Grid Interconnection of Micro/Mini Hydropower in Indonesia

What happens when the national grid arrives?

Mini-Grid Webinar Series

Energypedia UG, Hydro Empowerment Network, Skat Foundation

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Renewable Energy for Rural Applications

GMN Focus Areas

Solar Home Systems

Drinking Water

Navigation Aid

Telecommuniaction

Hybrid Systems

Micro Hydro

Solar Process Heat

Bioenergy

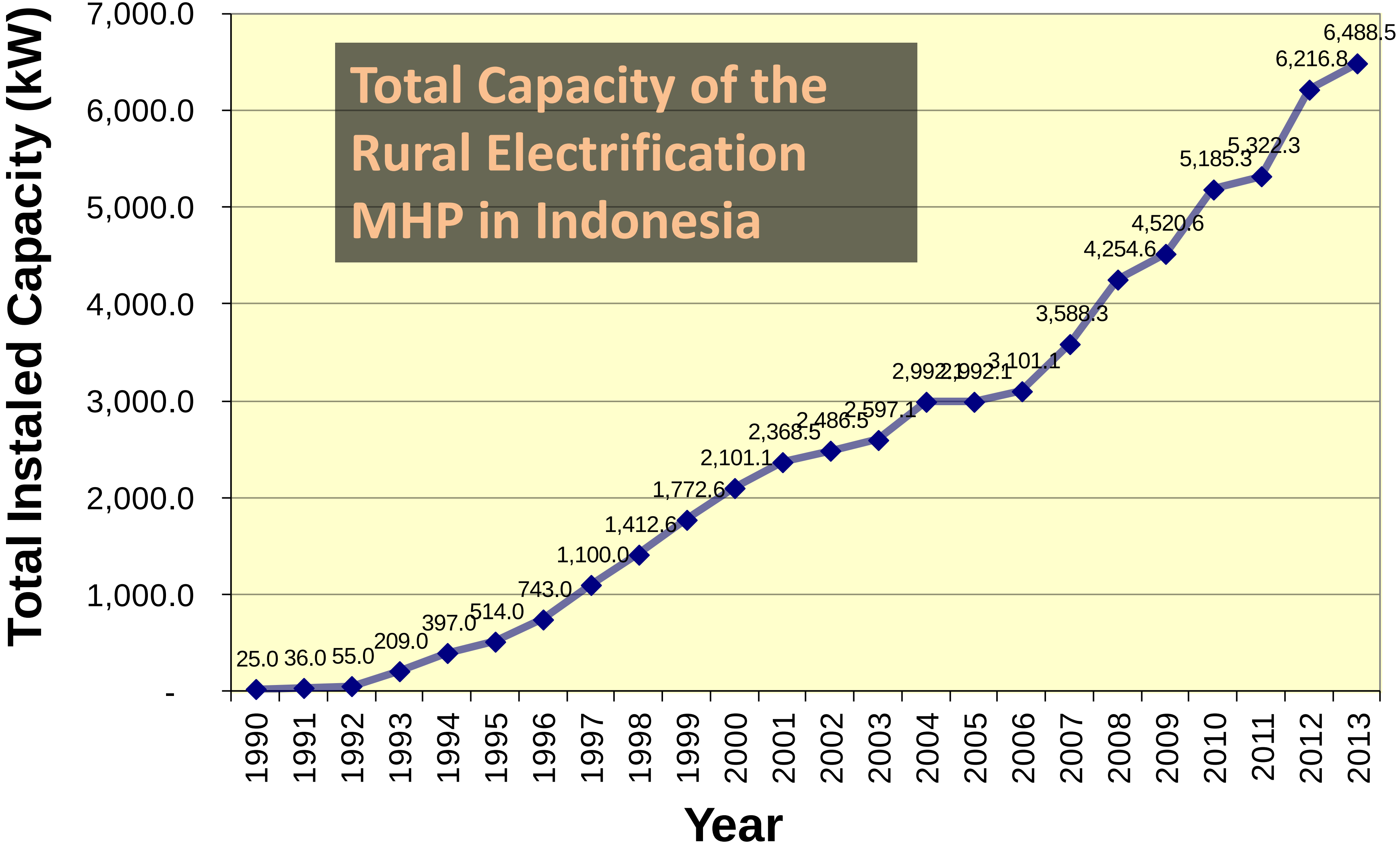
Micro/Mini Hydro Development in Indonesia

- Standalone MHPs for rural electrification in Indonesia have been developed by

Non-Government Organizations (NGOs)	Government Initiative
Paguyuban Kalimaron, Yayasan Mandiri, IBEKA, WWF, Cooperatives, etc.	• Ministry of Energy and Mineral Resources, • Ministry of Cooperative and SME

International Cooperation Programs

- **30-years of cooperation** with international organisations, e.g. GTZ/GIZ, JICA, UNDP, ADB, and World Bank, others.
  - "MHPP" for **technology transfer** of MHP technologies and mini grid implementation (1995-2008)
  - "IMIDAP"; Integrated Microhydro Development and Application Program (2006-2010)
  - PNPM and "Green PNPM" rural infrastructure programme and Technical Support Unit TSU (2009-2012)



Total Capacity of the Rural Electrification MHP in Indonesia
Total Instaled Capacity (kW)
Year
7,000.0
6,000.0
5,000.0
4,000.0
3,000.0
2,000.0
1,000.0
-
1990
1991
1992
1993
1994
1995
1996
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1998
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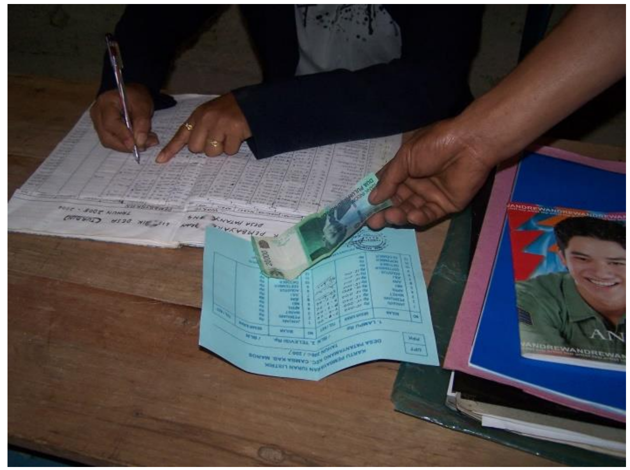
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
25.0
36.0
55.0
209.0
397.0
514.0
743.0
1,100.0
1,412.6
1,772.6
2,101.1
2,368.5
2,486.5
2,597.1
2,992.1
2,992.1
3,101.1
3,588.3
4,254.6
4,520.6
5,185.3
5,322.3
6,216.8
6,488.5

Technology transfer, training, implementation of MHPs in Indonesia



National Government Programs

- Ministry of Energy and Mineral Resources
  - Regular/annual program funded by State Budget; since 1995
  - Main goal: electrify remote areas and increase electrification ratio

- Ministry of Cooperative and SME
  - Regular/annual program funded by State Budget; since 2005
  - Main goal: income generation for rural community-based cooperatives

Technical components today “Made in Indonesia”

- Cross flow turbines up to about 1000 kW
- Pelton and (small and tubular) Propeller turbines
- Electric load controllers
- For Grid Interconnection: Synchronizer, Protection, and Cosphi Regulator

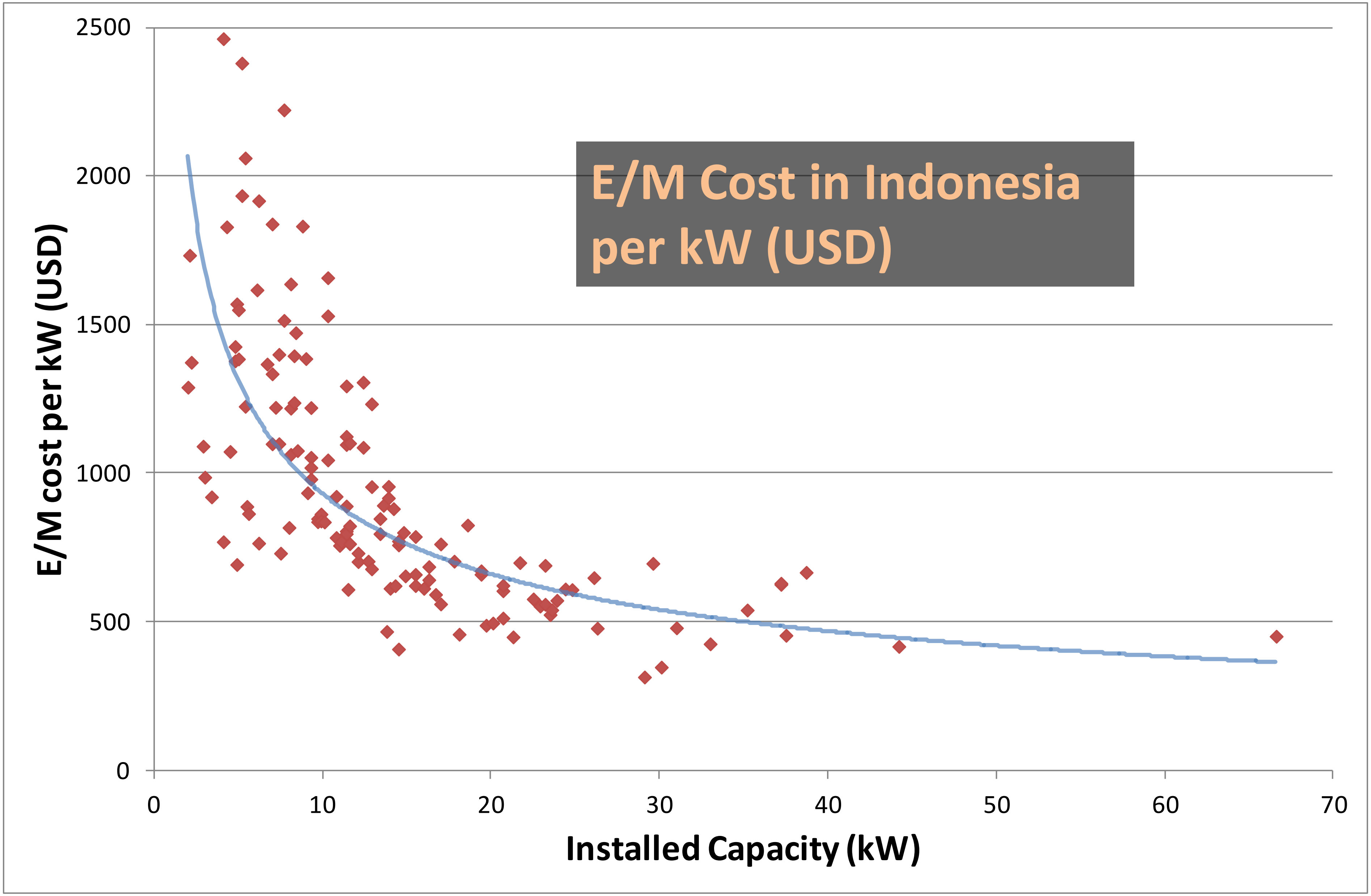




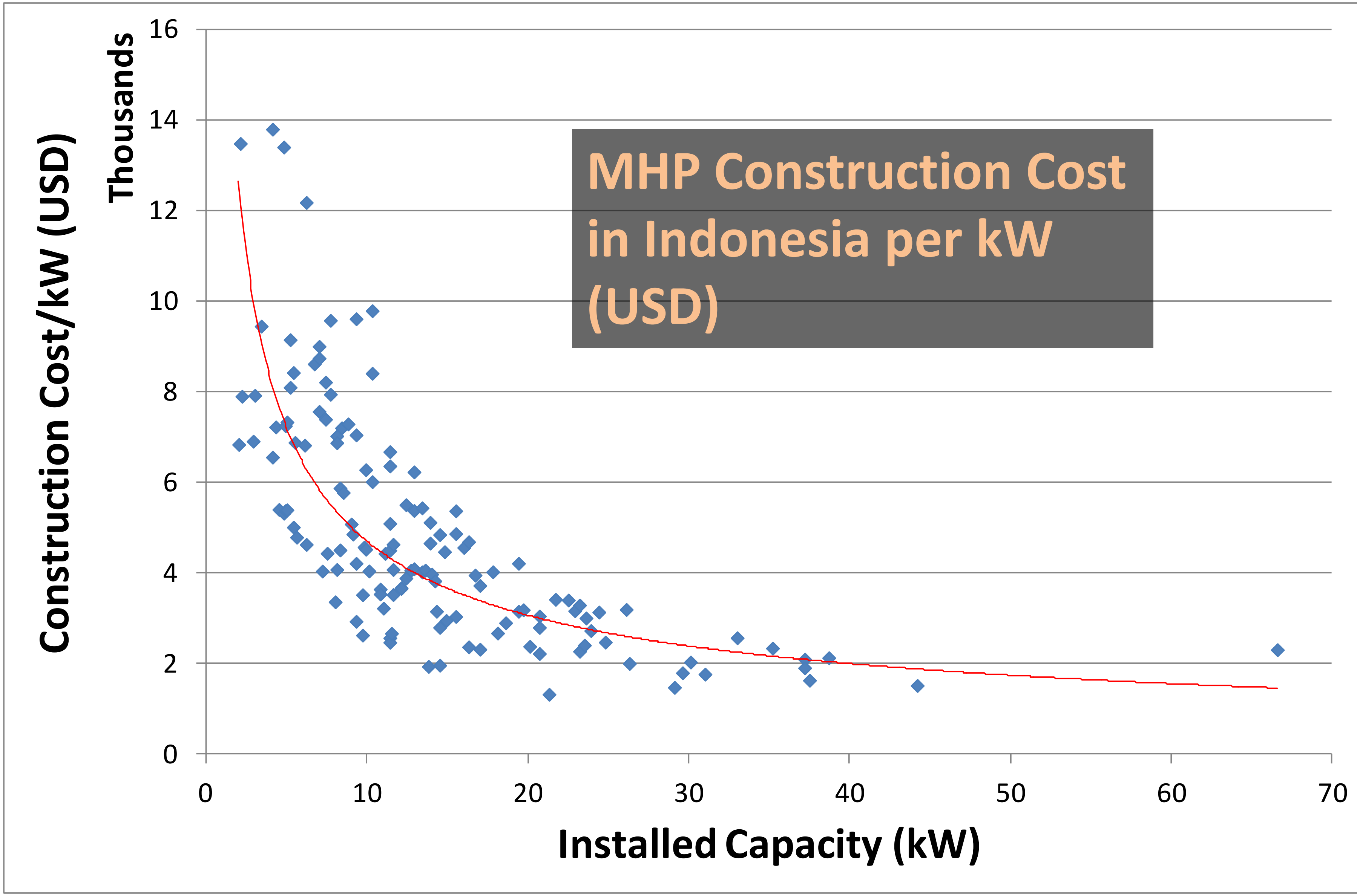
Local Added Value: Job Creation, Micro Hydro Associations, Regional Training Centre

HYCOM

ASEAN HYDROPOWER COMPETENCE CENTRE



Source: Ministry of Home Affair (TSU)



Source: Ministry of Home Affair (TSU)

Micro Hydro Project Management

(for Government funded projects)

- Assets are **owned** by local (district or provincial) government.
- Community-based organization created to **manage** MHP system:
  - Operation & Maintenance: 2 operators, 1 head of management, 1 secretary
  - Total wages ~USD 2,000 per year
  - Collected revenue ~900 to 1,000 USD/month
  - Technical complexity: Most with ELCs; some with flow-control, plus synchronizer for grid interconnection.

When the National Grid Arrives

Case 1: MHP constructed by Government

- **Policy:** No guidelines to feed into the national grid!
- **Two different grids:** *mini-grid* and *national grid*
- **If the micro hydro project is well managed →** Customers stay with mini-grid connection
- **Example:** Gunung Halu MHP, 20 kW, in West Java
  - MHP customers (20 households) keep utilizing the MHP
  - Monthly tariff: ca. USD 2.3 flat tariff for 900 W/HH
- **If micro hydro NOT well managed →** Customers who can afford, switch to national utility (initial connection fee ca. USD 150); and MHP likely to be abandoned.

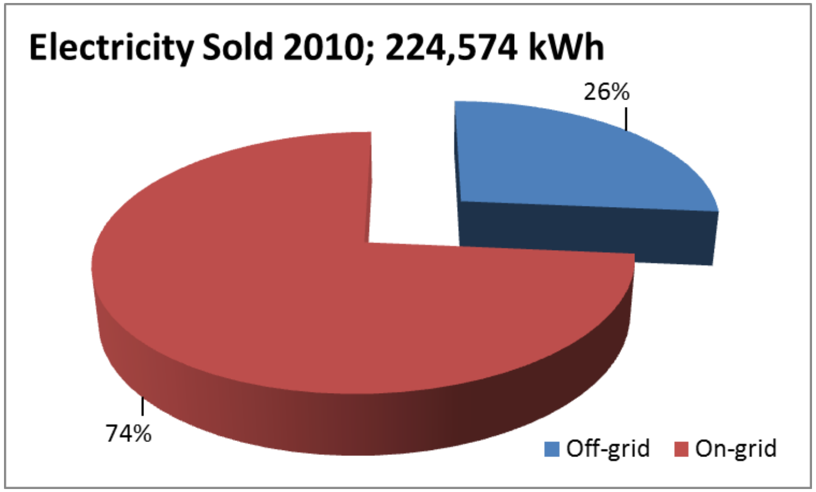
When the National Grid Arrives

Case 2: MHP constructed by NGO

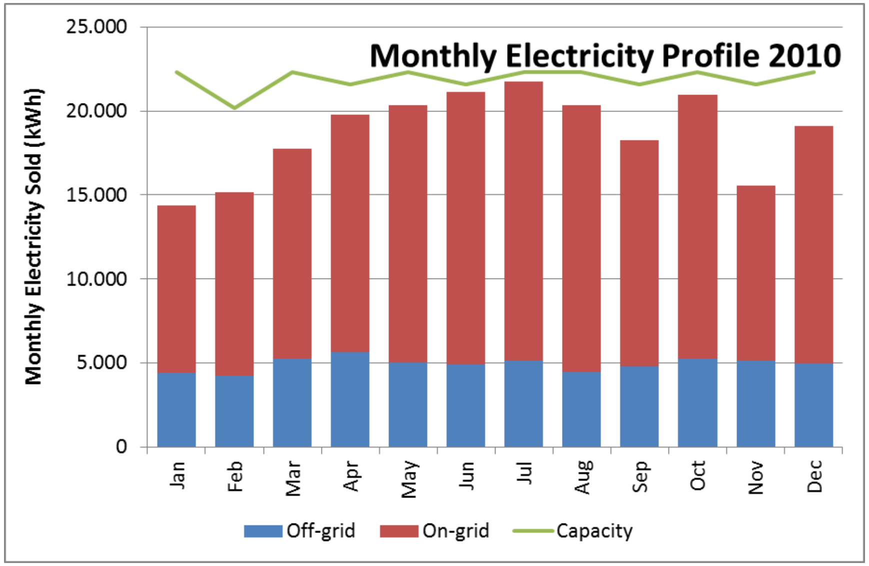
- Assets **owned** by local community/organisation.
- **Policy:** Allowed to connect to and feed into national grid in accordance to applicable FIT.
- **Example MHP Kalimaron:**
  - Originally constructed (1994) and operated as off-grid scheme;
  - With issuance of government legislation (no. 1122/2002), MHP Kalimaron connected to the National Grid in 2003 to **sell surplus energy**
  - **Additional investments:**
    - Synchronizer, step-up transformer, on-grid lines, and transaction meter → about 6,000 USD (at 2003 exchange rate).
    - Cost to fulfill technical standards (technical test etc.) about 750 USD (*normally 1,000 – 5,000 USD*)
  - **Relevant tariffs (all based on exchange rate 2017)**:
    - (old) MHP consumers pay **2.1 US₵/kWh** (average)
      for comparison: PLN tariffs 3 / 5 / 11 US₵/kWh for up to 450 / 900 / 1300 W
    - National utility as "new customer" today pays **4.01 US₵/kWh as FiT**

Case of MHP Kalimaron

Yearly Market Share



Monthly Profile



Market	Energy		Revenue	
	kWh	%	USD	%
Electricity Sold and Revenue 2010				
Off-grid	59,304	26.41	1,840	15.83
On-grid	165,270	73.59	9,788	84.17
Total	224,574	100.00	11,628	100.00

Year 2010 price

Capacity Factor (2010): 85%

Community receives more than 6-fold revenues

Profile of Cascading MHPs at Seloliman

- Output (P) 30 kW (built 1994 with 12 kW, 1999 upgraded to 30 kW)
- Design Flow (Q) 300 l/s
- Net head (Hn) 14 meter
- Open channel (150m)+underground PVC pipe (70m)
- Penstock: Pipe Rolled Steel
  - Diameter 300 mm
  - Length 45 m
- **2003 grid connection to sell surplus!**

- Output (P) 20 kW (built 2009)
- Design Flow (Q) 250 l/s
- Net head (Hn) 14 meter
- Head race: Open channel 500 m
- Penstock: Steel
  - Diameter 350 mm
  - Length 35 m
- **2010 both plants sell surplus to PLN!**

Grid Interconnection Regulations

- **<u>IPP</u> Regulation: All produced power is sold to utility**
  - Start from 2002 (Regulation No. 1122/2002)
    - FIT= **80%** of BPP of local system at medium voltage
    - FIT= **60%** of BPP of local system at low voltage

*Note: **"BPP",** Biaya Pokok Penyediaan Pembangkitan, refers to Electricity Generation, Transmission and Distribution Cost, meaning it refers to **avoided cost of overall electricity system cost in province** (e.g. higher if most electricity comes from diesel power plants).*

  - Many regulation changes since then 2002.
  - Latest regulation (No.12/2017) introduces FIT to market price:
    - i.e. Max FIT = **85%** of base BPP of local system

- **<u>Excess power</u>: Only surplus sold to the utility**

  According to Regulation No.19/2017:
    - Max FIT Excess Power = **90%** of BPP of local electricity system

→ Higher remuneration of feeding in of "excess power only" is incentivizing "local consumption" to reduce transmission and distribution cost

Results of Regulations

Nine Off-Grid MHPs Converted to On-Grid

Year	MHP Location	Operator	Capacity (kW)	Cost in year of intercon. (USD)	FIT* (US Cent/kWh)	Yearly income in year of intercon. (USD)
1991/2005	Curug Agung, W. Java	Cooperative	12	12,000	0.84	3,200
1994/2003	Dompyong, E. Java	Cooperative	30	6,700	4.51	-
1994/2003	Kalimaron, E.Java	NGO	30	6,700	4	9,700
2004	Santong, Lombok - NTB	Cooperative	40	10,500	No-info	-
2005/2006	Salido Kecil, W Sumatera	Private	668	14,000	3.32	20,000
2008	Wot Lemah, E. Java	NGO	20	See above	4	6,700
2010	Krueng Kalla, Aceh	NGO	40	60,000	9.05	27,500
2012	Ciganas, W. Java	NGO	100	29,000	4.93	43,000
2013	Bakuhau, Sumba - NTT	NGO	35	14,000	3.95	18,000

Cascading MHPs at Seloliman Village

* Assuming 133 Rp = 1 US Cent (2017)

Results of Regulations

Eight MHPs started as On-Grid

MHP Site	Operator	Year	Capacity (kW)	Cost in year of intercon. (USD)	FIT* (US Cent/ kWh)	Yearly income in year of intercon. (USD)
Waikelosawah	Community	2000	15	2,400	1.8	12,100
Cinta Mekar, W. Java	NGO	2004	120	30,200	3.91	54,600
Melong, W. Java	Cooperative	2004	100	-	3.2	-
Kombongan, W. Java	Cooperative	2006/2009	65/165	-	No-info	-
Ulu Danau, S. Sumatera	Cooperative	2005	224	13,300	4.5	43,000
Sengkaling, E. Java	NGO	2007	100	-	No-info	-
Wanganaji, C. Java	Cooperative	2008	140	-	4.18	-
Banyu Biru, C. Java	NGO	2010	170	23,900	4.93	80,800

* Assuming 133 Rp = 1 US Cent (2017)

Grid Interconnection Benefits

- **For the Utility**

  Access electricity that is **cheaper than its own avoided cost**; "distributed generation" **reduces risk** of total black-out.

- **For community:**
  - Technical

    Improved **capacity factor** and improve **electricity quality**.
  - Commercial

    Generate **additional revenue** for community and/or project developer; Potential to develop a public-private partnership
  - Socio-Economic

    With **additional community revenue:** potential to promote **community development and rural livelihoods**, e.g. income generating activities, support local education, healthcare cultural activity, and watershed protection.

- **Environment**

  Generate awareness of the community on **environment** and improved water management (e.g. reduce trash in river);

  Reduce CO_2 emission from utility's thermal power plants.


Thank you