Welcome

Further Optimization of Upper Karnali Project: A Key to Energy Crisis and Prosperity

By

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Content of Presentation

• Why this Presentation
• Why Upper Karnali in Consideration
• Conceptual Layout of Development Options
• Technical and Financial Indices of Options
• Comparison with Other Reservoir Projects
• Financing Model
• Time Frame of Implementation

Why this Presentation

• Cheap, Reliable Energy is the Key input for industrial Development and Prosperity of any Nation
• Do we have Resources?
  • No Oil, No Gas, No Coal
  • 83,000 MW, 44000 Economically Feasible Hydropower
  • With the balance of Storage and RoR Projects ~ 100,000 MW (with PF~ 0.5) can be generated
  • Considering all kinds of benefit (Power, Irrigation, Navigation, Fisheries, Water Supply, Recreation…) about 12 times the Annual Budget (6,000 bln/Year)
  • And Energy can be generated at a much cheaper price if we develop in a planned way

• Do we have Financial Resources?
  Remittance Alone
  • About 4,000,000 Nepalese work outside
  • About 2,500,000 alone in Gulf and Malaysia
  • Minimum wage is NRs 25,000/month (saving)
  • In average NRs 40,000/month (saving) can be estimated
  • In Annual term 12 00 bln is received through official and non official (Hundi) channel
  • However most of this resource is not utilized in productive sector
Why this Presentation

- **Existing Scenario**
  - **Power Energy Scenario**
    - ~ 700 MW Installation with < 50% capacity in Winter
    - Peak load ~ 1100 MW
    - Load shedding ~ 18 hrs plus
    - 1200 MW addition in 4 years all except KL-3 (14 MW) are RoR
    - Only ~ 250-300 MW will be available in Winter
    - In 4 years time again a shortfall of ~ 600 MW
    - Large Storage Project with capacity ~ 1500-2000 MW should be sought in 10 yrs time horizon

Why this Presentation

- **Existing Scenario/Plan**
  - **Upper Seti – Tanahun 140 MW**
    - Small reservoir, very expensive
  - Budigandaki Storage (600 MW in next 8-10 yrs)
    - Very expensive, social issues severe, severe impact for eg. Flood, Financing ~ 250 bin not easy
  - Nalsaugad (400 MW) in Planning
    - In Ten years horizon again we will have shortage of ~600 MW
  - Remember for a similar dam height the cost of the dam is almost same be it Kulekhani or Karnali

Why this Presentation

- **Import from India ????**
  - Upper Karnali 900 MW
    - 12% free Energy, 27% Equity, Royalty etc. Looks wonderful
    - 900 MW in Summer, ~150 MW in Winter out of that 12% (~18 MW will be supplied to domestic grid)
  - Similar situation with Arun 3
    - Imbalanced generation makes energy very expensive and state authority Bankrupt
  - Ministry of Water Resources eliminated, institutions weakened or destroyed
  - **Who to be blamed???

Problem in Understanding??

- Whether we need Power/ Energy?
- Whether we need Water?
- Whether we need both water and Energy?
- In Major river basins we have surplus water for irrigation and Water Supply
- Only in some Basins such as Babai, Kamala, Bagmati are deficit basins
- Therefore, not a dam with big storage but a small dam/reservoir with multiple benefit in cascade is the viable and cheaper option for Nepal
Problem in Policy/Regulations

- Licensing Haphazard
- No policy for the pricing of Regulated flow
- Licensing of RoR Projects is a continuous process
- No River Basin Study
- No Master Plan
- Made aware Chief Secretary and DoED – no Response from either institutions

Why Upper Karnali Project (UKP)

- Because of Magic bend with a head difference as 140 m this project is the cheapest in Nepal and probably in the World
- Often called “Jewel of the Crown” by Engineers and Economist
- Instead of Developing a single PRoR Project as planned (UK 900 MW) dam and reservoir followed by RoR project with several options can be planned.
Methodology

- Topography and Head: Topographical Map, 1:25,000 (FinMap)
- Geology: FSR by NEA/CIWEC, 198? and Site Visit and Study
- Quantity Estimation: Sections Drawn from Topo Sheets, Quantity Estimates from “Base Cost for large Hydropower Plants, NVE, Norway, 2010
- Cost: NVE, 2010 and Contractor’s rates from ongoing Projects, Nepal
- Benefit: Avg. Price of Energy U$c 6.0/kWh
- Reliability/Accuracy: Revenue ±5%, Cost (±20%)

Hydrology and Energy Potential

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<tr>
<th>Month</th>
<th>Days</th>
<th>Q (m3/s)</th>
<th>Asraghat (1962-2006)</th>
<th>Env Runoff (mcm)</th>
<th>Effective Runoff (mcm)</th>
<th>Runoff Wet</th>
<th>Runoff Dry</th>
<th>Gexcess</th>
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<td>Nov</td>
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<td>234</td>
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<td>Dec</td>
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Hydrology and Energy Potential

- FSL: 620 m
- MDDL: 730 m
- TWL: 480 m
- OD: 619.6 m
- Gross Head: 340.0 m
- Net Head at FSL: 333.2 m
- Reservoir Variation: 90.0 m
- Rated Head: 304.0 m
- Overall efficiency: 0.9 m
- Installed Capacity: 1,822,704 kW
- Total Generation at rated head: 11,626 GWh
Development Alternatives

Alternative 1: Projects in Cascade

- Project 1: Reservoir Project
  - 230 m Dam at Tuinkuna (U/S of Ramagad) with FSL at 820 masl
  - Gross Head = 200 m
  - Powerhouse at Dam toe
  - Discharge = 680 m$^3$/s
  - Power = 1177 MW
  - Energy = 6272 GWh

- Project 2: RoR Project in Cascade
  - Tailrace Tapping with FSL at 620 masl
  - TWL = 480 masl
  - Gross Head = 140 m
  - Underground powerhouse
  - Discharge = 680 m$^3$/s
  - Power = 825 MW
  - Energy:
    - RoR 3931 GWh
    - Reservoir storage 1303 GWh
    - Total 5233 GWh
Development Alternatives

Alternative 2: Projects not in Cascade
Assumption: Project 2 starts earlier (Now)

- Project 1: Reservoir Project
  - Same as in Alternative 1
- Project 2: PRoR Project downstream of Ramagad
  - FSL at 620 masl
  - Diversion Headworks with all components
  - TWL = 480 masl
  - Other Parameters same as Alternative 1
- As the project starts earlier, about NRs 15-18 Bln more compared to Alternative 1

Development Alternatives

Alternative 3: Single Dam/reservoir

- Dam/Reservoir at Dailekh/Achham
  - FSL = 820 masl
  - TWL = 480 masl
  - Gross Head = 340 m
  - Underground Powerhouse across Valley
  - Discharge = 680 m³/s
  - Power = 1823 MW
  - Energy
    - Wet = 7716 GWh
    - Dry+ storage = 3910 GWh
    - Total = 11626 GWh
Comparison of Alternatives

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Single Project</th>
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</thead>
<tbody>
<tr>
<td>Storage RoR (MW)</td>
<td>1177</td>
<td>824</td>
<td>1177</td>
<td>824</td>
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<td>Total Power (MW)</td>
<td>6272</td>
<td>5233</td>
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<td>5233</td>
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<tr>
<td>Total Energy (GWh)</td>
<td>1719</td>
<td>375</td>
<td>1719</td>
<td>537</td>
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<td>Total Cost (US, Mln)</td>
<td>690</td>
<td>691</td>
<td>691</td>
<td>537</td>
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<tr>
<td>Cost/kw (US$)</td>
<td>1045</td>
<td>1128</td>
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<td>Cost/kwh (USc)</td>
<td>2.0</td>
<td>2.2</td>
<td>1.95</td>
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<tr>
<td>Cost/kwh (NRs)</td>
<td>2.0</td>
<td>2.2</td>
<td>1.95</td>
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</table>

Note: Interest Rate: 10%
Plant calculation Without IDC

Benefit to downstream Project

- Benefit in Capital investment
  - No dam, no settling basins, which is major cost item of Civil works. NRs 15 -18 Bln saving
- Benefit related to Operation and Maintenance (Annual Flood and Sediment benefit)
  - No or negligible outage of plant
  - No or negligible damage in hydro-mechanical equipment such as turbines and accessories, 3-4% of revenue in most of the RoR projects
  - Significant reduction in operation maintenance cost, especially, due to reduced number of manpower

Which Alternative Preferred

- Phase 2 Development
  - With the development of RoR projects, peak demand will be increased
  - About 2000 Mw can be installed keeping 8hrs/day peaking (West Seti, BG 640 etc)
  - Therefore, Alternative 1 with Dam and Reservoir upstream followed by RoR plant with tailrace tappings is recommended.

Benefit to downstream Project

- Benefit due to Catastrophic Flood events and Glacier Lake Outburst Floods (GLOF)
  - With the reservoir upstream, flood is dampened and smaller flood peak is generated. In case of GLOF, flood peak may not be the issue but a debris flow, with a huge quantity of bed load is anticipated, which is trapped in the upstream reservoir.
- Benefit in revenue due to augmented flow during dry season
- If sold in a same market the Energy Price will be much higher because of increased Firm Energy
**Downstream benefit**

**In Nepal**
Reduction of dam height at least by 20-40 meters in Karnali Chisapani Dam.
No irrigation benefit is perceived in Nepal as there is already sufficient flow for such purpose.

**India and Bangladesh**
Irrigation: 500,000 ha additional (which receives no water during dry season) can be irrigated.
The resulting net benefit according to a research carried out in farm land of Bihar is about NRs 15 billion/year.

**Flood Benefit**

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**Cost Benefit Sharing**

- Downstream project – right to Energy due to Natural Flow only ~ 4000 GWh
- Upstream project – right to regulated Energy from downstream Project- Total 7600 GWh
- Saving in Capital cost in d/s project can be settled by mutual understanding
- Cost/Benefit sharing with India/ Bangladesh can be settled with dialogues

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**UKP VS other Reservoir Projects**

**UKP VS other Reservoir Projects**

- Study of ICIMOD - So Far no threat to GLOF
- Sediment concentration 3 times less than other rivers such as Budigandaki
- Much less Environmental and Social impact, sparsely populated area (~ 800 HH within Reservoir area counted from Topo sheet)
- Generation cost too low

**UKP VS other Reservoir Projects**

<table>
<thead>
<tr>
<th>Name of Project</th>
<th>Power (MW)</th>
<th>Energy (GWh)</th>
<th>Dam H (m)</th>
<th>Reservoir (mcm)</th>
<th>Total Cost (Bln,NRs)</th>
<th>Cost/kW (Mln,NRs)</th>
<th>Approx.Cost/kWh (NRs)</th>
<th>Revenue, Nepal (Bln,NRs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancheswar Multipurpose Project (PMP)</td>
<td>6,480</td>
<td>10,671</td>
<td>315</td>
<td>6,560</td>
<td>298</td>
<td>45,988</td>
<td>3.07</td>
<td>53.41</td>
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<td>Upper Seti</td>
<td>140</td>
<td>586</td>
<td>140</td>
<td>323</td>
<td>45</td>
<td>321,429</td>
<td>8.45</td>
<td>3,516</td>
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<td>Budigandaki</td>
<td>640</td>
<td>1,800</td>
<td>2,900</td>
<td>3,320</td>
<td>250</td>
<td>390,625</td>
<td>9.48</td>
<td>17,400</td>
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<td>Upper Karnali</td>
<td>1,823</td>
<td>3,910</td>
<td>11,623</td>
<td>3,900</td>
<td>206</td>
<td>113,001</td>
<td>1.95</td>
<td>69,738</td>
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</table>
GLOF Threats (Recent ICIMOD Study)

How to Consume Huge Energy

- Energy 11626 GWh
  - Wet 7716 GWh
  - Dry+ storage 3910 GWh
- Fertilizer Industry ~ 800 – 1000 MW
- Replacing Cooking Gas by Electricity ~ 500-1000 MW
- Other Industries - Cement, Metal, Agri, ...
- Transportation
  - Electric Car
  - Trolley bus/tram
  - Electric Railway

WORK SCHEDULE

Financing Model

- Public Private Partnership
  - 50 % (~100 bln) from Public
  - 20 % (~40 bln from Govt)
  - 15-20% (~40 bln from Banks)
  - 15-20% (~40 bln from Power Developers/Investors)
    - UTK
    - Chilime
    - NEA
    - Other Developers
    - NTC, Citizen Trusts
  - 10% International Investor (Unconditional, who provides technical Assistance in Grant)
  - More than 100%
Model of Federal state

- Water Resources is the major Income Generating Resources so the states should be planned according to Watershed with sub-states as discussed now
  - Less conflict in resources sharing
  - Optimum Benefit can be achieved
  - Infrastructure will be developed faster

THANK YOU