

Netherlands Enterprise Agency

NEW SOLAR PV BUSINESS OPPORTUNITIES BETWEEN THE NETHERLANDS AND CHINA



AUTHOR MARK MEIJER (ENERGY INDEED) FINAL REPORT APRIL 2014



TABLE OF CONTENTS

	SUM	MARY	3			
1	INTRODUCTION					
	1.1	Background	4			
	1.2	Aim	5			
	1.3	Method	5			
	1.4	Abbreviations	5			
	1.5	Lay out	5			
2	SOLAR PV IN CHINA					
	2.1	Introduction	6			
	2.2	Market	6			
	2.3	Industry	9			
	2.4	Organizations	10			
3	SOLA	AR PV IN THE NETHERLANDS	11			
	3.1	Introduction	11			
	3.2	Market	12			
	3.3	Industry	13			
	3.4	Organizations	15			
4	NEW	BUSINESS OPPORTUNITIES	16			
	4.1	Existing PV relations	16			
	4.2	Opportunity 1: PV production equipment	17			
	4.3	Opportunity 2: BIPV	19			
	4.4	Other opportunities	21			
5	CON	CLUSIONS	22			
6	RECC	OMMENDATIONS	23			
	REFE	RENCES	24			
	INITE	R//IF\A/S	36			
	INTERVIEWS					
	COLOPHON					

SUMMARY

Introduction

Propelled by the largest seaport of Europe – Rotterdam – and the largest seaport of the world – Shanghai – the Netherlands and China have a strong economic relation. This strong relation concerns many different sectors, with photovoltaic (PV) solar energy being no exception. Nevertheless, there is a growing feeling that both countries can do more for each other in this sector than they already do.

With the recently extended Memorandum of Understanding (MoU) between the Netherlands and China, the boundary conditions for such an enhanced collaboration seem to be in place. Therefore, the Netherlands Enterprise Agency (RVO.nl) has asked Energy Indeed to explore new solar PV business opportunities between the two countries. This report presents the results of that exploration.

Method

In 2013 Energy Indeed visited several PV organizations in China to make a first inventory of new solar PV business opportunities between the Netherlands and China. This exploration builds further on those visits, through a desk study and 15 interviews. The preliminary results of those activities were shared during a meeting on April 11, 2014, at RVO.nl in Utrecht. This report shows the final results.

Results and conclusions

China is by far the global PV industry leader. In the past its PV production was mainly used for export, but more and more it is used to develop a home market, thereby solving the global PV industry's overcapacity. As a result, the Chinese PV market is now the largest in the world, with an annual world-record of more than 11 GW of PV installations in 2013.

This development is good news for the Netherlands as well, since a bunch of Dutch companies has a leading position in the supply of specialized PV production machines. These companies are to a large extent complementary to each other. Therefore, it is suggested that enhanced collaboration between them and with well-positioned Dutch research organizations in China like ECN might create synergy. Their business potential in China is estimated to be at least a few hundred million euros per year.

Another interesting business opportunity seems to be building-integrated PV (BIPV). With enormous amounts of new buildings in China and a strong demand for distinctiveness, this niche market is increasingly attracting investors. Dutch architects in China are already successful in this BIPV-market, thereby affirming the historically good position of the Netherlands and 'Dutch Design' in this field.

Recommendations

In line with these business opportunities, a recommendation for Dutch suppliers of PV production equipment would be to explore possibilities for enhanced collaboration in China, for instance through the Partners for International Business (PIB) programme. RVO.nl supports a workshop of ECN a day before the SNEC 2014 in Shanghai (May 19) to discuss these possibilities.

Regarding BIPV, it seems recommendable for the Netherlands to bundle forces as well, in order to keep the lead in the new IEA PVPS task about BIPV and to invite China to have a strong involvement in this task as well. Further, a brainstorm session between Chinese PV manufacturers and Dutch architects about the Chinese BIPV market might be interesting, but only with extensive preparation.

1 – INTRODUCTION

1.1 - Background

Next to strong cultural and political ties, the Netherlands and China share an intense economic relation. Propelled by the largest seaport of Europe – Rotterdam – and the largest seaport of the world – Shanghai – this economic relation has intensified over the past fifteen years to a total trade value of about 40 billion euros a year (see *Figure 1.1*). Consequently, the Netherlands is now the second biggest trading partner of China in Europe after Germany.

Figure 1.1 – Trade of goods between the Netherlands and China in 1996-2012 (CBS, 2014a)

This intense economic relation concerns many different sectors, with solar energy being no exception. Already for decades Dutch and Chinese organisations work closely together in the field of solar energy research and education. More and more, this relation translates into a trade relation; principally with Dutch companies delivering specialized production equipment to Chinese solar manufacturers, who in turn show strongly increasing sales in the Dutch market.

In the meantime however, there is a growing feeling that both countries can do more for each other in the field of solar energy than they already do. In particular: would it be possible for China – as the undisputed industry leader – to take a next step regarding quality, efficiency, product diversification and environmentally friendly production? And would it be possible for the Netherlands – based upon current relations – to join China even more in accomplishing that mission?

The boundary conditions for such an enhanced collaboration seem to be in place. For example, in March 2014 China's National Energy Administration (NEA) and the Dutch Ministry of Economic Affairs (EZ) extended their Memorandum of Understanding (MoU) of 2009. This MoU has solar energy as one of its priorities. Besides that, the Netherlands has set up a 'Top consortium for Knowledge and Innovation' on solar energy (TKI Solar Energy), with internationalisation as one of its focal points.

In line with the above, the Netherlands Enterprise Agency (RVO.nl) has asked solar energy consultancy company Energy Indeed to explore new business opportunities between the Netherlands and China. Energy Indeed already visited several PV organizations in China in August 2013 to make a first inventory of new solar PV business opportunities between the Netherlands and China. This exploration builds further on those visits.

1.2 – Aim

The aim of the exploration is twofold:

- 1. Explore new or enhanced business opportunities between the Netherlands and China in the field solar photovoltaics (PV);
- **2.** Advise Dutch organizations on how to utilize these business opportunities and the Dutch government on how to facilitate this.

1.3 – Method

In order to fulfil this aim, three steps are taken:

- 1. Desk study: consulting literature on the current situation regarding solar PV in the Netherlands and China and existing collaborations between the two countries;
- **2. Interviews:** consulting public and private organizations with solar PV related connections in both the Netherlands and China (see names on *page 26*);
- **3. Meeting:** sharing the preliminary results of the first two steps with the involved organizations and discussing possible follow-up actions on April 11, 2014, at RVO.nl in Utrecht.

1.4 – Abbreviations

Table 1.1 shows an overview of the abbreviations being used in this report:

a-Si	Amorphous silicon	PBT	Pay-Back Time
BIPV	Building-Integrated Photovoltaics	PV	Photovoltaics
c-Si	Crystalline silicon	R&D	Research & Development
EU	European Union	RE	Renewable Energy
FIT	Feed-In Tariff	RMB	Renminbi (China's currency, 1 RMB = 0.122 euro)
GW	Gigawatt	RVO.nl	Netherlands Enterprise Agency
IEA	International Energy Agency	TU	Technical University
kW	Kilowatt	TF	Thin film
kWh	Kilowatt-hour	ТКІ	Top consortium for Knowledge and Innovation
MoU	Memorandum of Understanding	USA	United States of America
MW	Megawatt	VAT	Value Added Tax
NEA	National Energy Administration	w	Watt

Table 1.1 - Overview of abbreviations

1.5 – Lay-out

Chapter 2 provides a brief characterization of the PV sector in China, including market developments, industry developments and relevant organizations. *Chapter 3* does the same, but then for the PV sector in the Netherlands. With those characterizations in mind, *Chapter 4* describes the business opportunities as suggested during the interviews. Finally, *Chapter 5 and 6* provide an overview of the conclusions and recommendations.

2 – SOLAR PV IN CHINA

2.1 – Introduction

Since the 1990s, China has experienced a period of unprecedented growth. This growth does not only concern the country's population, but also its energy use and CO_2 -emissions. In all these aspects, China is now the largest country in the world (IEA, 2013a).

So far, coal has been the dominant fuel in this growth picture. However, facing limited coal reserves and alarming levels of pollution, the transition towards renewable energy in China has now become an urgent necessity.

In order to enable this transition, China has invested heavily over the past few years in solar manufacturing facilities. As a consequence, the country has now by far the world's largest production capacity for crystalline silicon (c-Si) solar products (see *Figure 2.1*).



Figure 2.1 – Global PV production capacity shares by geography *~82% of the global PV market is c-Si; ~15% is TF (EPIA, 2013)

Until recently, this production capacity was mainly used for export to the EU and – to a smaller extent – the USA. However, due to overcapacity, changing policies and the introduction of import barriers, China is now forced to address other markets.

Besides other foreign markets like Japan, India, South America and Africa, a more strategic development in this respect is the development of China's domestic market. The paragraph below illustrates that development.

2.2 – Market

To some extent, one could argue that the development of the Chinese domestic PV market started in the late 1990s with the introduction of the Brightness program. This program represented the first initiative driven by the Chinese government to use off-grid renewable energy applications, other than

small hydro power plants, to provide electricity in remote rural areas. Despite obvious difficulties regarding the country's large geographical coverage, this program has been very successful, pushing China's electrification rate towards almost 100%.

In terms of installed capacity however, the first real push started in 2009. In that year the Chinese government launched upfront subsidies for PV installations, like the PV Building Project and the Golden Sun Demonstration Project. The latter could cover 50% to 70% of the installation costs.

Unfortunately, these upfront subsidies drew more attention to the installation costs than the actual performance after installation. Therefore, in 2013 the Chinese government replaced them by a performance-based subsidy: the Feed-In Tariffs (FITs).

For large-scale PV projects these FITs are 0.90-1.00 RMB/kWh (0.11-0.12 euro/kWh), depending on the solar irradiance in a certain province. For building PV projects these FITs are 0.42 RMB/kWh (0.05 euro/kWh), no matter if the electricity is directly consumed or fed back into the grid (see *Table 2.1*).

The FITs enable predictable annual returns for a period of 20 years. For large-scale PV projects these returns can be more than 10% a year (Reuters, 2014). For building PV projects the returns can differ strongly, for instance due to the different levels of retail grid prices throughout China (see *Table 2.2*).

Classification of	Large-scale	PV	Building	g PV (self-consumed	l) Buildin	Building PV (feed to grid)		
solar resources	RMB/kWh	euro/kWh	RMB/kWh	euro/kWh	RMB/kWh	euro/kWh		
T	0.90	0.11	0.42 +	0.05 +	0.42 +	0.05 +		
П	0.95	0.12	Retail grid price	Retail grid price	Whole sell price	Whole sell price		
Ш	1.00	0.12						

Consumption	Consumption Beijing		Shanghai Gua		Guangzhou		Qinghai	
category	RMB/kWh	euro/kWh	RMB/kWh	euro/kWh	RMB/kWh	euro/kWh	RMB/kWh	euro/kWh
Household	0.48-0.49	0.06	0.61-0.62	0.07-0.08	0.61	0.07	0.43	0.05
Commercial	0.76-0.82	0.09-0.10	0.85-0.92	0.10-0.11	0.98-1.02	0.12	0.22-0.93	0.03-0.11
Industry	0.58-0.64	0.07-0.08	0.85-0.90	0.10-0.11	0.66-0.71	0.08-0.09	0.14-0.59	0.02-0.07

Table 2.1 – FIT's in China (NDRC, 2013)

Table 2.2 – Examples of retail grid prices in China, including VAT. Prices are indicative, because some places (like Shanghai) distinguish summer tariffs and some places (like Qinghai) distinguish common, peak and valley prices (IEA, 2013b)

Because of the FITs, there was a rush on PV installations near the end of 2013, resulting in more than 11 GW of PV installations in 2013. This number implies a tremendous market speed up (see *Figure 2.2*) and a worldwide PV installation record of one country within one year.

Looking at the worldwide figures of PV installations in 2013, China was responsible for more than 30% of the total. Also this number is an enormous increase with respect to previous years. In fact, *Figure 2.3* shows that China and the Asia Pacific region were by far the strongest growth markets in 2013.

Annual installations (GW)



"The sleeping dragon has awoken"

Jenny Chase, head of solar analysis at Bloomberg New Energy Finance (BNEF, 2014a)

Figure 2.2 – Annual PV installations in China in 2007-2013 (EPIA, 2014; IEA, 2013b)



Annual installations (GW)

"China should be able to remain the number-one market in the coming years"

EPIA Press Release (2014)

Figure 2.3 – Annual PV installations in the world in 2007-2013 (EPIA, 2014)

So far, most of the PV installations in China are large-scale installations in the sunny and not-socrowded western provinces. However, for 2014 the Chinese government has the ambition to increase the share of building installations in the less sunny and more crowded Eastern provinces. This ambition might be related to the delays and high costs of connecting large solar (and wind) projects to the grid.

The total installation number in 2014 is expected to be as high as 14 GW (Bloomberg, 2014a; Reuters, 2014). In that way, China could reach its cumulative PV installation target of 35 GW in 2015 earlier than expected. Announcements of higher targets might therefore be on the way.

2.3 – Industry

Thanks to the development of China's domestic market and the upswing of other markets like Japan, India and South-America, the overcapacity in the PV market is slowly resolving. This is good news for the global PV industry, which had a hard time over the past few years.

At this moment, China has a solar module manufacturing capacity of about 45 GW (Reuters, 2014). This is about as much as the global PV demand, which could – according to market analysts – reach a level of 43 GW (Mercom, 2013), 45 GW (BNEF, 2014b; IHS, 2013) or 49 GW (SolarBuzz, 2013) in 2014.

Combined with falling production costs, this means the margins of solar module manufacturing companies are improving again. For instance, the production margins of Tier 1 c-Si module manufacturers, where China has about 73% market share (see *Figure 2.1*), have increased from about 3% in Q1 2012 to almost 20% in Q4 2013 (see *Figure 2.3*). This has led to a recovery in financial results, with many Tier 1 companies reporting positive gross margins for the first time in several quarters (SolarBuzz, 2014a).

"After two years of punishing downturn, the global solar industry is on the rebound"

Ash Sharma, senior research director for solar at IHS Solar (IHS, 2013).



Figure 2.3 – Tier 1 c-Si module production margins (SolarBuzz, 2014a)

Both in solar module and in solar cell manufacturing, the majority of the top 10 companies are Chinese companies (see *Table 2.3*). The total market share of these top 10 companies is increasing, at the expense of smaller companies. As an illustration, Jifan Gao, chairman of Trina Solar, recently said he expects three to five "leading" solar companies to remain in China by 2017, with 80% of the country's market share (Bloomberg, 2014b).

Тор 10		Country	Change	Тор 10		Country	Change
Moo	dule manufacturers		from 2012	Cell manufacturers			from 2012
1	Yingli Green Energy	China	-	1	Yingli Green Energy	China	+1
2	Trina Solar	China	+1	2	JA Solar	China	+1
3	Sharp Solar	Japan	+3	3	Trina Solar	China	+1
4	Canadian Solar	China	-	4	Neo Solar Power	Taiwan	+3
5	Jinko Solar	China	+3	5	First Solar	USA	-4
6	ReneSola	China	+7	6	Motech	Taiwan	-
7	First Solar	USA	-2	7	Jinko Solar	China	+4
8	Hanwha SolarOne	China	+2	8	Gintech	Taiwan	+2
9	Kyocera	Japan	+5	9	Canadian Solar	China	-1
10	JA Solar	China	-3	10	Hareon Solar Technology	China	-1

Table 2.3 – Top 10 solar module and solar cell manufacturers in 2013 (PV Tech, 2014; SolarBuzz, 2014b)

China's Ministry of Industry and Information Technology (MIIT) might also play a role in this shake-out, as it recently introduced a list of Chinese companies that meet *standard PV manufacturing conditions*,

including technical, financial, environmental and social criteria. Only companies on this list can receive benefits such as bank loan support and government export tax rebate. So far, according to IHS, the 109 companies on the list account for more than 90% of China's polysilicon, wafer, cell and module manufacturing capacity (PV Magazine, 2014), but stricter criteria and control might be on the way.

2.4 – Organizations

The final paragraph of this chapter lists some organizations in China that might be relevant in the solar PV context.

Government

Since 2009 the Dutch Ministry of Economic Affairs (EZ) has an MoU with China's National Energy Administration (<u>NEA</u>), which is part of the of the National Development and Reform Commission (<u>NDRC</u>). The NEA is responsible for formulating and implementing industrial policies and energy development plans, like China's 12th Five-Year Plan for the PV Industry (2011-2015). In 2013 the NEA incorporated the State Electricity Regulatory Commission (<u>SERC</u>), because of overlapping duties.

As mentioned in the previous paragraph, the Ministry of Industry and Information Technology (<u>MIIT</u>) is in charge of a list of PV manufacturers who can benefit from certain governmental benefits. However, there are more ministries involved with solar. For instance, the Ministry of Science and Technology (<u>MOST</u>) is the government unit to be in charge of the R&D of PV and the Ministry of Finance (<u>MOF</u>) has the management duty of the Renewable Energy (RE) Surcharge, a kWh-tax to finance RE projects.

Market

With the majority of the solar PV projects so far located in the country's sunny and not-so-crowded western provinces, China's state-owned power generators China Power Investment Corporation (<u>CPI</u>), China Three Gorges (<u>CTG</u>) and China Huadian Corporation (<u>CHD</u>) have become the world's largest owners of solar assets (BNEF, 2014a). Besides that, also a host of Chinese solar module manufacturers owns solar projects in China.

An interesting development is that these module manufacturers sometimes cooperate with Chinese coal and nuclear giants to develop their projects. For instance, Datong Coal Mine Group (<u>DTCM</u>), China's third-largest coal-mining company, recently announced a joint venture with Yingli to develop and construct solar power plants in the city of Shuozhou (Shanxi). China National Nuclear Corporation (<u>CNNC</u>) has a joint venture with Yingli as well to develop 500 MW of PV projects across the country.

Further, also non-traditional companies step into solar projects. This includes companies such as toll road operator Huabei Express and Jiangsu Kuangda Auto Textile Group (Reuters, 2014).

Industry

In addition to the manufacturers mentioned in *Table 2.3*, relevant sector organizations on a national level are for instance the China Photovoltaic Industry Alliance (<u>CPIA</u>) and the Chinese Renewable Energy Industries Association (<u>CREIA</u>). Next to those, there are also sector organizations on a lower level like the Shanghai New Energy Industry Association (<u>SNEIA</u>) and on a higher level like the Asian Photovoltaic Industry Association (<u>APVIA</u>).

3 – SOLAR PV IN THE NETHERLANDS

3.1 – Introduction

"Such a small country, so little sun and so much knowledge!". That was a reaction that the Dutch sector organization Holland Solar received during one of its first international solar trade missions in the 1980s (Holland Solar, 2014). A possible reason for this reaction was the pioneering role of Dutch organizations those days in the development of solar technology. Thanks to this pioneering role, still a large share of the technology in solar panels has a Dutch origin. "In half of the solar panels produced worldwide, you can find a piece of Dutch technology"

Henk Kamp, Dutch Minister of Economic Affairs (Website Dutch government, 24 November 2013)

Now, about 30 years later, the Netherlands is still at the forefront of solar technology research and development (R&D). Particularly the Energy Research Centre of the Netherlands (ECN) and for instance TNO, AMOLF and several technical universities play a meaningful role in international solar R&D (see example in *Figure 3.1*). But R&D is by far not the only Dutch contribution to the world of solar. This chapter therefore shows the development of Dutch solar PV market (see *3.2*) and the solar PV industry (see *3.3*). Subsequently, the final paragraph sums up some organizations that might be relevant in this context (see *3.4*).



Figure 3.1 – A symbol of Dutch solar R&D: in October 2013 the Nuna-car of the Delft University of Technology (TU Delft) won the World Solar Challenge for the fifth time. A car of the TU Eindhoven won in the cruiser class.

3.2 – Market

By the end of 2013, the Netherlands had a cumulative PV installation number of about 0.7 GW (preliminary minimum estimate; Klimaatmonitor, 2014). Approximately 80% of these installations has been installed in the last two years, indicating a very strong market acceleration (see *Figure 3.2*). Of course, the absolute numbers are no comparison with the Chinese installation numbers, but the cumulative installations per inhabitant and the growth curves are quite comparable (see *Figure 3.3*).

Annual installations (GW)



Cumulative installations (W/inhabitant)



Figure 3.2 – *Annual PV installations in the Netherlands in 2000-2012 with preliminary minimum estimate for 2013.*

Figure 3.3 – *Cumulative PV installations in the Netherlands* and *China in 2000-2013.*.

Like in other countries, the spectacular decreases in the prices of solar panels over the past few years have played an important role in this market acceleration. Another important factor is the Dutch energy policy. Unlike neighbour-countries, the Netherlands does not have a FIT-system. It does however have a tax on the use of electricity, which is particularly high for small electricity consumers (see *Figure 3.4*). Thanks to a net metering system, these consumers can save a lot of tax by producing electricity themselves, as long as they do not produce more electricity than they use on a yearly basis.



Figure 3.4 – Breakdown of electricity costs in the Netherlands (PBT = Pay-Back Time; VAT = Value Added Tax)

Because of this high energy tax and the net metering system for small electricity consumers, there are many initiatives in the Dutch market that try to make the installation of PV systems for small consumers as easy as possible. Examples of those initiatives are lease options (no upfront investment for the consumer), green loans (specific low interest loans) and collective PV purchasing actions (buying PV as a group).

The business case of large-scale PV systems is generally weaker, but there are some incentives to make these projects more attractive. In particular, there is a national SDE+ subsidy (Stimulating Renewable Energy) that aims to bridge the financial gap in the business case of large renewable energy systems. There is a limited budget every year to apply for this subsidy, but when you succeed it provides a subsidy per kWh of solar electricity for a period of 15 years.

Another, more recent option to strengthen the business case of large-scale PV systems is the 'lowered energy tax' system for renewable electricity produced by local cooperatives. This allows cooperatives to sell their locally produced electricity with a 0.09 euro per kWh tax reduction (including VAT), as long as the consumers are within the same postal area or in a neighbouring postal area. In Dutch, this area is referred to as a 'postcoderoos'.

More in general, the installation of PV systems in the Netherlands is also stimulated by several fiscal advantages. For instance, there is an energy Investment tax deduction (EIA) and a small-scale investment tax deduction (KIA). Entrepreneurs who invest in solar PV systems can use these fiscal advantages to lower the tax on their profit. The net benefit of these kinds of fiscal advantages is usually around 10% of the solar PV investment.

Finally, an important focus in the Dutch PV market at this moment is quality assurance. This focus does not only concern the quality of the material, but also the quality and safety of the installation work. Particularly, in 2013, in line with the European directive on Renewable Energy Sources (RES), the Netherlands successfully implemented a certification system for PV installers. This system enables PV installers to distinguish themselves on quality in the market.

3.3 – Industry

Based upon its strong position in solar R&D and the semi-conductor industry, the Netherlands has some world-leading manufacturers of PV production machines. Examples of these companies are ASMI, Eurotron, Lamers HTS, Levitech, Meco, OTB/Roth & Rau, Rimas, Smit Ovens, SoLayTec, Tempress and VDL Flow. Thanks to these companies, the Netherlands is in the global top 6 of PV production machine manufacturers, together with Germany, Japan, Korea, Switzerland and the USA (FD, 2013).

Over the past few years the capital spending of the global PV industry has decreased strongly (see *Figure 3.5*). However, with the resolving overcapacity in the global PV market ahead, there seems to be a chance to increase the sales of PV production machines again. The interviews suggest that in a balanced market the export value of these machines from the Netherlands to China would be at least a few hundred million euros per year.

"We are in a small global leading group"

> **Prof. dr. Wim Sinke, ECN** about the position of Dutch manufacturers of PV production machines (FD, 2013)

Capital spending (billion US\$)



Figure 3.5 – Global PV capital equipment spending in 2005-2016 (SolarBuzz, 2014c)

Another important field in the Dutch PV industry is the R&D and production of Balance-Of-System (BOS) components, like (micro-)inverters, power optimizers and mounting systems. Examples of Dutch companies working in this field are Femtogrid, Heliox and Mastervolt. The Solar Energy Application Centre (SEAC) in Eindhoven currently performs a unique field test, to compare the performance of these companies' products in the built environment.

Finally, in terms of solar cell and solar module production, the production capacity in the Netherlands is relatively small. Nevertheless, there are a few companies working in this field, both in c-Si (for example Solland Solar) and in thin film production (for example HyET). Besides, there are some start-ups focussing on the development and production of innovative PV products. Examples of these start-ups are SolarExcel (in 2013 acquired by Royal DSM), SunCycle and TULiPPS (see *Box 3.1*).

SolarExcel (Royal DSM)

SolarExcel has developed a high tech foil that maximizes the performance of PV panels. This foil 'catches' sunlight, using a unique light management technology. Royal DSM acquired SolarExcel in 2013 in order to upscale the production and to enable worldwide sales. The acquisition strengthens DSM's position in this field, as it has also developed an anti-reflection coating for solar panels (Khepricoat) that can improve efficiencies up to 4%.

SunCycle

SunCycle has developed a new high-efficiency solar module, using concentrator technology. "The yield of our panel is more than 40% higher", according to Peter Penning, co-founder of SunCycle. "A key additional benefit of the mirror technology is that we need 99.9% less of the expensive semiconductor material. In our panels, we have replaced it with less expensive materials, such as plastics and aluminium. This allows us to lower the price."

TULiPPS

TULIPPS Solar develops highefficiency, low-weight and lowcost frameless BIPV modules. Two unique aspects of these modules are the use of ultra-thin glass (2 mm) and an invisible hybrid plastic-metal construction at the backside of the modules. In January 2014, TULIPPS received a 4 million euro funding from the European Commission to build and test these BIPV modules. It does so together with consortium partners in a project called SUMMIT.

3.4 – Organizations

The final paragraph of this chapter lists some organizations in the Netherlands that might be relevant in the solar PV context.

Government

At the national level, the <u>Ministry of Economic Affairs</u> (EZ) is responsible for (renewable) energy matters. <u>RVO.nl</u> supports this ministry, dealing with the implementation of policies and helping entrepreneurs for instance to find the right knowledge or business partners. On a lower level, several <u>provinces and municipalities</u> are also involved with solar PV initiatives, for instance by providing subsidies, offering green loans and/or installing PV systems on governmental buildings.

Market

The Dutch solar sector organization is called <u>Holland Solar</u>. This organization started in 1983 and now has about 130 members, including both solar PV and solar thermal companies. Besides Holland Solar, there is also a sector organization for installation and technical retail companies called <u>UNETO-VNI</u>. These two sector organizations and some other organizations (including RVO.nl) have joined forces to introduce the Dutch quality certificates for installers of PV systems (see *3.2*).

Already since 1979 there is a national association of citizens and cooperatives supporting renewable energy production. This association, called Organization Renewable Energy (<u>ODE</u>), has about 15.000 members. Since recently, there are also several organizations that focus particularly on local renewable energy initiatives, aiming to build bridges between them and to join forces. Examples of these organizations are <u>e-Decentraal</u> and <u>HIER Opgewekt</u>.

Industry

Most of the Dutch manufacturers in the PV industry (see 3.3) have strong linkages with research institutes (see 3.1). Particularly, in the field of thin film, several manufacturers and research institutes are linked via <u>Solliance</u>. Solliance is an alliance between ECN, IMEC, TNO, TU Eindhoven, Holst Centre, and Forschungszentrum Jülich, working closely together with industrial partners to strengthen their regional position (in the Eindhoven-Leuven-Aachen triangle) as a world player in thin film PV.

As many Dutch manufacturers of PV production machines are located in the Province of Brabant, also the Brabant Development Agency (<u>BOM</u>) has many linkages with PV production machine manufacturers. They support these manufacturers, either with knowledge or investments. Another umbrella organization in this field is <u>Cleantech Holland</u>. This organization started in 2008 and acts as the Dutch export platform for sustainable technological products, concepts and innovations.

4 – NEW BUSINESS OPPORTUNITIES

4.1 – Existing PV relations

There are many relations between the Netherlands and China related to solar PV. This differs from universities working together on solar PV research to the installation of Chinese solar panels in the Netherlands. Without neglecting all those relations, this paragraph briefly highlights two of them:

- PV production equipment As indicated in paragraph 3.3, there is a bunch of Dutch organizations delivering production equipment to Chinese PV manufacturers and sometimes working on new technologies in close collaboration. An example of this is the collaboration between the Chinese world-leading PV manufacturer Yingli, the Dutch energy research institute ECN and the Dutch PV production machine manufacturer Tempress Systems. This collaboration on n-type technology (see Box 4.1) started in 2009 and is still in place.
- 2. Building-integrated PV (BIPV) Another example is the collaboration between Chinese and Dutch architects, engineers and urban planners working on BIPV. Companies like BEAR-iD and Grontmij have an office in China, aiming to add a taste of 'Dutch Design' to the large amount of new buildings in China, for instance in order to make them more sustainable and/or more distinctive. *Figure 4.1 and 4.2* show examples of that, all with PV integrated in the buildings.



Figure 4.1 – R&D centres of Trina Solar in Shanghai Minghang and Changzhou, designed by BEAR-iD, company of the Dutch architect Tjerk Reijenga.

Figure 4.2 – Wuhan Energy Flower, claimed to be "the most sustainable office in the world", designed by Soeters Van Eldonk, project management by Grontmij

The interviews suggest that especially in these two areas it might be interesting to explore new collaborations/combinations between Chinese and Dutch organizations in order to enhance each other's businesses. Therefore the next two paragraphs elaborate on those areas (see 4.2 and 4.3). The final paragraph briefly indicates some other possible new business opportunities (see 4.4).

4.2 – Opportunity 1: PV production equipment

In China there is a strong 'copy-paste' relation between factories. In fact, when a certain production line operates successfully in one factory, it will more than likely be applied in many other factories in China. Accordingly, many Chinese PV manufacturers use about the same technology and produce about the same products.

As a consequence, still much of the innovation in the Chinese PV sector comes from abroad. For instance, several Dutch companies supply production lines to Chinese PV manufacturers that enable them to make processes cheaper, faster, more flexible, less energy intensive and/or less environmentally damaging.

At the same time, there are Dutch companies working on product innovations. While the large majority of the global solar PV production concerns (a) p-type, (b) front-contact, (c) c-Si solar cells, Dutch companies are for instance working on (a) n-type technology, (b) back-contact technology and (c) thin film technology. *Box 4.1* briefly introduces these technologies:

(a) From p-type to n-type

Advantages e.g.:

- Higher efficiency
- No light induced degradation
- Better low light response
- Suitable for IBC (see b)

Different cell concepts e.g.:

- Yingli (PANDA)
- Roth and Rau (HELiA)
- Sanyo (HIT)
- PVGS (EarthON)
- SunPower (IBC)

Equipment from e.g.: Tempress Systems

(b) From front- to back-contact

Advantages e.g.:

- Higher output (e.g. no busbars)
- Lower cell-to-module losses
- Less dead area
- Easier to recycle

Different types e.g.:

- Emitter Wrap Trough (EWT)
- Metal Wrap Trough (MWT)
- Interdigitated Back Contact (IBC)
- Hetero-Junction Back Contact (HJBC)

Equipment from e.g.: Eurotron

(c) From c-Si to thin film

Advantages e.g.:

- Lower production costs
- Higher temperature resistance
- Flexible and low-weight
- No EU trade barriers (yet)

Different types e.g.:

- Amorphous Silicon (a-Si)
- Copper Indium Gallium Selenide (CIS/CIGS)
- Cadmium Telluride (CdTe)
- Organic PV (OPV)

Equipment from e.g.: Smit Ovens

Box 4.1 – Introduction to new technologies

Over the past few years, due to the worldwide overcapacity of PV production facilities, the Dutch companies supplying these innovative production lines generally had a tough time. However, in line with the market expectations (see *Figure 3.5*), most of them now observe increasing orders again. *Box 4.2* shows three examples of those orders in various media:

"Several leading China-based module manufacturers have licensed **ECN**'s MWT technology such as Canadian Solar and Yingli Green."

PV Tech (December 2013)

"A multi-million euro investment is being made by China-based start-up, Nanjing Sunport Power Co. Ltd., in purchasing a complete, back-contact PV module assembly line from Dutch manufacturer, **Eurotron**."

PV Tech (December 2013)

"SoLayTec receives repeat Al2O3 order from Chinese Tier One cell manufacturer"

> SoLayTec Press Release (October 2013)

Box 4.2 – Examples of recent messages about Chinese orders of Dutch PV technology.

An important characteristic of these companies is that their activities are mainly complementary to each other (hardly any direct competition) and that they tend to work closely together with research organizations like ECN. This might be a good basis to join forces in reaching their similar goal: propelling innovation in the Chinese PV industry.

In this way, it might be easier to tackle the obstacles mentioned by these organizations in the interviews:

1. Focus on current technology / lowest price – At the moment, Chinese PV manufacturers tend to prefer incremental improvements in the current technology rather than a more radical shift to new technologies. A reason for this preference might be that the latter is observed to be more risky and that banks are reluctant to finance these investments. Another reason might be that the market tends to compare solar panels on the price per Wp rather than for instance their long-term performance. As a consequence, specific long-term advantages of new technologies (for instance 'no light induced degradation' or 'easier to recycle') might not translate into increased sales. In that respect, also market organizations in the Netherlands could propel innovation by focusing more on quality and sustainability (see *Figure 4.3*). An example of such a feedback-loop is the recent rise in demand for all-black panels in the Netherlands: in reaction to this increased demand dedicated production lines for all-black panels have been implemented by Chinese manufacturers, with increased quality as a result.



Figure 4.3 – Schematic impression: the importance of attention for quality and sustainability

- 2. Payment conditions and retreating banks Due to the overcapacity in the worldwide PV market, PV manufacturers have become more in the position to impose requirements on the payment conditions of both their supply and their sales. Roughly, this has led to a shift from 'payment upfront' to 'payment afterwards' for their suppliers and a shift from 'payment afterwards' to 'payment upfront' for their buyers/importers. Combined with the trend that banks are retreating from the PV sector, this shift in payment conditions has raised a serious trade barrier for Dutch suppliers of PV production machines. With tough years behind, their financial reserves are generally shrunk, making it sometimes impossible to meet the imposed payment conditions. A solution might be to offer this group of suppliers the opportunity to get export financing or to introduce a guarantorship towards banks. Opinions about the solution differ however.
- 3. Protection of intellectual property (IP) Because of the in general innovative character of Dutch PV production machines, protection of IP is an important subject for their suppliers. Some of the people involved in the interviews have their doubts about the practical value of IP in China, but others believe IP is becoming more and more respected. Therefore, they believe for instance international patenting should be encouraged. Another suggestion to prevent leakage of IP is to keep the production line of the PV production machines in the Netherlands (preservation of the Dutch 'maakindustrie') and above all to keep innovating.

4.3 – Opportunity 2: BIPV

The second business opportunity for enhanced collaboration between the Netherlands and China is building-integrated PV (BIPV). Besides the architects mentioned in the first paragraph of this chapter, more and more other organizations see the rising importance of this subject. Illustrative in this respect might be last year's decision of the Dutch development bank FMO to invest in Singyes Solar, one of the prominent players in China developing BIPV projects (see Box 4.3).

FMO invests in Singyes Solar Technologies

FMO has invested in China Singyes Solar Technologies Holdings Limited, a professional renewable energy solution provider and building contractor ("Singyes"). Singyes has received a US\$90 million A/B Loan Facility* from FMO, the Dutch development bank, and a consortium comprising Hong Kong, Taiwanese and Korean banks. This is the first syndicated loan Singyes has raised since its listing in Hong Kong and the second financing made by FMO in the China solar energy sector. [...]

China Singyes Solar Technologies Holdings Limited is a professional renewable energy solution provider. It focuses on renewable energy systems integration with the core of building energy saving, and dedicates to economical solutions for green buildings. Singyes Solar specializes in system design, processing, assembling and operation of curtain walls, building integrated photovoltaic/solar thermal (BIPV/BIST) systems, etc. It also develops systems and auxiliary products such as photovoltaic modules, solar collectors and air source heat pumps. [...]

Box 4.3 – Press release of FMO about their investment in Singyes (19 July 2013)

This investment is remarkable because at the moment the willingness to invest in Chinese solar energy companies is generally low. In fact, over the past few years many solar energy companies have gone bankrupt and most of the survivors are in a difficult financial position with high debts.

But the BIPV business is another business than purely the production and sales of solar panels. It is a business with (in general) higher margins and more room for product differentiation. Therefore, being wiped out of the market solely on price seems to be less likely than in the 'normal' PV business.

With a strong background in BIPV and having 'Dutch Design' as a strong international trademark, there seem to be many business opportunities here for the Netherlands to seek for enhanced collaboration with China on this subject.

This business opportunity lies at the interface of two so-defined 'top sectors' of the Dutch economy: creative industry and energy. Besides, within the top sector energy it concerns several TKI's; not only solar, but for instance also energy in the built environment (EnerGO) and smart grids (see *Figure 4.4*).



Figure 4.4 – Interface between two top sectors of the Dutch economy: creative industry and energy

The strong background of the Netherlands in BIPV is also visible within the International Energy Agency (IEA). In the past, the Netherlands had the leading role in the IEA task about BIPV (IEA PVPS Task 7) and currently the country is again leading in the preparation of a new task about this subject (IEA PVPS Task 16). The start of this task will probably take place at the 29th EU PVSEC 2014, this time being held in Amsterdam (September 22-26, 2014).

In a broader respect, also the Sino-Dutch Sustainable Building platform might be worth mentioning. This platform supports Chinese and Dutch firms to connect with each other and to do business together. This does not only concern BIPV, but for instance also energy savings and cradle-to-cradle solutions for buildings. The platform is led by the Dutch consulate in Shanghai.

A challenge – similar to the first challenge in the previous paragraph – is to increase the attention for quality in this market. The quality of buildings in China is generally low, while BIPV requires high quality. On the other hand, this might open up opportunities for knowledge exchange and for Dutch companies that are able to increase the quality of buildings. Moreover, it might be interesting for the production machine suppliers and urban planners and designers to join forces on this subject (for instance Smit Ovens and Grontmij working together on high-quality thin film BIPV-products).

4.4 – Other opportunities

In addition to the business opportunities mentioned in the previous paragraphs, the final paragraph of this chapter briefly indicates some other suggested business opportunities:

Import of Chinese solar panels

The interviews suggest that Dutch importers and Chinese PV manufacturers are well able to find each other. In line with that, no direct signs of new or untapped business opportunities were observed. Nevertheless, as indicated in *Figure 4.3*, increased attention for quality and sustainability might create new business opportunities; maybe not directly, but at least indirectly.

Chinese companies in the Netherlands

The Netherlands has an attractive investment climate and is often seen as 'the gate to Europe'. Therefore, an increasing number of foreign companies and foreign investors moves to the Netherlands, including Chinese companies. An example of such a company is the Hanergy Group, a world-leading thin film company which has its European headquarters in Amsterdam.

Solar radiation measuring instruments

All over the world, solar PV systems are equipped with solar radiation measurement equipment in order for instance to monitor the system's efficiency. A leading company in this field is Kipp & Zonen, a Dutch company that exists since the year 1830. The company already has a local distributor and producer in China and will soon be opening an office in Beijing.

Innovative Dutch PV products

As indicated in *Box 3.1*, there are several Dutch start-ups working on the development and production of innovative PV products. Examples of those start-ups are SolarExcel (in 2013 acquired by Royal DSM), SunCycle and TULiPPS. Their products are unique, which makes them interesting for the international market. Some collaborations with Chinese organizations are therefore already in place.

Energy storage

One of the largest challenges, or maybe *the* largest challenge of the solar energy sector at this moment is to find a cheap and long-lasting solution for energy storage. With the growth of solar energy from a small and innocent part of the electricity mix to a meaningful share, this challenge becomes more and more important. Possibly, Dutch and Chinese organizations can join forces on this subject.

Recycling

Another – seemingly less urgent but without any doubt challenging – issue is recycling. This issue is dealt with for instance by PV Cycle, a pan-European take-back and recycling scheme with currently about 20 collection points in The Netherlands. Obviously this scheme requires collaboration between European and Chinese companies, maybe with new business opportunities as a result.

5 – CONCLUSIONS

The desk study, the interviews and the meeting on April 11, 2014, suggest that there are at least two areas of new or enhanced business opportunities between the Netherlands and China. These areas are (1) PV production technology and (2) building-integrated PV (BIPV).

1. PV production equipment

Several Dutch companies supply specialized production equipment to leading Chinese PV manufacturers. In general, these companies have had some difficult years because of the global overcapacity in the PV industry, but since recently orders are increasing again. China, as the undisputed global PV industry leader, is a dominant factor in this revival.

What makes this revival interesting, is that to a large extent these Dutch companies are complementary to each other and that they face similar challenges. These challenges are for instance to proof the added value of enhanced quality or sustainability in PV production processes and to meet payment conditions in a market from which banks are retreating.

This complementary character suggests that enhanced collaboration between Dutch suppliers of PV production equipment in China might create synergy. In other words, with less effort per organization it could create a stronger image and a better result overall. ECN, who already has alliances with some of the suppliers (especially in China, where it has an excellent reputation on PV research), could play a crucial role in instigating this enhanced collaboration.

2. BIPV

Until recently, the Chinese PV industry was mainly focussed on export. Over the past years however, facing global overcapacity, the Chinese home market for PV has increased tremendously. In 2013, this market saw a world-wide record of PV installations in one country and there is no sign at all that this was a one-hit wonder.

An interesting niche within this home market is BIPV. With the enormous amount of new buildings still being built every year and with a strong demand for distinctiveness, this market is becoming more and more prominent. Moreover, with higher margins and less focus on price, it increasing attracts the attention of PV manufacturers.

Why is this a business opportunity for the Netherlands? First of all, 'Dutch Design' and Dutch architects have a strong reputation in China. Second, the Netherlands has a strong background in BIPV, for instance as the leader of the IEA tasks about this subject (IEA PVPS Task 7 and 16). And third, there are some well-known BIPV projects in China with a Dutch design, for instance the R&D centres of Trina Solar and the Energy Flower in Wuhan.

Besides these two areas, other suggested areas of new or enhanced business opportunities are: import of Chinese solar panels, Chinese companies in the Netherlands, solar radiation measurement instruments, innovative Dutch PV products, energy storage and recycling.

6 – RECOMMENDATIONS

As mentioned in the introduction chapter, the aim of this exploration is twofold: (1) explore new or enhanced business opportunities and (2) advise Dutch organizations on how to utilize these business opportunities and the Dutch government on how to facilitate this. This chapter deals with the latter.

1. PV production equipment

The previous chapter argues for enhanced collaboration between Dutch suppliers of PV production equipment in China. A good occasion to take a step in this direction might be the SNEC 2014 in Shanghai, one of the largest international solar PV expo's in the world on which several Dutch companies will be present. Supported by RVO.nl, ECN organizes a workshop in Shanghai the day before the start of the expo (May 19). The focus of this workshop is on back-contact technology, but it is open for all interested Dutch companies and organizations. A recommendation would be to use this workshop not only to meet Chinese stakeholders, but also to explore synergies between each other. If there is a match between several Dutch organizations, programmes like Partners for International Business (PIB) might be able to support their cooperation in China. With regard to future expo's and conferences, a recommendation would be to bundle the presence of Dutch organizations. An example in that direction is the 'Holland Paviljoen' on the EU PVSEC 2014 in Amsterdam (September 23-25).

2. BIPV

In order to utilize the BIPV business opportunities, a relevant development seems to be the start-up of a new IEA task about BIPV (IEA PVPS Task 16). So far, the Netherlands has the lead in this task. A recommendation would be bundle Dutch forces to keep this leading role and to invite China to have a strong involvement in this task as well. Another recommendation from the interviews is to have a brainstorm session with Chinese PV manufacturers and Dutch architects in China. With the upcoming BIPV market and its interesting characteristics (especially: less competition on price), it might be interesting for them to explore opportunities for collaboration in the Chinese BIPV market and for instance to develop complete BIPV packages together. An important recommendation for such a brainstorm session is to have an extensive preparation, since the Chinese attitude in brainstorm sessions is generally quite different from the Dutch attitude.

Other, more general recommendations are to increase the attention for quality and sustainability in the PV market (thereby indirectly increasing the demand for innovative technologies), to respect the position of the Dutch 'maakindustrie' (not only presenting the Netherlands as a 'knowledge economy') and to improve the coordination of Chinese relations and trade missions (these seem to be numerous but also fragmented).

REFERENCES

- **Azure (2013)** Opportunities for Dutch Clean Energy Companies in China. *Azure International, December 2013.*
- **Berenschot (2011)** Zon op Nederland (Sun on the Netherlands): Roadmap 2011-2015. *Project team 'Zon op Nederland', supervised by Berenschot, February 2011.*
- Bloomberg (2014a) China Maintains Solar Target After Record Installations. *Feifei Shen, Bloomberg News, 24 January 2014.*
- Bloomberg (2014b) Solar Mergers Likely to Accelerate, Trina Founder Says. *Zijing Wu and Reed Landberg, Bloomberg News, 26 January 2014.*
- **BNEF (2014a)** China's 12 GW Solar Market Outstripped All Expectations in 2013. *Nathaniel Bullard, Bloomberg New Energy Finance, 23 January 2014.*
- **BNEF (2014b)** Chinese Solar Growth To Underpin Record Global Expansion in 2014. *Marc Roca, Bloomberg New Energy Finance, 25 February 2014.*
- **CBS (2014a)** International Trade; Import and Export according to the SITC classification. *Statline, Statistics Netherlands, as visited on 31 January 2014.*
- **CBS (2014b)** Renewable Energy; capacity, domestic production and consumption. *Statline, Statistics Netherlands, as visisted on 10 February 2014.*
- **EPIA (2013)** Global Market Outlook For Photovoltaics 2013-2017. *European Photovoltaic Industry Association, May 2013.*
- **EPIA (2014)** Record-year for photovoltaic markets in 2013, Asia taking over the leading role. *European Photovoltaic Industry Association, 6 March 2014.*
- FD (2013) 'Made in Holland' speelt een cruciale rol in mondiale productielijnen zonnepanelen ('Made in Holland' plays a crucial role in global production chains of solar panels). *Henk Engelenburg, Financieel Dagblad, 17 May 2013.*
- **Holland Solar (2014)** Een terugblik op 25 jaar Holland Solar (A retrospect on 25 years Holland Solar). *Website of Holland Solar, as visited on 10 February 2014.*
- **IEA (2013a)** CO₂ emissions from Fuel Combustion: Highlights. *International Energy Agency, October 2013.*
- **IEA (2013b)** National Survey Report of PV Power Applications in China 2012. *Co-operative Programme on Photovoltaic Power Systems Task 1, International Energy Agency, 16 July 2013.*
- IHS (2013) Solar Market Predictions for 2014. IHS News Flash, 18 December 2013.
- **Klimaatmonitor (2014)** Vermogen PV-installaties in Productie Installatie Register (Capacity PV-installations in Production Installation Register). *Database on the website of Klimaatmonitor, as visited on 4 March 2014.*
- **Mercom (2013)** Global Installations To Reach Approximately 43 GW in 2014. *Mercom Capital Group website, 17 December 2013.*
- **MIT (2013)** Solar-cell manufacturing costs: innovation could level the field. *David L. Chandler, MIT News Office, 5 September 2013.*
- **NDRC (2013)** Notice on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect. *National Development and Reform Commission, August 2013.*
- **NEA (2014)** Preliminary PV installation numbers of 2013 in BNEF (2014a). *China's National Energy Administration.*
- PV Magazine (2014) China's PV company 'cull list' to have minimal global impact. Edgar Meza, PV Magazine, 9 January 2014.

- **PV Tech (2013)** Tool Order: Chinese start-up buys Eurotron back-contact module manufacturing line. *Mark Osborne, PV tech website, 12 December 2013.*
- **PV Tech (2014)** What does NPD Solarbuzz' solar cell rankings for 2013 reveal? *Finlay Colville, PV Tech website, 29 January 2014.*
- **Reuters (2014)** China's solar industry rebounds, but will boom-bust cycle repeat? *Charlie Zhu, Reuters, 23 January 2014.*
- **SolarBuzz (2013)** Strong Growth Forecast for Solar PV Industry in 2014 with Demand Reaching 49 GW. *SolarBuzz website, 23 December 2013.*
- **SolarBuzz (2014a)** Tier 1 Solar PV Module Margin Recovery: How Long will it Last? *Michael Barker, SolarBuzz, posted in PV Module, 21 January 2014.*
- **SolarBuzz (2014b)** Top 10 Solar Module Suppliers in 2013. *Ray Lian, SolarBuzz website, 8 January 2014.*
- **SolarBuzz (2014c)** New Solar PV Capital Expenditure Cycle to Start in 2015. *SolarBuzz website, 30 January 2014.*
- **SPVI (2013)** China's Solar Industry Lacks Differentiation, ECN Sees n-Type Technology as a Solution. *Robert Dydo, Solar PV Investor News, 10 February 2013.*

INTERVIEWS

Persons who have been interviewed:

- Tjerk Reijenga (BEAR-iD)
- Oscar Goddijn (DSM)
- Levien de Legé (ECN)
- Carol Olson (ECN)
- Ye Zhang-Steenwinkel (ECN)
- Jan Bakker (Eurotron)
- Bram Verschoor (Eurotron)
- Gerhard Engel (FMO)
- Edward Hamers (HyET)
- Vincent Paalvast (Mastervolt)
- Martijn Zwegers (Meco)
- Jingmin Kan (NOST China)
- Dennis Gieselaar (Oskomera)
- Daisy Xu (ReneSola)
- Wiro Zijlmans (Smit Ovens)
- Huib Heezen (SoLayTec)
- Paul Stassen (TULiPPS)

Other persons who have provided input:

- Michel Weeda (BOM)
- Ming Eikelenboom (Consulate General Shanghai)
- Hillebrand Ehrenburg (Grontmij)
- Foeke Kuik (Kipp & Zonen)
- René van Vlimmeren (Roth & Rau)
- Agnes Agterberg (RVO.nl)
- Otto Bernsen (RVO.nl)
- Li Hua (RVO.nl)
- Wiep Folkerts (SEAC)

COLOPHON

Title

New solar PV business opportunities between the Netherlands and China

Version

Final

Date April 24, 2014

An assignment of Netherlands Enterprise Agency (RVO.nl)

A production of Energy Indeed

Author Mark Meijer +31 6 417 09 652 mark@energyindeed.com