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

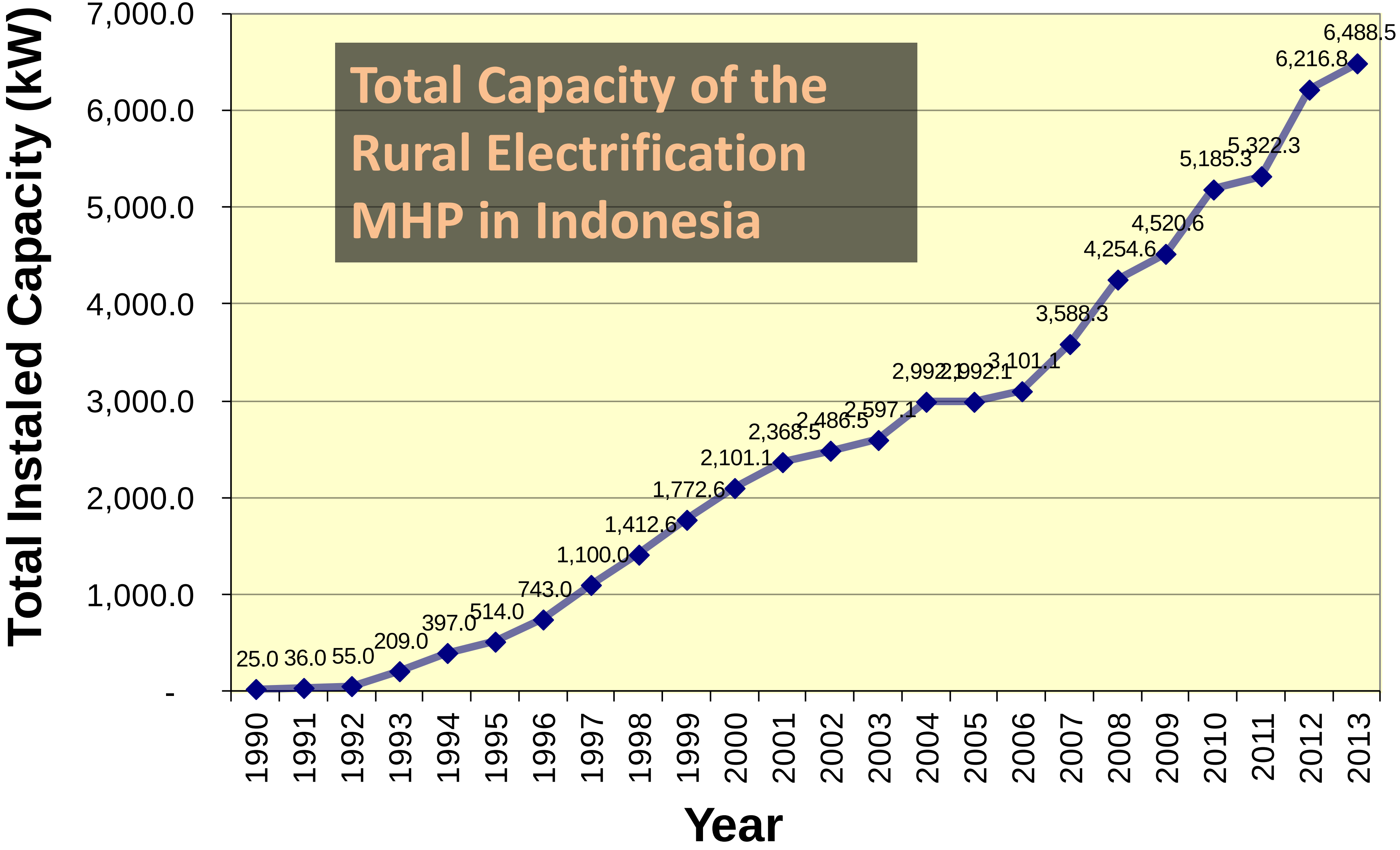
Micro/Mini Hydro Development in Indonesia

- 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)
7,000.0
6,000.0
5,000.0
4,000.0
3,000.0
2,000.0
1,000.0
-
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
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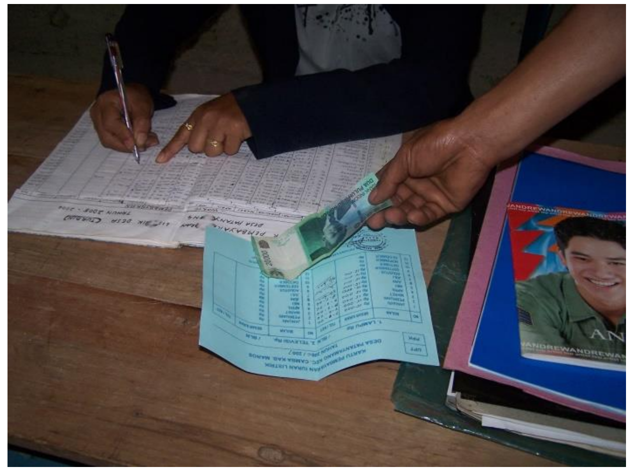
Year

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

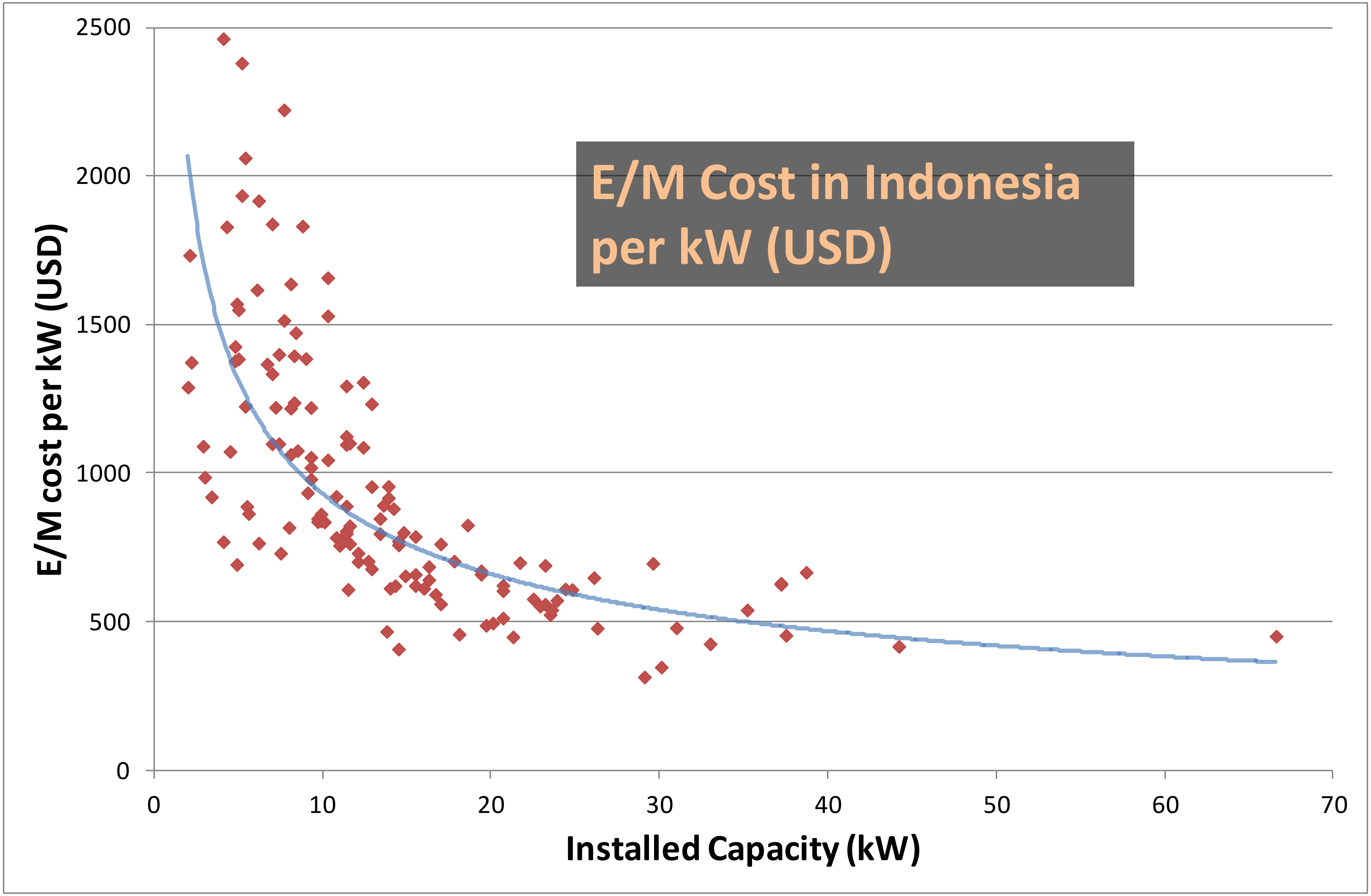
Technical components today “Made in Indonesia”

- 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

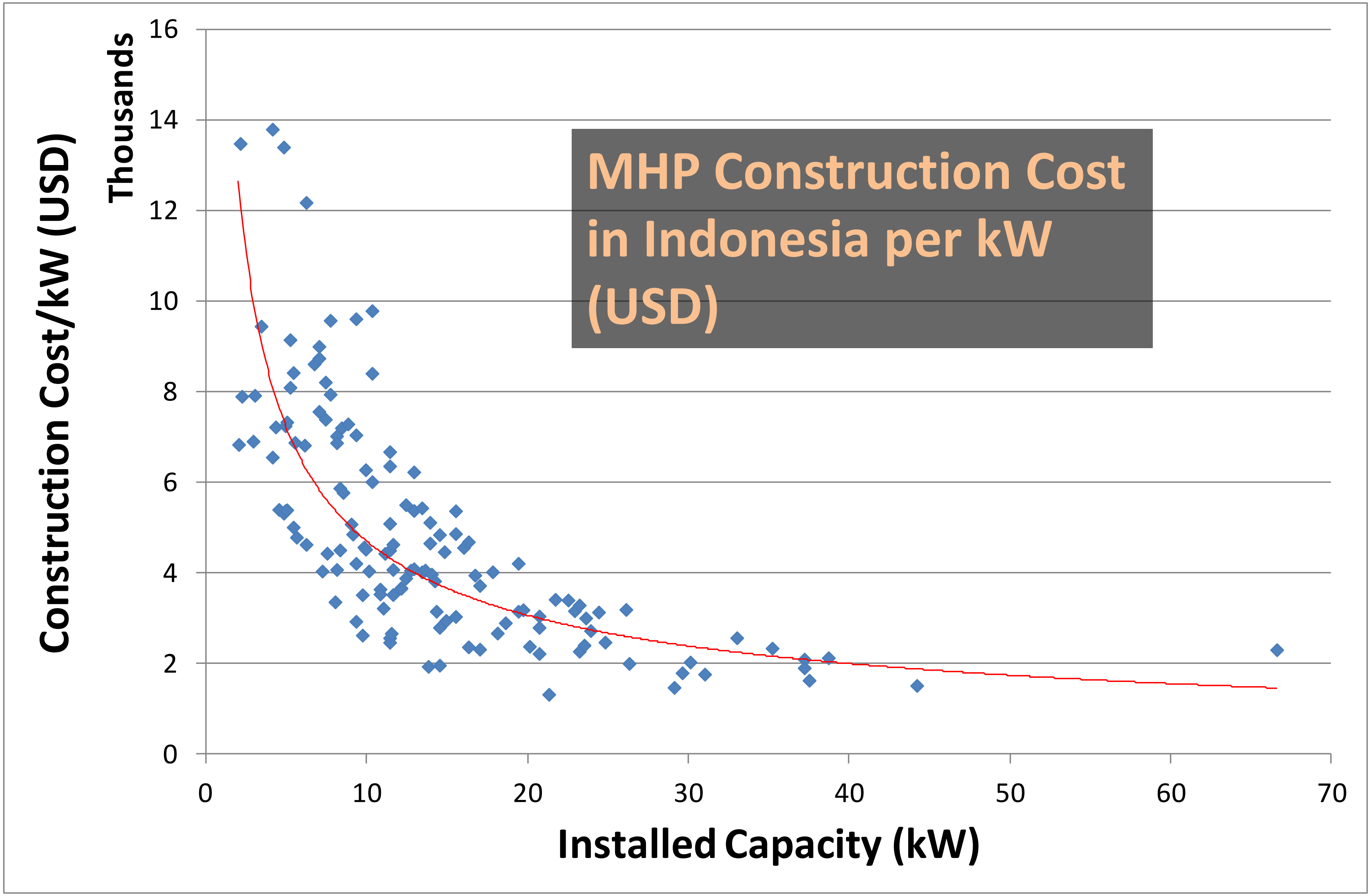
Local Added Value: Job Creation, Micro Hydro Associations, Regional Training Centre

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.

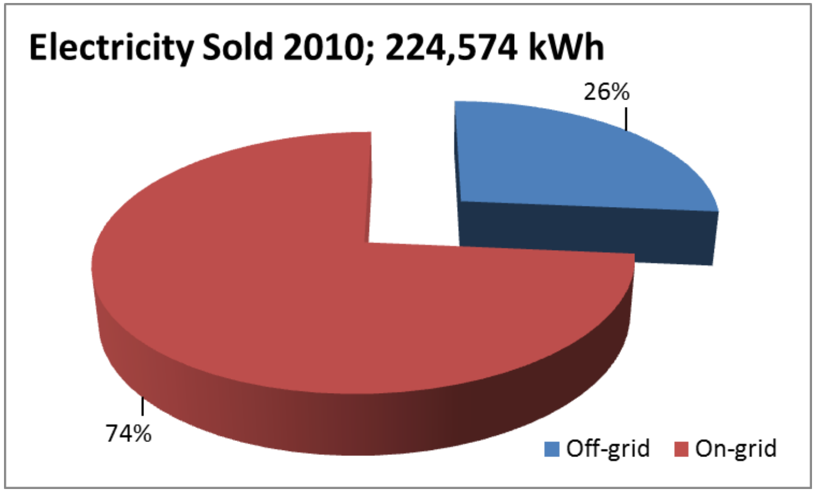
When the National Grid Arrives

Case 2: MHP constructed by NGO

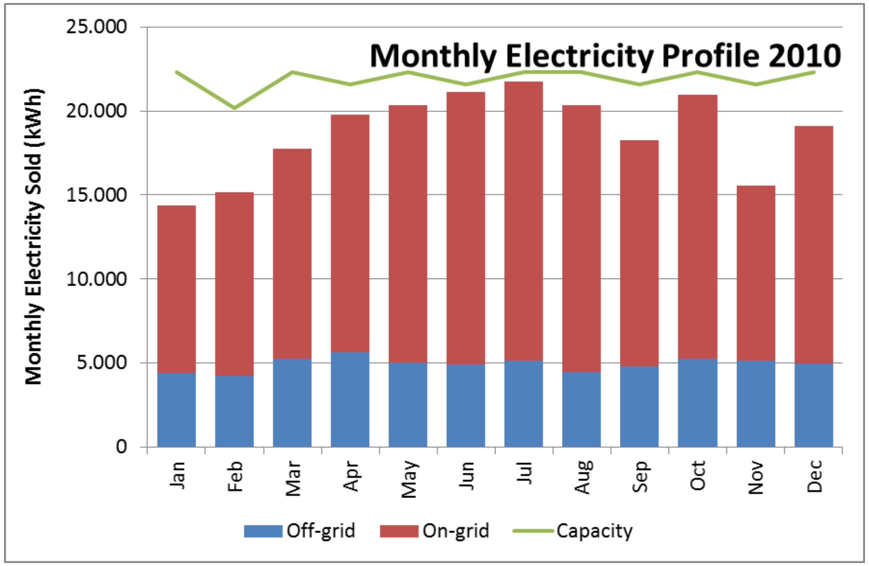
- Assets **owned** by local community/organisation.
- **Policy:** Allowed to connect to and feed into national grid in accordance to applicable FIT.
- **Example MHP Kalimaron:**
  - ➢ Originally constructed (1994) and operated as off-grid scheme;
  - ➢ With issuance of government legislation (no. 1122/2002), 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

- **IPP 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

- **Excess power: 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