PHOTOVOLTAIC MARKET DEVELOPMENT IN THE NETHERLANDS – 2013, THE YEAR OF PRICE STABILIZATION

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ABSTRACT: Quarterly market inventories have been made since fall 2011 for modules, inverters, and systems that are available for purchase in the Netherlands to provide the fast growing Dutch market with proper market information. Since October 2011, the average selling price of modules and inverters decreased with 53.7 and 18.5%, respectively: April 2014 average selling prices are 1.09 €/Wp and 0.37 €/Wp for modules and inverters, respectively. About 40% of the modules originate from China, and are 12% cheaper on average. System prices have seen a temporary increase mid 2013 and now are back on the level of early 2013. Average installation costs amount to 0.34 €/Wp. Grid parity for consumers continues: using an energy yield of 900 kWh/kWp, 25 years system lifetime, 6% discount rate, and 1% operation and maintenance (O&M) cost, a levelized cost of electricity (LCOE) is calculated for a 2.5 kWp system to be 0.188 €/kWh for a system price of 1.92 €/Wp (including installation).
Keywords: PV modules, inverters, system price, kWh price, grid parity, market analysis

1 INTRODUCTION

In the past decades the growth of the photovoltaic (PV) systems market in the Netherlands has shown various steps, as is illustrated in Fig. 1. The present installed capacity is 722 MWp. Due to globally decreasing module prices many consumers in the Netherlands have invested in PV systems, realizing that with net metering in force, grid parity had been reached. This was shown in our earlier studies [1-3].

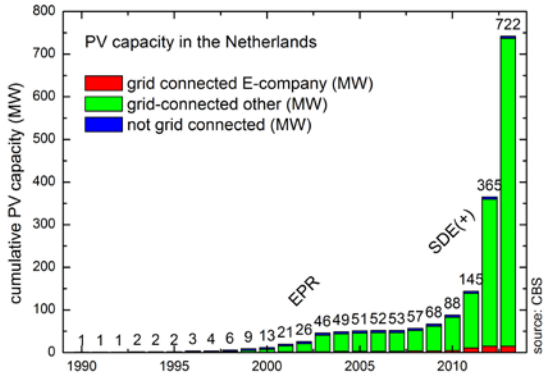

Figure 1. Development of cumulative installed PV capacity in the Netherlands (data source: CBS [4]).

We continued our effort in making further inventories of the PV market in the Netherlands. The last one was executed in April 2014. As before, we collected price data on PV modules, inverters, other system components including installation and consultancy, and complete systems. We also determined the market size and prices of modules of Chinese origin in the Netherlands. Finally, for four different typically sized PV systems, performance and cost calculations were performed. This allowed for the determination of the levelized cost of electricity of PV systems in order to compare with retail electricity prize of typically 0.23 €/kWh, and assessment of consumer grid parity.

2 METHODOLOGY

The collection of market data was performed using extensive Internet searches that identified the relevant retailers of PV modules, inverters, complete systems, and other Balance of System (BOS) components. We have identified the country of origin for most of the modules. Note that all prices in this paper are quoted including 21% VAT, as this is relevant for consumers.

The Levelized Cost of Electricity (LCOE) was calculated using

$$LCOE = \frac{\alpha I + OM}{E}\ , \qquad (1)$$

where α is the capital recovery factor, I the initial investment, OM the operation and maintenance cost, and E the annual electricity production. The capital recovery factor is defined as

$$\alpha = \frac{r}{1-(1+r)^{-L}} \qquad (2)$$

with r the discount rate, and L the lifetime of the system.

In the Netherlands a large number of 4-6 module systems are installed, and still are offered, mostly for historical reasons: system size then is on average about 600 Wp, and installation is straightforward do-it-yourself, complying to electricity regulations. A typical household roof system that contributes substantially to a typical annual electricity demand of 3500 kWh is sized at 2.5 kWp. Present legislation allows for unlimited net-metering, and we observe that the average system size is increasing. Therefore a 5 kWp system is also used in our calculations. Larger systems on for example barns or office buildings range from 10-50 kWp. We therefore have chosen four typical sizes for the LCOE calculation: 0.6, 2.5, 5, and 50 kWp. A typical, mortgage-related interest rate presently is 6%, while a lower, soft-loan (or green-loan) rate may be possible at 3%. Commercial rates

are 8% or higher. Further, energy ratings of systems in the Netherlands are between 800 and 1000 kWh/kWp, depending on correct and optimal installation. System lifetime is 25 years, and O&M cost is taken as 1%. Results will be presented using these ranges of values.

3 RESULTS

3.1 PV modules

In the first inventory of PV modules at the end of October 2011, 165 different types were collected. Only mono and multicrystalline silicon modules were found. The average selling price was 2.28 €/Wp; the average capacity was 144 Wp/m^2. In the inventory taken at the end of April 2014 much more modules were collected (819 different types, also some thin film silicon and CdTe modules, ~2% of total). In January 2014, the average price per rated power was 1.06 €/Wp, which is 53.7% lower than at the end of October 2011, as illustrated in Fig. 2. It is clear that the largest price reduction occurred in 2012. The price reduction in 2013 was 15.9%.

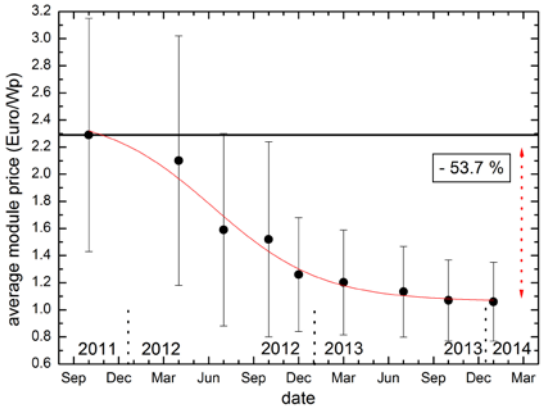

Figure 2. Development of PV module price (including tax) between October 2011 and January 2014.

Our analysis of the country of origin of the modules revealed that some 40% of the modules originate from China, as shown in Fig. 3. Figure 4 shows that modules from China have a 12% lower average price compared to the average price of all modules. They are presently 17% cheaper than modules from Germany.

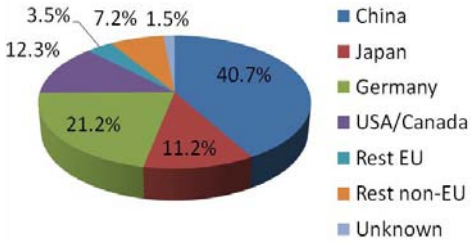

Figure 3. Country of origin of the modules (status January 2014).

3.2 Inverters

At the end of October 2011, the inverter inventory contained 98 unique ones, with average selling price of 0.45 €/Wp. The April 2014 update showed a price decrease to 0.37 €/Wp presently (18.5%) as shown in Fig. 5, with the April 2014 update containing 715 inverters. Inverter price has decreased by 9.8% in 2013.

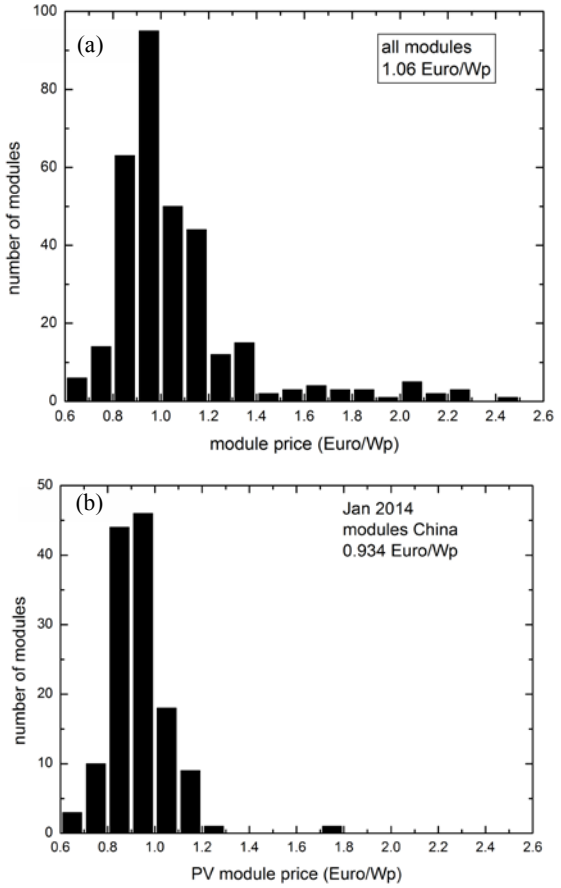

Figure 4. Distribution of PV module price for (a) all modules, and (b) modules from China.

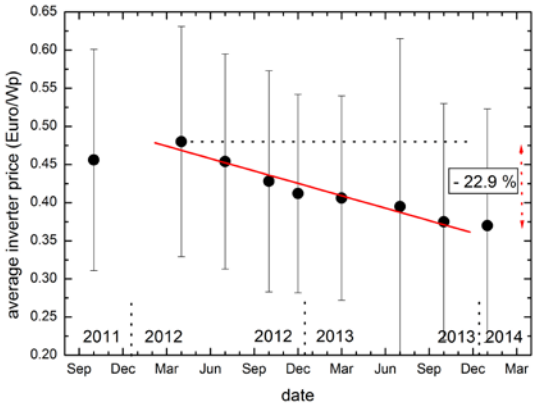

Figure 5. Development of inverter price (including tax) between October 2011 and January 2014.

3.4 Complete systems

The number of systems for tilted (flat) roofs in the inventory rose dramatically from 2352 (2270) in December 2012 to over 21000 in April 2014. The average selling price for tilted systems (excluding installation) decreased by 4.1% (tilted) in 2013 (from 1.46 to 1.40 €/Wp) and 6.1% (flat) (from 1.52 to 1.43 €/Wp). Early 2013, the system price experienced an increase, most probably in anticipation for the EU import duties for Chinese made panels.

Average installation cost are 0.34 €/kWp, and vary with installation size, as can be seen in Figure 7.

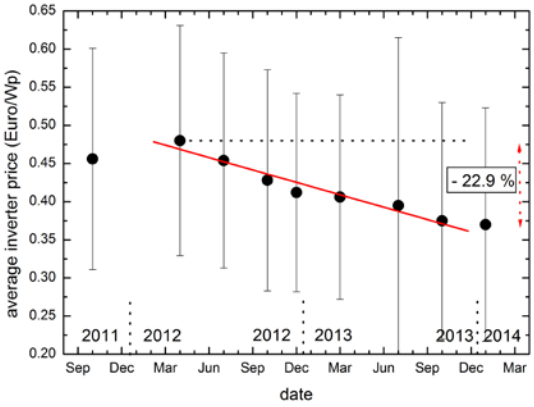

Figure 6. Development of system price (including tax, excluding installation) between April 2012 and January 2014.

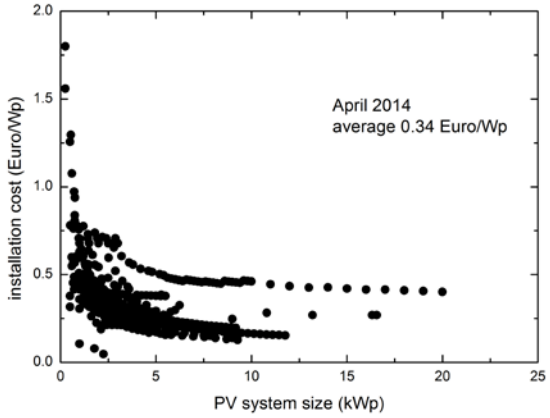

Figure 7. System installation April 2014.

The average prices for three system size ranges have been determined from the inventory data, i.e., for 0-1 kWp, 1-5 kWp, and 5-25 kWp. This is also performed for installation cost, in order to calculate levelized cost of electricity.

3.5 Levelized cost of electricity

For the four system sizes the LCOE is calculated for three different values of the interest rate (3, 6 and 8%), including installation cost, see Table I. Results are shown in Table II; the yellow marked values are similar or lower than the current price of electricity (0.23 €/kWh) that utilities charge to customers. Clearly, grid parity continues for soft and mortgage type loans, i.e., the cost of electricity is lower than that charged by utilities. This holds for systems of 2.5-5 kWp, and depends on energy yield as well. Also, as a rule-of-thumb, system price (in €/Wp) can be divided by ~10 to reach LCOE (in €/kWh). With energy rating values of 1000 or 800, LCOE values will be 11% lower or 11% higher, respectively.

4 CONCLUSION

Our continued market analysis effort resulted in quarterly inventories of PV modules, inverters, and complete systems. It is clear that PV module price continues to decrease, while this predominantly occurred 2012. In the first half of 2013, prices nearly stabilized, but continued to decrease in the second half of 2013.

Table I: Prices of four typical PV systems

system size kWp	price €/Wp	installation €/Wp	total €/Wp
0.6	1.78	0.60	2.38
2.5	1.52	0.40	1.92
5	1.32	0.30	1.62
50	1.32	0.20	1.51

Table II: Levelized cost of electricity for the four typical PV systems; yellow marked data illustrate that grid parity has been reached, as the consumer price for electricity is 0.23 €/kWh.

850 kWh/kWp			interest rate		
1% O&M	kWp	Euro/Wp	3	6	8
	0.6	2.38	0.189	0.247	0.290
	2.5	1.92	0.152	0.199	0.234
	5	1.62	0.129	0.168	0.198
	50	1.52	0.121	0.158	0.185
900 kWh/kWp					
1% O&M	kWp	Euro/Wp	3	6	8
	0.6	2.38	0.178	0.233	0.274
	2.5	1.92	0.144	0.188	0.221
	5	1.62	0.121	0.159	0.187
	50	1.52	0.114	0.149	0.175

Chinese modules still are cheaper than modules originating from other countries, but the difference is somewhat smaller. The inverter price decrease seems to continue rather unaffected. The system prices increased early 2013 to levels of mid 2012, but decreased again in the second half of 2013. We attribute this to the fact that system suppliers had difficulty in securing low modules prices they contracted earlier. Another explanation may be that suppliers increased their margins in order to be prepared for expected module price increases.

The system price increase in combination with a somewhat lower installation cost did not affect grid parity conditions for consumers.

5 ACKNOWLEDGEMENTS

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6 REFERENCES

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