Financing New High Voltage Transmission Lines in Nepal Using HTLS Conductors

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Overview of Nepal Power System

• Total installed capacity: 782 MW
• Under Construction: 1300 MW
• Transmission Lines: 2640 cct km
• 40 Grid Substations of 2200 MVA
• Average annual growth rate of peak: 10%
• Average annual growth rate of energy: 8.5%
• Access to grid electricity: 65%
• Peak Load in FY 2014/15= 1300 MW
Hydropower Potential and Licensing Status

- Hydropower Potential: Over 83,000 MW
- Storage capacity plants: 21,400 MW
- Survey license issued: 6600 MW
- Government reserved: 5584 MW
- Survey application: 3096 MW
- Projects under construction: 1300 MW
  - NEA and subsidiary companies = 1002 MW
  - IPPs = 297 MW
SASEC Power System Expansion Project

• **Project Cost:** $440 million
  - ADF loan: $180 million
  - EIB: $120 m
  - Norway: $60.0 m
  - ADB SCF: $11.2 m
  - GoN: $60.34 m
• Loan signed: 11 July 2014
• Loan closing: 30 June 2022
Components of SASEC Power System Expansion Project

- **Output 1: Power transmission capacity increased.**
  - Construction of 45 km of 400 kV and 191.5 km of 220 kV transmission lines along Kaligandaki Corridor and Marsyangdi-Kathmandu route;
  - Construction of 125 km of 220 kV TL along Marsyangdi Corridor and 24 km of 132 kV TL along Samundratar-Trishuli route.

- **Output 2: Power distribution network improved**
- **Output 3: Mini-grid based renewable energy systems in off-grid areas increased.**
- **Output 4: Capacity development supports to NEA and AEPC.**
<table>
<thead>
<tr>
<th>Description</th>
<th>Kaligandaki River Basin</th>
<th>Marsyangdi River Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential, MW</td>
<td>2000</td>
<td>2200</td>
</tr>
<tr>
<td>PPA signed, MW</td>
<td>150</td>
<td>119</td>
</tr>
<tr>
<td>Survey license issued, MW</td>
<td>840</td>
<td>652</td>
</tr>
<tr>
<td>IBN Project, MW</td>
<td></td>
<td>600</td>
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</table>
**CHALLENGE**

- Provide ~ 1500 MW transmission capacity in each of 2 river basins
- Commissioning dates uncertain
- Multiple projects total ~ 150 MW in each river under construction now
- Minimize environmental footprint
Options Considered

- 400 kV line with Quad MOOSE Conductors
- 400 kV line with Twin MOOSE Conductors
- 220 kV with Quad MOOSE Conductors
- 220 kV with Twin HTLS Conductors
- Transfer requirement is 1600 MW.
- RoW acquisition is major problem in Nepal.
- 220 kV with HTLS reduces RoW requirement significantly from 52 m (400 kV) to 35 m.
- Comparison of the options provided 220 kV with twin HTLS as optimum solution.
Why HTLS Conductors?

For reconductoring:
- Enhanced current carrying capacity.
- No modification / reinforcement to existing towers.
- Cost effectiveness.

For new lines:
- Enhanced current carrying capacity.
- Reduction in overall capital expenditure.
- Reduction in overall operating expenditure.
- Low sag tension property
- Shorter project period
Typical Span 350 meter

35 m Total Right of-Way
Manufacturers

- Southwire: ACSS (Aluminum Conductor, Steel Supported)
- 3M: ACCR (Aluminum Conductor, Composite Reinforced)
- J-Power: Gap
- LS Cable: Invar
- CTC: ACCC (Aluminum Conductor, Composite Core)
Gap

Invar

Source: EPRI
ACCC (CTC Carbon fibre)  

3M (ACCR)  

Source: EPRI
Comparison of Cost and Current Carrying Capacity

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Current capacity</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>ACSR</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ACSS</td>
<td>1.8 to 2.0</td>
<td>1.2 - 1.5</td>
</tr>
<tr>
<td>GAP</td>
<td>1.6 to 2.0</td>
<td>2</td>
</tr>
<tr>
<td>INVAR</td>
<td>1.5 to 2.0</td>
<td>3 - 5</td>
</tr>
<tr>
<td>ACCR</td>
<td>2 - 3</td>
<td>5 - 6.5</td>
</tr>
<tr>
<td>ACCC</td>
<td>2</td>
<td>2.5 - 3.0</td>
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</table>

Source: EPRI
## Technical Comparison: Current Carrying Capacity

<table>
<thead>
<tr>
<th>Particulars</th>
<th>ACSR Moose</th>
<th>ACSS (ACSR Moose equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Carrying Capacity (Amperes)</td>
<td>876</td>
<td>1950</td>
</tr>
<tr>
<td>Current Carrying Capacity (Twin)</td>
<td>1752</td>
<td>3900</td>
</tr>
<tr>
<td>Current Carrying Capacity (Quad)</td>
<td>3504</td>
<td>7800</td>
</tr>
<tr>
<td>Same Current Construction</td>
<td>Quad</td>
<td>Twin</td>
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<tr>
<td>Total Conductor Weight (Per Circuit)</td>
<td>24048</td>
<td>11898</td>
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<tr>
<td>Savings in Weight (%)</td>
<td>-</td>
<td>50.00</td>
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*Source: Sterlite*
220 kV vs. 400 kV?

Maximum Power Transfer (MW)

- **S/C**
  - 132kV ACSR (Bear)
  - 220kV ACCC (Budapest)

- **S/C Twin**
  - 400kV ACSR (Moose)

- **D/C Twin**
  - 220 kV ACSR (Moose)

- **D/C Triple**
  - 400kV ACSR (Moose)
<table>
<thead>
<tr>
<th>Conductor Type &amp; Code Name</th>
<th>Voltage (kV)</th>
<th>Circuits</th>
<th>Conductors per Phase</th>
<th>Unit Cost ($)</th>
<th>A</th>
<th>MW</th>
<th>A</th>
<th>MW</th>
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<tbody>
<tr>
<td>ACSR</td>
<td>220</td>
<td>1</td>
<td>1</td>
<td>0.17</td>
<td>947</td>
<td>343</td>
<td>413</td>
<td>150</td>
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<tr>
<td>Moose</td>
<td>400</td>
<td>1</td>
<td>1</td>
<td>0.51</td>
<td>947</td>
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<td>434</td>
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<td></td>
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<td>1</td>
<td>2</td>
<td>0.20</td>
<td>1,894</td>
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<td>2</td>
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<td>3</td>
<td>0.34</td>
<td>2,841</td>
<td>2,057</td>
<td>1,424</td>
<td>1,031</td>
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<tr>
<td>220 kV vs. 400 kV</td>
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<td>2</td>
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<td>0.80</td>
<td>1,894</td>
<td>2,493</td>
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<td>2,841</td>
<td>3,740</td>
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<tr>
<td>ACCC</td>
<td>220</td>
<td>1</td>
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<td>0.23</td>
<td>2,002</td>
<td>725</td>
<td>542</td>
<td>196</td>
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<td>Budapest</td>
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<td>1</td>
<td>2</td>
<td>0.27</td>
<td>4,005</td>
<td>1,450</td>
<td>831</td>
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<td>0.45</td>
<td>6,006</td>
<td>4,348</td>
<td>1,858</td>
<td>1,345</td>
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Thank you!