Photovoltaic industry 2009: a journey into uncertainty

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ABSTRACT

Despite over 30 years of unprofitability, being viewed as too expensive and in many cases, unattractive, the PV industry has also enjoyed over 30 years of strong growth. Though granted, in the past, this growth was often from a much smaller base than the gigawatt levels experienced today, it is still an impressive achievement. Table 1 provides a history of PV industry growth from 1978 to the present. The data in Table 1 is based on what was sold into the global market to the first point of sale, eliminating double shipment (sales) of technology.

During most of its >30-year history, the industry has experienced the sort of accelerated growth expected from emerging industries; for example, the internet boom. In the 30 years from 1978 to 2008, the PV industry had two years of >100% growth (1978 at 100% and 1980 at 120%); and six years of growth >50% (1979 at 50%, 1981 at 61%, 1983 at 88%, 2004 at 55%, 2007 at 55% and 2008 at 79%). It has not all been good times though: in 1985 industry sales (demand) grew by 11% over 1984; in 1986 industry growth was 8%; in 1993 industry growth was 3% and in 1994 industry growth was 10%.

In the early days when the industry saw <25MWp in yearly sales, most demand was for the remote applications (remote homes, villages, telecommunications, battery charging, etc.). In the late 1990s, Japan and Germany implemented incentive structures that drove demand for grid-connected installations. From 2000 through 2008, industry growth has consistently been >30%. It is important to remember, however, that despite extraordinary growth, on the manufacturing side (supply) the industry first turned a profit in 2004. Table 2 offers data on the major applications for the photovoltaic industry from 1998 through 2008, with a forecast to 2013. In 1998 the grid-connected application was still only 31% of total demand. The first year that saw demand for grid-connected systems take a major share of sales was in 2000, when the grid-connected application was 51% of demand and sales. In 2008, grid-connected sales were 94%.

The photovoltaic industry has suffered from unprofitability, from the high capital expense required to develop the technology – in part because of the long timeline from R&D through pilot-scale to commercial production, from the

stigma of its continuing need for subsidies (even though all energy technologies are subsidized at some point in the chain), and early on, from the perception that the technology was new and different and those who invested in it were similarly new and different. This is a lot for any industry to overcome, and through it all – the bad unprofitable days and the recent profitable ones – the industry has persevered, continuing to develop the best distributed generation technology currently available. Figure 1 shows the industry's 30-year climb to gigawatt sales.

Year	MWp	% Chg
1978	1.0	100%
1979	1.5	50%
1980	3.3	120%
1981	5.3	61%
1982	7.7	45%
1983	14.5	88%
1984	17.5	21%
1985	19.4	11%
1986	21.0	8%
1987	24.9	19%
1988	31.5	27%
1989	37.9	20%
1990	42.7	13%
1991	48.2	13%
1992	54.1	12%
1993	55.7	3%
1994	61.0	10%
1995	71.5	17%
1996	82.6	16%
1997	114.1	38%
1998	134.8	18%
1999	175.5	30%
2000	252.0	44%
2001	352.9	40%
2002	504.9	43%
2003	675.3	34%
2004	1049.8	55%
2005	1407.7	34%
2006	1984.6	41%
2007	3073.0	55%
2008	5491.8	79%

Table 1. PV industry growth (1978 – 2008).

The rise of thin films

The silicon shortage that hampered growth from 2004 through 2007 was not new; indeed, it had concerned the industry for many years and many discussions were had, and consortiums formed to address it. In 1995, when industry sales were 71.5MWp and the industry's primary silicon supply was scrap, there was panic over a silicon shortage and higher prices when the price of scrap remelt nearly doubled from US$7 to US$8.00 per kilogram to US$13.00 per kilogram. Crystalline manufacturers responded by announcing potential price increases. In fact, in 1995 average prices decreased by an average of 5% for all categories of buyers. The same year saw thin-film technologies represent 14% of total shipments, though thin film's share of global sales decreased for several years thereafter.

The silicon shortage that began (in earnest) in 2004 and continued through the beginning of 2008 was more severe than earlier shortages because the volume of demand had increased significantly. The PV industry had waited years for this strong demand, and the constraints to meeting it were frustrating. This increase in demand, driven by Europe's feed-in tariff incentive model, led directly to growth of large-field (often referred to as utility-scale) installations of >1MWp. As silicon became more costly (>US$400 per kilogram in some cases) and more scarce, and as demand climbed, crystalline modules became more costly and a case was made for thin films, which are theoretically less expensive to manufacture.

During this period, thin film's share of total sales increased from a 5% share in 2004, to a 7% share in 2006, to an 11% share in 2007 and to a 14% share in 2008. Previously viewed as a risky technology choice by system integrators and installers, thin-film technologies (in particular CdTe and a-Si) were able to overcome market resistance and make real, perhaps long-term, gains. Figure 2 presents thin films' contributions to total shipments from 1980 through 2008. The relative strength of thin films in the mid- to late-1980s was due to strong sales into the consumer indoor application (calculators, watches, etc.). During the mid- to late-1980 period, total shipments (sales) were <50MWp annually.

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Currently, high levels of inventory and soft demand are driving the cost of crystalline technologies down, and thin films are experiencing difficulties competing with the higher efficiency of crystalline. Despite this, thin films have made real gains in the market and are expected to have a 16% share of 2009 sales.

The good times screech to a halt

In the early days, PV manufacturers were unprofitable; research and development was (and still is) extremely capital expensive, and the market was either remote (off-grid) or demonstration (grid-connected). In 2004, the industry entered a stage of supply-constrained profitability, where strong demand was unquestioned and was assumed to be everlasting. Debt and equity financing were reasonably easy to come by. Particularly in markets with strong feed-in tariffs (Spain and Germany), systems sprang up seemingly overnight, and modules were bought under the belief that growth would continue at >40% a year for the foreseeable, and even unforeseeable, future. During this time industry quality standards and performance guarantee

	1998	2003	2008	2013		CAGR	CAGR	CAGR 2008-2013	
Grid Sub-Application	MWp	MWp	MWp	Conservative MWp	Accelerated MWp	1998-2003	2003-2008	Conserv.	ACC.
Grid-Residential	32.8	426.1	1544.0	4587.3	8514.9	67%	29%	24%	41%
Grid-Commercial	6.7	51.3	2727.7	7492.5	13907.7	50%	121%	22%	39%
Grid-Utility	2.5	6.8	874.9	3211.1	5960.5	22%	164%	30%	47%
Total Grid	42.0	484.2	5146.6	15290.9	28383.1	63%	60%	24%	41%
Total Demand	134.8	675.3	5491.8	15839.8	28994.4	38%	52%	24%	39%
Grid % Total	31%	72%	94%	97%	98%				

Table 2. PV industry application split (1998 – 2008).

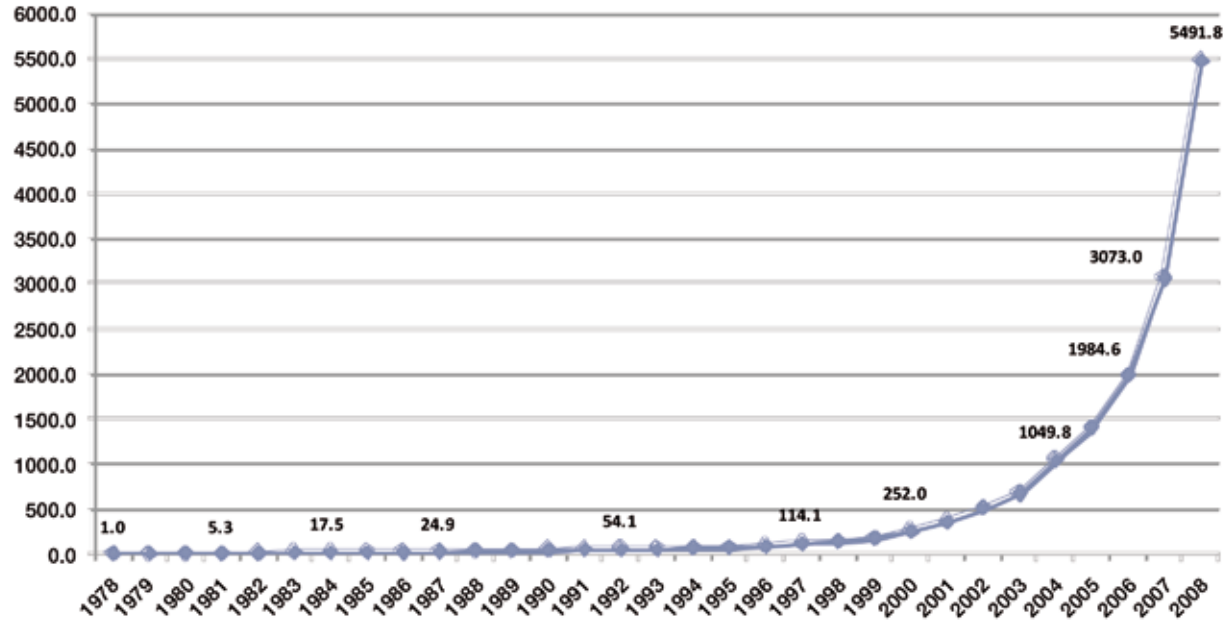

Figure 1. PV industry shipments (1978 – 2008).

requirements were relaxed (primarily by investors, who have now learned how important these standards were and are to industry sustainability). New entrants, though well-meaning but also lacking the experience of 30 unprofitable years, did not understand that the potential of lower-cost manufacturing is not the entire story, and that grid parity is a far more complex concept than it appears.

During this period strong demand drove up prices, even for thin films in certain markets. In 2008, technology revenues increased by 80% to US$20.4 billion.

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Unfortunately, in 2008 the market in Spain was significantly oversold, and has since collapsed. Even more unfortunate, worldwide economies were driven into recession by a global financial collapse that has almost frozen debt and equity availability into 2009. Regarding the markets in Europe, Spain and Germany consumed 74% of total module sales in 2008, with the rest of Europe taking another 5%. In particular, with the collapse of the market in Spain, there is simply no other global market that can consume 42% of sales. Figure 3 presents supply (sales)

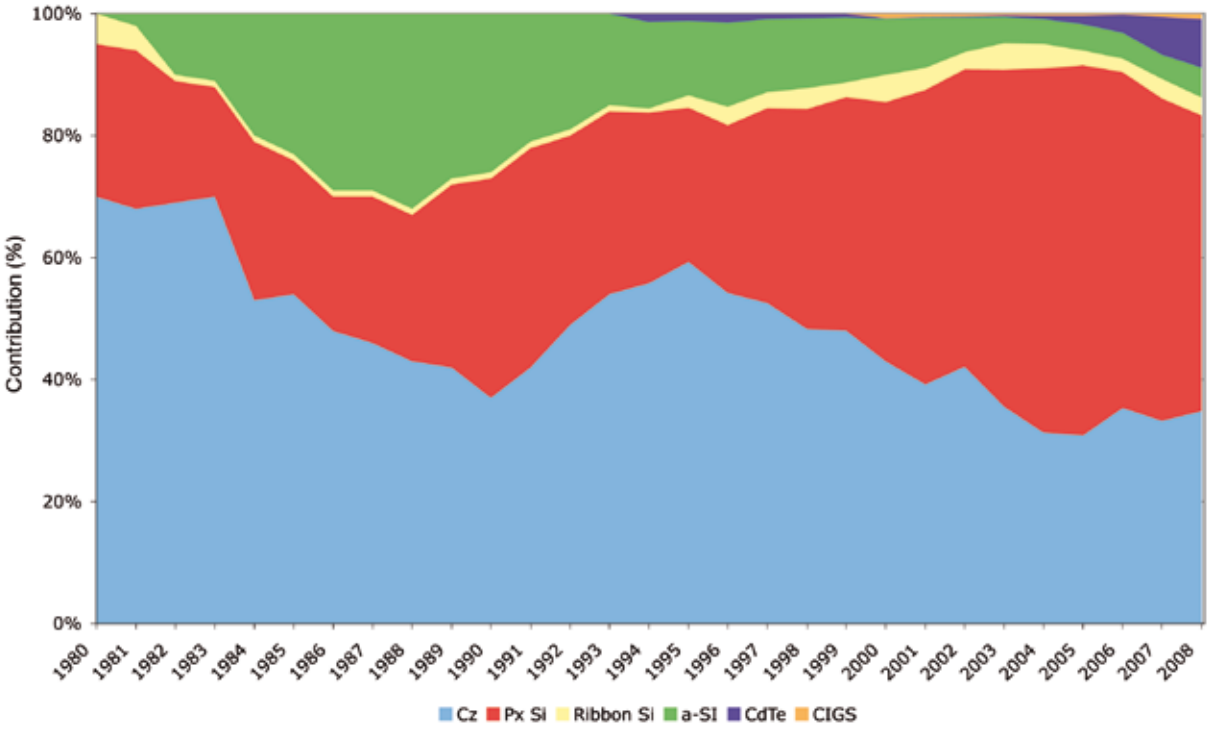

Figure 2. Thin film contribution to total industry shipments (1980 – 2008).

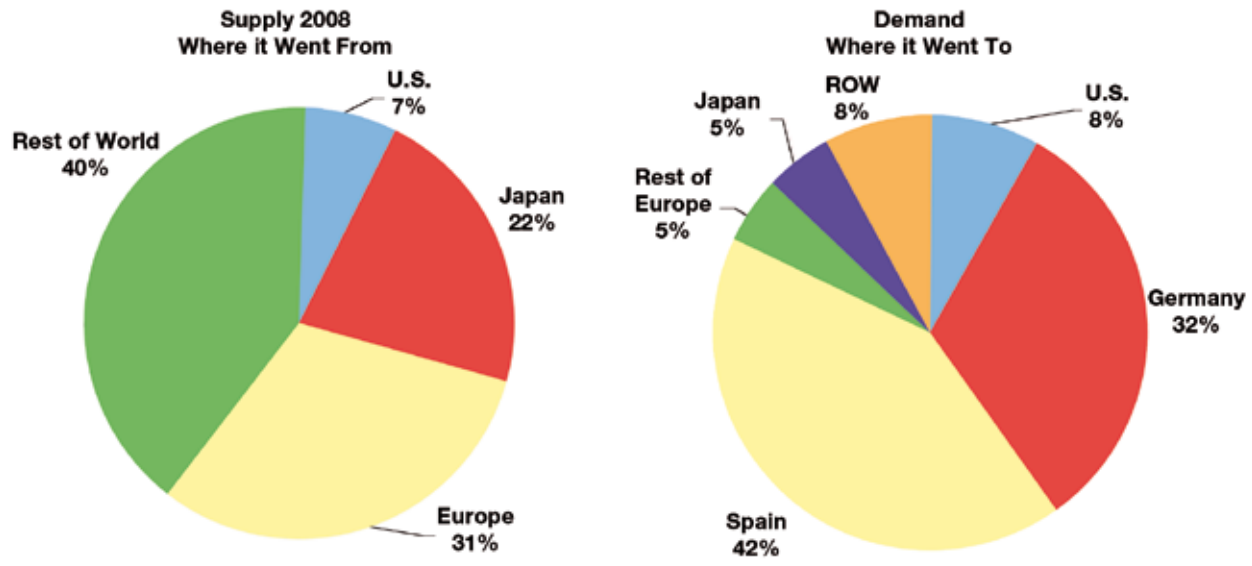

Figure 3. Supply and demand 2008 (based on a 5491.8MWp total).

and demand (market) share information for 2008.

Long-term industry participants remember the struggles of the past, but new entrants are in for a shock. With current levels of inventory, lower prices and softer demand, revenues are expected to decline significantly in 2008 anywhere from 12% to 26%, depending on the overall volume of sales. The reason for the decline in revenues is, again, falling prices for module and cell products. When demand softens and inventories rise, any industry will lower its prices to and beyond the point of pain. It also follows that an industry that has endured more than 30 profitless years will raise prices until the market balks.

Figure 4 presents a picture of pricing trends over time, including the recent 2009 decreases. The prices used to prepare this figure are averages, and so, for every year there is a low and high, along with a range. A weighted average that takes into account volumes and regions is used annually to arrive at the global average selling price. In the 2004 through 2008 period, cell prices were in many cases the same as module prices.

Particularly as there are several reasons for the current slow demand (collapse of Spain, global recession, frozen credit and securitization markets, among other causes), the industry can expect at least one, perhaps two difficult years. During this time, lower module and system prices may have the effect of lowering margins for the long term. That is, this new market reality we are entering may have a long memory and new expectations as to what it will pay for a photovoltaic system of any size, and the electricity generated from a system. The industry is therefore encouraged to continue lowering costs so that there is enough of a buffer in the margin to ensure profitability.

Photovoltaic systems come with a high upfront capital cost, low running costs, and a long lifetime. The end user, however, is buying electricity, and they want the stability in electricity prices that solar can provide, but at a price close to or lower than that paid for conventional energy. In some cases, when economic times

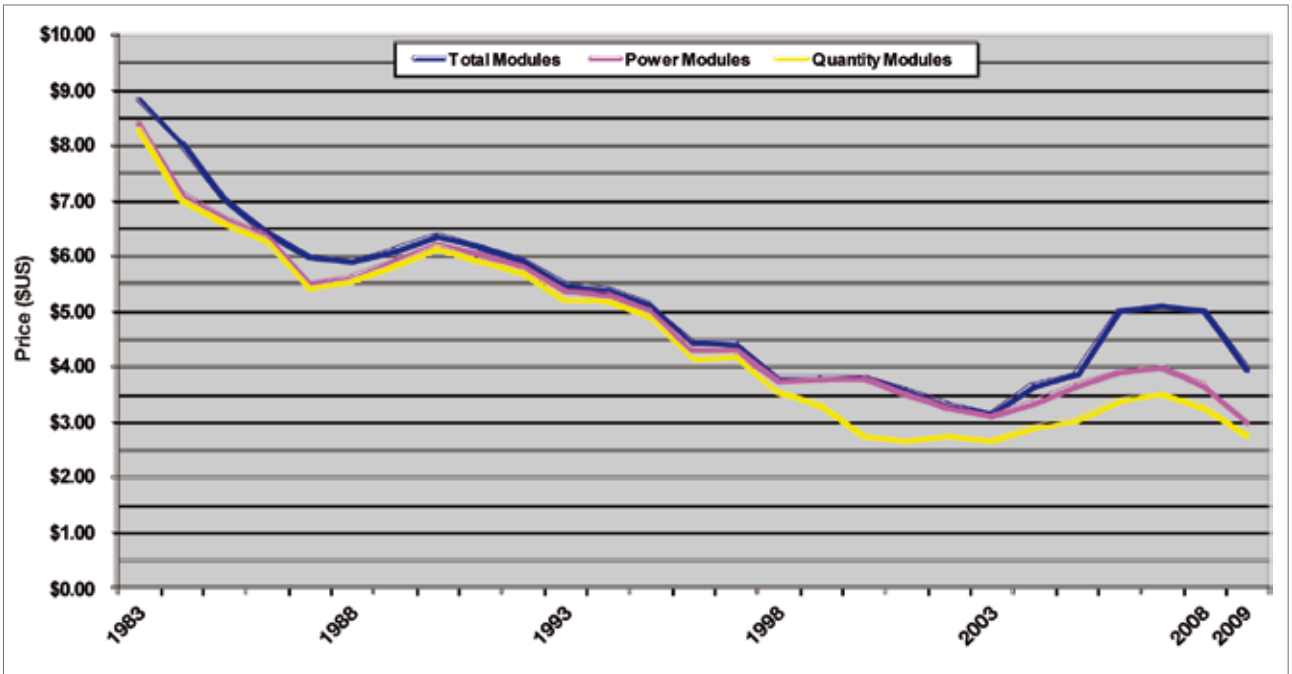

Figure 4. Average module prices (1983-2009).

are good, customers are willing to pay a premium for renewable energy, but when times are difficult, these same customers are driven to economize, whether or not these economies are short-sighted. Like it or not, humans are a short-sighted bunch, and governments (who legislate for or against incentives) will pay attention to their constituents.

Call it grid parity if you will, it is crucial that the industry continue to work towards demand that not driven by incentives, but again, is sustainable on its own. The grid-parity concept is, as previously stated, complex, differing by market (U.S. state, country, sometimes city). Complicating the grid parity concept is the fact that all energy technologies are subsidized somewhere along their value chain. However, photovoltaic technologies still have to prove economic sustainability without subsidies. This leaves the industry a one- to two-year period to retrench, mature its business models and to continue developing its technologies. The latter technology development is something that the industry does very well. The technologies are all following their development timelines towards lower costs and increasing conversion efficiencies. Hard times tend to bring on great technological gains, out of necessity if for no other reason.

During the silicon shortage, great gains were made in the use of silicon for crystalline technologies. Strong demand and effective incentives (particularly in Europe) also encouraged the development of new business models for the implementation of solar systems. With the current downturn and low availability of financing, the industry will continue maturing these business models so that when demand returns it can be met on all levels of the business value chain. Certainly the capacity will be in place to meet future volumes, but available capacity alone is not enough to mature an industry. Some of the new entrants will likely be absorbed, or possibly disappear. Lastly, the PV industry has time to open new markets, which is crucial for its future. Europe alone cannot continue to support an entire industry.

The developing world continues to offer potential for business, though a method of meeting this need profitably is still a work in progress. Figure 5 provides a short-term forecast through 2013 under three scenarios: recession, conservative, and accelerated. It is assumed that 2009 will be closer to the recession forecast, and 2010 will likely be conservative. However, 2011 and 2012 have the potential of returning to the accelerated forecast. Long-term accelerated forecast is an outlier, that is, an indication of an industry that is still maturing.

In the future, demand will settle at some sustainable point if again, the industry continues to mature its business models, lower its costs so that it can price profitably at a sustainable (for the market) level, and continue maturing its technologies.

About the Author

Paula Mints is the Principal Analyst for the PV Service Market Research Program, and an Associate Director at Navigant Consulting, Inc. She also serves as primary author and executive editor of the *Solar Outlook* Quarterly Newsletter, and is a member of the European Union WG3 PV Technology Platform. A widely recognized industry expert on PV technologies and markets, she has been published in several industry journals and is in demand as a speaker on the industry at global events. She has a B.S. degree in business concentration and an M.B.A. in market research focus, both from San Jose State University.

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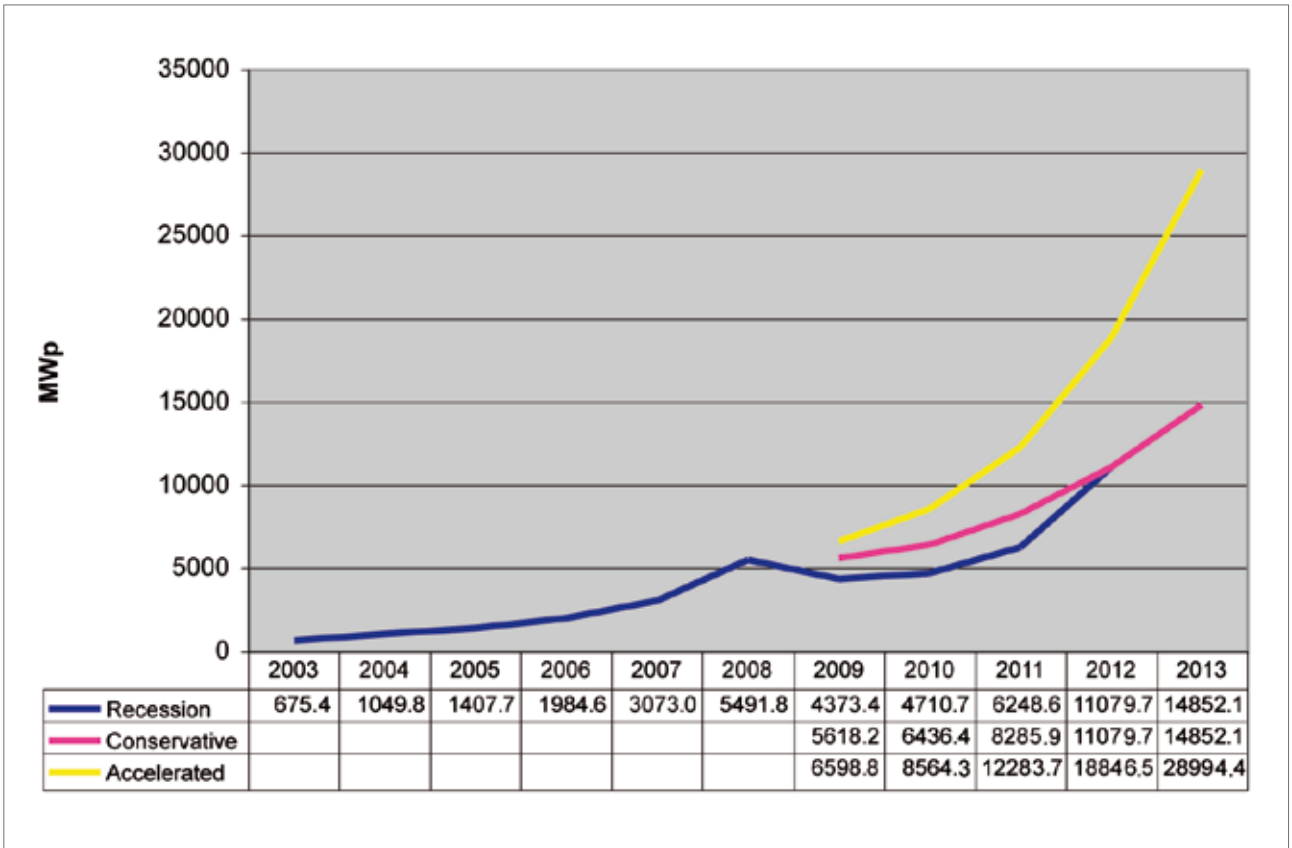

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Recession	675.4	1049.8	1407.7	1984.6	3073.0	5491.8	4373.4	4710.7	6248.6	11079.7	14852.1
Conservative							5618.2	6436.4	8285.9	11079.7	14852.1
Accelerated							6598.8	8564.3	12283.7	18846.5	28994.4

Figure 5. Photovoltaic industry forecast scenarios: recession, conservative, accelerated (2003-2013).