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

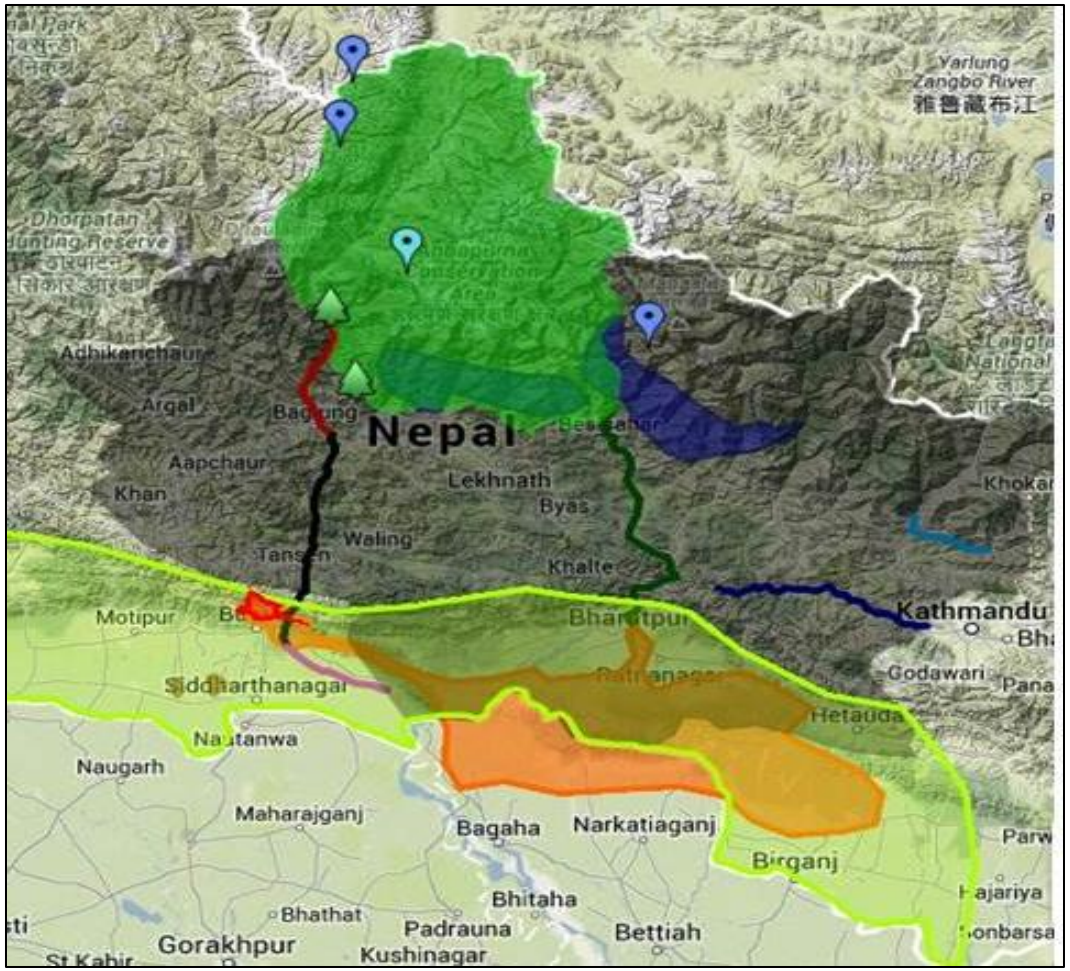
Components of SASEC Power System Expansion Project

- **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.**

Description	Kaligandaki River Basin	Marsyangdi River Basin
Potential, MW	2000	2200
PPA signed, MW	150	119
Survey license issued, MW	840	652
IBN Project, MW		600

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



Terai Arc Landscape

Tiger Survey Landscape of TCL

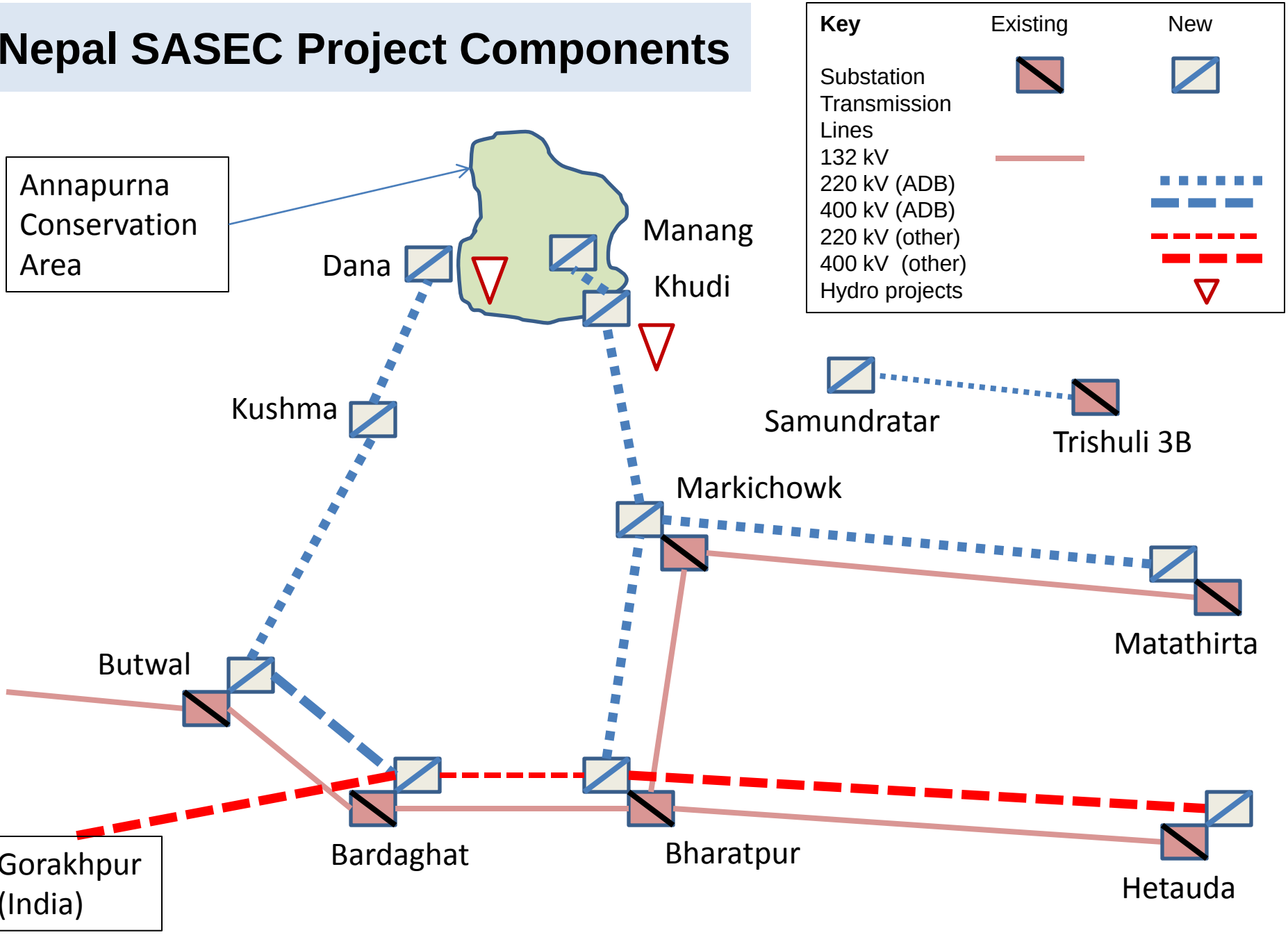
Dovan Bottleneck

Royal Chitwan Landscape of TCL

Annapurna Conservation Area

Chitwan Annapurna Landscape

Nepal SASEC Project Components



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.

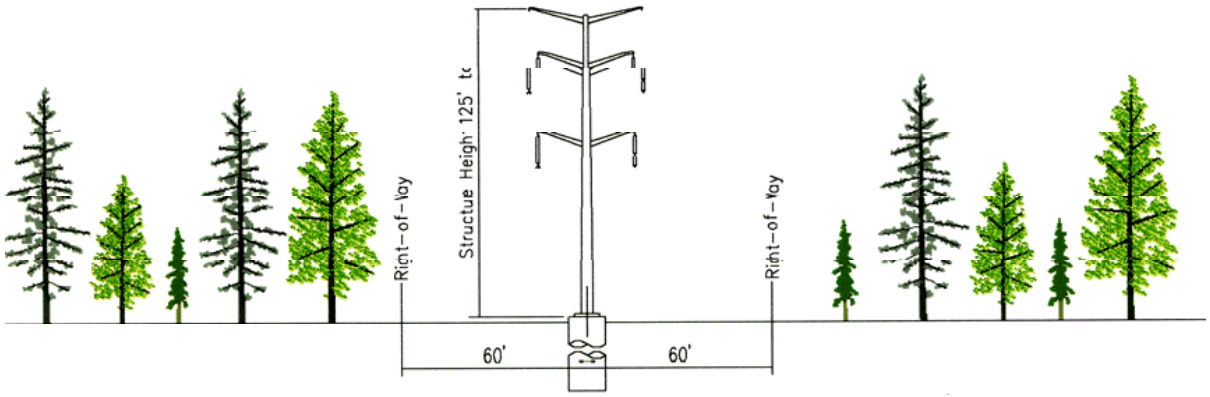
Why HTLS Conductors ?

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

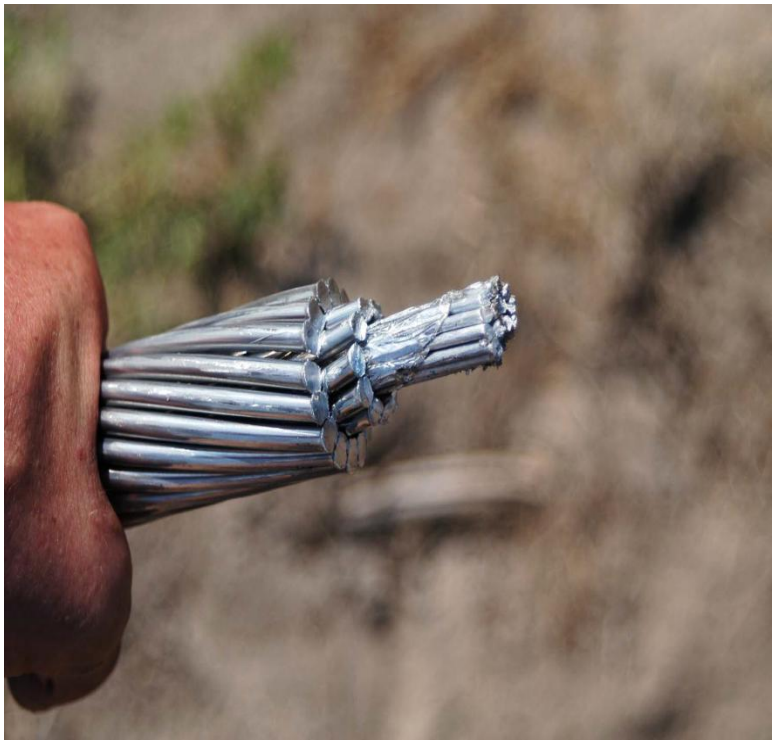
- Southwire: ACSS (Aluminum Conductor, Steel Supported)
- 3M: ACCR (Aluminum Conductor, Composite Reinforced)
- J-Power: Gap
- LS Cable: Invar
- CTC: ACCC (Aluminum Conductor, Composite Core)

Gap

Invar

Source: EPRI

ACCC (CTC Carbon fibre)



3M (ACCR)

Source: EPRI

Comparison of Cost and Current Carrying Capacity

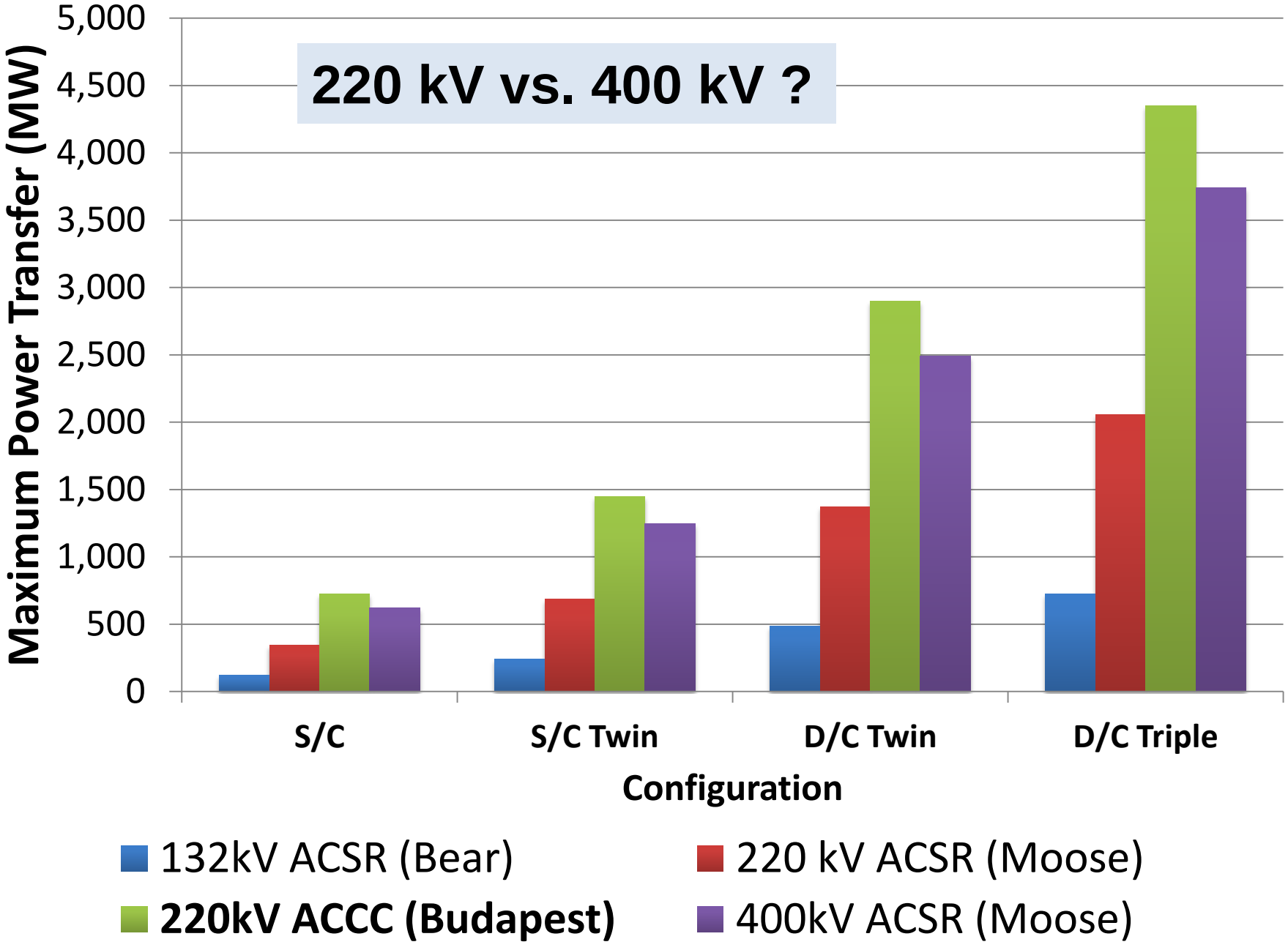
Conductor	Current capacity	Price
ACSR	1	1
ACSS	1.8 to 2.0	1.2 -1.5
GAP	1.6 to 2.0	2
INVAR	1.5 to 2.0	3-5
ACCR	2-3	5-6.5
ACCC	2	2.5-3.0

Source: EPRI

Technical Comparison: Current Carrying Capacity

Particulars	ACSR Moose	ACSS (ACSR Moose equivalent)
Current Carrying Capacity (Amperes)	876	1950
Current Carrying Capacity (Twin)	1752	3900
Current Carrying Capacity (Quad)	3504	7800
Same Current Construction	Quad	Twin
Total Conductor Weight (Per Circuit)	24048	11898
Savings in Weight (%)	-	50.00

Source: Sterlite


220 kV vs. 400 kV ?
Maximum Power Transfer (MW)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
S/C
S/C Twin
D/C Twin
D/C Triple
Configuration
132kV ACSR (Bear)
220 kV ACSR (Moose)
220kV ACCC (Budapest)
400kV ACSR (Moose)

Conductor Type & Code Name	Voltage (kV)	Circuits	Conductors per Phase	Unit Cost $M/km	Thermal Rating A	Thermal Rating MW	Economic Optimal Loading A	Economic Optimal Loading MW
ACSR Moose	220	1	1	0.17	947	343	413	150
		1	2	0.20	1,894	686	634	230
		2	2	0.30	1,894	1,371	1,098	795
		2	3	0.34	2,841	2,057	1,424	1,031
220 kV vs. 400 kV ?	400	1	1	0.51	947	623	660	434
		1	2	0.60	1,894	1,247	1,023	673
		2	2	0.80	1,894	**2,493**	1,670	***2,198***
		2	3	0.90	2,841	3,740	2,165	2,850
ACCC Budapest	220	1	1	0.23	2,002	725	542	196
		1	2	0.27	4,005	1,450	831	301
		2	2	0.40	4,005	**2,900**	1,391	***1,007***
		2	3	0.45	6,006	4,348	1,858	1,345


Thank you!