MICRO HYDRO SCHEME FOR RURAL DEVELOPMENT: ENVIRONMENT FRIENDLY ENERGY SUPPLY AND OPTION FOR SOCIO-ECONOMIC DEVELOPMENT

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NEPAL: AN OVERVIEW

Population: 25 million (2003E)
Main Export: Huge possibility for Exporting electrical energy.
Electricity: 5.256 GWh  2003E
Fossil : 5.13%, Hydro: 94.87%
HISTORY OF EVOLUTION OF PRIVATE & PUBLIC SECTORS

Trends of Development of public and private companies in Nepal since 1900

Public Utility (1900-1995)

Private Power Companies
1942 Morang Hydro Electric Co.
1949 Birgunj Electric Power Co.
1963 Bageshari Electric Co.
1963 Eastern Electric Co.
1964 Dharan Electric Supply Co.
1965 Butwal Power Company
1994 Lamjung Electricity Dev. Co.

Private Companies (1900-1995)

Structure of Public Utility
1911 Bizuli Adda (Electric Office)
1958 Electricity Department (ED)
1962 Nepal Electricity Corp. (NEC)
1985 Nepal Elec. Authority (NEA)*
*formed by merging ED & NEC
1995 Electricity Dev. Center EDC)
1995 Electricity Dev. Dept. EDD)
CLASSIFICATION OF HYDRO PROJECTS

HYDRO PROJECTS:

(1) Hydro Power Generation
(2) Hydro Schemes

(1) Hydro Power Generation

(a) Pico hydro [<5 KW]
(b) Micro hydro [5 -100 KW]
(c) Mini hydro [0.1 –1 MW]
(d) Small hydro [1 -10 MW]
(e) Medium/Large hydro [>10 MW]

(2) Hydro Schemes

(a) Mechanical for agro-processing etc.
CLASSIFICATION OF HYDRO POWER PROJECTS BY SIZE CONT'D....

Large- hydro: >100 MW, Feeding into large electricity grid
Medium-hydro: 10 - 100 MW - Usually feeding into a grid
Small-hydro: 1 - 10 MW - Usually feeding into a grid
Mini-hydro: 0.1 MW - 1 MW; Stand alone schemes or more often feeding into the grid
Micro-hydro: 5 KW – 100 KW, Stand alone/Add-on Types
Pico-hydro: Less than 5KW (Provided power for a small community or rural industry in remote areas away from the grid.)

KW (kilowatt) - 1000 Watts; MW (Megawatt) - 1 000 000 Watts or 1000 kW
MICRO HYDRO ENERGY SITUATION IN NEPAL

Cost of MHP plants: US$ 655 - 2200 per kW (in 2002 dollars)

- 1950 => Concept Started
- 1970 => 50 KW/1 BPC*
- 1980 => 9 KW/10 Nos.
- 1985 => 166 KW/23 Nos.
- 1990 => 549 KW/615 Nos.
- 1999 => 87000 KW
- 2002 => 13000 KW/2000
CARBON DIOXIDE EMISSIONS

(One tenth of millions)

0  250  500  750


Thousands Metric Tons

Year

Population*

CO₂ Emissions

Million Metric Tons

Millions Metric Tons

Fiscal Year (A.D.)

Japan

Nepal

0  50  100  150  200  250  300  350

0  0.2  0.4  0.6  0.8  1

0  200  400  600  800  1000

0  250  500  750

1950 1970 1990 2010
(1) Per Capita CO₂ emission in Japan is roughly 100 times greater than Nepal (10-25).
(2) There is a sharp rise of CO₂ generation and Per capita CO₂ from 1990 to 1999 in Nepal, whereas there is a peak in the 1970-1980 and afterwards there is a decrease in CO₂ generation in Japan.
COST STRUCTURE IN NEPAL

Pico-hydro: (<5KW)

Micro-hydro: (5-100KW)
US$ 655-US$ 2100

Mini-hydro: (0.1-1MW)

Small-hydro: (1-10MW)

Medium-hydro: (10-100MW)
US$ 1200- US$ 3500

Large-hydro: (>100MW)
(>US$ 2640)
Fig. 5 Electric generation and persons/KW

25 Watts/Person (2003)

Watts/Person

Persons per KW

Year (A.D.)

1900 1930 1960 1990 2020

Thousands of KW

0 200 400 600 800 1000

0 100 200

0 1000

1900 1930 1960 1990 2000

Watts/Person

Persons per KW

Year (A.D.)


25
## SAMPLE SITES

<table>
<thead>
<tr>
<th>Schemes</th>
<th>Capacity</th>
<th>Cost/KW</th>
<th>Ownership</th>
<th>Turbine</th>
<th>End-Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harichau</td>
<td>25</td>
<td>US$ 2160</td>
<td>Private</td>
<td>Cross-flo</td>
<td>Battery Charging, Milling, Lighting</td>
</tr>
<tr>
<td>Hatiya</td>
<td>?</td>
<td>N/A</td>
<td>Private</td>
<td>Cross-flo</td>
<td>Milling, Lighting, Saw</td>
</tr>
<tr>
<td>Ghandru</td>
<td>50</td>
<td>2252</td>
<td>Community</td>
<td>Pelton</td>
<td>Lighting, Milling, Heating/Cooling</td>
</tr>
<tr>
<td>Barpak</td>
<td>50</td>
<td>1295</td>
<td>Community</td>
<td>Pelton</td>
<td>Lighting, milling, ropeway etc.</td>
</tr>
<tr>
<td>Gorkhe</td>
<td>25</td>
<td>655</td>
<td>Private</td>
<td>Pelton</td>
<td>Battery charging, milling, drying</td>
</tr>
</tbody>
</table>

### Summary: Sample Projects Studied in Detail

<table>
<thead>
<tr>
<th>End-Uses</th>
<th>Community</th>
<th>Private Entrepreneur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
LOAD CHARACTERISTICS: PLANT FACTOR ISSUES

Load Factor (including mechanical): Ratio of Output KWh to the nominal plant capacity
Harichour: 28%

It is very unfortunate to say that load factor of many MHP plants are found very low.
### IMPACT ON SOCI ECONOMICS

<table>
<thead>
<tr>
<th>Education</th>
<th>Food</th>
<th>Medical</th>
<th>Security</th>
<th>Employment</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Impact on Education</td>
<td>Enhancement of security</td>
<td>Improvement in health care</td>
<td>Positive Impact of security</td>
<td>Enhancement on job opportunities</td>
<td>Source of Income</td>
</tr>
</tbody>
</table>

**Economic growths:** REP has brought the community leading to the sustainable development in many areas.

**Quality of life:** Improvement in quality of life.

**Better health:** Better Medical Care

**Performances:** Students able to devote longer hours resulting better performances in study.

**Access to Media:** Entertainment (TV/Radio) & access to global world.

**Security:** Electrification brings safety.
MICRO HYDRO BLOCK DIAGRAM & AC INDUCTION MICRO HYDRO TURBINE

Induction Motor used as a Generator

- Step up/down Transformer
- Output to Load
- Optional Transformer
- Optional Transformer
- AC Loads
- Automatic Voltage Regulator
- Electronic Load Controller
- Volts / Hz. Regulator
- Shunt Loads
# CARBON DIOXIDE MITIGATION OPTIONS

<table>
<thead>
<tr>
<th>Divisions/Subdivision</th>
<th>Mitigation Options (Japan) Adoption of energy conservation Technologies</th>
<th>Mitigation Options (Nepal) Shifting energy from fossil to renewable energy sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial Sectors</strong></td>
<td>● Photovoltaic Power Generation&lt;br&gt;● Lighting devices with Sensor</td>
<td>● Lighting device with sensor.</td>
</tr>
<tr>
<td><strong>Residential Sectors</strong></td>
<td>● Reduction of leakage of electricity in electric household appliances&lt;br&gt;● Introduction of Latent Heat Recovery Heater</td>
<td>● Replacing kerosene and fuel wood by Biogas &amp; MHPs&lt;br&gt;● Reduction of leakage electricity</td>
</tr>
<tr>
<td><strong>Public Utilities</strong></td>
<td>● LNG power Plants&lt;br&gt;● Extension of Nuclear Power&lt;br&gt;● Fuel Cell &amp; Waste Power Generation</td>
<td>● Hydro electric Plants&lt;br&gt;● Replacing Thermal by Solar/Hydro</td>
</tr>
<tr>
<td><strong>Transport Sectors</strong></td>
<td>● Electric Vehicles&lt;br&gt;● Hybrid-powered Buses</td>
<td>● Electric Vehicles&lt;br&gt;● LNG Vehicles</td>
</tr>
</tbody>
</table>
VIABILITY OF MICRO HYDRO AND RURAL ELECTRIFICATION IN NEPAL

- Population: Growing rapidly, more than 1.3 billion (2002E)
- Economic Growth: Energy need growing rapidly
- Carbon dioxide: CO$_2$ emissions is increasing sharply in the recent days.
- Big Hydro: Negative impact on environment & Cost of production is larger
- Solar power: Popular, but MOST expensive
- Wind power: Wind is unpredictable.
- Fuel cells: Better for the environment, However, the manufacturing cost is the highest
CONCLUSION

- It should be firmly realised that Micro hydro power as an renewable energy source and as a mitigation of CO$_2$ generation, is an inevitable energy for Nepal.
- Load factor issue must be considered during planning stage
- The private sector, NGOs, and government utilities need to play concentrated role. A policy incentive package need to be introduced.
- A quality control mechanism need to be introduced.
- Role of each unit involved need has to be clearly defined.
- The micro-hydropower plant need to be considered as a nucleus of overall development of Nepal.