Determination of Technical and Economic Potentials of Rooftop PV in Thailand

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20 June 2019

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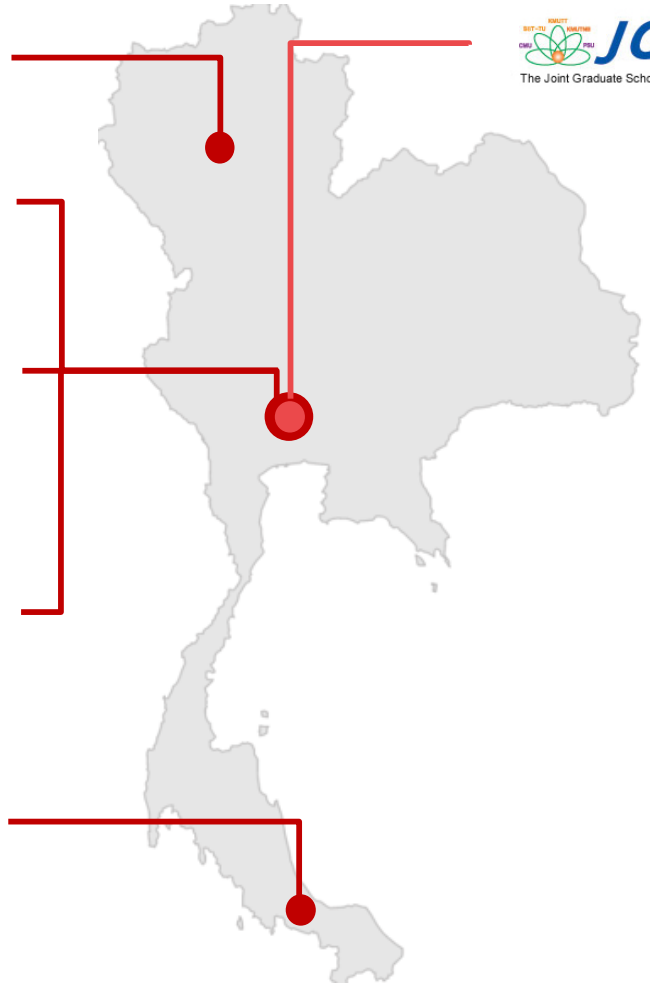
Prince of Songkla University (PSU)



JGSEE
The Joint Graduate School of Energy and Environment

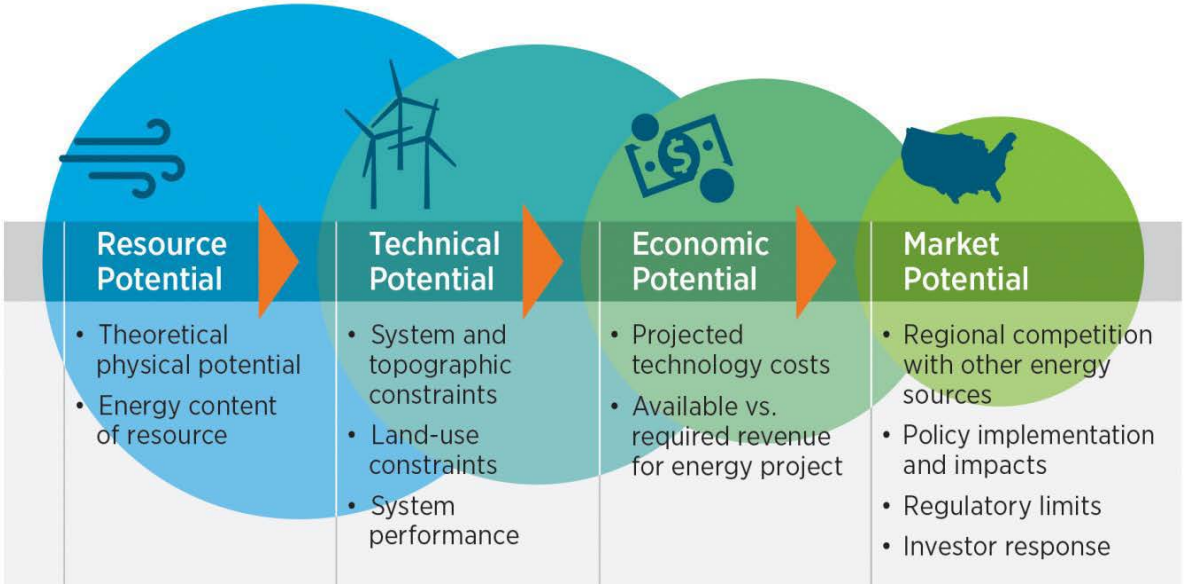
CEE PERDO
Center for Energy Technology and Environment

Who we are

A consortium of 5 universities led by KMUTT with aim to enable high profile Master and Doctoral researchers through the research and profession based higher education.

Established in 1998, later (2000) as the Center of Excellence on Energy Technology and Environment supported by ADB, EPPO and OHEC-Ministry of Education

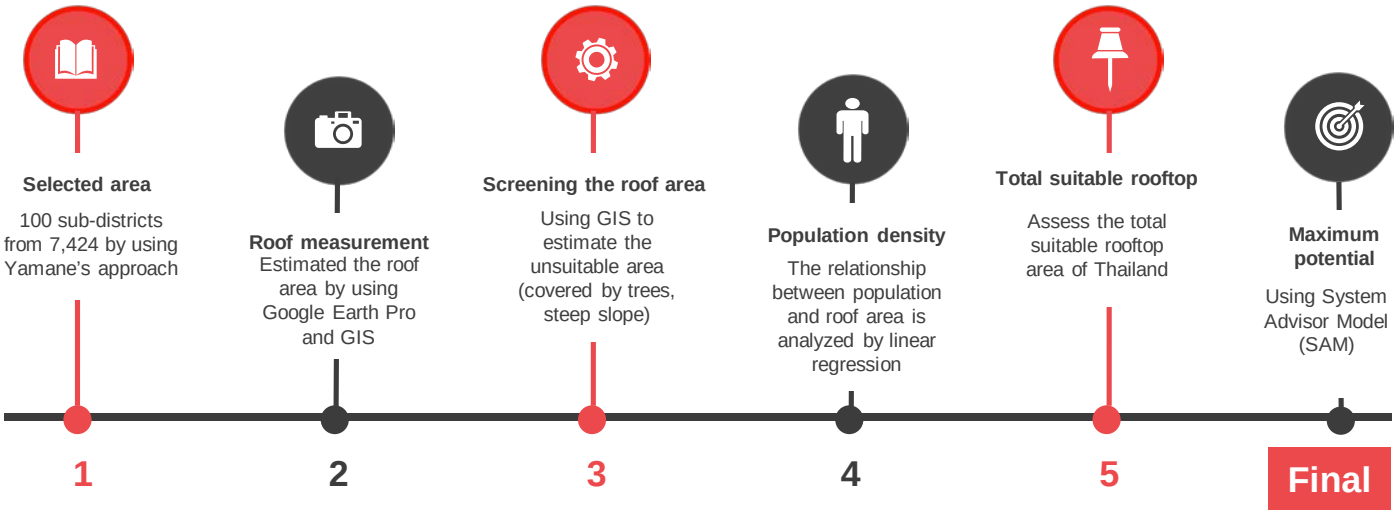
Types of renewable energy potentials



Source: “Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results.” Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-64503.

Technical potential

Methodology



Sample size

$$n = \frac{N}{1+Ne^2}$$

Yamane's formula

At 90% confidence level
100 sub-districts will be randomly selected from the total 7,424 sub-districts

n is number of samples
N is total populations
e is the the confidence level

Total Thailand area = 513,120 km^2

77 Provinces

928 Districts

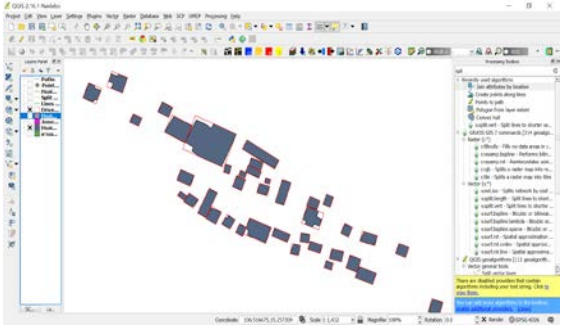
7,424 Sub-districts

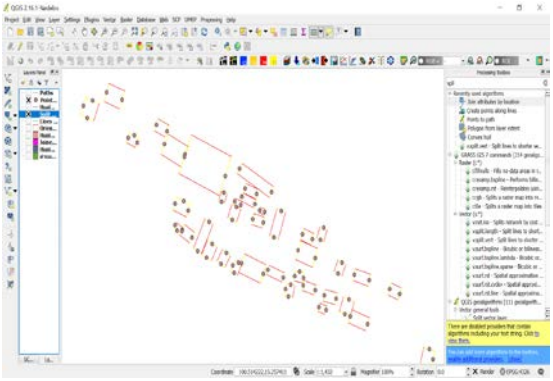
25,233,077 Registered households

65,931,550 Persons

Department of Provincial Administration (DOPA).

Roof area measurement





01 Add building polygons and create the optimum bounding boxes

02 Convert all building boxes to line figure, create object ID and separate them by the vertices

03 Select the shortest length and create two points along each line then calculate the the starting coordination points

04 Identify lower points then insert a line between them by using point-to-path tool

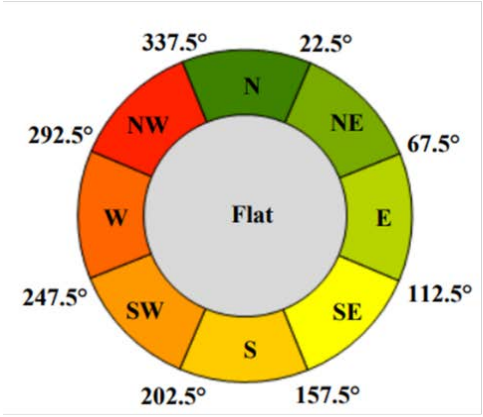
05 Calculate the azimuth of each line and create the azimuth attributes of each building by joining the attributes at each location

06 Use the GIS program to calculate the azimuth of each roof

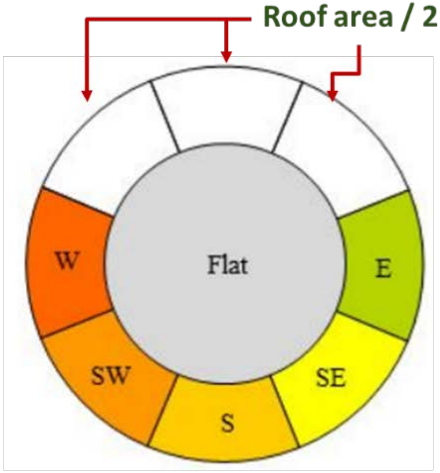
07 Determine the azimuths of the roof plane by using Python programming below

```
df_tmp['Azimuth_Roof']     = np.where( (df_tmp.AZIMUTH <= 90.5) , 270+df_tmp.AZIMUTH, df_tmp.AZIMUTH)
df_tmp['Azimuth_Roof']     = np.where( (df_tmp.AZIMUTH >= 269.5) , 90+df_tmp.Azimuth_Roof, df_tmp.Azimuth_Roof)
df_tmp['Azimuth_Roof']     = np.where( (df_tmp.Azimuth_Roof >= 360) , df_tmp.Azimuth_Roof - 360, df_tmp.Azimuth_Roof)
```

Screening for suitable roof areas



Nine azimuth classifications



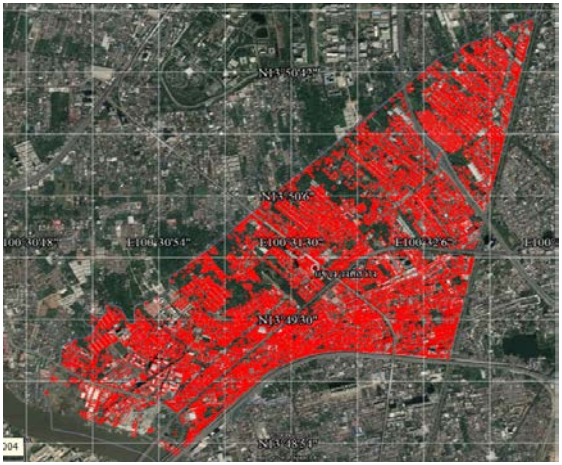
Rooftop azimuths included in final suitable planes data set

Source: Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment, NREL, Jan. 2016

Results

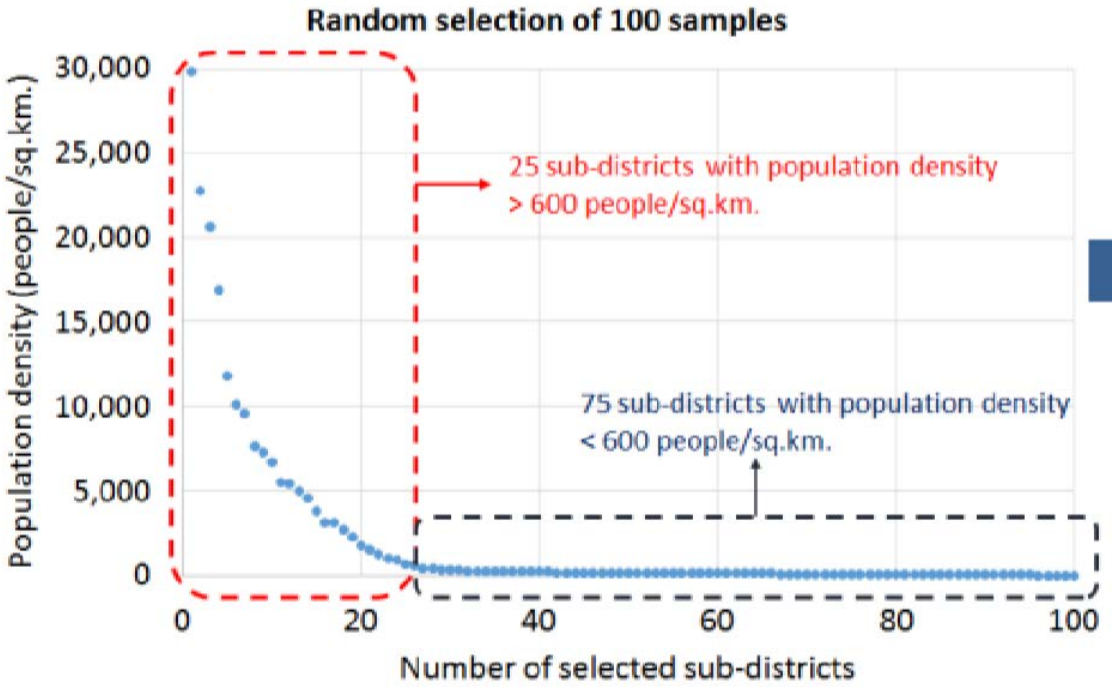
Roof area of Pom Prab sub-district

Bangkok City



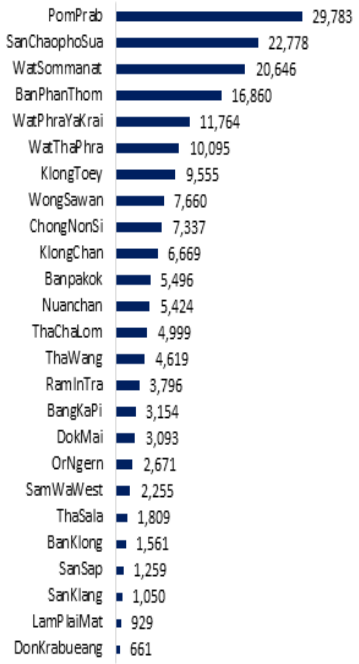
Roof Area of Nong Bua Ban sub-district

Chaiyapoom City

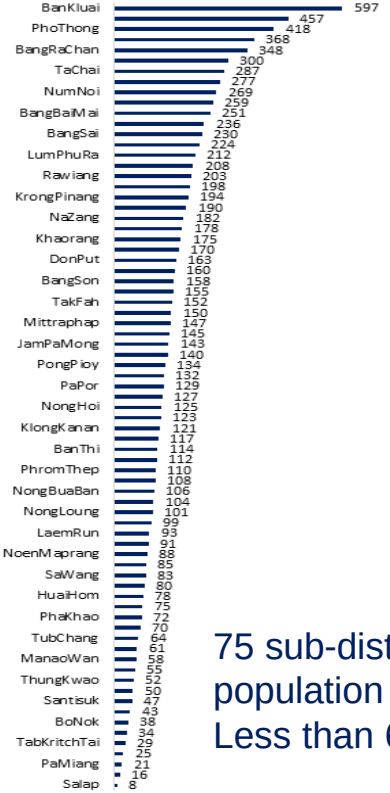


Source: Preliminary result for stakeholder review: Thailand Grid Renewable Integration Assessment (IEA, 2018)

25 sub-districts with population density more than 600 people/sq.km.

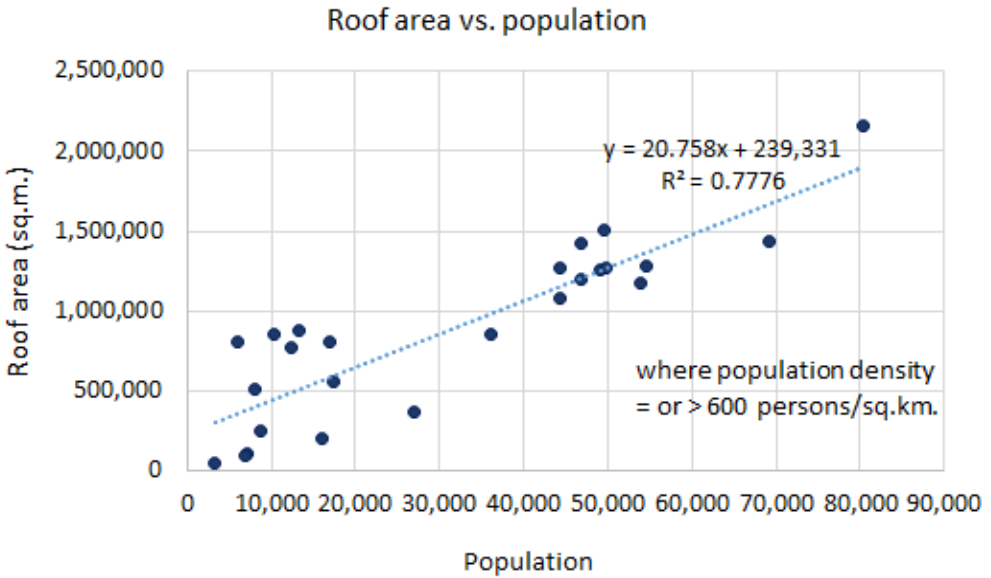


Population density ≥ 600 people/sq.km.



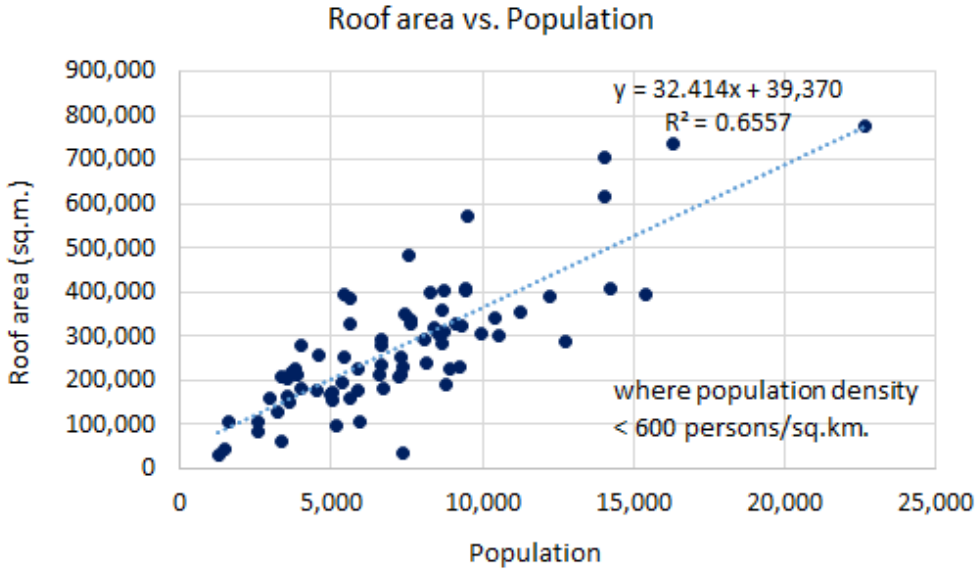
Population density < 600 people/sq.km.

75 sub-districts with population density Less than 600 people/sq.km.



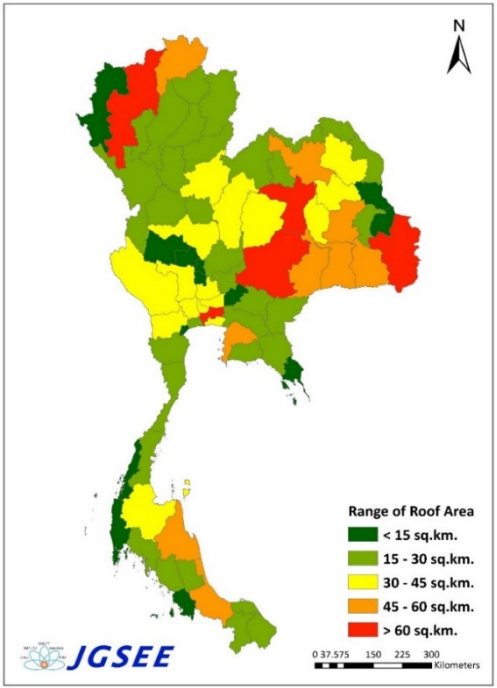
The fitted line plot shows the relationship between the roof area and population where **population density ≥ 600 persons/sq. km.**

Estimated roof area = (20.758 x population) + 239,331



The fitted line plot shows the relationship between the roof area and population where **population density < 600 persons/sq. km.**

Estimated roof area = (32.414 x population) + 39,370



Source: Preliminary result for stakeholder review: Thailand Grid Renewable Integration Assessment (IEA, 2018)

The total suitable roof area for PV installation in the whole country was estimated to be 2,383 km^2.

Bangkok has the most suitable roof area of about 158.82 km^2.

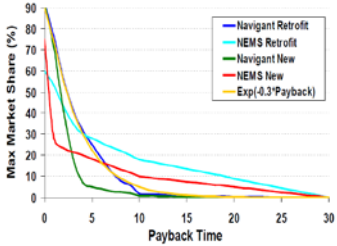
Bangkok,
Nakhon Ratchasima,
Ubon Ratchathani and
Khon Khaen
were estimated to have the greatest roof-top surface area available for PV installations.

The total gross maximum technical rooftop potential is estimated at 2 383 km^2. Even if only 10% of this potential were used, over 38 gigawatts (GW) of distributed solar PV could be installed, more than the current peak demand of the Thai power system. This analysis thus indicates that rooftop area is not a relevant constraint for the buildout of DPV in Thailand. However, other constraints, in particular, the technical ability of the distribution grid to host large amounts of solar PV, may lead to a lower potential estimate.

Economic potential

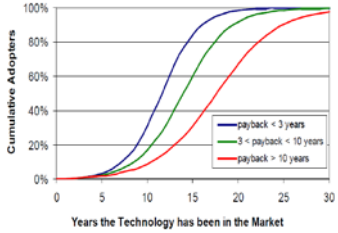
NREL's System Advisory Model

Load profile, Weather data, technical parameters and economic/financial parameters that based on Thailand's market



Beck's equation

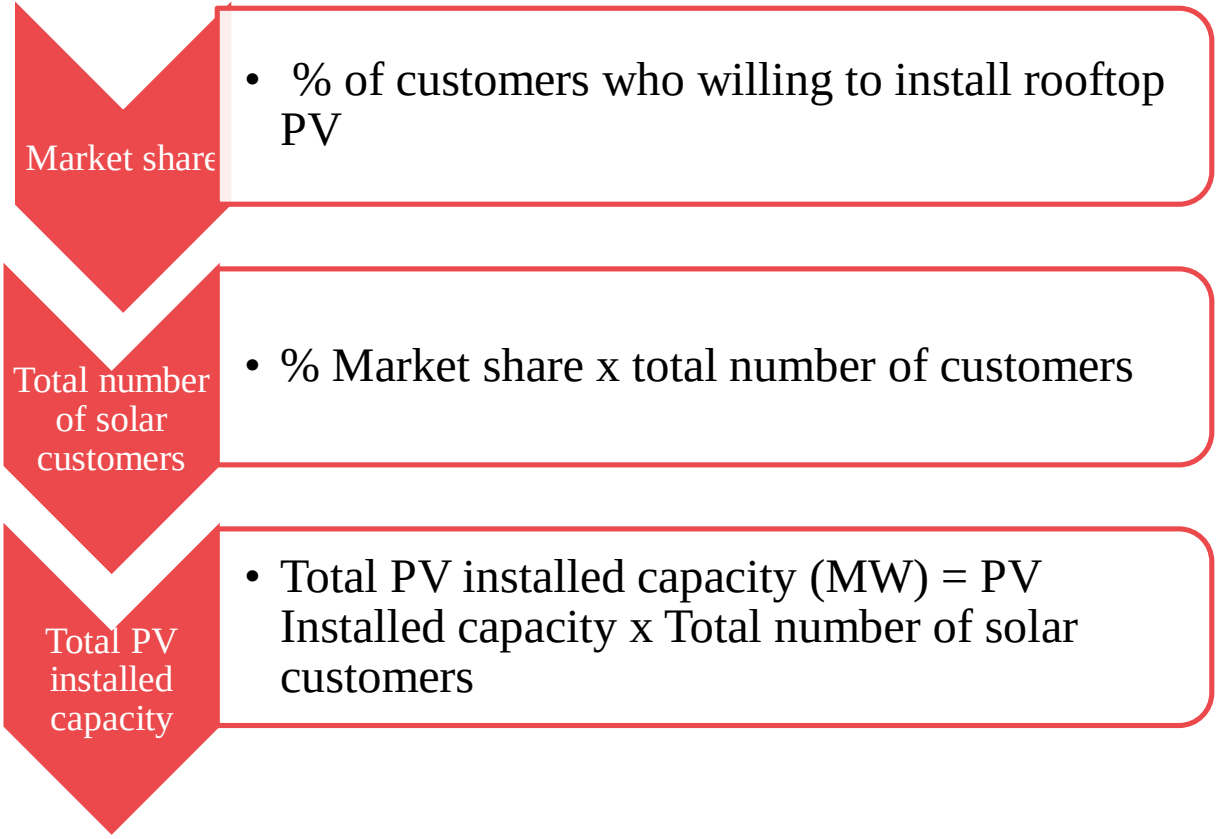
$$Maximum\ Market\ Fraction = e^{-Payback\ Sensitivity\ *\ Payback\ Time}$$



Bass Diffusion Model → 90% saturation at the end of AEDP

- Cost/Benefit components came from literature review and stakeholder interview
- All assumptions were selected based on current PDP/AEDP or utilities' report/website

From % market share to maximum PV capacity (MW)



* Note: Res and SGS = 5 kW, MGS = 100 kW, LGS = 1,000 kW

https://webstore.iea.org/partner-country-series-thailand-renewable-grid-integration-assessment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