

Under which conditions do micro/mini hydro powered mini-grids remain attractive compared to other MG technologies?

Mini-grid webinar series

1: Why mini-grid technologies -- PV, biomass, diesel, micro/mini hydro, wind, and hybrid systems -- need to be differentiated (May 4th , 2017)

Energypedia UG, Hydro Empowerment Network, SKAT Foundation

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Khumbu Bijuli Company (KBC) (630 kW mini-hydro) – Namche Bazaar



Overview

How do hydro mini-grids compare?

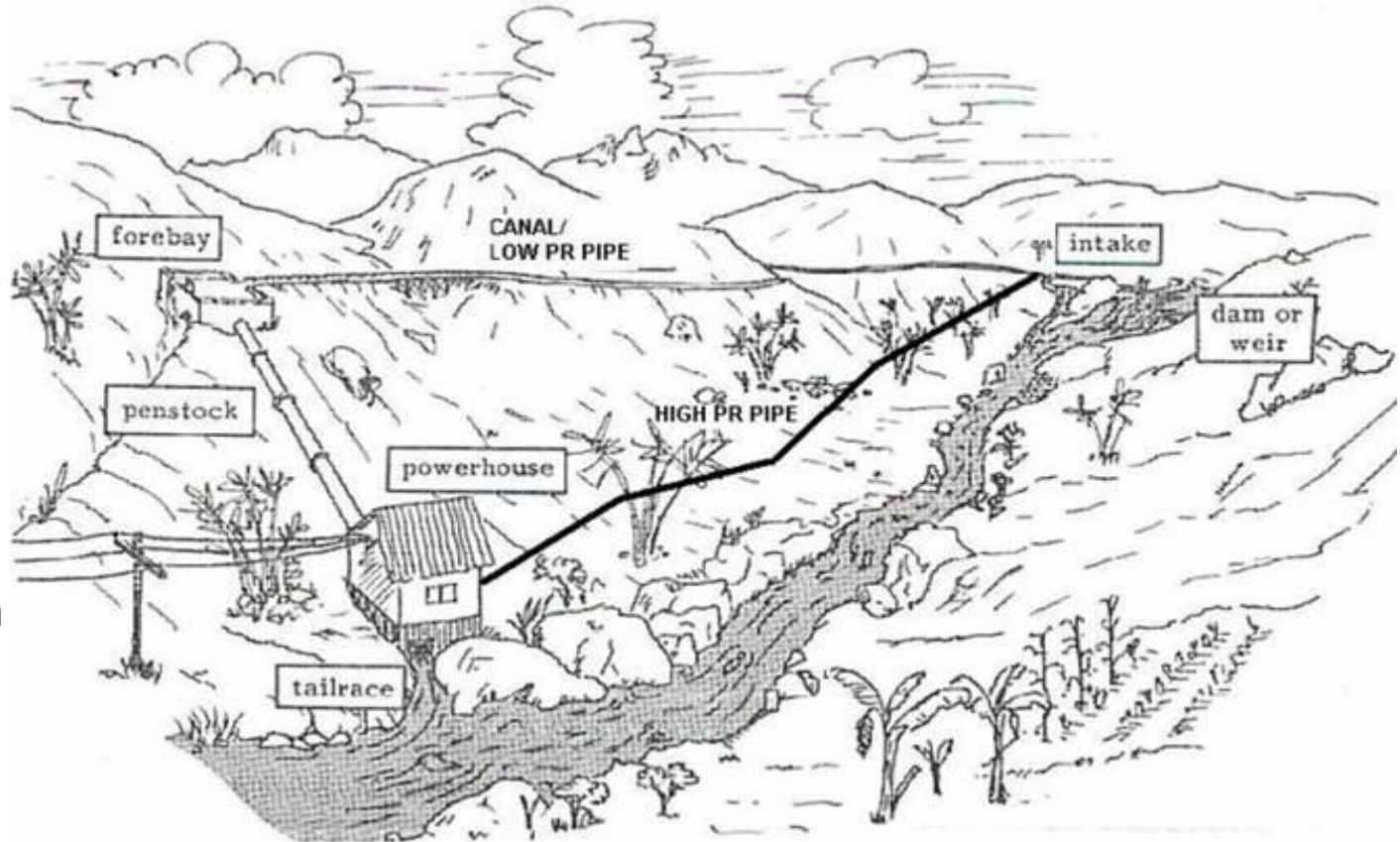
- Investment costs
- Price of energy
- Productive use and load management
- Operation and management
- Specific challenges of hydro mini-grids

Investment costs (\$500-\$10,000/kW)

- Low where there are good hydropower resources and there can be high local content.
- Similar or even more expensive investment costs compared to solar and wind when hydro requires expensive civil works and import of expertise and major components.
- If there is sufficient water in the river it makes sense to oversize civil construction (intake, headrace, penstock pipe) to be able to add a new turbine and generator later, once demand for power increases.

Typical run of river hydro

- Intake (weir)
- Headrace (canal or pipe)
- Forebay tank (or reservoir)
- Penstock pipe
- Powerhouse
- Tailrace
- Transmission /distribution



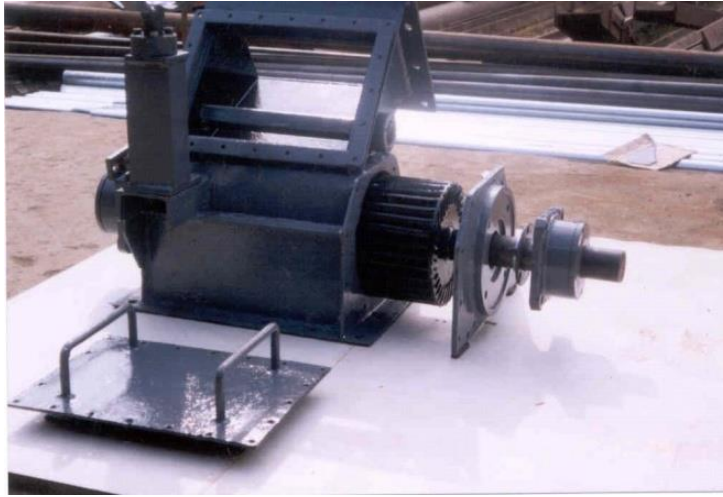
Resources

- Head (2 m – 200m): higher the better
- River gradient or slope ($> 1:50$): higher gradient means shorter headrace construction
- Civil works:
 - secure intake (expensive to build protection from landslide and floods)
 - good geology
 - easy headrace;
- Hydrology: design flow available for at least 10 months a year for isolated system, or space to construct reservoir for daily pondage.

Civil works and site conditions impact cost of installation



Local manufacturing brings down cost of hydro but requires investment to establish



Price of energy (US 0.05 to 0.30/kWh)

- Hydro typically produces 3-4 times as much kWh per kW installed compared to solar and wind (hydro runs: 24 hours, solar: 6, wind: 8)
- Higher the plant load factor the cheaper the energy effectively becomes
- Low cost of energy enables productive end uses and higher revenue from productive loads means lower cost energy for everyone
- Opportunities for using flexible pricing to increase sales of energy during off-peak hours.

KBC – tariff levels to encourage off-peak usage

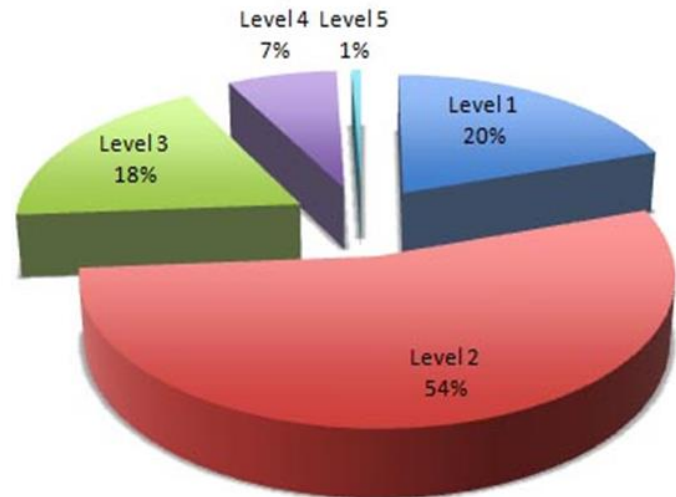
Customer breakdown by level of use

Level	Level wise customer	Average Subscript ion (kW)	power demand (kW)	Type of Customer	Remarks
Level-1	153	0.1	15.3	Social customer (poor household)	
Level-2	431	1.25	538.75	social customer (farmer, trekking & mountaineering business household)	
Level-3	148	3.74	553.52	Commercial customer (lodge, cyber, tailor, mineral water, bar and shop)	Mostly women owned/managed enterprises
Level-4	58	7.48	433.84	Commercial customer (lodge and bakery)	Mostly women owned/managed enterprises
Level-5	5	9.98	49.9	Commercial customer hotel	
Industrial level	3	25	75	Mineral water blowing and cement block factory	
Total	798				
Off peak level-1	32	3	96	Off peak user mainly water heating	
Off peak level-2	59	5	295	Off peak user mainly water heating	

KBC Tariff

Tariff System	Level	Power	Flat Rate USD/mo	Price per kWh (Usc)	Energy meter
Social (74%)	1	100 W	0.60		No
	2	1,260 W	6.00		No
Commercial (26%)	3	4,000 W	3.00	7.50/kWh	Yes
	4	12,000 W	8.00	7.50/kWh	Yes
	5	30,000 W	30.00	7.50/kWh	Yes

Customer Distribution By Connection Level 2069/70



Operation, maintenance, ownership, management

- Village operators can be trained for operation and minor maintenance
- System can be owned and managed by village committee or by a developer
- High subsidy programs typically require community ownership

Specific challenges for hydro

- Can take 1-2 years to construct compared to much shorter periods for solar
- Minimum of one dry season flow needs to be recorded
- Requires investment into local construction and manufacturing capability to achieve low installation costs
- Community micro-hydro can build up social capital but is often associated with low utilization factor of energy. Often requires a capable developer or substantial investment in community capacity building (e.g. KBC) to improve returns.



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