SERVICES IN GLOBAL VALUE CHAINS

SOLAR PANEL MANUFACTURING IN CHINA

International Trade Centre

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This case study, based on corporate survey methodology, undertaken with the Fung Global Institute (FGI) in Hong Kong, China, contributes to and forms part of a larger FGI study on the importance of services in global value chains. It outlines the value chain for solar panel production; identifies the types of services entering the value chain; and calculates their share in overall costs.The study finds that 40 services are required for this value chain, and three-quarters of those are partially or fully outsourced to third parties. The study highlights the impact of government policies in shaping the photovoltaic sector and the impact of trade policies on export-dependent manufacturing.

Descriptors: **China, Global Value Chains, Environmental Industries, Manufacturers, Services, Outsourcing, Trade Policy, Case Studies.**

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The International Trade Centre (ITC) is the joint agency of the World Trade Organization and the United Nations. The Fung Global Institute (FGI) is an independent Hong Kong-based think tank that undertakes business relevant research on global issues from Asian perspectives.

Foreword

Quan Zhao's study of a Chinese solar panel manufacturer is in reality a study of the role of services in production. The study forms part of a wider project in which the ITC is an institutional partner with the Fung Global Institute (FGI) in Hong Kong. The project, initiated at FGI, seeks to analyse more deeply the role of services in production and consumption along global value chains (GVCs). It is based on a series of case studies which are intended to build insights to feed more systematic analysis.

Services are receiving greater attention today than ever before. Partly this reflects a broadly shared recognition that policymakers, analysts, scholars and sometime businesses have neglected the various economic contributions of services. The neglect has led to missed opportunities and policy miscalculations.

Several factors help to explain why the economic contributions of services have been under-appreciated. Historical habit of thought is one. Classical economic doctrine had it that services were worthless because value was equated to accumulation, and services could not be stored. Later on, fears arose that since populations produced and consumed proportionately more services as they grew richer, their economies would stagnate and decline because services could not contribute to growth through increased productivity. Added to that, the invisibility of services, their customized nature, the tendency for them often to be bundled with goods, combined with the huge challenges of measuring them, and the picture of past neglect is perhaps not surprising. But it is changing.

With the growing internationalization of economic activity, the rise of GVCs and intensified demand for services across a broad range of economic activities, interest has grown in trying to understand what and how services contribute to economic activity and human wellbeing.

Zhao's study of solar panel production sheds light on the variety of services used in GVCs, how they enter and what they can contribute. No fewer than 40 services are required for this value chain, and three-quarters of those are partially or fully outsourced to third parties. Outsourcing to this degree is not uncommon in many sectors. The implications of outsourcing opportunities for developing economies wishing to participate in value chains and upgrade that participation over time deserve careful study.

Finally, this project attempts to shed light on how government policies influence the configuration, location and cooperation of GVCs. Zhao's study identifies several key policy interfaces in the solar panel value chain. Services are more intensively regulated, and frequently more protected, than in many other sectors, and in virtually all economies. The collection of case studies that comprise the overall project will enrich our understanding of how governments can both help and hinder growth and development opportunities.

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Contents

Acronyms

The following acronyms are used:

AFASE	Alliance for Affordable Solar Energy
CPC	Central product classification
EPC	Engineering Procurement Construction
EPIA	European Photovoltaic Industry Association
FGI	Fung Global Institute
GDP	Gross domestic product
GVC	Global value chain
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IPO	Initial public offering
ISO	International Organization for Standardization
IT	Information technology
ITC	International Trade Centre
JET	Japan Electrical Safety and Environment Technology Laboratories
MW	Megawatt
PR	Public relations
PV	Photovoltaic
PVPS	Photovoltaic Power Systems Programme
R&D	Research and development
RMB	Renminbi
SOE	State-owned enterprise
TUV	TÜV Rheinland Group
UL	Underwriters Laboratories

Summary of Findings

The company analysed in this case study is engaged in two segments of the photovoltaic (PV) value chain: namely, the manufacture of solar cells and the assembly of solar modules, commonly known as solar panels. The company's operations do not yet fully cover the entire value chain from the development of solar chips through to the construction of solar power plants.

About 75% of the company's total cost of production is spent on material inputs. Services account for 20% to 25% of the total cost. When material inputs are excluded from the calculations, however, services account for about 70% of the cost of production, with the remaining 30% spent on bank loan interest and wages for workers on the production line (excluding services posts). While over 70% of the company's workforce is on the production line, the wages for these manufacturing jobs represent less than 7% of the company's total costs.

The company's pilot investment in a solar power plant in the United Kingdom shows that in higher value added segments of the PV value chain – such as the installation of solar systems and construction of solar power plants – services account for about 70% of the total cost. In this case, however, local companies in the United Kingdom retained the majority of the services' value added, since most of the services were outsourced to them. Immigration, labour and investment-related laws prevented the company from directly engaging in the building of the power plant.

This study identifies a total of 40 types of services inputs in the production process, of which 30 are fully or partially outsourced, and only 10 supplied in-house. Key considerations involved in the decision to outsource include: economies of scale and scope, the necessity of maintaining strong relationships with relevant stakeholders, and the feasibility – dependent on expertise and resources – of supplying certain services in-house. Those services that are provided in-house – such as procurement, production management, quality control, accounting, human resources and so forth – for the most part contribute to the company's core competitiveness, or are retained for trust and security considerations.

Even though PV manufacturing in China is a fully competitive market, with the majority of the players being private companies, the intertwined relationship between government and business allows the former to exert considerable influence over the decisions and operations of companies within the sector. Due to concerns over Gross Domestic Product (GDP) growth, for instance, government officials have been known to discourage private companies from reducing their investment in this clearly overinvested sector. China needs to pursue further reforms to ensure that the market, and not the government, plays a 'decisive' role in resource distribution.

Industrial policies can also shape the sector in dramatic ways. The Chinese PV manufacturing market grew rapidly due to policy incentives that encouraged private investment within the sector. These same policies, however, also contributed to the sector's overcapacity. On the other hand, a lack of clarity surrounding grid connection policies, as well as lengthy and opaque licensing procedures, discouraged investment in the downstream segments of the value chain, such as the construction of solar power plants. This resulted in the sector's heavy dependence on the export market.

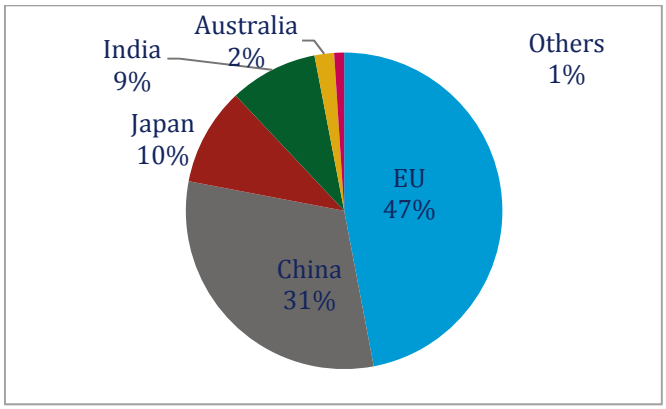
Trade disputes can similarly have a significant impact on export-oriented manufacturing. Antidumping and countervailing measures can divert imports in favour of higher-cost, and higher-quality, producers. Trade disputes not only hit the companies directly, through investigations and punitive tariffs, but also indirectly, through increased costs for key services inputs, such as insurance, legal and consulting services, accounting and auditing services.

1. Background information: the company

The company under study is a NASDAQ-listed Chinese manufacturer of solar cells and solar modules. Its headquarters are located in Nanjing, China, where it operates a production facility. The company also operates a factory in Shanghai and has recently established an overseas factory in south-eastern Europe. It maintains country offices in the United States of America, the United Kingdom, Germany, France, Italy, Turkey and Thailand. These country offices mainly serve as the company's distribution channels.

The company focuses on the production of solar cells and solar modules. In 2013, its total turnover exceeded US$ 300 million. The domestic market accounted for about 31% of total sales, with the remaining 69% generated from export markets. As indicated in figure 1 below, Europe is by far the largest export market for the company, accounting for 47% of total sales, followed by Japan (10%), India (9%) and Australia (2%). In addition to the production and distribution of solar products, the company is diversifying into solar power plant construction, both in China and overseas. As discussed below, the company built a 5-megawatt (MW) solar plant in the United Kingdom in 2013.

Figure 1. Key markets for company's PV products



Source: Courtesy of the company

The company employs around 3,000 full-time staff, of whom about 2,500 (83%) are based in China, with a further 500 (17%) stationed and employed overseas. Of the 500 employees abroad, more than 400 are stationed in the company's overseas production base in Europe. The remainder occupy management and sales posts in the United States, Germany and other European country offices.

Table 1 below itemizes the occupational demographics of the company's employees. The vast majority of the total workforce – 77% of the employees – serves on the production lines. Other posts – maintenance and repair, quality control and warranty, management and administration, research and development (R&D), sales and marketing, and procurement – account for the remaining 23%.

Table 1. Occupational demographics

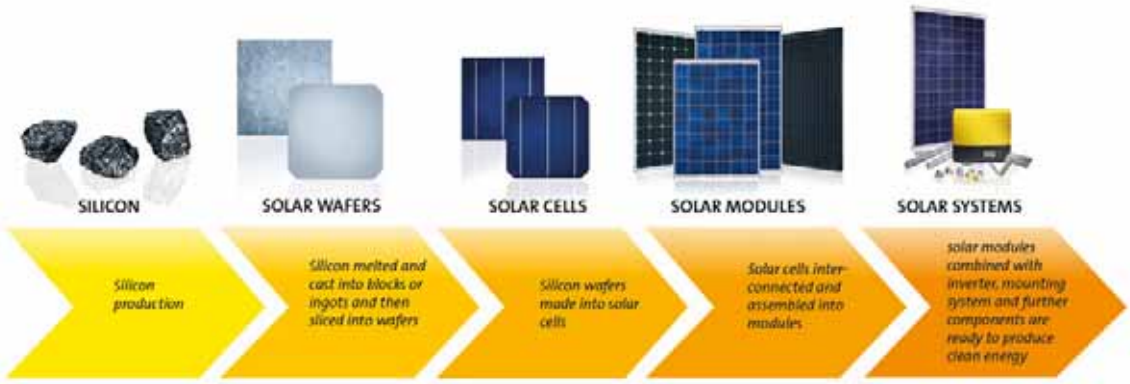
Posts	Number of Employees
Manufacturing	2,275
Maintenance and repair of production equipment	190
Quality Control	123
Procurement	31
Research and development	58
Sales and marketing	63
Administration and management	197
Total	**2,937**

Source: Courtesy of the company

2. Description of the value chain

Solar systems generate electricity from sunlight through the photovoltaic (PV) effect, so the solar energy market is frequently referred to as the PV market. Figure 2 illustrates the process behind the solar system production chain. This process begins with mining raw silicon materials. The raw silicon is melted, cast into blocks and sliced into thin silicon wafers. These wafers are then cleaned, and undergo surface texturing, diffusion, etching, anti-reflection film application and screen-printing, before being assembled into solar cells that can convert light into electricity. Multiple solar cells are then interconnected, wired with electronic components and placed between reinforced glass and a backboard, fixed by an aluminium frame to form solar modules. Finally, these modules are combined with inverters and mounting systems to form solar systems ready to produce clean energy.

Figure 2. Workflow of solar system production chain



Source: ProSun: Sustainable Solar Energy Initiative for Europe. Available from www.prosun.org

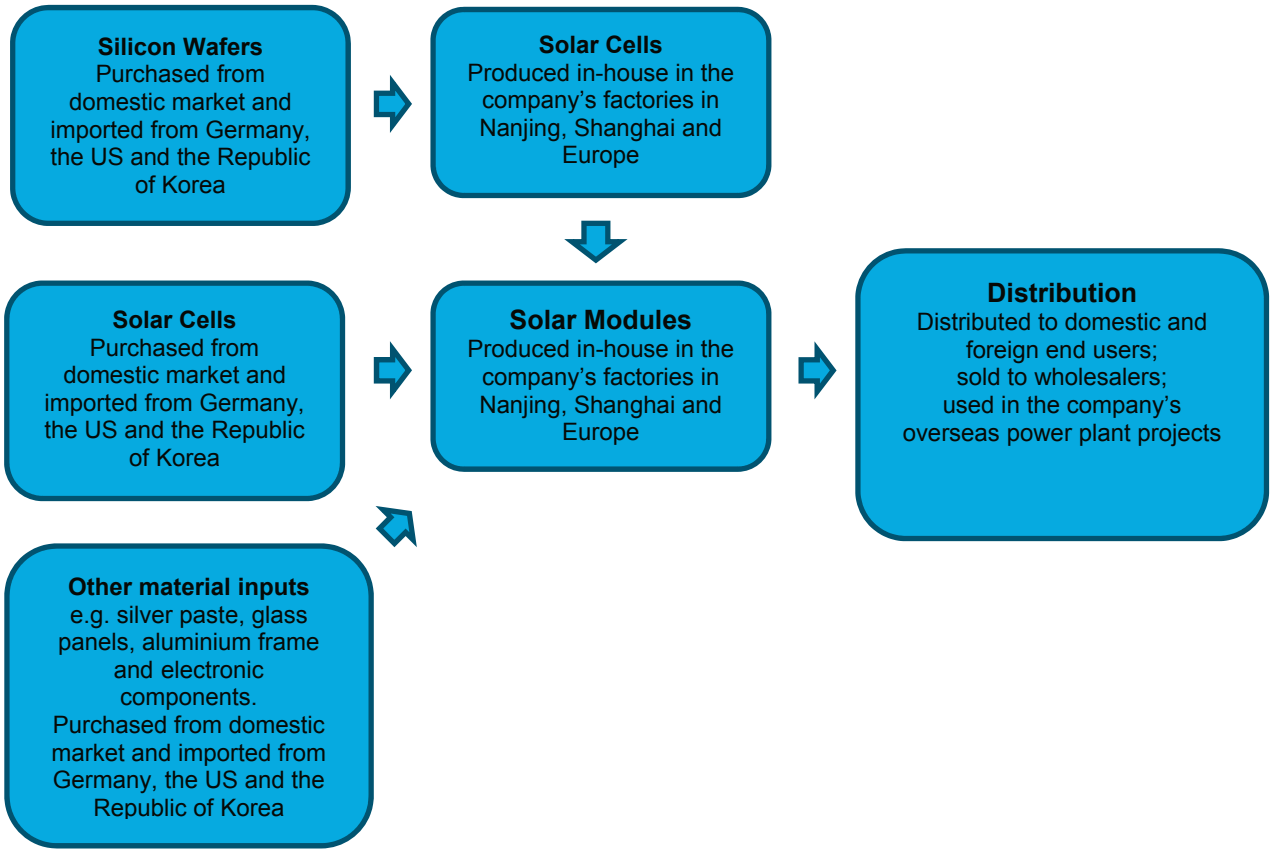
The company is predominantly engaged in the production of solar cells and the assembly of solar cells into solar modules. Solar modules account for 95% of the company's final products. The remaining 5% are solar cells sold to other PV manufacturers.

About 50% of the solar cells used by the company for the assembly of solar modules are produced in-house (from solar wafers both purchased domestically and imported from international suppliers), while the remaining 50% of solar cells used for production are purchased readymade from both domestic and international suppliers.

The value chain under consideration in this study is the one related to the company's main product: solar modules. Though the company produces various specifications of solar modules – such as monocrystalline silicon/polycrystalline silicon, with varying dimensions, e.g. 60/72 cells per module – solar modules are homogeneous products, produced through the same processes in the same factory, and from the same services inputs. Therefore, for the purposes of this study, the company's total output is regarded as a single product (since solar modules account for 95% of the company's final products), and the services' contribution to the value chain is evaluated through an examination of the total non-material inputs into production.

Figure 3 below illustrates the value chain involved in this process. The value chain starts with the purchase of solar wafers, solar cells and other material inputs (such as silver paste, glass panels, aluminium frames and electronic components) both from domestic suppliers – about 50% of total procurement – and from international suppliers, with American and German producers accounting for the remaining 50% of the total procurement. The solar wafers are converted into solar cells, before multiple solar cells are assembled into solar modules in the company's factories in Nanjing, Shanghai and Europe. The company also outsources part of the production to other manufacturers in the vicinity of its Nanjing/Shanghai factories, either during peak seasons, when the company's production capacity cannot meet demand, or during the low seasons, when it is more cost-efficient to outsource rather than operate a production line in-house.

Figure 3. Mapping the company's value chain



The company sells about 60% of the final products directly to the end users via its domestic and overseas sales offices, and the remaining 40% to domestic wholesalers and foreign importers.

The company operates a small in-house sales and marketing team. Similarly, packaging is performed at the factory, while specialized companies engaged in international transportation and trade provide transportation and customs-clearance services for its exports.

3. Services along the value chain

This study identifies a total of 40 services in the company's activities along the PV value chain.[1] As table 2 illustrates, these services can be grouped according to the various stages at which they enter the value chain. These four groupings include: i) services upon importation of material inputs for production; ii) in-factory and factory-related services; iii) sales and export-related services; and iv) operation and management-related services.

These 40 services can be further broken down into 68 services if more specific types of services within a broader set are classified individually. Freight transportation services, for instance, can be itemized into land, water and air freight services, as well as including a series of auxiliary freight-handling services. Financial services can be further refined to include investment banking services, mergers and acquisition services, corporate finance and venture capital services, deposit services, credit-granting services, financial consultancy services and foreign-exchange services.

[1] Certain services – such as technical testing and freight transportation services – occur at more than one stage, but are counted only once to avoid duplication.

Table 2. Services entering the value chain

Services	Corresponding Central Product Classification (CPC) Rev. 2 code
Services upon importation of material inputs for production	
1. Customs-related services (for import)	85999. Other support services n.e.c.
2. Procurement services	85999. Other support services n.e.c.
3. Technical testing (for the procured inputs)	83441. Composition and purity testing and analysis services
4. Freight transportation services (of raw materials) by road, rail, sea or air	Division 65. Freight transport services (a bundled set of many services loosely described as logistics)
In factory and factory-related services	
5. Production administration, including production management	83115. Operations management consulting services
6. Utilities (electricity, water and gas)	691. Electricity and gas distribution (on own account) 692. Water distribution (on own account)
7. Installation of production equipment	87320. Installation services of industrial, manufacturing and services industry machinery and equipment
8. Maintenance and repair of production equipment	87156. Maintenance and repair services of commercial and industrial machinery
9. Storage of raw materials – general storage	67290. Other storage and warehousing services
10. Technical testing (for quality control)	8344. Technical testing and analysis services
11. Research and development (R&D)	8111. Research and experimental development services in natural sciences
12. Packaging services	85400. Packaging services
13. Accommodation for workers and managers	63220. Room or unit accommodation services for workers in workers hostels or camps 72111. Rental or leasing services involving own or leased residential property
14. Canteen services	63393. Other contract food services
15. Training services (for workers)	9291. Other education and training services
16. Security services	8523. Security systems services 8525. Guard services
17. Cleaning services	85330. General cleaning services
18. Sewage water treatment services	94110. Sewerage and sewage treatment services
19. Government inspections on fire prevention, health hazards, environmental protection and other aspects	91133. Public administrative services related to mining and mineral resources, manufacturing and construction 91290. Public administrative services related to other public order and safety affairs

Sales and export-related services	
20. Product testing (for obtaining standards compliance certification at the export market)	8344. Technical testing and analysis services
21. Freight transportation (domestic and cross-border bundled set of services loosely described as logistics)	651. Land transport services of freight 652. Water transport services of freight 653. Air and space transport services of freight 67910. Freight transport agency services and other freight transport services
22. Freight insurance	71333. Freight insurance services
23. Warehousing (rented warehouses in China, the Netherlands, Australia, Germany, the United States, and elsewhere)	672. Storage and warehousing services
24. Advertising (advertisements in related journals)	8361. Advertising services
25. Marketing (including trade fairs and conventions)	8596. Convention and trade-show assistance and organization services 83114. Marketing management consulting services
26. Retail trade services	624. Other non-store retail trade services
27. Design of packages	83919. Other specialty design services
28. Market research and consulting services	8370. Market research and public opinion polling services 8311. Management consulting and management services
29. News and information service (including PR Newswire and Thomson Reuters)	84410. News agency services to newspapers and periodicals
Operation and management-related services	
30. Company registration and licensing services (including obtaining the permit to build the power plant in the United Kingdom)	91138. Public administrative services related to general economic, commercial and labour affairs
31. Financial services (including IPO-related services)	7120. Investment banking services 71511. Mergers and acquisition services 71512. Corporate finance and venture capital services 7112. Deposit services 7113. Credit-granting services 71591. Financial consultancy services 71592. Foreign-exchange services
32. Social insurance for factory workers and managers	91320. Administrative services related to government employee pension schemes; and old-age disability or survivors' benefit schemes (other than for government employees) 91330. Administrative services related to

	unemployment compensation benefit schemes
33. Insurance services (commercial life and accident/health insurance, property insurance for the factory compound, product quality insurance, management liability insurance)	7131. Life insurance and pension services 7132. Accident and health insurance services 71334. Other property insurance services 71335. General liability insurance services
34. Legal consulting, including legal compliance, dispute settlement and arbitration	8212. Legal advisory and representation services concerning other fields of law 8213. Legal documentation and certification services 82191. Arbitration and conciliation services
35. Services charges for listed companies in the securities market	71552. Financial market regulatory services
36. Accounting, auditing and bookkeeping services	8221. Financial auditing services 8222. Accounting and bookkeeping services
37. Public relations (PR) services	83121. Public relations services
38. Business hospitality	63. Accommodation, food and beverage services
39. Human resources	8512. Labour supply services 8511. Personnel search and referral services 83113. Human resources management consulting services
40. Information technology (IT) services	83132. IT support services 83151. Website hosting services
41. Telecom services	841. Telephony and other telecommunications services 8422. Internet access services
42. Visa and immigration services for foreign investors and employees (including travel between headquarters and country offices)	91290. Public administrative services related to other public order and safety affairs
43. Travel services	642. Long-distance transport services of passengers 641. Local transport and sightseeing transportation services of passengers

4. Analysis of the services inputs in the value chain

Despite the diversity of services used by the company in the PV production process, the total value of services inputs in the value chain remains modest. As highlighted above, services inputs account for 20% to 25% of the total cost of production. This relatively low percentage may largely be attributed to the following factors.

First, the company's operations do not fully capture the whole PV value chain from the upstream (development of PV chips) to downstream (installation of solar systems and construction of solar power plants). Rather, it is only engaged in the middle section of the value chain, namely production of solar cells and the assembly of solar cells into the solar modules. The company's overall cost structure, as analysed in the following paragraph, indicates that this is the low value added part in the value chain of the PV market.

The international market price (in US$) for solar cells, the company's main inputs, is around $0.35 per watt, and for solar modules, the company's main output, is between $0.56 and $0.57 per watt. Solar cells alone already comprise 62% of the total cost of the modules. Apart from the cells, the company also buys other material inputs, such as silver paste, glass panels, aluminium frame and electronic components. As the company's figures indicate, out of the US$ 360 million of the total cost of production, the greatest share (about US$ 270 million, or 75%) is spent on purchasing material inputs.

If the cost of material inputs is excluded from calculations, however, services would account for about 70% of the cost of the actual production process, with the remaining 30% spent on interest costs for bank loans and wages for workers on the production line (not including wages for services-related posts, such as maintenance and repair of production equipment, quality control and warranty, procurement, R&D, sales and marketing, or administration and management). It is also worth noting that even though manufacturing jobs account for more than 70% of the company's entire workforce, wages for workers on the production lines represent less than 7% of the company's total costs.

The higher value added activities along the PV value chain relate to the installation of solar systems and the construction of solar power plants. Services account for a significantly larger share of these value-chain activities, as was revealed when the company built a 5MW solar power plant in the United Kingdom. For this project, the modules accounted for only 30% of the total cost. Engineering Procurement Construction (EPC) – including building of the power plant and installation of the solar modules – was outsourced to a local company in the United Kingdom and accounted for 40% of costs, while the permit cost was around 20%. Land rental, legal consultation, technical consultation and related testing and conformity assessment services, and project management services accounted for the remaining 10% of the total investment. In the case of this value chain, services accounted for about 70% of value, while material inputs (solar modules) accounted for only 30% of the total cost.

The company's decision to diversify into solar power plant construction was driven mainly by the declining profit margins on solar modules trade. This move overseas did not, however, prove to be as profitable a business strategy as the company intended. The predominant share of value added in the company's United Kingdom project was retained by the local EPC company (40%) and by the United Kingdom government (20%), as well as by local law firms and testing labs. The company only profited from modules sales, earning a small overall return on its investment on the sale of the facility. Immigration, labour and investment-related laws prevented the company from directly engaging in the construction of the power plant.

In the domestic market, furthermore, solar power plant construction is deemed a high-risk activity. Land prices in electricity-hungry coastal China are high, while in western regions – where land prices are lower – demand for electricity is also lower. Transferring electricity from west to east requires connectivity with the country's main grid, which is difficult due to the lack of clarity in the related laws and regulations as well as lengthy and opaque licensing procedures.

Second, the international PV market has been in deep recession in recent years. Against the backdrop of the financial crisis and the slowdown of the European economy, all the major PV markets – the European Union, the United States, Japan and Australia – have cut their PV energy subsidies. In the market's heyday in 2007 and 2008, Europe granted between €0.6 and €0.7 per watt in subsidies. This figure dropped drastically in 2010 to €0.2 per watt, before declining further to €0.05 per watt. Subsidies – once the main contributor to the boom of the PV market – have also led to its bust. As subsidies decreased, production levels geared to a subsidized market did not adjust concurrently, resulting in a dramatic drop in the price for solar modules. The majority of Chinese PV manufacturers are operating at a loss as a result, with some having already exited the market. Despite the effort to cut all nonessential costs, the company in this case study recorded a loss of about US$ 50 million in 2013. In the years before the recession, the company spent more on services inputs, such as marketing and advertising as well as R&D, so the services share in the overall cost could have been higher at that time.

A third factor contributing to the modest share of services inputs in the value chain is the fact that solar modules are homogeneous products, with end users comprising a limited group. Common consumer electronics such as phones and laptops, for instance, have a much larger user base and varying consumer preferences drive producers to invest more heavily in the services activities such as R&D, design and marketing to develop and sell differentiated products. But PV companies, especially those in the lower value added assembly part of the value chain, often compete on maximum reduction of overall production costs, because the consumer preference in this case is rather singular: USD per watt. For the company

under study, R&D, combined with sales and marketing (63 plus 58 full-time employees) accounts for only a small share (4%) of the total employment of the company, a small percentage compared to other electronic-equipment companies.

While all products are covered by warranty, after-sales services account for an insignificant share of the total cost because solar modules are considered to be durable products; quality-related malfunctions rarely occur. Of the company's 123 employees working on 'quality control and warranty', most are on the production lines ensuring quality control. For end users, periodic maintenance of solar equipment is recommended, but the company is focused on manufacturing and does not supply maintenance services to its customers. Part of the warranty is covered by the product quality insurance, since the International Electrotechnical Commission (IEC) and the TÜV Rheinland Group (TUV) standards require that attenuation of power output should be less than 20% over 25 years. If the company's product fails to meet this requirement over 25 years, the insurance company will provide compensation to its customers. To date, however, all of the company's products are less than a decade old.

5. Outsourcing, bundling and other aspects of services supply

5.1. Outsourcing

Of the 40 services identified in the value chain above, 24 are fully outsourced, 6 are partially outsourced, and only 10 – or a quarter of all types of services input – are supplied in-house.

As illustrated in table 3 below, a range of factors motivates the company's decision to outsource certain services: i) certain types of services can only be supplied by governments, such as company registration, permit and visa services, and government inspections; ii) services that are required by laws and regulations, such as testing and certifying, auditing, social insurance and stock exchange listing fees; iii) it is not feasible to supply some services in-house, including electricity and water supply, banking and insurance services, telecommunications services, travel services, and business hospitality services; iv) efficiencies associated with economies of scale and scope – such as labour supply services, transportation services, real-estate agency services and design of packaging – and skills intensity – such as legal services, investment banking and consulting services – need to be taken into account; v) the company must ensure access to the best services, for example, market research and news agency services; vi) it is vital to maintain strong relationships with the stakeholders – in many instances, government agencies – to supply services such as customs-related services, public relations and advertising services; and vii) although not shown in the table, during the peak season the company outsources the production of a limited share of solar modules to other manufacturers in the vicinity of its factories. While the company can earn a small margin from outsourced production, it keeps such transactions to a minimum, as it is difficult to ensure the quality of the final products.

Services that are provided in-house are mainly core services related to production. These include procurement, production management, quality control, daily maintenance of production equipment, storage of material inputs, packaging, training for workers, sewage water treatment, human resources, accounting services, R&D, security services and other related services. For the most part, services kept in-house are related either to the quality of products and the reduction of costs, or to trust and security considerations.

5.2. Bundling

From the perspective of case studies such as this one, which focus on the activities of a single lead firm, bundling can only be observed at the point where the value chain is deemed to begin and end, and where the lead firm buys inputs from arm's-length suppliers. This is because we take a slice of production and marketing out of the complex network that links all economic activity in order to make the analysis tractable. The analysis could switch lead firm and follow the value chain that the relevant firm controls, but that would be an additional case study, where the lead firm also began and ended where the analyst says so, and where inputs are also outsourced. There is no meaningful sense in which we can speak of bundling when it comes to production sourced from in-house inputs, as these inputs are by definition all combined (bundled) in the very production sequence under study.

The company does not enter the silicon production chain from the outset (for instance, from the mining of silicon raw materials and the production of silicon wafers from silicon raw materials). Almost all material

inputs that the company purchases therefore have a certain percentage of services inputs in their value. Had the analysis extended further back along the value chain, those services components would have been identified separately rather than being lumped together with the material inputs in the sources of value analysis.

Certain services in the company's value chain are also bundled with other services or goods. One example is labour services firms that supply the company with a low-skilled workforce on the production lines. The labour services firms in fact supply an entire pool of services, including the recruitment of workers, training and accommodation, managing workers by classifying them into various grades according to relative work experience, paying workers' social insurance and resolving labour disputes.

Additional examples of bundled services include integrated logistics services, which encompass various means of transportation services, cargo handling at ports and customs-clearance services, as well as warehousing services. The local bank that acts as the company's main financial services provider also provides a bundle of financial services, including deposit services, credit-granting services, asset management services and financial consultancy services, as well as foreign-exchange services. The telecommunications operator provides fixed telephony, mobile and Internet access services bundled in a single package.

Table 3. Factors affecting outsourcing decisions

Services	In-house or outsourced	If outsourced		Bundled
		Reasons	To whom	
Services upon importation				
1. Customs-related services (for import)	Outsourced	Efficiency and networking	Local customs clearance company	Bundled
2. Procurement services	In-house			
3. Technical testing (for the procured inputs)	In-house			
4. Freight transportation services (of raw materials and manufactured component inputs) by road, rail, sea or air	Outsourced	Efficiency	Transportation/logistics service provider in China	Bundled
In factory and factory-related services				
5. Production administration, including production management	In-house			
6. Utilities (electricity, water and gas)	Outsourced	Not possible to supply in-house	Industrial parks in Nanjing, Shanghai, and Turkey providing electricity and water supply infrastructure services are in most cases SOEs.	Bundled
7. Installation of production equipment	Outsourced	Insufficient technical expertise	The German manufacturer of production equipment installed factory equipment. The company commissions an EPC company from	Bundled

			the United Kingdom to install solar systems.	
8. Maintenance and repair of production equipment	Critical repairs outsourced; daily maintenance supplied in-house	Insufficient technical expertise	German supplier of production equipment	Bundled
9. Storage of raw materials and manufactured component inputs (general storage)	In-house			
10. Technical testing (for quality assurance)	In-house			
11. Research and development	In-house			
12. Packaging services	In-house			
13. Accommodation for workers and managers	for workers: provided in-house; for managers: outsourced to real-estate agent		Local real-estate agent	Unbundled
14. Canteen services	Outsourced	Economy of scale	Operation of canteen subcontracted to a local catering company	Bundled
15. Training services (for workers)	In-house			
16. Security services	In-house			
17. Cleaning services	Outsourced		A local cleaning company	Bundled
18. Sewage water treatment services	In-house			
19. Government inspections of fire prevention, health hazards, environmental protection and other aspects	Outsourced (government service)		Government agencies	Unbundled
Sales and Export related services				
20. Product testing (for obtaining certification at the export market)	Outsourced	Required by law	International testing and certifying labs in the United States, the United Kingdom and Japan	Unbundled
21. Freight Transportation (domestic and cross-border)	Outsourced	Efficiency	Transportation/logistics service provider both in China and in the export markets (United States, European Union)	Bundled

22. Freight insurance	Outsourced	Not possible to supply in-house		Bundled
23. Warehousing	Outsourced	Closeness to market	Rented warehouses in China, the Netherlands, Australia, Germany, United States, etc.	Bundled
24. Advertising	Outsourced	Lack of expertise and channel	Advertisements in PV-related journals and magazines, outdoor advertisements. Partnership with both Chinese and international large and medium-sized advertising companies.	Unbundled
25. Marketing	Outsourced for participation in the trade fairs and conventions In-house marketing team maintain daily marketing operations	Lack of expertise and channel	Exhibition platforms and convention hosted both in China and abroad.	Unbundled
26. Retail trade services	Partially outsourced		Sales agents in China and overseas offices are engaged in retail. The company also contracts third-party retailers to distribute products.	
27. Design of packages	Outsourced	Infrequent change of packaging	Local design workshop	Unbundled
28. Market research and consulting services	Outsourced	Critical to have first class market information	International leading market research and consulting firms in PV business	Unbundled
29. News and information services	Outsourced	Not possible to supply in-house, requires access to best service	PRNewswire/ Thomson Reuters	Unbundled
Operation and Management related services				
30. Company registration and licensing services (obtaining the permit to	Outsourced (government service)	Required by law	Registration offices and agencies in charge of issuing permits to build	Unbundled

build the power plant in UK)			solar power plants in the United Kingdom.	
31. Financial services (including IPO related services, investment banking services, mergers and acquisition services, corporate finance and venture capital services, deposit services, credit-granting services, financial consultancy services, and foreign exchange services)	Outsourced	Not possible to supply in-house	Local bank provides deposit services, credit-granting services, financial consultancy services and foreign-exchange services. International investment bank provides investment banking services, mergers and acquisition services, and corporate finance services.	Bundled
32. Social insurance for factory workers	Outsourced	Required by law	Supplied by the labour service company supplying factory workers	Bundled
33. Insurance services (commercial life and accident/health insurance, property insurance for the factory compound, product quality insurance, management liability insurance)	Outsourced	Not possible to supply in-house	Commercial, life and accident/health insurance, as well as property insurance for the factory compound are outsourced to a domestic insurance company. Product quality insurance, management liability insurance are outsourced to an international insurance company.	Unbundled
34. Legal consulting, including legal compliance, dispute settlement and arbitration	Outsourced	Insufficient expertise, efficiency	Leading law firms in China, the United States and the European Union, mainly for settling trade disputes and legal compliance	Unbundled
35. Services charges for listed companies in the securities market	Outsourced	Required by law	NASDAQ	Bundled
36. Accounting, auditing and bookkeeping services	Auditing outsourced Accounting supplied in-house	Required by law	Leading international auditing firm	Unbundled
37. Public relations (PR) services	Outsourced	Efficiency, networking	PR companies both in China and in export markets	Unbundled
38. Business hospitality	Outsourced	Not possible to supply in-	Various restaurants, hotels, and	Unbundled

		house	entertainment centres	
39. Human resources 8512. Labour supply services 8511. Personnel search and referral services 83113. Human resources management consulting services	Outsourced, except for in-house human resource management	Efficiency	Local private labour service company supplying factory workers; joint venture headhunt company supplying management personnel	Unbundled
40. Information technology (IT) services (including IT support and webhosting services)	Outsourced	Insufficient expertise, efficiency	IT support and webhosting services by local IT companies	Bundled
41. Telecom services	Outsourced	Not possible to supply in-house	China Telecom and China Mobile (large SOEs), as well as local telecom operators supplying service for overseas offices	Bundled
42. Visa and immigration services (travel between headquarters and country offices)	Outsourced (government service)	Required by law	Visa sections in the embassies	Unbundled
43. Travel services	Outsourced	Not possible to supply in-house	Domestic and international airlines Online travel agency service (booking)	Unbundled

6. Policies affecting services in the value chain

This section aims to identify the impact of government policies on the services inputs in the value chain and to indicate areas in which a change in these policies could contribute to improved efficiency within the service sectors, as well as within the entire value chain.

Although the study focuses on the services inputs, the PV market itself is interesting to examine. This is in part because the higher value-added segment of the chain – the supply of electricity through solar power plants, for instance – is a service. More importantly, the PV market is heavily impacted by government policies, and better-designed policies could have contributed positively towards sustainable growth in the PV market. The lessons drawn from this particular sector – such as the kind of role the government should play in the economy – may be applicable to other services sectors.

6.1. The role of government in economic activities

China's PV production accelerated in 2005, when the National Development and Reform Commission listed the PV sector in the *Catalogue for the Guidance of Industrial Structure Adjustment* as a sector to be encouraged on account of its contribution to clean energy. Since then, local governments across China have poured resources into attracting investment in the PV market. By 2007, just two years after the statement of policy intent, China had become the largest PV manufacturer in the world. Production capacity kept growing until 2011, at which point China supplied about 80% of the total global output. It was reported that over 300 'Solar Cities' or 'PV Parks' were established across China, dozens of which had an overall investment exceeding RMB¥ 100 billion.

The Chinese government played a positive role in encouraging industries to capitalize on the investment opportunities afforded by this emerging, profitable and eco-friendly industry at a time when the global demand for PV products was on the rise. Subsequently, the government also supported companies in

responding to antidumping and countervailing actions initiated by China's trading partners, helping the companies both to relocate their production bases overseas and to expand into higher value added segments of the value chain, such as building solar plants. Nevertheless, it is clear that the extent of direction and support for the industry from the government resulted in an excess of supply.

The majority of firms in the Chinese PV market are private companies, which in theory are supposed to be guided predominantly by the 'invisible hand' of the market. In practice, however, local governments can exert considerable influence over company decisions and operations within the sector.

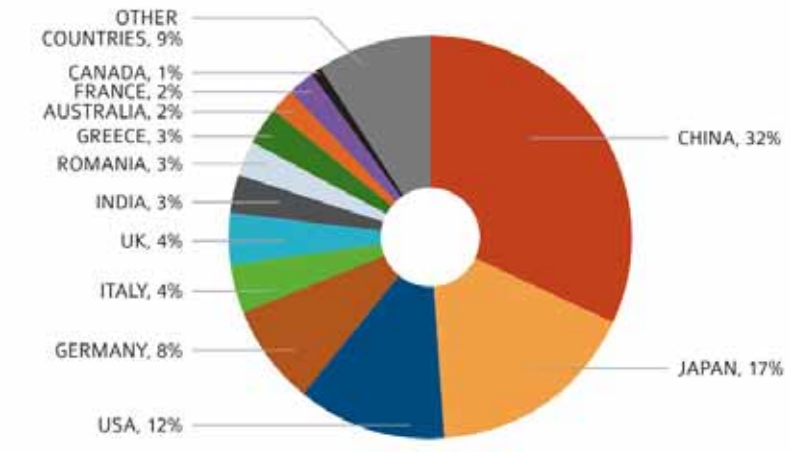
For entrepreneurs in China, maintaining a good relationship with local government officials is vital for business success. In instances in which policies and regulations are complex and ambiguous, government officials' decisions can make a big difference. Maintaining strong ties with government officials can also provide access to vital information and networking, as well as offering up possibilities for loans and subsidies. For government officials, on the other hand, GDP growth was until recently a key factor for assessing their performance. Officials had a strong incentive to attract investment and promote local economic growth.

This intertwined relationship between the government and private companies sometimes encroached upon the decision-making autonomy of enterprises. Even after it became apparent that overcapacity was becoming a problem, for instance, in some cases local governments – fearing that a slowdown in investment would affect local GDP growth – continued to encourage investment in the PV sector. Government officials were also known to discourage companies from halting or reducing investment, and even to persuade firms to expand investment by promising to assist with access to bank funds.

The central government is aware of this conundrum. Accordingly, an important outcome from the Third Plenum of the 18th Communist Party of China Central Committee held in November 2013 was to enable the 'market to play a "DECISIVE" role in the distribution of resources,' as opposed to the earlier 'BASIC' role. This modification demonstrates that the government is committed to launching further reforms to reduce public intervention in investment decisions, pricing mechanisms and other market activities, and to putting an end to the enduring government-dominated economic growth model.

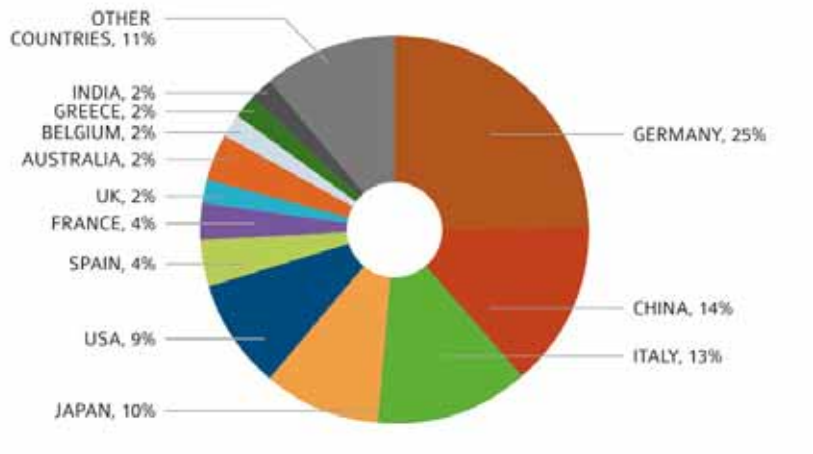
In the case of directing private investment, the government might have overplayed its role and stimulated overinvestment. On the regulatory front, however, the government should have done more to promulgate laws and regulations in a timely manner to secure the healthy growth of the sector. As figures 4 and 5 below illustrate, although China was the largest producer of solar modules in the world in 2013, its cumulative installed capacity of solar systems in solar power plants accounted for just 14% of the global total that year, compared with Germany's 25%. Most products are exported rather than used in domestic solar installations. This dependence on foreign markets was partly due to the lack of clarity in the relevant policies, as well as lengthy and opaque licensing procedures.

Figure 4. Global PV Market in 2013: installed capacity



Source: IEA PVPS, EPIA

Figure 5. Global PV Market at the end of 2013: cumulative capacities



Source: IEA PVPS, EPIA

Until recently, China's policies discouraged private investment in domestic solar power plants, which could have absorbed part of the PV production capacity. Conducting electricity from solar power plants in western regions to the coastal cities required clear rules ensuring both connectivity to the state grid and permission to sell electricity through the grid. It was only in 2014, however, that new regulations allowed solar power plants to sell their whole electricity output to the grid. Previous regulations required electricity from solar power projects to be predominantly generated for self-supply purposes, with only the 'remainder' liable to be sold to the grid. The lack of clarity in the regulations made investment in solar power plants in the domestic market a risky business, and contributed to the heavy dependence of solar equipment manufacturers on the export market.

Furthermore, building solar power plants is subject to licensing, and the total number of licenses is capped by the annual installed-capacity target. Applying for a license is usually a lengthy and costly process, due to cumbersome licensing requirements, lack of transparency and, in some instances, under-the-table transactions. Fearing that delays in obtaining a license mean missed market opportunities, companies often decide to disregard this prior licensing requirement. Construction usually starts immediately after companies have negotiated deals with the local government, and applications for licenses are frequently processed while the power plant is being built. This strategy is often successful, as license applications are rarely denied if the power plant is already on the ground. However, bypassing the licensing requirement has serious consequences for both the companies and government. The licensing requirement helps to keep track of the total investment in the sector, key data on which companies should base their business decisions. By skipping the licensing requirement, companies are venturing into the sector with imperfect information. This also undermines government's ability to monitor and effectively regulate the sector, through dynamic adjustment of capital inflow to prevent overinvestment.

6.2. Trade Disputes

Antidumping and countervailing duties

The antidumping investigation into imported PV products from China, launched by the European Union in 2013, is the largest trade dispute between the two economies to date, and the largest antidumping case undertaken by the European Commission. The investigation affected Chinese imports worth €21 billion. Chinese PV manufacturers suffered greatly from the combined effect of a global downturn in the PV market and the punitive tariffs, with over 300 companies reportedly closing as a result. The case was resolved through a negotiated outcome on a minimum (or floor) price commitment. It has been estimated, however, that while Chinese PV products dominated about 70% of the European Union market before the dispute, this share shrank to 30% after the implementation of the minimum price commitment. The primary

reason for this reduction is that the Chinese PV products were predominantly in the lower value added end of the market and competed on lower prices. Once the floor price was capped, some production was diverted to the Republic of Korea, Chinese Taipei and Japan, for higher-quality products.

Not all actors in the European Union PV market welcomed the move by the Commission. Upstream and downstream industries opposed the move, for instance, on the grounds that antidumping duties would have a detrimental effect on Europe's solar industry. While helping European Union solar panel manufacturers, these industries argued, the move would hurt the overall PV business in Europe, including installers and equipment manufacturers, as well as polysilicon and silver paste producers that supplied Chinese panel makers. The Alliance for Affordable Solar Energy (AFASE) – a coalition of over 450 companies in the European Union PV industry – stated in an open letter, co-sponsored by 1,024 signatories, to European Union Trade Commissioner De Gucht:

> Around 70% of the PV supply chain's value in the EU market is created in Europe. The value added created by the upstream and downstream activities in the EU is immense, at € 40 billion, providing 265,000 EU jobs along the solar PV value chain according to European Photovoltaic Industry Association (EPIA). By contrast, the employment represented by the complainant, EU ProSun, and its supporters in the ongoing investigations based on the data they presented is a maximum of 8,000 jobs. Module manufacturing represents at most 30% of the 70% value added by EU solar industry. Thus, imposing duties may be beneficial to only perhaps 30% of the industry while harming the remaining 70%.

Prior to the European Union's investigations, the United States Commerce Department decided in May 2012 to impose antidumping tariffs of 31% to 250% on solar products imported from China. These levies were applied on top of a 4.73% countervailing duty imposed in March countering subsidies by the Chinese government.

The Chinese government, too, has initiated antidumping and countervailing cases in the sector. It launched investigations, for instance, into the imported silicon raw materials from the European Union, the United States and the Republic of Korea in 2012, and decided to suspend the processing trade[2] on imported polycrystalline products, effective from 1 September 2014. This led to increased prices of imported silicon raw materials and further tightened companies' profit margins.

Legal, accounting and consultation services

Trade disputes can hit companies in unexpected ways. In 2012, when the United States and China were disputing proposed Chinese legislation that would affect the operation of foreign accounting firms in China (the 'big four' in particular), financial services regulators in the United States responded by initiating a more rigorous system to monitor NASDAQ-listed Chinese companies. The company's books were investigated by all four United States financial services regulators vested with the authority to do so. As a result, the company under consideration here had to invest greater resources in order to comply with the investigations, hiring more local accounting firms to work with the regulators.

6.3. Labour service companies

'Labour service companies' fill the majority of jobs on the production line in the company's factory in Nanjing and Shanghai, supplying low-skilled workers to manufacturing companies on a contractual basis (the company itself customarily fills posts requiring some form of skills or training directly). These labour service companies are gaining popularity with assembly factories in coastal China for three main reasons. First, manufacturing is becoming increasingly automated, and therefore requires low-skilled labour with minimum training, e.g. moving parts between assembly lines. It is therefore easy to move workers among factories making different products. Second, most of the companies do not operate at maximum production capacity at all times. Production plans vary according to market demand, and contractual labour supply

[2] Processing trade refers to the business activity of importing all or part of the raw and auxiliary materials, parts and components, accessories, and packaging materials from abroad in bond, and re-exporting the finished products after processing or assembly by enterprises within mainland China.

arrangements provide greater flexibility for the factories to adjust their employment costs. Companies do not need to keep all workers in-house at all times. With the help of labour service companies, enterprises can easily expand the workforce at times of high demand, and cut the number of workers in low periods. Third, these arrangements also help companies to reduce recruitment and management costs. For workers, this arrangement also provides a means of turning 'sporadic jobs' into more secure 'organized labour', as the labour service companies pay social security and provide certain unemployment benefits.

Labour service companies represent a relatively new form of economic activity in China. Related laws and regulations are therefore not yet fully developed and lack legal certainty in regard to which laws pertain to the registration and operation of a company, which basis should be used to calculate the company's revenue; and which tax should be applied. In many cases, it is difficult to define the specific scope of the company's activity because the labour supply company is also engaged in labour intermediary and subcontract services. The absence of a clear division of rights and responsibilities also increases the risk of labour disputes and affords less protection of workers' rights.

6.4. International labour mobility

Another aspect of labour mobility pertains to mode 4 of services trade. The company has about 500 employees stationed overseas. Visa and work permits have always presented a major difficulty for sending professionals overseas. For instance, due to requirements in the United Kingdom, the company had to commission a local Engineering, Procurement and Construction (EPC) contractor to build the power plant and install the modules, instead of sending its own professionals to install the equipment. It was estimated that if the company had been allowed to send its own technicians to install the modules, the cost of building the power plant could have been reduced by as much as 50%.

6.5. Policy-related cost increases

Transportation and import-related services

Many factors influence the costs associated with international freight, such as trade policy, route security, oil prices and the overall economic environment. On occasion, prices for shipments along the same route may vary up to 100% from month to month, adding a significant operating risk for companies. Furthermore, in some ports, companies have encountered prolonged customs procedures that result in additional costs associated with container detention charges.

Business and financial services

Legal compliance and accounting fees are responsible for a significant share of overall costs. As a NASDAQ-listed business, the company hires American law and accounting firms to fulfil the compliance requirements. While no regulation requires listed companies to hire the 'big four' accounting firms, investors often prefer that the company employ leading services providers. The hourly rate of the 'big four' accounting firms can be 50% higher than smaller firms, leading to increased costs for the company.

Insurance fees also account for a large share in the company's overall services inputs. Rather than providing a means for the countercyclical mitigation of the costs and risks, however, certain insurance is viewed as 'pouring oil onto the flame,' as it were. The firm complained, for instance, that when the United States announced antidumping and countervailing investigations into Chinese PV products, the premium for some insurance products – such as management liability insurance, product liability insurance and even freight transportation insurance – rose drastically. In particular, management liability insurance (provided by only a handful of international insurers) increased from US$ 100,000 to US$ 300,000 per year. The insurance company argued that due to the investigations, Chinese PV companies listed on the United States stock market would likely face a higher risk of penalties and were therefore liable to pay a higher premium to offset these risks.

Table 4. Policies affecting services in the value chain

Government policies and services	Authority/ authorities in charge	Details	How the policy affects services in the value chain
Catalogue for the Guidance of Industrial Structure Adjustment	National Development and Reform Commission	Listed PV as among sources of clean energy to be encouraged	Encouraged private investment in the PV sector
Notice of the National Energy Administration on Further Implementing the Policies Related to Distributive Photovoltaic Power Generation (2 September 2014)	National Energy Administration of China	Added 'all into the grid' mode to the 'remainder into the grid' mode; and further clarified PV power subsidies	Provided greater policy certainty to investment in PV installations
Product safety standards	Product safety regulators in China and export markets	International standards and certification system promulgated by TUV, for instance. The company also complies with MCS certification in the United Kingdom, UL certification in the United States, and JET certification in Japan. It will acquire all necessary local testing and certificates before entering a new market.	Products need to go through tests and obtain certifications before entering the market
Environmental Safety Policies	Chinese Ministry of Environmental Protection	China's Eleventh Five-Year Plan and Twelfth Five-Year Plan have established both rigorous standards for environmental protection and ambitious goals for emission cuts. Local governments in Nanjing and Shanghai approached environmental protection seriously, strictly monitoring the implementation of relevant standards. The Nanjing Government has also issued regulations on ecological protection and reconstruction.	The company implemented ISO14001 standards for environmental protection management system, and established a special taskforce within the company responsible for environmental safety.
United States and European Union antidumping and countervailing duties on Chinese exports	United States Department of Commerce, European Commission	United States levies a 31% to 250% antidumping duty and a 4.73% countervailing duty on solar products imported from China.	The company is obliged to cooperate in the investigations, resulting in additional costs on legal consultation and representation fees.
European Union antidumping and countervailing duties on Chinese exports of glass used in solar panels	European Union Commission	European Union imposes a five-year antidumping duty (up to 36.1%) and countervailing duty (up to 17.1%) on Chinese exports of solar glass	

Chinese antidumping and countervailing investigations on imported silicon raw materials from the United States and the Republic of Korea	Chinese Ministry of Commerce	China has launched antidumping and countervailing investigations on the imported silicon raw materials from the United States and the Republic of Korea. The Chinese government decided to suspend export processing trade on imported polycrystalline products, effective 1 September 2014.	Impact on the prices of imported silicon raw materials

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