Chapter 6

Innovative Business Models and Financing Mechanisms for Distributed Solar Photovoltaic (DSPV) Deployment in China

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Chapter 6

Innovative Business Models and Financing Mechanisms for Distributed Solar Photovoltaic (DSPV) Deployment in China[17]

Sufang Zhang

Abstract

Following my report 'Analysis of Distributed Solar Photovoltaic (DSPV) Power Policy in China', this report looks into innovative business models and financing mechanisms for distributed solar photovoltaic power in China by reviewing existing literature and conducting interactive research, including discussions with managers from China's policy and commercial banks, and photovoltaic projects. It first provides a comprehensive review of literature on business models and financing mechanisms. Then, the paper looks into the rapidly evolving business models and financing mechanisms in the United States, one of the countries leading the deployment of DSPV. The emerging innovative business models and financing mechanisms for DSPV projects in China are next discussed. The report concludes that: (a) innovative business models and financing mechanisms are important drivers for the growth of DSPV power in the United States; (b) enabling policies are determinant components of innovative business models and financing mechanisms in the country; (c) innovative business models and financing mechanisms in the Chinese context have their advantages and disadvantages; and (d) support through government policies is imperative to address the challenges in the emerging innovative business models and financing mechanisms in China.

Keywords: Distributed solar photovoltaics, business model, financing mechanism, China, renewable energy policy

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1. Introduction

As discussed in my report entitled 'Analysis of Distributed Solar Photovoltaics (DSPV) Power Policy in China', China's government has put in place a number of incentives since the end of 2012 at both national and local levels, all of which have progressively addressed the constraints on DSPV's development. Nevertheless, there remain other constraints on DSPV power deployment. These, thus, require further innovative policies, particularly policies that support innovative business models and financing mechanisms for these projects.

The main questions addressed in this chapter are (a) What are the advantages and disadvantages of current business models and financing mechanisms for DSPV deployment in China? and (b) what types of government support should be provided to such models and financing mechanisms for DSPV deployment in China?

Towards this end, this chapter is structured as follows:

(1) Section 2 provides a comprehensive literature review on business and financing mechanism concepts, on the importance of business innovation and on DSPV-specific business model as well as DSPV-specific financing mechanisms.
(2) Given that the United States (US) is one of the countries that lead in DSPV deployment and has business models and financing mechanisms that have evolved rapidly over the years, Section 3 reviews business models and the financial mechanism in the US DSPV market.
(3) Section 4 turns to existing business models and financing mechanisms for DSPV project in China and discusses their advantages and disadvantages.
(4) Section 5 provides conclusions and policy implications.

In this research, a comprehensive literature study based on academic sources as well as non-academic sources such as sector reports, website articles, government documents, and presentations, attempts to set an initial overview of the different types of business models and financing mechanisms in both the United States and China. The author also attended several Chinese solar conferences and meetings.

2. Literature review

2.1. Business model and business model innovation

The first reference to the term 'business model' dates back to the 1950s (Bellman et al., 1957). Ever since the expansion of internet commerce in the mid-1990s, such a term has become a buzzword in media, business, and the sciences. Nevertheless, in theory and practice, there is yet no standard definition of the term. Literature has diverse interpretations and definitions of a business model, using it for a broad range of informal and formal descriptions to represent core aspects of a business.

A business model can be simple or complex. In the earlier days, a business model merely described the way a company makes money, or the means and methods used to earn revenue. In the last decade, the understanding of business models has become more complex. For example, Amit and Zott (2012) defined a business model as a system of interconnected and interdependent activities that determines the way the company 'does business' with its customers, partners, and vendors. In other words, a business model is a bundle of specific activities—an activity system—conducted to satisfy the perceived needs of the market, along with the specification of which parties (i.e., a company or its partners) conduct which activities, and how these activities are linked to each other. Osterwalder et al. (2005) maintained that a business model describes the rationale of how an organisation creates, delivers and captures value.

Whatever the definition, 'business model innovation' is considered to be a source of competitive advantage for companies. At its simplest, it demands neither new technologies nor the creation of brand-new markets. It is about delivering existing products that are created by existing technologies for existing markets. Because business model innovation often involves changes invisible to the outside world, it can bring advantages that are hard to replicate. As noted by a chief executive officer from IBM: 'In the operation area, much of the innovation and cost savings that could be achieved have already been achieved….It's not enough to make a difference on product scale or delivery readiness or production scale. It's important to innovate in areas where our competition does not act' (Amit and Zott, 2010).

2.2. DSPV-specific business model

Distributed solar photovoltaics power development has attracted the attention of academics given that there is a need for innovative business models to overcome the high upfront capital costs.

Richter (2013) argued that innovative business models for DSPV could drive the transformation of the electric power industry from one characterised by a small number of large projects to that consisting of a large number of small projects. Also, utilities can greatly benefit if they treat photovoltaics (PV) as a strategic gateway into the emerging distributed generation and service market. In addition, Richter argued that strengthening the business model innovation capabilities of a company is crucial to mastering changes in the external environment.

Huijben and Verbong (2013) examined the reasons for the rapid growth of DSPV power in the Netherlands. One reasons behind the PV breakthrough in the Netherlands, results show, has been the development of new business models where there is financial support---for example, in the form of tax deduction after investment---from both local and national governmental bodies. The link between institutional factors (regulation) and business models is very clear. The three main types of business models identified in the study are customer-owned, community shares and third-party models.

Asmus (2008) discussed the ‘community solar’ or ‘solar shares business model’. Under this model, multiple users can draw from a single solar PV array or a series of arrays on different buildings but operated as a single system, supplying clean electricity to community institutions (e.g., fire stations, community centres, among others) as well as residents. Participants, in essence, purchase shares of solar systems’ total output without ever having to pay the upfront costs or deal with technical installation challenges. Through collective participation, larger and more efficient projects can be done, leading to cost efficiencies.

According to Graham et al. (2008), current DSPV business models principally revolve around the ownership of PV systems by individuals and increasingly by third parties, rather than by utilities. However, they argued that as PV market penetration accelerates, utilities will become critical stakeholders, driven primarily by concerns about grid operation, safety, and revenue erosion.

Drury et al. (2012) found that third-party business models that started to appear in the United States in 2005 and have been operating in 20 states, are attracting new customers who are younger, less educated, and have a lower income than those investing in PV systems themselves.

2.3. Innovative financing mechanism for DSPV

2.3.1. Financing mechanisms for DSPV

Financing mechanisms for DSPV projects are means to raise funds from investors. Investors are buyers of real and financial assets and may be government, state-owned, or private sector entities. Examples of private sectors are corporations (electric utilities), retail investors (individuals), investment partnerships (hedge funds, private equity firms), financial intermediaries (banks, insurance companies, pension funds), and endowment (foundations and universities) (Donovan, 2015).

Private sector investors in DSPV power projects are *strategic investors* consisting of companies with an existing presence in the energy sector, or newly established with DSPV as their core activity. Unlike strategic investors, *financial investors* usually have no specific impetus for getting involved in the industry. The key difference between strategic investors and financial investors is their preference for real assets (physical properties such as solar PV systems) versus financial assets (less tangible than real assets such as a certificate of deposit at a savings bank). Financial investors typically maintain a portfolio of investments in more than one asset, including equities, fixed income, and real estate.

Investments in solar PV sector span multiple asset classes. Investors may, for example, buy shares in publicly traded solar PV companies (equities), lend directly to solar PV projects (fixed income), or have ownership in production facilities (real estate) (Donovan, 2015). Strategic investors do not have much financial resources at their disposal to scale up investments in DSPV project.

There is a growing awareness that more funding from financial investors will be necessary to meet DSPV investment goals. Many large, regulated financial intermediaries, however, prefer financial assets, as these assets tend to offer important benefits to investors---namely, scale (the capacity to absorb sizable capital inflows/outflows) and liquidity (frequent trading that allows securities to be bought or sold immediately) (Donovan, 2015).

2.3.2. Innovative financing mechanisms

The term 'innovative financing mechanism' can mean different things to different people. Broadly speaking, innovative financing mechanisms include not only mechanisms designed to raise funds but also mechanisms that improve the use of those funds (Gargasson and Salomé, 2010). They should involve a creative idea — the process of conceiving and implementing a new way of mobilising and channelling financial resources. This could be, for example, through the incorporation of new elements, a new combination of existing elements, or a significant change or departure from the traditional way of doing things.

2.4. Summary

The literature review demonstrates that the concept of business model varies in different contexts and for different people. However, what remains is that innovation in a business model is a source of any company's competitive advantage. Along this line, innovative business models for DSPV are an important driving force for the DSPV industry.

The literature review also shows that investors in DSPV projects consist of government, state-owned and private sector entities such as strategic investors, which prefer real assets such as solar PV systems; and financial investors, which prefer financial assets such as a certificates of deposit in savings banks. Investments in the solar PV sector span multiple asset classes.

There is a growing awareness that financial investors' funding is important in increasing DSPV investments. An innovative financing mechanism may take the form of new marketable funding instruments that can be used to attract public and private investment, and may make improvements in revenue and spending policies (UNEP, 2007).

3. Business models and financing mechanisms for DSPV projects in the United States

Based on the literature reviewed earlier, this study defines the *business model for DSPV* as the ownership structure of the DSPV project. Meanwhile, *financial mechanisms for DSPV* refer to the ways of mobilising and channelling financial resources during the construction phase of DSPV projects.

This section specifically looks at business models and financing mechanisms for DSPV projects in the United States.

3.1.Business models

3.1.1. Enabling legislation for business models

National legislation has enabled the development of particular types of business model in the United States, particularly the federal *solar investment tax credit* (ITC), the *modified accelerated cost recovery system* (MACRS), and *net-metering policy*.

(1) **Federal solar investment tax credit.** The ITC is one of the most important federal policy mechanisms to support the deployment of solar energy in the United States. It is a federal tax credit worth 30% of the cost for both commercial solar developers and residential consumers who install on-site solar systems. To take advantage of the credit, solar developers must have some tax liability. However, most of these solar developers lack sufficient tax liability to fully utilise the credit (SEIA, 2015; Mendelsohn and Kreycik, 2012; Burns and Kang, 2012).

The ITC was first applied between 1 January 2006 and 31 December 2007. In December 2006, the ITC was extended for one more year. The US Emergency Economic Stabilization Act of 2008 included an 8-year extension of the commercial and residential solar ITC. This suggests that unless modified, the 30% ITC will remain in effect until the end of 2016. The ITC has driven the growth of annual solar installation by over 1,600% since its implementation in 2006 – a compound annual growth rate of 76% (SEIA, 2015; Mendelsohn and Kreycik, 2012; Burns and Kang, 2012).

(2) **Modified accelerated cost recovery system (MACRS).** In the United States, businesses investing in solar projects may also claim accelerated depreciation deductions. Under the MACRS, businesses may recover investments in solar energy property through depreciation deductions on an advanced 5-year schedule (SEIA, 2015; Mendelsohn and Kreycik, 2012; Burns and Kang, 2012).

The ITC and MACRS can provide a tax benefit that amounts to more than half of the upfront installed cost of a solar system. Furthermore, a variety of state-level incentives exist to assist homeowners with upfront installation costs, such as renewable portfolio standards, cash or tax incentives, and favourable regulatory environments. With few exceptions, the states with significant solar markets were found to be the ones that offer meaningful solar policies.

(3) **Net-metering policy.** Net metering is a service to electric consumers wherein electric energy generated by electric consumers from an eligible on-site generating facility and delivered to the local distribution facilities is used to offset the electric energy provided by the utility to electric consumers. As a result, customers are only billed for their 'net' energy use.

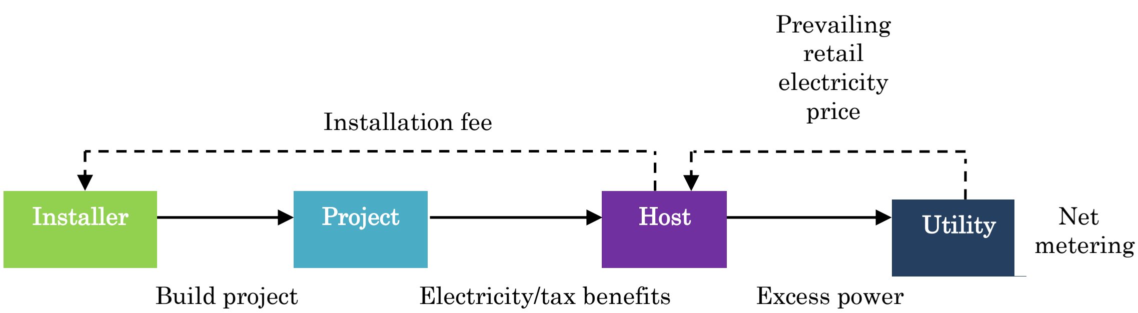
Currently, 43 states, Washington DC, and four territories are adopting a net-metering policy. The net-metering policy varies significantly between states (SEIA, 2015; Mendelsohn and Kreycik, 2012; Burns and Kang, 2012).

3.1.2. Business models for DSPV in the United States

(1) **Host-owned model.** In this model, the project is owned by the host – i.e., the owner of the property on which the projects sits (e.g., rooftop or adjoining land) – and the electricity the project produces is primarily for the said host. The system owner receives credit for any excess generation the solar system sends into the grid.

Figure 6.1 shows the tax benefits enjoyed by the host (Frantzis et al., 2008). On the other hand, this model's disadvantages include (a) high upfront and maintenance costs; (b) the risk of poor system performance, depending on what the engineering, procurement, and construction (EPC) contractor offers to guarantee the systems' performance; and (c) transaction costs associated with grid interconnection.

Figure 6.1: Host-owned Model

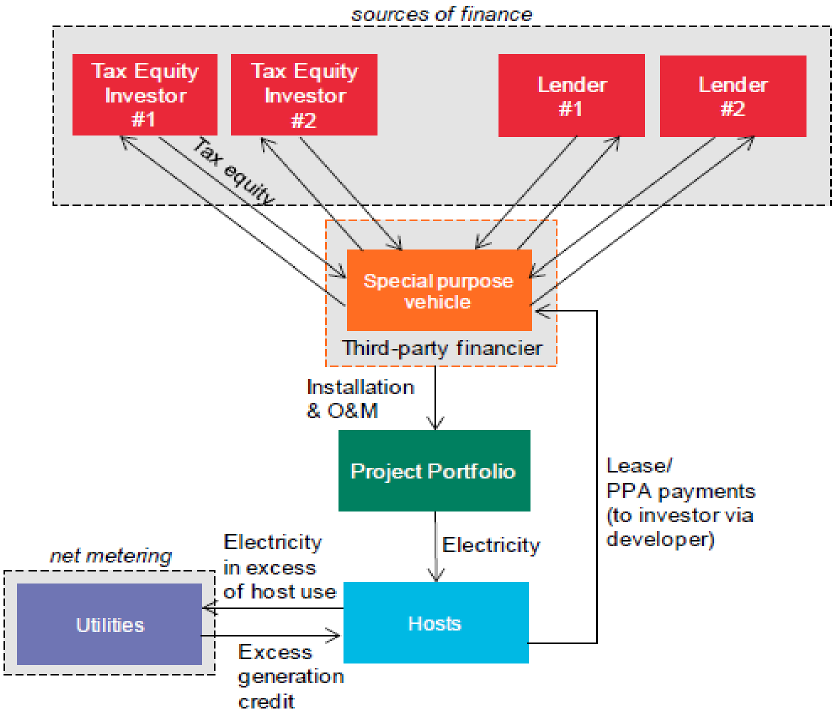


Source: Compiled by the author.

(2) **Third-party ownership model (SolarCity model).** Due to high upfront and maintenance costs, many residential and commercial users may not be able to afford the upfront cost of a solar system, do not want to assume risks associated with ownership, or prefer a low down payment option. The third-party ownership model (also called third-party financing model, or SolarCity model) offers customers the benefits of a solar system without the upfront cost.

In this model (Figure 6.2), a system owner (the third-party financier) handles customer origination, installation, engineering, maintenance and financing services for the PV system on the host customer's properties via a 10- to 25-year solar lease or a power purchase agreement (PPA).

Figure 6.2: Third-party Ownership Model



O & M = operation and maintenance; PPA = power purchase agreement.
Source: BNEF (2012).

In a solar lease, the host customer pays a specified amount every month regardless of the system's energy production. In a solar PPA, the customer pays a specified amount per kWh of generation; thus, the amount paid varies monthly as a function of power generation. Regardless of the type of contract, host customers typically pay a one-time, upfront down payment and monthly payments (BNEF, 2012; Davidson et al., 2015).

The advantage of this model is that third-party financiers could pool multiple leases and PPAs from multiple systems into investment portfolios to attract larger outside project investors (project finance lenders and tax equity[18] providers) who would not otherwise be interested in such small projects on a one-off basis.

Use of third-party ownership model for PV has increased over the past years from an estimated 10% to 20% in large US markets in 2009, to an estimated 65% of the US market

[18] 'Tax equity' is a term that is used to describe a passive ownership interest in an asset or a project, where an investor receives a return based not only on cash flow from the asset or project but also on a federal and state income tax benefits (tax deduction and tax credits).

in 2013 (GTM Research, 2013; GTM Research, 2014). Solar leases and PPAs are widely available in markets with: (a) favourable interconnection and net-metering policies; (b) legal or regulatory clarity for third-party solar ownership models; and (c) local financial incentives (Speer, 2012).

(3) **Community-shared model**. In this model, a solar garden (solar PV array or solar farm) with multiple subscribers is connected to the utility grid. Subscribers may purchase a portion of the power produced by the array of PV panels and receive a credit on their electricity bill. Utility customers within the solar garden's service area can include residences, businesses, local governments, non-profit organisations, and religious groups. Management of solar gardens' subscribers can either be via a limited liability corporation, a cooperative, or any for-profit or non-profit entity, including but not limited to solar developers, municipalities or other organisations in the community. An example of a solar garden programme managed by a limited liability corporation is that undertaken by the Clean Energy Collective (CEC), which has Xcel Energy as its utility partner (Monica Oliphant Research, 2012).

The CEC provides a member-owned model that enables individuals to directly own panels in community-shared solar projects that deliver reliable, commercial-scale renewable energy to an electric utility's grid. The utility's customers, including residences, businesses, and tax-exempt entities, can own or lease solar panels in the array without having to install panels on their own rooftop or property. Clean Energy Collective is responsible for subscriber management, where they sign up scribing customers and interface with them. Customers will receive a credit on their electricity bill for the energy produced by the PV system less a charge to deliver the energy to the subscribers' location (Funkhouser, 2015).

A CEC-developed metre, RemoteMeterTM, automatically transfers PV data to the utility's billing system to ensure appropriate metre crediting directly on the customer's monthly utility bill. Confirmation and reconciliation reports are provided to the utility and the subscriber to assure proper crediting and to permit historic tracking and auditing (Monica Oliphant Research, 2012).

3.2.Financing mechanisms

Financing mechanisms currently available to homeowners in the United States are grouped into three categories (Table 6.1): (a) traditional self-financing; (b) third-party ownership financing; and (c) utility and public financing. In addition, financing mechanisms available for DSPV project developers – such as crowdfunding – are emerging.

Table 6.1: DSPV Financing Mechanisms in the United States

Traditional Self-financing	Third-party Ownership Financing	Utility and Public Financing	Crowdfunding
• Cash purchase • Home equity loan (HEL) • Home equity line of credit (HELOC) • Cash-out mortgage refinancing (COMR)	• Model1 • Model 2 • Model 3	• Utility financing • Credit-enhanced and revolving loans • Property-assessed clean energy (PACE) financing • Crowdfunding	• Mosaic loan • SolarCity bonds

DSPV = distributed solar photovoltaic.
Source: Compiled by the author.

3.1.1. Traditional self-financing

Traditional self-financing options are widely available across the United States. They include cash purchase, home equity loans (HEL), home equity lines of credit, and cash-out mortgage refinancing.

Cash purchases are the least expensive option in terms of total dollars spent to acquire PV, as these do not incur any financing costs or solar financing company fees. However, the upfront cost of a PV system is significant and a likely barrier for most households. In addition, homeowners will need a sufficient federal tax liability to take full benefit of the federal ITC (Speer, 2012; PWC, 2011; Sanders, 2013).

Home equity loans, home equity lines of credit, and cash-out mortgage refinancing are provided by banks and credit unions across the United States and are likely to be the most available option for homeowners. However, accessing these financing options requires homeowners to have good credit, enough equity in their home to finance the system and, preferably, a home in an area with stable property values. Similar to cash purchases, homeowners must also determine whether they can take full benefit of the federal ITC (Speer, 2012; PWC, 2011; Sanders, 2013).

3.1.2. Third-party ownership financing (SolarCity financing)

Third-party ownership business model and *third-party ownership financing* are sometimes used interchangeably. Indeed, the third-party ownership business model embraces elements of third-party ownership financing; for instance, the host customer is financed through PPA/lease. However, the third-party ownership financing discussed in this paper refers to the financing mechanism in the development stage of a DSPV project rather than its operations stage.

The third-party ownership financing is also known as SolarCity financing as it was first created by SolarCity. In this model, SolarCity designs, finances and installs solar energy systems. It partners with banks, large corporations including Bank of America, Merrill Lynch, Citibank, Morgan Stanley, National Bank of Arizona and US Bancorp, among others, to create solar funds so as to finance its lease and PPA options. Among SolarCity's more well known financing partnerships was a USD 280 million fund created with Google in June 2011 to finance residential solar installations.

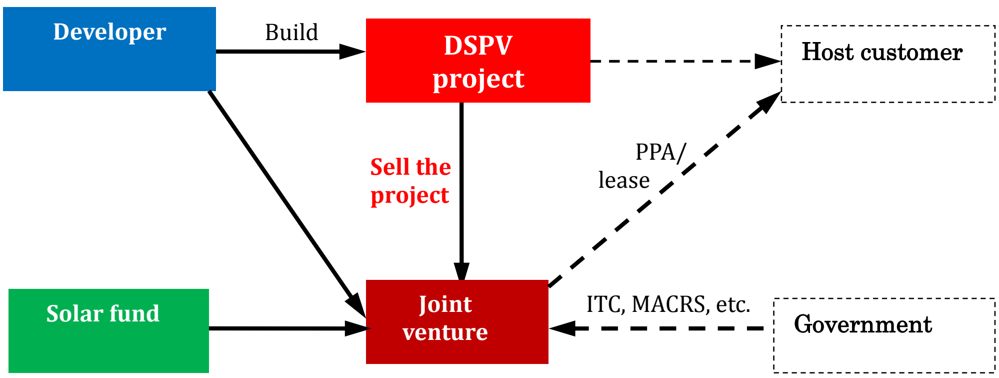
There are three models in the SolarCity’s solar funds mechanism: joint venture model, sublease model, and sale leaseback model (SLSE, 2014).

Under the *joint venture model*, the developer (e.g., SolarCity) builds the project and sells it to the joint venture of the developer and the solar fund. The joint venture then signs a PPA or lease contract with the host customers (Figure 6.3). Under this model, the developer shares the upfront cost, the government subsidy, and tariff revenue with the Fund.

Under the *sublease model*, the developer builds and leases the project to the solar fund, which then subleases it to the host customers and transfers the lease rental to the developer (Figure 6.4). This suggests that the developer needs to bear the upfront cost alone. While the developer obtains the tariff revenue alone, the solar fund gets the benefits from the ITC and MACRS.

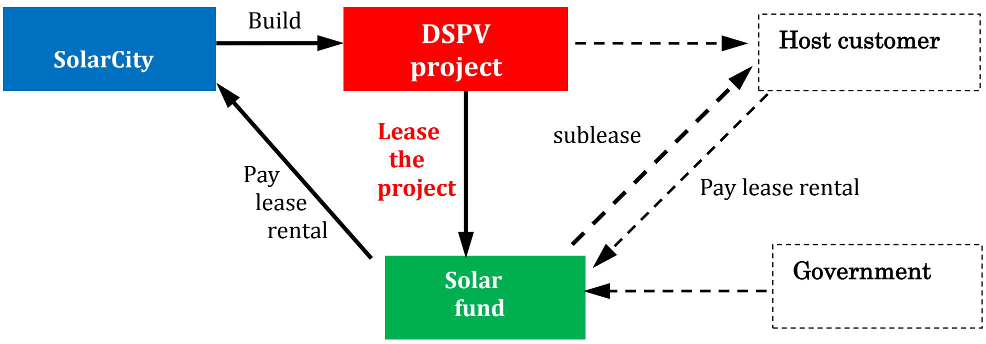
Under the *sale leaseback model*, the developer sells the project it built to the solar fund and then leases it back (Figure 6.5). Thus, the developer can recover its investment quickly and gain from power revenues, but cannot benefit from the government’s subsidy (Liu, 2014).

Figure 6.3: Solar Fund/Joint Venture Model



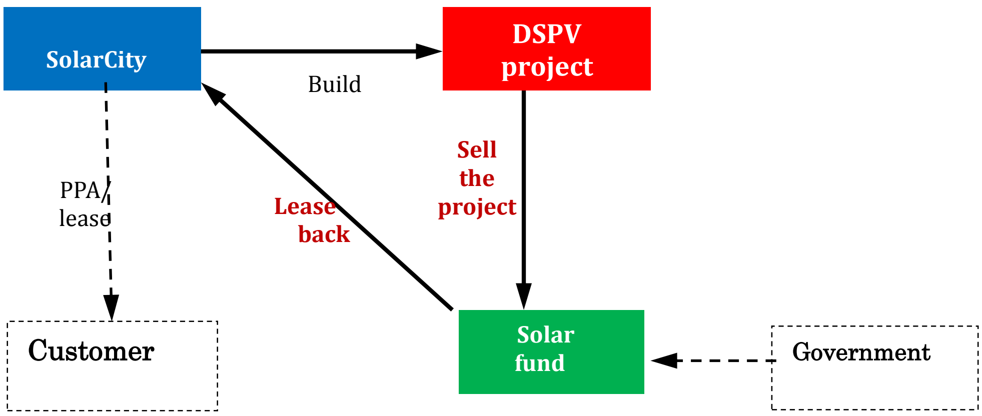
DSPV = distributed solar photovoltaic; ITC = investment tax credit; MACRS = modified accelerated cost recovery system; PPA = power purchase agreement.
Source: Compiled by the author.

Figure 6.4: Solar Fund/Sublease Model



DSPV = distributed solar photovoltaic.
Source: Compiled by the author.

Figure 6.5: Solar Fund/Sale-leaseback Model



DSPV = distributed solar photovoltaic; PPA = power purchase agreement.
Source: Compiled by the author. ‘

3.1.3. Utility and public financing

State and local governments, and utilities' three primary types of financing options are: utility financing (utility loans), public financing (i.e., credit-enhanced and revolving loans), and property-assessed clean energy (PACE) financing.

(1) **Utility financing**. Utility financing comes in two primary forms: *on-bill financing*, where customers repay the principal and interest on their electricity bill (or on a separate bill); and *metre-attached financing*, where the loan is tied to the metre/property. Because an on-bill loan is tied to the borrower, the homeowner must repay the loan when they move out of the property. In contrast, a metre-attached loan is underwritten to the property. Thus, if the property is sold, the buyer could potentially take over the loan payments. Only homeowners who are customers of utilities that provide or participate in financing programmes can access these loans (Speer, 2012; Sander, 2013).

(2) **Credit-enhanced and revolving loans**. Credit-enhanced loans are loans provided by either the state or local government, wherein it can, for example, offer a revolving loan on a portion of the principal as well as a credit enhancement for the private lender-provided portion of the loan. The state or local government portion often subsidises the net cost of the loan by providing a reduced interest rate. By dividing up the loan, the state or local government and lender share in the risk of default. Credit-enhanced programmes include loan loss reserves, subordinated debt, and interest rate buy-down (Speer, 2012; Sander, 2013).

Revolving loans, on the other hand, are loans to the homeowner that ideally replenish a pool of funds over time as the principal and interest is repaid. Revolving loans may be initially funded (and/or continually supported) by different methods, including appropriations, public benefit funds, alternative compliance payments, environmental non-compliance penalties, bond sales, and tax revenue. These loans can be combined with the credit enhancements (Speer, 2012).

(3) **Property-assessed clean energy.** Property-assessed clean energy financing is a public financing mechanism that has been utilised by state and local governments in the United States to fund PV projects since the 1990s. In areas with PACE legislation in place, governments offer a specific bond to investors and then turn around and loan the money to property owners for financing energy efficiency upgrades or renewable energy installations for buildings. The loans are repaid over the assigned term (i.e., somewhere

between 5 and 25 years) via an annual assessment on their property tax bill. One of the most notable characteristics of PACE programmes is that the loan is attached to the property rather than to an individual. Like other financial options introduced above, the primary benefit of PACE financing is the removal of significant upfront cost. This allows property owners to begin saving on energy costs while they are paying for their systems. On the other hand, the biggest challenge for PACE financing is that it is only available to a very few due to federal mortgage regulations and other concerns (Kaatz and Anders, 2014).

3.1.4. Solar crowdfunding

Solar crowdfunding is a new financing mechanism in the United States as well as in other countries. In solar crowdfunding, investment funds in solar systems are raised from individual investors through the internet. The companies that run solar crowdfunding platforms pool small investments from many individual investors, and the individual investors receive interest and are paid back in full over a specified number of years (Tongsopit, et al., 2013).

Mosaic is the company that pioneered solar crowdfunding platforms in the United States when it launched its online platform in January 2013, inviting individuals to invest as little as US$25 in specific solar projects while earning a 4.5% annual return on their money. The money pooled from investors serves as loans to small- and medium-scale project developers of commercial scale rooftop solar system at a 5.5% interest rate. Mosaic takes a 1% fee, while investors can expect a full return on their investment in 9 years.

In 2014, SolarCity, the country’s leading installer of rooftop solar systems, began selling bonds online to ordinary investors. SolarCity would pay these investors with its income from the monthly solar electricity payments made by its customers (composed of homeowners, schools, businesses, and government organisations) in 15 states and Washington, DC (Cardwell, 2014).

3.3. Summary

The business models and financing mechanisms for DSPV power reviewed above, among others, have helped spur the solar industry’s growth in the United States. Tax equity financing has significantly driven the expansion of US renewable energy over the past decade. Because most developers cannot utilise the tax credits and depreciation benefits themselves, they must incorporate third-party investors into the deals. This tax equity financing is primarily provided by banks, insurance companies, and a few large corporations. These provide the upfront capital in exchange for the tax credits and depreciation deductions associated with the development of solar energy projects.

Although each country has its own DSPV incentives, financial institutions and regulations, and electricity market structure, the business models and financing mechanisms in the United States may provide insights and lessons for China. Indeed, some of the emerging business models and financing mechanisms in China were drawn from the US experience, as will be presented in the next section.

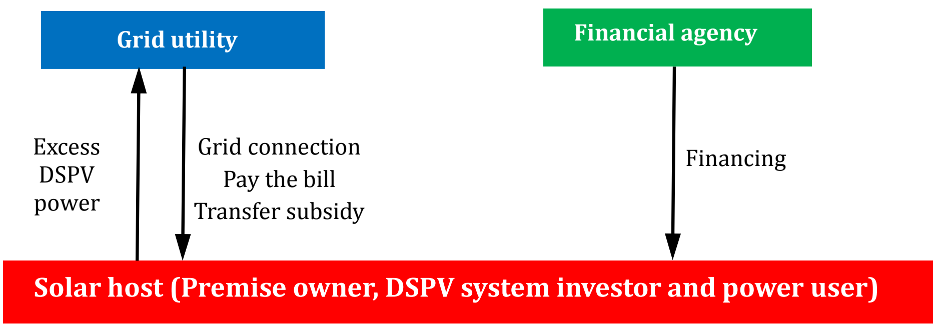
4. Existing business models and financing mechanisms for DSPV projects in China

4.1. Business models

4.1.1. Host-owned model

China's host-owned model is the simplest business model and is similar to that of the United States. In this model, the solar hosts purchase the solar system, have it installed on their rooftops or other solar sites, and use the power that the system produces, selling the excess power to the grid utility (Figure 6.6). In China, pioneer homeowners such as solar PV engineers and environment protection advocates are adopting this model.

Figure 6.6: Host-owned Model



DSPV = DSPV = distributed solar photovoltaic.
Source: Compiled by the author.

Box 6.1

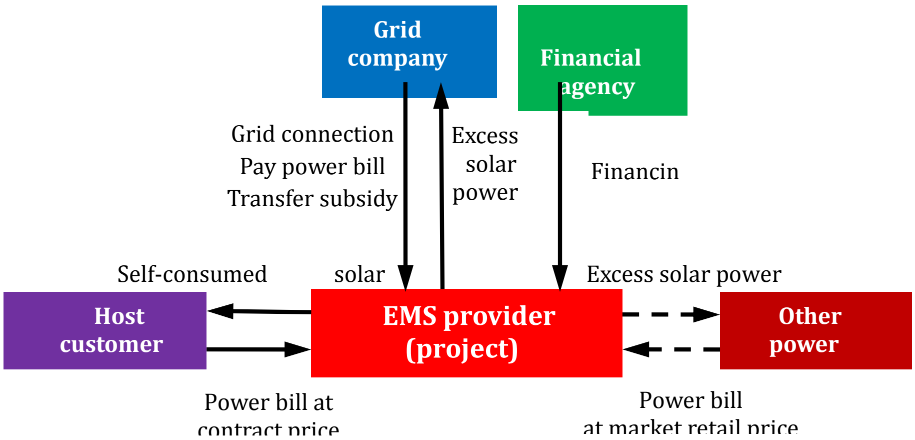
Case study: In October 2012, Ren Kai was the first in Beijing to install a solar system on the rooftop of his house. He paid CNY40,000 for his solar PV system and installed it himself. In 2014, the system generated 3,700 kWh in total, of which 80% was self-consumed and 20% was sold to the grid company. Subsidy from the state for this 3,700 kWh was CNY1,554 (CNY0.42/kWh), while the power revenue from the grid company was CNY300. Thus, the power bill saved was CNY2300, while the net income from the solar installation was CNY4,200. Payback time was 6 to 8 years (Source: Author's interview with Ren Kai).

The advantages of the host-owned model are: (a) The host customer saves on the electricity he uses; (b) The host customer gets the government subsidy of CNY0.42/kWh for all the power his PV system produces. Meanwhile, the disadvantages are: (a) the host customer has to pay the upfront cost, about 80% of which is the cost of the PV system (CNY40,000 or roughly $6,500); (b) the host customer has to look for an EPC contractor (solar PV developer) to design, procure, and install the solar PV system as well as provide a comprehensive O&M support, and runs the risk of poor system performance; and (c) the host customer has to bear the transaction costs associated with the grid interconnection.

4.1.2. Solar energy management service model

The *solar energy management service* (EMS) model is similar to the US third-party ownership model, and is also composed of the PPA model and lease model. Under the PPA model, the EMS provider owns and installs the PV system on the host customer's rooftop. The rooftop is offered to the EMS provider for free, and in return, the host customer receives solar power supply at a price 80% to 90 % lower than the market retail price. Thus, the host customer's revenue is in the form of savings on his electricity bill. Meanwhile, the EMS provider's revenue is composed of three parts: the discounted sales of the solar power to the host customer, the sales of the excess solar power to the grid and/or other end users at the local benchmark on-grid price for desulfurised coal-fired power, and the government subsidy (Figure 6.7).

Figure 6.7: The PPA Model



EMS = energy management service; PPA = power purchase agreement.
Source: Compiled by the author.

The second model, the lease model, is one where the host customer leases the PV system from the EMS provider and makes fixed monthly payments. Thus, the host customer's revenue under this model is the electricity bill saved, the sales of excess solar power to the grid, and the government subsidy minus the lease rental.

Table 6.2 shows the revenue model of the EMS provider and the host customer under the PPA model and lease model. Currently, the host customer prefers PPA over the lease model for two reasons:

(a) The PPA model is simpler than the lease model. In the PPA model, the host customer does not need to deal with grid connection or power sale issues.

(b) The PPA model provides a definite benefit to the host customer. In this model, the host customer's revenue is the discounted power supply (i.e., the saved electricity bill), which is relatively definite.

Table 6.2: Revenue Models Under PPA Model and Lease Model

ASSUMPTIONS	
Power generation in a specified month	100 kWh
Industrial and commercial power price	CNY0.85/kWh
Proportion of self-generation and self-consumption	80%
Government subsidy	CNY0.42/kWh
On-grid benchmark price for desulfurised coal-fired power	CNY0.40/kWh
Discount rate of sale price for host customer	90%
PPA MODEL	
EMS provider's revenue (①+②+③)	CNY111.2
① Sales of solar power to the host customer	100*80%*0.85*90% = CNY61.2
② Sales of excess solar power to the grid and/or end users	100*20%*0.40=CNY8.0
③ Government subsidy	100*0.42=CNY42.0
Host customer's revenue	100*80%*10%*0.85 =CNY6.8
LEASE MODEL	
EMS provider's revenue (lease rental)*	CNY111.2
Host customer's revenue (①+②+③-④)	
① Power bill saved	CNY6.8
② Sales of excess solar power to the grid and/or end users	100*80%*0.85= CNY68.0
③ Government subsidy	100*20%*0.40= CNY8.0
④ Lease rental	100*0.42=CNY42.0
	CNY111.2

EMS = energy management service; PPA = power purchase agreement.
Note: *Assumes that the lease rental under the lease model is equivalent to the revenue of the EMS provider in the PPA model.
Source: Compiled by the author.

However, several challenges exist for the EMS providers:

(1) **Liquidity risks.** Under the current on-grid tariff and subsidy policy, the payback time is generally 6 to 8 years for commercial and industrial PV projects and more than 10 years for residential PV projects. On the other hand, commercial banks tend to provide short-term (1–5 years) loan financing. Therefore, liquidity risks are present for EMS providers who rely on long-term returns to cover short-term loan expenses.

(2) **Risk of non-performance on the part of host customers.** In cases where the power generated by the solar PV system accounts for a very small amount in the total power consumption of host customers (industrial and commercial customers in particular), non-performance on the part of host customers (i.e., non-payment of the discounted solar PV power tariff) would have little impact on the revenue of these

customers. This suggests that the probability of non-performance of contract on the part of host customers could be great.

(3) **Other risks**. As discussed in the paper, 'Analysis on Distributed Solar PV (DSPV) Policy in China', although many incentive policies have been put in place, some of the policies that pertain to grid-connection services have not been well implemented. As such, there exist risks of non-grid connection of DSPV projects.

All in all, while the solar EMS model seems attractive to the host customer, it brings about many challenges to the EMS provider, who faces greater risks than the EPC company in the host-owned model.

4.2. Financing mechanisms

This section presents the main financing mechanisms for DSPV projects in China, with a particular focus on recently evolving financing mechanisms, and identifies the key challenges or problems under these mechanisms.

4.2.1. Conventional bank loan

On 22 August 2013, the National Energy Administration (NEA) and the China Development Bank (CDB) jointly promulgated the 'Opinions on Financial Services to Support Distributed Solar PV', which calls for China's policy and commercial banks, and other financing agencies to provide preferential and pledge loans, and to establish financing platforms for DSPV projects, while encouraging local governments to provide discounted loans (NEA and CDB, 2013).

A bank loan provided by Chinese policy banks such as the CDB, and the commercial banks is the main financing mechanism for DSPV projects in China. In response to the government's call and along with the growing confidence in China's DSPV industry, the CDB and other state-owned commercial banks have progressively shown interest in DSPV projects. For instance, both the Industrial and Commercial Bank of China and China Merchants Bank issued guiding opinions on providing credit to solar industry. While the Industrial and Commercial Bank of China is committed to give loan priority to rooftop DSPV system, China Merchants Bank is committed to provide appropriate loans to the best DSPV projects.

Nevertheless, as discussed in 'Analysis of Distributed Solar PV (DSPV) Power Policy in China' in this special issue, the complex sources of risk have created confusion among

Chinese banks regarding the predictability of risk and return on DSPV investments. This has greatly constrained the availability of bank loans. The current conventional bank loans are in the form of mortgages based on the borrower's credit, real estate or negotiable security, and normally short term (1–5 years) for DSPV. This appears to be not good enough for DSPV projects that derive their revenues from power generation during their operation period and have a life of 20–25 years. Also, the majority of the DSPV investors in China are private companies whose credibility is not as good as that of state-owned enterprises.

4.2.2. Local financing platforms

Due to the constraints on bank loans for DSPV projects, particularly for non- state-owned enterprises, the NEA and CDB jointly promulgated the establishment of local financing platforms where the CDB provides credit lines to finance eligible loan borrowers.

The platform is presumed to play the role of small credit provider and offers credit endorsements---an ideal financing form for medium- and small-sized companies (mainly non-state-owned enterprises) and individuals who cannot get access to bank loans due to limited credibility or financing capability.

However, a survey report issued by the Energy Research Institute under the NEA shows that this financing mechanism has not been performing well, as seen in the Sanshui case.

Along with two other enterprises, the management committee of Sanshui Solar PV Demonstration Area in Guangdong Province established a limited liability company to act as a financing platform for DSPV projects in the demonstration area. However, the CDB required the local government to provide financial guarantees to the loans the platform provided. Given that the requirement would undoubtedly put financial burden on the local government, the local government rejected CDB's request. As a consequence, the limited liability company had no other option but to require the shareholders of the company to provide financial guarantees in proportion to their shareholdings in the company (Xie and Gao, 2015). This suggests that no breakthrough in financing mechanism innovation has been achieved.

In addition, in 2014 the Chinese government initiated three types of solar PV projects under a national poverty alleviation programme; namely, household DSPV projects, solar PV stations on barren hills and slopes, and agricultural facility DSPV projects.

Meanwhile, the government has proposed that 5-year low-interest bank loans should be provided to rural residential and agricultural facility DSPV projects, and 10-year low-interest bank loan to ground PV stations in rural areas (CREEI, 2015).

4.2.3. Solar PV industry investment fund

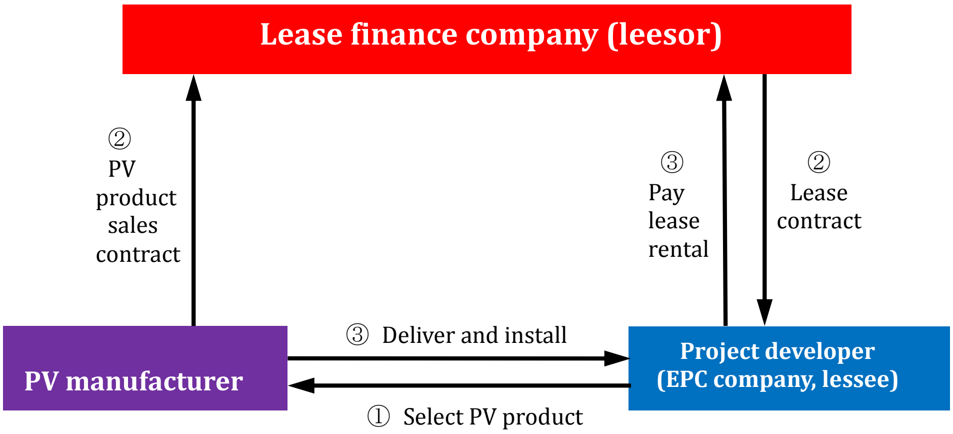
The solar PV industry investment fund is the fund set aside for the construction of solar PV projects. On 17 April 2014, the Beijing Guolin Harlyn Solar PV Industry Investment Fund was jointly initiated by Harlyn Capital and the PVP365.com website as originators, and several well-known enterprises such as limited partners at CNY 500 million. This fund not only makes equity investment in large-scale PV stations and DSPV projects but also provides value-added services along the whole PV supply chain, including coordinating relevant PV parties, introducing insurance, as well as searching for PV project buyers, among others.

To date, the fund has built cooperative relationships with several local governments, strategic buyers, policy banks, commercial banks as well as third-party asset management agencies; has completed the first phase of financing amounted to CNY 500 million; and has provided start-up capital to the best PV projects currently available. The capital will be withdrawn with an expected rate of return of between 10% to 20% once the PV projects are built. As such, the fund is expected to leverage CNY10 billion if it operates smoothly. Evidently, this financial mechanism helps to mitigate the problem in obtaining start-up capital for PV projects in China. Its major drawbacks, though, are its high financing cost, limited fund sources as well as risks involved.

4.2.4. Lease financing

As one of the most popular financing tools in modern business world, *financial leasing service* uses finance leases to leverage assets. A *finance lease* (or capital lease) is a method of raising finance to pay for assets, rather than a genuine rental. Lease financing is emerging for DSPV projects in China. For instance, the Ronglian Lease Company, a subsidiary company under the China Power Investment Corporation, provided financing lease to China Power Investment Corporation's Yunnan Branch in the development of its 20MW DSPV project in 2014. In this model, the lessee (the project developer) selects the PV product (type, size, price, quantity, etc.), and the lessor (finance company) purchases the required PV product and leases it to the lessee, who then pays lease rentals for the use of the PV system (Figure 6.8).

Figure 6.8: Lease Financing/Direct Lease Model



EPC = engineering, procurement, and construction; PV = photovoltaic.

Source: Compiled by the author.

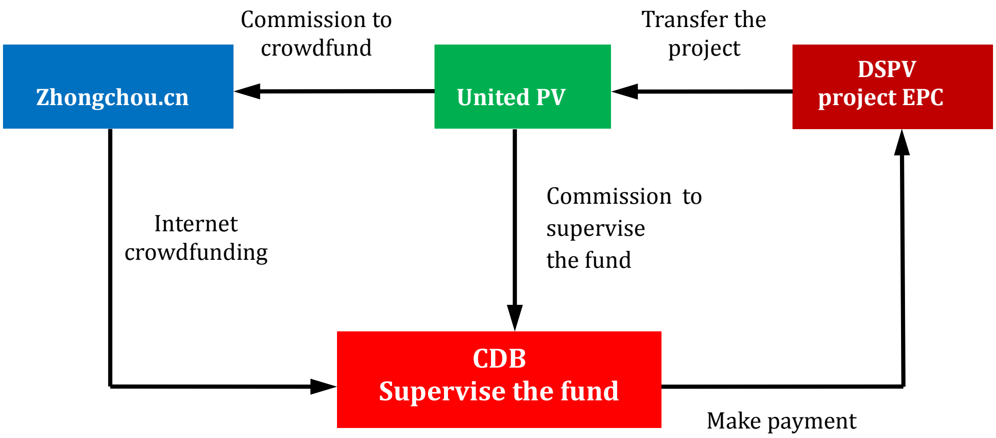
In this model, whether the lease rental could be duly paid is determined by several factors including the lessee’s credibility, the PV system’s quality, and the sale revenue of the PV system, which depends on grid connection and the host customer’s credibility, among others. The problem is some of the well-designed policies have not been well implemented as discussed in ‘Analysis of Distributed Solar PV (DSPV) in China’.

4.2.5. Internet financing

(1) **Equity crowdfunding.** United Photovoltaics Group Limited (United PV), a leading Chinese solar power plant investor and operator, pioneered solar crowdfunding in China. In February 2014, United PV raised CNY 10 million to develop the world's first megawatt-level distributed solar power project in Qianhai, Shenzhen, in cooperation with its two strategic partners through China's most influential internet crowdfunding platform – zhongchou.cn – a website that raises capital from the public.

As shown in Figure 6.9, United PV commissions zhongchou.cn to launch a crowdfunding activity and the CDB to supervise the fund. The CDB makes regular payments to the DSPV project constructor (the EPC contractor), who will then transfer the DSPV project to United PV once the project is completed.

Figure 6.9: United PV's Internet Fundraising Model



CDB = China Development Bank; DSPV = distributed solar photovoltaic; EPC = engineering, procurement, and construction.
Source: Compiled by the author.

However, there is concern about the legality of the United PV's equity financing. In March 2014, an official from China Securities Regulation Committee gave positive comments on United PV, but this does not suggest that this model has no legal problem. According to a report of T*he Diplomat*, Liu Zhangjun of the China Banking Regulatory Commission noted that crowdfunding and peer-to-peer lending are potential illegal fundraising models of particular concern. In these models, lenders often do not know their borrowers, and borrowers do not know their lenders. The internet funding companies are often unauthorised to engage in lending practices. Risk control and truth in advertising may be abandoned in some cases, leading to consumer fraud (Hsu, 2014).

(2) **SPI Solarbao: An innovative internet financing scheme**. In January 2015, Solar Power, Inc. (SPI), a vertically-integrated PV developer that focuses on the downstream PV market (including the development, financing, installation, operation and sale of utility-scale and residential solar power projects in China, Japan, Europe, and North America), launched the innovative online platform Solarbao.com in mainland China.

Under the SPI Solarbao model (Figure 6.10), the investor buys solar PV panels on the Solarbao's investment platform and then leases them to Solarbao. The minimum investment is as little as CNY 1,000. The panels bought by the investor will be installed in the power station for power generation via Solarbao. The then investor receives a monthly rental payment, which is technically from the value of the electricity produced by the investors' panels. He/she can retain ownership of the solar PV panels or choose to sell the panels to Solarbao after the lockup period, during which the he/she receives payback for the investment (Solarbao, 2015).

Figure 6.10: Simplified SPI's Solarbao Model

Source: Solarbao (2015).

Solarbao was reported to successfully raised CNY200 million for one of its wealth investment products named 'Orange No. 1' in just two months through its online platform and proved extremely popular with investors. Nevertheless, industry insiders, financial experts, or lawyers have raised certain concerns about the scheme (Yu, 2015).

The first concern is about its high rate of return. For one, the rate of return for its first two product series (one for pipeline PV projects; the other for completed projects) is around 10%. In financial experts' view, the rate is too high, as the internal rates of return for PV projects are 12% to 14% at most. They therefore cast doubt on the model's profitability.

The stability of the cash flow from its projects is also put to question since not all DSPV projects in China could be effectively connected to the grid, and government DSPV subsidies may not be appropriated in time (Solarzoom, 2015).

The second concern is about the investment's security. According to the Solarbao.com website, the investment is put into the company's account rather than into a third-party account (Solarzoom, 2015).

The third concern is about its legality. In the Solarbao model, Solarbao appears to be a leasing company that leases panels on behalf of investors. Theoretically, under a financing lease contract, the lessor's (principal's) income comes from the lease rental minus the charges and taxes paid by the leasing company (Solarbao). In the case of Solarbao, what the lessor receives is a monthly rental, which is technically the value of the electricity generated by the investors' panels. In this sense, Solarbao's products are financial rather than physical products. As such, it is an effective crowdfunding that has obscured the legality problem, as noted above (Solarzoom, 2015).

5. Conclusions and policy implications

Based on the literature review and the analysis of business models and financing mechanisms for DSPV in both the United States and China, this paper concludes that: (a) Enabling policies are determinant components for innovative business models and financing mechanisms in the United States; (b) Innovative business models and financing mechanisms drive the rapid growth of DSPV power in the United States; (c) While innovative business models and financing mechanisms for DSPV are emerging in China, there are challenges; (d) Government policy support is imperative to address these challenges.

5.1. Policy implications

5.1.1. Incentivise innovative bank loan mechanism

The prevailing bank loans in China still largely take the form of conventional mortgages based on the borrower's credit rating, real estate, or negotiable security. Also, banks usually provide short-term rather than long-term loans to PV project developers. This has greatly constrained the availability of bank loan financing. It is suggested that based on the very nature of PV projects, loans mortgaged on power bill and project assets as well as long-term bank loans be provided to DSPV projects. So as to incentivise banks to do this, tax incentives similar to the US tax credits needs to be provided. In addition, bank loan subsidies may also be provided to drive banks to provide lower interest loans.

5.1.2. Improve the regulation of solar PV internet financing

Internet financing provides an excellent channel for the public to make indirect investment in solar PV projects. However, since internet financing in China is at its early stage, it has been viewed with negativity or suspicion over the years. As a new concept in China, internet financing is neither regulated nor well defined. As a result, it operates on unclear legal boundaries that have prompted Chinese internet financing platforms to be cautious amid the government's strong stance against illegal fundraising (China Impact Fund, 2014).

Nevertheless, what is worth noting is that on 18 July 2015, 10 regulatory agencies jointly issued the 'Guidelines on Promoting the Healthy Development of Internet Finance'. These are the most formal and comprehensive guidelines issued by high-level Chinese state authorities in the area of Internet finance and is the first time central Chinese authorities have supported internet financing.

While the guidelines encourage innovation and support the steady development of internet finance, there are a few unresolved issues that must be clarified. For instance, the guidelines only mention equity crowdfunding, but do not address other forms of crowdfunding that have arisen in the market such as product and income rights crowdfunding. The guidelines state that unless otherwise specified, internet finance enterprises shall select qualified banking financial institutions as the depository entities that will manage client funds and the enterprise's proprietary funds under separate accounts. However, most internet finance enterprises currently use third-party payment institutions as their funds' depository. It is unclear whether 'qualified financial institutions' include these third-party payment institutions or not. If these are not, it is also unclear how one can bring the current market practice into compliance (Han Kun Law Office, 2015).

5.1.3. Push the implementation of direct power sale policy

The pilot programme of direct power sale to large users was implemented in limited areas in China after the electricity market reform in the early 2000s. The recent power sector reform launched in March 2015 will further open up the retail market, leading to the growth of direct sales deals between generators and large users. This would undoubtedly benefit distributed generators, including DSPV producers.

The low proportion of self-generation and self-consumption of DSPV power, and the low on-grid tariff policy for DSPV power have lowered the internal rates of return of DSPV projects. This, in turn, has undermined the enthusiasm of the DSPV project investors. Direct sale of DSPV power to end users, particularly to industrial and commercial end users whose power prices are much higher than the on-grid price of DSPV power, could increase the internal rates of return for PV project developers. This suggests that the Chinese government needs to come in and help open up the power retail market.

5.1.4. Push the implementation of the existing DSPV policies

Over the past years, many incentive policies have been promulgated both at central and local government levels. However, some of these policies have not been well implemented. This underscores the need for the government to give more importance to the implementation of existing policies as well as to address these implementation problems.

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