COMMUNITY ENTERPRISE HYDRO MINI GRIDS

A CLOSER LOOK AT DECENTRALIZED RENEWABLE ENERGY IN SOUTH AND SOUTHEAST ASIA

Bhutan Renewables Readiness Assessment
IRENA Validation Workshop
July 2019

OUR WORK

KNOWLEDGE EXCHANGE

Capacity building events (online and in-person)
Knowledge exchange tools for multi-actors
South-South and peer-to-peer exchange

STRATEGY ADVOCACY

Platform for local practitioner voices
Multi-stakeholder facilitation
Data and mapping to quantify impact

THEMATIC FOCUS AREAS

Technology and skills advancement
Socio-environmental sustainability
Enabling financing and policy for scalability

OUR APPROACH

OVERVIEW

Why Small-Scale Hydropower

Sustainability Factors

Case Profile: Myanmar

Community Enterprise Models

Options for Hydro Mini-Grid Policy

Why Enterprise-based Solutions

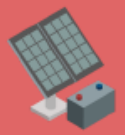
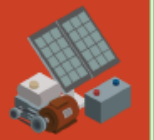
Enabling Access to Financing

Regional Hindsight

Reliability, Socio-Environment Sustainability and Scalability


Watershed
Intake
Forebay
Penstock
ELC
Ballast
Generator
Turbine
Powerhouse
Synchronizer
Connect to Main Grid
Transmission Line
Productive End Use
Grain Mill
House Appliances
HPNET
HYDRO EMPOWERMENT NETWORK

BEST PRACTICE #1: TECHNOLOGY DIFFRENTIATION

	 Micro/mini hydro	 Solar-battery	 Solar-battery + diesel	 (solid) Biomass gasifier	 Wind-battery	 Diesel
Range of investment cost USD/kW (generation, distribution)	500 - 10,000	4,000 - 7,000	5,000 - 10,000	1,500 - 10,000 (gasifier, cleaning system, heat exchanger, gas genset, grid)	4,500-13,000	400-1,000
Pure O&M cost (assuming overall system lifetime of about 20 years; without depreciation) as % of investment (depends on equipment quality; battery and diesel genset replacement to be included)	2-5 %			min 10% without fuel cost; daily maintenance required!	5-15% (wind turbine to be replaced in 20 year period!); turbine service once a year → highest O&M cost among RE!	
Range of cost (LCOE) in US Cent per kWh	5-30	40-100	50-100	5-50 (biomass cost!)	60-100	60-120 (fuel price and transport!)

Percentage of local contribution (equipment and installation)	40-70%	5%	5%	30%-95%	20-40% in community 50-90% in country depends on country; parts like charge controller, batteries, inverters etc. often imported	5%
Local availability of spare parts	+++	-	-	++	+ Depending on country (normally all spare parts can be sourced locally except magnets)	++
Resource assessment	Measure water level (min 1 year) and flow	Data from … database worldwide available?		Collect data on agro residues for at least 3 years (supply chain!); make forecast Seasonality important to consider!	Measure wind speed (minimum 1 year)	Accessibility for diesel transport and affordability of diesel
Typical cost driver	Low head - high flow (more expensive than reverse) Complicated civil works (difficult terrain) Long distance betw. hydro site & supply area	Battery component (high investment x USD per… every y years)	Battery + cost for diesel fuel	Biomass fuel price Gas cleaning system Quality of gasifier (insulation etc.) level of automatisation	Required battery capacity depending on volatility of wind resource	Local price of diesel fuel

				pollutant, but: Deficient operation leads to generation of tar from cleaning system; can be problem	complementary source to save fuel or generate at night or during winter/rainy season	
Productive end use	Direct drive e.g. of agro processing machines possible Lower LCOE attractive for end use	Due to resource peak in dry season, very appropriate for irrigation		Heat (or cold) and electricity can be used! Agro enterprises that produce the biomass resource Used for various mills and local industry		

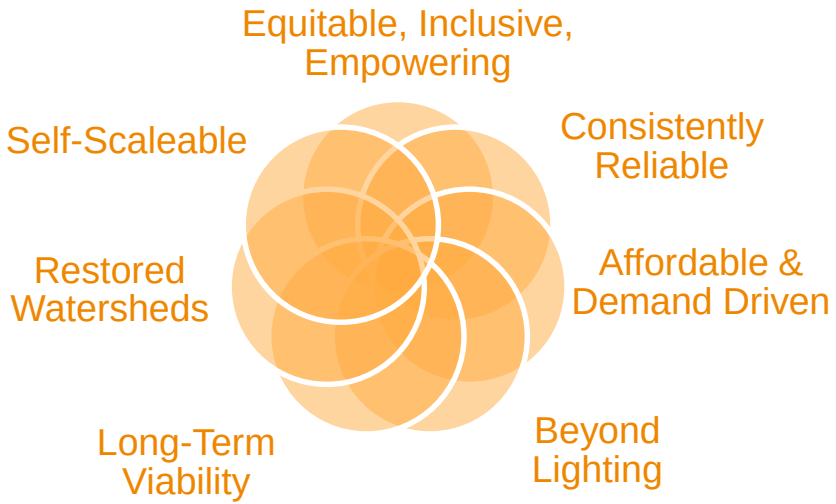
Developed by:

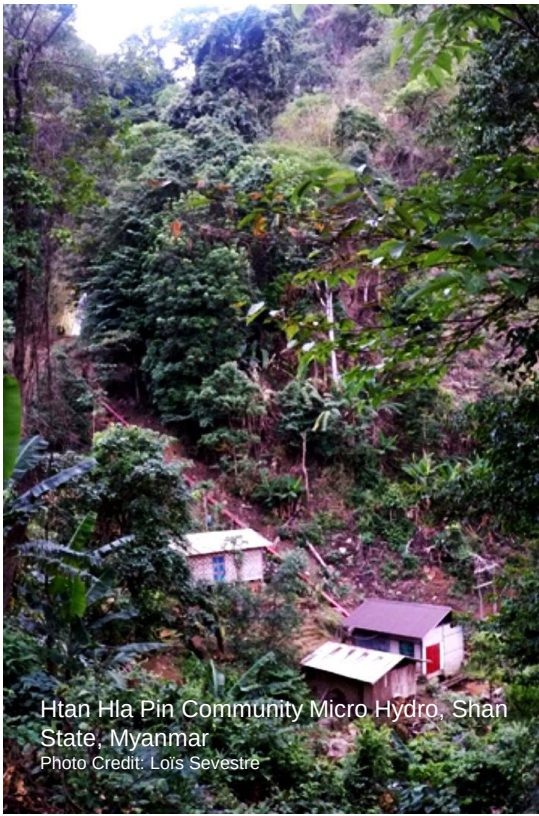
skat_ Swiss Resource Centre and Consultancies for Development

References:

International Renewable Energy Agency (IRENA)
Swiss Resource Centre and Consultancies for Development (Skat)
Trama TecnoAmbiental (TTA)
Wind Empowerment
Winrock International

FACTORS FOR SUSTAINABILITY

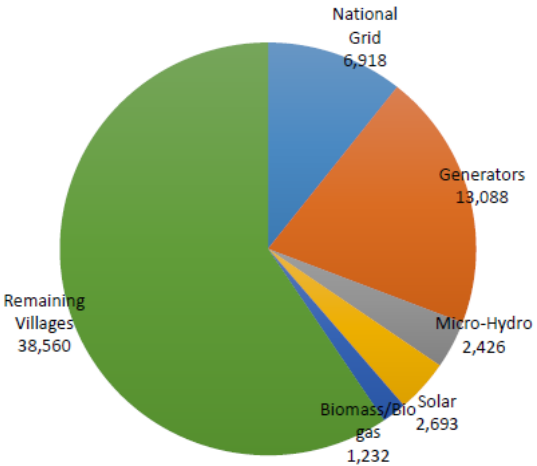




Htan Hla Pin Community Micro Hydro, Shan State, Myanmar
Photo Credit: Loïs Sevestre

Renewable Energy Mini-Grids in Myanmar

35 Years of Experience



Source: Department of Rural Development 2015; World Bank NEP PAD 2015; Consultant Analysis

- Micro/Mini Hydropower
  - 5600 units below 1MW for village electrification
- Biomass Gasifiers
  - 10,000+ units powering small-scale rice mills
  - 500+ units for village electrification

Source: State-wise Statistical Data Collection, Pyi Pyi Thant, Mekong Ecology and Energy Net (MEE Net), July 2017.
Source: Interview, Soe Tint Aung, Royal Htoo Linn Manufacturing, Co, Ltd. August 2017.
Source: Feasbility Study on Rice Husk Power Generation, Mitsubishi Research Institute, 2014.

Myanmar's Unique Progress

Learning from Hindsight

- International development programs **aim to design** programs that can **scale, self-replicate, and sustain.**

- How did **Myanmar's 6000+, local technology RE mini-grids** happen?
  - No technology training
  - No international or government funding
  - No enabling policy
  - **Yet, more RE mini-grids than any funded program in S/SE Asia**

- Opportunity for development partners to **learn from Myanmar** how **locally-driven RE mini-grids** can be **scaled and sustainable long-term**.

Source of Myanmar's Indigenous RE Mini-Grid Progress

Communities and Social Entrepreneurs

- 35+ Years of Experience
- 6000+ Mini-Grids
- Self-Financed, Community-Owned
- Locally-Developed Technology
- High Productive End Use
- Phase-wise Generation

Kachin State Social Entrepreneurs

Dry Zone Social Entrepreneurs

Dry Zone Biomass Energy Cooperatives

Micro / Mini Hydro Cooperatives

Southern Shan State Micro Hydro VECs

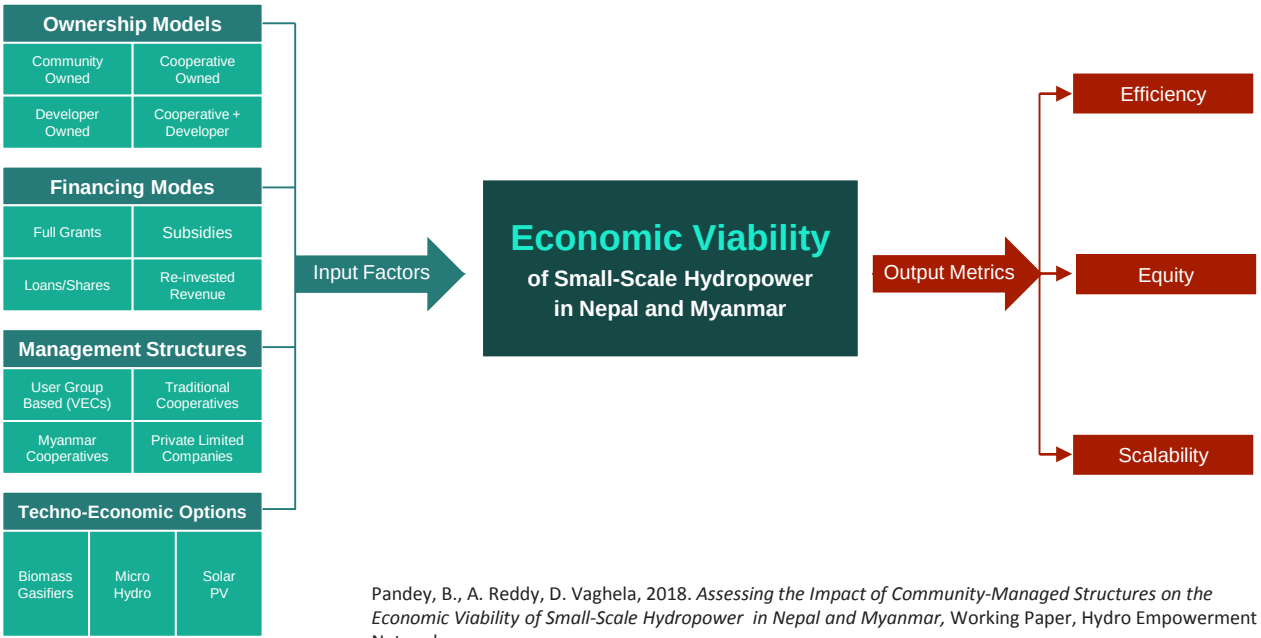
Kachin State Social Entrepreneurs

Kayin State Social Entrepreneurs

Eastern Shan State Pico and Micro Hydro VECs

Enterprise-Based Renewable Energy Mini-Grids

Factors for Efficiency, Equity and Scalability



Pandey, B., A. Reddy, D. Vaghela, 2018. *Assessing the Impact of Community-Managed Structures on the Economic Viability of Small-Scale Hydropower in Nepal and Myanmar,* Working Paper, Hydro Empowerment Network.

Made-in-Myanmar: Clean & Efficient Biomass Gasifiers

Multiple designs up to 2 MW by social entrepreneur, Royal Htoo Linn Manufacturing

- **No-liquid discharge** and triple air filter systems
- Tar and ash **auto removal** and re-use
- **Efficient** use of water
- O/M **cost savings** for rice mills and communities

Made-in-Myanmar: Small-Scale Hydropower, 5kW – 3MW

Local Social Entrepreneurs of Hydro Mini-Grids

- **Multi-generational: grandfather, father, son**
  - **Reliable and affordable** local manufacturing
    Francis**,** Pelton, Turgo, Crossflow, Propeller
    Plus penstock and transformers
  - Each entrepreneur: Over 150 projects

- **Community-centric ownership & management**
  - Watershed strengthening **at the start**
  - Ownership and viability model **customized to each community's** strengths
  - Skills-building for **long-term sustainability**

Case Profile

Myanmar's Mae Muk Waterfall Micro Hydro Project

U Sai Htun Hla, Project Co-developer/ Co-owner

2013
30kW hydro plant

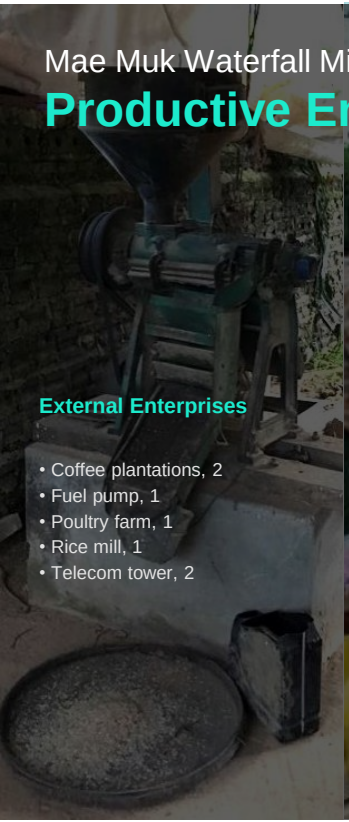
2015
80 kW hydro plant

2019
Upgrade to 300kW

Generation capacity	**80kW to be upgraded to 300kW**
Design Flow and Head	100 l/s dry season, 200 l/s wet season; 183 meters
Connections	600 households, plus enterprises and social services
Transmission	32 km MT line (11kV), plus 32 km LT line, covering 11 villages
Project Cost	**USD 350,000** (as per current exchange rate)
Government Subsidy	None
Loan	None
Equity	60% from shareholders, 40% from connection fees

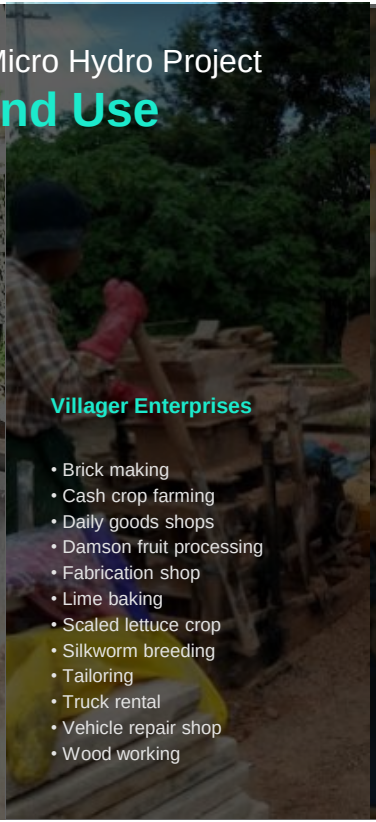
Mae Muk Waterfall Micro Hydro Project

Productive End Use



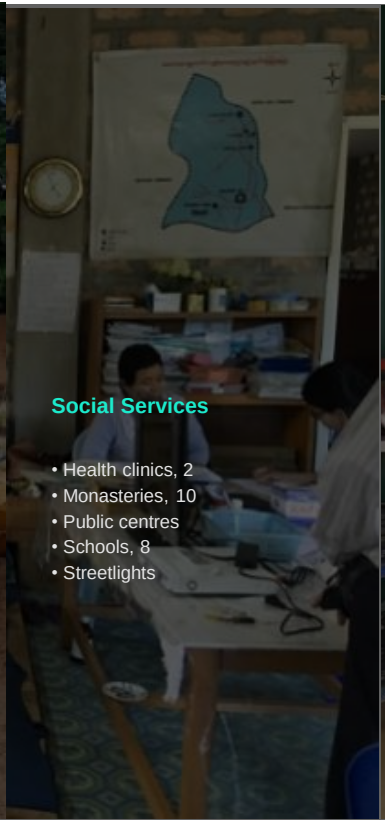
External Enterprises

- Coffee plantations, 2
- Fuel pump, 1
- Poultry farm, 1
- Rice mill, 1
- Telecom tower, 2



Villager Enterprises

- Brick making
- Cash crop farming
- Daily goods shops
- Damson fruit processing
- Fabrication shop
- Lime baking
- Scaled lettuce crop
- Silkworm breeding
- Tailoring
- Truck rental
- Vehicle repair shop
- Wood working



Social Services

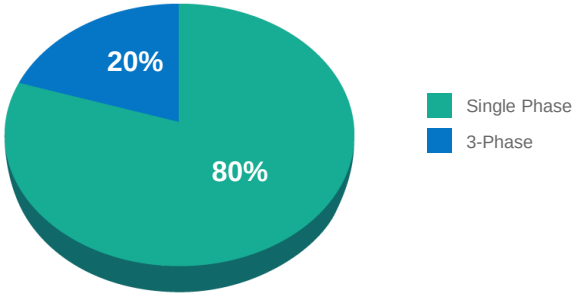
- Health clinics, 2
- Monasteries, 10
- Public centres
- Schools, 8
- Streetlights

Household Use

- Carpentry tool, 1
- Corn thrasher, 1
- Electric rice cookers, ~250
- Electric frying pans, ~200
- Fans, many
- Grinders, several
- Mobile phone charging, many
- Rice mills, several
- Refrigerators, several
- Televisions, many
- Water heaters, several
- Washing machines, several
- Water pumps, many

Mae Muk Waterfall Micro Hydro Project

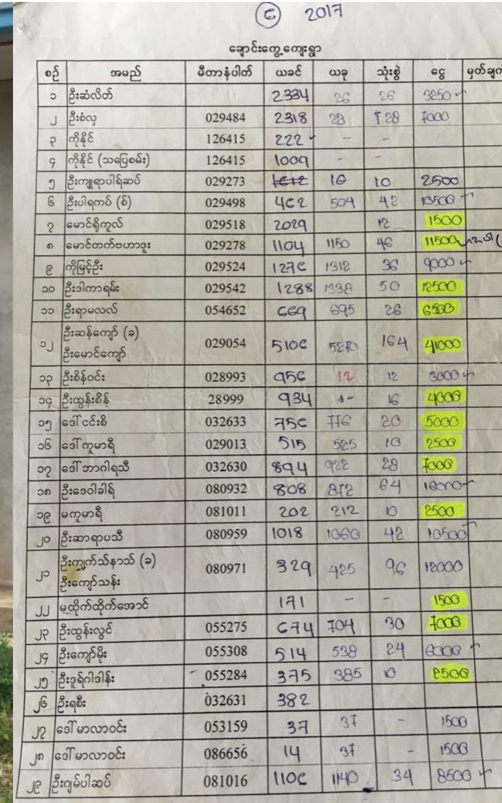
Financial Viability



Tariff Structure (as per current exchange rates)

Services (24 hours)	Residential	Village Enterprises	Shareholders (Cooperative Members)	Dedicated Lines (External Enterprises)
Single Phase	USD 0.11	USD 0.11	USD 0.05	USD 0.11
3-Phase	USD 0.20	USD 0.20	USD 0.10	USD 0.11

Lin Yuang Chi Micro Hydro Cooperative-Owned Utility in Myanmar
Photo Credit: D. Vaghela



(၆) 2017

ချောင်းတွေ့ကျေးရွာ

စဉ်	အမည်	မီတာနံပါတ်	ယခင်	ယခု	သုံးစွဲ	ငွေ	မှတ်ချက်
၁	ဦးဆံလိတ်		2334	26	26	3250	
၂	ဦးစံလှ	029484	2318	28	28	7000	
၃	ကိုနိုင်	126415	222	-	-		
၄	ကိုနိုင် (သခြေစမ်း)	126415	1009	-	-		
၅	ဦးကျူရာပါရ်ဆပ်	029273	~~[illegible]~~	16	10	2500	
၆	ဦးပါရကပ် (စ်)	029498	462	504	42	10500	
၇	မောင်ရှိကူလ်	029518	2029		12	1500	
၈	မောင်တက်ဗဟာဒူး	029278	1104	1150	46	11500	[illegible]
၉	ကိုမြင့်ဦး	029524	1276	1312	36	9000	
၁၀	ဦးဒါကာရမ်း	029542	1288	1338	50	12500	
၁၁	ဦးရာမလလ်	054652	669	695	26	6500	
၁၂	ဦးဆန်ကျော် (ခ) ဦးမောင်ကျော်	029054	5106	5270	164	41000	
၁၃	ဦးစိန်ဝင်း	028993	956	12	12	3000	
၁၄	ဦးထွန်းစိန်	28999	934	1-	16	4000	
၁၅	ဒေါ်ငင်းစိ	032633	756	776	20	5000	
၁၆	ဒေါ်ကူမာရီ	029013	515	525	10	2500	
၁၇	ဒေါ်ဘာဂါရသီ	032630	894	922	28	7000	
၁၈	ဦးဒေဝါခါရ်	080932	808	872	64	16000	
၁၉	မကူမာရီ	081011	202	212	10	2500	
၂၀	ဦးဆာရာပသီ	080959	1018	1060	42	10500	
၂၁	ဦးကျက်သ်နာသ် (ခ) ဦးကျော်သန်း	080971	329	425	96	12000	
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၂၅	ဦးဒူရ်ဂါဒါန်း	055284	375	385	10	8500	
၂၆	ဦးရစီး	032631	382				
၂၇	ဒေါ်မာလာဝင်း	053159	37	37	-	1500	
၂၈	ဒေါ်မာလာဝင်း	086656	14	37	-	1500	
၂၉	ဦးဂျမ်ပါဆပ်	081016	1106	1140	34	8500	

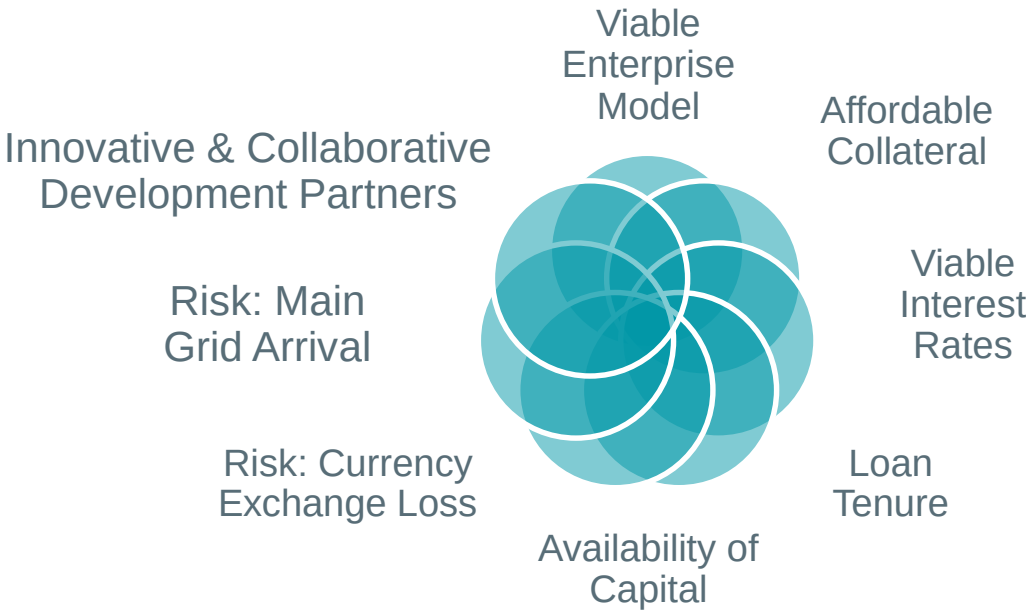
WHY ACCESS TO CREDIT?

- **Grant-based** mini-grids can be **short-lived**
  - **No accountability** for financial and economic viability
  - Minimal or **no revenue** generation

- **Credit** mandates **enterprise-based** mini-grids.
  - **High productive end use** → Starting from project conceptualization
  - Ownership and management → Local Social **Enterprise models**
  - Revenue is generated → **Long-term** O/M and rehabilitation when required

- **Hindsight** Voices: **Nepal, Indonesia, Myanmar**
  - HPNET Panel: IRENA IOREC 2018
  - HPNET Deep Dive: ADB ACEF 2019

ACCESS TO FINANCING FOR MINI-GRIDS



BEST PRACTICE #2: DEMAND-DRIVEN DESIGN

WHAT IS THE ENERGY NEEDED FOR?
WHAT IS **MINIMUM REQUIRED KW** OUTPUT – HOURLY AND MONTHLY?
HOW WILL THE **DEMAND GROW**? CAN IT BE **INCENTIVIZED AND INCLUSIVE**?
WHAT IS THE **LEAST COST APPLICATION** TO MEET THE DEMAND?

BEST PRACTICE #2: LOCAL MANUFACTURING AND SKILLS BUILDING

Loius Gombolog, Master Machinst at the Centre for Renewable Energy Appropriate Technology (CREATE), Malaysia
Photo Credit: Di.Vaghela

BEST PRACTICE #3: ADVANCE LOCAL PRACTITIONERS

HPNET S/SE Asia Regional *Training of Trainers for Electronic Load Controllers* at ASEAN Hydropower Competance Centre (HYCOM)

Photo Credit: D. Vaghela

BEST PRACTICE #4

ENABLING FINANCING FOR COMMUNITY- PRIVATE PARTNERSHIP (LOCAL SOCIAL ENTERPRISES)

Nepal, AEPC-DFID-Winrock: **Enabling local banks** to lend to RE mini-grids; **Capital Subsidies vs Interest Subsidies.**

BEST PRACTICE #5

INCENTIVIZED TARIFFS AND CONNECTION FEES

Nepal and Myanmar Micro Hydro Entrepreneurs: **Anchor loads / productive end use** loads can **reduce household tariffs**.

BEST PRACTICE #6

GRID INTERCONNECTION, PROJECT-TO-PROJECT INTERCONNECTION AND PV-HYDRO HYBRID

Nepal UNDP Renewable Energy for Rural Livelihoods: **Policy for grid interconnection** and forming **local grids.**

BEST PRACTICE #7

WOMEN-CENTRIC APPROACHES

Pakistan, Mini Hydro Utilities, Aga Khan Rural Support Programme: **Women-shareholders** of the mini-grids and end uses.

BEST PRACTICE #8

ECO-SYSTEM RESTORATION

Malaysia & Philippines: **Watershed strengthening** prior to micro hydro implementation, **including upstream communities**

Next Phase of HPNET: Allocation of micro hydro **revenue to fund eco-restoration** of watersheds.

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