Workshop on the Future Direction of Rural Electrification in Myanmar
At Department of Rural Development, The Ministry of Livestock, Fisheries and Rural Development, NayPyiTaw

[Session 2: The UT's Research]
Cost Estimation in Rural Areas in Myanmar by UT

Policy Alternatives Research Institute

Development of Preliminary Scenarios for Rural Electrification with Cost Estimation of Micro-grid in Myanmar

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Introduction

- **According to our estimation based on JICA's master plan, the target is to electrify 70% by 2030.**
  - **434MW should be provided by micro-grid.**
- **Not only grid extension but off-grid electrification.**

State/Region	Demand in 2012			Demand in 2030		
	MOEP forecast	JICA forecast		MOEP forecast	JICA forecast	
		High case	Low case		High case	Low case
Demand (MW)	1,666	2,075	2,075	19,217	15,477	9,414
Population	50,495,377			66,014,658		
kWh per capita	173	216	216	1,530	1,232	750
Electrification ratio (%)						
Whole country	26			90	80	70
Urban area	45			100	95	90
Rural area	18			86	74	61

Research Questions and Methodology

- **Research Questions**
  - How much does it cost to electrify rural area in whole country.
  - Explore implications of the national electrification rate target of 70% by 2030

- **Methodology:**
  - Demand Projection (Mr. Seino has presented)
  - Cost Estimation
  - Development of Preliminary Scenarios

Source: http://www.asean.fta.govt.nz/myanmar-overview

Framework of this Research

(1) Demand Projection

Estimate
- Setting target electrification rate (On-grid + Off-grid)
- Medium voltage distribution line area → Projection of electrification area (On-grid・Off-grid)
- The number of electrified villages and demand projection (Off-grid)

Population

Power supply plan
High voltage transmission lines extension plan

Achievements of rural electrification in neighboring countries

(2) Cost Estimation

Simulate
- Optimal system design for representative demand cases

Estimate
- Minimum cost for Off-grid electrification

(using “HOMER®“ for calculations)

Renewable energy potential

Costs of power generation technologies, etc.

Costs of fuel, etc.

(3) Development of Preliminary Scenarios

Estimate
- Total cost to meet off-grid demand

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Equation for calculating minimum NPC

Total Net Presented Cost(NPC) [USD]

required for Rural Electrification by 2030

$$=N\ of\ Micro\text{-}grid|_{case1} \times Unit\ Cost/Micro\text{-}grid|_{case1}$$
$$+N\ of\ Micro\text{-}grid|_{case2} \times Unit\ Cost/Micro\text{-}grid|_{case2}$$
$$+N\ of\ Micro\text{-}grid|_{case3} \times Unit\ Cost/Micro\text{-}grid|_{case3}$$
$$+N\ of\ Micro\text{-}grid|_{case4} \times Unit\ Cost/Micro\text{-}grid|_{case4}$$
$$+N\ of\ Micro\text{-}grid|_{case5} \times Unit\ Cost/Micro\text{-}grid|_{case5}$$
$$+N\ of\ Micro\text{-}grid|_{case6} \times Unit\ Cost/Micro\text{-}grid|_{case6}$$

Low case 70%

Middle case 20%

High case 10%

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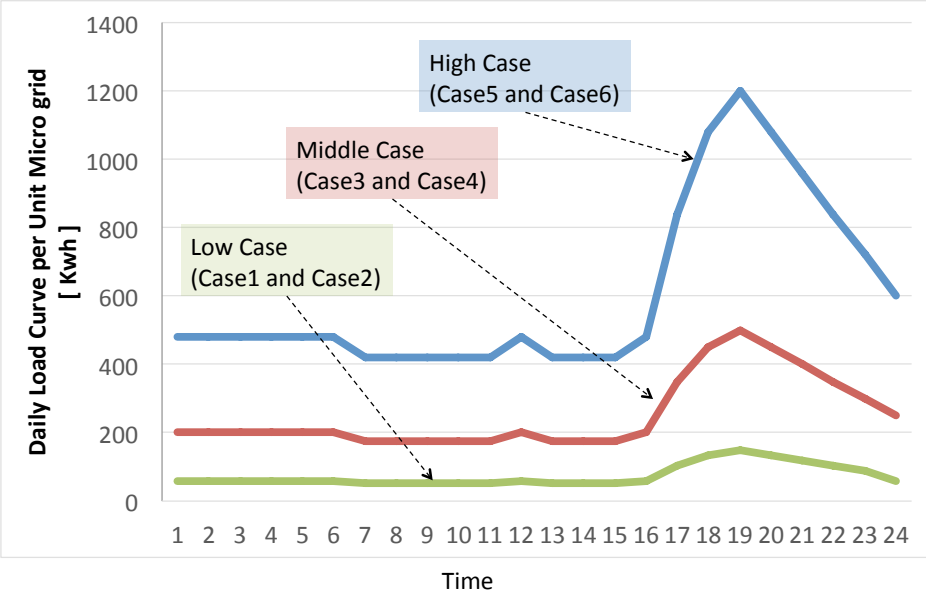
(2)Cost Estimation - Boundary Condition

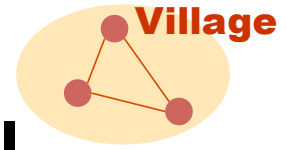
6 Cases

= 3 Cases (Load Level) × 2 Cases (Environment)

- Low Case(Case 1 and 2)
- Middle Case(Case 3 and 4)
- High Case(Case 5 and 6)

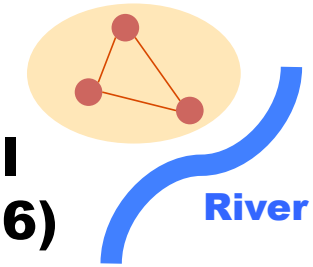


·Without Hydro potential (Case 1, 3 and 5)



90% of whole Micro grids in Myanmar
(No evidential data)

·With Hydro potential (Case 2, 4 and 6)



10% of whole Micro grids in Myanmar
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(2)Cost Estimation - Boundary Condition

Components

- **Photovoltaic(PV)**
- **Diesel Generator**
- **Biogas Generator**
- **Battery**
- **Converter**
- **Hydro Generator**

For All Cases

Only for Case 2, 4 and 6

→Seek for an optimal (minimum cost) configuration for each micro grid.

(2)Cost Estimation - Boundary Condition

Technical Specification of Composite Power Sources (1)

Characteristics	PV module	Hydro turbine	Diesel Generator
Model	Typical	Mini hydro	Typical
Power	1kWp	151kW	50 kW
Life time	20 years	25 years	20 years
Price	2250 USD/kW	4000 USD/kW	15000 USD/50kW
Replacement	1500 USD/kW	4000 USD/kW	8000 UDS/50kW
Maintenance[/year]	2 USD/kW	80 USD/kw	0.7 USD/hr/50kW
Install Unit	10 kW	1 unit	10 kW

Adapted Source: Author edited refer from Lipu, et al., (2013).

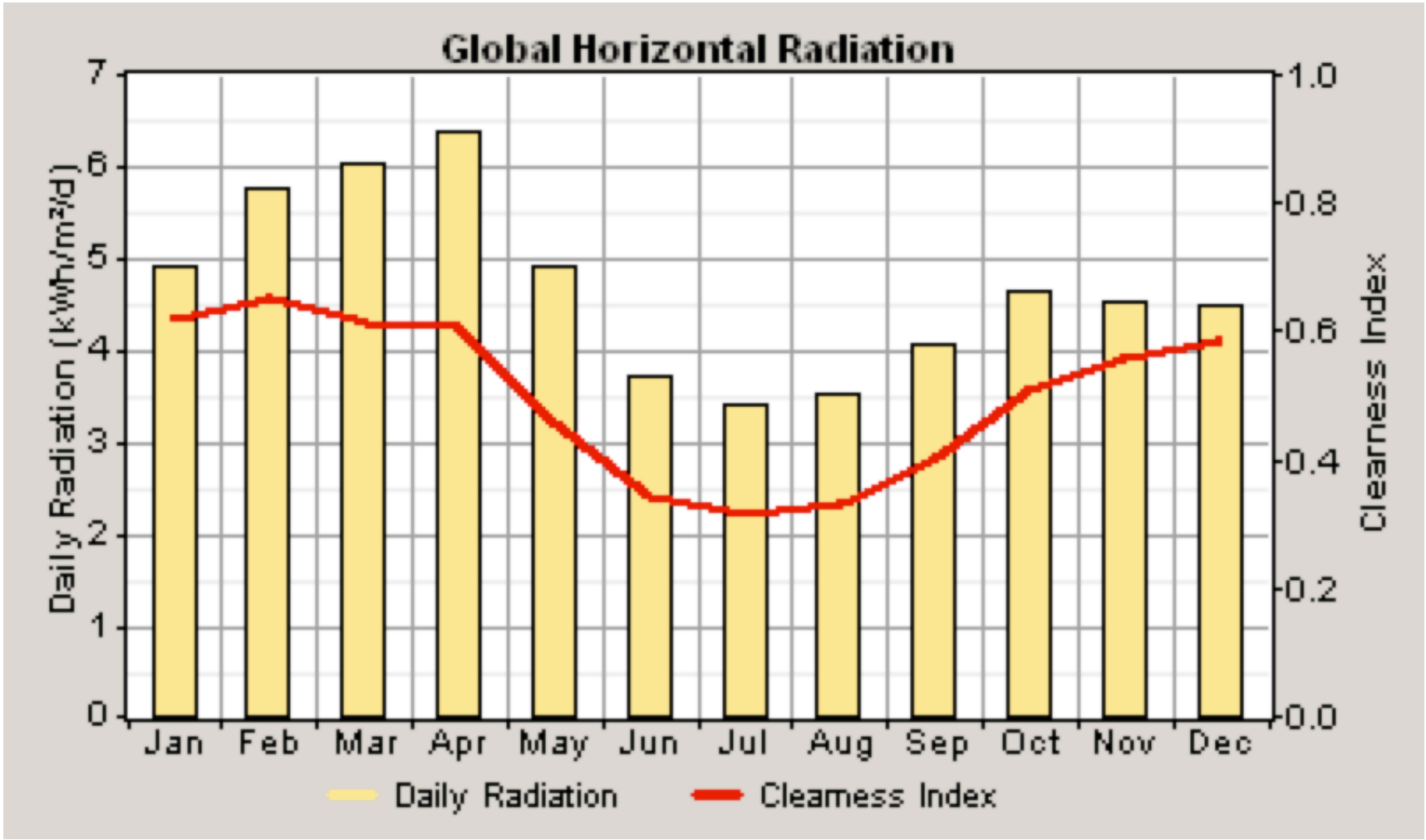
(2)Cost Estimation - Boundary Condition

Technical Specification of Composite Power Sources (2)

Characteristics	Biogas Generator	Battery	Converter
Model	RH-3	Trojan T-105 Nominal voltage 6V	Typical
Power		Nominal capacity 225 Ah	1kW
Life time		Lietime throughput 845 kWh	20 years
Price	2300 USD/6kW	225 USD/battery	400 USD/kW
Replacement	1700 USD/6kW	200 USD/battery	250 USD/kW
Maintenance[/year]	0.01 USD/10kW	1 USD/battery	1 USD/kW
Install Unit	10 kW	10 unit	10 kW

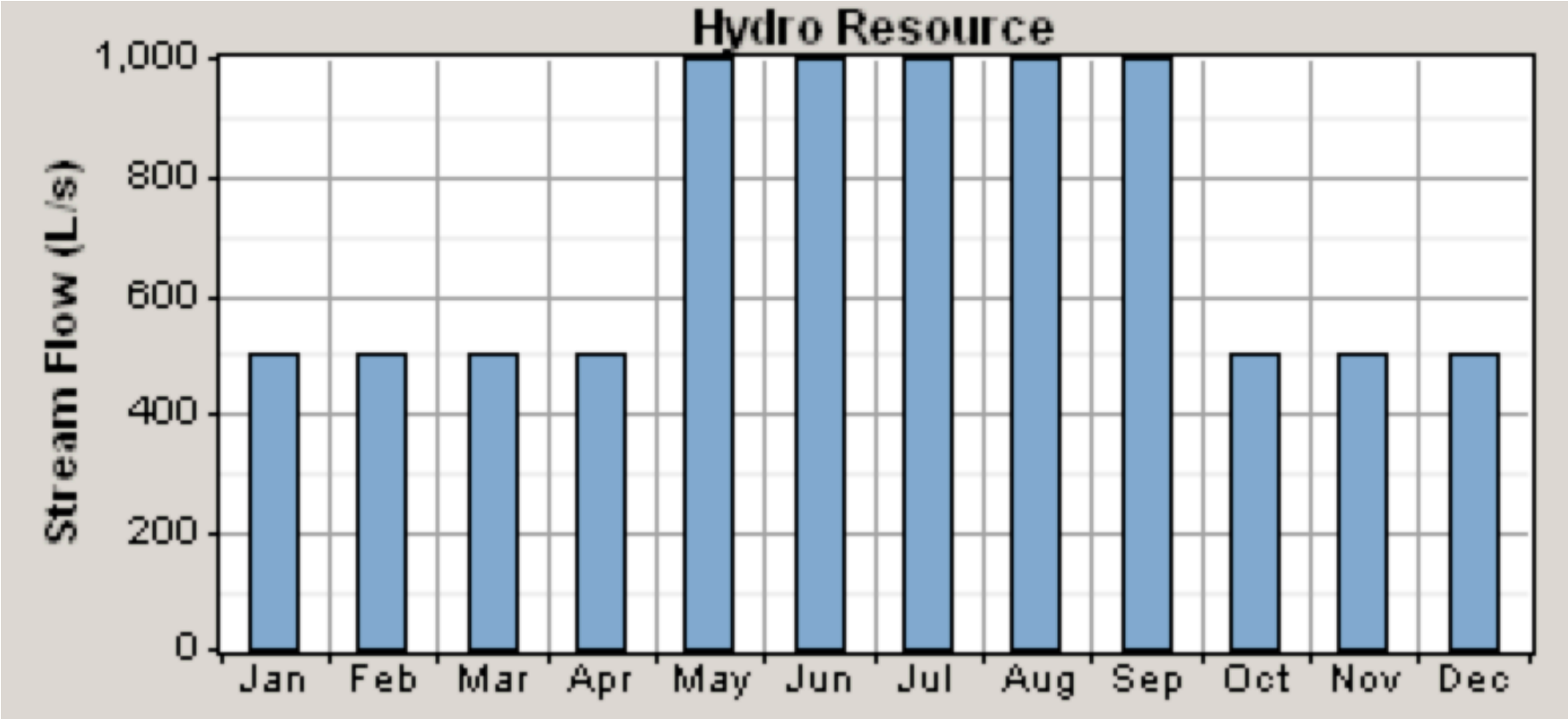
Reference Source: Author edited refer from Lipu, et al., (2013).

Amount of Sunlight



Source: Tiet et al. (2008)

Boundary Condition - Hydro Power Potential



Source: The Institute of Electrical Engineers of Japan. (2001).

Biogas potential

State / Division	Population in 1997	Paddy Production in 1996–1997	Paddy Production par capita	Rice Husk Production	Potential Energy	Potential Power
	1,000	1000 ton	kg	1,000 ton	GWh	kW
Ayeyarwady Division	6,436	5,894	916	1,179	94	43,060
Bago Division	4,848	2,930	604	586	47	21,420
Yangon Division	5,295	1,623	306	325	26	11,870
Shan State	4,629	942	203	188	15	6,890
⋮	⋮	⋮	⋮	⋮	⋮	⋮
Union Total	46,402	17,397	375	3,480	278	127,120

Source: The Institute of Electrical Engineers of Japan (2001)

The daily production:
123 kg / day
(Average)

(3) Scenario Preparation

Total cost for micro-grid installation in off-grid electrification

Case	Component of micro-grid	Electrification cost (MUS$) by 2030		
		Capital cost	Operating cost	Total
1	PV+Dies+Biog+Bat+Con	638	1,482	2,120
2	PV+Dies+Biog+Bat+Con	71	165	236
3	PV+Dies+Biog+Bat+Con	458	1,729	2,187
4	Hydro+Bat +Con	192	11	203
5	PV+Dies+Biog+Bat+Con	544	2,229	2,773
6	Hydro+Dies+ Biog+Bat+Con	101	16	117
Total		2,004	5,632	7,636
US$ per micro-grid		126,387	355,197	481,584
US$ per kW		3,891	10,936	14,827

Capital Cost: 2,004 M USD
Operating Cost: 5,632 MUSD

Caveats: the results depend on: hydro availability, technology costs (e.g., PV), rather large demand, coarse data resolution

Summary

- (1) Demand Projection of Rural Area
  - To achieve 70% electrification, 434MW should be provided by micro-grid.
- (2) Cost Estimation
  - Unit micro grid cost is estimated at 0.2M USD - 2M USD depending on configurations.
- (3) Development of Preliminary Scenarios
  - We tentatively estimated total cost(inc. capital and operation costs) at 7.6 Billion USD for rural electrification for approx.16,000 micro-grids.

Future Work & Our Proposal

- This result is tentative.
- Produce multiple scenarios that take priorities into account.

- Need to Improve data.
  - Potential data for Hydro Power
  - Potential data for Biogas
  - Specification data for Compositions. Such as
    - Diesel Generations.
    - Batteries and Converters.

Information to Improve Our study and to Contribute for Myanmar's Electrification. (from Mr.Seino's presentation)

- Current national census data and
- Geospatial data of villages
- Current data of household and village electrification rates and demand
- Geospatial data of current and future plan of transmission line and sub-station
- Standard connection method of HV line and MV line
- Data of existing and planned small hydro power
- Data of existing diesel power