ASIA-PACIFIC
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Instructions to Abstract Authors

2018 Key Dates

Submission of Abstracts due:	**Monday, 16 July 2018**
Notification of abstract selection to authors:	**Monday, 13 August 2018**
Papers due for peer review:	**Monday, 15 October 2018**
Feedback from reviewers to authors:	**Monday, 12 November 2018**
Final paper submission due from authors:	**Monday, 26 November 2018**

Your contribution will not be formally accepted and scheduled, until you have registered your attendance at the conference.

Please indicate by ticking which stream/s best fits your abstract

	STREAMS Topics listed are a guideline only. Submissions in related areas are welcome
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√	**Deployment & Integration** *Renewables integration, policy and regulation* *Forecasting and Resource assessment* *Minigrids and Community owned Renewables* *Field experience, performance, yield and reliability* *Distributed Energy Resources, EVs and Low emissions transport*
√	**Solar Heating and Cooling, Low Carbon Living** *Energy Efficiency and Demand Management* *Housing and appliances* *Solar heating and cooling including heat pumps* *Cities and Communities* *Competing with gas in the domestic & commercial market*
☐	**Concentrating Solar Thermal** *Fundamentals and components* *Storage, systems and power cycles* *CSP integration, design and modelling* *CSP and high temperature processing*
☐	**Solar Fuels & Chemistry** *Storage* *Hybrids, complementary solutions and discrete applications* *Fuels and chemicals from electricity and heat* *Energy for heavy industry*
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Modelling of Isolated Solar PV Households with Battery Energy Storage

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The paper describes the modelling of one isolated or two interconnected households based on Indonesian energy and demand data with all electricity supplied by 300 W solar panels and lead-carbon batteries. The research was funded by the Australia-Indonesia Centre to support electrification of remote areas of Indonesia but the work methods developed would also be readily applied elsewhere.

- Design Concept

The model combines Indonesian survey data on the relationship between domestic energy consumption and income, and published information on the use of energy for various domestic services to build a stochastic model of potential electricity demand for typical work and non-work days. The profile of appliance use is derived from an assumed pattern of household activities on work and non-work days and an association between household activities and appliance use. A set of seven domestic activities was assumed with different probabilities by hour of the day. The activities and appliance ownership for 20 levels of energy consumption from 10 kWh to 200 kWh per month were developed as case studies. Six of these were fully simulated to test the method.

Solar power was represented using trigonometric equations of panel location and orientation, the parameters of which were fitted to daily energy demand from a published source at a Jakarta location from pvoutput.org. Solar energy was represented as randomly modelled daily energy production based on the published data. The daily energy was then distributed into half-hourly production using an autoregressive simulation method to approximate the target daily energy.

- Modelling and Design Evaluation

An optimisation algorithm was designed to simulate multiple sampled years of the load and solar production half-hourly to find the least cost combination of solar panels and lead-carbon batteries. The cases ranged from 10 kWh to 200 kWh per month of electricity consumption. Unserved energy and deferred use of appliances was also valued at USD5.0/kWh and USD2.5/kWh respectively so that an optimal level of reliability could be assessed relative to these values. The model was formulated in Excel with Visual Basic Programming to simulate the multiple years.

The best design for each of the first 15 years of service was found allowing for 3% per annum linear battery degradation and replacement after 10 years and for 1% per annum solar panel degradation. Average electricity demand was assumed constant over the period in each case. The best single configuration of solar panels and battery size was found from the best solutions for each year by direct evaluation of each design. The confidence that the best design had been identified among the candidates and the confidence range for the total cost were used to choose how many random simulations were needed up to 100 simulations.

- Maximum interconnection distance

The single house designs were then adjusted by modelling two houses connected by a 23kW 200V AC single phase rated cable of 100 m length to assess how much of the solar/battery installation could be avoided due to the benefits of interconnection. This was tested for all combinations of the 6 levels of energy consumption by comparing the cost of supplying the two houses with the interconnection and the avoided cost of separate operation. By this means the maximum distance within which the houses could be economically connected was calculated assuming 40 year life for the interconnection, no demand growth and annualised costs for the solar panels and batteries evaluated for the first 15 years of operation.

- Results for isolated houses

The single house solutions showed costs ranging from USD0.49/kWh to USD1.40/kWh and a fairly consistent relationship between cost and average monthly energy consumption that could be fitted with a double exponential function as shown in Figure 2. They also showed consistent

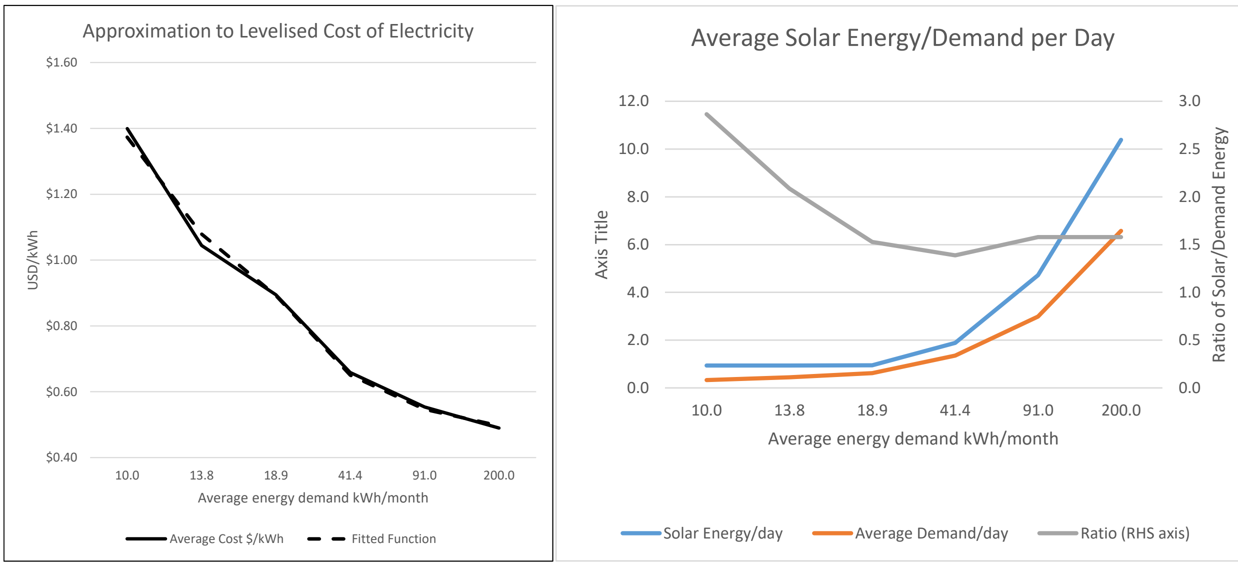

Figure 2 Cost of electricity and ratio of average daily solar yield to daily energy demand

relationships between battery capacity and peak demand and between daily average solar yield and the average daily energy demand, the latter shown in Figure 2. The unserved and deferred energy was able to be represented as a simple exponential function of the design parameters so that designs could be evaluated for other levels of demand and optimal designs readily developed for all 20 cases based solely on the detailed simulations of the 6 initial cases.

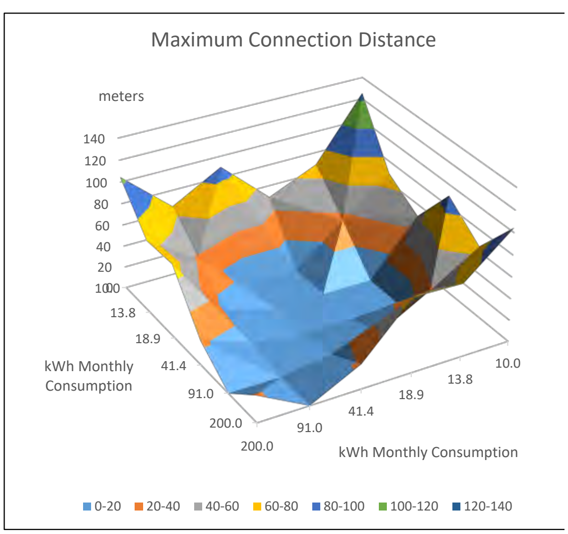

Figure 1 Maximum interconnection distance between two houses

- Results for interconnecting two houses

The simulations of interconnection showed that with the same solar panel orientation on each house consistent with the model of the Jakarta site that houses could be interconnected economically for up to 120 m apart as shown in Figure 1. Other studies also looked at dissimilar solar panel orientation and showed that optimal configurations did not necessarily select the solar panel location with the highest energy yield. The matching of solar production to the timing of peak demand can also influence the best configuration when dissimilar roof orientation is available.