Meeting Renewable Energy Targets: Accurate resource data as fundamental industry driver

Iban Vendrell, Programme Leader, Mott MacDonald

17th June 2015, ACEF, Track 2: Renewable Energy

Mott MacDonald

Presentation Overview

- Context and challenges for appropriate government incentive definition
- Overview: Solar Resource Characterization
- Case Study: Mott MacDonald study results: Independent Solar Energy Yield Assessment in the Philippines
- Conclusions and recommendations, relevant both to solar power and other renewables

Mott MacDonald

Mott MacDonald Introduction

16k

staff

We work in

140

countries

£1bn

turnover

Employee owned

Mott MacDonald

Context and Challenges

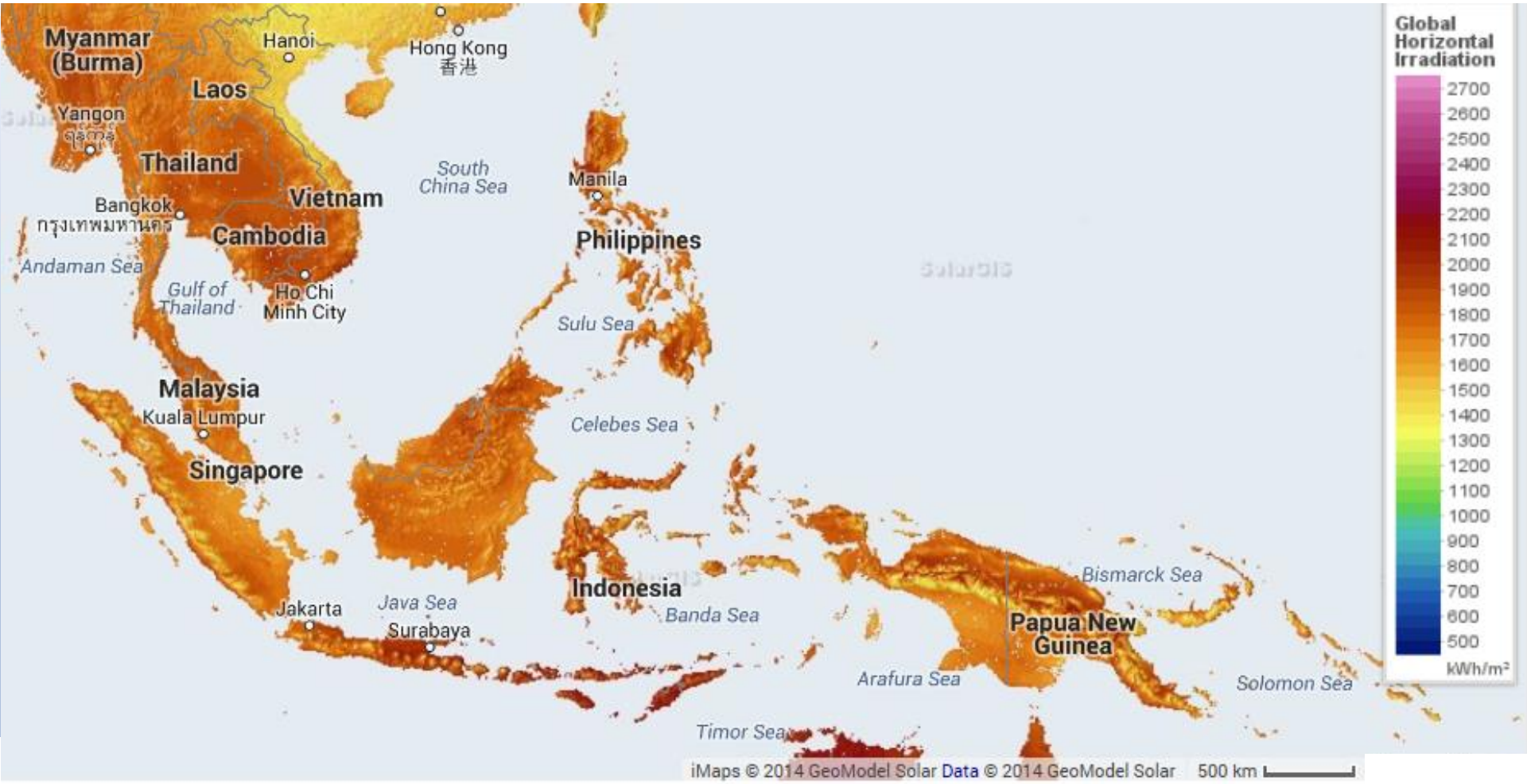
- Definition of appropriate tariff support mechanisms are instrumental to meet national renewable energy targets
- Tariff calculations driven by cost and revenue potential, with the latest driven by variable renewable resource production
- Optimal characterization of resource and estimation of system energy production are instrumental to confirm adequate tariff structure and to justify individual project viability

Challenges

- Limited measurement data for resource characterization
- Using consistent metrics for plant technical assumptions and capacity factor ratio estimations for tariff calculations

Mott MacDonald

Regional Solar Irradiation Profile



Mott MacDonald

Solar Irradiation Data Sources

Gathering Data

- Terrestrial versus satellite data sources – fundamentals
- Available data sources in region (e.g. MeteoNorm, SolarGIS, 3Tier, National Meteorological Agency,etc)
- Availability of ground measurement stations in region
- Site meteorological station for accurate long term prediction (pyrometers, reference cell)

Data Analysis

- *Correlation/verification of two independent sources of Irradiance data e.g.*
  - *National Meteorological Agency, SolarGIS, etc*
- *Independent Energy Yield Analysis, using:*
  - *In-house modelling*
  - *off-the-shelf software (PVSYST)*

meteonorm 3TIER solargis

Mott MacDonald

Solar Irradiation Selection Considerations

- Available irradiation data accuracy varies significantly across the region
  - Countries with more complex topography subject to higher variations in irradiance conditions
  - Long-term, quality-controlled pyranometer measurements close to the site (e.g. within 20 km) the best possible irradiance data source, but rarely available
- Satellite-derived irradiation data an essential tool, but only subject to suitable validation
  - Validation must be for ground measured data in a similar climate to the Project site, and ideally located close by

Mott MacDonald

Philippine Irradiation Data Selection: Key Questions to Address

- PAGASA data is short-term
  - Representative of long-term?
  - Consistent with other data sources?
- Satellite-mapping shows irradiance at any location in the Philippines
  - Modelling accuracy?
  - How to validate?

Mott MacDonald

DC Capacity Factor Results, 1 MWp PV plant

Areas	Annual Average Irradiance (kWh/m^2)	Initial PR (%)	Plant Energy Yield (MWh/year) Year 1	Average DC Capacity Factor, Years 1-20	Average AC Capacity Factor, Years 1-20
Luzon 1	1,799.3	79.9%	1,433	15.4%	17.8%
Luzon 2	2,066.5	79.3%	1,634	17.6%	20.4%
Visayas 1	1,899.2	79.1%	1,498	16.1%	18.7%
Visayas 2	1,655.5	79.6%	1,314	14.1%	16.4%
Mindanao 1	1,991.8	79.0%	1,569	16.9%	19.5%
Mindanao 2	1,862.1	79.5%	1,476	15.9%	18.4%
Average				**16.0%**	**18.5%**

$$Capacity\ factor = \frac{Actual\ energy\ output}{Installed\ capacity\ x\ 8{,}760}$$

Mott MacDonald

Study Results – Capacity Factor

- Average P50 lifetime capacity factor:
  - DC basis: 14.1-17.6%
  - AC basis: 16.4-20.4% (can raise with plant design)
- Operating plant DC capacity factors:
  - 15.0-16.5% during the first operating years, per range of 15.0-18.7% estimated by this study
- For P90 case typically used for debt financing, lifetime: DC capacity factor of 12.9-16.0%

Mott MacDonald

Summary of Case Study Outcomes

- To justify tariff structure, the Philippine ERC referenced a US study in which a 22% capacity factor from international PV plant operating experience was stated, and proposed to apply for solar PV projects in the Philippines
- Our independent study identified capacity factors in the range 14.1-20.4%, depending on definition and design
- The case study illustrates how poor resource data and large variations in country-wide resource can lead to both inappropriate policy and misdirected project siting
  - Undermines the ability to meet national targets
  - Discusses mitigation actions that can be taken

Mott MacDonald

Parallels with other Renewables

	Solar	Wind	Bioenergy	Geothermal
National level measurements	Irradiation measurements at national meteorological (met.) stations	Wind resource measurements at national met. stations and airports	Agricultural statistics and survey data	Geological , geophysical, and geochemical characterization of area or field
Global simulations / databases	Satellite-derived irradiation modeling (public and private)	Reanalysis datasets (public) and meso-scale models (private)	Only relevant in case bulk international imports viable	Reservoir modelling on a case by case basis
Project sites	Unusual for PV; ≥ 1 year for CSP	≥ 1 year of met. mast data	Local market study	Independent resource assessment verified with well data

General Recommendations for Renewables

- Derive CUF from optimized resource characterization at national/regional level using a combination of resource simulation (e.g. national level mapping) and available measurement data
- Increase ground resource mapping and validation of simulated resource data to reduce typical spatial variability e.g. due to topographical and climate regional characteristics
- Consistent capacity factor definitions are adopted for calculations of tariff structure

Mott MacDonald

Mott MacDonald

Thank you for your attention

References

- **“Independent Solar Energy Yield Assessment, select Philippine PV plant sites”**, ERC Public Hearing , Key note presenter, Manila, 28 January 2015. Phil Napier Moore.
- “**Solar PV Technical Guidelines for Financiers: Techno-Commercial Risk Mitigation for grid connected PV systems in Southeast Asia**”, Deutsche Gesselchaft für Internationale Zusammenarbeit (GIZ) GmbH & Renewable Energy Support Programme for ASEAN (ASEAN-RESP), 1 October 2014. Vendrell, I;. Korsakul, R.; Verojporn, S.; Smithtinand, P.; Indradesa, P.
- “**In-field performance of a polycrystalline versus a thin-film solar PV plant in Southeast Asia**”, Photovoltaics International - 22nd Edition, 18 December 2013. Verojporn, S.; Napier-Moore, PA.
- “**Gaining confidence in PV module performance through laboratory testing, factory audit and analysis of in-field data**”, POWER-GEN Asia, Bangkok, October 2012. Napier-Moore, PA; Verojporn, S.
- “**Concentrating solar power compared with flat-plate collectors: Why South-East Asia's largest solar plant uses thin film PV technology**”, Energy, Volume 164 May, Issue EN2, Proceedings of the Institution of Civil Engineers, May 2011, Napier-Moore, PA.

Mott MacDonald