GRID SOLUTIONS
for
ENERGY ACCESS FOR ALL

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Affordable and Clean Energy - Ensure access to affordable, reliable, sustainable and modern energy for all.
Energy <-> Grid Electricity

- What SDG 7 means to an Electric Utility
  - Energy
  - Electric
  - Grid Electricity
  - Hydroelectricity

  Half the assumption is corrected as
  - Electricity is Off-grid in Remote areas
  - On-grid Electricity follows far behind
  - But it is still about Electricity only.

AND electricity as a source of energy is increasing with technology and time (18% world average/ 2% Nepal)
Grid Map of Nepal
Areas covered by Grid Electricity
Off-Grid Nepal
Map of areas covered by AEPC
How Long to wait for Reliable Electricity? Connecting the two – ’Haves’ and ‘Have Nots’

Nepal facts –

1. Mountainous country - Road access is limited
2. Grid Electricity – 60% of the population, Geographical coverage – Central hills, southern plains and eastern border region and western border region – < 40% of populated areas
3. Off-Grid – claims of 15% access, but not functioning, many fall to disrepair within few years of operation
4. Subsidy to Off-Grid Micro-hydro power or solar grid – conditional on distance from Grid > 5 years (No Economics)
Where there is a will, there is a way..
A Snapshot – hard work for Energy in Remote Areas
1. Grid expansion is targeted towards large loads and generators.


3. Grid expansion is capital intensive and has low returns.

4. Grid expansion is afflicted by ROW issues and large affected areas, forcing transmission lines to the government domain in order not to increase the cost of energy.

5. Transmission network is centrally planned (Top-down approach) and expansion is slow.

How long to wait for reliable electricity? >> From Grid Expansion Direction >>
Looking from the Rural Off-Grid

A look at the Off-Grid MHP model

- The distribution network is not safe for grid connection.
- Low Income (low plant factor/low productive uses) forces low quality of Operation.
- Distance from Roadhead increases O&M time and cost.
- MHP Design at river discharge of high exceedence (Q90); yet Plant factor is 20-30% only.
- The Electronic Load Controller (ELC) is used. Controls frequency by dummy load. Useful where raw material is free—Water/wind/solar etc.
- The switchgear is not ready for grid interconnection.

BUT most villages would find a viable river source for MHP (pico, micro or mini) if a workable business model and funding available.

Problem of MHPs—Low Income (low plant factor) forces low quality of Operation.

Low skill/knowhow, low p.f. and low revenue, accessibility, less room for industrial use >> tendency to fail.
“We cannot solve our problems with the same level of thinking that created them.”

- Albert Einstein
Grid Solutions to Off-Grid distribution

1. Inter-connection of Clusters of small power plants in a mini-grid ready for Connectivity with Grid

2. Help / subsidy >> Grid-readiness for remote/ offgrid generators/ users >> synchronizing switchgear and relaying

Grid Energy is mostly cheaper and reliable than Isolated systems.

1. Distributed Generation has Multiple Impacts on Local economy that offsets the Initial high costs of electricity

2. Spin-off for Grid - Reduces demand on Reinforcement of grid & Reactive power management by doing Distributed generation

Most rural areas in Nepal have Some sources to produce Electricity

1. Mountain areas – Hydro and Solar; Remote areas in Terai – Solar and Biopower, some areas – wind etc.

2. Government support for Grid Connectivity – Sustainability of the DG and also enable expansion of grid. ‘Biggest Bang for a Buck’

>> EARLY ACCESS TO CLEAN ELECTRICITY BY ALL >>
Role of **Switched ELC** in Grid-operated MHP –
1. Protective device against Over-speed during Grid-disconnect
2. Allows Operator mobility and free to work within village
**Typical costs of Interconnection of a <100 kW MHP**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCB</td>
<td>6 lakh</td>
</tr>
<tr>
<td>Transformer</td>
<td>4 lakh</td>
</tr>
<tr>
<td>CT, PT - 0.5C + meter</td>
<td>2 lakhs</td>
</tr>
<tr>
<td>Synchronizing eqpt, ELC+ AVR modification</td>
<td>4 lakh</td>
</tr>
<tr>
<td>Switchyard, LA and Isolator, Earthing</td>
<td>3 lakh</td>
</tr>
<tr>
<td>Commissioning</td>
<td>2 lakh</td>
</tr>
<tr>
<td>VAT + contingency</td>
<td>3 lakh</td>
</tr>
</tbody>
</table>

Total -24 lakh ~ 24,000 $

Providing for O&M costs and interest of loan, the Payback period is 7/8 years for 20 kW, and 4/5 years for 30 kW, excluding Plant costs and interests if any.
Hence, *Interconnection requirement at 11kV with VCB and metering is Not Viable for very small MHP*
BangDovan Mini-grid- Baglung District
>> Along Mid-hill highway; Grid is within 50 km reach
>> Population and electricity demand is increasing – it is Off-Grid
>> Planning for a sub-transmission and mini-grid subsidy will deliver Grid supply quickly
Usually, Isolated MHPs fall into disrepair (the community is not well-synthesized, and tariff does not support major repair, nor quality operation)

MHPs when connected to grid – provides incentive to operate

Becomes Sustainable

- Sustainability of MHP is a net gain for community and the government.
- No sunk costs, technical base
- Capacity investment, dry season energy

Challenges

- Feed In tariff – comparably Low
  
  [NRs 4.8 (8mth)/8.4

- Financing for Interconnection equipment – High costs

- Once grid-connected, capacity can be upgraded (from Q90 to Q40)

- Plant Factor may increase from 30% to 90%

Private equity injection to MHP/Isolated mini-grid and private management models are being explored to make them sustainable.
What works for MHP ... will also help Access for Rural areas, So...

Source – World Bank report on Nepal: Scaling up Access through mini-grid
Connecting Off-Grid to Grid-> Best of Both Worlds

- Off-Grid MHP - Subsidy for Grid-Connectivity

- Required -> Sub-transmission networks – radial 132kV line, 132/33/11 kV substations and 33/11 kV lines to villages/ MHP

- Investment in Sub-transmission lines by Govt. - as Integrated subsidy plan to clusters of MHPs, padded with soft Loans - in Build – Own – Transfer BOT model -

- After Subsidy, remaining Amortized costs to be recovered as Local Transm. Charges from present and future Users of the Line

Optimized Network planning – from sub-transmission line requirements from villages – “Bottom Up but Coordinated” approach

Subsidy to Off-Grid electrification with “Biggest Bang for the Buck” - Distributed Generation bringing multiple local benefits + system benefits

What Next? CEUG.
Financial Initiative that worked – Grid Connected – Community Electricity Users Group CEUG

**Subsidized distribution of electricity** at NRs 3.60 / kwh to Community Electricity User Groups (CBOM)

**Community Electrification** – 90% subsidy by Government – 10% community - enabled expansion of rural networks at 400V / 11 kV and 33 kV

It has worked – No of CEUG increasing and its consumer members

The technical (distribution- 6-8%) and non-technical loss (> 8-10%) that otherwise occur justify the **reduction in tariff below cost of generation**, Generation and transmission cost = 27382 M NRS, Total energy = 4794 (6% system loss) M units, = **5.70 / unit Cost of Energy** for NEA at 11kV delivery - w/o operating costs /depreciation / overhead)

Tariff needs revisit due to increased purchase price.

**Administrative cost of NEA ( Losses )** to administer the Rural Distribution is saved.

For Embedded Generators within CEUG, Purchase tariff is Bounded.
For Larger MHPs, near such CEUG, it should be connected to Grid directly before the CEUG point – to enable it to get the Regular PPA Tariff.
Options for Grid Solutions

1. Optimized network planning and Extensive Public Investment

2. Private Investment for the Funding Gap - > Market-based Transmission Development – *Only suitable for Large Generators and Consumers*
## NEPAL High Voltage Transmission Lines & Substations

<table>
<thead>
<tr>
<th>Transmission Lines</th>
<th>Existing (Circuit km)</th>
<th>Under Construction (Circuit km)</th>
<th>Planned (Circuit km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>66kV Voltage Level</td>
<td>511.16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>132kV Voltage Level</td>
<td>2337.7</td>
<td>1010.0</td>
<td>1320.0</td>
</tr>
<tr>
<td>220kV Voltage Level</td>
<td>-</td>
<td>659.0</td>
<td>949.8</td>
</tr>
<tr>
<td>400kV Voltage Level</td>
<td>-</td>
<td>648.0</td>
<td>6495.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2848.86</strong></td>
<td><strong>2317.0</strong></td>
<td><strong>8765.4</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substations</th>
<th>Existing (Numbers/Capacity)</th>
<th>Under Construction (Numbers/Capacity)</th>
<th>Planned (Numbers/Capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>66kV Voltage Level</td>
<td>13/509.15MVA</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>132/66kV Voltage Level</td>
<td>28/1622.4MVA</td>
<td>10/506.5MVA</td>
<td>21/917MVA</td>
</tr>
<tr>
<td>220kV Voltage Level</td>
<td>-</td>
<td>-(* )</td>
<td>18/3876MVA</td>
</tr>
<tr>
<td>400kV Voltage Level</td>
<td>-</td>
<td>-</td>
<td>5/2025MVA</td>
</tr>
</tbody>
</table>
The core of the transmission network is to be commissioned during the next 10 years. The total investment cost planned for the whole 2015-2035 period amounts to 5.15 billion USD and is mainly concentrated in the first ten years, i.e., between 2015 and 2025:
Grid Expansion Issues ...

1. Optimized network planning and Extensive Public Investment

2. Private Investment for the Funding Gap - > Market -based Transmission Development – Only suitable for Large Generators and Consumers

3. For challenge faced from PAF by ROW and Towers –
   1. Considering options of Long-Term Lease in lieu of Purchase/one-time compensation – Yet to be proven.
   2. Pro-rata allocation of Project developer equity from the lot given to affected people – Long-term benefit sharing by the people – Yet to be proven

4. Build, Own and Transfer (BOT) model for transmission / distribution lines by communities and Build Transfer model for isolated generators – Policy in process

5. Policy of declaration of shallow Grid – Not done yet
Grid Solutions

Focus - DG and Village Load potential

Integrated Planning for Sub-transmission network

Energy to All by National Grid Access

Subsidy / Soft Loan for 33 and 11 kV sub-trans/distrib links to Grid

Policy for Transmission charges and Private Trans owner / operator

MHP subsidy Extend TO Grid Synchro equipment

Build and Transfer BT Policy for Private Generators

Community Electricity Users Groups CEUG - Handover

Change Approach - Grid Planning for DG and Rural Access

Use Hydro-developers’ strength for Construction & ROW

Efficient Admin of Rural Consumers

Sustainable / Profitable MHP – “Most Bang for Buck”

Earlier Access -> Amortized costs

Funding Deficit -> Private Capital

Off-Grid

Grid Side
What has worked?

- MHP and distribution network with larger consumer base and anchor loads – Case – Khumbu Bijuli (900kW), Salleri Chyalsa (400kW) – Having Periodic oversight and Support
- Subsidized tariff to CEUG (having small consumers & capped to 5 A users) – Successful CEUGs adapting the lessons learnt.

What needs reform?

- Stand-alone MHPs with weak consumer base – Scale up!
- Top-down Rural Electrification without Regional Optimized planning –> Reverse direction!
- Subsidy for MHP / Rural electrification – Include Grid Connectivity with Partial Payback (90/10 model) in the Integrated Subsidy model!

What can be learnt? for Rapid Grid Expansion

- Involve community – allow BOT for sub-transmission networks and Use subsidy/ VGF model
- Involve Private / Developers – and / or allow BT model for rapid expansion of Main Grid
Creativity and adaptation

✓ **Top-down** approach of grid-planning coordinated with **Bottom-Up** approach to Identify/Prioritize and

✓ **Investment Rethink** - Need to support/ subsidize community-driven / **owned grid-connection** and expansion coupled with **local DG economics**.
Thank you! Namaste!