very like to grow from 35GW to 42GW (Figure 1) and various sub-industries will have a small capacity expansion, including silicon wafer. However, the oversupply situation remains. It will affect the industry's capacity utilization rate. Fortunately the current rate of total demand growth is higher than productivity growth rate. Therefore, the projected average capacity utilization will still rise. Utilization of polysilicon industry is expected to increase to 71%; silicon and silicon cells will increase to 75%; modules and thin film silicon modules increased to 67%. In other words, due to lower technical barriers the module industry will have more new entrants, resulting in lower capacity utilization.

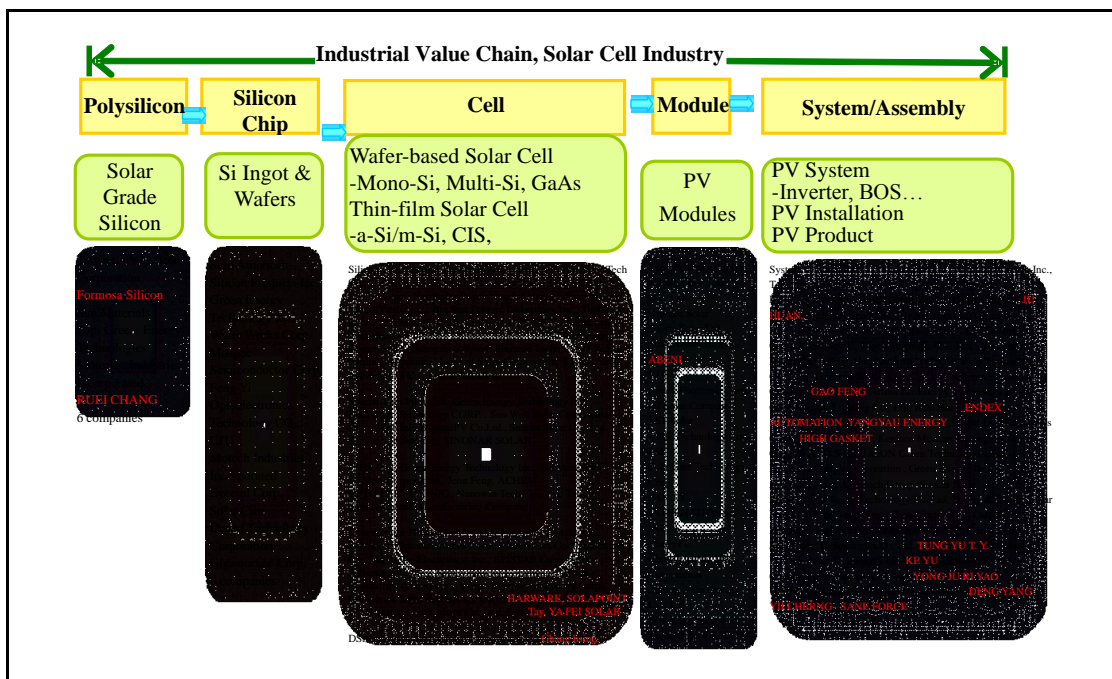


Source: IEK (2013/12)

Figure 1 Current Capacity and New Demand of Taiwan's PV Industry

III. Operational Status and Future Plans of Important Manufacturers in the PV industry in Taiwan

To enhance global competitiveness, Taiwan manufacturers all engage in either horizontal or vertical integrations. Even for Gintech Energy Corp, or the top manufacturer in Taiwan, they still choose to move toward vertical integration.



Source: IDB, IEK

Figure 2 Industrial Chain of Solar Cell Industry in Taiwan

In general, the supply chains of the solar cell industry are classified as upstream (materials, silicon ingot, wafer), midstream (battery and module), and downstream (system, inverter, BIPV and other terminal products).

UMC Group was the earliest manufacturer to vertically integrate its supply chain. UMC Group first founded NexPower Technology Corp, or the thin film solar module supplier for the midstream, and then entered into the fields of mass manufacturing, sales and marketing. Its current production capacity is 100MW with a 9~10% photoelectric conversion rate; UMC Group later established Topcell Solar International and Copartner, upstream solar cell suppliers for RD and mass production of mono-crystalline silicon cells, multicrystalline cells and GaAs. Then AUO and TSMC also bet on the thin film market and committed RD resources for the market. AUO can manufacture CIGS modules by itself (but not yet for product sales and distribution); TSMC set its CIGS plant in Taichung and

the timing for mass manufacturing is not yet clear.

The midstream suppliers are also starting to seek partners to enhance their competitiveness. For instance, Gintech Energy Corp. CTCI Corp, Taiwan Fertilizer and Mitsubishi Corp (Japanese Supplier) have established a cross-industrial and collaborative alliance. This alliance capitalizes on channeling resources from CTCI, lands from Taiwan Fertilizer, financial strengths and experience from Mitsubishi to compete in the marketplace. In the future, the solar cell market will be the battlefield for groups rather than individual manufacturers.

The Table below lists operational performance of major participants in the supply chain. Terminal products are mostly export-oriented, and their sales are subject to fluctuation in the international market, but the industrial structures and environments are still health and complete.

Table 3 Important Suppliers of the PV Industry in Taiwan

Unit: NT\$ million

	2013		2012		2011	
	Revenue	Net Profit Ratio (%)	Revenue	Net Profit Ratio (%)	Revenue	Net Profit Ratio (%)
Giga Solar	4,851	12.57	3,474	17.25	3,055	33.73
DARFON	23,501	0.02	13,034	1.72	12,375	1.3
Sino-American Silicon Products	22,215	1.53	4,373	-54.14	14,856	2.88
Green Energy Technology	13,258	-18.01	9,836	-36.33	18,615	-12.73
Wafer Works	5,446	-11.61	3,429	-19.4	5,158	1.61
Danen Tech	1,011	-61.72	902	-84.17	3,869	-8.46
Gintech	15,098	-3.92	13,966	-13.77	18,808	-8.44
Motech	21,350	1.13	10,210	-49.33	20,430	-12.01
E-Ton Solar	3,269	-49.19	2,046	-87.84	6,729	-60.23
Neo Solar Power Corp.	20,084	2.57	12,271	-34.01	20,576	-14.08
Solartech Energy Corp	7,021	-5.27	6,137	-29.59	12,153	-10.1
Tainergy Tech	5,148	4.25	3,497	-41.56	3,952	-15.25
Powercom	1,821	-28.73	2,004	-55.46	3,241	-41.85

Source: MOPS (2014.06)

IV. Advantages of the PV industry

- ◆ Complete supply chains, talent pools, and industrial clusters for the midstream and upstream sectors in the PV industry in Taiwan.
- ◆ Taiwan is one of the top four PV production countries; the industry expands rapidly and can provide excellent environments to develop intelligent PV automation technologies.
- ◆ Silicon chips: solid semiconductor manufacturing and technology management experiences are available and these experiences can be applied to production process of silicon chips (components for solar cells) to lower production costs.
- ◆ Solar cell: rich talent pools of semiconductor professionals are available and the barrier for entering into the silicon chip and solar cells is very low.
- ◆ Industrial end: domestic suppliers are very flexible and can raise capital and expand capacity very fast and this is very beneficial to capitalize on the first mover advantage and the professional division model is very helpful to increase production benefits.

V. Opportunities of the PV industry

- ◆ Domestic suppliers can rapidly expand their production capacity and demands for PV equipment can be enlarged. Also, to solve the issue of talent shortages, domestic suppliers have high demands for production automation. Automation equipment from overseas vendors are expensive and user-unfriendly and their lead time is very long and service efficiency is very low. So, they are not popular among domestic suppliers.
- ◆ Industrial end:
 - Continuous development in the global market
 - Applications of architectural integration can be seen as demands in a different market
 - Use downstream module suppliers to perform supply chain consolidation and integration.

The table below details the subsidy policies from the government in Taiwan to encourage installations of distributed PV systems in private properties.

Table 3 Subsidy Policies for Solar Cells

Item	Descriptions of PV initiatives in Taiwan
Subsidy for Equipment	<p>Highlights of subsidizing installations of PV systems</p> <p>Condition: applies to only new systems with a capacity of no less than 1 kWp</p> <p>Subsidized amount: maximum of NTD\$150,000 for every kWp and the subsidized amount shall not exceed 50% of total system installation fees. Government branches, schools and public hospitals located in offshore islands and remote locations can apply for subsidies of Solar photovoltaic power generation system for use in emergencies and disasters via municipalities, county or city governments from Bureau of Energy:</p> <ol style="list-style-type: none"> 1. for independent systems, the maximum subsidy is NTD\$350,000 for every kWp 2. for emergency and disaster prevention systems (hybrid models), the maximum subsidy is NTD\$400,000. After review, if the system provides benefits associated with disaster prevention, energy benefits, and demonstration effects, applicants can receive the full balance and it is not subject to restrictions from the first point.
Subsidy for Electricity Consumption	<p>Renewable Energy Development Regulation:</p> <p>In case the device generates electricity with renewable energy, if the device capacity is less than 500W, then the device is not subject to articles 97, 98, 100, 101 and 103 in the Electricity Act</p> <p>Except articles 8, 9 and 14 which have different regulations of renewable energy power generation devices, the Electricity Act applies to installations, projects, operations, monitoring, registration and management of the renewable energy power generation devices.</p> <p>Taipower Corp. buy back regulation for electricity generated using renewable energy – the buy back rate is NTD\$2 per degree and this applies until the following conditions occur:</p> <ol style="list-style-type: none"> 1. announcement of regulations governing development of renewable energy 2. the power generating devices (using renewable energy) for which the purchasing contract of electricity buy back is signed under has power capacity of 600,000 W 3. the Electricity Act is revised and published and Taipower Corp has completed privatization
Practices of Tax Credit as Subsidy	<p>Industrial Promotion Regulation: A tax credit of 5~20% of device installation fees will be provided to companies investing in clean energy devices, and the tax credit is valid for five years from the first year of request application</p> <p>35% of corporate RD expenditures and employee trainings expenses; the tax credit will be valid for five years from the first year of request application; if the RD expenditure of the year of subsidy application exceeds the average of the expenditures from the previous two years or the training expense of the year of subsidy application exceeds the average of the training expenses from previous two years, 50% of the exceeded amount can be subsidized.</p> <p>The remaining tax credit from the last two points can be used in the subsequent years, but the amount subsidized shall not exceed 50% of the total income tax.</p>

Source: Executive Yuan

Because the demands in the solar energy market continue to grow and the trend – rapid market expansion and demand creation through low product prices – has become clear, known suppliers (such as J&R, ACI, ABB from Europe) and developed countries such as Japan are actively developing automation production technologies to lower their reliance on human labor, to increase throughput and equipment utilization rates and to achieve the goal of doubling the per capita output level. However, automation equipment from overseas vendors are expensive and user-unfriendly and their lead time is very long and the interfaces are hard to integrate. These combined drawbacks cause high breakage rates or production interruptions. Moreover, the low service efficiency of the distributors make them ineffective to address user issues. So, they are not popular among domestic suppliers and users are very negative about these systems. Another issue is that most domestic suppliers are looking to expand their capacity to GW. They have a lot of production lines and handle a large quantity of base substrates. Tests on the defectives and electric property are usually conducted offline. The online tests and production lines are very difficult to integrate, causing low production capacities and low yield rate. Furthermore, Turnkey equipment and manual production lines are adopted in the plant and wafer thickness is reducing from 200 μ m to 160 μ m. Because of these factors, the chance of artificial pollutions and breakage rates become very high (current breakage rate: 3%). Thus, increasing production capacity for individual production lines and yield rates are urgent issues suppliers need to address first before their competitiveness can truly be enhanced.

Currently, the production capacities of Taiwanese suppliers and Chinese suppliers together make up 50% of the global capacity, but whether it is extracting silicon materials or manufacturing equipment, our standards and qualities are still far behind developed countries including Japan and western countries. What Taiwan has is the quality semiconductor process technologies. If this can be combined with the strengths of China (one stop shop, great bargaining power to lower material prices with orders of large quantity) to expand production capacity, enhance the photoelectric conversion rate, to cut down shipping cost, to lower production cost with effective HR management skills and to offer cheaper but more effective PV products, then the results will be far better than if Taiwan and China are to go different ways.

Taiwan has a complete industrial chain of silicon solar cells and industrial gaps are mostly found in other emerging processing technologies (ex. CIGS research and development) and new applications (BIPV module). Major cities in

Taiwan have their urban renewal plans in place and the overall environments are very complete. Thus, these conditions make Taiwan an ideal destination for developing international trades and BIPV systems foreign investments.