

SALIENT FEATURES OF LOWER SOLU KHOLA SMALL HYDROPOWER PROJECT

1. Location

District	Solukhumbu
Geographical Location	Between Latitudes 27° 25' 29" N and 27° 26' 30" N Longitudes 86° 35' 29" E and 86° 37' 07" E

2. Meteorology and Hydrology

Average Annual Precipitation	1760 mm
Catchment Area	411 km ²
Average Flow	26.2 m ³ /s
90% Firm Flow	5.81 m ³ /s
Design (Turbine) Flow	11.30 m ³ /s

3. Diversion Weir

Type	Uncontrolled concrete gravity structure
Spillway length	24 m
Spillway crest	EL 1760.0 m
Design Flood (1 in 100 years)	276 m ³ /s
Diversion Flood (1 in 10 years)	67.5 m ³ /s

4. Undersluice

Location	At right side of the weir
Section	With two gates each of 2 m wide and 3 m high separated by a 1m wide pier
Crest Level	EL 1756.00 m

5. Intake

Location	Immediately upstream from the undersluice at right angle with the weir axis
Invert level	EL 1757.7
Number of Openings and size	Two openings each with 4.0 m wide and 2.2 m high separated by 1.0 m wide pier
Approach Velocity	0.75 m/s in front of the coarse trash rack

6. Gravel Trap and Emergency Spillway

Gravel Trap	3.0 m wide, 5.7 m high and 25 m long
Side channel spillway	12.0 m long
Sill level of side channel spillway	EL 1759.81 m

7. Approach Canal

Length	361.84 m
Freeboard	0.52 m
Section	Rectangular with 3.0 m wide and 2.5 m high

8. Desanding Basin

Type	Double chamber Du-four type surface desanding basin with provision of continuous flushing.
Number of chambers	Two
Nominal size of trapped particles	0.20 mm

Length 85 m

9. Connecting Open Canal

Type Rectangular
Breadth and height 2.4 m X 2.3 m
Freeboard 0.54 m
Length 13.8 m

10. Headrace Tunnel

Length 4150 m
Shape Inverted D-shape
Size 2.5 m wide and 3.45 m high
Water flowing section 2.5 m and 3.45 m high

11. Forebay

Live capacity 2016 m³
Effective size 10 m X 4 m X 50 m with extra depth of 1 m
Spillway With design capacity of 1.5 times the design discharge

12. Penstock

Length of the pipe 1,075 m upto bifurcation and then 30 m.
Diameter of the pipe 1.80 m and 1.3 m after bifurcation
Thickness of the pipe (including corrosion allowance of 2 mm) Ranges from 11 mm to 40 mm

13. Powerhouse

Type Surface
Length X Breadth X Height 37.0 m X 13.3 m X 30.0 m
Number of Generating Units Two
Turbine Type Pelton vertical axis
Turbine Centre line EL 1324.80 m
Rated Net Head 421.00 m
Generator Synchronous with vertical shaft
Rated Capacity 2 X 20 MW

14. Tailrace

Type Cut and cover conduit
Inner dimension 3.2 m X 2.7 m

15. Switchyard and Transmission Line

Switchyard type Outdoor, conventional
Transmission line length, voltage and circuit 3.0 km, 132 kV and single circuit with "Bear" conductor

16. Energy Generation

Annual average energy output 280.93 GWh
Firm energy at Q_{90%} 179.1 GWh

17. Investment Costs

Economic Cost NRs. 3,338,380,000
Financial Cost NRs. 4,053,226,437

18. Economic and Financial Indicators

Economic:

EIRR	21.39 %
B/C Ratio	2.23
Financial with average energy price of NRs. 3.70 per kWh	
IRR on equity investment	19.43 %
B/C ratio	1.306

Salient Features of the Mewa Khola Small Hydroelectric Project

Hydrology

Catchment Area at Dam Site	527 km ²
Mean Annual Precipitation	2164 mm
Mean Annual Flow	34.9 m ³ /s
Design Flood (1 in 100 yr.)	921 m ³ /s
Design Flood (1 in 1000 yr.)	1454 m ³ /s

Power Development

Type of Power Generation	Run-of-river
Turbine Discharge	9.4 m ³ /s
Total Gross Head	135.0 m
Gross Head at Forebay	130.6 m
Net Head	127.6 m
Installed Capacity	10 MW
Average Annual Energy	77.43 GWh
Firm Energy	48.47 GWh
Dry Energy	19.49 GWh
Wet Energy	57.94 GWh

Main Dam

Type of Dam	Overflow, 43.3 m long Diversion
Weir	
Size of Weir (Spillway) (L x H)	28.5 m x 6.5 m
Weir Foundation Level	El. 960.500 m
Crest Level	El. 967.000 m
Gate Deck Level	El. 975.200 m
Gate Hoist Deck Level	El. 981.000 m

Undersluice Structure

Nos. of gates	Two gated
Size of gate opening (nos. x W x H)	2 x 5.0 m x 4.0 m

Bottom level El. 963.300 m

Power Intake

Intake Type Side Intake
Intake Gates 2 nos.
Gates opening size (W x H) 5.65 m x 1.8 m
Intake water level El. 967.000 m
Intake Invert Level El. 965.600 m
Intake Channel length 25 m

Power Canal

Section Rectangular box culvert
Size (W x H) 2.7 m x 2.7 m
Length 59.132 m
Hydraulic Slope 1:750

Desanding Basin

Type Dufour, Continuous flushing
Size (L x B x H) 78 m x 8 m x 4.8 m
Desanding chambers 2 nos.
U/S transition (L) 19.013 m
D/S transition (L) 19.038 m

Canal after Desander

Section Rectangular
a) Size (W x H) 2.7 m x 2.7 m
Length 1270.815 m
b) Size (W x H) 2.7 m x 2.7 m - 3.1 m
Length 359.498 m

Box Culvert after Desander

Section Rectangular
Size (W x H) 2.7 m x 2.5 m
Length 543.649 m

Canal after Side Spillway

Section	Rectangular
Size (D x H)	2.7 m x 3.1 m - 4.45 m
Length	1226.183 m

Forebay

Type	RCC Lined
Size (W x L x H)	2.7 – 14.0 m x 53.0 x 4.45 – 8.4 m
Normal Operating Level	El. 962.700 m
Maximum Water Level	El. 964.639 m
Minimum Operating Level	El. 961.114 m

Penstock

Size (L x D)	281 m x 1.8 m
Manifolds (L x D x nos.)	15 m x 1.3 m x 2 nos.

Powerhouse including Control Building

Type of powerhouse	Semi underground
Size (L x B x H)	27.6 m x 17.8 m x 27.6 m (roof ridge)

Tailrace Canal

Tailrace canal Culvert)	Cut and covered (Box
Size (L x B x H)	50 m x 3.4 m x 2.0 m
Tail water level	El. 832.100 m

Turbines

Type	Vertical Axis Francis
Design Discharge	9.4 m ³ /sec (2 x 4.7 m ³ /s)
Rated Output	10 MW (2 x 5 MW)
Synchronous Speed	750 rpm

Generators

Type	Synchronous AC 3 phase,
Vertical Axis,	
Max Rated Capacity	2 x 6 MVA

Switchyard

Type Out door
Size (L x W) 35 m x 25 m

Access Road 15.5 km

Transmission Line 15 km long 33 kV single circuit
connected to Taplejung
Substation

Economic Parameters

Total Project Cost NRs. 1,554.6 million or
US\$ 19.80 million (2003 Price
level)

Internal Rate of Return (EIRR) 12.36 %

Net Present Value (NPV) NRs. 333,261 thousand

Benefit Cost Ratio (B/C) 1.18

Cost per kW Installed Capacity US\$ 1,980.39

Levelised Unit Cost (Specific Energy Cost) US Cent 3.3

Financial Parameters

Internal Rate of Return (FIRR) 19.10 %

Net Present Value (NPV) NRs. 900,523 thousand

Benefit Cost Ratio (B/C) 1.53

Pay back period 4 years 3 months

SALIENT FEATURES OF SOLU KHOLA SMALL HYDROPOWER PROJECT

1. Location

District	Solukhumbu
Geographical Location	Between 457783 and 458064 Easting 3040152 and 3036410 Northing

2. Meteorology and Hydrology

Average Annual Precipitation	1760 mm
Catchment Area	291 km ²
Average Flow	17.70 m ³ /s
95% Firm Flow	4.02 m ³ /s
Design Flow	8.33 m ³ /s

3. Diversion Weir

Type	Uncontrolled concrete gravity structure
Spillway length	26 m
Spillway crest	EL 1993 m
Bottom level of the shear key	EL 1989.50 m
Design Flood (1 in 100 years)	186 m ³ /s
Diversion Flood (1 in 5 years)	21.4 m ³ /s

4. Undersluices

Location	At left side of the weir
Number and size	Two each of 2 X 3 m
Crest Level	EL 1991.00 m

5. Intake

Location	About 6 m upstream from the undersluice at an angle of 15° with the weir axis
Invert level	EL 1992.00
Number of Openings and size	Two openings each with 5.0 m wide and 1.2 m high separated by 1.5 m wide pier
Entrance Velocity	0.96 m/s in front of the coarse trash rack

6. Intake Canal

Width	3.0 m
Side channel spillway	10.0 m long
Sill level of side channel spillway	EL 1992.80 m

7. Desanding Basin

Type	Surface
Number of chambers	Two
Nominal size of trapped particles	0.20 mm
Length	55 m

Depth of flow	2.80 m at the start and 6.09 m at the end
Flushing Conduit	Two numbers each of dimensions 0.5 m X 0.5 m rectangular shape with length of 15 m and bed slope of 1:35.

8. Headrace Canal

Type	Rectangular
Breadth and height	2.85 m X 1.5 m
Freeboard	0.25 m
Length	4,046 m

9. Aqueducts and Cross Drainages

Number of aqueducts	8
Span	Each of 6 m
Number of cross drainages	
Minor pipe culvert type	9 along canal alignment and 8 along access road alignment

10. Forebay

Live capacity	1500 m ³
Effective size	5 m X 6 m X 50 m
Flushing gallery	0.4 m X 0.4 m
Water Level at forebay	EL 1986.22 m

11. Penstock

Diameter of the pipe	1.80 m
Thickness of the pipe (including corrosion allowance of 2 mm)	Ranges from 7 mm to 24 mm
Length	348.00 m
Centre line of penstock at the forebay	EL 1977.14 m

12. Powerhouse

Type	Surface
Length X Breadth X Height	22.29 m X 10.29 m X 17.86 m
Number of Generating Units	Two
Turbine Type	Pelton vertical axis with 4 nozzles
Runner Centre line	EL 1770.00 m
Minimum Net Head	214.71 m
Generator	Synchronous with vertical shaft
Rated Capacity	2 X 7.6 MW

13. Tailrace

Type	Culvert
Length	36 m
Number, width and height	Two with the dimension of 3.4 m X 4.0 m each

14. Switchyard and Transmission Line

Switchyard type	Outdoor, conventional
Transmission line length, voltage and circuit*	18.4 km, 33 KV and Double circuit with ACSR Panther conductor

15. Energy Generation

Annual average energy outputs	103.92 Gwh
Firm energy at Q _{95%}	63.69 Gwh

16. Investment Costs

Economic Cost	NRs. 1,202,530,211
Financial Cost	NRs. 1,292,359,835

17. Economic and Financial Indicators

Economic

EIRR	21.12%
B/C Ratio	2.20

Financial

Scenario-1 with average energy price of NRs. 3 per kwh

IRR on equity investment	19.02%
B/C ratio	1.469

Scenario-2 with seasonal energy prices of NRs. 5.50 kwh for dry season and NRs. 2.50 / kwh for wet season

IRR on equity investment	20.66%
B/C ratio	1.549

Note: Transmission length may be around 8 Km from power house to Nele Solokhumbu.

Salient Features of Khimti 2

Item	Description
Hydrology	
Catchment area, km ²	320
Mean annual rainfall, mm	2157
Mean annual runoff, mill.m ³ /year	952
Annual runoff, m ³ /s	30.2
Design flood, m ³ /s	1675
Dam and Reservoir	
Type of Dam	concrete
Dam and weir height, m	14
Intake, width*height in m	7.2*4
Spillway type	Rubber/steel gates
Live storage, m ³	175,000
High reservoir level, m amsl	1554
Low reservoir level, m amsl	1551.5
Waterways	
Underground settling basin (L m*B m*H m)	3*(90*5.4*8)
Headrace tunnel, length in m /cross section area in m ²	3900 /14.5
Pressure shaft, length in m	377
Penstock, length in m /dia. in m	65/1.8
Tailrace tunnel, length in m /cross section area in m ²	300/14.5
Power Station	
Access tunnel, length in m /cross section area in m ²	250/22
Rated head, m	275
Power house (37 m*10 m* 17.5 m)	underground
Power house size , L*B*H	37 m*10 m* 17.5 m
Installation, MW	27.2
Max discharge, m ³ /s	11.1
No. of units, No.	2
Turbine	Francis, horizontal
Transmission	
Voltage, kV	132
Length, km	16
Production	

Peak power, dry season, GWh/year	23.0
Peak power, wet season, GWh/year	33.0
Non peak power, GWh/year	104.0
Sum, GWh/year	160.0
Cost	
Construction time, months	33
Cost *, Mill. USD	45.0

* Includes civil construction works, procurement of mechanical and electrical equipment and engineering

Salient Features of Maya Khola Small Hydropower Project

1. Location

District	Sankhuwasava
Geographical Location	Between 87°19'15" and 87°22'05" East and 27°15'45" and 27°13'40" North
River	Maya Khola

2. Meteorology and Hydrology

Average Annual Precipitation	1448 mm
Catchment Area	90 km ²
Average Flow	5.35 m ³ /s
90% Firm Flow	0.96 m ³ /s
Design Flow	1.5 m ³ /s

3. Diversion Weir

Type	Uncontrolled concrete gravity structure (ogee shaped overflow weir)
Length	53 m
Spillway crest	EL 892 m amsl
Height from the deepest foundations	8.02 m
Design Flood	210 m ³ /s

4. Undersluices

Location	At left side of the weir
Number and size	1X 3 m
Crest Level	EL 887.00 m amsl

5. Intake

Location	About 6 m upstream from the undersluice at an angle of 15° with the weir axis
Invert level	EL 890.00
Number of Openings and size	Single opening with 2.0 m wide
Shape	Trapezium

6. Intake Canal

Width X Height	1.25 m X 2.5 m
Side channel spillway	3 m long
Canal Length	17.0 m long

7. Desanding Basin

Type	Dufour type
Number of chambers	Two
Nominal size of trapped particles	0.20 mm
Length	31 m
Slope of flushing conduit	2%

8. Headrace Conduit

(i) Type	Circular metallic pipe
Diameter	1.25 m
Length	7,435 m
Slope	1:1000
(ii) Type	Rectangular Channel (R.C.C.)
Size	1.5 m wide and 1.24 m height
Length	701.0 m
Slope	1:1000
Total Length	8136.0 m

9. Cross Drainages

Number	27 including 4 suspension bridges
Span	Varies from 1.5 m to 48.65 m

10. Forebay

Live capacity	270 m ³
Effective size	Length 29.32 m, width 5 m and average depth 3.48 m

11. Penstock

Diameter of the pipe	1.25 m
Thickness of the pipe (including corrosion allowance of 2 mm)	Ranges from 12 mm to 25 mm
Length	547.00 m
Full Supply Level at the forebay	EL 885.28 m amsl

12. Powerhouse

Type	Surface
Length X Breadth	16.0 m X 10.5
Number of Generating Units	Two
Turbine Type	Impulse with horizontal axis
Runner Centre line	EL 480.0 m amsl
Generator	Synchronous with horizontal shaft
Rated Net Head	402.73 m
Rated Capacity	2 X 2.5 MW

13. Tailrace

Type	Box Culvert and Open Canal
Length	110.8 m of box canal and 29.70 m of open canal
Size	1.25 m X 1.5 m

14. Switchyard and Transmission Line

Switchyard type	Outdoor, conventional
Transmission line length and Voltage	1.5 km, 33 KV

15. Energy Generation

Annual average energy outputs	40.006 Gwh
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16. Investment Costs

Economic Cost	NRs. 788,742,028
Financial Cost	NRs. 868,676,769

17. Project Indicators (Base Case):

Economic:

IRR	13.83%
B/C Ratio	1.35%

Financial:

Scenario-1 with energy price escalated at 6% per year:

IRR on equity investment	17.29%
B/C ratio	1.408

Scenario-2 with energy price not escalated

IRR on equity investment	8.74%
B/C ratio	0.96

Table ES 6.1: Salient Features Singati

Location of the Project	27 ⁰ 44' 00" to 27 ⁰ 46' 54" N 86 ⁰ 07' 41" to 86 ⁰ 09' 55" E
Capacity	6.4 MW
Power Development	
Type of Power Generation	Run-of-river
Turbine Discharge	3.6 m ³ /s
Total Gross Head	224.5 m
Gross Head at Forebay	217.8 m
Net Head	213.144 m
Installed Capacity	6.4 MW
Average Annual Energy	49.38 GWh
Firm Energy	24.44 GWh
Dry Energy	13.37 GWh
Wet Energy	36.01 GWh
Firm Capacity	2.79 MW
Weir	
Type of Weir	Overflow Diversion Weir
Size of Weir	36.5 m x 11.1 m
Weir Foundation Level	El. 1165.5 m
Gate Deck Level	El. 1176.6 m
Gate Hoist Deck Level	El. 1181.8 m
Geology	Augen gneiss of the Suri Dobhan Augen gneiss.
Diversion Facilities	
Length (For three stages)	140,120,100 m = 360 m
Cross Section (W x H)	(2+6)/2 x 2 m
Spillway	
Type	Overflow
Crest Elevation	El 1170.5 m
Maximum Flood Level (1:1000 yr.)	El 1176.5 m
Width	24 m
Discharge	606.38 m ³ /s
Undersluice Structure	

No. of gates	2 nos.
Size of gate opening (nos. x W x H)	2 x 4.0 m x 2.8 m
Bottom level	El. 1168.0 m
Discharge	167.62 m ³ /s

Power Intake

Intake Type	Side Intake
Intake Gates	2 nos.
Gates opening size (W x H)	2.8 m x 1.5 m
Intake water level	El. 1170.5 m
Intake Invert Level	El. 1169.3 m
Intake Channel Length	19.615 m
Intake Gate to Power Canal (W x H)	1 no. with opening 2.0 m x 1.9 m
Geology	Augen gneiss of the Suri Dobhan augen gneiss

Water Conveyance System

Power Canal

Section	Rectangular box culvert
Size (W x H)	2.0 m x 1.9 m
Length	162.63 m
Hydraulic Slope	1:750

Desanding Basin

Type	Dufour, Continuous flushing
Size (L x B x H)	49 m x 5 m x 3.15 m
Desanding chambers	2 nos.
U/S transition	14.47 m
D/S transition	14.47 m
Geology	The Suri Dobhan Augen gneiss but the foundation is on rock of schist and phyllite.

Canal after Desander

Section	Rectangular
Size (W x H)	2.0 m x 1.9 m
Length	4,471.43 m
Size (W x H)	2.0 m x 1.9 m to 2.1 m
Length	150 m
Geology	Augen gneiss of the Suri Dobhan Augen gneiss

Box Culvert after Desander

Section	Rectangular
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Size (W x H)	2.0 m x 1.75 m
Length	483.6 m

Canal after Side Spillway

Section	Rectangular
Size (W x H)	2.0 m x 2.1 m - 3.05 m
Length	939.3 m
Geology	Partly the augen gneiss of the Suri Dobhan Augen Gneiss and the foundation is partly on the schist, phyllite and quartzite of the Laduk Phyllite and also on stable colluvium deposit.

Total length of waterways	6206.96 m
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Forebay

Shape	Rectangular (RCC Lined)
Size (L x W x H)	46 m x 6.0 m x 4.1 m (6.1 m)
Maximum Operating Level	El. 1165.1 m
Minimum Operating Level	El. 1162.4 m
Normal Operating Level	1163.5 m
Geology	The schist, phyllite and quartzite of the Laduk Phyllite but foundation covers the thick colluvium deposits.

Penstock

Length	448 m
Diameter	1.2 m
Thickness	10 mm
Manifolds (L x D x nos.)	12 m x 0.85 m x 2 nos.
Geology	The schist, phyllite and quartzite of the Laduk Phyllite but passes through thick colluvium deposits

Power Facilities

Powerhouse including Control Building

Type of powerhouse	Semi underground
Size (L x B x H)	30.0 m x 16.2 m x 19.4 m (roof ridge)

Tail Water Level	946.0 m amsl
Q ₉₀ %	1.57 m ³ /s
Firm Capacity	2.79 MW
Geology	The schist, phyllite and quartzite of the Laduk Phyllite but surfacially it covers the thick alluvium deposits.
Transmission Line*	18.5 km long 33 kV single circuit connected to Charikot Substation
<u>Economic Parameters</u>	
Total Project Cost	NRs. 1,076.54 million or US\$ 13.714 mill. (2003 Price level)
Economic Indicators	
- Benefit Cost Ratio (B/C)	1.12
- Internal Rate of Return (EIRR)	11.63 %
Financial Indicators	
- Benefit Cost Ratio (B/C)	1.41
- Internal Rate of Return (FIRR)	17.48 %
Specific Energy Cost	3.55 US Cent
Cost per kW installed Capacity	2,142.80 US\$

Note: Transmission length may be around 500 m from power house to Singati bazar substation.

SALIENT FEATUES Khare Khola Hydroelectric Project (KKHEP)

Location

Latitude	27°45' 36" N to 27°48' 00" N
Longitude	86° 14' 00" E to 86° 18' 00" E
District	Dolakha

Type of power plant

Type	Run-of-the-river
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Hydrology

Catchment area at intake site	150 km ²
Long term annual average flow	15.20 m ³ /s
Average minimum flow	2.60 m ³ /s
Design flood at intake (1 in 100 Years)	273.22 m ³ /s

General hydraulics

Gross head	338.79 m
Net head	327.97 m
Design flow	5.40 m ³ /s
Capacity	14.7 MW

Diversion weir

Type	Semi permanent type, boulder lining with cut-off wall
Length	27 m
Height	1.61 m above natural bed
Crest elevation	1537.6 masl

Intake chamber

Type	Orifice type
Size of opening	7.0 m wide and 0.85 m high (2 Nos. 3.5 m wide)

Gravel trap and approach canal

	Gravel trap width 7.5 m
	Gravel trap length 11 m
	Coarse trash rack 7.5 m x 3.7 m
Intake gate	3 m x 3 m (1 No.)
Intake box culvert/approach canal	2.8 m x 3.2 m x 33.0 m long (max.)

Settling basin

No of bays	2 nos.
Nominal size of trapped particle	0.2 mm
Trap efficiency	90%
Length	
Inlet transition	18.25 m
Uniform section	83.00 m
Outlet transition	3.8 m

Width

Uniform section	10.0 m (5.0 m x 2 nos.)
Depth (Total depth including hopper)	5.6 m

Headrace canal

Type	Combination of stone masonry and reinforced concrete, rectangular open channel
Length	233.0 m
Width	2.4 m
Height	3.2 m
Slope	1:675

Headrace tunnel

Shape	D-shaped
Length	4796 m
X-Section	2.8 m wide x 3.0 m high
Cross-sectional area	7.56 m ²

Surge shaft

Type Semi	underground
Internal diameter	6.0 m
Height	24 m

Penstock

Type	Exposed
Diameter	1.55 m mild steel pipe
Length	870.0 m
Thickness	10 mm to 28 mm

Powerhouse

Type	Surface
Size (length*wide*height)	39.0 m * 14.65 m *12.35 m

Tailrace box culvert

Shape	Rectangular (concrete box culvert)
Length	90.0 m
Cross-section area	4.08 m ² (2.4 m wide x 1.7 m high)

Turbines

Type	Pelton
No. of jets	2
Alignment	Horizontal shaft
Rated net head	327.97 m
Rated discharge	1.8 m ³ /s
Turbine rated output (power on shaft)	5150 kW x 3
Turbine efficiency	89 %
No of units	3 Nos.
Speed	500 rpm
Axis level	1198.82 masl

Generators

Type	Brushless Synchronous
Capacity	6.125 MVA
Voltage	6.6 kV
Power factor	0.8
Operating range	0.8 (lag)- unity – 0.95 (lead)

Transmission line

Length 9.8 km (from Lantipur to Singati)
Voltage 33 kV

Transformer

Type Three phase
Rating 18.5 MVA
vector group Ynd11
Power factor 0.8
Voltage ratio 6.6/33 $\pm 5\%$ in step of 1.875%
Frequency 50 Hz

Energy generation

Mean annual energy per year 90.43 GWh
Dry energy 19.74 GWh
Wet energy 70.69 GWh

Access

Road Class District Road Class II
Length (Lamakari to Headwork site) 10.66 km
Powerhouse (Chamar) to surge shaft (Bothu) 2.7 km

Construction Period

3 Years

Economic Indicators (based on 2006 January price level, economical life = 50 years)

Project cost including transmission line
and access road US\$ 28.715 mill.
Cost per kW US\$ 1,954
Energy cost per kWh (after financing) US\$ 0.021
Economic Net Present Value (NPV) US\$ 23.703 million
Economic Internal Rate of Return (EIRR) 26.45 %
Economic B/C ratio at discount rate of 10% 1.55

Financial Indicators (based on 2006 January price level, economical life = 25 years)

Project cost including transmission line
and access road US\$ 28.369 mill.
Cost per kW US\$ 1,930
Energy cost per kWh (after financing) US\$ 0.059
Financial Net present value (NPV) US\$ 13.161 million
Financial Internal Rate of Return (FIRR) 20.52 %
Financial B/C ratio at discount rate of 9% 1.25

SALIENT FEATURES Lower Hongu Khola Small

Hydropower Project (LHKSHP)

Location (Longitudes and latitudes of the points bordering the project area)

North-West corner and 86°43' 43" E	27°39' 31" N
North-East corner and 86°46' 01" E	27°39' 31" N
South-East corner	27°33' 03" N and 86°46' 01" E
South-West corner	27°33' 03" N and 86°43' 43" E
District Solukhumbu	

Type of power plant

Type Run-of-river

Hydrology

Catchment area at intake site	550 km ²
Long term annual average flow	33.04 m ³ /s
Average minimum flow	5.96 m ³ /s
Design flood at intake (1 in 100 Years)	626.97 m ³ /s

General hydraulics

Gross head	174.1 m
Net head	168.78 m
Design flow	16.2 m ³ /s
Capacity	23.5 MW

Diversion weir

Type Concrete weir with dress stone lining	
Length	40 m
Height	6.0 m above natural bed
Crest elevation	1012.0 masl

Intake chamber

Type Orifice type side intake	
Size of opening	11.7 m wide and 1.8 m high (4 Nos. 2.92 m wide)

Gravel trap and approach canal

Gravel trap width	12.8 m
Gravel trap length	12.3 m
Coarse trash rack	12.8 m x 3.8 m
Regulating gate	1.65 m x 3 m (2 Nos.)
Box culvert	3.3 m x 3.0 m x 10.1 m
Approach canal	3.3 m x 4.0 m x 59.4 m

Settling basin

No of bays	2 nos.
Nominal size of trapped particle	0.2 mm
Trap efficiency	90%
Length	
Inlet transition	39.25 m
Uniform section	128.00 m
Outlet transition	13.2 m

Width Uniform section	19.0 m (9.5 m x 2 nos.)
Depth (Total depth including hopper)	8.2 m
Headrace tunnel	
Shape	D-shaped
Length	2593.70 m
X-Section	4.2 m wide x 4.2 m high
Cross-sectional area	15.75 m ²
Tunnel Audit	1 340m long and 3.5m dia.
Surge shaft	
Type	Semi-underground
Internal diameter	6.0 m
Height	31 m
Tunnel Audit	2 80 m long and 3.5m dia.
Inclined shaft / Penstock	
Type	Underground inclined shaft
Diameter	2.3 m mild steel /2.9m inclined shaft
Length	353.5 m
Thickness	14 mm to 30 mm
Powerhouse	
Type	Underground
Size (Length*Wide*height)	50.0 m, 8.9 m and 9.0 m
Access tunnel	194.0 m long and 4.2m dia.
Tailrace tunnel	
Shape	D-shape
Diameter	3.9 m
Length	428.5 m
Cross-section area	12.04 m ² (3.9 m wide x 3.5 m high)
Slope	1 in 1000
Turbines	
Type	Francis
Alignment	Horizontal shaft
Rated net head	168.78 m
Rated discharge	5.4 m ³ /s
Turbine rated output (power on shaft)	7833 kW x 3
Turbine efficiency	92 %
No of units	3 Nos.
Speed	600 rpm
Tailwater level	837.90 masl
Generators	
Type	Brushless Synchronous
Capacity	9.8 MVA
Voltage	11 kV
Power factor	0.8
Operating range	0.8 (lag)- unity – 0.95 (lead)
Transmission line	
Length	9.97 km (from Kuwapani to Nele)

Voltage	132 kV
Transformer	
Type	Three phase
Rating	10 MVAx4(1 Spare)
vector group	Ynd11
Power factor	0.8
Voltage ratio	11/132 \pm 5% in step of 1.875%
Frequency	50 Hz
Energy generation	
Mean annual energy per year	134.35 GWh
Dry energy	26.87 GWh
Wet energy	107.49 GWh
Access	
Road Class District Rural Road Class	'A' (DRRA)
Length (Budhidada to Headwork site)	23.52 km
Construction Period	3 Years
Economic Indicators (based on 2007 January price level, economical life = 50 years)	
Project cost including transmission line and access road	US \$ 49.066 million
Cost per kW	US \$ 2,126
Energy cost per kWh (after financing)	US \$ 0.365
Economic Net Present Value (NPV)	US \$ 49.613 million
Economic Internal Rate of Return (EIRR)	28.88 %
Economic B/C ratio at discount rate of 9%	1.63
Financial Indicators (based on 2007 January price level, economical life = 25 years)	
Project cost including transmission line and access road	US \$ 55.501 million
Cost per kW	US \$ 2,400
Energy cost per kWh (after financing)	US \$ 0.413
Financial Net present value (NPV) US \$	19.756 million
Financial Internal Rate of Return (FIRR)	18.00 %
Financial B/C ratio at discount rate of 9%	1.199