A Comparative Analysis of Solar Financing Methods for Public Buildings

Rubenrajoo Sri Rengarajoo and Yujie Lu

Department of Building, National University of Singapore, 4 Architecture Drive, 117566, Singapore

Abstract: The challenges associated with widespread use of solar power are due to huge upfront costs. Developing alternative financing models is critical to solving this problem, especially in cases involving large scale implementation. This paper discusses and compares five alternative project financing models for procuring the large-scale solar Photovoltaics (PV) technologies for public buildings. The five models are self-financing, power purchase agreement (PPA), solar leasing, hybrid PPA, and hybrid solar leasing. For each of these models, its unique attributes, stakeholders relationship, project revenue stream, and potential savings were discussed. The discussion is set in the context of Singapore public housing and uses the largest public building owner, Housing Development Board (HDB), as a case to illustrate the potential implications of all models. The results of the study would aid government in the financial decision making process, as it is the midst of expanding its solar infrastructure. The comparative results can also help government better understand multiple project delivery options in order to best optimize their capital resources in vibrant economic and market conditions.

Keywords: Solar energy, solar power purchase agreement, solar leasing, solar procurement, project finance

DOI: 10.7492/IJAEC.2015.017

1 INTRODUCTION

The increasing effects of global warming and climate change, coupled with the rising issue of energy security, has led to countries diversifying their energy portfolios by incorporating renewable energy. Solar PV has become a promising technology over the last decades with the research and technology development. The global solar PV market has experienced rapid growth in the last decade, with an estimated global installed capacity of 140,000 MW in 2013 (EPA 2015). However, large scale public solar PV projects require new financial schemes which can greatly leverage the scale of solar deployment. As solar PV projects require high upfront capital contributions, with high cost of capital and limited revenue earning potential, the current financing and procurement (F&P) models used by the public sector, are not sustainable for upscaling large scale solar projects. This indicates a need to explore and study alternative procurement models for upscaling solar PV installations, with instruments that allow the leveraging of private capital, thereby allowing the public organizations to maximize solar generating potential in the most cost effective manner.

The study sets in the context of Singapore public housing industry. In Singapore, over 80% of national residential house is constructed and managed by the statutory board, Housing and Development Board (HDB). Given its large building stock of over 9,000 residential blocks, HDB has a huge potential for generating solar energy using available roof-space, with an estimated installed solar capacity ranging between 856 to 1,050 MW by 2050 (Doshi et al. 2014). Furthermore, Singapore has a great potential to harness solar energy with an annual average solar insolation of 1,663 KWh/m² and 4.55 peak sun hours/day (NSR 2015). However to upscale its solar installation and fully capitalize on its solar potential, HDB would have to invest approximately $2-3 billion, based on the current PV installation costs in Singapore. Such a significant upfront investment would reduce the capital available for HDB to focus on its main organizational priority of developing affordable public housing in Singapore. Thus this research aims to compare alternative project procurement models which are applicable for large scale PV projects with greater leveraging capabilities, for the implementation of large scale public sector solar PV projects.

*Corresponding author. Email: luy@nus.edu.sg
2 LITERATURE REVIEW AND RESEARCH METHOD

This research uses literature review to identify multiple project delivery approaches, and sets these approaches in the context of a case study in Singapore in order to analyse their differences.

2.1 Grid-Connected Solar PV Technologies and the Scales of Production

A solar PV system comprises of solar panels and balance of system components (BOS), which includes inverters, electrical cabling, supporting structures and mounting for the solar panels. PV systems can be connected to the electric grid, whereby energy generated from the system can be fed directly to the grid. To date, there are three main categories of commercially available PV technologies, which include crystalline silicon, thin film and hybrid cells, with efficiencies that range accordingly between, 13-23%, 5-13% and 4-11% (Doshi et al. 2014). These cells are long lived assets with life spans ranging from 15 to more than 25 years. A global market study by (EPIA 2013) also found that, silicon cells were the most commonly used PV technology, accounting for about 78% of all modules produced globally.

There are generally two scales of producing solar PV electricity: demand-scale and utility-scale. The demand-scale of production, is where the electricity produced from solar PV, is primarily meant to supplement customers electricity demand (Sunshot 2012). This scale of production is generally applicable for smaller residential and commercial applications. The utility-scale of production, is one where there is a need to sell the electricity generated to remain afloat, either through a power purchase agreement (PPA) or through net metering, where generated power is used on site and excess power is fed into the grid which is purchased by the producer (Donnelly-Shores 2013).

2.2 Global Solar Economics and Financial Barriers

DeGroat et al. (2009) and Bradford (2006), state that solar deployment acceleration is achieved through the integration of solar-generated electricity with the electricity grid, cost of grid electricity reduction in manufacturing and deployment costs and expansion of manufacturing capacity. This conclusion echoed with Bloomberg’s “Solar White Paper” report (Bloomberg 2012), which states that solar PV projects generally lack the ability to access capital markets, due to the financial barriers and issues related to solar PV. The major barriers include: high cost of capital, inappropriate cost structure, and reliance on financial incentives.

2.3 Financing Mechanisms for Solar PV Projects

Financing solar PV systems is deemed as one of the most important tool to overcome market barriers (Tampier and Beaulieu 2006). The literature review found that although several alternative F&P methods were proposed by various sources, there were only three main established mechanisms: self-financing, third-party financing, and hybrid financing.

The self-financing mechanism, is where the operator finances the up-front costs (Capex) of installing PV either with its own cash or from capital markets, through bank loans, equity loans and occasionally mortgages (Kollins 2009). This model is suitable for sites with less power requirements, as the higher the power requirements the higher the Capex required. Therefore it is a barrier for large-scale deployment as the operator has to invest millions or billions of dollars in Capex which will results in an increase in debt for the organization.

The third-party financing model, also known as the Opex based procurement model, allows customers to enjoy solar power by transferring the initial Capex to a specialised company called a Solar Service Provider (SSP), whose main purpose is to invest, build, generate, maintain and deliver energy to the operator (GSMA 2012; Speer and Karlynn 2010). In exchange, the customer transfers its rights of ownership to the land used for solar development to the SSP for a given concession/contract period. For public solar projects, the use of third-party financing, allows government incentives to be maximised, as the SSP is an entity designed to capture all available tax benefits (Speer and Karlynn 2010). This reduces the overall cost of the solar project, and is transferred to the public entity through lower electricity prices. There are two main third-party financing mechanisms, which include the power purchase agreement, and solar leasing agreement.

The hybrid financing model incorporates the private and public sector together in public project, also known as a public-private partnership, can allow parties to capitalize on each other’s resources and expertise and transfer risks accordingly to the party which is better able to manage a particular risk (PWC 2011).

3 COMPARATIVE ANALYSIS OF FIVE SOLAR FINANCING MODELS

The study exams five different project financing methods as follows:

Model 1: HDB Self-Financed

Under this model, HDB will be the owner of the project, and will design, finance, operate and maintain the solar PV facility throughout the projects life. The electricity generated from the solar PV panels, would be used to meet HDB’s electricity demand from
power services in common areas such as lift operations, corridor and staircase lighting, and water pumps. This model, has been used by HDB for several small scale test bedding project, including the 75.75 kWp test bed at the Serangoon North Precinct and the Wellington Circle precinct in 2008 (EMA 2014), and never for large scale solar procurement projects thus far.

Model 2: Power Purchase Agreement (PPA) Contract

In this model, the SSP and operator, enter a long-term contract, where electricity generated from the solar energy system, is usually sold to the operator at a discount off the actual utility rate ($/KWh), known as the PPA rate. Depending on the contract terms, the operator will have to pay for all the electricity generated, or only for the amount of electricity that has been used. Some contracts may include a floor and ceiling tariff rate, which acts as a hedging mechanism for the operator, and protection for the SSP from market variations (Sunseap 2014).

The use of PPA’s for renewable energy generation has grown rapidly since its introduction in 2006, and has become a popular strategy for financing new public installations. According to Guice and King (2008), 50% of the growth in the commercial and institutional market for solar in the U.S. in 2007 was carried out using this model. In Singapore, the PPA contract was used by HDB in 2011 for the first time, to develop a 2 MWp solar PV system in Punggol Eco-town, where HDB entered a PPA contract with a local SSP, Sunseap Enterprises (Cheam, J. 2011). Under this model, HDB will transfer ownership of its roof spaces required for the solar PV project development, to a SSP for a given contract period equal to the projects life. In return for the roof space, the SSP would sell electricity generated from the project at a preferential rate known as the PPA rate to HDB who would assume the role of a customer, till the end of the contract period.

This model offers two kinds of uniqueness. 1) It effectively transfers all upfront and project related costs from HDB to the SSP, who would be responsible for all costs and expenses incurred during the projects life, including the initial installation cost, O&M cost, financing cost and decommissioning cost. 2) PPA contract incorporate a performance guarantee, whereby the SSP would be obliged contractually to supply HDB with a fixed amount of electricity annually, which would be stipulated in the contract. In the event that the SSP fails to supply the agreed amount, it would be subject to a penalty, whereby it has to cover the shortage by buying electricity from the grid at its own expense. This allows HDB to secure supply of electricity throughout the projects life.

Model 3: Solar Leasing Agreement

In a solar lease, the SSP covers the cost of installing the systems, captures rebates and incentives, provides warranty service on the PV system, and collects any net excess generation produced to sell back to the grid (Kollins 2009). The customer does not pay any up-front costs, but instead leases the equipment for a fixed monthly payment at a pre-determined price. This allows the customer to maximise up-front savings and leverage on the SSP, thereby immediately lowering electricity costs. Under this model, HDB would transfer ownership of its roof spaces required for the solar PV installation to a SSP for a given contract period, equal to the projects life.

This model provides similar conditions as model 2, except for two aspects. 1) The payment is predetermined and locked at a price for the contract term, so it provide less risks for the customers of being exposing to the volatility of electricity price. Ideally, savings on the electricity bill should exceed the cost of the lease otherwise the customer ends up paying more for solar power on a levelized basis ($/KWh) than for conventional electricity (Kollins 2009). This allows HDB to hedge the risks of price escalation and to ensure a constant supply of electricity annually. 2) The contract term could be shorter than the PV product life if a fixed monthly payment is determined at a high level. So a PV leasing contract may offer the customer an early option to close the contract and this option bring additional flexibility for the customer when s/he is reluctant to lock in a long term contract for power supply.

Model 4: PPA Hybrid

Model 4 is a public-private partnership (PPP) between the SSP and HDB. It is a variant by using the principle of the alternative financing models discussed in the literature. 1) Kreycik (2011) introduced a bond-PPA hybrid model which has the ability to combine many of the benefits of self-ownership and third-party PPAs. It is a financing option whereby the public entity, issues a government bond at a low interest rate and transfers that low-cost of capital to a SSP in exchange for a lower PPA price. Currently this model has been implemented by Morris County (2011), New Jersey administrators, for a 3.2 MW project, where notable energy cost savings of $3.2 million in net present value (NPV) was reported. 2) PWC (2011) introduced another financing model as the public sector debt capital model. This model is based on the premise that government funding could be used to supplement private finance, through providing project debt by co-lending on an equal basis with commercial debt.

Although these models have not been widely been used for public solar PV projects, the fundamentals of these models are very applicable as it addresses and mitigates some of the financial barriers to solar PV projects, as well as balances the project risks faced the parties. Inspired by these studies, two PPP hybrid models are discussed in this study as model 4 and model 5.
The model 4 has three kinds of uniqueness. 1) When the model 2 and 3 transfers the upfront financial cost from HDB to SSP to release its financial burden, the PV ownership is also transferred exclusively to the SSP. This brings potential concerns for a building owner (HDB), especially for a government agency, since they lose control to the project design, construction, and maintenance in the long term, and may lose negotiation or decision power to protect the public interests in the long term. Therefore this PPP hybrid model can offer somewhat “joint ownership” to HDB and involve HDB for the project execution, and also best protect the public interest. 2) This model also combines the advantages from both parties to form a strong project execution team, since government has advantage of providing land (building rooftop) and cheap financing cost, i.e. by securing debt at a low government rate; while private sector has high efficiency for the project management and operations. Therefore the model integrates best resources for a project. 3) The contract year is shorter than the life span of a PV project. During the PPP contract period, the SSP and HDB would share the initial project cost, in which the SSP would have to contribute a mix of equity and debt into the project. At the end of the contract period, the ownership of the solar system would be transferred from joint venture to HDB, who would run the project for its remaining life, bearing all costs related to the project and benefitting from the electricity generated from the project.

Model 5: Leasing Hybrid
Model 5 is also a hybrid model by combining PPP with model 3 (solar leasing). A joint venture arrangement is established between the SSP and HDB to undertake the project cost and risks for a certain contract year. Under this arrangement, the debt incurred from the project will be co-shared between HDB and SSP as similar in Model 4. The SSP and HDB will share the initial cost of installation, whereby the SSP will contribute a mix of equity and debt into the project, while HDB will only contribute to a certain amount of the debt obligation.

The contract period of the SSP will be shorter than the total project life. After the contract period, the ownership of solar system will be transferred from the joint venture over to HDB, who will run the project for its remaining life, bearing all costs related to the project and benefitting from the electricity generated from the project. This is to compensate HDB for the additional risk exposure from the co-sharing arrangement.

4 DISCUSSION

This study presents five financing models and their characteristics such as the parties involved, general obligations and revenue or savings determinants for the SSP or HDB.

4.1 Project-level Comparison
At the project level, all five models are similar since the main revenue is generated from solar power. The contract term of model 2 and 3 is similar and the contract term equals to the solar system life span. Therefore, SSP undertakes the most of the project cost and risks. Model 4 and 5 are both joint ownership structure, in which the contract term may be shorter than the solar system life. All four alternative project contracts as in model 2/3/4/5 provide a performance guarantee to the client to deliver certain required electricity usage. For both Model 2 and model 4, the performance guarantee obligates the SSP to supply a given amount of electricity annually to HDB during the contract period, at a preferential rate (PPA rate) which will be less than the retail electricity tariff. The SSP would pay a penalty for failing to meet this obligation. In model 3 and model 5, the performance guarantee obligates the SSP to supply a fixed amount of electricity annually to HDB during the contract period. In return, a fixed lease payment would be paid to the SSP. The SSP will pay a penalty if it fails to meet this obligation. The project revenues come from the fixed lease payment and from the sale of excess electricity generated from the solar PV panels to the grid. Both of them are mainly decided by the amount of the electricity generated by the project in any year.

4.2 Comparison of HDB
Compared to model 1 in which HDB undertakes all project cost, by engaging in the model 2, HDB not only save all upfront cost but also yield an annual saving equal to the product of the difference between the PPA rate and grid purchase rate, and the fixed amount of electricity purchased from the SSP. From engaging in the model 3, HDB receives lower electricity rates for a long term contract, and does not have to be responsible for O & M activities and costs. The annual saving of HDB equals to the difference between the amount it would have paid for the fixed amount of electricity annually from purchasing directly from the utility and the fixed annual lease. Compared to model 2 (PPA), model 3 (solar leasing) may assume more risks to the HDB as the SSP receives fixed monthly payments from the lease of equipment even if the system is not producing electricity, or if the price of electricity falls over time. However, the HDB may also hedge the risk of rising electricity price under this solar leasing scheme. For model 4 (hybrid PPA) and model 5 (hybrid solar leasing), within the contract period, the revenue is similar to model 2 and model 3 respectively; in the post contract period when HDB takes over the project, the revenues for HDB will be calculated using its generated electricity minus the O&M cost.
4.3 Comparison of SSP

Using the model 2 (PPA), the revenues for the SSP come from two sources. The main revenue source for the SSP would come from the PPA contract, where a fixed amount of electricity generated by the solar PV panels is sold to HDB at the PPA rate. The secondary revenues stream for the SSP, from the project, would come from the sale of excess electricity generated from the solar PV panels to the grid. The total revenue potential in any given year of the project varies widely based on the amount of electricity generated from the project. The model 3 (solar leasing) is different to this scheme since the payment to HDB is fixed instead of variable. In both model 2 and 3, SSP will take responsible for the designing, financing, installing, operating and maintaining of the solar PV system. For model 4 (hybrid PPA) and model 5 (hybrid solar leasing), during the contract period, the revenues made from the project for the SSP can be calculated similarly in Model 2 and model 3, respectively. After the contract period, the SSP quits all obligations from the project and take no responsibility any more.

5 CONCLUSION

This study delineates benefits and challenges among the self-financing ownership, the third-party financing model, and hybrid financing models. The comparative analysis provide a synthesis of project procurement information to facilitate governmental procurement of large-scale solar projects, such as enabling the tax-exempt entity to benefit through savings passed on from tax incentive like the third-party financing model, and allowing the public entity to take advantage of low-cost public debt by using the hybrid financing model. Further research can explore more empirical case studies and arguments, such as focusing on the project financial feasibility and project profitability.

REFERENCES


