AN ANALYSIS FOR PROMOTING RESIDENTIAL- SCALE SOLAR PHOTOVOLTAIC (PV) IN BANGKOK, THAILAND

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Overview

Thailand is facing an energy crisis from high dependence on imported non-renewable energy resources due to continuous depletion of domestic energy reserves with a significant increase in electricity demand. The estimated reserve to production ratio for oil is 4.1 years, while it is 12.5 years for natural gas and 100 years of coal. One of the possible solutions to reduce the Thailand's reliance on imported (fossil) energy is to increase the production of renewable energy, such as from solar, wind and biomass resources. In Thailand, there is a significant potential for distributed solar in the urban environment. However, due to, the high capital costs of solar installation and the lower level of awareness of green energy, the solar PV installation rate at residential scale in Thailand is still very low compared to other countries, such as Germany, the United States (U.S.), Japan and China.

This paper focuses on the feasibility analysis of solar PV in residential areas of Bangkok, Thailand by analysing the relationship between electricity demands and solar radiation in order to estimate the feasibility of distributed solar PV in Bangkok. We use this economic analysis to investigate any required policies (e.g., value of solar tariff) related to household income and economic growth that can encourage Thai people to install solar PV. We also compare PV costs to other electricity generator sources, such as coal and natural gas to better understand how to improve solar incentive policies there.

Methods

We got electric loads for residential scale and solar irradiance in the greater Bangkok from the Metropolitan Electricity Authority (MEA) and the Bureau of Solar Energy Development in Department of Alternative Energy Development and Efficiency of Ministry of Energy in Thailand.

We use the PV Watts module in System Advisor Model (SAM) simulation, created by National Renewable Energy Laboratory to study the relationship between electric loads of residential scale in Bangkok and power from solar panels (system output) by inputting 3,000 MW of solar cell, which is the goal of a renewable energy plan enacted by Ministry of Energy in Thailand. Also, we evaluate change in net electric load after PV installation to estimate the impact on the cost of grid electricity.

Another goal of this research is to understand the economics for the residential consumers in Bangkok by analysing their income relative to how much they pay for electricity. We compare current electricity expenditures to the cost of installing solar PV and utility scale electricity generators in order to contemplate appropriate solar tariffs that relate to the economic situation of Bangkok residents.

Results

Load Pattern versus Daily Insolation

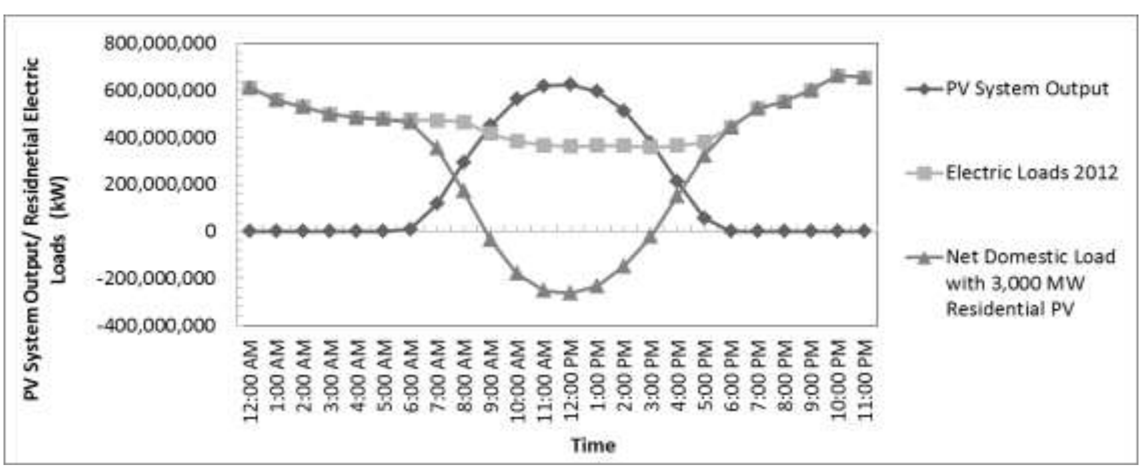

Figure 1. The relationship among power from solar PV, electric loads, and net domestic load with 3,000 MW residential PV in the greater Bangkok

Figure 1 illustrates a typical daily (one-year basis) pattern of power output from 3,000 MW installed solar PV and residential electric loads in greater Bangkok. The peak of power output from PV panels is from 9am to 3pm, while the electric load peak is at night (9 pm until midnight). However, even if the solar PV panels might not totally decrease peak load of electricity uses in Bangkok, they are still useful in terms of lowering electric demands in each day, especially at noon. As shown in figure 1, from 7am to 6 pm, the demands of electricity can be reduced by the power generation from installed solar PV by 24 percent. Additionally, electricity from solar panels, generated around noon, is able to exceed electric demands in one-year basis. When compared to the U.S., Thai electric load patterns are quite different. This difference is due to the fact that many residential-scale electric loads in the U.S. peak in the afternoon (particularly due to air conditioning load in the summer) that somewhat better correspond with solar insolation, while in Thailand the peak in residential electric load is after sundown. Therefore, it is necessary to understand Thailand's electric load pattern related to solar radiation in each season of the year in order to understand the technology and policy incentives that could motivate Thai people to install the PV. Another reason this is important is that future electric load is projected to increase 4.7 percent each year, and PV could play a valuable role in meeting that demand.

Income distribution

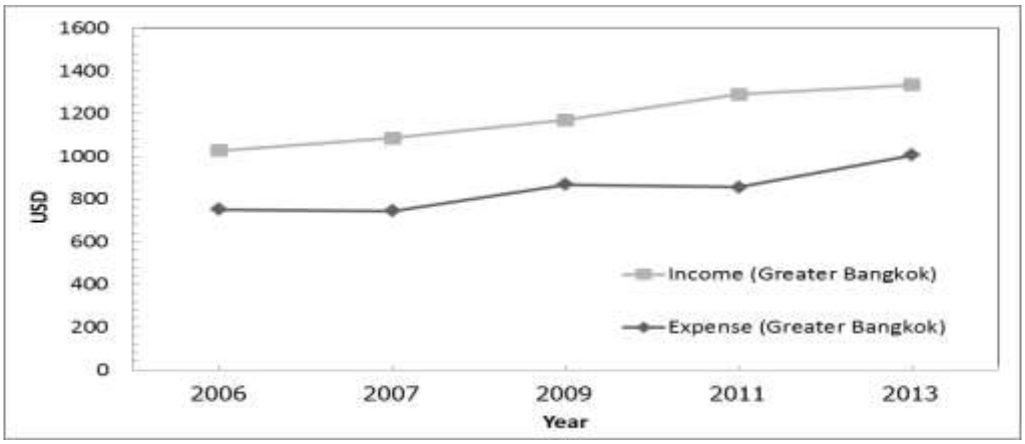

Figure 2. Income and Expense of people in Bangkok from 2006- 2013

In greater Bangkok, populations have higher income and expenses (on all items) compared to the whole country. As shown in figure 2, income per person is approximately $1,000-1,400, while expense is around 75 percent of their income. Thus, most people in Bangkok tend to save a considerable portion of their income every year. Approximately 3 percent of household expenses are for electricity payment. It is possible that people in Bangkok might not be interested in decreasing electricity costs compared to other expenses that account for more than 90 percent of their total expenses.

The installation costs of residential- PV in Bangkok are near $2.0/W, and average loads per household per month are around 400 kWh. Thus, installing PV that generates 400 kWh/month in Bangkok area should cost around $8,000. This is much higher than household incomes and also savings. Normally, installation costs of solar PV are higher than other sources, including wind, coal and natural gas. Today, the Thai government uses Feed-in Tariff (FIT) system as a policy to promote power generation from solar. However, it is very important to use other financial incentives, such as tax credit, along with FIT to increase solar PV installation rates in Bangkok. Different policies might be suitable with different group of people. For instance, tax credit seems to be appropriate with high income tax payers, who might be interested in reducing their tax payments, while low income tax payers might be interested in FIT or low interest rate loans since they needs these incentives to reduce capital costs for solar PV investment.

Conclusions

Electricity load pattern in Bangkok is quite different from other countries, such as the U.S., because peak loads are at night instead of afternoon. Peak solar radiation and electric loads are not correspondent; however, generating electricity from solar PV is another possible way to secure energy situation in Thailand by decreasing load consumption in each day. Before promoting solar installation, the Thai government needs to understand people's income and expense trends in order to adjust financial incentives for each group of people in Thailand properly. Without solar tariff, PV installation rates in Thailand might not be able to increase due to high installation costs that Thai people cannot afford them, even if Thai people tends to have their savings every year.

Reference

Chaianong, A., Pharino, C., 2015, Outlook and challenges for promoting solar photovoltaic rooftops in Thailand, Renewable Sustainable Energy Reviews, v. 48, p. 356-372.