PV BUSINESS IN MINIGRIDS

PV AND UTILITIES WORKSHOP, Bangkok (Thailand)

ASEAN POWER WEEK

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3rd September 2015
People without access to electricity

Source: World Alliance for Decentralized Energy
Possible solution

- Off-Minigrid

- To be considered
  - Technical point of view
  - Business point of view
Benefits about Minigrids

- Technical/operational
  - Improved electrical services

- Financial
  - Improved LCOE for operators

- Social
  - Opportunity for rural enterprise

- Environmental
  - Environmental protection
Risks about Minigrids

- **Technical**
  - Improved electrical services

- **Organisational**
  - Inadequate business models
  - Geographical isolation
  - Supply and installation issues

- **Financial**
  - Appropriate pricing and payments

- **Others…**
Technical point of view
General scheme Mini-grid

- DC BUS
- R S T
- Wind Turbine Grid Connected System
- PV-Grid Connected System
- Battery Bank
- APOLLO MTP-410 series

Components:
- PV Array
- Charge Controller with MPPT
- Wind Turbine Charge Controller
- Generator
- AC Loads in Village
**PV Penetration**

- **Low Penetration < 20%**
  - No specific control
  - Genset (s) run at full-time
  - Photovoltaic energy reduces net load on diesel
  - All PV energy goes to primary load
  - No supervisory control system

- **Medium Penetration 20% - 65%**
  - Continuous Genset Operation
  - Relatively Simple Control
  - PV power limiting (grid-connected inverters)
  - Installations secondary genset units
  - Load shedding

  - Intermittent Genset Operation
    - Without Energy Storage 20 - 40%
    - With Energy Storage 40 - 65%

- **High Penetration 65% to 100%**
  - Sophisticated Control
  - PV power limiting (grid-connected inverters)
  - Installations secondary genset units
  - Long-term energy storage
  - Load shedding
  - Demand-side management

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**PV Business in Minigrids**
Minigrids: types

- Micro (less than 5 kW)
- Small (5-30 kW)
- Medium (30-100 kW)
- Large (100 kW-1 MW)
- Very large (greater than 1 MW)
Real current implementation: very large MG

(PV) = Photovoltaic Module,
(B) = Battery,
(I) = BDI + GCI,
(DG) = Diesel Generator

**Kema**
- 850 kWp (PV)
- 850 kW (I)
- 4,800 kWh (B)
- 1600 kW (DG)

**Bario**
- 905 kWp (PV)
- 1,100 kW (I)
- 3,860 kWh (B)
- 1,443 kVA (DG)

**Banggi**
- 1,200 kWp (PV)
- 2,075 kW (I)
- 2,880 kWh (B)
- 1,650 kVA (DG)

**Tanjung Labian**
- 1,212 kWp (PV)
- 1,650 kW (I)
- 4,320 kWh (B)
- 1,250 kW (DG)

T&C 14-Nov-12

Total Power of INV+DG+PV

**LEONICS**
ADVANCED POWER TECHNOLOGY

**PV Business in Minigrids**
Example: Kema (Malaysia) 3.3 MW

PV/Diesel Hybrid System at Kema, Gerik, Perak, Malaysia COD on Nov 14, 2012
Example: Kema (Malaysia) 3.3 MW
Example: Kema (Malaysia) 3.3 MW
Minigrids: types

- From technical point of view

- Minigrids for MW scale stand-alone PV/Diesel hybrid mini grids systems are ready

- Large power converters are in the market

- Example: Leonics (Thailand manufacturer)
From the technical point of view everything is ready

Now, the problem is the business

But...we can find some solutions
Spending annual energy access

Off-Grid and Mini-Grid Renewable Energy Spending as a Percentage of the Annual Energy Access Portfolio (THREE YEAR AVERAGE)

- **World Bank Group**: 25% Off-grid and mini-grid, 75% Other Energy
- **Inter-American Development Bank**: 25% Off-grid and mini-grid, 75% Other Energy
- **Asian Development Bank**: 7% Off-grid and mini-grid, 93% Other Energy
- **African Development Bank**: 100% Off-grid and mini-grid
- **IEA “Energy For All” Case**: 36% Off-grid and mini-grid, 64% Other Energy

**Source**: World Alliance for Decentralized Energy
Tariff applied to Minigrids

- Consumers: ability to pay

- Consumers: willingness to pay
Financing models for Minigrids

- Fully-subsidized
  - Costs are fully subsidized by governments/donors

- Partially-subsidized
  - Large subsidies for capital costs
  - O&M cost recovery occurs from tariff

- For profit
  - No subsidies
  - O&M costs covered by tariff collection
  - Tariffs provide a return on the non-subsidized portion of the capital cost
Business (Tariff) options for Minigrids

- Energy as a service (Fee for service provided)
- Capacity-based tariff (Maximum power amount)
- Consumption-based Tariff (Energy consumption per time)
- Seasonal Tariff (Price established regarding environmental constraints)
- Per-Device (Number of devices allowance)
- Lifeline and Inverted Block Tariff (Tariff increases with consumption)
- Binomial Tariff (Different price regarding power source type or period of the day)
Energy as a service

- Energy consumption per time
- Customer pays per energy consumption
- Meter and reader required
- Incentives energy efficiency
Consumption-based tariff

- Energy consumption per time
- Customer pays per energy consumption
- Meter and reader required
- Incentivises energy efficiency
Capacity-base tariff

- Maximum power amount
- Flat-Rate or subscription tariff
- Customer pays a maximum power amount
- Overcurrent device / No metering
Per-device tariff

- Number of devices allowance
- Power tariff adaptation
- Customer pays per number of devices
- Reduces initial costs / No meter nor load limiter
- Pre-paid but requires on-site control
Lifeline/inverted block tariff

- Tariff increases with consumption
- Customer charge increases with consumption
- Cross-subsidy from high to low-consumption customer
Binomial tariff

- Different price regarding to power source type or period of the day

- Tariff varies by time of day (peak / non-peak) and need for battery/diesel generator

- Attractive tariff for hybrid MGs

- Aims for energy efficiency
Seasonal tariff

- Price established regarding environmental constraints
- Price defined by seasonal variation of renewable energy availability
- Aims for energy efficiency
Energy as a service

- Fee for service provided

- Energy not sold per unit of energy but for service provided

- Pre or post paid: Kg, Hours, Liters, etc.
Tariff determination

1. **Capacity-based**
   - Batteries or Diesel Generator required?
     - **Yes**
       - **Consumption-based**
         - Connection dimension by user
           - **High**
             - Fluctuation of RE supply or predictable pattern?
               - **Daily**
                 - Seasonal
               - **Seasonal**
                 - Large variation among users
               - **Lifeline**
             - **Low**
               - Per-Device
             - **Medium**
               - Ability to pay
                 - Very small
               - Energy as a Service
           - **Low**
             - Per-Device
           - **High**
             - Seasonal
Thank you and have a nice day!

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