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Taiwan's photovoltaic (solar) industry is rapidly establishing itself as a major international player. Currently ranked fifth in global production, it has tremendous long-term growth prospects. The domestic legislature has proposed spending NT \$30 billion (US \$8.8 billion) over five years to support renewable energy research and development projects, especially the photovoltaic and LED industries. In response, the National Science Council is heavily promoting the status of photovoltaic R&D projects in 2009. Investors and scientists alike hope to transform Taiwan into a "Green Silicon Island" that can stay globally competitive by remaining at the forefront of new technological trends and advances. As the United States continues to search for cleaner sources of energy, partnerships with Taiwanese PV manufacturers would ultimately benefit both sides.

In search of a cleaner, greener future

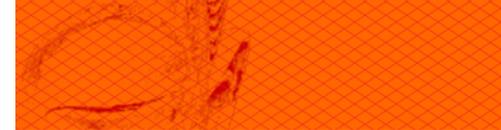
Imagine a time when efficient solar panels can meet the energy needs of every household in America. One day, clean solar energy could power our televisions, our dishwashers, and heat our homes. The United States would no longer suffer from the effects of volatile oil markets or depend upon the unstable and odious regimes feeding our national addiction. As China consumes an increasingly large share of global energy supplies, competition for access to existing oil, natural gas, and coal resources will continue to exacerbate the problem. Reducing U.S. dependence on carbon-based fuels requires pragmatic, long-term solutions. As observers highlight the growing need for environmentally sound alternatives, Taiwan is at the cutting edge of global renewable energy technology. By combining U.S. research and development expertise with Taiwanese industrial prowess, both countries draw closer to developing viable solutions to the energy security and environmental challenges that lay ahead.

The Taiwanese photovoltaic (solar) industry, while affected by the global financial crisis, still has tremendous long-term growth prospects. Solar panels are part of the same supply chain comprising the silicon chip and LCD industries that have already made the island famous. Based on a total estimated production value of NT\$90 billion (US\$2.6 billion) in 2008, the Taiwan PV industry already ranks fifth globally. According to the [Photovoltaics Technology Center \(PVTC\)](#), part of Taiwan's [Industrial Technology Research Institute](#), last year Taiwan exported 900MWp of crystalline silicon solar cells, comprising 16.4% of the 5.5GWp PV systems installed globally. Taiwan also exported 100MWp of PV modules and 5.5MWp of systems. One study estimates that the total production value will quadruple by 2010, increasing to NT \$20-25 billion (US \$590-738 million).ⁱ

The industry comprises more than 70 domestic firms. The two largest Taiwanese players in the international market are [Motech](#) and [Gintech](#). Motech was ranked as the sixth-largest PV cell manufacturer in 2007, and was the eighth-largest producer of thin-film PV cells in 2008. Industry analysts expect that Gintech, established in 2005, will also rank within the top ten in global production capacity this year. The company expects to produce 8% of the estimated world total of seven gigawatts.ⁱⁱ The domestic semiconductor and LCD panel industries have already exceeded total production values of NT \$1 trillion (US \$29 billion), and Taiwanese officials hope that the PV industry will emerge as the third domestic industry to pass this benchmark.ⁱⁱⁱ

In response to these trends, Taiwan's Executive Yuan has proposed spending NT \$30 billion (US \$8.8 billion) over five years to support renewable energy research and development projects, especially the photovoltaic and LED industries. The [National Science](#)

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Council is consequently elevating the status of R&D projects in these two industries in 2009, which will guarantee increased levels of government funding. Greater funding will drive the industry to increase its energy conversion efficiency rates (currently 15-16%, in comparison to international levels of 17%), as well as to ensure its self-sufficiency of polycrystalline silicon (a key ingredient of PV panels).^{iv} The Ministry of Economic Affairs (MOEA) has also recently announced that the government will earmark NT \$486 million (US \$14.5 million) in 2009 to subsidize projects generating solar power.

Cross-Strait cooperation in the photovoltaic industry is also moving forward. A two-day seminar held in late March in Taipei brought together approximately 600 solar energy manufacturers, photovoltaic scientists, and energy regulators from both China and Taiwan. Seminar participants discussed PV industry policy, trends, and the development of new standards. As Chinese firms gain the ability to invest into the Taiwanese PV industry, both sides anticipate that they will begin to engage in more robust cooperation starting in 2011.^v

The semiconductor industry begins to revolve around the sun

Industry analysts have recognized over the past couple of years that Taiwan's semiconductor industry might not remain profitable in the long-term. During the past economic boom, firms rushed to increase capacity to keep up with burgeoning demand. However, a recent rise in silicon prices and the global economic downturn has resulted in overcapacity problems and lost profits. The Taiwanese government has begun to consolidate some companies to increase their competitiveness.

Consequently, approximately 70-80% of domestic semiconductor companies have begun to investigate potential investment in the solar industry. Some of the big players, such as [United Microelectronics Corporation](#), are retooling existing factories to produce thin cell wafers. These wafers are less expensive to produce, although they're not as efficient as traditional wafers. The entire industry will require increased amounts of investment as well as research and development to reach its full potential. Significantly, the Taiwanese government is offering tax breaks for investors during the economic downturn. The Ministry of Economic Affairs (MOEA) is providing short-term investment incentives to manufacturers in hopes of spurring industrial growth across the island.

American and Taiwanese firms in the semiconductor industry have hitherto enjoyed a symbiotic and profitable relationship. Over the years, American firms have moved towards a fabless model, often handling product design as well as research and development. Although there are still a number of prominent semiconductor fabrication firms, such as Texas Instruments, IBM, and Intel, their numbers are decreasing. Conversely, efficient Taiwan firms, which pioneered the dedicated foundry model of development, produce the actual product either in Taiwan proper or in Taiwanese-run factories abroad. (The Apple iPhone is an excellent example of this partnership.) Major companies such as DuPont are thus investing directly in Taiwan, taking advantage of its regional science parks, intellectual property protection laws, highly educated workforce, and strong rule of law. DuPont owns four manufacturing facilities in Taiwan, including two research and development centers and one laboratory. The [DuPont Taoyuan Electronics](#) site in northern Taiwan is a PV research,

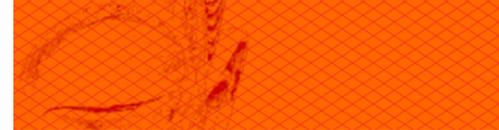


Lighting the 2009 World Games

The multi-purpose stadium in Kaohsiung, Taiwan, host for the 2009 World Games, is the world's first stadium to be powered by solar energy. The stadium's 8,844 solar roof panels generates up to 110 Kwh of electricity per year, meeting the 55,000 seat stadium's energy demands for lighting and air conditioning during the Games. This breakthrough innovation in photovoltaic technology, engineering and architecture will also allow surplus electricity to be sold to the Taiwan Power and Co., generating up to NT\$5 million in revenue for the Kaohsiung city government.

Images: the stadium (top), solar roof panels (bottom-left) and interior of the stadium (bottom-right).

Source: [The World Games Concert](#) and Flickr



development, and technical support facility, in addition to housing an educational display area and laboratories.

Building a “Green Silicon Island”

In order to stay globally competitive, Taiwan must remain at the forefront of new technological trends and advances. As part of the government economic strategy to transform Taiwan into a “Green Silicon Island,” it is looking to create a regional nanotechnology research and development center. Nanotechnology has direct applications in both the semiconductor and photovoltaic industries. On the one hand, employing narrow circuitry allows engineers to produce greater numbers of chips on increasingly larger wafers, thereby reducing costs and increasing market competitiveness in the semiconductor industry.^{vi} On the other hand, scientists are also taking advantage of nanotechnology to reduce costs and increase competitiveness. The Photovoltaics Technology Center is using nanotechnology to improve solar cell conversion efficiency. Researchers have successfully produced minute columns on solar cell surfaces. These cells consequently absorb sunlight and convert it into power far more efficiently.^{vii}

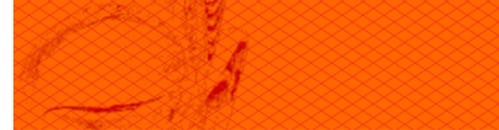
Such advances are extremely useful for creating better thin-film solar cells. Thin-film cells are industrially advantageous because do not require high-cost raw materials or elaborate manufacturing equipment during production. Dye-sensitized and other thin-film cells are mechanically robust and engineers can use them to create flexible sheets. For example, Taiwanese researchers have looked at ways to incorporate thin-film solar cells into handbags, so that consumers can use them to power their portable electronic devices. The cost of setting up a thin-film production line is also relatively inexpensive. The Bureau of Energy states that while establishing a production line for standard 12-inch semiconductor wafers can cost as much as NT \$60 billion (US \$1.8 billion) and a typical crystalline silicon solar cell production line can require expenditures between NT \$200 million (US \$6 million) and NT \$300 million (US \$9 million), it costs only about NT\$2 billion (US\$60 million) to set up a thin-film solar cell production line.^{viii} The greatest disadvantage to using thin-film cells, however, is that their energy conversion efficiency is lower. Recent advances in nanotech R&D are thus all the more important as researchers, investors,

and manufacturers are extremely interested in the future development of thin-film solar cell technology.

Creating successful partnerships between U.S. and Taiwanese firms

President Obama has advocated pumping \$150 billion dollars over the next ten years into both renewable technologies and energy conservation measures. The economic stimulus bill itself allocates tens of billions of dollars to green initiatives. Although stimulus funds cannot be placed directly in the hands of foreign companies, joint partnerships are an excellent opportunity to take advantage of the best assets of American and Taiwanese companies. For example, Hemlock Semiconductor Corporation (HSC) in Michigan produces quartz-based polycrystalline silicon. The factory employs over 1,000 direct and contract employees. In addition to its corporate headquarters, it has sales offices in Belgium, Japan, and Korea. HSC is a joint venture of Dow Corning Corporation and two Japanese companies: Shin-Etsu Handotai Co. Ltd. (the world's largest semiconductor producer) and Mitsubishi Materials Corporation. Hemlock recently announced a \$3 billion expansion project, welcome tidings for an economy desperately seeking profitable industries. Green initiatives in the United States lack the types of government subsidies present in countries such as Germany and Spain, making it necessary for the American PV industry to partner with established firms to ensure greater efficacy and profitability. Joint venture partnerships between American and Taiwanese firms are thus an especially attractive option for U.S. investors looking to benefit from the nascent green revolution and find safer investments in a challenging economic climate.

United States firms looking to invest in the Taiwanese photovoltaic industry should first make the appropriate contacts and seek the proper introductions. On the American side, there are three primary organizations that represent U.S. business interests. The [US-Taiwan Business Council](#) facilitates American trade, business, and investment in Taiwan. The Arlington, Virginia based organization is funded solely by its members, which range from small consulting firms to large multinational corporations. Likewise, the [American Chamber of Commerce](#) in Taipei promotes foreign



business interests, boasting a membership of over 500 companies. These are both non-governmental organizations. The [American Institute in Taiwan](#), with offices in Taipei and Kaohsiung, offers U.S. companies counseling and custom market research services. AIT, a government entity that serves as the de-facto embassy, represents the U.S. Department of Commerce and its export and business assistance programs. On the Taiwan side, American investors should contact the Ministry of Economic Affairs (MOEA) [Department of Investment Services](#) or the [Taiwan Photovoltaic Industry Association](#) (TPVIA). The MOEA can provide current information regarding national trends and insight into which industries may receive future government funding. The TPVIA is a non-profit trade organization that acts as a portal for foreign investment and INGOs. It also coordinates with the Taiwanese photovoltaic industry, the government, and research organizations.

In an uncertain global economic climate, U.S. firms should invest in reliable industries with strong growth potential. The Taiwan photovoltaic industry is rapidly establishing itself as a major international player. As the United States continues to search for cleaner sources of energy, the photovoltaic industry will only continue to attract R&D funding and investment. A partnership with Taiwanese manufacturers would ultimately benefit both sides.

ⁱ “Academics Upbeat on Solar Cell Industry,” Taipei Times, Mar 1, 2007. Online Edition. <http://www.taipeitimes.com/News/biz/archives/2007/03/01/2003350563>

ⁱⁱ For a straightforward introduction to the PV industry in Taiwan, see Oscar Chung, “Toward a Sunnier Future,” *Taiwan Review*, March 1, 2009. Online edition. <http://taiwanreview.nat.gov.tw/fp.asp?xItem=48016&CtNode=128>.

ⁱⁱⁱ Sean Scanlan, “Solar and LED Industries Provide Energy Alternatives,” *Taiwan Business Topics* 39, no. 2 (2009), <http://www.amcham.com.tw/content/view/2670/421/>. The author utilized data from the Photovoltaics Technology Center of Taiwan’s Industrial Technology Research Institute (<http://www.itri.org.tw/eng/PVTC/>).

^{iv} Nuying Huang and Adam Hwang, “Taiwan Government to Beef Up Development of Solar Energy and LED Industries,” *Digitimes*. March 19, 2009. <http://www.digitimes.com/pda/a20090318PD200.html>.

^v “Taiwan, Mainland China Hold Talks on Photovoltaic Cooperation,” Reed Business Information Asia, Electronics Manufacturing Asia, March 24, 2009. <http://www.emasiamag.com/article-5267-taiwanmainlandchinaholdtalksonphotovoltaiccooperation-Asia.html>.

^{vi} “Nanotechnology,” Ministry of Economic Affairs, Department of Investment Services. Online resource. <http://investintaiwan.nat.gov.tw/en/opp/inds/nanotech.html>.

^{vii} Chung, “Toward a Sunnier Future.”

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For further reading:

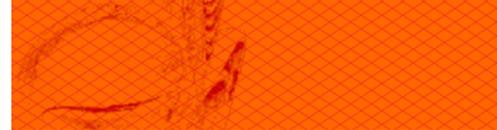
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