Project Summary

Detailed Feasibility Studies: Transmission Projects in Nepal

Volume 8: Project Summary

MCC-15-BPA-0032, MCC-16-CL-0002

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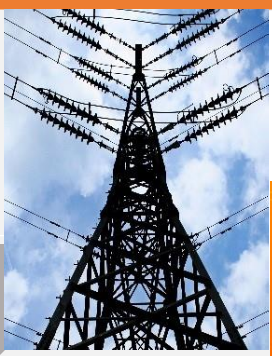

TETRA TECH

Detailed Feasibility Studies: Transmission Projects in Nepal

Volume 8
Project Summary

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MCC-15-BPA-0032, MCC-16-CL-0002

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Acronyms

ADB	Asian Development Bank
AIS	Air-insulated switchgear
BIL	Basic insulation level
CAR	Conceptual Assessment Report
CIF	Compact Implementation Funding
DD	Due diligence
DFS	Detailed feasibility study
EIA	Environmental impact assessment
EPC	Engineering, procurement and construction
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FESIA	Final Environmental and Social Impact Assessment
FPIC	Free, prior, and informed consent
GHG	Greenhouse gas
GIS	Gas-insulated switchgear or geographic information system
GoN	Government of Nepal
IEE	Initial environmental examination
IPs	indigenous peoples
IPP	Independent power producer
KfW	German development bank
LRT	Linear Routing Tool
M&E	Monitoring and evaluation
MCC	Millennium Challenge Corporation
NEA	Nepal Electricity Authority
NR	Nepal Rupee
NTFP	Non-timber forest product
OMCN	Office of the Millennium Challenge Nepal
PESIA	Preliminary Environmental and Social Impact Assessment
PI	Points of inflection
PIU	Project Implementation Unit
RAP	Resettlement Action Plan
ROW	Right of way
RPF	Resettlement Policy Framework
RPGCo	Rastriya Prasaran Grid Company
RTU	Remote terminal unit
SCADA	System Control and Data Acquisition
S/S	Substation
TIP	Trafficking in persons
TL	Transmission line
USAID	United States Agency for International Development
WB	World Bank

Project Summary

In December 2014, the Millennium Challenge Corporation's (MCC's) Board selected Nepal as eligible to develop a compact program. The Government of Nepal (GoN) and MCC identified four binding constraints to growth in Nepal: political instability, poor labor relations, high cost of transport, and unreliable supply of power. MCC and the GoN further identified the transport and energy sectors for further exploration. Subsequently, the GoN requested funding from MCC for a diverse set of activities in the power sector.

MCC and the GoN determined that a stronger transmission network can address three root causes of the country's inadequate supply of electricity: lack of generation, lack of imports and high losses. They then identified a series of transmission line and substation projects that will strengthen the transmission network and thereby improve the country's power supply.

The following transmission projects were selected. They are shown in Figure 1.

The East-West Transmission Backbone

- NR1: 400 kV East-West transmission backbone
- NR1.1: Upgrade of the Dhalkebar substation to 400 kV and upgrade of the Dhalkebar – Hetauda 400 kV transmission line

Transmission Network Reinforcements

- NR3: Upgrade of the Ilam - Inaruwa 132 kV transmission line
- NR4: Upgrade of the Balanch - Ataria 132 kV transmission line

Enabling Generation – Connecting Generation Pooling Points to the National Grid or Nepal/India Border

- T2: Garjyang - Khimti 132 kV transmission line
- T2': Likhu Hub to New Khimti transmission line
- T3: New Tadhekani to Kusma transmission line
- T8: New Lamki substation and transmission line to the Nepal border

Cross-Border Electricity Transmission

- XB1: New Butwal 400 kV transmission line to the Nepal/India border.

MCC engaged WSP as its due diligence technical consultant and AECOM as its due diligence environment and social consultant. They conducted initial assessments of the above projects. Tetra Tech was selected on August 29, 2016 to perform a detailed feasibility study (DFS) of these projects. The goal of the DFS is to help MCC prepare to present a case to its Board for investment in these projects at its June 2017 Board meeting. For consideration of the proposal at the June Board meeting, an investment memo is to be submitted to an internal MCC investment committee in March 2017. The DFS work is expected to help in the preparation of the investment memo.

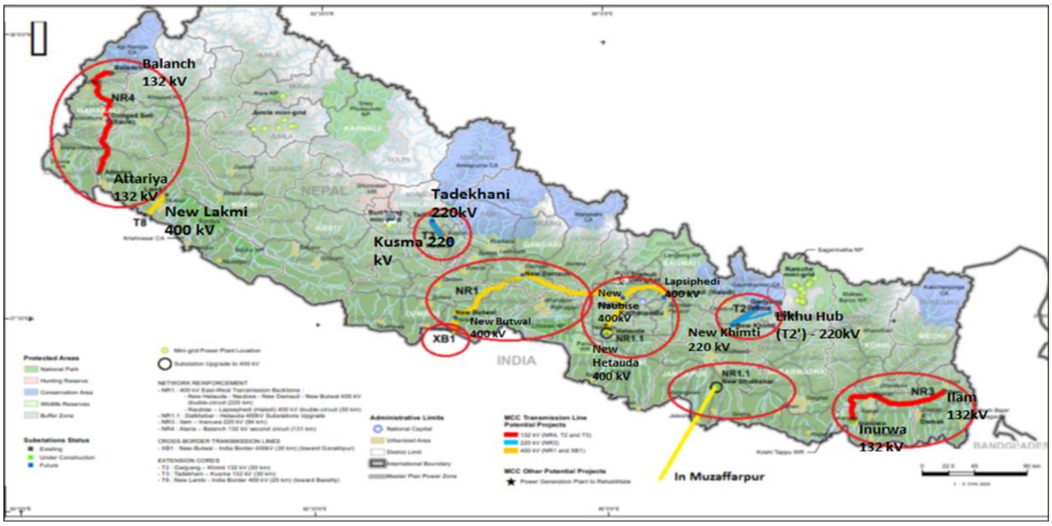

Figure 1: Locations of the Transmission Projects

The DFS work was conducted under seven tasks:

- Task 1: Technical Assessment of Network Improvements
- Task 2: Environmental and Social Assessment
- Task 3: Resettlement Policy Framework
- Task 4: Economic and Financial Assessment
- Task 5: Sustainability Arrangements
- Task 6: Monitoring and Evaluation
- Task 7: Implementation Planning.

A video conference kickoff meeting on the DFS work was held on August 31, 2016 and an on-site kickoff meeting was held on September 13, 2016 in Kathmandu. Tetra Tech assembled a team of 46 consultants from 6 countries to engage in the work and by September 13 had established a project office at the Radisson Hotel in Kathmandu. All the work of MCC's due diligence consultants was made available to Tetra Tech; MCC also set up initial meetings and introduced Tetra Tech to various stakeholders.

Previously, Tetra Tech submitted its Inception Report, Conceptual Assessment Report (CAR), and Draft Feasibility Report (DFR) to MCC, and conducted two workshops. The October 26, 2016 workshop in Kathmandu was held to present the CAR and obtain stakeholder feedback. The December 8-9, 2016 workshop at Gokarna Resort at Kathmandu was held to share the findings of the feasibility assessment with MCC, OMCN and the team of due diligence consultants. The final report was submitted on January 26, 2017 after addressing the comments provided by MCC on DFR. In February 2017, MCC further provided comments on the January 26, 2107 report, and discussed those comments with Tetra Tech. This report is the updated version of the final report after addressing the final comments provided by MCC.

This Final DFS Report is presented in eight volumes. Volumes 1 to 7 are numbered to correspond to each of the seven tasks. Volume 8 contains the summary of the full assignment. Each volume is self-contained and makes only limited references to the other tasks.

After a desk study of the proposed projects' locations using Google Earth, Tetra Tech reviewed the information provided by the due diligence (DD) consultants and made initial visits to the all the sites using commercial flights, charted helicopters and land routes together with MCC and OMCN. This preliminary work helped the team gain a common understanding of the activities required. Then, a more detailed scope of work was developed and agreed with MCC and OMCN at the stage of the CAR, which is presented in Table 1 below.

Table 1: Scope of Work

Projects		Transmission Lines	Substations	
			New	Existing*
NR 1, XB1	NR 1	400 kV, 271 km	Lapsephedi**	
		Lapsephedi to Naubise (48 km)	New Damauli	
		Naubise to New Hetauda (41 km)	Naubise	
		Naubise to New Damauli (98 km)	New Butwal**	
		New Damauli to New Butwal (84 km)	New Hetauda***	
	XB1	New Butwal to Nepal/India border (23 km)		
NR 3		132 kV, 110 km		
		Ilam* to Inaruwa*		Ilam Inaruwa
NR 4		132 kV, 131 km		
		Balanch* to Attariya*		Balanch Attariya
T8		400 kV, 47 km		
		New Lamki to Nepal/India border	New Lamki	
T2'		200 kV, 30 km		
		Likhu Hub to New Khimti*	Likhu Hub	New Khimti
T3		220 kV, 30 km		
		Tadhekani to Kusma*	Tadhekani	Kusma
Total		642 km	8	6

* Bay extensions will be provided at these existing substations.
** The 220 kV systems of these substations are funded by the Asian Development Bank.
*** The 220 kV system of this substation is funded by the World Bank.

The full DFS report is organized as follows. The preliminary technical design of each of the substations (S/S) and transmission lines (TLs) in Table 1 along with their layout design drawings, bills of material, technical specifications of major equipment, cost estimate, packaging, implementation schedule and risk assessment (Task 1) are presented in Volume 1. Its annexes include terms of reference for the project engineers. The Preliminary Environmental and Social Impact Assessment (PESIA) of the project (Task 2) is presented in Volume 2, annexed with terms of reference for the full Environmental and Social Impact Assessment (ESIA) and for the Environmental and Social

Management Plan (ESMP). The Resettlement Policy Framework (Task 3) is covered in Volume 3, annexed with terms of reference for the Resettlement Action Plan. The financial and economic analysis (Task 4) is covered in Volume 4. The Task 5 analysis of risks to sustainability and a risk mitigation plan are presented in Volume 5. Volume 6 provides the monitoring and evaluation (M&E) framework (Task 6) to track the compact's progress, outputs and outcomes. Volume 7 (Task 7) suggests an implementation plan to complete the project within the five-year compact period and an assessment of the availability of contractors and resources to carry out the work called for under the compact.

To complete this assignment, Tetra Tech's team of 61 consultants (although the assignment began with a team of 46 consultants, several specialized local consultants were added later) relied upon:

- *Information and knowledge* provided by MCC, OMCN, MCC's DD consultants, and staff of Nepal Electricity Authority (NEA), GoN, Asian Development Bank (ADB), World Bank (WB), KfW, USAID and other individuals active in transmission work, private power developers, and many other stakeholders.
- *Data* collected from various sources***,*** such as the DD consultants, NEA, the Forestry and Land and Survey Departments of the GoN, satellites, site inspections, aerial surveys, Google earth, the World Wildlife Fund, among other sources. Approximately 50 GB of digital data were considered.

A summary of the Tetra Tech team's approach and key results are presented below for each task.

Task 1: Technical Assessment of Network Improvements

Our approach to this task was based on data collected on existing transmission practices (design standards, procurement and implementation mechanisms) in Nepal, the substations and transmission lines in which NEA and/or other donor agencies are also involved (as highlighted in Table 1), site visits, geotechnical assessments, power assessments using the PSSE model provided by MCC and its DD consultants, as well as international experience, best practices, etc.

Substation Site Selection: Our substation site selection process was based on a multi-criteria approach. We evaluated sites based on the recommendations made by OMCN and the DD consultants, space availability, site conditions, environmental sensitivity, and accessibility. As a first step, a preliminary site visit was conducted for most of the DD-proposed sites along with other proposed sites. Generally, three possible locations were shortlisted for each of the new substations, although in some cases, only two were found. As a next step, the site selection was finalized based upon space availability for the ultimate layout and impacts (e.g., resettlement). A final round of site visits was conducted in order to obtain geotechnical data for the selected site. Table 2 shows the alternatives considered and selected site coordinates for each of the substations:

Table 2. Alternatives Considered and Selected Site Coordinates for the Substations

Substation	Alternative #1	Alternative #2	Alternative #3	Selected
New Hetauda	N/A	N/A	N/A	Site selected by NEA/World Bank.
Galcchi	27° 47' 55.72'' N 84° 54' 53.79'' E	27° 47' 09.25'' N 84° 56' 02.21'' E	N/A	Galchhi was initially proposed as an alternative for the Naubise site. These alternatives were dropped after Naubise was selected as a final substation location.
Naubise	27° 43' 59.40'' N 85° 06' 57.56'' E	27° 44' 09.15'' N 85° 07' 13.77'' E	N/A	Alternative #1 was selected as it offers better land topography and larger footprint.
New Damauli	27° 57' 13.8" N 84° 17' 10" E	27° 56' 54.26'' N 84° 17' 54.20'' E	27° 58' 04.94" N 84° 17' 33.97" E	Alternatives #1 and #2 were on steep slopes. Alternative #3 is located on farmland and offers better topography. The site selected is alternative #3.
New Butwal	27° 34' 31.83'' N 83° 41' 25.49'' E	27° 35' 46.27'' N 83° 37' 25.78'' E	27° 35' 32.03'' N 83° 41' 8.03'' E	Three alternatives were proposed initially. Alternative #1 was selected as it was found that ADB has already purchased this land for its 220 kV substation.
Lapsephedi	N/A	N/A	N/A	The substation is to be built adjacent to ADB's 220 kV substation.
Tadhekani	28° 23' 40.43'' N 83° 25' 04.86'' E	28° 26' 48.40'' N 83° 30' 10.98'' E	28° 23' 25.69'' N 83° 26' 21.53'' E	Alternative #1 was selected as other two alternatives are not suitable from the geotechnical and land topography perspectives.
Likhu Hub	27° 29' 58.74'' N 86° 17' 18.95'' E	27° 29' 17.23'' N 86° 18' 19.66'' E	27° 31' 36.84'' N 86° 21' 25.32'' E	Alternative #3 is on land purchased by an independent power producer (IPP), which volunteered to provide it. This site was selected.
New Lamki	28° 36' 55.50'' N 81° 13' 39.13'' E	N/A	N/A	This location was selected through a site visit and since all stakeholders agreed, no other alternative sites were explored.

The physical layout and configuration of the substation designs were developed based on two underlying principles: COMS (constructability, operability, maintainability and safety) and reliability. A breaker-and-a-half scheme was selected for the bus bar configuration of all new 400 kV stations.

Equipment Insulation Levels and Minimum Design Clearances: The basic insulation level (BIL) was determined for each site based on IEC 60071 Parts 1 and 2, and on the basis of rated maximum operating voltage, elevation above sea level, and estimated pollution level. Design clearances were selected based on the BIL level such that the minimum requirements outlined in standard IEC 61936 Part 1 are met or exceeded.

Substation Design: To address the issue of the availability of flat land, we recommend gas-insulated switchgear (GIS) for five substations (New Hetauda, New Damauli, Lapsephedi, Likhu Hub and Tadakhani) and air-insulated switchgear (AIS) for the remaining S/Ss. Typically, a GIS substation takes 60% less space than older designs using AIS. Based on an assessment of the limited road and transportation infrastructure in Nepal, and following consultations with OMCN, we have not recommended transformer sizes of more than 160 MVA because of weight limitations. However, this limits the capacity of 400 kV substation and thereby affects return on investment. Thus, we suggest that at the final design stage a more detailed assessment of the road network and transportation of materials in Nepal be done with the help of logistics professionals, and if required, appropriate changes in transformer capacity be considered. Most of the good developers in Nepal rely on the route survey report prepared by these professionals for the specified site. Logistics professionals are being engaged for the transport of materials from the manufacturer's works to the site.

Conductors: Conductors of 300 mm^2 copper for the main ground grid and major outdoor equipment connections, and 120 mm^2 for fence grounding and indoor grounding as per IEC 60228, were considered for grounding (earthing). The building designs of substations, including staff quarters etc. have been provided.

Protection, Communication and System Control and Data Acquisition (SCADA): A two-level protection scheme is proposed: primary and backup. Numerical, digital relays with appropriate software are recommended. All substations are designed with SCADA, an appropriate number of meters, an energy management system (Spectrum Power Module), and remote terminal units (RTUs), telemetering panels and their suitable connectivity with new SCADA (these are being installed at NEA's Load Dispatch Center by KfW). The substation equipment is to have three levels of control:

- Local, at the equipment for maintenance – the default position of the normal/ maintenance switch is normal for remote operation from the control building or through SCADA.
- Remote, from the control panel – the local/remote switch on the control panel is in the "local" position to enable control from the panel. In the "remote" position, the control is remote through SCADA.
- Remote, from SCADA for breaker reclosing.

Transmission Line Design: The design criteria for transmission lines were developed using the Nepal Electricity Act 2050, IEC standards, IEEE guidelines, ASTM, BS, CSA, VDE and, where there is no coverage by other standards, Indian Standards. The reliability approach was adopted as per IEC 60826. As per the Nepal Electricity Act, right of way widths for transmission lines were 18 m, 30 m and 46 m at the feasibility level design for 132 kV, 220 kV and 400 kV transmission lines, respectively. In the detailed design stage, right of way widths for each line at each span will be calculated based on the width of tower cross arms, conductor sags at respective spans, and safety clearances.

Although these calculated values (according to our cross checks) will result in values close to those given in the Nepal Electricity Act, land acquisitions can be planned according to exact and detailed calculated right of ways. Optical ground sire is recommended for overhead shield ground wires. It has added the benefit of containing optical fibers that can be used for telecommunications purposes. Those towers without two overhead ground wires have galvanized steel ground wire as the second wire. Composite-type insulators were selected for 132 kV and 220 kV transmission lines, and porcelain or glass (ball and socket) type insulators were selected for 400 kV transmission lines. Suspension (for angle deviations of up to 2 degrees), tension (for deviations between 3 and 30 degrees) and dead end (for end points and where deviations are above 30 degrees) type towers are recommended. The transmission line models were prepared using PLS-CADD software.

The fine tuning of the transmission line route in an optimal corridor or in the presence of a multi-criteria selected centerline was done by locating the points of inflection (PIs) in the corridor or slightly moving the PIs to improve line routes from a technical perspective without compromising environmental, social and resettlement criteria. After the centerlines of the transmission lines were finalized, preliminary tower spotting of transmission lines was carried out.

Our practice for transmission line routing is based on adopting multi-criteria routing for all transmission lines and, as per MCC's suggestion, took a Linear Routing Tool (LRT) approach. The initial intent was to apply the LRT approach to all line routings; however, the number of routes were later selected based on a combination of the multi-criteria approach and the LRT approach due to the availability of data and time limitations. For optimal line routing, consideration was given to social, environmental, economic and engineering factors as described in Task 2. The LRT approach was applied at full scale to the main featured investments: the NR1 and XB1 transmission lines. The outputs of the LRT model were used in multi-criteria meetings and the required minor adjustments were applied to the suggested routes. Our geotechnical assessment was based on published data followed by a 35 bore holes study. Of course, this is a very limited sample of a wide area, and a more comprehensive geotechnical study at the detailed design stage will be needed to verify our findings. To fill this gap, an enhanced contingency of 40 to 50% was considered in the tower foundation design costs.

Procurement Packaging: In summary, this project consists of 8 new substations, 6 substation upgrades and more than 600 km of 10 transmission lines from 132 kV to 220 kV and 400 kV, which are spread all across the country from the far eastern to the far western regions. From many perspectives, it is not good practice to award all of these projects to one or two contractors. After considering the pros and cons of various packaging methodologies, such as geography, lines, substations, voltages, and types of equipment needed, we have suggested four packages, which are bundled largely by geographic zones and voltage levels:

Zone A EPC (engineering, procurement and construction) Contractor
Projects include:

- NR1: Transmission line between New Damauli and Naubise
- NR1: New Damauli substation work
- NR1: Transmission line between New Damauli and New Butwal
- NR1: New Butwal 400 kV substation work (400 kV switchyard, transformers and 400 & 220 kV transformer bays) to connect to ADB's 220 kV substation
- XB1: Transmission line Between New Butwal substation and Nepal/India border
- T8: New Lamki 400 kV substation
- T8: 400 kV Transmission line between New Lamki substation and Nepal/India border

Zone B EPC Contractor
Projects include:

- T3: 220 kV Transmission line between Tadhekani and Kusma
- T3: 220 kV Tadhekani substation work
- T3: 220 kV Kusma substation upgrade work
- NR4: Adding one circuit to the existing transmission line
- NR4: Upgrading (adding one line bay) to Balanch substation
- NR4: Upgrading (adding one line bay) to Attariya substation

Zone C EPC Contractor
Projects include:

- NR1: Naubise 400 kV substation work
- NR1: 400 kV Lapsiphedi substation upgrade (400 kV switchyard, transformers and 400 & 220 kV transformer bays) to connect to ADB's 220 kV substation
- NR1: 400 kV New Hetauda substation upgrade (400 kV switchyard, transformers and 400 & 220 kV transformer bays) to connect to WB's 220 kV substation
- NR1: Transmission line between Naubise to Lapsiphedi
- NR1: Transmission line between Naubise to New Hetauda

Zone D EPC Contractor
Projects include:

- T2': 220 kV Likhu Hub substation work
- T2': 220 kV New Khimti upgrade
- T2': Likhu Hub to New Khimti 220 kV transmission line
- NR3: Upgrading (adding two line bays) to Ilam substation
- NR3: Upgrading (adding two line bays) to Inaruwa substation
- NR3: Ilam to Inaruwa 220 kV transmission line

Power System Assessment: The PSSE model was provided by MCC's DD consultants. It was adapted and run by the Tetra Tech DFS team based on a set of scenarios that was first proposed to MCC and after four iterations, agreed on. These scenarios were developed to enable estimates of the project benefits to be made. The basis was for two years: 2023 and 2030. For each year, dry and wet seasons were considered. The goal was to use PSSE to provide annual estimates of energy throughput, transmission energy losses, load shedding, energy imports and exports, and generation available but not utilized. The study was carried out for seven scenarios starting from the Base Case without any of the proposed projects to a case with all the proposed projects included. With scenario runs required for each of these seven cases, each over the 2 years and the wet/dry seasons, there were thus a total of 28 scenarios. In addition to these 28 scenarios, sensitivity analyses were conducted for the high and low demand and supply scenarios, and for reduced trade with India. Power flow, loss evaluation, short circuit, and transient stability analyses were also carried out. The results of the technical benefits study for 2023 and 2030 are presented in Tables 3 and 4, respectively.

Table 3. PSSE Results for 2023

Scenairo	Annual GWh supply	Annual GWh consumption	Annual GWh loss	Annual GWh load shedding	Annual GWh import	Annual GWh export	Annual GWh generation not utilized
Counterfactual base case	12219.6	12986.5	377.0	3924.8	3571.1	2427.2	8482.5
Base Case + NR1	12180.1	13012.2	272.7	3899.1	3570.2	2465.4	8522.0
Base Case + NR1 + XB1	12604.9	15184.9	347.4	1726.4	5823.2	2895.8	8097.2
Base Case + NR1+ XB1 + T2' + T3	15577.0	15313.5	400.3	1597.9	4911.2	4774.4	5125.1
Base Case + NR3	12215.1	13004.9	350.3	3906.4	3570.8	2430.7	8486.9
Base Case + NR4	12217.4	12985.1	373.7	3926.2	3570.8	2429.3	8484.7
Base Case + T8*	17097.5	13133.5	411.4	3777.8	3501.6	7054.1	3604.5
Base Case + all MCC Projects	20702.0	15349.6	351.7	1561.7	4670.0	9670.8	0.1

Table 4. PSSE Results for 2030

Scenairo	Annual GWh supply	Annual GWh consumption	Annual GWh loss	Annual GWh load shedding	Annual GWh import	Annual GWh export	Annual GWh generation not utilized
Counterfactual base case	19305.1	18635.9	740.2	9452.7	4462.7	4391.7	12869.9
Base Case + NR1	19650.8	19915.1	660.2	8173.5	5315.8	4391.3	12524.2
Base Case + NR1 + XB1	23852.8	24923.8	1072.2	3164.7	10615.9	8472.6	8322.2
Base Case + NR1+ XB1 + T2' + T3	26801.9	25025.7	1155.2	3062.9	9982.6	10603.5	5373.2
Base Case + NR3	19305.1	19463.2	708.2	8625.4	5267.4	4401.2	12869.9
Base Case + NR4	19285.6	19418.2	757.5	8670.3	5281.4	4391.2	12889.5
Base Case + T8*	24036.8	19636.7	809.0	8451.9	5297.2	8888.4	8138.2
Base Case + all MCC Projects	31710.2	25138.3	946.7	2950.3	9790.5	15415.7	464.8

Our analysis of the above results is presented in Table 5.

Table 5. Power System Assessment Conclusions

Project	Study results or justifications
400 KV East-West Transmission Trunk Line - NR1	NR1 project would provide the backbone to Nepal's transmission network, enhancing the Nepal network's transmission capacity. It provides the transmission backbone to transfer remote energy to load centers and import/export energy from/to India.
XB1	XB1 project is critically important within all MCC projects. It doubles the energy exchange capability between Nepal and India. It also greatly reduces the load shedding requirement due to the increasing import capability, and greatly increases generation utilization due to the increasing export capability.
T2', T3, NR3, and NR4	T2', T3, NR3, and NR4 are remote transmission projects. These projects enhance the remote area transmission capacities to accommodate increasing remote generation projects.
T8	T8 is a dedicated transmission line project that will provide greater exports to India from western Nepal, including the transmission network for the 900 MW Upper

	Karnali hydro power generation project, from which around 12% of energy will be delivered to Nepal.

Cost Estimates: Bills of material were developed based on a feasibility-level design of substations (S/S) and transmission line (TLs) and were used for costing. Most of the cost were taken from Indian vendors, the rate schedules of Indian state transmission utilities, and NEA contracts. Costs were calculated for each S/S and TL. Cost multipliers were developed and used for each TL to cover feasibility-level routing. Cost estimates were developed by Task 2 for environmental and social costs and by Task 3 for resettlement costs. To this, overall costs were added for works such as M&E, ESIA, engineering, and ESMP.

The cost estimates for each project and projects in the recommended package (assuming all projects are funded) are provided in Table 6 and 7, respectively.

Table 6. Cost Estimates for all Projects (in US $million)

Project	Technical Cost, Equipment & Installation	Environmental & Social Cost	Resettlement Cost	Total
	Task 1	Task 2	Task 3	-
NR1	386.95	6.91	40.78	***$ 434.64***
XB1	9.78	0.69	3.42	***21.45***
NR3	15.78	1.99	10.98	***19.52***
NR4	4.01	1.46	0.00	***5.47***
T2'	25.29	1.12	1.74	***32.64***
T3	37.97	1.73	6.22	***48.71***
T8	38.70	0.89	9.01	***43.01***
Total	***518.49***	***14.80***	***71.37***	*$ 604.66*
Other Compact-level Costs:				
M&E Cost			0.68	
Engineer Cost			31.60	
ESIA Development and Implementation Cost			4.92	
Grand Total			**$ 641.86**	

Table 7. Cost Estimate for Various Packages

Package 1		
(Zone A)	Technical Cost	178.0
	Environment and Social Cost	3.7
	Resettlement Cost	26.1
	Total Package Cost	207.8
Package 2		
(Zone B)	Technical Cost	42.0
	Environment and Social Cost	3.2
	Resettlement Cost	5.9
	Total Package Cost	51.1
Package 3		
(Zone C)	Technical Cost	257.4
	Environment and Social Cost	5.2
	Resettlement Cost	27.0
	Total Package Cost	289.6
Package 4		
(Zone D)	Technical Cost	41.1
	Environment and Social Cost	2.8
	Resettlement Cost	12.4
	Total Package Cost	56.2
Total		604.7
	M&E Cost	0.68
	Engineer Cost	31.60
	ESMP Implementation	0.85
	ESIA Development Cost	4.07
Grand Total		**641.86**

Of this total, it is estimated that the funding required during the Compact Implementation Funding (CIF) period will be US $14 million. The remaining cost is estimated to flow during the compact period as follows:

Table 8. Cost Estimates on the Basis of Time Period (US $million)

		Compact Year				
Cost Projections	CIF	1	2	3	4	5
Annual Cost	14	159.7	180.96	126.1	95.7	65.4
Cumulative Cost	14	173.7	354.66	480.76	576.46	641.86

Implementation Schedule: The implementation schedule for all the four packages was prepared using Primavera and MS Project, local knowledge and standard practice. We have assumed that 24 months (from October 2017 to September 2019) will be available for CIF and 60 months (from October 2019 to September 2024) of the compact period. The full implementations plan is provided in Annex A of Task 1. The following float was identified for each of the four packages/zones:

- Zone A EPC Contractor - ~ 8 Months
- Zone B EPC Contractor - ~ 7 Months
- Zone C EPC Contractor - ~ 7 Months
- Zone D EPC Contractor - ~ 5 Months

Key Points:

1. The average span between 400 kV towers decreases when towers are located in mountainous terrain. Also, the span must be lowered when lines are diverted to avoid communities. It is not always possible to design the line segment (a stretch of line between two adjacent angle points) as a multiplier of the desired average span. When the line designer sees a residential area ahead, he/she needs to divert the line from a straight alignment at a shorter span. This was often the case for the MCC projects, an thus, a reduced average span was considered.

2. Two boreholes were drilled at most substation sites to provide a general idea of their soil conditions. This information was used to verify the safe soil bearing pressure used for the preliminary design of foundations at the sites. As only limited information can be derived from two boreholes and in some cases, the soil bearing capacity found was less than what was assumed for the foundation quantities, a contingency factor was applied to the foundation costs to compensate for undersized foundations and limited geotechnical information. Different contingencies values (50% for hilly terrain and 40% for plains) were used for the sites based on the differences between boreholes results and the assumed soil condition as well as the resulting uncertainty.

3. The power flows provided by WSP included the transmission system (400 kV, 220 kV and 132 kV) in detail. Only some parts of the sub-transmission system (33 kV and 66 kV) were included and the distribution system was not modelled. Furthermore, most of the loads were directly placed at the transmission level busses. It was found that the 132 kV and 66 kV systems included in the model are not capable of supplying the demand expected by 2030. As a result, a significant number of 132 kV and 66 kV line upgrades were identified from the studies. Further, a significant amount of reactive power compensation at these voltages would be required. In order to determine the reactive power compensation required at each bus. A reactive power compensation study needs to be carried out considering proper distribution feeders. The 66 kV and 33 kV networks need to be included and the loads should be placed at the feeders. It is also necessary to properly model the tap changing transformers with the voltage regulators. Also, the generators needs to be placed at the right locations connected with their feeder lines.

4. The proposed site for Naubise was selected using a combination of desktop studies and field visits by MCC, OMCN and Tetra Tech. The original location had an elevation drop of about 60 meters, hence a terraced design option was considered. This design led to an increase in the width of the station, from 200 m to 400 m, which would increase the civil and electrical construction costs. The increased width was required in order to provide appropriate transition

distances between the different flat segments. It was not feasible to simply provide a retaining wall given the 30 m elevation difference between flat segments. A 3 to 1 slope was provided for slope stability as per good engineering practices. Thus, the higher cost has been taken.

5. The use of a 400 kV GIS building while maintaining the 220 kV AIS portion, at the Naubise substation was studied in order to determine if cost savings could be achieved by reducing the footprint of the station. The use of a GIS building on the 400 kV section would have led to savings of approximately 20% on total land use. This would have led to savings on civil costs of approximately US $475,000 (53,000 m^3 of cut and 52,000 m^3 in fill). However, the use of GIS switchgear would have increased the electrical cost by approximately $6-7 million. The difference in cost was estimated by comparing the costs for Hetaude and Naubise. These two stations are similar in terms of the numbers of feeders but use two different substation types. Given that the GIS option ended up being more expensive, it was decided to maintain the AIS design.

6. The use of rigid bus bar scheme with vertical disconnect switches was considered initially. Once it was decided to use the breaker and a half scheme, the vertical break switch had to be reviewed. Given the nature of the breaker and a half scheme, it is not advantageous to use the vertical break disconnect switches to transfer between buses. The feeders need to be connected to each other via a breaker, which prevents connecting a single line to two different buses starting from the same bus by using vertical break switches. As a matter of fact, using a rigid bus for the breaker and a half configuration was found to increase the overall footprint of the substation. The strain bus design was found to minimize the amount of land required.

7. A 3D model was created for every substation in order to model with greater accuracy the amount of civil work required. In some cases, the amount of civil work was reduced significantly from the estimates in the draft feasibility study report. Furthermore, the estimated amounts for road work considered in the cost estimates were revisited. As a result, there are significant cost reductions associated with civil work.

Task 2: Environmental and Social Assessment

The Preliminary Environmental and Social Impact Assessment (PESIA) was developed according to the scope of work identified in Table 1. In addition to the transmission lines and substations, the projects will require the construction of several access roads to transport materials to the sites. These are generally short links to existing roads, except in the cases of Tadhekani and possibly Likhu Hub. Because other developers are active in some of the same locations as the proposed MCC projects, not all roads are the responsibility of the MCC compact program, as shown in Table 9.

Table 9. Substation Access Road Information (as of December 2016)

Substation	New access roads total length required (regardless of funding source) (km)	Segment of new road that is the responsibility of the MCC projects (km)	Donor/funding source; responsibility for road environmental assessment
Lapsiphedi	5.0	0	ADB
Naubise	1.6	1.6	MCC
New Damauli	0.45	0.45	MCC
New Butwal	0.15	0.15	ADB
Tadhekani	19.8	19.8	MCC
Likhu Hub	0.45	0	IPPs
New Lamki	0	0	
New Hetauda	0.2	0.2	World Bank
Totals	**27.65**	**22.00**	

These roads are generally paved, and one will require a 60 m long bridge with the capacity to handle trucks carrying heavy equipment. No roads are expected to be built to access the tower sites, although temporary passage may be required across some agricultural land. The towers will be built at their sites, and materials and equipment are expected to be brought to the sites by porters or mules in the less accessible areas.

Regulatory Requirements: The preliminary ESIA was prepared according to the requirements of the International Finance Corporation, World Bank Group Safeguards, MCC's Environmental Guidelines, and applicable laws and regulations of the GoN. In addition, a participatory multi-criteria transmission line route selection process was applied to avoid or reduce a number of potential environmental, social, and resettlement impacts prior to final route selection.

Nepal has a national framework for environmental and social assessment that is well established and documented extensively in the literature. With respect to the MCC projects, the environmental authorities are the Ministry of Population and Environment and the NEA, whose Environmental and Social Studies Department has published a clear set of guidelines for conducting initial environmental examinations (IEEs) and environmental impact assessments (EIAs) for all projects to pass a screening test. Projects that pass the screening are implemented in accordance with national environment protection rules, including EPA (1997) and EPR (1997). It is assumed by MCC that Nepal IEE/EIA requirements, if applicable to the proposed projects, will be fulfilled during the preparation of the full ESIA for the projects.

Methodology for Multi-Criteria Route Selection of Transmission Lines and Substations:
The traditional approach to stakeholder involvement in project siting consists of presenting a set of proposed and alternative sites (or routes) to the affected parties after the siting process has been essentially completed. The approach used here gives stakeholder representation throughout all phases of the siting process. The methodology that was applied created least constraint/cost solutions that were generated by transparent and replicable methods. The process considers all available data and incorporates the siting criteria developed by technical experts, in collaboration

with stakeholders and their representatives. For each of the potential lines, this approach involved four steps:

Step 1. Gather and verify data in the form of geo-referenced geographic information system (GIS) layers, and look at the general corridors suggested by the preliminary routes laid out by MCC's DD consultant and NEA as a starting point for the routing process. The project benefited from receiving extensive GIS information on environmental issues from the World Wildlife Fund Nepal.

Step 2. Implement the Linear Routing Tool (LRT), Tetra Tech's proprietary software that uses ESRI GIS. The process also involved providing weights to each of the attribute layers being used in the model. These weights were originally assigned by the Tetra Tech team, and then modified using stakeholder preferences gathered in an October 2016 workshop and responses to a questionnaire survey. The weights basically informed the model on what features should receive greater importance than others when routing.

Step 3. The results of the LRT were reviewed using multi-criteria analysis by overlaying the LRT-preferred routes on Google Earth and fine tuning the routes using current data, participation with Task 1 and Task 3 specialists, the local knowledge of the team's national experts, and keeping in mind the wishes of stakeholders.

Step 4. These routes were then turned over to the engineers (Task 1 team) who used the PLS-CADD program to prepare a preliminary design of the routes, again making minor route changes where needed by the design constraints.

Stakeholder engagement and consultation are vital parts of this feasibility study and the PESIA. As discussed above, stakeholder input was integrated into the selection of the corridors, and it is expected that stakeholders will continue to be engaged during the duration of the compact project design, ESIA, construction and operation.

The Stakeholder Engagement Framework is designed to:

- Define the policies and guiding principles for stakeholder engagement applicable to compact development
- Identify compact-wide stakeholder engagement and communication objectives and information needs during the compact development phase
- Identify stakeholders using a stakeholder mapping approach
- Define the activities, tools and procedures needed to complete the stakeholder engagement process during compact development, including redress of grievances and reporting
- Define roles and responsibilities to manage stakeholder engagement during compact development
- Establish parameters for ongoing stakeholder engagement during subsequent stages of the compact, including the development of stakeholder engagement plans for each compact project and the hand-off of stakeholder engagement data and plans from one stage to the next.

During the early part of the feasibility exercise, teams visited the Far Western, Middle and Eastern regions of Nepal in which substations and transmission lines were likely to be constructed, expanded or rehabilitated. The teams focused largely on district-level discussions, although a few community-level interactions were held. These exchanges provided useful input on the issues associated with earlier transmission line projects, and in gaining a better perspective of the potential risks that future investments might face in implementation, especially in the MCC five-year compact period. From a social and gender perspective, these site visits highlighted the needs and challenges faced by the diverse groups that make up the country's citizens. From Dalits in the Far West to indigenous peoples in the Middle and Eastern regions, poverty reduction, including both income and non-income, is a priority.

The proposed projects yield an important opportunity to provide benefits to those living in areas through which the transmission lines pass, particularly as there may be no immediate local benefits from power derived directly from those lines. Thus, benefit sharing can be considered part of establishing a social license to operate. This is particularly true in the context of Nepal, where community opposition is known to delay infrastructure work. There is a specific focus of the proposals on women, especially those from disadvantaged groups, as their participation in activities with higher return is limited by 1) lack of time, 2) lack of access to economic assets and to marketing networks and technology, 3) restricted mobility and risk-taking capacity, 4) limited education and lack of vocational training, and 5) social discrimination on the part of employers. We have attempted to address the challenges posed by items 2) through 4).

Findings

Existing Baseline Conditions: The proposed projects are spread throughout Nepal. The PESIA provides a summary of the existing or baseline environmental and social conditions in all parts of Nepal that apply in general to all of the proposed projects. The following parameters were considered for the base line:

- ***Physical:*** covering geophysical issues such as seismic danger, flooding risk, slope, erosion, landslide potential, and soils; water quality and water resources; air quality and noise; hazardous materials/waste; and greenhouse gas emissions
- ***Ecological:*** including protected areas, rare and endangered species habitats and wildlife corridors, important bird areas, and ecosystem services
- ***Socio-economic:*** covering general impacts on the national economy, general impacts on local/regional, gender issues (such as the potential for gendered differences in impacts), potentially affected households, agriculture, communities, indigenous and vulnerable people issues (such as changes in population), expected changes in governance, institutions or practices, formal or territorial disputes, and changes in land use or other economic uses of affected lands, and land use, including urban, agricultural/pastoral, and various types of forests.
- ***Cultural:*** including temples, sacred forests, visual resources, and touristic resources.

Climate Change: The effect of climate change on/by the MCC transmission projects was considered in two ways: 1) the effect of the transmission lines on the production of greenhouse gases (GHG), and 2) the effect of climate change on the transmission lines. Both aspects are addressed in the PESIA and recommendations are made regarding the types of materials that would reduce GHG emissions as well as minimize the taking of forest lands, which provide CO_2 sequestration. Climate change can also adversely affect the project (for example, by raising the risk of catastrophic flooding from glacial lake outbursts caused by the formation of unstable glacial lakes that eventually overflow or burst due to continued warming). Given their location, T3 and T2' are most likely to face these risks.

Project Screening: MCC will not fund a project unless there is provision for appropriate screening and appropriate environmental and social impact analysis. The proposed projects have been preliminarily screened based on desk studies, limited field observations and stakeholder contributions, and inputs from knowledgeable local experts. Six of the seven proposed projects fall under Category A, requiring a full ESIA, while one project (NR4) is Category B, requiring only an environmental evaluation and Environmental and Social Management Pan (ESMP).

Transboundary Impacts: Although India may experience some environmental or social impacts from new or enhanced transmission lines, substations, or even additional electricity generation, impacts beyond the Nepal border are not addressed in this PESIA; however, it is recommended that MCC investigate whether Executive Order 12114 is applicable to these projects. If MCC determines that Executive Order 12114 applies, it should proceed with an environmental review of transboundary impacts and contact the State Department to coordinate discussions with India.

Environmental and Social Impact and Mitigation Measures: The PESIA presents a summary of potential impacts and mitigation measures that are common to all the projects and all regions, followed by individual project-by-project assessments. Field inspection on a sample basis has been conducted and a multi-level impact evaluation process was utilized in conjunction with transmission line and substation routing and location decisions described earlier, more than two dozen selected site visits, and a multidisciplinary visual inspection of detailed satellite imagery. This approach serves as starting point for the more detailed analysis to be conducted during the preparation of the final ESIA.

While new substations and transmission line towers will have perceptible impacts on the acquisition of lands and attendant involuntary resettlement implications, the general impacts of the lines were not found to be significant, except perhaps in forest areas in which trees will have to be coppiced or removed and right of ways (ROWs) cleared. These actions may have impacts for access to non-timber forest products and potential loss of incomes. Table 10 presents the impacts and mitigation measures applying in general to the proposed projects.

Table 10. Impacts and Mitigation Measures for Proposed Projects

Environmental concern	Significant environmental impacts without mitigation	Required mitigation measures (see detailed information in the ESMP)
Detailed design phase		
Hydrological Impacts	Untreated runoff or wastewater negatively affecting quality or flows of water courses	Design/construct and maintain drains and retention structures to eliminate impact

Table 10. Impacts and Mitigation Measures for Proposed Projects

Environmental concern	Significant environmental impacts without mitigation	Required mitigation measures (see detailed information in the ESMP)
Wetlands	Small areas of disturbance. Potential negative impacts to these habitats.	Routing avoidance, slit screens, restoration post-construction
Accessibility	Impacts unlikely	MAPF, disabled access provided
Soil Erosion	Earth borrows quarries and disposal for access roads and towers. Erosion and impacts to water courses.	Use existing borrow and disposal pits; erosion protection measures
Impact of Borrow Pits, Quarries and Waste Disposal	Unlikely to need new facilities. Erosion and habitat impacts could occur.	Obtain proper offsite permits from local officials, and document all locations and permits
Landslides	Possible on ridges. Improper tower siting may cause landslides.	Follow Nepal landslide prevention standards
Safety	Issues always likely. Workers and local populations exposed to construction hazards.	Fences, signs, and all applicable design safety standards; community training
ROW Environmental Impacts	Scattered areas of critical habitat may be encountered. Potential negative impacts to these habitats.	Avoid tower placement in areas of critical habitat, install transmission lines above vegetation, limit construction during breeding season, remove invasive species,., integrated vegetation management. *(Note A)*
Aquatic Habitat	Line will cross occasional wetlands and fish habitat. Potential negative impacts to these habitats.	Avoid siting towers in wet areas; use clear span bridges for access roads, open bottom culverts; minimize disturbing riparian vegetation. *(Note A)*
Electric and Magnetic Fields	Potential exposure when crossing inhabited areas. Impacts of these fields are not clear, so should be avoided.	Evaluate exposure according to standards of the International Commission on Non-Ionizing Radiation Protection; if below standards, implement protective engineering measures. *(Note A)*
Construction phase		
Inadequate Environmental Awareness of Workers	Likely to be instances with subcontractors, leading to violations of the ESMP requirements	Contractors to retain environmental health & safety officers. Conduct special and regular briefings and trainings. *(Note B)*
Water Quality	Temporary impacts highly likely from spillages, wastewater disposal, and onsite solid waste disposal. Could affect surface or groundwater.	Operator training, maintain lubricant and fuel storage facilities and procedures, properly designed drainage system, 50 m standoff of facilities and construction from receiving water bodies, onsite dumping prohibitions, vehicle and machine maintenance enforced, sanitation

Table 10. Impacts and Mitigation Measures for Proposed Projects

Environmental concern	Significant environmental impacts without mitigation	Required mitigation measures (see detailed information in the ESMP)
		facilities and wastewater treatment at work sites and construction camps.
Air Quality/Dust	Likely only at substation construction sites. Increased levels of respirable particulate matter above health-related standards leading to health issues for workers or local populations.	All machinery to be fitted with air quality control equipment to IFC and national standards; use Euro IV diesel fuel when available; enclosing sand stockpiles & wind barriers; providing all-weather roads where there is regular vehicle movement; wetting of other roads; closed storage of cement materials and aggregate; fuel-efficient vehicles, idle engine turnoff; on-site vehicle washing; dust control measures.
Noise/Vibration	Exceedance of standards likely at substations and temporarily at tower construction sites, especially where piles need to be driven.	Noise abatement gear for vehicles and powered mechanical equipment; daylight operation restrictions near populated areas; maintenance of equipment and vehicles, especially mufflers; speed controls; acoustic screens near sensitive receptors (schools, temples, etc.).
Soil Erosion and Soil Contamination	Likely at substations and tower construction sites (temporary).	Complete drainage works to be designed and maintained, strengthen steep slopes, properly dispose of extracted soils, avoid use of arable land for borrow and fill, restore cover as soon as feasible.
Handling and Storage of Hazardous Materials	Unlikely, and limited to construction yards.	Constructed storage areas on impermeable surfaces, safe ventilation practices, controlled access procedures, use of refrigerants and fire extinguishing materials in accord with the Montreal Protocol.
Landslides	Possible but unlikely.	Use of landslide prevention measures, careful use of excavation equipment so as not to destabilize topsoil layers.
Damage to Historic/Cultural Monuments	Unlikely after studies during detailed design are complete	Training of workers in artifact recognition, immediately cease work provisions in case of finds, prior coordination with Ministry of Culture regarding procedures, documentation of findings, rarely, design avoidance/preservation features. *(Note C)*
Work Camp/ Temporary Yard Operation and Location	Wherever present. Possible tree cutting; water and sanitation impacts, solid and hazardous waste releases, failure to maintain waste separation, collection and transport away from site,	Avoid settlements where possible; avoid tree cutting; provide water & sanitation, manage solid, hazardous waste and sewerage; maintain waste separation, collection & transport away from site; site restoration, re-vegetation; inspect & validate that site is returned to pre-project conditions

Table 10. Impacts and Mitigation Measures for Proposed Projects

Environmental concern	Significant environmental impacts without mitigation	Required mitigation measures (see detailed information in the ESMP)
	failure to restore / revegetate the site	
Worker Safety	Wherever present. Workers exposed to construction hazards.	Engineer-approved EHS plan, to include: warning signs, personal protective equipment, worker training, vehicle & equipment training, licensing, first aid and medevac transport available, regular safety checks, maintain 24-hour emergency contact lists, provide HIV/AIDS & STD awareness training and testing.
Traffic Management and Construction Safety	At all long- and short-term construction sites. Traffic-related accidents and congestion in roads used during construction.	Prepare & enforce traffic management plan, to include, *inter alia,* traffic warning signs and regulations enforcement, awareness program, traffic control personnel/flaggers, alternative pedestrian access, arrange for passer-by safety, select quarry and borrow sites with capacity for heavy trucks, vehicular speed control, road damage repair, local authority approval for use of local roads
Operational phase		
Bird Protection	All valley crossings and designated flyways. Significant bird mortality due to collisions with conductors or towers.	Install reflectors on all transmission line major river crossings and in areas of frequent fog. Plant tall growing trees outside ROW to encourage birds to fly higher and avoid trees and lines; include nest and resting platforms on towers for raptors and vultures. *(Note A)*
ROW Maintenance	Throughout route, and especially through community forests. Improper maintenance of the ROW leading to potential vegetation reaching too close to the conductors. Increased erosion on steep slopes. Potential use of herbicides could affect nearby agricultural lands or water courses.	Develop and implement a vegetation management plan to provide local job opportunities, especially for women and vulnerable people. Avoid use of pesticides and herbicides where possible; otherwise, train and certify personnel in safe application procedures.

Notes:

A. Detailed location and extent of problem areas shall be determined during the preliminary design phase.
B. Individual contractors shall be asked to fill in questionnaires to be prepared and administered by the client's environmental health and safety officer.
C. All known sites have been avoided during feasibility studies. Further site investigation will be needed during the detailed design phase and prior to construction.

Socio-Economic Impacts: Specific attention has been given to addressing the concerns of forest users whose access to non-timber forest products (NTFPs) may be restricted by the transmission lines and who may face losses owing to the ROWs established for the lines. Of primary interest to affected people will be the implementation of a fair and prompt compensation program for their losses. Construction phase impacts such as trafficking in persons (TIP) and HIV/AIDS need to be addressed through strong mitigation measures in the construction contracts and with comprehensive monitoring.

Analysis of Alternatives: The alternatives considered in the PESIA are: Preferred Alternatives, Initial Alternatives and No Action. No Action implies that the projects would not be performed under the MCC compact. The impacts of different technical designs, such as GIS or AIS for substations, were also considered.

Environmental Management: The PESIA includes an outline for an Environmental and Social Management System (ESMS). The ESMS for the MCC Nepal program is being developed by MCC's ESP due diligence consultants and will be applied to the activities of the GoN organization responsible for the implementation of the compact projects. The PESIA also includes an Environmental and Social Management Plan (ESMP) that will become an integral part of the construction contracts.

Costs: The environmental and social costs for the project were determined under two categories:

- Costs for the implementation of the ESMP including environmental mitigation costs (not including land acquisition) and
- Benefit-sharing costs.

Benefit-sharing can take many forms, as has been shown by the World Bank and others. Most often benefit sharing programs are features of hydropower projects where there is a reasonably well-defined projection of revenues that can be shared. In those cases, benefit-sharing programs have ranged from 1 to 9% of annual gross sales or revenues. In the case of the MCC transmission lines, the funding mechanism for benefit-sharing is described as a "system benefit charge" that is applied to the predicted financial annual capital recovery amounts for the projects. As of this writing, this "system benefit charge" is taken as 5% of annual capital recovery, based on recovery over 15 years at 10%.

Table 11 shows estimates of the environmental costs associated with the project lines. The environmental costs illustrated in this table are based on the latest feasibility study construction costs. Details of the "bottom-up" approach to obtaining these estimates can be found in Annex K of Volume 2. The environmental cost estimates will be revised and updated based on subsequent design refinements and the more detailed environmental and social information gathered during the preparation of the Final Environmental and Social Impact Assessment (FESIA). The total cost of the proposed benefit-sharing program over the life of the compact is estimated at US $19.8 million

Table 11. Estimated Project Environmental Costs

Line ID:	Total Construction Cost (million USD)	Environmental Mitigation and Monitoring Cost (million USD)	Annual Benefit Sharing Cost Allowance (million USD)	Total Benefit Sharing Cost over the Compact (million USD)
NR1	385.61	$6.91	$2.17	$8.21
XB1	9.78	$0.69	$0.18	$0.69
NR3	15.78	$1.99	$0.90	$3.40
NR4	4.01	$1.46	$1.03	$3.91
T2'	25.29	$1.12	$0.28	$1.06
T3	37.97	$1.73	$0.29	$1.09
T8	38.70	$0.89	$0.37	$1.41
Total	***517.15***	***$14.80***	***$5.22***	***$19.77***
Note: Total Construction Cost is defined as the total technical cost plus contingency, not including resettlement or MCC / MCA-N management costs				
Estimated Cost of the four (4) ESIAs for the four (4) packages				$4.07
Assumptions (Please see Annex K to Volume 2 for a more detailed list of assumptions)				
Total 5-year ESMP and ESMS Implementation Cost (this is a management cost accruing to MCA-N that covers all lines; not included in the mitigation/ monitoring costs above, which will be part of the construction contracts)				$ 0.85
Total Construction Cost Percent Needed for Environmental Mitigation and Monitoring				2.62%
Discount rate				10%
Capital Recovery Factor (percent of construction) for 15 years at 10% (used to estimate benefit sharing budget)				13.15%
System Benefit Charge for Benefit Sharing (percent of annual capital recovery)				5.0%

Full or Final ESIA: The terms of reference for the PESIA can be found in Annex L of Volume 2. A detailed cost estimate designed to guide the development of the FESIA and ESMP for this project is presented in Annex K. It is proposed that the FESIA be performed during the CIF period prior to the compact's entry into force.

Key Points:

1. The Linear Routing Tool was an effective method for the initial identification of transmission line alignments. The LRT was used for routing all projects except NR4 (an existing TL) and T8. Limitations on time and geospatial data required that an additional multi-criteria assessment be conducted to fine-tune the LRT alignments.

2. Overall, the projects have few significant impacts.

    a. The most significant potential environmental impacts ascertained in the PESIA are:

  - Forest resource impacts due to the need to have safe clear-cut zones beneath the power lines
  - Erosion (impacts on slope stability and aquatic resources) from various construction activities
  - Climate change (likely to be positive impacts due to a reduction in the use of diesel back-up generators)
  - Bird migration conflicts with power lines.

b. In terms of social impacts, the following issues were identified:
  - Potential lack of access to community forest resources, including NTFPs
  - Implementation of a fair and prompt compensation program
  - Lack of benefits to local stakeholders from the high-voltage lines, which would not bring electrification to all areas that they cross
  - Construction phase impacts such as trafficking in persons and HIV/AIDS will need to be addressed through strong mitigation measures in the construction contracts and with comprehensive monitoring.

c. These potential impacts can be mitigated through the implementation of a comprehensive Environmental and Social Management Plan (ESMP).

d. The PESIA does not identify any fatal flaws (defined as non-compliance with any IFC Performance Standard, inclusive of the implementation of mitigation measures) for any of the projects.

3. The transmission line projects can be built with minimal environmental and social impact provided the ESMP is complied with, the resettlement and compensation issues are properly addressed in the Resettlement Policy Framework (RPF), and the resettlement action plans (RAPs) are developed during the preliminary and final designs. A benefit-sharing framework is included that will enhance the project's social license to operate.

4. It is recommended that the results and conclusions of the PESIA be reviewed and, as appropriate, revised during the preparation of the full ESIA. A detailed terms of reference for the full ESIA is provided (in Annex L). It will fill gaps in the PESIA, such as an indigenous peoples plan and comprehensive field studies that will produce a more comprehensive assessment of impacts.

Task 3: Resettlement Policy Framework

The Resettlement Policy Framework (RPF) is based on the guiding resettlement policies and procedures, and the applicable requirements of the GoN and MCC's policy on Involuntary

Resettlement,[1] which requires compliance with the International Finance Corporation Performance Standard 5 (PS5), Land Acquisition and Involuntary Resettlement.

In general, transmission lines do not require land acquisition, but only place a restriction on land use under the lines, and require the removal of all structures, tall trees, etc. located within the ROWs of the lines. However, the transmission towers and the associated substations and other facilities do result in a need to acquire land permanently. The primary involuntary resettlement impacts expected during the current projects include both temporary and permanent impacts, as listed below:

Permanent impacts expected for:

- All structures located within the ROW of the transmission lines will have a permanent land use restriction/easement placed on it – no structures can be built or trees, etc., planted. However, agricultural processes, grazing and other similar land uses can continue.

The ROWs for the seven project lines vary according to the voltage levels of each line, as follows:

- 132 kV line: 18 meters (9 m to either side of centerline).
- 220 kV line: 30 meters (15 m to either side of centerline).
- 400 kV line: 46 meters (23 m to either side of centerline.
- Tall trees within the ROW will need to be removed.
- The land under the footprints of the transmission towers are to be an approximate 400 m^2 to 625 m^2 (20m x 20m for each tower base for 220 kV towers, 25m x 25m for 400 kV towers).
- The land for the new substations must be acquired, as well as for the substations that require additional land for expansion.
- Any permanent or expanded/widened road access ways.
- The land needed for living quarters for the staff at the new substations.

Temporary impacts expected include:

- Temporary impacts to land within the ROW due to the installation of the towers and/or the stringing of conductors. Agricultural land, for example, will be temporarily impacted until the completion of construction.
- Temporary road access ways.

Overall, there is a total of approximately 600 km of transmission lines, 8 new substations, and 10 transmission lines – including 132 kV, 220 kV and 400 kV lines – spread from west to east in the country. During the RPF, the resettlement team worked very closely with the technical and environmental teams to avoid or minimize the number of impacts while keeping in mind the technical requirements and avoiding impacts to important environmental areas. The following describes each of the individual projects and the resettlement impacts expected for each. Note: the numbers of structures impacted (as well as the estimates for land) were determined by reviewing 1:6,000 scale GIS maps of the project lines and substations overlaid on Bing or World Map images. Visits were also made to several of the districts and Village Development Committees along the impacted lines to glean further information about social structures and other important information about the communities that may be impacted by the projects. These impacts are estimates and will

[1]Resettlement is considered involuntary when project affected persons do not have the right to refuse land acquisition, or restrictions on land use, resulting in physical displacement (leading to a loss of home or business) and/or economic impacts (leading to a loss of a main source of livelihood).

require more detailed analysis during the RAP period, as well as more extensive consultations with the impacted communities.

NR1

- The NR1 backbone transmission project consists of 5 new substations and approximately 280 km of 400 kV transmission lines, with 1,012 transmission towers, impacting approximately 1,326 total hectares of land. Each of the five substations are new and four of the five substations will require land acquisition. The 1,012 tower footprints will require the acquisition of approximately 21 hectares of land, not including estimated government-owned land for which acquisition will not be an issue.
- The land under the line that was identified as either agricultural or barren land (which may potentially be farmed) will require an easement arrangement for approximately 760 hectares.
- There are approximately 618 structures that will be impacted under the tower lines, substations, and access roads.
- Lapsiphedi substation will be constructed beside a 220 kV substation designed by the Asian Development Bank (ADB). The two will be connected by underground cables. ADB is in the process of purchasing the land for its 220 kV substation. Some of this land will be available for the MCC 400 kV substation, but an estimated additional 1.63 hectares of land will need to be acquired. All of the land appears to be farmland with no structural impacts expected. The existing road leading to the substation land will need to be upgraded (which may affect about 31 structures). However, it is expected that this will be completed by the ADB. Staff quarters will be built on the same site.
- Naubise substation will require the purchase of an area of 8.78 hectares, and will also require the construction of a new access road that is approximately 1.6 km long 7 m wide. There are expected to be a minimum of 15 structures impacted due to the substation land, as well as the 12 structures impacted due to the new access road.
- New Hetauda has an existing 220 kV Hetauda substation located in Makwanpur District that is under construction by the World Bank. The MCC project will construct a new 400 kV station alongside this existing one. Two 400 kV lines will connect to Naubise from the new Hetauda substation. Several options were considered for the placement of the new substation and the most optimal location (from a technical, environmental and resettlement consideration) is located adjacent to the current Hetauda substation. The expected land required is 9.84 hectares, with a new access road approximately .2 km long and 5.5 m wide. The substation land is expected to impact 17 structures, with no impacted structures due to the new road access.
- New Damauli's selected site is an L shaped area of approximately 6.63 hectares where the flat land was adequate to install a station. There are no expected impacts to structures due to this placement of the substation or due the planned road, which will be 430 m x 5.5 m. The primary impacts in this area will be agricultural fields.
- New Butwal is a new 400 kV substation that will be connected to a 220 kV station designed by others. It will connect to New Damauli via two 400 kV lines. It will also have two 400 kV lines that will cross into India to provide export/import capacity. It will require the acquisition of approximately 14.5 hectares of land for the substation and a new .13 km x 5.5 m road access. There are not expected to be any impacted structures on the substation land and approximately 6 structural impacts will occur due to the new road.

NR3

NR3 is one of the four transmission lines connecting power from planned hydropower generation sites to demand centers via substations. It has 439 towers covering about 110 km. Both of its two substations, Inaruwa and Ilam, are existing substations with no requirement for land acquisition.

- The 439 tower footprints will require the acquisition of approximately 2.14 hectares of land.
- The number of structures identified under the towers that are expected to be impacted is 264.
- The land under the line was identified as either agricultural or barren land (which may be farmed potentially) and will require an easement arrangement for approximately 228 hectares.

T2'

T2' includes a new 220 kV substation, Likhu, which will help new hydropower generating plants to bring energy into the national grid. T2' runs between Likhu Hub and New Khimti. New Khimti is an existing substation. The Likhu Hub 220 kV-132 kV substation is planned to be constructed adjacent to a 132 kV substation currently being built by an independent power producer (IPP). The land required for the substation has already been acquired by the IPP, and it is understood that MCC will buy from the IPP the land needed for the T2 220 kV substation. The land that the IPP has acquired can accommodate the MCC new substation. It consists of approximately 119 towers spanning about 30 km.

- The 119 tower footprints will require the acquisition of approximately 2.3 hectares of land.
- The number of structures identified structures under the towers that are expected to be impacted is 31.
- The amount of land under the line, which was identified as either agricultural or barren land (which may potentially be farmed), that will require an easement arrangement is approximately 70 hectares.
- The land under the substation that will require purchase is 1.34 hectares. It is expected to impact approximately 1 structure. The road is not expected to impact any structures.

T3

T3 includes a new 220 kV substation, Tadekhani, which is to be constructed in the Myagdi District. The Tadhekani substation to Kusma substation project is a new development of approximately 35 km, 220 kV double-circuit transmission line through hilly regions in western Nepal. This line is to connect new hydro generation plants in the surrounding area of the Tadhekani substation to the national grid. It consists of 149 towers connecting the two substations.

- The 149 tower footprints will require the acquisition of approximately 2.23 hectares of land.
- The total identified structures under the towers that are expected to be impacted are 189.
- The land under the line identified as either agricultural or barren land (which may be farmed potentially) that will require an easement arrangement is approximately 86 hectares.
- The land under the substation that will require purchase is 2.05 hectares. It is expected to impact approximately 9 structures, and an additional 3 under the access road.

T8

T8 is composed of the New Lamki Substation, located in the Kailali District in the southwestern region along the lowlands/Terai region. It is a new substation with approximately 30 km of 400 kV double-circuit transmission lines crossing into the Nepal-India border. This line is designed to export 88% of the power generated from the Upper Karnali hydro generation plant to India and also will be used for importing power from India during Nepal's dry season. The existing Lamki substation is a large 132 kV substation that sits on a very large piece of land that has been acquired by NEA. There is no room for expansion on this land, so a new site was selected.

- The 91 tower footprints will require the acquisition of approximately 1.25 hectares of land.
- The total identified structures under the towers that are expected to be impacted are 58.
- The land under the line identified as either agricultural or barren land (which may be farmed potentially) that will require an easement arrangement is approximately 114 hectares.
- The land under the substation that will require purchase is 10.37 hectares. It is not expected to impact any structures under the road or substations.

XB1

XB1 extends from the New Butwal substation (described under NR1 above) to the India border via approximately 18 km of 400 kV lines.

- The 53 tower footprints will require the acquisition of approximately .90 hectares of land.
- The identified structures under the towers that are expected to be impacted are 26.
- The land under the line identified as either agricultural or barren land (which may be farmed potentially) that will require an easement arrangement is approximately 84 hectares.

A gap analysis was conducted during the RPF to identify the gaps between the Nepal land acquisition and resettlement requirements and those of the IFC in order to define the policies that the project will follow. An entitlement matrix was also prepared to define those people along the project who are entitled to compensation and/or additional assistance, the type of impacts, and the actual entitlements/ compensation to be provided.

When resettlement is unavoidable, compensation, as specified in IFC PS5, is to ensure that the impacted persons or groups are left in the same, or preferably improved, condition compared with their pre-project state. For this, such things as land compensation includes not only the straight price for the land (market price) but also compensation for all transaction fees, and no deduction for depreciation. Similarly, for structures, the replacement compensation involves not only the full market value for the structure but, in the case of a displaced home, for example, it includes a moving allowance to allow for the transport of goods from the home and rental for six months in an equivalent dwelling as well as other compensations. The various entitlements and compensation to be provided to the project affected persons or groups is included in the entitlement matrix.

In order to determine the estimated cost of each individual project, the RPF team gathered data on the prices of both land and structures in several of the impacted districts. Land data were gathered from the Land Revenue Offices, while structure costs were gathered from the District Technical Offices. The Land Revenue Office prices include government pricing, which is updated on an annual basis. Each of the districts use different pricing based on the location and type of land (e.g., land with road access was worth more than land with no road access). Each of the prices also included a range. For our purposes, we included the mid-level range for the land pricing in each area. For the structure prices, we hired a valuation expert to assist in identifying the market prices for certain types of houses (usually rated according to their roof types and structural make-ups) by using the values obtained in three representative districts (lowland/Terai region, mid-land, and mountainous region). We used these prices to assess the total cost of each project. In addition, we included: a 10% transaction fee cost to all land and structure costs, 10% contingency to the structure costs to account for the possibility that the GIS maps available were older and may not fully include all possible structures, allowances for various items such as loss of crops (as identified from another project in Nepal that is being overseen by the Investment Bank of Nepal and is also following IFC requirements), and a contingency to account for other allowances that will need to be finalized by the RAP team (such as the Livelihood Restoration Plan).

Table 12 includes the estimated costs for each of the projects (it should be noted that NR4 was not included in this assessment due to the findings that NEA is already in the process of completing this part of the project with a South Korean contracting firm).

Table 12 Estimated Project Costs

Item	Detail	Total estimated cost (USD)
NR1		
1. Land - acquisition	62.20 hectares under towers and substations	$6,583,000
2. Land - easement	766.46 hectares	$10,025,000
3. Structures	492	$4,566,000
4. Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$1,073,000
5. Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$797,000
6. Contingency for other compensation	25% on 1-5	$5,761,000
7. Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$4,897,000
8. RAP development and implementation		$6,302,000
9. Grand Total		**$40,004,000**
NR3		
1. Land - acquisition	1.83 hectares under towers and substations	$220,000
2. Land - easement	228.26 hectares	$1,373,000
3. Structures	264	$3,280,000
4. Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$320,000
5. Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$327,000
6. Contingency for other compensation	25% on 1-5	$1,380,000
7. Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$1,173,000
8. RAP development and implementation		$2,904,000

Table 12 Estimated Project Costs		
9. Grand Total		**$10,977,000**
T2'		
1. Land - acquisition	2.95 hectares under towers and substations	$186,000
2. Land - easement	36.55 hectares	$279,000
3. Structures	32	$264,000
4. Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$43,000
5. Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$41,000
6. Contingency for other compensation	25% on 1-5	$203,000
7. Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$173,000
8. RAP development and implementation		$555,000
9. Grand Total		**$1,744,000**
T3		
1. Land - acquisition	4.29 hectares under towers and substations	$691,000
2. Land - easement	44.34 hectares	$724,000
3. Structures	189	$1,704,000
4. Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$224,000
5. Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$235,000
6. Contingency for other compensation	25% on 1-5	$895,000
7. Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$716,000
8. RAP development and implementation		$1,030,000
9. Grand Total		**$6,219,000**
T8		

Table 12 Estimated Project Costs			
1.	Land - acquisition	11.62 hectares under towers and substations	$2,356,000
2.	Land - easement	114.24 hectares	$2,317,000
3.	Structures	58	$685,000
4.	Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$298,000
5.	Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$76,000
6.	Contingency for other compensation	25% on 1-5	$1,433,000
7.	Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$1,218,000
8.	RAP development and implementation		$624,000
9.	Grand Total		**$9,007,000**
XB1			
1.	Land - acquisition	0.90 hectares under towers and substations	$164,000
2.	Land - easement	83.75 hectares	$1,531,000
3.	Structures	26	$307,000
4.	Transaction costs (10% land acq. and structure costs)	10% of 1 & 3	$44,000
5.	Other Allowances	Moving allowance (NRs 94,800 per impacted structure); Food security allowance (NRs 80,136 per vulnerable HH – assume 50% of impacted structures); Transitional allowance (NRs 6,000 per Ha – assume for all SS land); Loss of Crops allowance (NRs 325,600 per Ha – assume for land in #1 above)	$32,000
6.	Contingency for other compensation	25% on 1-5	$520,000
7.	Provision for inflation	3% per year to mid-point of resettlement actions (estimated 5 years ~ 17%)	$442,000
8.	RAP development and implementation		$384,000
9.	Grand Total		**$3,424,000**
		***Total for All Projects*:**	**$71,375,000**

Key Points:

1. The highly politicized and contentious issue of land easement compensation for transmission line projects in Nepal is an important factor to take into account, especially when considering the mitigation of risks that have the potential to cause significant construction delays. The GON has included this issue as action item #30 in its 99-point action plan on energy development. Section 6 of the RPF includes a table with an evaluation of possible easement land options. It is suggested that MCC consider one of the two options that will include the one-time 10% flat fee with an additional yearly annuity or “transmission line shares” provided to the impacted persons under the lines. If the GoN resolves item #30 in the action plan prior to the start of the MCC project, MCC should review the findings for consideration in the projects.

2. It is important to maintain awareness of whether project-affected persons or groups are considered vulnerable, and resettlement policies should be implemented in a way that takes these groups into account, in accordance with the RPF. This includes aspects such as ensuring that all members of an affected household are benefitting from compensation payments and that persons of a certain caste or ethnic group are not inadvertently being steered toward traditionally-held occupations during livelihood restoration activities, if it is not their choice to do so; effective mechanisms should be put in place to monitor and measure changes to the status of affected women, Dalits, and other groups before, during, and after resettlement activities. It should also be ensured that no explicit or implicit discrimination is occurring on the basis of gender, ethnicity, caste, or indigeneity throughout the process of land acquisition and resettlement.

3. The potential application of IFC PS7 on indigenous peoples (IPs) is a consideration in the resettlement process, particularly because PS7 calls for detailed and intensive consultation with affected IPs, beyond the scope of consultation in IFC PS5. This is especially relevant to the potential triggering of the requirements of free, prior, and informed consent (FPIC). The Guidance Notes on IFC PS7 maintain that the Performance Standard applies to “groups of Indigenous Peoples who reside in mixed settlements, such that the affected Indigenous Peoples only form one part of the more broadly defined community.” To this end, particular attention will need to be paid by the RAP consultant to ensure meaningful, inclusive participation of any affected IPs in all appropriate stakeholder meetings and decision making processes if IFC PS7 – and, more specifically, FPIC – is triggered.

4. It is important that facilities that are (or will be) directly or indirectly associated with MCC-funded projects be identified and appropriately researched, in order to ensure that any resettlement activities being conducted by another contractor or donor are held to a standard that is similar to that being applied to MCC projects. Should there be discrepancies between projects, in terms of the levels of compensation or degree of consultation, this could cause dissatisfaction with compensation packages by project affected persons. In turn, this can create disputes between those compensated by ADB, for example, and those compensated by MCC (especially if the differences are large). The ADB and World Bank (both of which will be implementing projects in the immediate vicinity of MCC projects) adhere to similar standards

and safeguards as the IFC Performance Standards; however, close coordination with the RAP teams for those projects is advised, so as to ensure the consistency of resettlement activities.

Task 4: Economic and Financial Assessment

The economic and financial assessment of the proposed transmission system investments is intended to 1) determine the benefits of the proposed MCC investments and calculate the economic internal rate of return for these projects and 2) provide quantitative findings on the level of tariffs required to sustain the MCC investments within the NEA system. In addition to these two major objectives, we determined the net benefits of exports and imports of power from India and the extent to which success in MCC's program depends on new generation capacity in the country. To meet these objectives, Tetra Tech conducted independent assessments of the following key elements:

1. Specification of baseline conditions in Nepal – what happens if MCC does not invest?
2. Projections of future demand for electricity in Nepal by region and consumer categories
3. Generation expansion plans – what is realistic, hopeful, and pessimistic over the next 15 years?
4. What levels of loss reduction and load shedding mitigation are reasonable?

Model Development: The information developed on demand, generation, trade with India, and technical benefits must be put into a modeling framework before assessing which proposed investments will be worthwhile for the country. Providing this assessment required the Tetra Tech team to develop both economic and financial models.

MCC is responsible for developing the economic model that will be used to make recommendations to its Board. The MCC model is based on a consumer surplus approach to benefits that includes both output benefits and cost savings benefits. As part of the Tetra Tech team's assistance to MCC in developing the economic model, Tetra Tech was asked to provide an approach to valuing the various benefits and incorporating them into an economic framework. This work became the consultant's version of the economic model when it became clear that in the interest of a timely reporting of results in this project's compressed time frame, it would be necessary for the consultant to complete an initial version of the economic model.

The financial model is structured in a manner almost identical to the economic model and permits MCC to see whether and to what extent the Nepal Electricity Authority's tariff structure and other programs can sustain the MCC investments.

The models were run on the agreed scenarios and variations in demand and generation. In addition, each model allows the user to vary a number of key parameters with regard to efficiency, pricing, valuation of electricity, valuation of trade with India (imports and exports), and various system-wide parameters covering transmission and generation costs, among others.

Benefits Estimation. The technical benefits of the MCC investments were estimated on the assumption that the generation expansion program will continue to be implemented more slowly than is shown in NEA's latest forecast. Technical benefits with and without the MCC projects were evaluated for each of the various scenarios, including the Counterfactual (Without Project) Base Case. The Counterfactual and all scenarios were tested for sensitivity against variations in demand and generation higher and lower than the baseline cases.

The MCC's investments will provide three major categories of economic and financial benefits:

1. Increased supplies to consumers through improved transmission of domestically generated and imported electricity
2. Increased supplies to consumers through reduced load shedding and technical losses
3. Increased revenues for domestic generation through exports to India.

In quantitative terms, the benefits to domestic electricity users outweigh the value of additional exports by several fold. For example, the value of increased domestic consumption through more imports far exceeds the cost of such imports in the economic model. However, the export earnings made possible by improved transmission may be crucial in the decisions to invest in new generation, thereby creating the large benefits for domestic electricity users.

Only three of the scenarios were consistently feasible in the economic model. The *All MCC,* the *NR1+XB1+T2'+T3*, and the *NR1+XB1* scenarios provide significant increases in supply to domestic users with both greater utilization of domestic generation and increased supply from India during the dry season to remedy load shedding. Other scenarios do not boost consumption by domestic users, as they fail to reduce load shedding much. Though generating some benefits, these export-oriented packages do not provide system-wide net benefits for Nepal.

Economically Feasible Packages:

- NR1 *without* XB1 is infeasible under all conditions since there is no additional supply of imported energy to Nepali consumers
- T8 is infeasible because there are few domestic benefits and the net reduction in imports is small. In strict isolation (i.e., without the Nepali system to support) T8 *may* show positive net benefits, and is also positive when integrated in the *All MCC* package scenario
- NR3 and NR4 are infeasible because they do not provide relief from load shedding or additional energy to domestic users
- All MCC *without* XB1 is infeasible since the reduced level of dry season imports fails to reduce load shedding adequately.

Valuation of Electricity. In the economic model, additional net supplies of electricity to domestic users must be valued at the highest applicable current tariff, called "marginal tariffs" in the model (Table 13). Load shedding relief must be valued at the opportunity cost of the defensive measures consumers use to mitigate the adverse impacts of the load shedding. The opportunity cost of these defensive measures is higher than the marginal tariff for each class of consumer.

Table 13. Average and Marginal Electricity Tariffs in Nepal

Consumer Category	Average Price per kWh		"Marginal" Price per kWh	
	USD	**NRs**	**USD**	**NRs**
Domestic	0.100	10.918	0.120	13.102
Commercial	0.125	13.648	0.150	16.377
Industrial	0.080	8.735	0.095	10.372
Average per kWh Sold	**0.097**	**10.608**	**0.116**	**12.694**

Note: Tariffs from the current schedule are converted to values shown in the table including fixed monthly fees and demand charges converted to a kWh basis.

The financial model introduces taxes, depreciation, and other elements not included in the economic model. However, the general findings are similar:

- The *All MCC* and the *NR1+XB1+T2'+T3* are feasible under most foreseeable circumstances. However, these projects all require that NEA move to a higher tariff based on its current marginal tariffs for each customer category.
- The *All MCC* package shows considerable variability with respect to valuations and prices for additional energy supplied, and trade with India.
- *NR1+XB1* is feasible if export prices include capacity credit for displaced new power plants in India.
- *T8* is almost feasible with high export prices, and likely to be feasible in isolation.
- The packages without *XB1 (restricted exports & imports)* are not feasible even with high prices.
- *NR3* and *NR4* remain infeasible for NEA without the domestic market tie-ins.
- The *All MCC-XB1* (restricted trade with India) is infeasible under all conditions save extremely high valuations/prices for domestic energy consumption and reduced load shedding.

A low valuation of electricity will drop all projects except the *All MCC* package to strongly negative present worth. This indicates that the results of the willingness to pay study (being conducted by MCC's due diligence consultants, for which results are not yet available) will be a key to confidence in the robustness of modeling results and project feasibility.

Table 14. Economic and Financial Results for Feasible MCC Investment Packages

Scenario	Economic Internal Rate of Return (%)	Financial Management Rate of Return (%)	Notes
ALL MCC – Baseline	40.03	34.81	EIRR generally more volatile than FMRR due to calculation method
ALL MCC – High Valuations & prices	55.24	49.94	High Gx scenario
ALL MCC – Low Valuations & Prices	-2.49	-8.93	Low Gx scenario

Table 14. Economic and Financial Results for Feasible MCC Investment Packages

<table>
<tr><th>Scenario</th><th>Economic Internal Rate of Return (%)</th><th>Financial Management Rate of Return (%)</th><th>Notes</th></tr>
<tr><td>NR1+XB1 – Baseline</td><td>19.64</td><td>17.34</td><td rowspan="3">Package features fewer exports to India than ALL MCC package</td></tr>
<tr><td>NR1+XB1 – High Valuations & prices</td><td>20.89</td><td>23.35</td></tr>
<tr><td>NR1+XB1 – Low Valuations & Prices</td><td>7.88</td><td>7.33</td></tr>
<tr><td>NR1+XB1+T2’+T3 – Baseline</td><td>25.96</td><td>23.52</td><td rowspan="3">Most stable of packages due to higher proportion of domestic benefits</td></tr>
<tr><td>NR1+XB1+T2’+T3 – High Valuations & prices</td><td>32.68</td><td>33.26</td></tr>
<tr><td>NR1+XB1+T2’+T3 – Low Valuations & Prices</td><td>17.70</td><td>14.34</td></tr>
<tr><td colspan="4">Note: N/A means the model was not able to calculate a result, generally due to the absence of positive cash flows in any year.</td></tr>
</table>

An interesting finding of the economic analysis is that if Nepal were able to increase generation significantly without MCC’s network investments, then the return to those investments would fall, making all but the *ALL MCC* packages infeasible.

Financial analysis results are generally sensitive to domestic tariffs and export prices. The weighted average cost of capital does not much influence the results for the three feasible projects. However, the NEA hurdle rate does affect these results. Free cash flow values show that the three feasible packages can generate a great deal of investable resources for NEA, even after accounting for taxes and ongoing operations.

Results, Conclusions, and Recommendations*:* The findings and results of the economic and financial analyses provide some key indicators of MCC investment performance and how these proposed projects may fit into the country’s overall electricity supply enhancement programs. The economic and financial results generally mirror each other with regard to the key factors influencing project assessments. These are:

- Domestic market integration is vital; most benefits come from greater supply to Nepali users, only one export-priority line, T8, is feasible under *some* conditions.
- Prices matter – prices/valuations for new supply and load shedding relief are the most important factors in project performance.
- NEA reform is vital – loss reduction, maintaining cost recovering tariffs, and negotiating good export transactions with India are critical to project outcomes; indeed, if Nepal can negotiate trading arrangements that allocate credit for supplying firm capacity in India to Nepal, and can avoid annual renewals that will expose the country increasingly to fuel price risk, the longer term arrangements, similar to those now under preparation by the U.S., may be highly beneficial.
- One finding of the economic analysis is that if Nepal were able to increase generation significantly without MCC’s network investments, then the return to those investments would fall. The increased supply in the Without MCC Project case would reduce the differential between the With Project and

Without Project throughput. Since net benefits are calculated on the basis of this differential then the value of net benefits would fall as well.

- Cash flow is critical – financial analysis shows that projects with large free cash flow under the baseline conditions are quite resistant to pessimistic events in pricing, exports, and generation costs.

Way Forward. The two models should be modified as appropriate and their data updated so that each can play a continuing role in the monitoring and evaluation activities. The financial model will be useful to assess ongoing NEA reforms and performance improvements. It will also be useful to assess the adequacy of tariff reform in general and the unbundling of tariffs in particular. A particular strength of the current financial model is its ability to quickly and accurately assess the impacts of prices on company performance, which is especially relevant when tariff reform is likely to remain both controversial and subject to MLA (Multilateral Landing Agencies) and MCC project conditionality.

The financial model is a partial model. It does not provide a high level of detail on assets and liabilities for NEA overall. There is no inventory of NEA debt and the entry into service of new generation is not modeled in detail. However, the results of this model, when compared with more detailed NEA enterprise models, indicate a good degree of accuracy in the areas of the company that are treated in detail – namely, new investments in transmission, reductions in load shedding, and exports and imports of electricity. It would be useful for NEA if some of the parameter and scenario menus could be translated to the more detailed enterprise financial models.

The MCC economic model is likely to supersede the current Tetra Tech model. However, some of the features of the current approach can be useful in the MCC model. The project benefit sheet and its transfer of data to package sheets is critical to a straightforward implementation of changes in project specifications, a normal occurrence for MCC's power sector activities. The multi-attribute scenario menus allow the user to combine a series of assumptions about performance and pricing into a plausible set of circumstances, rather than simply dialing one parameter or another up and down.

Finally, both models point to what might be feasible with one or more of the packages in terms of modifications. For example, the T8 results show that trade oriented investments do not necessarily pay for Nepal if they are not integrated with domestic supply enhancements. However, a small increase in the T8 package's contribution of load shedding relief makes that project quite feasible. This could happen if the East-West line were upgraded. Other variations can also be tried out in the economic model to determine whether and to what extent certain technical approaches are worth trying, before a lot of money is spent on engineering and environmental studies.

Task 5: Sustainability Arrangements

This task addresses the sustainability of MCC's investment in reducing poverty and increasing economic benefits through its contributions to improving electricity sector operations and its effectiveness in developing and delivering power. This is a goal guiding the proposed compact between the GoN and US Government. This task included an analysis of program and project risks and uncertainties that could affect the completion of the compact and/or sustainability of the project, suggested mitigation measures, and the development of an outline of an overarching risk and uncertainty mitigation plan.

The tight time limitations associated with MCC investments magnify the challenges. Likewise, the complexity and number of the electricity policy and sector reforms underway simultaneously add another layer of risk and uncertainty within which the project must succeed. All this makes it imperative to identify risks and uncertainties, develop proposed solutions, and implement them during the project design, implementation and operations phases. Adequate and effective monitoring and course corrections will be essential during each phase.

The MCC/GoN compact and project are being launched in an uncertain environment where a lot is going on. The proposed project itself is complicated: eight separate projects, each with multiple components such as transmission line additions, reinforcements, extensions and upgrades, along with 14 associated substations. These projects complement and link to the GoN and donor actions to address the deficiencies in the electricity sector that are resulting in inadequate power supply, daily power interruptions in the dry season, and a proportion of the population that is unserved by either grid-based or off-grid power.

The proposed risk management plan consolidates the numerous and varied potential risks to and uncertainties affecting MCC's investment that have been identified across its various components (i.e., technical design, environment and social accommodations, financial/economic analyses, implementation arrangements, and M&E function). The plan links them with solutions and mitigation measures already developed or being recommended for application to proposed MCC transmission line projects to improve the likelihood of sustainability over the short and long terms. Risks are ranked according to the degree to which they jeopardize a project's sustainability and thus the urgency of their mitigation. Strategic and contingent risks are our main priority, while non-strategic risks are noted in the other reports but not elevated to the sustainability issue that is the focus of this task.

Data and information that support the risks and mitigation measures are drawn from the MCC due diligence phase, the analyses presented in this DFS, and discussions with the OMCN, NEA, and key development partners involved in generation, transmission, and distribution. Another key source of information is the electricity sector crisis action plan that GoN and development partners compiled covering reforms, policies, and practices that will be priorities for sector reform. Progress is being made in implementing the action plan; so a major effort was made to determine its implementation status. Risks are divided between project risks (which include design, implementation through the completion of construction, and preparations for smooth project operation) and those associated with the long-term financial health and economic benefits resulting from the investments after the investments become operational.

Project Risks. As the timing of completion and costs are the overriding primary risks to the sustainability of the MCC investment, the major project risk is completing the project within the nominal five-year timeframe (i.e., hand-over to the institution designated to house the investment – which MCC expects to be the new Rastriya Prasaran Grid Company (RPGCo) or NEA). The main strategic project risk is whether the investment package being developed is deemed financially and economically viable according to MCC's requirements. The main contributors to investment risk at the project level involve the resolution of environmental and social issues (including resettlement) associated with the routing of transmission lines and the siting of substations without requiring too much time and money, or causing disruptions or delays in construction.

The main contingent risks (those beyond the control of the project but which can affect the outcome of the project) are the resolution of cross-border trading arrangements and tariffs that will directly and significantly affect the viability of the financial return from the project. Being that transmission projects are inherently in the middle of the electricity supply chain, other major contingent risks are 1) the readiness of the NEA distribution system components that will be necessary to deliver the power to customers and 2) the sufficiency of the hydropower to supply the needs of Nepal (to both reduce load shedding and create export revenues via cross-border exchanges). The development of cost-reflective wheeling charges to support the RPGCo is another important contingent risk.

The recommendations for a risk and uncertainty mitigation plan presented here focus heavily on timelines, pinch points, and critical paths, and the development of appropriate monitoring tools and mechanisms. Also important will be capacity building within the key institutions, and reinforcement of key personnel needs during the transition to the new sectoral entities, particularly the RPGCo, NERC (Nepal's independent energy regulator), and the Power Trading Corporation, while not forgetting that the NEA as a distribution company will need substantial support to coalesce and augment its efficiency and effectiveness on the distribution side. Obviously, MCC/MCA cannot do this alone, so continued concerted coordination efforts by the development partners is essential.

Sustainability Priorities. The following are short-term urgent sustainability priorities:

- ***Financial impacts of Indian/Nepali arrangements on power trading benefits:*** Ensuring that there is a viable Indian/Nepali financial arrangement on power trading that will meet the compact investment's financial and economic hurdle requirements. The severity of this risk has been dampened due to technical requirements of Indian power system to export hydro power from Nepal to balance the grid with about 30% of the generation coming from renewable energy sources in 2022.
- ***Blockage and slowdown of reforms due to labor dissatisfaction:*** Reducing the risk that labor dissatisfaction does not hold up sector reform or slow down/stop coordination on the next stages of project development.
- ***Tariff reform fails to provide wheeling charges.***
- ***Distribution system readiness to evacuate power from new transmission projects and distribute it to customers:*** Distribution system readiness to evacuate power and deliver it to its intended destination when new transmission projects become operational.
- ***Sufficiency of power injection to MCC transmission projects:*** Injection sufficiency (hydropower capacity available to meet expected supply).
- ***Readiness of necessary transmission projects sponsored by others and important to MCC project's system integration***
- ***Failure to implement reforms in time to maximize the benefits of MCC projects.***

Task 6: Monitoring and Evaluation

The proposed power transmission project must be implemented within a five-year timeframe and will cover about 600 km of 400 kV and 220 kV transmission lines, and 14 associated substations. The project will include the first 400 kV transmission network in Nepal. It is anticipated that MCC's compact will produce a five-fold increase in cross-border electricity trade with India, increase per capita electricity consumption, and accelerate economic and social development in Nepal. An effective monitoring and evaluation framework is needed to measure the compact's progress/process, outputs and outcomes in an objective fashion.

To meet this requirement, we have recommended 33 performance indicators: 18 process indicators, 7 output indicators, and 8 outcome indicators. Outcome indicators were developed primarily to measure the post-implementation impacts of the transmission system. Out of the nine performance indicators provided in MCC's Common Power Indicators document, all were retained.

The M&E framework provides details on the data needed to measure the performance indicators, and how data will flow to help calculate/determine them. Efforts should made to collect most of the data from MCA office software and the SCADA (supervisory control and data acquisition) of the load dispatch center without human interference. However, some site-specific data will be collected manually from project sites and will be entered into the management information system through a web-based window.

The measurement methodology and reporting of all the 33 performance indicators on a monthly, quarterly, or annual basis has been provided. Two full-time resources are recommended for the development and operation of the suggested M&E framework. The total estimated cost, including the cost of these two resources and development of specific MIS software, is estimated to be US $684,000.

Key Points:

1. All the substations constructed under MCC project have SACDA with required meters to measure indicators and have a sufficient number of RTUs and telemetering panel to get connected with NEA LDC (Load Dispatch Centre) SCADA, which is being installed with the help of KfW. The SCADA at the LDC end has a provision to accommodate new substations.

2. The targets and baselines for indicators have been taken based on the technical design in Task 1 and the benefits considered in Task 4 for financial and economic analysis.

3. For many indicators, the baselines need to be established when the compact is coming to an end to compare the impact/change MCC project has made. However, we have provided their values to track their movement during the compact as well.

Task 7: Implementation Planning

The implementation plan consists of three main activities:

- Review of the existing implementation mechanisms prevalent in Nepal
- Recommendations on an Implementation Plan for this project
- A market assessment of the capabilities of local and international vendors to undertake implementation planning.

Most transmission projects in Nepal are implemented by the NEA, ADB, and the World Bank. A small transmission project has also been implemented by the German development bank KfW. The implementation mechanisms of all four of these actors were examined. We determined that all of them have more or less similar implementation mechanisms. Their central feature is that the implementation entity is NEA. The project sponsoring/donor agency enters into an agreement with the GoN. This agreement guides the flow of funds, implementation mechanism and other support the GoN is bound to extend. The role of the project sponsoring/donor agency is limited to ensuring adherence to agreement conditions and high-level supervision of the project.

In addition, MCC guidelines for procurement and compact implementation were studied. In particular, we analyzed the challenges (such as the fixed five-year compact period, rugged terrain, difficulties in transporting heavy material to sites) in the implementation of transmission projects in Nepal.

Based on these reviews, we have recommended an implementation plan for this compact covering project management, project execution, Project Advisory Board, Stakeholder Committee, and positively impacted stakeholders. The success of this plan will depend upon the effective utilization of the 27-month period between the compact's approval by MCC's board and the compact coming into force, incentivized by the implementation of a success fee model and the involvement of positively impacted stakeholders from the beginning. The number of activities that can be performed during this 27-month period are suggested. We have recommended the creation of a Project Implementation Unit (PIU) in NEA specifically for MCC project as one of the conditions for compact agreement. The role of the PIU will be to facilitate design and specification uniformity with NEA, provide ground support, participate in the procurement process, review progress, quality check witness tests, facilitate the integration of the MCC project with Nepal's transmission system and finally, smooth the project's handover to NEA/the new entity.

A market assessment was conducted using MCC's tool kit. Ninety firms that have worked on transmission projects in Nepal sponsored by the WB, ADB, and NEA, as well as Tetra Tech data sources, were identified for the market assessment. The firms were first given a structured questionnaire, which was followed by telephone calls, face-to-face interactions and email exchanges. Data for many firms were collected through desktop studies. As a result, 50 responses were obtained from four categories of firms: 1) engineering, procurement and construction (EPC) contractors, 2) civil contractors, 3) materials suppliers, and 4) local consultants.

Our overall assessment of the market is that Nepal has the indigenous capability to take up civil works and supply of some the minor accessories. There are a few good local consulting firms that can extend support to international firms. Thus, it is recommended that materials, EPC contractors and engineers be procured from outside Nepal (in particular, India and China due to their geographic proximity). The international firms can be encouraged to have local partners. A skilled workforce will also be required from outside Nepal as 400 kV transmission lines and gas-insulated switchgear substations will be installed in Nepal for the first time.

Key Points:

1. Involvement of NEA from start to end.
2. Strong engineer contractor.
3. Effective utilization of the CIF period.
4. Special attention to the selection of the EPC contractor, schedule and progress of Package 3.

Overall Recommendations

Together, the projects present a strong case for boosting the economy of Nepal. The projects' EIRRs ranges from 55.24% to -2.49% depending upon most optimistic and pessimistic sensitivities.

No potential impacts were found that cannot be mitigated through the implementation of a comprehensive Environmental and Social Management Plan. Barring political considerations, the acquisition of land for substations and towers should not be challenging due to better compensation that will be provided under IFC standards than the compensation determined by local governments in Nepal. If land easement and stakeholder issues are adequately addressed, land acquisition should be manageable.

Nepal has resource constraints in terms of materials and skilled labor, but both India and China have sufficient resources and are keen to work in Nepal owing to business opportunities and political considerations. The Government of India's renewable energy target of 175 GW by 2022 has resulted in a technical necessity for India to import sufficient hydropower from Nepal to keep its grid/power system stable.

Even considering that work will take place only nine months a year owing to climate, holidays, and political considerations, the implementation schedule has a float of 5-8 months for various projects. The other risks, such power sector reform, regulatory mechanisms, the formation of a separate transmission company, etc. will have limited impacts on the usefulness of the transmission system (unlike the distribution network). Thus, all of these conclusions present a healthy environment for launching this MCC compact, and its potentially significant contributions to the socio-economic life of Nepal's citizens through the provision of reliable electricity, which can increase industrialization, improve education and health, and reduce carbon emissions.

The cost estimates indicate that the projects will require an investment of $642.64 million, almost double the amount envisaged at the time compact discussions began about 15-18 months ago. The rough terrain of Nepal, its limited roads and bridges, the need to import materials and labor, the compressed time schedule, and concerns about quality of work, etc., contribute to the total. MCC has the options to expand the budget or encourage the governments of Nepal and/or India to involve private investors to fill the gap. However, if there are difficulties in meeting the budget, there are options for downsizing:

Scenario 1 (Rough Cost Estimate: $350 million excluding environmental, social and resettlement cost)

- New Damauli Substation is dropped and no land will be acquired for this substation. This is because the 220 kV Lekhnath-Damauli line is under study and its financing is being discussed. If MCC decides not to build the New Damauli substation now, the Lekhnath-Damauli project will build a 220 kV substation first. Its owners can be informed of the land requirement for a future 400 kV substation so they can procure enough land.
- No change to other components of NR1.

Scenario 2: Hybrid Substation, 400 kV & 220 kV (Rough Cost Estimate: $290 million excluding environmental, social and resettlement cost)

- Lapsiphedi is dropped. Land for a 400 kV switchyard land to be acquired as per the ultimate stage of the base case.
  - No land development or construction of access roads is required.
  - Consider the following in estimates: 2 x 220 kV line bays.
- New Hetauda is dropped, Land for a 400 kV switchyard to be acquired as per the ultimate stage of the base case.
  - No land development or construction of access roads is required.
  - Consider the followings in estimate: 2 x 220 kV line bays.
- New Damauli is dropped. No land will be acquired for this substation for the reason cited in Scenario 1.
- Naubise: land to be acquired as per the ultimate stage of the base case. Consider the following in estimates:
  - Number of 400 kV line bays to be reduced to 4.
  - No change to 220 kV line bays (4 line bays).
  - No change to the number of 400 kV transformers (4), the same as in the base case (submitted through the draft report).
- No change to other components of NR1.

Scenario 3: Bare Minimum Option (Rough Cost Estimate: $245 million excluding environmental, social and resettlement cost)

- New Butwal – change to 220kV.
  - No land acquisition and land development are required.
  - Consider the following in estimates:
    4 X 220 kV line bays (no transformer & 400 kV transformer bays required)
    No land acquisition required as per the base case.
- New Damauli – land needs to be acquired as per the ultimate stage of the base case.
  - Land development is to be done for a 220 kV switchyard only.
  - Access roads to be constructed to 65 tons of load bearing capacity only.
  - Consider the following in estimates:
    4 X 220 kV line bays
    2 X 220kV line bays
- Naubise – land needs to be acquired as per the ultimate stage of the base case.
  - Land development is to be done for a 220 kV switchyard only.
  - Access roads to be constructed to 65 tons of load bearing capacity only.
  - Consider the following in estimates:
    6 X 220 kV line bays
    2 X 220 kV line bays (for LILO of Marsyangdi)
- Lapsiphedi – land for a 400 kV substation needs to be acquired as per the ultimate stage of the base case.
  - No land development or construction of access roads is required.
  - Consider the following in estimates:

2 X 220 kV line bays.

- New Hetauda – land for 400 kV substation needs to be acquired as per the ultimate stage of the base case.
  - No land development or construction of access roads is required.
  - Consider the following in estimates:
    2 X 220 kV line bays.

Annex A. Referencing

The terms of reference for the assignment specifies what is to be covered in this Draft Feasibility Study Report. For easy checking we provide in below Table 16 referencing for all these requirements.

Table 16 Referencing

S N	Content	Task	Section Reference
1	Project Description/Scope	Task 1	Volume 1, Section 1, Page 7-8
2	System Plans and Profiles	Task 1	Volume 1, Annex C – Substations Volume 1, Annex D – Transmission Lines
3	Transmission Line Route	Task 1, 2 and 3	Volume 1, Section 2.4.3, Page 51 - 57 Volume 2, Section 2.2, Page 52 - 55 Volume 3, Section 4, Page 59 – 103
4	Calculations and Technical Evaluations	Task 1	Volume 1, Section 3, Page 106 - 211
5	Specifications	Task 1	Volume 1, Annex C – Substations Volume 1, Annex D – Transmission Lines
6	Cost Estimates	Task 1	Volume 1, Excel files - Cost Estimate
7	Environment and Social Assessment	Task 2	Volume 2, Section 5, Page 197 - 202
8	Schedule	Task 1	Volume 1, Annex F
9	Outline Terms of Reference	Task 1, 2 and 3	Volume 1, Annex B Volume 2, Annex L Volume 3, Annex D
10	Economic and Financial Analysis	Task 4	Economic Analysis: Volume 4, Section 1.3, Page 16 - 28 Financial Analysis: Volume 4, Section 1.4, Page 28 - 33
11	Resources	Task 1 and Task 7	Volume 1, Annex B Volume 7, Section 5, Page 34 - 66
12	Risk Management Plan	Task 5	Volume 5, Section 2, Page 13 - 39

Annex B. List of Consultants

Position	Name
Key Personnel	
BPA Program Manager	David Keith, Tetra Tech
Project Manager/Sector Technical Specialist and Tasks 6 and 7 Lead	Rakesh Kumar Goyal, Tetra Tech
Senior Power Sector Engineer – Transmission and Task 1 Lead	Ramin Eftekhari, Tetra Tech
Senior Environmental Assessment and Management Specialist and Task 2 Lead	Armando Balloffet, Cenibark
Non-Key Personnel	
Power Sector Engineer – Transmission	N.S. Saxena, Feedback Infra
	Hemanta K. Joshi, consultant to Tetra Tech (Nepal) consultant
Power Sector Engineer – Transmission Design	Shilpa Shah, Tetra Tech
	Kishorchandra Keshavlal (K.K.) Shah, Feedback Infra
Power Sector Engineer – Transmission Line Survey/Routing	Salman Amjad, Tetra Tech
	Mohd. Ahafaz, Feedback Infra Sanket Menjoge, Feedback Infra Kamal Nayan Dwivedi Geo Tech Expert. Feedback Rushiraj Rohit Feedback Infra Kartik Kakrecha Feedback Infra
	Bashant Sharma, consultant to Tetra Tech (Nepal)
Power Sector Engineer – Substations	Mario Germani, Tetra Tech
	Rajesh Mundheda, Feedback Infra
Power Sector Engineer – SCADA	Frank Chan, Tetra Tech
	J. Nandapurakar, Feedback Infra
Power Sector Engineer – Metering, Communication and Protection	Hassan Kalankesh, Tetra Tech
	Sanjay Changde, Feedback Infra
	Bhuvan Kuman Chhetry, consultant to Tetra Tech (Nepal)
Power Sector Engineer – Tower Foundation	Ted Fichman, Tetra Tech
Power System Modeler/Planner	Mojtaba Mohaddes, TransGrid Solutions Chandana Karawita, TransGrid Solutions Janath Geeganage, TransGrid Solutions Matthew Kulasza, TransGrid Solutions Rebecca Ostash, TransGrid Solutions
	Mike Shen, Tetra Tech
Environmental Assessment and Management Specialist	Dave Burack, Cenibark
	Sunil Goonetilleke, Cenibark
	Raj Kumar Singh, Feedback Infra

Position	Name
	Niranjan Shrestha, consultant to Tetra Tech (Nepal)
	Paul N. Seeley, Cenibark Principal Lesli A. Rucker, Cenibark Principal Mr. Prayag Raj Tamrakar, Local Forestry Expert
Resettlement Specialist and Task 3 Lead	Terri Stiffler, Tetra Tech
Resettlement Specialist	Kate Kowalski, Tetra Tech
	Bill Crowley, Tetra Tech
	Anna Murphy, Tetra Tech
	Mike Betteker, Tetra Tech
	Cady Gifford, Tetra Tech
	Ed Gardner, Tetra Tech
	Gandikota Ananda, Feedback Infra
	Ms. Apsara Chapagai, Local Consultant
	Mr. Rishi Ram Koirala, Local Valuation Consultant
	Mr. Rabin Dhakal, Local Resettlement Expert
Social and Gender Specialist	Albab Akanda, Cenibark
	Jennifer Mudge, Cenibark Ms. Sharad Jnawali, Local Consultant
Sector Economist/Economic Modeler and Task 4 Lead	Donald Hertzmark, consultant to Tetra Tech
Economic and Financial Analyst	Jitendra Bhanushali, Feedback Infra
	Surendra Uprety, consultant to Tetra Tech (Nepal)
Sustainability Specialist	Suresh Prasad Yadav, consultant to Tetra Tech (Nepal)
Scheduler	Jason McLindon, Tetra Tech
	Samantha Keat, Tetra Tech
GIS Specialist	Jared MacLachlan Tetra Tech Mark Fobert, Tetra Tech
Local Project Manager	Ramesh Nepal, Consultant to Tetra Tech (Nepal)
Risk Analyst and Task 5 Lead	Connie Smyser, consultant to Tetra Tech
Task 6 Support	Apoorv Nagpal, Tetra Tech
Task 7 Support	Shahab Alam, Tetra Tech
Technical Writer	Wynne Cougill, Tetra Tech
Junior Engineer	Mr. Milan Wagle
Junior Engineer	Mr. Bikash Gelal
Junior Engineer	Ms. Kripa Tiwari
Junior Engineer	Ms. Ritu Pradhan Shrestha
Junior Engineer	Mr. Deepak Aryal
Junior Engineer	Mr. Suraj Shakya
Office Assistant	Mr. Bal Krishna

Annex C. List of Subcontractors

Name	Address	Description of Expertise
Cenibark International Inc	Kennewick, WA, United States	Cenibark International, Inc. (CII) is a small business with specialized expertise in environmental and social assessments, gender equality, risk assessment, health and safety, hazardous material and waste management, and resettlement. The company specializes in project due diligence, development, implementation and oversight. CII has a team of over 40 subject matter and technical resource experts with extensive international experience. Its team members all possess a thorough understanding of MCC Environmental Policy, the IFC Performance Standards for Environmental and Social Sustainability, the Equator Principles, and international industry best practices. CII has supported a variety of international development projects sponsored by government funding agencies, multilateral development banks as well as international private industries.
Trans Grid Solutions	Winnipeg /Manitoba, Canada	TransGrid Solutions (TGS) is a world-renowned company in power systems consulting, with a focus on HVAC, HVDC and FACTS, system studies and the integration of renewables. TGS provides all of the necessary services from the initial project planning and feasibility stages through to technical specification development, factory testing and commissioning, operation & maintenance, and refurbishment. With its unique blend of utility, manufacturing and academic background, TGS assures a well planned and executed approach to meeting its clients' needs.
Feedback Infra	Mumbai, India	Feedback Infra Pvt. Ltd. is one of the largest professional and technical service providers in India with a dedicated team providing integrated services in the infrastructure sector such as energy, transportation and real estate infrastructure across advisory, planning & engineering, transactions, program management, project management, and operations & maintenance. With its corporate office near New Delhi and drawing on the knowledge of a 4000+ team, Feedback Infra brings a considerable diversity of skills to implementing infrastructure projects through its 5 regional offices in India, 4 international offices and over 100 project offices, nationally and internationally.

Annex D. List of Local Vendors

	Company's Name	Address	Tasks Performed
1	Mountain Buddha Tours and Transport P. Ltd.	Hadigaun, Kathmandu	Provided vehicles in the valley and outside for field trips.
2	Tech-Line International Pvt Ltd	Kopundole Height, Lalitpur	Provided storage server and maintained internet.
3	Manang Air	Minbhawan, Kathmandu	Providing helicopter services during field trips in remote areas.
4	Lalima Travels Pvt Ltd	Kamaladi, Kathmandu	Arranged air tickets
5	International Electronics Concern Pvt. Ltd	Putali Sadak, Katrhmandu	Provided office equipment and support.
6	Hotel Radisson	Lazimpat, Kathmandu	Provided hotel and office facilities, and conference facilities for workshop 1
7	Gokarna Forest Resort	Gokarna, Kathmandu	Provided hotel and conference facilities for workshop 2

For Information/Clarifications
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