

Solar and Off-Grid Renewables Presented by Sarah Fairhurst 30th November 2016



General trend in power prices

How renewable costs compare to wholesale prices

Outlook for wind and solar farms

Case study: Philippines



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What is the wholesale price of power in each market?

- Philippines has a spot market but is that really the wholesale price of power?
 - The majority of the power sales in the Philippines market are transacted under Power Supply Agreements (many of which are very long term)
 - Such PSA's are approved by the regulator (ERC)
 - Each PSA may have a different price, as the PSA's are approved on a "cost-plus" basis rather than a "mark to market" basis
- Indonesia and Thailand have no market, making determination of the wholesale prices much harder
 - Both markets are Single Buyer model markets, which means that a Single Buyer (or in the case of Thailand, two buyers) purchase all the power generated by the private sector for supply to customers
 - Contracts for supply of power are signed up after competitive tenders or negotiations and the price of power may differ under each contract



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Wholesale prices in the Philippines can be represented by the spot market there, the WESM, which can be volatile



Note: * Buying price of spot energy (with 100% net settlement surplus); ** ERC has ordered (case no. 2014-021MC, dated 3 March 2014) re-calculation of WESM prices in Nov/Dec 2013. Source: PEMC; TLG analysis

The WESM is a bidding market – prices reflect competitive dynamics as much as fuel prices...

- Since mid 2016, WESM prices have exhibited a general downtrend, and on a rolling 30-day average basis currently sit around 2.25 to 2.50 PhP per kWh
- The uptick in coal prices has had no manifest impact on WESM prices, likely due to the fact that it has coincided both with:
 - Lower seasonal demand
 - Several recent coal-fired capacity additions (SLPGC U2, Anda, PEDC Expansion, Palm Concepcion U1, amongst others)



Development of Luzon Ex-Post LWAP prices

- Historically, there has been a better linkage WESM prices and oil prices (not coal), largely due to the impact on peak prices via distillate and diesel-fired peaking generation
- Prices in Luzon are generally more resilient to the oversupply dynamic that the Philippines is heading into. We are though beginning to see noticeable regional divergence in certain sub-grids (Negros and Panay) due to the combination of increased solar, relatively large coal-fired plant additions, and limited transmission capacity



An alternative view of wholesale prices in the Philippines comes from the generation cost component of retail tariffs



- This is a blend of purchases under long term power agreements (some of which were signed before the start of the market) and purchases from the WESM
- WESM purchases have fallen since Oct 2013 after some high prices (which were since adjusted downwards by the regulator)

Thailand's power prices have moved up since 2010 largely driven by fuel costs

- But have eased in the last 18 months on the back of the falls in commodity prices
- In Thailand there are three adjustments to power prices per year or every four months via the Fuel Transfer (FT) mechanism
- Occasionally the full pass-through is not approved – usually when fuel prices are rising and only some of the uplift is passed through
- But the difference is made up in later periods
 usually when commodity prices are falling



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Indonesian wholesale costs are driven by forex movements But wholesale prices are entirely separate due to the large subsidies

- Prices are subject to approval by Parliament, Sub-committee seven
- Prices are not cost reflective for all users and a large payment from the government to PLN covers its 'public service obligation'
- Power prices have almost caught up with PLN's costs, but PSO payment still large.
 - Minister of Finance Regulation Number 170/PMK.02/2013 dated November 28, 2013 sets mechanism for PSO payment and includes seven percent margin above costs for PLN
- Subsidies have declined due to gradual increase in power prices especially to industry and commerce coupled with fortuitous decline in price of fossil fuels
 - Our analysis indicates that a further 10 to 15 percent lift to PLN's average power price would eliminate the need for a PSO subsidy

Indonesia average end user power prices



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Which wholesale price should we use? Average, marginal or other prices?

- In comparing solar (and wind) costs to wholesale prices, it's important to know what to compare to
 - Average costs are a reflection of historic decisions; essentially they reflect sunk costs
- When making decisions about the next increment of capacity, marginal cost are the ones to use
 - What is the marginal cost of the competing option that is, what would otherwise be installed to meet the demand?
- For economic entry, renewables can be treated just like any other source of power but adjusted for the time when the resource is used
 - For solar, this means comparing with alternative option during daytime hours
 - For wind this means comparing with alternative options during the times wind is available, which varies by geography



On a historical cost basis, it's hard to make solar look attractive



Residential energy costs across Asia as of Nov 2016 US¢ per kWh



Industrial energy costs across Asia as of Nov 2016 US¢ per kWh



The charts show estimates of the generation cost component of various tariffs across Asia



However, average costs can differ considerably from the marginal costs of different alternative options





Solar may break even against new CCGT at some load factors

- Thailand's peak demand is a midday peak
- Thus solar is ideally positioned to compete for that load against gas fired CCGTs, the traditional peak supplier
- In the diagram we assume
 - the marginal fuel for CCGTs is imported oil linked LNG (at USD60/bbl) and include regasification and transmission costs
 - The capex for utility scale solar is USD 1.4 per watt and add on balance of system costs as well
- Solar PV can under cut LNG fired CCGTs between 10 to 20 percent capacity factor. During very peak periods Thailand tries to use hydro

RLNG fired CCGT versus solar





Solar is less attractive in mainstream Indonesia

- The peak load in most of Indonesia is not midday but in the early evening
- This means we have to compare solar against the marginal fuel used during the day, which is typically coal on the larger islands running at high capacity factors
- Solar PV cannot compete against a locally built coal plant using domestic coal at base load
- Clearly, in smaller islands served by diesel generations, the calculation is very different



... But in Indonesia location matters and finding niche locations served by higher cost fuels is the key to success



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Philippines LCOE solar versus New CCGT and Existing OCGT





- Philippines peak demand during the afternoon
- Similar to Thailand, solar is likely to compete against CCGT to generate in the mid-merit to peak period
- Existing solar LCOE is very competitive against new CCGT unless dispatch profile of CCGT go beyond 55%



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For rooftop solar, its utility tariffs (not wholesale costs) which are the key drivers



Commercial tariff costs across Asia as of Nov 2016 $\mathsf{US} \varepsilon$ per kWh

Residential tariff costs across Asia as of Nov 2016 US¢ per kWh



Industrial tariff costs across Asia as of Nov 2016 US¢ per kWh



There are additional factors such as tariff structure to take into account, but prima face this makes a strong case for rooftop installations in Thailand and Philippines



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- Thailand and Indonesia have ratified the Paris COP21 Agreement
- Philippines, to date, has not
 - The Philippine president has required each of his Cabinet members to sign a letter confirming they agree with ratification most have done so and Duterte has indicated (7 November) that he will ratify the treaty
 - The Energy Secretary was one of the few members who did not sign citing (in a recent conference) that he needed flexibility to deal with the need for energy to promote economic growth

So the market that has not yet ratified COP21 is the most attractive for real projects right now – surely it is time to forget subsidies and drive renewables where they are most economic?



Thailand should be meeting the midday peak with solar....

- The next round of solar build in Thailand is awaiting a solicitation
- The peak demand in Thailand is a mid-day commercial/industrial peak and that co-incides with the peak time for solar generation
- The marginal fuel in the grid power system is LNG into new build CCGTs
- Therefore there is a case that on a purely economic basis solar could be the purely economic choice for serving midday peak
- So no negative effect on overall power prices from more solar in the fleet mix
- The rice farmers are losing money producing rice why not lease out their land to solar farms?
- Regulators, what are you waiting for?



MEMR has released new regulation on the purchase of electricity from solar power plants....

- Ministry of Energy and Mineral Resources (MEMR) has released Reg No. 19/2016 in July 2016 to replace the old Regulation No. 17/2013
- Main draw out from the new regulation:
 - Capacity quota system will be introduced to each region which ultimately set by the MEMR.
 - Feed-in-tariffs vary by region
 - Move from the auction based competitive tender process to a three-step process on purchase of PV electricity by PLN
 - Standardised the power purchase agreement (PPA) issued by the PLN
- Contrary to Reg 17/2013 which sets one FiT for all regions, Reg 19/2016 has proposed different FiT for different regions. FiT ranges from USD 145/MWh to USD 250/MWh
- A 200MW capacity quota has set in the regulation in which 150MW has been assigned for the development in Java-Bali

....which is all very well, but who is going to pay for it?



Should Indonesia, a place that struggles to afford conventional power, really be adding to the costs of the system at these rates?





Indonesia needs to fix its' market before it tries to build renewables

- The subsidy system in Indonesia is strangling PLN and undermining efficient investment and sensible electricity use
- Our analysis is that if PLN could raise power prices rises to breakeven then it would be more open to a larger quotas for solar and wind and especially geothermal
- A ten to fifteen percent increase in the average tariff would enable PLN to reach this positive tipping point of breakeven
- That said for much of Indonesia the peak demand is an early evening peak for which (pending the battery revolution) solar is of little help



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We have tested what this might mean using our QUAFU model which simulates the operation of the WESM

QUAFU model framework



 QUAFU is an integrated generation dispatch modelling tool that incorporates state-of-the-art optimisation theory grounded in proven techniques

Comparison of actual vs. estimated quarterly average Luzon LWAP (2009-2015 Q2)



 QUAFU can reflect historical outcomes from bottom-up back-cast relatively well without resorting to 'over-fitting' by just taking into account actual demand, fuel prices and major outages



In a project for the Philippine Solar Alliance early in 2016, we looked at the potential for solar build in an unconstrained environment at various oil prices



Cumulative solar build in Luzon (from 2016)

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A more recent project, which is more realistic because it includes some constraints on ancillary services etc, shows lower solar build and occurring later

Luzon capacity additions & annual average prices





If coal is prevented from the fuel mix (an unrealistic scenario in its entirety) we see much earlier solar because prices increase due to higher gas costs

Luzon capacity additions & annual average prices





Changes in regulations that may impact on the wholesale price: Philippines

- RCOA (Retail competition and open access) is being pushed down to smaller customers
 - This will allow more customers to bypass utilities and buy directly from competitive retailers which include arms of existing utilities as well as generators and other players
 - It should increase the competitiveness of pricing to these customers, as retailers will have incentives to purchase and package least cost wholesale contracts (and spot purchases) rather than focusing solely on what can gain regulatory approval
 - Overtime this will increase the convergence of the wholesale spot market and the market for contracts
- CSP (Competitive Selection Process) is a new directive whereby utilities are required to run a CSP to purchase all new power supply agreements
- Implementation as been poor so far:
 - The start date was pushed back from November 2015 to end April 2016, and thousands of MW of PSA's (reportedly over 90 contracts) were submitted to the regulator immediately prior to the deadline
 - The number means that there is almost no room for new contracts for some years
 - Some CSP processes have been undertaken to date mostly using a "Swiss Challenge" approach with various shortcomings such as poor notice of the process and insufficient time for competitors to respond





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