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**Study of Impact of NewButwal-Gorakhpur 400 kV Transmission Line on The
Operation and Reliability of Integrated Nepal Power System**

by

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A THESIS

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ABSTRACT

In recent years, the significance and imperative of conducting impact studies on grid reliability evaluation have escalated. This thesis represents load flow analysis with a focus on improving resilience and efficiency after adding New Butwal-Gorakhpur 400KV cross border transmission line to existing power system of Nepal and simulation of 2028A.D. INPS network to find the reliability indices. The INPS is facing unprecedented challenges brought about by the increasing demand for electricity, the integration of hydropower and renewable sources, and the need for enhanced system reliability. This thesis reviews the current state of power systems and the challenges they face, including capacity constraints, energy losses. In this context, the integration of NB-G 400KV transmission line has emerged as a promising solution to address these challenges. The core of this research are used to assess the potential benefits, such as increased grid capacity, reduced transmission losses, improved power quality and reliability of the system after the integration of New Butwal-Gorakhpur (NB-G) line. Load flow analysis is carried out in DIgSILENT to find out system loss, voltage profile and reliability indices

Index: Cross Border Transmission line, NB-G 400kV, Load flow, Reliability Index, DIgSILENT.

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LIST OF ACRONYMS, SYMBOLS AND ABBREVIATIONS

CCT	Circuit kilometer
CUE	Cost of Unserved Energy
NB-G 400	NewButwal-Gorakhpur 400 KV Transmission Line
D-M 400	Dhalkebar-Muzzaffarpur 400 KV Transmission Line
ECOST	Expected Cost of Energy Not Served
EENS	Expected Energy Not Served
EENS _{p.u.}	Per Unit Value of Expected Energy Not Served
EIR	Energy Index of Reliability
GWH	Gega Watthour
H-D-D 400	Hetauda-Dhalkebar-Duhabi 4000 KV Transmission Line
IEAR	Interrupted Energy Assessment Rate
INPS	Integrated Nepal Power System
IPPs	Independent Power Producers
kV	kilo Volt
K-D 220	Khimti-Dhalkebar 220 KV Transmission Line
λ (Lambda)	Failure Rate
MTTR	Mean Time to Repair or Outage Time
MUSD	Million US Dollar.
MW	Mega Watt
MWH	Mega Watthour
NEA	Nepal Electricity Authority
PPA	Power Purchase Agreement
PTA	Power Trade Agreement
yr.	Year

CHAPTER 1. INTRODUCTION

1.1 Background

Nepal has entered a phase of power surplus during wet seasons, and this trend is expected to persist with the commissioning of additional generation projects. In the last fiscal year, the total power generation reached 2,684 MW, with 452 MW exported to India on a Day-Ahead basis through the Indian Energy Exchange (IEX). This export figure is anticipated to rise further as agreements are made to purchase more power from Nepal's hydropower sector. Over the next decade, the Government of Nepal and the Nepal Electricity Authority (NEA) have outlined a strategy to evacuate 15,000 MW of power to meet the growing demand, driven by an annual consumer increase of 7-10%, reaching a total of 5.13 million. However, the current status of Nepal's power system is inadequate to handle this increased capacity, necessitating upgrades. The transmission line, a critical component of the power system, poses challenges due to the substantial budget required for construction and its resistance to easy replacement or modification. Many 66 kV transmission lines, constructed during King Birendra's era, are struggling to efficiently evacuate power as more generators are added to the system. Notably, transmission lines like Hetauda-Pathlaiya 132kV, Damauli–Bharatpur 132 kV, Duhabi-Damak 132kV operate at full capacity, leading to issues such as power interruptions, high energy loss, voltage drops, reduced power capacity, cost inefficiency, limited hydropower integration, and diminished voltage stability.

In the current fiscal year, the western part of the country has encountered challenges in power supply operations due to insufficient generation. Transmission line constraints hinder the transfer of surplus power from the eastern part to the west, compelling major areas in the western region to be supplied power from Tanakpur, India. In response to these challenges, NEA is implementing upgrades, transitioning from 66kV to 132 kV and 132 kV to 220 kV, recognizing the need to address issues related to power interruption, energy loss, and capacity limitations. While these lower voltage lines have specific applications, such as local distribution networks, they are not well-suited for long-distance, high-capacity power transmission or trade with India, which is better facilitated by high voltage transmission lines operating at 400kV.

The Transmission Directorate holds the responsibility for the synchronous operation of the Integrated Nepal Power System (INPS) with the Indian Grid, aiming to enhance the system's reliability, security, and robustness. Additionally, this Directorate oversees power exchange activities with neighboring countries through cross-border transmission lines. The inaugural 400 kV Dhalkebar – Muzaffarpur cross-border transmission line has played a crucial role in facilitating power flow between Nepal and India.

To further strengthen cross-border transmission capabilities, a Joint Venture Company has been established between the Nepal Electricity Authority (NEA) and Power Grid India. This collaboration focuses on constructing the Indian portion of the Butwal-Gorakhpur 400 kV cross-border transmission line, spanning 120 km. A contractual agreement has been executed for both the transmission line and the associated substation. The funding for the construction of the Nepalese segment of the Butwal-Gorakhpur 400 kV cross-border transmission line, covering 20 km and its associated substations, is provided by the Millennium Challenge Account (MCA) Nepal, sponsored by the Millennium Challenge Corporation (MCC).

The Butwal-Gorakhpur line has the capacity to transmit up to 3500 MW, contributing significantly to cross-border power exchange and reinforcing energy connectivity between Nepal and India.

The Transmission Directorate is responsible for operating INPS in synchronous mode with Indian Grid to make the system more reliable, secured and robust. Moreover, this Directorate is also responsible for power exchange across border countries through cross-border transmission lines. The first-ever 400 kV Dhalkebar – Muzaffarpur cross-border transmission line has played a vital role in the power flow between Nepal and India. Joint Venture Company between NEA and Power Grid, India for the construction of Indian Portion of the Butwal-Gorakhpur 400 kV cross border 120 km transmission line has been formed and contract agreement has been signed for transmission line and substation. Millennium Challenge Account (MCA)Nepal funded by Millennium Challenge Corporation (MCC) has taken care of construction of Nepal portion of Butwal-Gorakhpur 400 kV cross-border 20 KM transmission line and associated substations. The New Butwal-Gorakhpur line can transmit up to 3500MW.

Higher voltage levels provide better voltage stability, reducing voltage fluctuations that can affect the operation of sensitive electrical equipment. 400 kV transmission lines have the capacity to support the increasing power demands of growing populations and industries over time. They allow for the expansion of the power grid without requiring extensive modifications. 400 kV transmission lines are designed to efficiently transmit large quantities of electrical power over long distances. The higher voltage reduces current flow, minimizing resistive losses, meaning less energy lost as heat during transmission. High-voltage transmission lines can use smaller conductor sizes and fewer substations than lower voltage lines to transmit the same amount of power. This can lead to cost savings in terms of materials and infrastructure. High-voltage transmission lines are associated with more reliable power supply. They are less susceptible to voltage drops and fluctuations, providing a stable and consistent power source for consumers. 400 kV lines are well-suited for integrating renewable energy sources, such as wind farms and solar power installations. They can efficiently transport electricity from remote generating sites to demand centers. They play a crucial role in supporting economic development, renewable energy integration, and the overall stability and resilience of the power distribution system.

High voltage transmission lines play a pivotal role in improving the reliability of power systems. By providing a strong and interconnected network, they reduce the susceptibility of the grid to localized failures. In the event of an outage or fault, high voltage lines offer the flexibility to reroute power, minimizing the impact on end-users. The integration of high voltage transmission lines enhances the grid ability to recover from disturbances and continue supplying electricity to critical facilities. Their redundancy and contingency capabilities allow for quick reconfiguration, reducing downtime and mitigating the effects of unforeseen events. When threats to power systems, the resilience offered by high voltage transmission lines becomes a critical component in ensuring the reliable supply of electricity. This thesis seeks to explore how these lines can be leveraged to enhance power system reliability.

1.2 Rationale of the Study.

Integrated Nepal Power System (INPS) is suffering power crisis problem in dry season and surplus power in wet season due to which Nepal electricity is trying to manage the surplus power and to import the power in dry season and the users are facing poor

quality power supply throughout the year. No sector remains immune to power shortage problems. So the NEA is desperately seeking a solution to end power surplus and power crisis problem either by exporting power to india in wet season and import power from india in dry season. To mitigate spillage in wet we need to incease consumption either by industrialing the nation or increasing the consumption of public. Aforementioned action takes long time; Short-term solution of the problem can be addressed by import from neighboring grid with proper transmission interconnection facility. For solving the current power crisis and to export to neighboring grid in the future, NEA and an Indian entity are jointly constructing the Newbutwal-Gorakhpur 400 kV cross border transmission line. Further, for power evacuation of Modi and Marsyandi Corridor Hydropower. For reinforcement of the transmission system, NEA is constructing the Hetauda-Dhalkebar-Duhabi (H-D-D) 400 kV transmission line and also the New Butwal-NewDamauli-Ratamate-Laphsiphedi and Ratamate-Hetauda 400kV transmission lines under the MCC project.

Hence, the evaluation of INPS after the upgradation of voltage level and addition of transmission link with Indian power grid is necessary for understanding the operation and reliability aspects.

1.3 Problem Statement

The Nepal power system is experiencing insufficient transmission capacity. Often (N-1) criterion has been violated. Further poor system voltage results in frequent and unusual system collapse. Lack of transmission facilities is the main hurdle for generation capacity expansion. Difficulties in acquisition of land for tower footings, construction of a new substation and acquiring Right of way for transmission lines are hindering system expansion. Major issues and challenges facing Nepal's power system are environmental issues, availability of funds, ability to carry out timely construction of a project, maintaining fiscal discipline etc. As in many other fields, the advent of democracy has opened the door for independent power producers for the development of electricity sectors and many public and private entities are being involved in this field. So, in near future, problem of power evacuation may arise due to lack of robust transmission system. The transmission system must accommodate changing electricity supply and demand conditions, unexpected outages, planned shutdowns of generators

or transmission equipment for maintenance, weather extremes, and other challenges. In institutional prospective, the basic function of a modern electric power system is maintaining a sustainable, robust or strong transmission grid and to satisfy its consumers with a reasonable assurance of service reliability. This requires additional generation and reliable power transmission line/equipment to accommodate for consumer present and future demands. The operating transmission voltage level of INPS is upto 132kV, 220kV and 400kV and also the reliability aspect of existing transmission system is still unknown. To date, impact study of INPS on operation and reliability after addition of high voltage including NewButwal-Gorakhpur 400 kV transmission line has not been studied.

So, this study aims to evaluate the impact on operation and reliability aspects of INPS after addition of Newbutwal-Gorakhpur 400 kV Cross border transmission line and also analyzes the effect on operation and reliability of INPS with the addition of New Butwal-New Damauli, New Damauli-Ratmate, Ratmate-Hetauda and Ratmate-Laphsiphedi 400kV transmission lines.

1.4 Objective and Scope

The overall objective of this thesis is the study of impacts of Newbutwal –Gorakhpur 400 kV transmission line on Operation and Reliability of INPS. Study of INPS with this line at different operating scenarios for dry and wet seasons including power export/import to/ from Gorakhpur has been carried out with following scopes:

- Analyze existing INPS for load flow, bus voltage profiles and transmission loss.
- Assess the reliability parameters of the current INPS, which include EENS, EIR, and ECOST.
- Analyze the power flow of the altered INPS (with NewButwal-Gorakhpur 400 kV line including power export/import) while also identifying bus voltage profiles and evaluating transmission losses under various operational conditions.
- Evaluate the reliability parameters of the modified INPS, including EENS, EIR, and ECOST.
- Recommend the most technically efficient operational scenario for the system.

1.5 Outline of Thesis

This thesis has been organized into five chapters:

Chapter 1 serves as the introductory chapter, encompassing the following components: providing a general background, outlining the rationale, stating the problem, setting forth the study's objectives, and defining its scope.

Chapter 2 offers a comprehensive overview of transmission line planning and expansion in Nepal, coupled with a review of relevant literature pertinent to this study.

In Chapter 3, the methodology employed in this research is elucidated. It delves into the tools and software utilized, such as Dig Silent. The chapter entails a thorough examination of load flow simulations, incorporating the proposed line, under various scenarios during both dry and wet peak operations. Additionally, it entails the assessment of system reliability indices, namely EENS, EIR, and ECOST.

Chapter 4 provides an analysis of the operational outcomes for both the current and modified INPS, including the introduction of the proposed line, across a range of scenarios during dry and wet peak operations.

In conclusion, Chapter 5 offers the final remarks and provides recommendations for future endeavors.

CHAPTER 2. LITERATURE REVIEW

2.1 Overview of Transmission Line Planning and Expansion in Nepal

Nepal Electricity Authority is the vertically integrated institution responsible for generation, transmission and distribution of power in Nepal. In Nepal, Transmission Directorate and Project Management Directorate of NEA is fully devoted to its responsibility of planning, constructing, operating and maintaining the high-voltage transmission lines and substations from 66 kV to 400 kV voltage level. The head of transmission directorate is Deputy Managing Director(DMD) and consists of Grid Operation Department (GOD), System Operation Department (SOD), Grid Development Department, Major Transmission Projects at 220 kV and 400 kV. This directorate monitors, operates and constructs transmission lines and substation facilities to evacuate power generated by both NEA and IPP owned power plants and undertake reinforcement of the existing transmission system. The Directorate is responsible for operating INPS in synchronous mode with Indian Grid to make the system more reliable, secured and robust. Moreover, this Directorate is also responsible for power exchange across border countries through cross-border transmission lines. The first-ever 400 kV Dhalkebar- Muzaffapur cross-border transmission line has played a vital role in the power flow between Nepal and India. Joint Venture Company between NEA and Power Grid, India for the construction of Indian Portion of the Butwal-Gorakhpur 400 kV crossborder transmission line has been formed and contract agreement has been signed for transmission line and substation. Millennium Challenge Account (MCA)Nepal funded by Millennium Challenge Corporation (MCC) is to construct of Nepal portion of New Butwal-Gorakhpur 400 kV cross-border transmission line and associated substations and also to construct a 315 km long 400kV transmission line. The bid for transmission line is under evaluation and substation bidding is yet to submit. The under construction transmission line of Hetauda-Dhalkebar-Inaruwa 400kV will help to build a strong and robust transmission grid in near future. The Dhalkebar-New Khimti-Upper Tamakoshi, Dana-Kusama 220kV transmission line is completed. This Transmission Directorate is also forging ahead for an updated Transmission System Master Plan upon which NEA intends to develop river basin wise transmission corridor (Kaligandaki corridor, Marshyangdi corridor, Kabeli corridor, Dordi Corridor, Koshi Corridor etc) as a long term strategy for power development of Nepal.

Project Management Directorate (PMD) under the Nepal Electricity Authority's organogram has a role to execute and facilitate projects funded by Asian Development Bank (ADB) and European Investment Bank (EIB). PMD is responsible for project preparation, procurement and implementation of all new and existing projects that is or will be funded by ADB. At present, PMD is executing diverse projects in energy sector like construction of transmission lines, substations and distribution systems, upgrading of transmission line through high capacity High Tension Low Sag (HTLS) conductors, modernization of distribution system, installation of smart metering and automation under ADB financed (i) SASEC– Power System Expansion Project (SPSEP) (ii) Electricity Transmission Expansion and Supply Improvement Project (ETESIP) (iii) Power Transmission and Distribution Efficiency Enhancement Project (PTDEEP) (iv) SASEC Power Transmission and Distribution System Strengthening Projects (SASECPTDSSP) and (v) Electricity Grid Modernization Project (EGMP). PMD is also leading environmental and engineering study of different transmission lines up to 400kV voltage level with length of more than 2000 circuit km and substations associated with it under ADB Grant.

Total existing length of 66 kV, 132 kV and 220 kV transmission lines are 514.46, 3873.87 and 675.10 circuit kilometer (CCT) respectively. Total under construction length of 132 kV, 220 kV and 400 kV transmission lines are 1110.6, 988 and 754 CCT respectively.

2.2 Literature Review

This work examines several research papers on Nepal's power system and its transmission and distribution system planning. Below, we provide a brief summary of the papers most relevant to this thesis works:

"In their paper titled 'Analysis of Load Flow and Reliability Assessment for the 220 KV Kerala Power System' [1], Dr. J. Abdul Jaleel and Shabna S.S. conducted load flow studies on the Kerala 220 KV Power system using ETAP software. The objective of their study was to facilitate future power system planning and enhance the current system's operational efficiency. Furthermore, the paper includes an assessment of various reliability indices for the system, offering valuable insights into its overall reliability."

In their work titled 'Probabilistic Reliability Assessment of 765KV Transmission Lines in KEPCO Grid Expansion Planning' [2], Trungtin Tran et al. have demonstrated the utilization of TRELSS version 6.2, a software package developed by the Electric Research Institute, for calculating Probabilistic Reliability Evaluation indices for the KEPCO system. The paper presents findings from various case studies conducted on the KEPCO-system using the TRELSS program.

In the research conducted by Sang-Bong Choi, titled 'Evaluation of Reliability in the Distribution System of an Industrial Complex' [3], the authors elucidate methodologies for assessing EPNS (Expected Point of Non-Supply) and EENS (Expected Energy Not Supplied) at specific load points, namely the substations (S/S). These evaluations are derived from computations involving load and power flow, failure rates, and outage durations.

In their publication authored by Xiakang Xu, Feng Dong, Lengchang Huang, and Baldwin P. Lam, titled 'Modeling and Simulation of Substation-Related Outages in Power Flow Analysis' [4], a probabilistic reliability approach is detailed. This approach is designed to model and simulate the potential outages of substation-related equipment, including incoming and outgoing lines, circuit breakers, disconnect switches, and bus sections. It employs a substation reliability model to quantify the unreliability of the substation in terms of load interruption and energy unavailability.

Rohit Kapahi's paper, titled "Utilizing ETAP Software for Load Flow Analysis in a 132 KV Substation" [5], explores the application of load flow analysis using ETAP software. The primary aim is to address undervoltage issues and utilize this approach as a robust tool in the planning of the transmission system.

In the paper authored by Zio E., Piccinell R., Delfanti M., Olivieri V., and Pozzi M. titled " Performance analysis of a power transmission system under load uncertain conditions and network configuration " [6], the focus lies on examining load flow challenges within a power transmission network, particularly when faced with uncertainties in both load demand and power generation, as well as potential transmission line failures. This paper involves the calculation of network performance indicators, and it assesses the significance of various network components using power flow betweenness centrality measures.

In the paper published by J. Manikya Rao, P.V.N. Prasad, and G. Tulasi Ram Das, titled "Customer Outage Cost Evaluation in Electric power systems " [7], the authors establish a connection between investment expenses and supply reliability levels. They achieve this by quantifying reliability in monetary terms through the calculation of expected interruption costs under varying system configurations and evaluating the corresponding reliability value at specific system load points.

CHAPTER 3. METHODOLOGY

To investigate the impact of the New Butwal-Gorakhpur Cross-Border 400kV Transmission Line on the Operation and Reliability of INPS, the thesis work involves the following key steps:

3.1 Collection of Appropriate Research Paper

The initial phase entails gathering pertinent literature for thesis project. Extensive research on transmission expansion, load flow analysis, and the assessment of reliability indices in transmission systems was conducted by consulting diverse sources. This thorough examination was conducted to establish the groundwork for future research and to identify suitable software tools for the research endeavor.

3.2 Collection of Data and Deciding of Software

Data related to the INPS, including network topology, generation capacity, load demand, and operational constraints, are collected. Information regarding the technical specifications of the New Butwal-Gorakhpur Cross-Border 400 kV Transmission Line and other relevant parameters are obtained. Data related to underconstruction line with voltage level of 220 kV and 400 kV were collected from System planning department, Load dispatch center, and other concerned department of NEA. Historical data on system disturbances and contingency events are collected for scenario development and analysis. Simulation for both the 2023 A.D. and 2028 A.D. scenarios will be carried out using DIGSilent PowerFactory simulation software version 15.1.7. This software specializes in digital simulation and network calculations, offering functionalities such as Load Flow analysis, Power Loss calculation, and Reactive Power Optimization (OPF) tools. To support the coding necessary for the thesis, coding platforms will be utilized: DIGSilent Programming Language (DPL).

3.3 INPS with New Butwal-Gorakhpur Transmission Line under study.

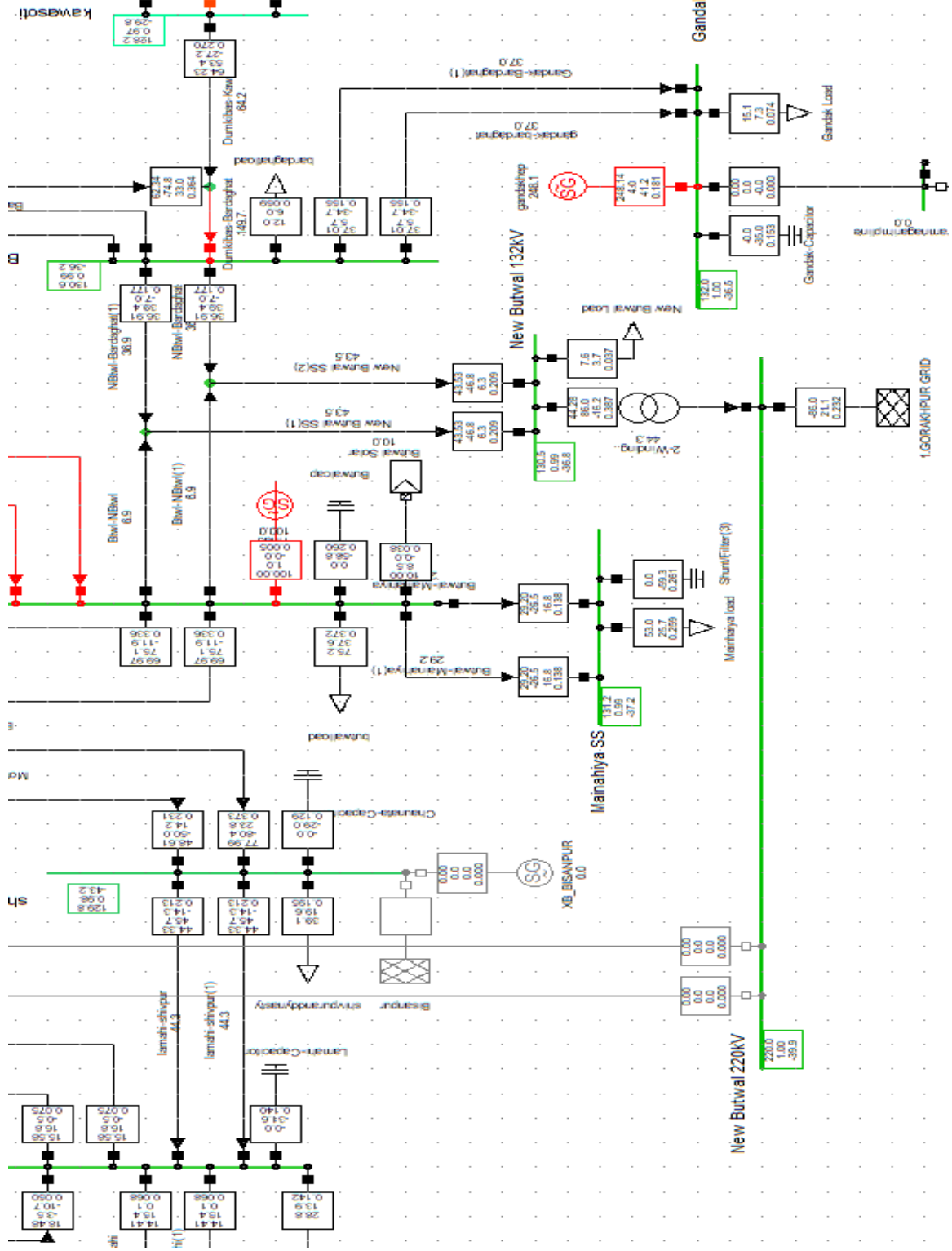


Figure 3. 1: Schematic representation of INPS with NB-G Transmission Line

3.4 Load flow analysis

Load flow analysis is crucial for the functioning and examination of a power system. In essence, load flow serves as the core of power system analysis. Its significance is particularly pronounced when it comes to the planning and expansion of transmission and generation facilities. Essentially, a load flow analysis is a process that aims to determine the unknown bus voltages, unspecified generation values, and ultimately, the complex power flow within network components in a given power system network. This is done while considering known loads and a set of specifications or restrictions on power generation and voltages. Typically, the analysis includes the computation of losses in individual components and within the entire network. Furthermore, the system is assessed for potential component overloads and voltage deviations outside the acceptable tolerance range.

In practice, there are two widely employed methods for conducting load flow analysis: The Gauss-Seidel method and the Newton-Raphson method. Both of these methods require specific input parameters to carry out the analysis. The Newton-Raphson method is the more commonly accepted approach within the power industry and is the method employed in this particular work. It's important to note that the determination of the Y-BUS or Z-BUS is a prerequisite before proceeding with the solution. In a network, buses are categorized into three distinct types: swing bus, generator or PV bus, and load or PQ bus. Each type of bus is associated with four parameters: voltage magnitude, phase angle, as well as real and reactive powers.

Swing bus: This is a generator bus in which the voltage and angle are specified for load flow analysis. The calculation involves determining the real and reactive powers to match generation, load, and losses.

Generator bus: Generators are connected to these buses. Here, the voltage and real power generation are specified, while reactive power and phase angle are determined as part of the analysis.

Load bus: Typically, loads are connected to these buses. The real and reactive load values for these buses are known, and the bus voltage and phase angle are computed during the analysis. It is also known as PQ bus.

Load flow Analysis using DIgSILENT PowerFactory:

The Load flow analysis toolbar in DIgSILENT computes various electrical system parameters, including bus voltages, branch power factors, currents, and power flows. It accommodates a variety of power sources, such as swing, voltage-regulated, and unregulated generators, and can handle complex configurations with multiple power grids and generator connections. This tool is versatile, capable of analyzing both radial and looped systems. DIgSILENT offers flexibility by allowing users to choose from several calculation methods to optimize efficiency. It provides two primary load flow calculation methods: The Newton-Raphson and Gauss-Seidel algorithms. The choice between these methods depends on factors like system layout, generator characteristics, load levels, and the initial bus voltage conditions.

In this analysis Newton Raphson method is used.

The Newton-Raphson technique involves iterative formulation and solution of the load flow equation as follows:

Real Power Balance Equation (P-ΔP):

The real power balance equation ensures that the active power generated is equal to the active power consumed in a power system.

$$P_i = P_{geni} - P_{loadi} - \sum_{j=1}^n |V_i||V_j|(G_{ij}\cos(\theta_i - \theta_j) + B_{ij}\sin(\theta_i - \theta_j))$$

Where:

P_i is the active power injection at bus i.

P_{geni} is the active power generated at bus i.

P_{loadi} is the active power consumed at bus i.

$|V_i|$ and $|V_j|$ are the voltage magnitudes at buses i and j .

θ_i and θ_j are the voltage phase angles at buses i and j .

G_{ij} and B_{ij} are the real and reactive component of the admittance between buses i and j .

Reactive Power Balance Equation (Q-ΔQ):

The reactive power balance equation ensures that the reactive power generated is equal to the reactive power consumed in a power system.

$$Q_i = Q_{geni} - Q_{loadi} + \sum_{j=1}^n |V_i||V_j|(G_{ij}\sin(\theta_i - \theta_j) - B_{ij}\cos(\theta_i - \theta_j))$$

Where:

Q_i is the reactive power injection at bus i .

Q_{geni} is the reactive power generated at bus i .

Q_{loadi} is the reactive power consumed at bus i .

$|V_i|$, $|V_j|$, θ_i , θ_j , G_{ij} , and B_{ij} are as defined above.

The Newton-Raphson method exhibits a distinctive quadratic convergence property, which often results in considerably faster convergence compared to alternative load flow computation techniques. One of its key advantages lies in the ability to specify convergence criteria for real power and reactive power discrepancies at bus bars, offering direct control over the desired accuracy of the load flow solution. Typically, these criteria are set at 0.001 MW and MVAR, respectively.

It's crucial to note that the Newton-Raphson method's performance is significantly influenced by the initial voltage values assigned to the buses. Therefore, a cautious selection of initial bus voltage values is strongly recommended.

The network's component data, such as information regarding generators, transmission lines, and substation loads and compensating devices within the existing INPS, was input into the simulated INPS network created using DIGSILENT. In this simulation, the

Dhalkebar Bus was designated as the swing bus for assessing the load flow within the existing INPS. The load flow analysis conducted with DIgSILENT provided valuable insights, including data on line losses, instances of line overloading, and estimates of bus voltage. These results played a crucial role in estimating the amount of export/import to ensure system stability. The amount of export/import quantity was determined based on the line capacity of slack bus, load flow analyses were carried out for both dry and wet season load scenarios, considering various network configurations and different levels of power export/import. The specific cases examined in this study are detailed as follows:

a) Dry season operation of INPS:

During the dry season, there is a rise in electrical energy consumption, while Nepalese hydroelectric power plants operate at reduced capacity due to a decrease in river water flow. This leads to a significant disparity between power generation and demand. As a result, the primary necessity becomes either reducing the load or importing power from neighboring countries. The examination of these scenarios in various contexts is detailed below:

- Operation of existing INPS at dry peak load serving of 1900.93 MW out of which 1301.76 MW from INPS generation and remaining power (693.18 MW) import from Dhalke-Muzaffarpur(D-M) line and other import points. (Base Case i.e. Case I)
 - Case II: When 25 MW power is importing via New Butwal-Gorakhpur line
 - Case III: When optimal power is importing via New Butwal-Gorakhpur line
- Operation of existing INPS at dry normal load serving of 1599.54 MW out of which 858.73 MW from INPS generation and remaining power(829.66MW) import from Dhalke-Muzaffarpur(D-M) line and other import points. (Base case i.e. Case I)
 - Case II: When 25MW power is importing via New Butwal-Gorakhpur line
 - Case III: When optimal power is importing via New Butwal-Gorakhpur line
- Operation of existing INPS at dry off-peak load serving of 1250.51 MW out of which 559.73 MW from INPS generation and remaining power(751.38MW) import

from Dhalke-Muzaffarpur(D-M) line and other import points. (Base case i.e. Case I)

- Case II: When 25MW power is importing via New Butwal-Gorakhpur line
- Case III: When optimal power is importing via New Butwal-Gorakhpur line

Assumption of the study:

- Only balance and steady state load flow is considered.
- Dhalkebar 400 kV sub station bus is always considered as swing bus 2023A.D. scenario analysis and for 2028A.D. scenario analysis bus is specified as per cases.
- Interrupted energy assessment rate (IEAR) is considered as 0.5 dollar per KWhr.

b) Wet season operation of INPS:

During the wet season, Nepalese hydroelectric power plants operate at their maximum capacity, resulting in a surplus of electrical power compared to the local demand. Consequently, it becomes necessary to export this excess power to the grids of neighboring countries. The examination of these scenarios under various conditions is outlined as follows:

- Operation of existing INPS at wet peak load serving of 2000.19 MW and exporting remaining power(-353.5MW) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation (Base Case I.e. Case I)
 - Case II: When 25 to 50MW power is exporting via New Butwal-Gorakhpur line
 - Case III: When optimal power is exporting via New Butwal-Gorakhpur line.
- Operation of existing INPS at wet normal load serving of 1799.68 MW and exporting remaining power(550.77MW) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation (Base Case i.e. case I)
 - Case II: When 25 to 50MW power is exporting via New Butwal-Gorakhpur line

- Case III: When optimal power is being exporting via New Butwal-Gorakhpur line
- Operation of existing INPS at wet off peak load serving of 1600 MW and exporting remaining power(731.67MW) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation (BaseCase ie case I)
 - Case II: When 25 to 50MW power is exporting via New Butwal-Gorakhpur line
 - Case III: When optimal power is being exporting via New Butwal-Gorakhpur line

3.5 Reliability Analysis.

For reliability analysis, the following reliability indices are considered in this study:

Expected Energy Not Served (EENS): The EENS is defined as the expected amount of energy not being served to consumers by the system during the period considered due to system capacity shortages or unexpected severe power outages.

Expected Power Not Served (EPNS): The EPNS is defined as the magnitude of power (load) that has been lost due to severe outages.

Energy Index of Reliability (EIR) = $1 - EENS_{p.u}$ where

$$EENS_{pu} = \frac{\text{Expected Energy Not Served (EENS)}}{\text{Total Energy Demanded (TED)}}$$

Expected Cost of Energy Not Served (ECOST) or Cost of unserved Energy (CUE) = EENS * IEAR, Where IEAR is the interrupted energy assessment rate.

For Reliability analysis of the transmission system, required input data i.e. failure rate of transmission line is taken from a book “forced Outage performance of Transmission Equipment 2006”, Canada Electricity Association as shown in table 3.1.

Table 3. 1: Failure rate data of Transmission line

S.N.	Description	Frequency of outage (λ)	Mean Time to Repair (MTTR)
1	66 kV lines	0.028 failure/yr/km	10.8 hr
2	132 kV lines	0.01 failure/yr/km	9.5 hr
3	220 kV Lines	0.0035 failure/yr/km	35.5 hr
4	400 kV Lines	0.002 failure/yr/km	18.8 hr

For reliability analysis of INPS, selecting standard value of annual failure rate λ (per yr.km) and mean time to repair MTTR i.e. outage time of transmission line are taken for each line. The line flows are taken from DIg SILENT load flow result. After obtaining these datas, annual expected power not served (EPNS) is calculated by multiplying power flow in megawatt due to load in the line and failure rate of that line. Expected energy not served (EENS) is calculated by multiplying expected power not served and outage time (MTTR) in hour annually, per unit value of expected energy not served ($EENS_{p.u}$) w.r.t. total demand, and energy index reliability (EIR) are found in each operating case of INPS. Cost of energy due to interruption ($ECOST_1$) is calculated from consideration of 0.5 \$/KWhr interrupted energy assesement rate (IEAR) and cost of unserved energy due to load curtailment ($ECOST_2$) is calculated from consideration of average NEA unit rate Rs.8.14/KWhr.

3.6 INPS Data

The necessary data for conducting a load flow calculation for the INPS are as follows:

3.6.1 Data required for a synchronous generator

The data required for load flow calculation for synchronous generators must include:

- Operating mode (Swing, Voltage Control or Mvar Control)
- Rated kV
- %V and angle for swing mode of operation
- %V, MW loading, and Mvar limits (Q_{max} & Q_{min}) for voltage control mode of operation
- MW and Mvar loading for Mvar control mode of operation

The generation MW rating of generators for dry and wet season are taken from load dispatch center, NEA are as per annex C.

3.6.2 Substation load Data

The data required for load flow calculation for lumped load must include:

- Load ID
- Rated kV, MVA, power factor, and % motor load
- Loading category ID and % loading

Load data for dry and wet peak period are taken from system planning department NEA are as per annex D.

3.6.3 Transmission line data

The information necessary for conducting load flow calculations involving branch data (such as transformers, transmission lines, cables, reactors, and impedance) should encompass:

- Branch Z, R, X, or X/R values and units, tolerance, and temperature, if applicable.
- Cable and transmission line length, and unit
- Transformer rated kV and kVA/MVA, tap, and LTC settings
- Impedance base kV and base kVA/MVA

Transmission lines datas are taken from NEA transmission department are as per annex E.

3.6.4 Existing capacitor data

To perform a load flow calculation involving an existing compensating devices (Capacitor, Reactor), the essential data needed should encompass:

- Compensating devices ID
- Rated kV, kvar/bank, and number of banks
- Loading category ID and % loading
- Equipment cable data

Existing capacitor data are taken from load dispatch center, NEA are as per annex F.

CHAPTER 4. RESULTS AND DISCUSSION

4.1 Overview

The load flow analysis and assessment of system reliability metrics for INPS during both dry and wet season operational periods are conducted. This process yields critical operational parameters, including voltage profiles, transmission losses, and system reliability indicators, for each operational scenario.

Different modes of operation of INPS for dry and wet season period are categorized on the basis of different loading of the system. The different loadings of the system are based on the available generation in INPS and power export and import from the Dhalkebar- Muzaffarpur (D-M) line and addition of new transmission lines i.e. New Butwal-Gorakhpur 400 kV cross-border line.

4.2 Dry season load operation of INPS

4.2.1.1 Operation of Existing INPS at dry peak load (Base Case i.e. Case 1):

The single-line diagram for the existing INPS has been created (refer to Annex G). A load flow analysis was conducted using DIGSILENT, focusing on a scenario in which the system serves a peak load of 1900.93 MW. Of this load, 1301.76 MW is generated by IPP and NEA power plants, while the remaining 716.36 MW is imported from various points of entry from Muzaffarpur 386.36 MW, Kataiya 120MW, Raxual 80MW, Tanakpur 70MW and Ramnagar 60MW. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The results indicated that the transmission loss within the system amounted to 117.18 MW, equivalent to 5.81 % of the total load. Specifically, the Simra Substation exhibited the lowest system voltage at 59.18 kV, operating at the 66 kV voltage level. Meanwhile, the Parwanipur Substation recorded the lowest system voltage of 121.70 kV, functioning at the 132 kV voltage level. This information is summarized in tables 4.1, 4.2, and 4.5

4.2.1.2 Operation of INPS at peak load when 25 MW power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2):

Load flow analysis of INPS after the addition of New Butwal-Gorakhpur(NB-G) transmission line at 400kV with the power import of 25 MW from Gorakhpur is carried out in DIgSILENT PowerFactory 15.1.7. The voltage profile, transmission loss and reliability indices of the INPS are evaluated. In this case the power import from NB-G line serving the load center Butwal sub-station. So the loss of the transmission system is reduced since the power has to travel the less distance. Transmission loss of the system is 104.88 MW i.e. 5.23 % and minimum system voltage appeared at 66 kV voltage level is 60.42 KV at Birgunj S/S and minimum system voltage appeared at 132 kV voltage level is 122.64 KV at Parwanipur132kV Bus S/S as shown in table 4.1, 4.2 & 4.5.

4.2.1.3 Operation of INPS at peak load when optimum power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3):

The single-line diagram for the existing INPS has been created (refer to Annex G). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a peak load of 1900.93 MW. Of this load, 1301.76 MW is generated by IPP and NEA power plants, while the remaining 696.26 MW is imported from Muzaffarpur 328.36 MW and from New Butwal-Gorakhpur 367.90MW. While optimum power is imported from Gorakhpur line then aforementioned import point are made off except Dhalke-Muzffarpur so in this case all power is imported from 400kV lines, which causes less losses then the cases 1 and 2. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The results indicated that the transmission loss within the system amounted to 97.09 MW, equivalent to 4.88 % of the total load. Specifically, the Simra Substation exhibited the lowest system voltage at 65.09 kV, operating at the 66 kV voltage level. Meanwhile, the Chapur Substation recorded the less system voltage of 132.35 kV, functioning at the 132 kV voltage level. This information is summarized in tables 4.1, 4.2, and 4.5

Though power transfer capacity of NB-G 400 kV transmission line is too higher, it is difficult to handle the large amount of power (equal or greater than 375 MW) import due to power transmission constraint of existing weak transmission line like New-Butwal-Bardghat, Bardghat-Kawasoti, Bardghat-NewBharatpur-Hetauda link. So, minimum

voltage magnitude and higher transmission loss has been faced by the system. So the aforementioned line should be upgrade to 220kV to transfer the huge amount of power to catter the load demand at peak time, further to meet the increasing load in western region we need 220kV or 400kV link to supply power.

If we are intending to supply the reliable and quality electricity we think very well to meet the increasing demand in case of dry season because total power imported in such case will cause more power loss with overloading of Lines.

4.2.2.1 Operation of Existing INPS at Normal Load (Base Case i.e. Case 1):

The single-line diagram for the existing INPS has been created (refer to Annex H). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a normal load of 1599.54 MW. Of this load, 858.73 MW is generated by IPP and NEA power plants, while the remaining 827.03 MW is imported from various points of entry from Muzaffarpur 497.03 MW, Kataiya 120MW, Raxual 80MW, Tanakpur 70MW, Ramnagar 60MW. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The results indicated that the transmission loss within the system amounted to 86.22 MW, equivalent to 5.11% of the total load. Specifically, the Simra Substation exhibited the lowest system voltage at 61.65 kV, operating at the 66 kV voltage level since the most of the industries load are inductive in nature and operate in normal time period but Birgunj voltage is in range 64 due to raxual import at Parwanipur. Meanwhile, the new Kamane Substation recorded the lowest system voltage of 126.26 kV, functioning at the 132 kV voltage level. This information is summarized in tables 4.1, 4.2, and 4.5.

4.2.2.2 Operation of INPS at Normal load when 25 MW power import via New Butwal-Gorakhpur line (NB-G) (i.e. Case 2):

Load flow analysis of INPS after the addition of New Butwal-Gorakhpur(NB-G) transmission line at 400kV with the power import of 25 MW from Gorakhpur, is carried out in DIgSILENT PowerFactory 15.1. The voltage profile, transmission loss and reliability indices of the INPS are evaluated. In this case the power import from NB-G line serving the load center Butwal sub-station. So the loss of the transmission system is

reduced since the power has to travel the less distance. Transmission loss of the system is 76.20 MW i.e. 4.55 % and minimum system voltage appeared at 66 kV voltage level is 62.07 KV at Simra S/S and minimum system voltage appeared at 132 kV voltage level is 126.72 KV at Parwanipur S/S as shown in table 4.1, 4.2 & 4.5.

Addition of NB-G 4000 kV line with INPS makes a better way to supply the electricity with reduced system losses and easy flow of huge amount of power for import/export. Here voltage profile has been increased than in comparison to all cases.

4.2.2.3 Operation of INPS at Normal load when optimum power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3):

The single-line diagram for the existing INPS has been created (refer to Annex H). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a normal load of 1599.54 MW. Of this load, 858.73 MW is generated by IPP and NEA power plants, while the remaining 811.28 MW is imported, of them 398.51MW is via NB-G line and 412.8MW from D-M line line and all other imports points are made off. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The results indicated that the transmission loss within the system amounted to 70.47 MW, equivalent to 4.22% of the total load. Specifically, the Simra Substation exhibited the lowest system voltage at 63.56 kV, operating at the 66 kV voltage level since the most of the industries load are inductive in nature and operate in normal time period. Meanwhile, the Chapur Substation recorded the minimum system voltage of 132.35kV, functioning at the 132 kV voltage level. This information is summarized in tables 4.1, 4.2, and 4.5.

Addition of NB-G 400 kV transmission line in INPS with 398.51 MW power import from Gorakhpurpur which reduces the transmission loss to 4.22 from 5.11%. Hence line reduces the loss, improve the system voltage profile and reliability of the INPS.

4.2.3.1 Operation of Existing INPS at dry Off-Peak Load (Base Case ie. Case 1):

The single-line diagram for the existing INPS has been created for off peak load operation (refer to Annex). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a peak load of 1250.51 MW. Of this load, 559.73 MW is generated by IPP and NEA power plants, while the remaining 751.38 MW is imported from various points of entry from Muzaffarpur 421.38 MW, Kataiya 120MW, Raxual 80MW, Tanakpur 70MW and Ramnagar 60MW. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The line loading of Dhalke-Nabalpur is 91.37% of loading further increase in load may lead to overloading so we need remedy to meet the increasing demand in coming future. The results indicated that the transmission loss within the system amounted to 60.59 MW, equivalent to 4.62% of the total load. Specifically, the Baneshwor Substation exhibited the lowest system voltage at 63.00 kV, operating at the 66 kV voltage level. Meanwhile, the new Switchatar Substation recorded the lowest system voltage of 130.22 kV, functioning at the 132 kV voltage level. This information is summarized in tables 4.1, 4.2, and 4.5.

4.2.3.2 Operation of INPS at Off-peak load when 25 MW power import via New Butwal-Gorakhpur line (NB-G) (i.e. Case 2):

Load flow analysis of INPS after the addition of New Butwal-Gorakhpur(NB-G) transmission line at 400kV with the power import of 25 MW from Gorakhpur, is carried out in DIgSILENT PowerFactory 15.1. since all other imports are connected near the load center and further imported power from NB_G line is added near the load center like Butwal ,Sunwal substation consequently loss is reduced in this case than the case 1. But the imported power from 132kV links is expensive than the 400kV links and also Bihar has higher and fix tariff rate than the Indian Energy Exchange Limited (IEX). Further the failure rate of low voltage transmission system is high as compared high voltage transmission system. Therefore, for reliable and cheap power, higher level voltage is best option. The voltage profile, transmission loss and reliability indices of the INPS are evaluated. Transmission loss of the system is 52.15 MW i.e. 4.00 % and minimum system voltage appeared at 66 kV voltage level is 63.43 KV at New chahabil

S/S and minimum system voltage appeared at 132 kV voltage level is 130.91 KV at Switchatar S/S as shown in table 4.1, 4.2 & 4.5.

4.2.3.3 Operation of INPS at Off-peak load when optimum power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3):

The single-line diagram for the existing INPS has been created (refer to Annex H). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which optimum import from the New Butwal-Gorakhpur line. In this case all other imports are made off except Dhalkebar-Muzaffarpur. The power import from the NB-G line is 375.20MW and 366.64 MW from Dhalke-muzaffarpur line to meet the demand at off-peak time. In this case all the PROR plants are stopped to collect water so that can be run in peak and normal time. The analysis encompassed an evaluation of the system's voltage profile, transmission losses, and reliability indicators. The results indicated that the transmission loss within the system amounted to 51.06 MW, equivalent to 3.92% of the total load. Specifically, the Baneshwor Substation exhibited the lowest system voltage at 63.36 kV, operating at the 66 kV voltage level and minimum system voltage appeared at 132 kV voltage level is 130.00 KV at Switchatar S/S as shown in table 4.1, 4.2 & 4.5.

Table 4. 1 :66 kV Bus Voltage profile of INPS in dry season for different load scenario

S.N.	Name of Buses	Peak load			Normal load			Off-peak load		
		Case1	Case2	Case3	Case1	Case2	Case3	Case1	Case2	Case3
1	Amlekhgunj	0.9156	0.9347	0.9963	0.9472	0.9533	0.9751	1.0029	1.0049	0.9870
2	Balaju	0.9467	0.9645	1.0052	0.9707	0.9767	0.9970	0.9914	0.9959	0.9904
3	Banepa	0.9420	0.9650	1.0097	0.9828	0.9869	1.0012	0.9591	0.9658	0.9644
4	Baneshwor	0.9239	0.9465	0.9962	0.9676	0.9734	0.9934	0.9546	0.9613	0.9599
5	Bhaktapur	0.9363	0.9581	1.0062	0.9753	0.9808	1.0003	0.9644	0.9709	0.9696
6	Birgunj	0.9074	0.9154	1.0140	0.9698	0.9698	0.9805	0.9951	0.9956	0.9904
7	Chapali	0.9440	0.9548	1.0034	0.9724	0.9763	0.9894	0.9669	0.9730	0.9697
8	Hetauda	0.9473	0.9650	1.0140	0.9691	0.9748	0.9953	1.0011	1.0045	0.9897
9	Indrawati	0.9514	0.9742	1.0100	0.9800	0.9800	0.9800	0.9707	0.9773	0.9760
10	K-3	0.9376	0.9569	1.0008	0.9643	0.9708	0.9929	0.9768	0.9816	0.9757
11	Kul-1	0.9777	0.9952	1.0257	0.9856	0.9915	1.0122	0.9992	1.0030	0.9910
12	Lainchaur	0.9450	0.9629	1.0039	0.9699	0.9760	0.9964	0.9924	0.9970	0.9914
13	Newchabil	0.9297	0.9407	0.9982	0.9664	0.9704	0.9837	0.9598	0.9611	0.9626
14	Panchkhal	0.9414	0.9645	1.0062	0.9804	0.9836	0.9947	0.9609	0.9676	0.9663
15	Parwanipur	0.9203	0.9282	1.0222	0.9696	0.9696	0.9800	1.0097	1.0102	0.9902
16	Patan	0.9323	0.9518	0.9960	0.9553	0.9619	0.9840	0.9752	0.9800	0.9740
17	Simara	0.8966	0.9165	0.9862	0.9341	0.9405	0.9631	1.0043	1.0055	0.9861
18	Sunkoshi	0.9408	0.9639	1.0000	0.9812	0.9844	0.9955	0.9641	0.9707	0.9694
19	Switchatar	0.9422	0.9611	1.0039	0.9661	0.9724	0.9941	0.9840	0.9887	0.9828
20	Teku	0.9377	0.9570	1.0008	0.9641	0.9706	0.9926	0.9771	0.9819	0.9760

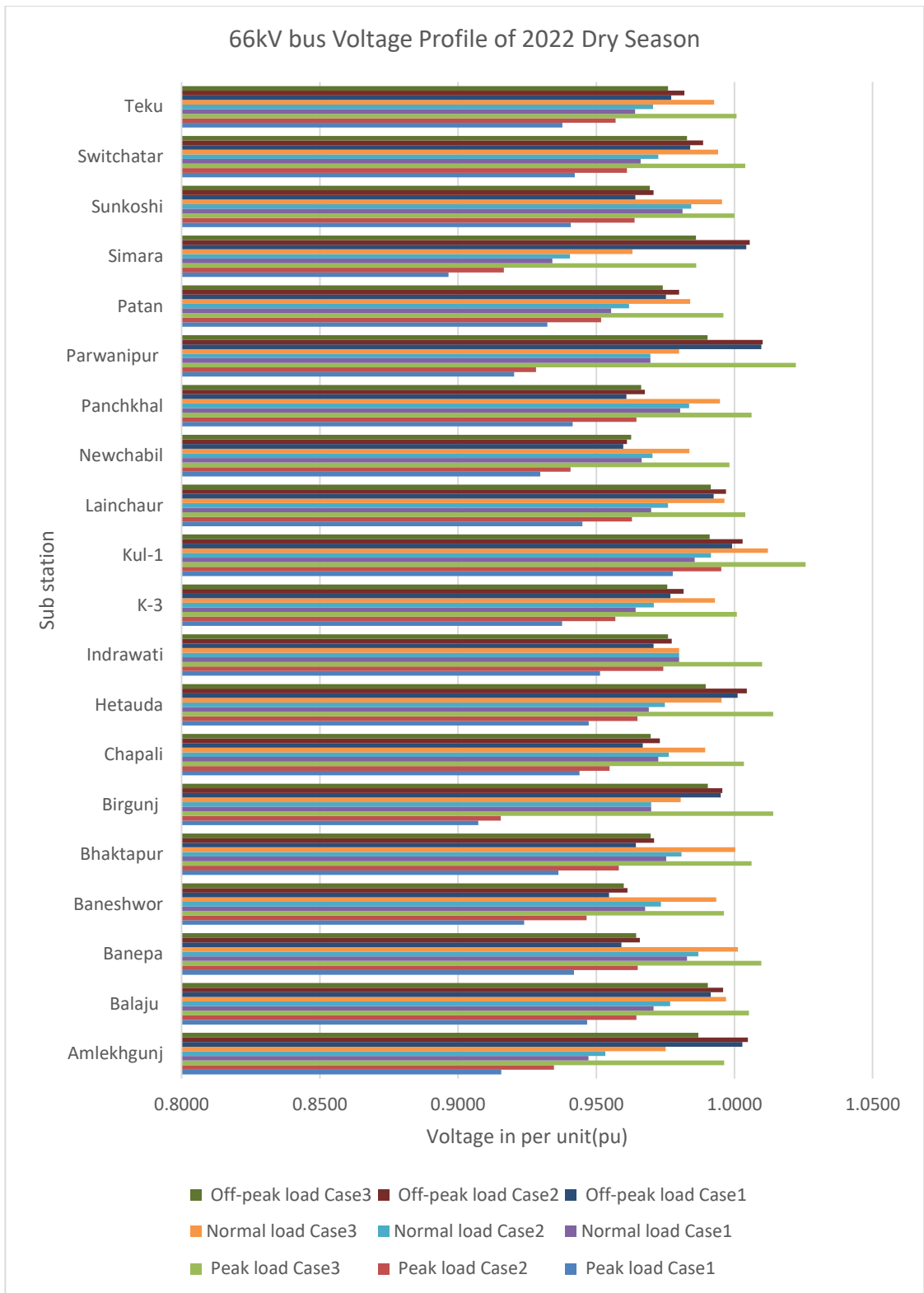


Figure 4. 1: Voltage profile for 66 kV buses of INPS (Vdry)

Table 4. 2 :132 kV Bus Voltage profile of INPS in dry for different load scenario

S.N.	Name of Buses	Peak load			Normal load			Off-peak load		
		Case1	Case2	Case3	Case1	Case2	Case3	Case1	Case2	Case3
1	Butwal	0.9479	0.9994	1.0325	0.9678	0.9797	1.0105	1.0159	1.0137	1.0262
2	Chapur	0.9307	0.9414	1.0026	0.9569	0.9610	0.9778	0.9980	1.0015	0.9821
3	Dana	0.9623	1.0179	1.0465	1.0033	1.0296	1.0333	1.0537	1.0401	1.0405
4	Dhalkebar	0.9946	0.9976	1.0163	1.0012	1.0028	1.0062	1.0116	1.0142	1.0090
5	Gandak	0.9324	0.9613	1.0262	0.9700	0.9700	1.0132	1.0000	1.0000	1.0204
6	Hetauda	0.9365	0.9535	1.0138	0.9614	0.9670	0.9883	0.9983	1.0020	0.9844
7	Kamane	0.9282	0.9432	1.0073	0.9565	0.9611	0.9797	0.9979	1.0010	0.9781
8	kawasoti	0.9342	0.9745	1.0186	0.9643	0.9744	1.0023	1.0000	1.0017	1.0071
9	KGA	0.9836	1.0351	1.0454	0.9846	0.9966	1.0277	1.0263	1.0241	1.0367
10	Kohalpur	0.9505	0.9702	1.0161	0.9734	0.9773	1.0029	1.0013	1.0007	1.0128
11	Kul-2	0.9435	0.9610	1.0179	0.9649	0.9707	0.9921	0.9962	1.0002	0.9871
12	Kushma	0.9592	1.0150	1.0436	0.9995	1.0260	1.0315	1.0477	1.0340	1.0372
13	Lahachok	0.9869	1.0405	1.0530	0.9982	1.0105	1.0426	1.0551	1.0529	1.0582
14	Lekhnath	0.9304	0.9603	1.0286	0.9861	0.9949	1.0101	1.0172	1.0210	1.0093
15	Mahendranagar	0.9499	0.9536	1.0033	1.0055	1.0061	1.0145	1.0200	1.0200	1.0491
16	Mainahiya	0.9449	0.9971	1.0318	0.9613	0.9733	1.0043	1.0160	1.0137	1.0264
17	Marsyangdi	0.9680	0.9959	1.0322	0.9844	0.9925	1.0075	1.0039	1.0077	0.9974
18	Motipur	0.9461	0.9901	1.0164	0.9681	0.9781	1.0003	1.0133	1.0115	1.0188
19	Nabalpur	0.9490	0.9573	1.0036	0.9663	0.9704	0.9853	0.9949	0.9991	0.9905
20	N. Butwal	0.9405	0.9932	1.0345	0.9704	0.9831	1.0225	1.0114	1.0091	1.0283

21	New Modi	0.9879	1.0415	1.0556	0.9995	1.0119	1.0439	1.0561	1.0538	1.0591
22	N.Bharatpur	0.9483	0.9813	1.0241	0.9738	0.9831	1.0036	1.0035	1.0069	1.0020
23	Parwanipur	0.9220	0.9291	1.0129	0.9600	0.9600	0.9696	1.0200	1.0200	0.9745
24	Pathlaiya	0.9268	0.9381	1.0100	0.9582	0.9611	0.9761	1.0068	1.0090	0.9782
25	Pokhara	0.9404	0.9553	1.0282	0.9862	0.9951	1.0104	1.0186	1.0224	1.0107
26	Sandhikharka	0.9420	0.9863	1.0127	0.9649	0.9749	0.9973	1.0113	1.0095	1.0168
27	Shivapur	0.9490	0.9878	1.0119	0.9705	0.9791	0.9979	1.0124	1.0109	1.0164
28	Sunwal	0.9418	0.9940	1.0301	0.9661	0.9784	1.0123	1.0118	1.0095	1.0243
29	Switchatar	0.9394	0.9591	1.0051	0.9630	0.9697	0.9914	0.9865	0.9917	0.9848
30	Syangja	0.9809	1.0339	1.0451	0.9880	1.0004	1.0322	1.0397	1.0375	1.0503

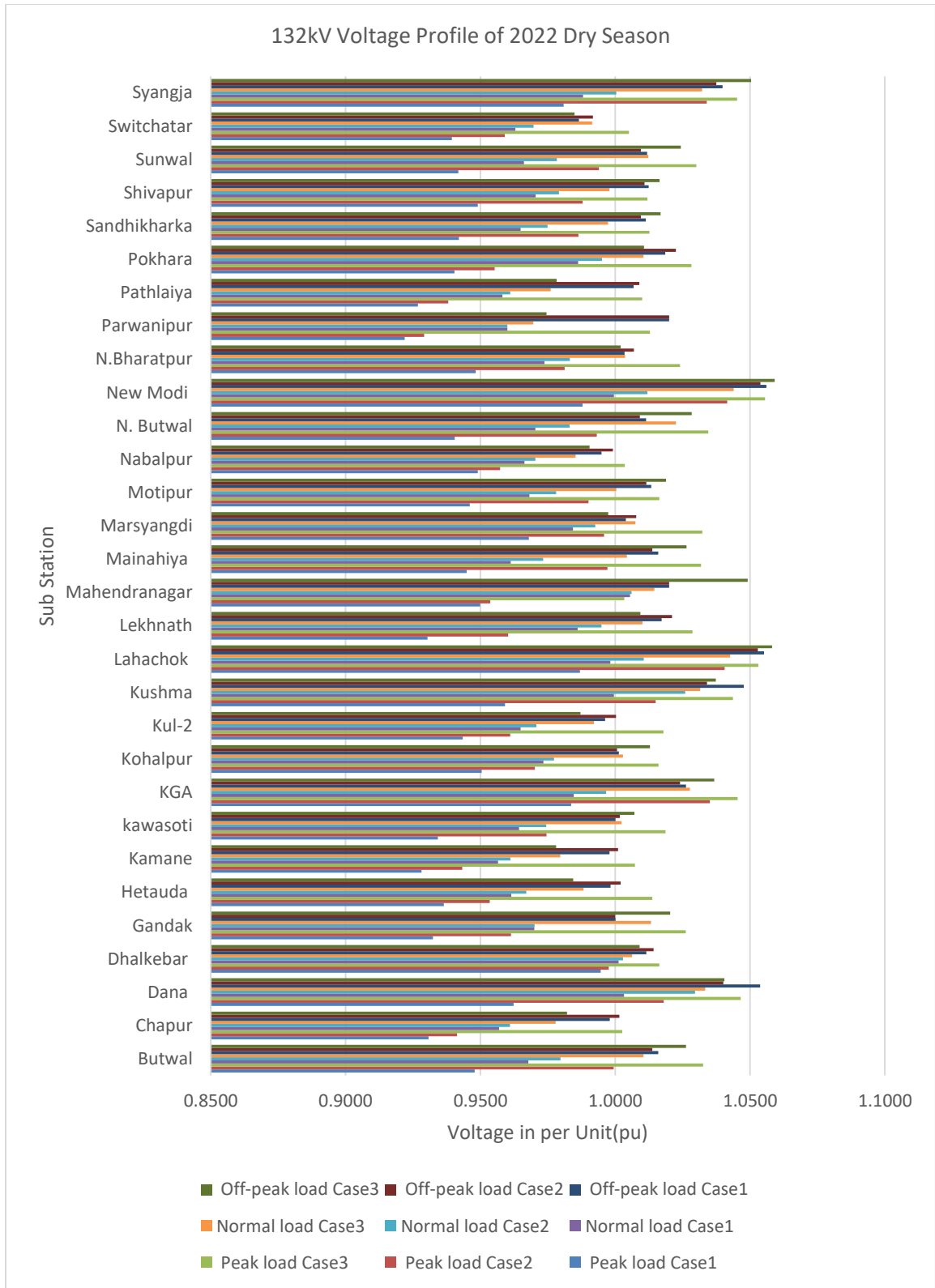


Figure 4. 2 :Voltage profile for 132 kV buses of INPS (Vdry)

4.3 Wet season load operation of INPS

4.3.1.1 Operation of existing INPS at peak load (Case 1)

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at peak load serving of 2000.19 MW and exporting remaining power(353.5W) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation with system loss, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 146.26 MW, equivalent to 5.85%. In our analysis, it was revealed that Birgaunj S/S exhibits the lowest system voltage at 57.79 kV within the 66 kV voltage level, while Parwanipur S/S registers the lowest system voltage at 118.48 kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

These substations are under voltage in wet season since these SS has large load as well as Raxual import is Off. The line loading Dhalke-Nabalpur is 76.43% and Bhaktpur-Lamasanghu is 88.87%. Due to loading of lines causes the voltage drop leads to lower voltage profile in the INPS.

4.3.1.2 Operation of existing INPS at peak load when export via NB-G line (i.e. Case2)

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIg SILENT PowerFactory 15.1.7 operation of existing INPS at peak load serving of 2000.19 MW and exporting remaining power (355.78MW) via Dhalke-Muzaffarpur(D-M) and New Butwal-Gorakhpur lines,330.78MW from D-M line and 25 MW from NB-G line, out of 2500 MW generation for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 144.03MW, equivalent to 5.76%. In our analysis, it was revealed that Birgaunj S/S exhibits the lowest system voltage at 56.28 kV within the 66 kV voltage level, while Parwanipur S/S registers the lowest system voltage at 115.88 kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

In this case the system loss and voltage profile of system is reduced due to over loading of lines Nabalpur-Dhalke upto 120%, Chapur-Nabalpur upto 109% and many others lines are under loading around 90%. Hence we conclude that we couldn't export power to Gorakhpur in this wet season due to balance between generation. The importance of line will be more when the Modi and Marsyangdi corridor power plant will be come in generation in near future. Hence to stop spill energy in future the line is crucial.

4.3.1.3 Operation of existing INPS at peak load when optimal export via NB-G line (i. e. Case3)

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIg SILENT PowerFactory 15.1 operation of existing INPS at peak load serving of 2000.19 MW and exporting remaining power(361.56MW) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 138.24 MW, equivalent to 5.53%. In our analysis, it was revealed that Birgaunj S/S exhibits the lowest system voltage at 60.89 kV within the 66 kV voltage level, while Parwanipur S/S registers the lowest system voltage at 122.83 kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

It is seen from the simulation that 26MW power need to import from NB-G line to meet the load around that area to improve the voltage profile and minimize the loss even in wet season.

4.3.2.1 Operation of existing INPS at Norma Load (Base Case i. e. Case 1):

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at normal load serving of 1799.68 MW and exporting remaining power(550.77W) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation including system loss, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 149.55 MW, equivalent to 5.98%. In our analysis, it was revealed that Birgaunj S/S exhibits the lowest system voltage at 59.48 kV within the 66 kV voltage level,

while Parwanipur S/S registers the lowest system voltage at 120.01kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

These substations are under voltage in wet season since these SS has large load as well as Raxual import is Off. The loaded lines are Bhaktpur-Lamasanghu is 89.41%, Duhabi-Damak 89.77% and Khimti-Dhalke at 102.36%. In normal time most of industrial loads are on operation due to which system faces the low voltage problem specially in sunny days. Due to over loading lines causes the voltage drop ultimately leads to lower voltage profile in the INPS.

4.3.2.2 Operation of existing INPS at Normal load when export via NB-G line (i.e. Case2)

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at normal load serving of 1799.68 MW and exporting remaining power(533.3MW) via Dhalke-Muzaffarpur(D-M) and 25MW exporting via NB-G line, out of 2500 MW generation including system loss, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 142.05 MW, equivalent to 5.68%. In our analysis, it was revealed that Parwanipur S/S exhibits the lowest system voltage at 60.34 kV within the 66 kV voltage level, while Parwanipur S/S registers the lowest system voltage at 121.49kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

In this case loss is reduced by 0.30% as compared to case 1 since the excess power near the New-Butwal area is exported to Gorakhpur.Line loading is also reduced.

4.3.2.3 Operation of existing INPS at Normal load when optimal export via NB-G line (i. e. Case3)

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at normal load serving of 1799.68 MW and exporting remaining power(469.3MW) via Dhalke-Muzaffarpur(D-

M) and optimum power 97MW is exporting via NB-G line, out of 2500 MW generation including system loss. The system's transmission loss is determined to be 134.02 MW, equivalent to 5.36%. In our analysis, it was revealed that Parwanipur S/S exhibits the lowest system voltage at 62.66 kV within the 66 kV voltage level, while Parwanipur S/S registers the lowest system voltage at 124.28kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5. In this case loss is least as compare to case 1 and case 2, so optimum power that can be exported to Gorakhpur is 97MW for this scenario simulation.

In this case there is slight improvement of voltage magnitude and reduction of transmission loss of the system as compared to case 1 and 2 because our major hydro power plants are close to New Butwal SS, which significantly support to supply the excess power. So that movement of power is limited only in the Butwal region and doesnot travel long distances as compared to the aforementioned cases in which excess power has to travel long distance New Butwal to Dhalkebar due to only one available export point.

4.3.3.1 Operation of existing INPS at Off-Peak load (Base Case i. e. Case 1):

Detail single line diagram of existing INPS is drawn (see Annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at Off-Peak load serving of 1600.19 MW and exporting remaining power(731.67MW) via Dhalke-Muzaffarpur(D-M) line out of 2500 MW generation with system loss of 168.14MW, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 168.14 MW, equivalent to 6.73%. In our analysis, it was revealed that Parwanipur S/S exhibits the lowest system voltage at 65.72 kV within the 66 kV voltage level, while Chapur S/S registers the lowest system voltage at 128.08kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

In this case loss is maximum because the excess power in the INPS has to travel longer distance upto only one export point Dhalkebar-Muzaffarpur so many lines such as Bardghat-NewBharatpur-Heatuda-Kamane-Pathlaiya-Chapur-Nabalpur to Dhalkebar, Syuchatar-Balaju, Lamosanghu-NewKhimti-Dhalkebar 220kV lines are well loaded. Not only upgrading the aforementioned lines to higher voltage level to reduce the loss but also

there should be export/import point in western region to reduce the loss significantly. So importance of New Butwal- Gorakhpur line is utmost to improve the voltage profile and reliability of the INPS specifically in the western part of the country.

4.3.3.2 Operation of existing INPS at off- peak load when export via NB-G line (i.e. Case2)

Addition of New Butwal-Gorakhpur cross border transmission line at 400kV in INPS, with 25 MW power export to Gorakhpur (see annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at Off-Peak load serving of 1600.19 MW and exporting remaining power(739.32MW) via Dhalke-Muzaffarpur(D-M) line and 25 MW from NB-G lines, out of 2500 MW generation with system loss of 160.49MW, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 160.49 MW, equivalent to 6.42%. In our analysis, it was revealed that Hetauda S/S exhibits the system voltage at 66.12 kV within the 66 kV voltage level, while Chapur S/S registers the lowest system voltage at 129.13kV within the 132 kV voltage level, as illustrated in tables 4.3, 4.4, and 4.5.

In this case loss is reduced by 0.31% then the case 1, it is clear that as the power exporting is increased from this point then loss can be further reduced which is simulated in case 3.

4.3.3.3 Operation of existing INPS at off-peak load when optimal export via NB-G line (i. e. Case3)

Addition of New Butwal-Gorakhpur cross border transmission line at 400kV in INPS, with optimum power export to Gorakhpur (see annex H). Load flow analysis from DIgSILENT PowerFactory 15.1.7 operation of existing INPS at Off-Peak load serving of 1600.19 MW and exporting remaining power(564.4MW) via Dhalke-Muzaffarpur(D-M) line and 201.7 MW from NB-G lines, out of 2500 MW generation, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 133.73 MW, equivalent to 5.35%. In our analysis, it was revealed that Kul-1 S/S exhibits the system voltage at 66.36 kV within the 66 kV voltage level, while Mainihawa S/S registers the system voltage at 128.73kV within the 132 kV voltage level which is less as compare to others substaion, as illustrated in tables 4.3, 4.4, and 4.5.

In this case loss is reduced by 1.38% then the case 1 and 1.07% then case2, and voltage profile of the overall system is increased, and many generating power plant faces the over voltages problem in Off-peak time so voltage control are necessary for this period. Since the overll voltage profile of the INPS system is in higher range so the power is exported with least loss.

4.3.4 Bus Voltage tables:

Table 4. 3: 66 kV Bus Voltage profile of INPS in wet season for different load scenario

S.N.	Name of Buses	Peak Load			Normal Load			Off-peak Load		
		Case1	Case2	Case3	Case1	Case2	Case3	Case1	Case2	Case3
1	Amlekhgunj	0.9220	0.9172	0.9416	0.9456	0.9514	0.9607	1.0021	1.0057	1.0210
2	Balaju	0.9533	0.9502	0.9704	0.9573	0.9622	0.9695	1.0078	1.0097	1.0172
3	Banepa	0.9547	0.9509	0.9842	0.9521	0.9613	0.9780	1.0184	1.0209	1.0306
4	Baneshwor	0.9369	0.9329	0.9679	0.9440	0.9535	0.9709	1.0037	1.0061	1.0152
5	Bhaktapur	0.9492	0.9454	0.9787	0.9530	0.9622	0.9788	1.0097	1.0122	1.0220
6	Birgunj	0.8755	0.8527	0.9225	0.9013	0.9233	0.9431	0.9973	1.0071	1.0482
7	Chapali	0.9464	0.9444	0.9642	0.9739	0.9788	0.9870	1.0101	1.0119	1.0191
8	Hetauda	0.9506	0.9462	0.9661	0.9587	0.9641	0.9726	1.0013	1.0018	1.0200
9	Indrawati	0.9922	0.9886	1.0207	0.9686	0.9777	0.9942	1.0517	1.0541	1.0187
10	K-3	0.9453	0.9418	0.9638	0.9467	0.9519	0.9596	0.9969	1.0126	1.0636
11	Kul-1	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	1.0250	1.0250	1.0054
12	Lainchaur	0.9510	0.9478	0.9681	0.9538	0.9587	0.9661	1.0069	1.0088	1.0250
13	Newchabil	0.9376	0.9356	0.9568	0.9724	0.9773	0.9858	1.0093	1.0112	1.0163
14	Panchkhal	0.9643	0.9605	0.9935	0.9573	0.9665	0.9831	1.0277	1.0302	1.0187
15	Parwanipur	0.8904	0.8684	0.9301	0.9108	0.9142	0.9494	0.9957	1.0052	1.0399

16	Patan	0.9404	0.9370	0.9589	0.9441	0.9493	0.9570	1.0006	1.0028	1.0448
17	Simara	0.9054	0.9003	0.9283	0.9386	0.9448	0.9546	1.0039	1.0077	1.0114
18	Sunkoshi	0.9787	0.9750	1.0075	0.9728	0.9818	0.9982	1.0432	1.0456	1.0238
19	Switchatar	0.9503	0.9469	0.9683	0.9534	0.9584	0.9660	1.0030	1.0051	1.0551
20	Teku	0.9460	0.9426	0.9644	0.9462	0.9513	0.9590	0.9981	1.0070	1.0129

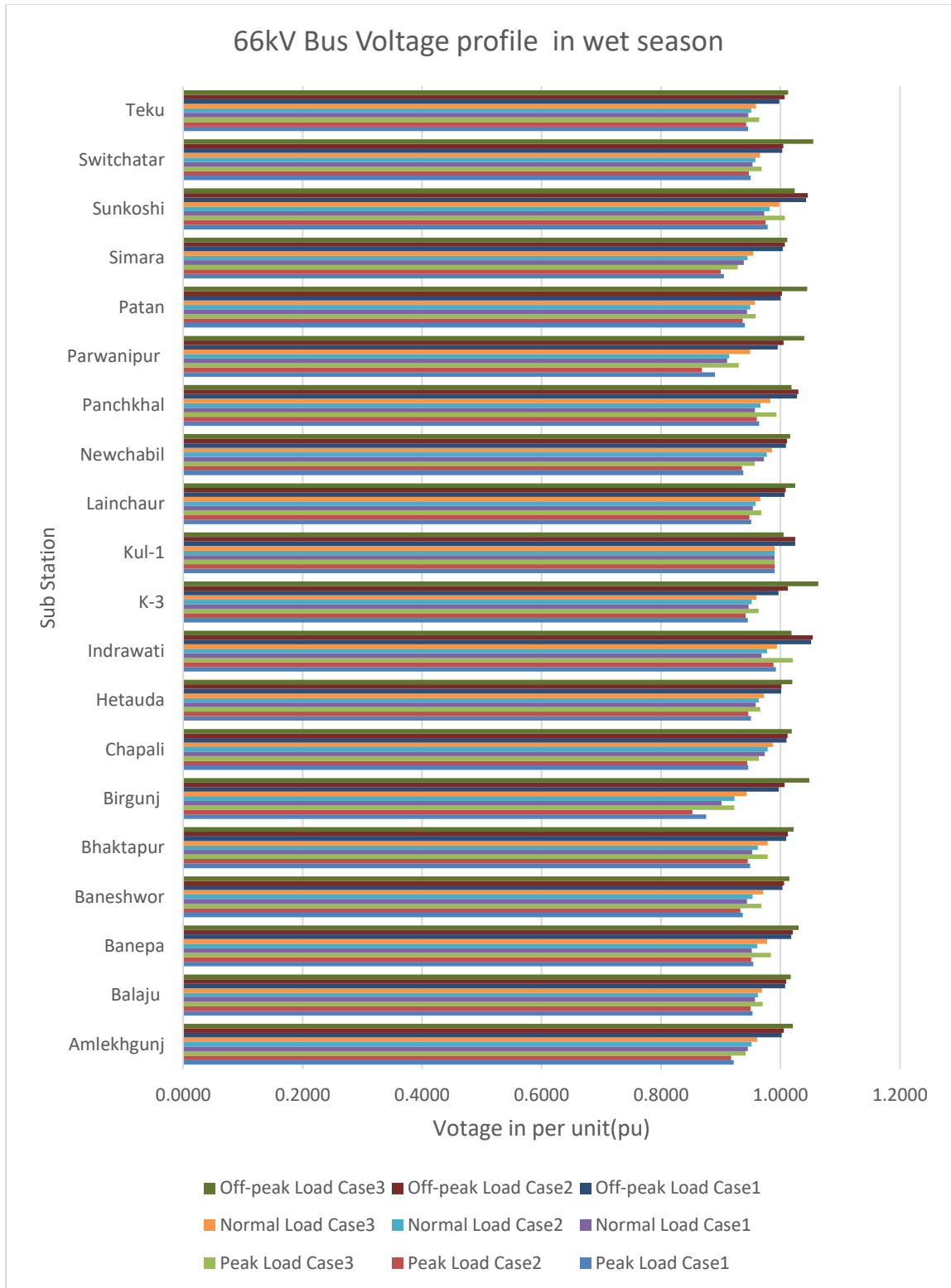


Figure 4. 3: Voltage profile of 66 KV buses of INPS 2023 Wet Season (V wet)

Table 4. 4: 132kV Voltage profile of INPS in wet season for different load scenario

S.N.	Name of Buses	Peak Load			Normal Load			Off-peak Load		
		Case1	Case2	Case3	Case1	Case2	Case3	Case1	Case2	Case3
1	Butwal	0.9433	0.9814	0.9957	0.9432	0.9790	0.9979	0.9886	0.9894	0.9769
2	Chapur	0.9146	0.8907	0.9376	0.9211	0.9294	0.9453	0.9703	0.9782	1.0109
3	Dana 132kV	0.9976	1.0425	1.0496	1.0012	1.0435	1.0454	1.0440	1.0451	1.0420
4	Dhalkebar	0.9651	0.9584	0.9701	0.9608	0.9637	0.9750	0.9896	0.9931	1.0107
5	Gandak	0.9527	0.9866	1.0025	0.9502	0.9826	0.9922	0.9918	0.9932	0.9799
6	Hetauda	0.9289	0.9183	0.9551	0.9362	0.9461	0.9612	0.9822	0.9882	1.0121
7	Kamane	0.9154	0.9027	0.9425	0.9233	0.9336	0.9507	0.9713	0.9783	1.0076
8	kawasoti	0.9579	0.9782	0.9578	0.9610	0.9869	0.9972	0.9980	1.0003	0.9942
9	KGA	0.9815	1.0197	1.0351	0.9712	1.0106	1.0273	1.0270	1.0278	1.0188
10	Kohalpur	0.9371	0.9546	0.9610	0.9628	0.9836	0.9943	0.9921	0.9925	0.9895
11	Kul-2	0.9323	0.9233	0.9581	0.9392	0.9490	0.9639	0.9840	0.9895	1.0119
12	Kushma	0.9895	1.0348	1.0419	0.9949	1.0375	1.0394	1.0382	1.0394	1.0362
13	Lahachok	1.0054	1.0385	1.0558	0.9932	1.0377	1.0443	1.0344	1.0353	1.0371
14	Lekhnath SS	0.9535	0.9589	0.9792	0.9685	0.9799	0.9895	1.0003	1.0012	1.0034
15	Mahendranag	0.9446	0.9535	0.9569	0.9630	0.9802	0.9890	0.9922	0.9923	0.9935
16	Mainahiya SS	0.9345	0.9730	0.9874	0.9402	0.9765	0.9957	0.9871	0.9879	0.9752
17	Marsyangdi	0.9673	0.9720	0.9922	0.9756	0.9867	0.9966	1.0000	1.0000	1.0000
18	Motipur	0.9390	0.9723	0.9847	0.9479	0.9791	0.9956	0.9899	0.9906	0.9803
19	Nabalpur	0.9285	0.9055	0.9441	0.9366	0.9419	0.9536	0.9769	0.9828	1.0063
20	New Butwal	0.9589	0.9969	1.0107	0.9548	0.9887	0.9979	0.9970	0.9978	0.9823
21	New Modi Bu	1.0061	1.0385	1.0558	0.9930	1.0376	1.0433	1.0332	1.0342	1.0360
22	NewBharatpu	0.9517	0.9601	0.9841	0.9574	0.9749	0.9859	0.9890	0.9913	0.9929
23	Parwanipur	0.8976	0.8779	0.9305	0.9092	0.9204	0.9415	0.9739	0.9825	1.0185
24	Pathlaiya	0.9090	0.8907	0.9375	0.9174	0.9278	0.9465	0.9708	0.9789	1.0127
25	Pokhara	0.9517	0.9572	0.9777	0.9675	0.9790	0.9887	1.0002	1.0011	1.0033
26	Sandhikharka	0.9344	0.9679	0.9804	0.9439	0.9753	0.9918	0.9867	0.9873	0.9770
27	shivapur	0.9402	0.9698	0.9808	0.9527	0.9807	0.9954	0.9912	0.9918	0.9830
28	Sunwal	0.9462	0.9844	0.9986	0.9449	0.9801	0.9952	0.9894	0.9902	0.9765
29	Switchatar	0.9434	0.9399	0.9675	0.9512	0.9599	0.9730	0.9943	0.9977	1.0116
30	SyangjaSS	0.9789	1.0165	1.0335	0.9684	1.0124	1.0248	1.0192	1.0202	1.0174

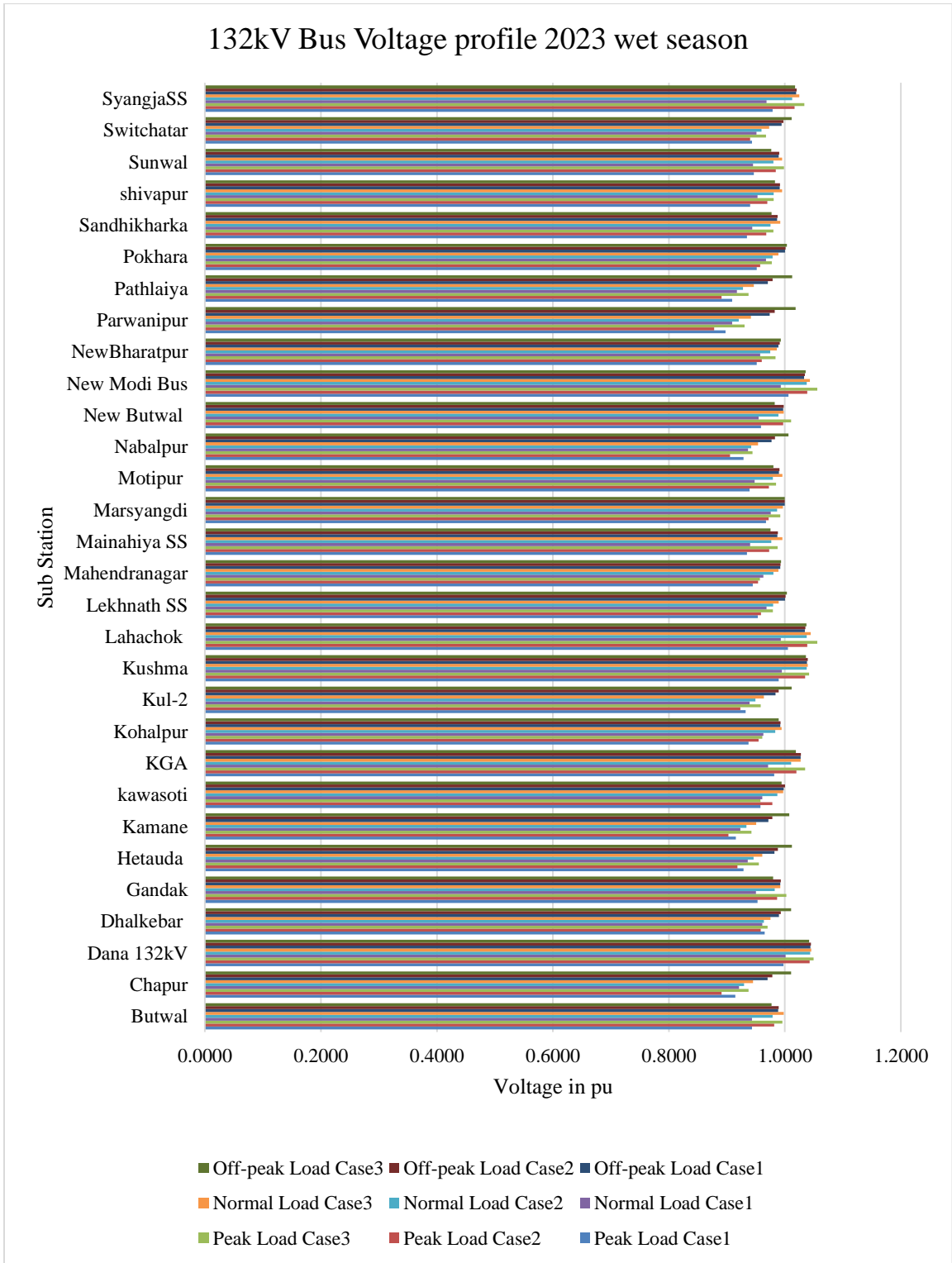


Figure 4. 4 : Voltage profile of 132 KV buses of INPS 2023 Wet season(V wet)

Table 4. 5: Comparison of loss for different mode of load scenario by 2022/2023.

S.N.	Mode of operation: Dry-Season	Generation (MW)	Cases	Total Import (MW)	Tr.Loss (MW)	Tr.Loss (%)	Import D-M	Import NB-G	Import 132kV
1	Peak Load (1900.93MW)	1301.76	Case-1	716.36	117.18	5.81	386.36	0.00	330
2			Case-2	704.05	104.88	5.23	349.05	25.00	330
3			Case-3	696.26	97.09	4.88	328.36	367.90	0.00
4	Normal Load (1599.54MW)	858.73	Case-1	829.66	86.22	5.11	497.03	0.00	330
5			Case-2	817.01	76.2	4.55	462.01	25.00	330
6			Case-3	811.28	70.47	4.22	412.77	398.51	0.00
7	Off-Peak Load (1250.51MW)	559.73	Case-1	751.30	60.59	4.62	421.38	0.00	330
8			Case-2	742.93	52.15	4.00	387.93	25.00	330
9			Case-3	741.84	51.06	3.92	366.64	375.2	0.00
S.N.	Mode of operation: Wet-Season	Generation (MW)	Cases	Total Export (MW)	Tr.Loss (MW)	Tr.Loss (%)	Export D-M	Export NB-G	Export 132kV
1	Peak Load (2000.19MW)	2500	Case-1	353.50	146.26	5.85	353.54	0.00	0.00
2			Case-2	355.78	144.03	5.76	330.78	-25.00	0.00
3			Case-3	361.60	138.24	5.53	387.56	26.00	0.00
4	Normal Load (1799.68MW)	2500	Case-1	550.77	149.55	5.98	550.77	0.00	0.00
5			Case-2	558.27	142.05	5.68	533.27	-25.00	0.00
6			Case-3	566.30	134.02	5.36	469.3	-97.00	0.00
7	Off-Peak Load (1600.19MW)	2500	Case-1	731.67	168.14	6.73	731.67	0.00	0.00
8			Case-2	739.22	160.49	6.42	714.32	-25.00	0.00
9			Case-3	766.00	133.73	5.35	564.38	-201.7	0.00

Above table represents operation summary of 2022 dry season and 2023 wet season cases.

Dry Season cases are:

Peak load cases:

- Operation of Existing INPS at peak load (Base Case I.e. Case 1)
- Operation of INPS at peak load when 25 MW power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at peak load when optimum power 380.9MW import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

Normal load cases:

- Operation of Existing INPS at normal load (Base Case I.e. Case 1)
- Operation of INPS at normal load when 25 MW power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at normal load when optimum power 398.5MW import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

Off-Peak load cases:

- Operation of Existing INPS at off-peak load (Base Case i. e. Case 1)
- Operation of INPS at off-peak load when 25 MW power import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at off-peak load when optimum power 350.6 MW import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

Wet Season cases are:

Peak load cases:

- Operation of Existing INPS at peak load (base Case i.e. Case 1)
- Operation of INPS at peak load when 100MW power export via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at peak load when optimum power 26 MW import via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

Normal load cases:

- Operation of Existing INPS at normal load (base Case i.e. Case 1)
- Operation of INPS at normal load when 25 MW power export via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at normal load when optimum power 97 MW export via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

Off-Peak load cases:

- Operation of Existing INPS at off-peak load (base Case i.e. Case 1)
- Operation of INPS at off-peak load when 25 MW power export via New Butwal-Gorakhpur line(NB-G) (i.e. Case 2)
- Operation of INPS at off-peak load when optimum power 201.7 MW export via New Butwal-Gorakhpur line(NB-G) (i.e. Case 3).

The losses in different cases of operation are summarized in bar chart shown as below.

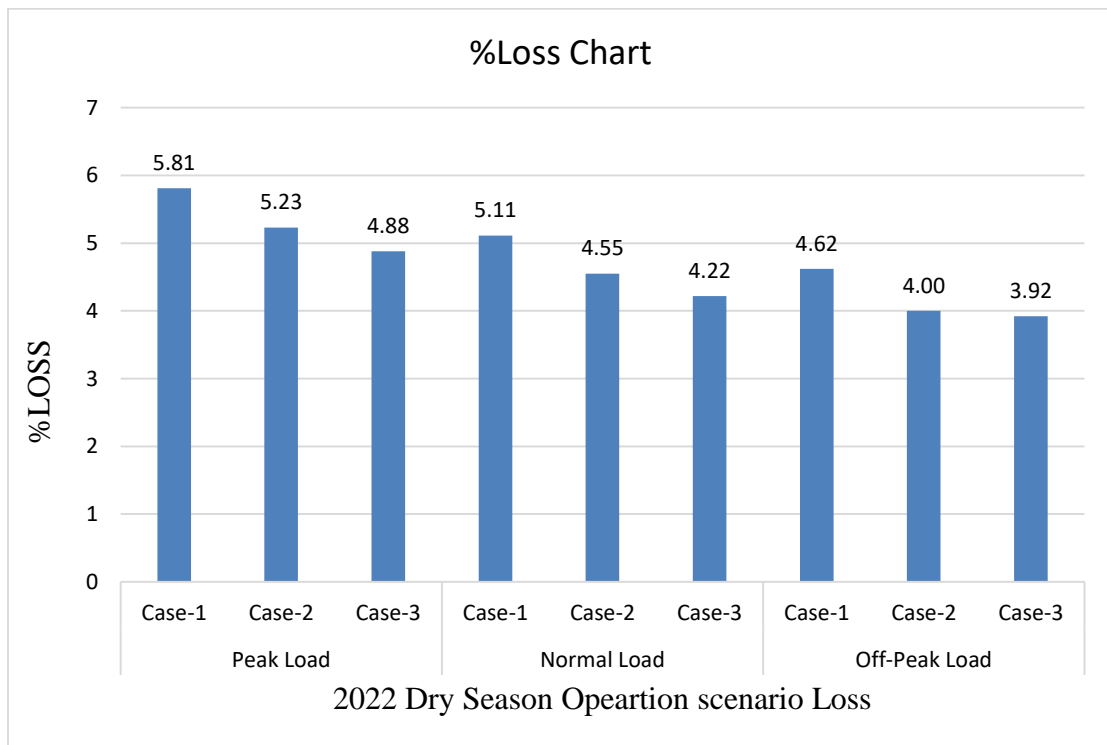


Figure 4. 5 : % Transmission loss for dry season operation of INPS

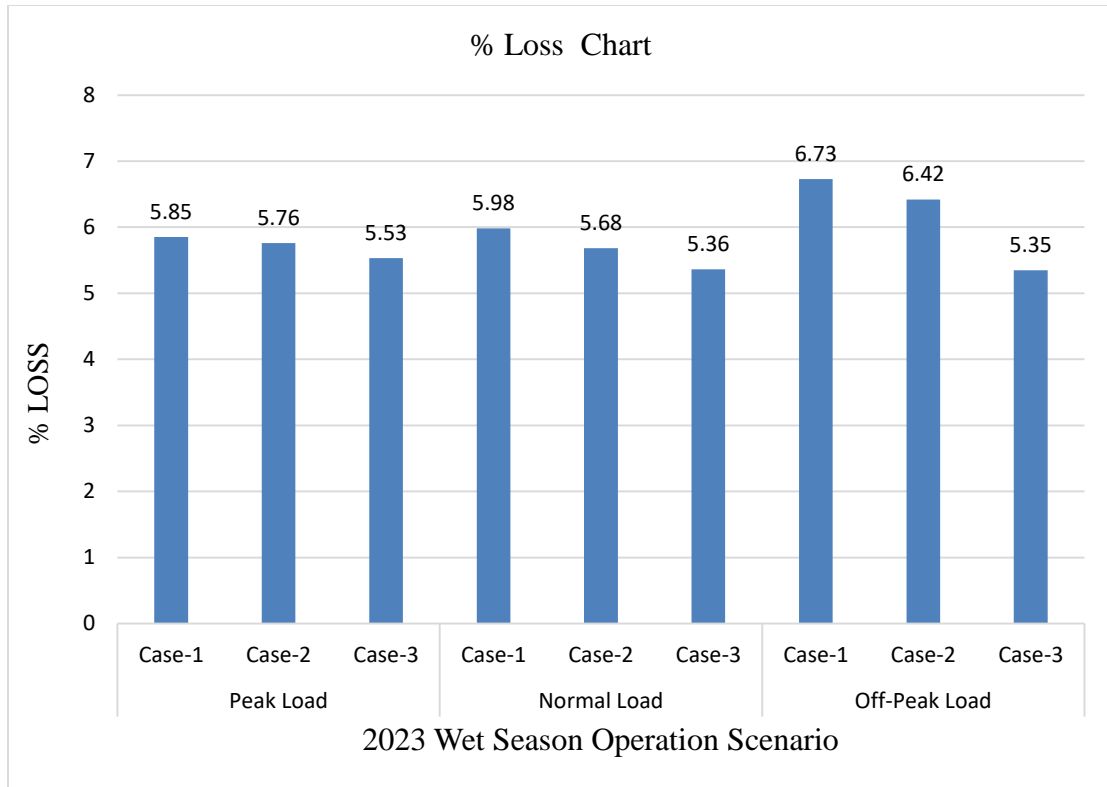


Figure 4. 6: % Transmission loss for wet season operation of INPS.

4.3.5 Modeling of INPS in 2028 A.D.

To facilitate modeling using data acquired from different entities such as the Nepal Electricity Authority, WECS Nepal, and the National Transmission Grid Company, Nepal, the 2028 A.D. Integrated Network Planning System (INPS) was segmented into five zones. This study presents a zonal-based description, and the model diagram is provided in the Appendix.

System Load

The total system load for 2028 A.D. is taken to be around 3500 MW. When export to India is also taken into consideration, the total generation in the year 2028 will come around 10870.4 MW which is shown in table in coming sections. Load for projected years is justified by the following Table 4.6.

Table 4. 6: Projected Load as per NEA

FY	Peak Load (MW)	Peak Load (MW)	Peak Load (MW)
	Previous Forecast	Base Case	Optimistic Case
2013/14	1303.9	1201.0	1201.0
2014/15	1426.4	1286.1	1310.6
2015/16	1542.6	1422.8	1400.5
2016/17	1653.7	1559.7	1561.5
2017/18	1837.1	1742.2	1800.6
2018/19	2018.8	1903.3	2003.5
2019/20	2208.7	2071.5	2220.3
2020/21	2361.0	2203.8	2408.6
2021/22	2523.0	2378.9	2652.6
2022/23	2695.4	2562.1	2744.7
2023/24	2888.1	2764.5	3024.9
2024/25	3109.0	2978.3	3330.1
2025/26	3345.5	3203.0	3661.6
2026/27	3597.6	3439.5	4022.0
2027/28	3866.4	3688.7	4414.5
2028/29	4168.8	3971.7	4866.7
2029/30	4493.2	4280.7	5371.2
2030/31	4841.4	4614.4	5930.4
2031/32	5216.4	4974.9	6550.3
2032/33	5621.8	5364.5	6779.9
2033/34	6200.23	5785.3	7491.8

We can see in the above table, expected load for the year 2022/23 is 2744.7 MW. But present peak load as per the data obtained from System Operation Department, NEA is 2000 MW. I have decided to put a multiplying factor for the 2028 A.D projection.

Multiplying Factor (m.f.) = $2000/2744.7 = 0.73$.

Generating Plants

The total system load for 2028 is taken to be around 3500 MW. When export to India is also taken into consideration, the total generation in the year 2028 would come around 10870 MW which is shown in table in coming sections

Zone-1

In the fifth year, the generating plants added along with the respective buses and connected years forecasted for zone-1 are given in Table 4.7.

Table 4. 7: Generating plants added along with the respective buses and connected years forecasted for zone-1

New Plants	Capacity(MW)	Connection Bus	Year
Chhetigad	85	Balanch	2023
Makari Gad	10	Balanch	2017
Naugadh Gad	8.5	Balanch	2016
Upper Khalangad	38.46	Upper Kalangad	2019
Upper SaniGad	10.7	Upper Kalangad	2019
SaniGad	10.7	Upper Kalangad	2019
Kalanga	15.33	Upper Kalangad	2019
Bajhang U. Seti	80	Bajhang	2017
Tila-1	440	Pulkot	2021
Tila-2	420	Pulkot	2021
Ruru Banchu-1	14	Pulkot	2021
Budi Ganga	20	Dodhara	2021
West Seti	750	West Seti	2025
Upper Karnali	917.8	Mugu Karnali	2025
Ruru Banchu-1	12	Phulkot	2025

Buses of zone-1 used in this model are presented in

Table 4. 8: buses of zone-1 used in proposed model

Bus	Voltage(kV)	Bus	Voltage(kV)
Dodhara	400	Pulkot	400
Kohalpur-N	400	Upper Khalangad	132
West Seti	132	Bajang	132
Balanch	132	West Seti	400
Bajhang	400	Mugu Karnali	400

According to information provided by the pertinent organization, the West Seti 400 kV project is scheduled to be finished in 2025. Within this model, the West Seti 132 kV line is illustrated, establishing a connection to Balanch 132 kV via Upper Khalangad 132 kV, and finally extending to Attariya 132 kV. Moreover, the Pulkot 400 kV project is incorporated into Dodhara 400 kV. As the completion of the Pulkot 400 kV project is anticipated in 2023, it is included in the representation of the model but still in planning phase.

Zone-2

In the year 2028, the generating plants added along with the respective buses and connected years forecasted for zone-2 are given in the Table 4. 9:

Table 4. 10: Generating plants added along with the respective buses and connected years forecasted for zone-2

New Plants	Capacity(MW)	Connection Bus	Year
BheriBabai Diversion	48	Maintada	2023
Nalsyau Gad	121	Nalgad	2024
Thuli Bheri -1	110	Dunai Hub	2028

Buses of zone-2 used in this model are shown in table 4.10

Table 4. 11: Buses of zone-2 used in proposed model

Bus	Voltage(kV)	Bus	Voltage(kV)
Maintada	400	Maintada	132
Dunai	400	Nalgad	400
Jagadulla	400	Bafikot	400

As the New Kohalpur-Nepal side is projected to be commissioned in 2023, it is incorporated into the Integrated Network Planning System (INPS) and connected to Maintada 400 kV. The Maintada 400 kV station in Zone-2 is linked to Pulbari 400 kV in Zone-1, serving as the singular point of connection to the 400 kV network in these regions. To summarize the progress in Zone-1 and Zone-2 thus far, the completed 400 kV bus stations include Phulkot 400 kV, Maintada 400 kV, Pulbari 400 kV, Dodhara 400 kV, and New Kohalpur-Nepal-400 kV.

Zone-3

In the year 2028, the generating plants added along with the respective buses and connected years forecasted for zone-3 are given in Table

Table 4. 12: Generating plants added along with the respective buses and connected years forecasted for zone-3

New Plants	Capacity(MW)	Connection Bus	Year
MistriKhola	42	Dana	2019
NilgiriKhola	38	Dana	2021
KaligandakiKowan	180	Dana	2019
ManangMarsyangdi	282	Manang	2022
Lower M. Mars.	140	Manang	2021

New Plants	Capacity(MW)	Connection Bus	Year
NyadiKhola	30	Khudi	2018
Upper Khudi	26	Khudi	2021
Upper Mars.-1	138	Khudi	2022
Super DordiKha	49.6	Udipur	2020
Upper Dordi A	25	Udipur	2018
DordiKhola	17	Udipur	2018
Upper Daraudi-1	10	New Mars. 220	2017
BadigadKhola	21	Burtibang	2016
Upper Myagdi	20	Dadakhet	2020
DurbangMyagdi	25	Dadakhet	2019
Rahughat	40	Rahughat	2019
RahughatManangle	37	Rahughat	2020
Upper Rahughat	48.5	Rahughat	2019
Upper Modi A	42	New Modi	2019
TanahuSeti	140	New Damauli	2020
Upper Madi	25	Lekhnath	2016
Super Madi	44	Upper Madi	2016
Kaligandaki U	73.9	Rahughat Hub	2025
Myagdi Khola	32	Rahughat Hub	2026
Nyadi Khola Manang	30	Manang	2026
Upper Marsyangdi 1	600	Khudi	2025
Marsyangdi Besi	50	Udipur	2028

New Plants	Capacity(MW)	Connection Bus	Year
Upper Chepe	11	Marsyangdi	2025

Buses of zone-3 used in this model are shown in Table 4.12

Table 4. 13: Buses of zone-3 used in proposed model

Bus	Voltage(kV)	Bus	Voltage(kV)
New Butwal	400	New Damauli	400
Kushma	400	Kushma	220
Damauli	220	AandhiKhola	220
Butwal	220	Bharatpur	220
Lekhnath	220	Upper Madi	220
Rahughat	220	DadaKhet	220
New Mars.	220	Udipur	220
Khudi	220	Manang	220
Dana	220	Burtibang	132
UModi	132		

Given the scheduled completion of Kushma 400 kV and New Butwal 400 kV before 2028, and considering the existence of an additional substation between New Butwal and Kushma, namely New Damauli, it is assumed that New Damauli 400 kV will also be completed before 2028. This assumption is based on the chronological order and proximity of these substations.

Moreover, taking into account the commissioning dates of the generating stations connected to Lekhnath 220 kV and UMadi 220 kV, it is inferred that these substations are expected to be completed before 2028. This consideration aligns with the timeline for the overall development and integration of the electrical infrastructure in the specified regions.

Zone-4

In the year 2028, the generating plants added along with the respective buses and connected years forecasted for zone-4 are given

Table 4. 14: Generating plants added along with the respective buses and connected years forecasted for zone--4

New Plants	Capacity(MW)	Connection Bus	Year
Likhu-4	52.4	Likhu	2020
LikhuKhola A	51	Likhu	2020
Likhu-1	77	Likhu	2020
Likhu-2	55	Likhu	2020
Khimti-II	48.8	New Khimti	2020
Upper Tamakoshi	456	Up Tamakoshi	2018
Khani Khola-1	40	Singati	2016
Khare HPP	24.1	Singati	2017
KhaniKholaDolakha	30	Singati	2020
Tamakoshi V	87	Singati	2022
Lapche Khola	160	Lapche	2027
Upper Lapche Khola	52	Lapche	2027

Buses of zone-4 used in this model are shown in Table 4.15.

Table 4. 15: Buses of zone-4 used in proposed model

Bus	Voltage(kV)	Bus	Voltage(kV)
Ratamate	400	LampsiPhedi	400
Barhabise	400	New Khimti	400
Tamakoshi	220	Barhabise	220
Likhu	132		
Lapche	220	Tingla	400
DudhKoshi	400		

Since Barhabise 400 kV(zone-4) and Butwal 400 kV(zone-3) is schedule to be completed before 2023, the substation connecting these two substation (i.e. Damauli 400 kV(zone-3) and Ratamate 400 kV (zone -4) are scheduled to be completed before 2023 but till now only tender is again published to construct the above lines, so the above lines are expected to completed in 2028.

Zone-5

In the year 2028, the generating plants added along with the respective buses and connected years forecasted for zone-5 are given in Table 4.16.

Table 4. 16: Generating plants added along with the respective buses and connected years forecasted for zone-5

New Plants	Capacity(MW)	Connection Bus	Year
Solu HPP	23.5	Tingla	2017
Lower Solu	82	Tingla	2017
SoluKhola	186	Tingla	2019
Lower Arun	659	Khandbari	2021
Kabeli B1	25	Inaruwa	2018
Kabeli A	37.6	Inaruwa	2016

New Plants	Capacity(MW)	Connection Bus	Year
Apsuwa Khola	50	Arun Hub	2026
Arun 3	300	Arun Hub	2025
Upper Arun HPP	725	Upper Arun Hub	2024
Sankuwa Khola 1	35.34	SitalPati	2026
Tamor Storage	762	New Basantpur	2028
Middle Tamor	54	Hangpang Hub	2027
Tamor Mewa	128	Hangpang Hub	2027
Simbuwa Khola	53.7	Tamor Hub	2026
Ghunsa Khola	78	Tamor Hub	2027
Kabeli 3	22	Duhabi Hub	2026

Buses of zone-5 used in this model are shown in Table 4.17

Table 4. 17: Buses of zone-5 used in proposed model

Bus	Voltage(kV)	Bus	Voltage(kV)
Mirchaiya	400	Arun	400
Inaruwa	400	Damak	400
Arun	220	SitalPati	220
Khadbari	220	Baneshwor	220
New Basantpur	220	Inaruwa	220
Tingla	220	Hangpang	220
Upper Arun	400	Hangpang	400
Tamor	220		

The load flow analysis and assessment of system reliability metrics for INPS during wet season operational periods are conducted. This process yields critical operational parameters, including voltage profiles, transmission losses, and system reliability indicators, for operational scenario.

This situation is evaluated within the context of the country's wet season, characterized by elevated river discharge across most regions. During this period, it is anticipated that all hydropower projects nationwide will operate at their maximum capacity. As of the commencement of the period under consideration for this report (2028), the overall system's power generation capacity is projected to exceed the anticipated load. Consequently, efforts are made to minimize reliance on electricity imports and thermal generation. Furthermore, the potential for exporting electricity to India is expected to be substantial, given the steady expansion of cross-border transmission infrastructure.

Additionally, a load flow analysis was performed for the maximum load instance in the daily load curve. In such circumstances, if the available generation surpasses the load demand, dispatching generators follows a merit order based priority. Specifically, run-of-river hydroelectric projects are presumed to be fully dispatched based on the corresponding available discharge, while storage-type projects are expected to exhibit flexible generation within their maximum generating capability.

Scenario 1: Wet season - Maximum Load (Wet-Max Load) When New Butwal-Gorakhpur line has not operation i.e. export via NB-G = 0.

The single-line diagram for the proposed INPS has been created (refer to Annex). In this simulation Attariya-Bareli bus is Slack bus(SL) and Dhalkebar-Muzzaffarpur(D-M) is assigned as PQ bus. A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a maximum load of 3500 MW and exporting remaining power(2200.34MW) via Dhalke-Muzaffarpur(D-M) and 3500MW via Attariya-Bareli line out of 9565.95 MW generation with system loss, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 331.93 MW, equivalent to 3.47 %. This information is summarized in annex.

Table 4. 18: Higher Bus Voltages of INPS in 2028 wet season Scenario

Bus Name	Voltage[V] in p.u.
Attariya	1.099998
indrawati	1.099892
Mahendranagar	1.095551
banepa	1.094413
panchkhal	1.092387
sunkoshi	1.091783
Balanch	1.08
lapche	1.054653
Manang220	1.054647
NewBasantpur	1.054587

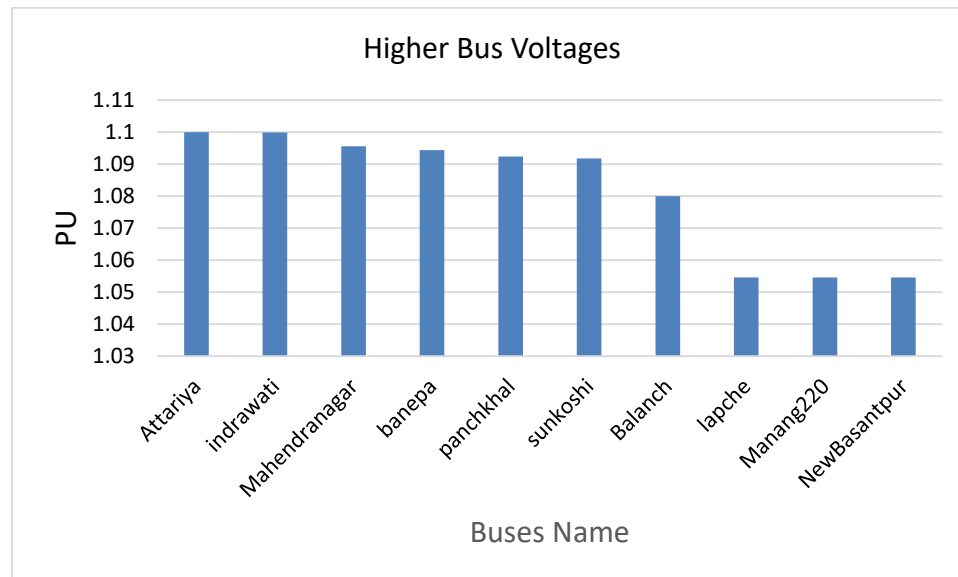


Figure 4. 7: Higher Bus Voltages of INPS in 2028 Wet Scenario

Table 4. 19: Lower Bus Voltages of INPS in 2028 wet season Scenario

Bus Name	Voltage[V] in p.u.
Jhimruk	0.9251698
k-3	0.9264094
Lamosanghu	0.9279881
bhotekoshi	0.9289405

Lamahi	0.9290576
teku	0.9292222
Duhabi	0.9309319
bhaktapur132	0.938787
changunarayan	0.9397761
chapali132	0.9419569

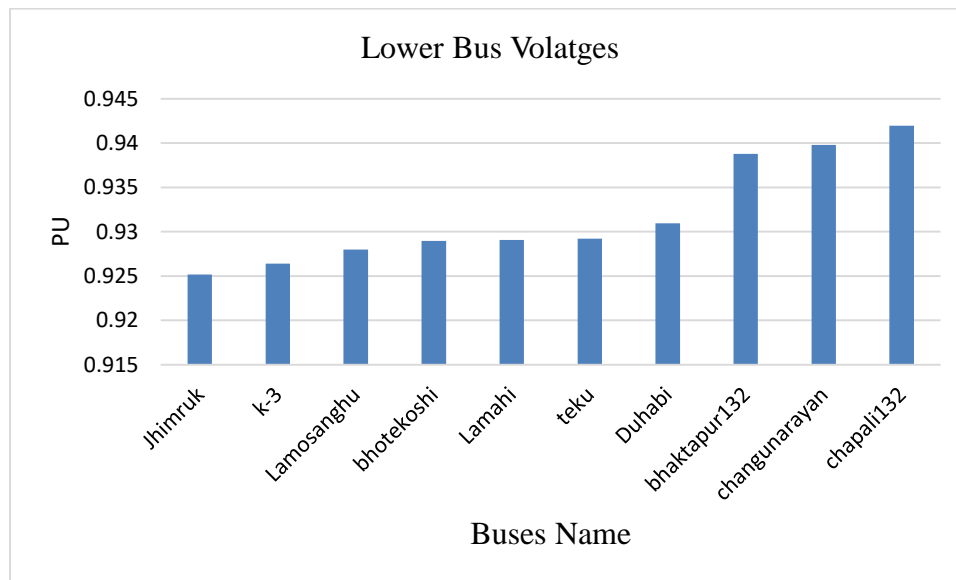


Figure 4. 8 : Lower Bus Voltages of INPS in 2028 Wet season Scenario

Scenario 2: Wet season - Maximum Load (Wet-Max Load) When exporting optimized power via. New Butwal-Gorakhpur(NB-G) line.

The single-line diagram for the proposed INPS has been created (refer to Annex). In this simulation Attariya-Bareli is PQ bus and Dhalkebar-Muzzaffarpur(D-M) is also assigned as PQ bus and New Butwal-Gorakhpur is treated as Slack Bus(SL). A load flow analysis was conducted using DIgSILENT, focusing on a scenario in which the system serves a maximum load of 3500 MW and exporting remaining power 7047.03MW: via. Attariya-

Bareli (A-B) is 2623MW and via. Dhalke-Muzaffarpur(D-M) is 2197MW and via. New Butwal-Gorakhpur is 2227.03MW, out of 10780.40 MW generation with system loss, for evaluating the voltage profile, transmission loss and reliability indices of the INPS. The system's transmission loss is determined to be 323.37 MW, equivalent to 2.97 %. This information is summarized in table 4.22.

Table 4. 20: Higher Bus Voltages of INPS in 2028 in wet season Scenario

Bus Name	Voltage[V] in Per Unit
indrawati	1.099904
Attariya	1.099599
Mahendranagar	1.095148
sunkoshi	1.093231
banepa	1.09205
panchkhal	1.091395
Phalampur	1.081136
Balanch	1.08
Lumki	1.06494
Upper Khalangad	1.064652

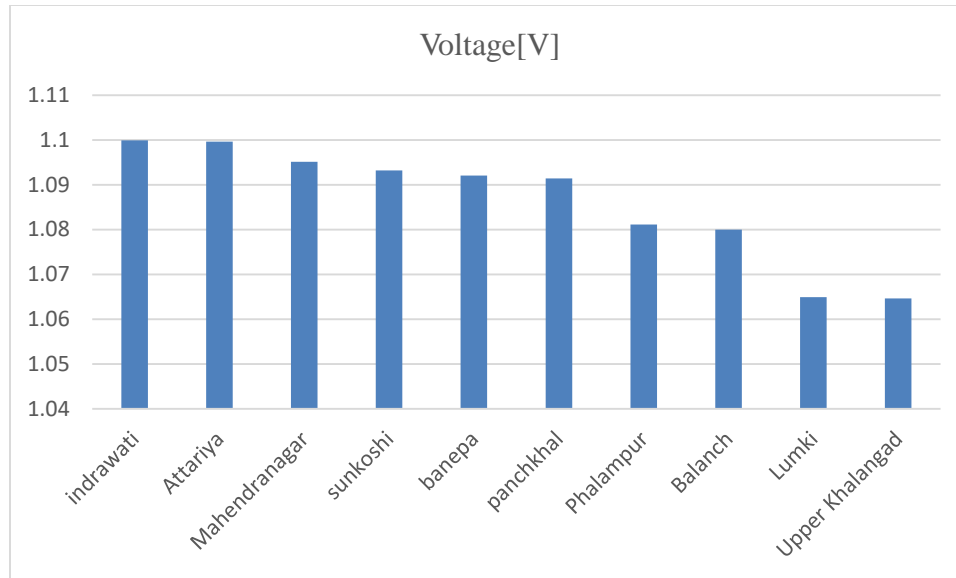


Figure 4. 9 : Higher Bus Voltages of INPS in 2028 in wet season Scenario

Table 4. 21: Higher Bus Voltage Profile of INPS in 2028 in wet season Scenario

Bus Name	Voltage[V] in Per Unit
Lamosanghu	0.9096203
bhotekoshi	0.9106
likhu132	0.920737
k-3	0.9226673
Khimti132	0.924005
teku	0.9254995
bhaktapur132	0.9299556
changunarayan	0.9317075
Duhabi	0.9319692
chapali132	0.9356148

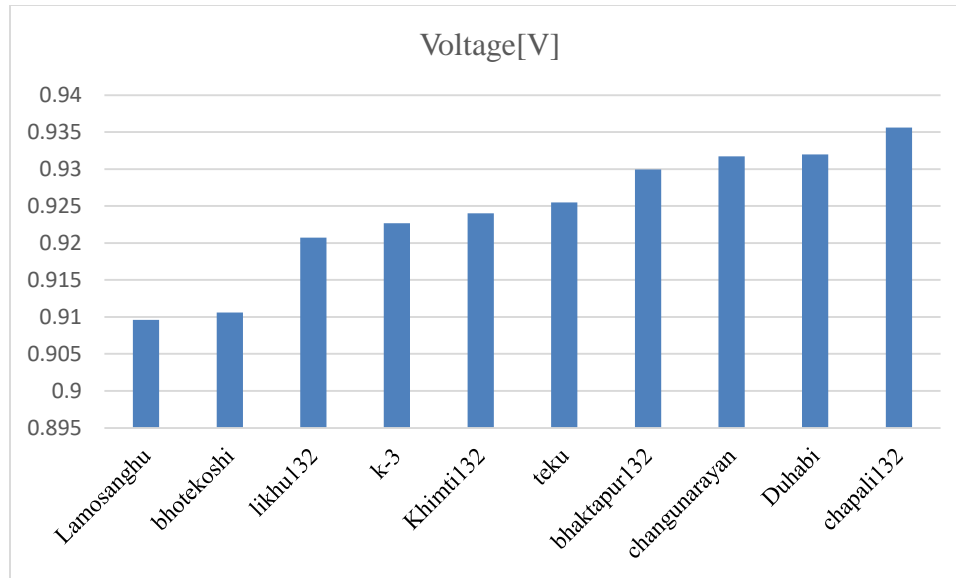


Figure 4. 10 :Lower Bus Voltages of INPS in 2028 in wet season Scenario

Table 4. 22:Summary of mode of operation scenario by 2028

S.N.	1	2
Mode of operation: Wet-Season	When NB-G Not Available	When NB-G Available
Generation (MW)	9565.95	10870.40
Surplus Power Spill (MW)	1302.94	0.00
Load (MW)	3500.00	3500.00
Total Export (MW)	5734.02	7047.03
Tr.Loss (MW)	331.93	323.37
Tr.Loss (%)	3.47	2.97
Export A-B (MW)	3500.00	2623.00
Export D-M (MW)	2200.34	2197.00
Export NB-G (MW)	0.00	2227.03

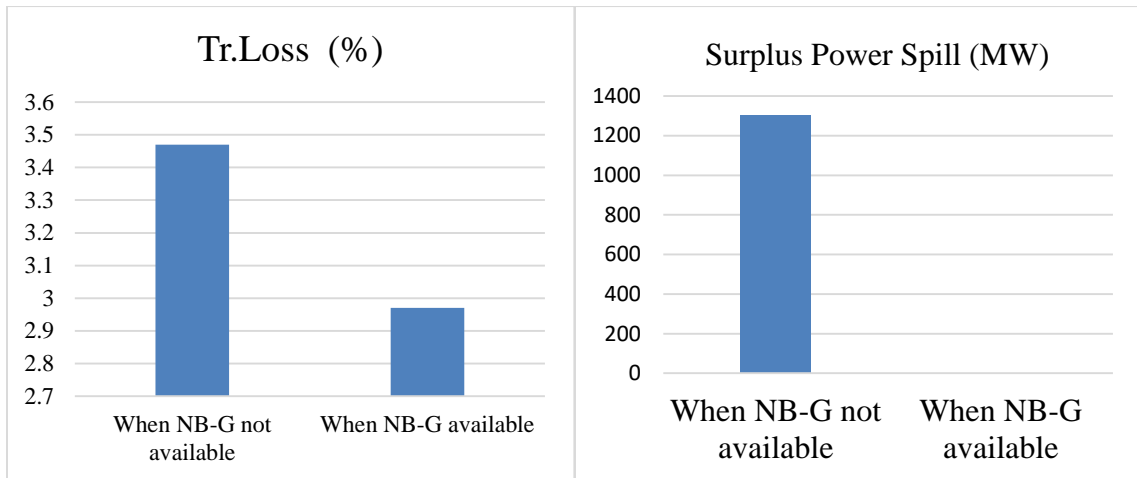


Figure 4. 11.:%Transmission loss in 2028 scenario Figure 4. 12 : Bar chart representation power spill

In the absence of the New Butwal-Gorakhpur line, the power system exhibits a surplus power spill of 1302.94 MW, accompanied by a system loss of 331.93 MW, equivalent to 3.47% of the total power generated. This indicates an inefficiency in power utilization and a notable loss in the system.

However, with the introduction of the New Butwal-Gorakhpur line in Scenario 2, a remarkable transformation is observed. The surplus power spill is completely mitigated, reaching zero, and the system loss experiences a significant reduction to 323.37 MW, corresponding to a mere 2.97% of the total power generated. This represents a noteworthy enhancement in system efficiency.

The reduction in system loss from 3.47% to 2.97% signifies a tangible improvement, specifically a decrease of 0.4%. This improvement not only contributes to enhanced energy utilization but also reflects a more optimized and resilient power system.

Furthermore, it is noteworthy that throughout these scenarios, line loading and bus voltages consistently remain within the specified limits. This suggests that the system enhancements brought about by the New Butwal-Gorakhpur line do not compromise the stability or safety of the power infrastructure.

For a more detailed understanding of the simulation results, the relevant output data from the DIgSILENT simulation is provided and attached separately, offering insights into the specific parameters and performance metrics. Relevant output results from DIgSILENT simulation are attached here.

Grid: Grid		Summary					
No. of Substations	0	No. of Busbars	139	No. of Terminals	0	No. of Lines	244
No. of 2-w Trfs.	31	No. of 3-w Trfs.	0	No. of syn. Machines	145	No. of asyn.Machines	0
No. of Loads	60	No. of Shunts	36	No. of SVS	0		
Generation	= 9565.95 MW	-761.77 Mvar		9596.23 MVA			
External Infeed	= -5734.02 MW	1055.79 Mvar		5830.41 MVA			
Inter Grid Flow	= 0.00 MW	0.00 Mvar					
Load P(U)	= 3500.00 MW	805.82 Mvar		3591.57 MVA			
Load P(Un)	= 3500.00 MW	805.82 Mvar		3591.57 MVA			
Load P(Un-U)	= 0.00 MW	0.00 Mvar					
Motor Load	= 0.00 MW	0.00 Mvar		0.00 MVA			
Grid Losses	= 331.93 MW	213.78 Mvar					
Line Charging	=	-3132.86 Mvar					
Compensation ind.	=	403.90 Mvar					
Compensation cap.	=	-1129.49 Mvar					
Installed Capacity	= 10965.86 MW						
Spinning Reserve	= 1302.94 MW						
Total Power Factor:							
Generation	= 1.00 [-]						
Load/Motor	= 0.97 / 0.00 [-]						

Grid: Grid		Summary					
No. of Substations	0	No. of Busbars	139	No. of Terminals	0	No. of Lines	244
No. of 2-w Trfs.	31	No. of 3-w Trfs.	0	No. of syn. Machines	145	No. of asyn.Machines	0
No. of Loads	60	No. of Shunts	36	No. of SVS	0		
Generation	= 10870.40 MW	403.57 Mvar		10877.89 MVA			
External Infeed	= -7047.03 MW	-387.18 Mvar		7057.65 MVA			
Inter Grid Flow	= 0.00 MW	0.00 Mvar					
Load P(U)	= 3500.00 MW	805.82 Mvar		3591.57 MVA			
Load P(Un)	= 3500.00 MW	805.82 Mvar		3591.57 MVA			
Load P(Un-U)	= 0.00 MW	0.00 Mvar					
Motor Load	= 0.00 MW	0.00 Mvar		0.00 MVA			
Grid Losses	= 323.37 MW	-3.19 Mvar					
Line Charging	=	-3226.51 Mvar					
Compensation ind.	=	348.94 Mvar					
Compensation cap.	=	-1135.20 Mvar					
Installed Capacity	= 10965.86 MW						
Spinning Reserve	= -1.50 MW						
Total Power Factor:							
Generation	= 1.00 [-]						
Load/Motor	= 0.97 / 0.00 [-]						

4.4 Evaluation of Reliability indices of INPS:

From the load flow analysis data, Evaluation of reliability indices of Integrated Nepal Power System (INPS) viz. expected power not served (EPNS), expected energy not served (EENS), and cost of energy due to outage (ECOST) at different operating cases are calculated (see annex A).

Calculation of EENS_{p.u} and EIR_{p.u}.

For Dry season operation:

$$EENS_{pu} = \frac{\text{Expected Energy Not Served (EENS)}}{\text{Total Energy Demanded (TED)}}$$

$$\text{Energy Index of Reliability (EIR)} = 1 - EENS_{p,u}$$

Table 4. 23: EENS, EENS_{p,u}. and EIR_{p,u} for 2022 dry season different cases.

S.N.	Mode of operation : Dry-Season	Load (MW)	Cases	EENS (MWhr)	EENS _{p,u}	EIR = 1-EENS p.u
1	Peak Load	1900.93	Case-1	22810.74	0.00136984	0.99863016
2			Case-2	19989.02	0.00120039	0.99879961
3			Case-3	17890.00	0.00107434	0.99892566
4	Normal Load	1599.54	Case-1	20445.03	0.00145911	0.99854089
5			Case-2	19358.18	0.00138155	0.99861845
6			Case-3	18458.19	0.00131732	0.99868268
7	Off-Peak Load	1250.51	Case-1	17570.76	0.00160398	0.99839602
8			Case-2	16474.37	0.00150390	0.99849610
9			Case-3	15400.76	0.00140589	0.99859411

A Table 4.22 illustrates key reliability indices—EENS (Expected Energy Not Supplied), EENS_{p,u} (Expected Energy Not Supplied per unit), and EIR_{p,u} (Energy Index of Reliability per unit) for dry season operations under various load conditions. During the dry season, with a peak load of 1900.93 MW, power is sourced from dispersed 132kV import points to meet the demand. However, since power is imported through multiple lines at low voltage, the probability of line failures is elevated, consequently increasing the Expected Energy Not Supplied.

In both Case 1 and Case 2, where power is imported from numerous lines at low voltage, the EENS values are higher compared to Case 3. This observation is attributed to the increased likelihood of line failures in scenarios involving power importation at lower voltages.

An interesting correlation is observed between EENSp.u and EIRp.u. When Expected Energy Not Supplied per unit (EENSp.u) is high, the Energy Index of Reliability per unit (EIRp.u) tends to be low, as indicated in the above table. This suggests a trade-off between the expected energy not supplied and the energy index of reliability, emphasizing the importance of balancing these reliability indices for effective system operation. In summary, the analysis underscores the impact of power importation from scattered 132kV import points during the dry season, emphasizing the trade-offs and challenges associated with reliability indices, particularly EENS, EENSp.u, and EIRp.u.

Normal load: During normal time the load in the system is 1599.54MW, to meet this load, import has taken from scattered import points for cases 1 and 2 in which the EENSp.u is greater than the case 3. Energy index reliability (EIRpu) of case 3 is higher than case 1 and 2. From this we can say that taking import from Gorakhpur via NB 400kV line is better than the import taking from the various points.

Off-Peak load: From the above table, it is seen that EENS is less in case 3 than the case 1 and 2, so the case 3 is better than case 1 and case 2 i.e. it is better to import from higher voltage as the chances of failure of lines are low due to which EENS is low as the EENS is low the Energy Index of Reliability is high which is better for system reliability.

From the above cases, it is clear that import from Gorakhpur via NB-G 400kV transmission line is best in dry seasons.

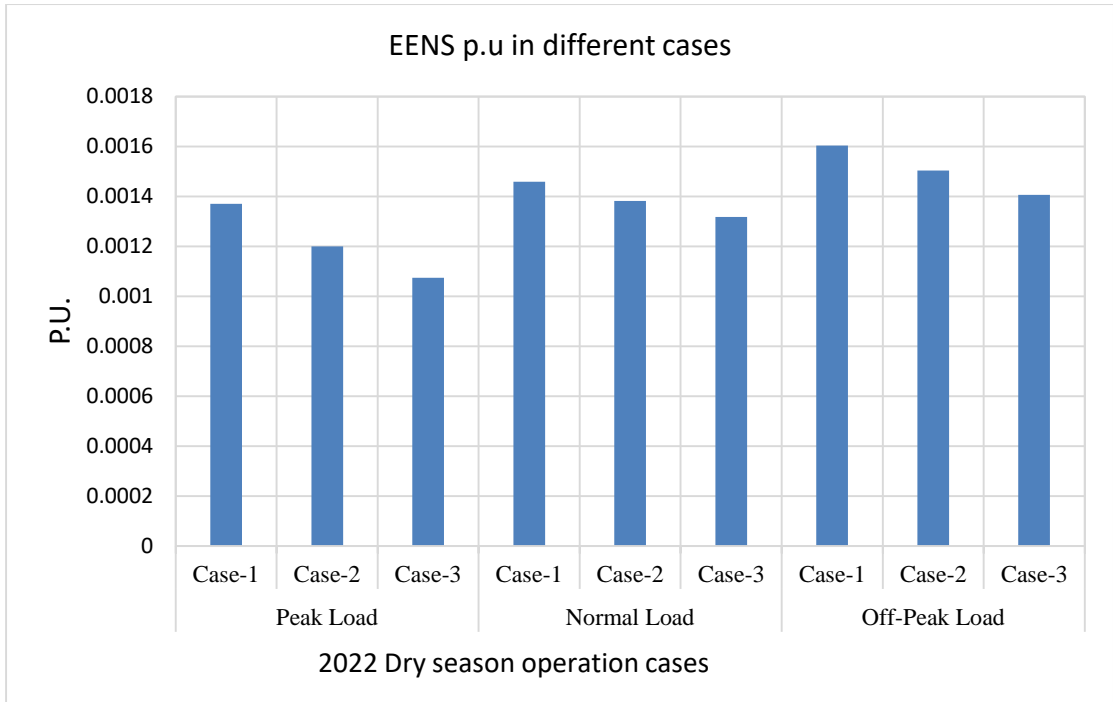


Figure 4. 13: EENS_{p.u.} for 2022 dry season operation of INPS.

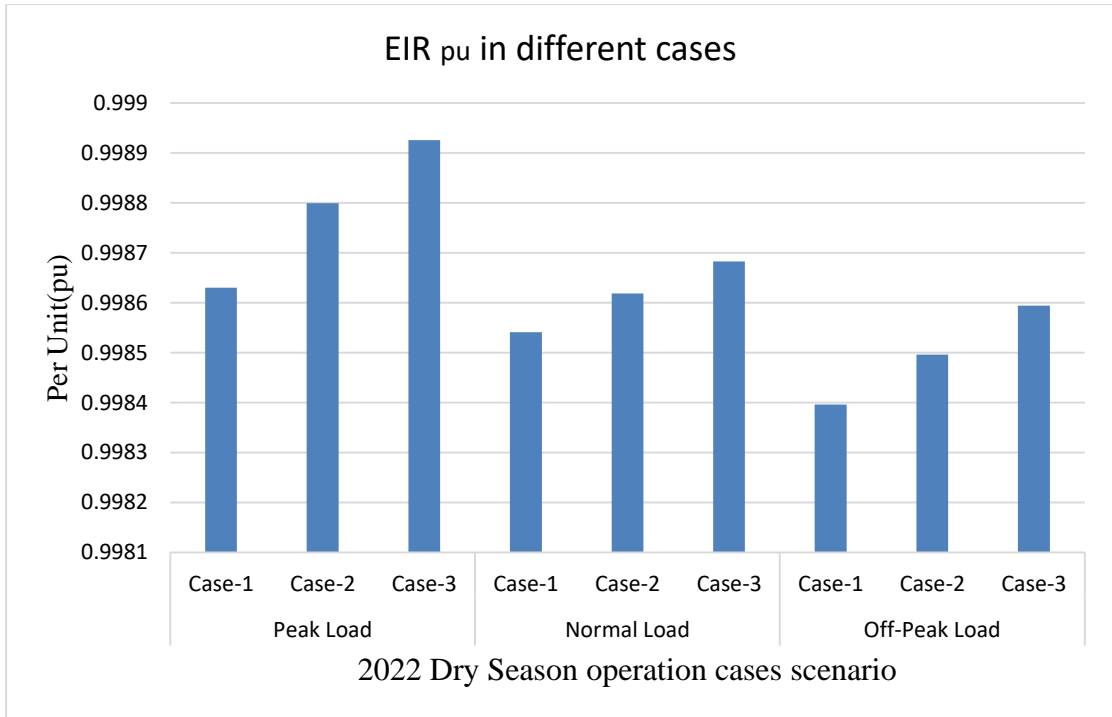


Figure 4. 14: EIRp.u. for 2022 dry season operation of INPS.

Table 4. 24: ECOST for 2022 dry season operation of INPS.

Type of Load	No. Cases	Dry Season Cases of Operation	ECOST (Nrs)in million
Peak Load	1	Operation of existing INPS at peak load (Base case)	1520.11
	2	Operation of existing INPS at peak load when import via NB-G line (25MW)	1332.06
	3	Operation of existing INPS at peak load when optimal import via NB-G line(380.9MW)	1192.18
Normal Load	1	Operation of existing INPS at normal load (Base case)	1362.45
	2	Operation of existing INPS at normal load when import via NB-G line (25MW)	1290.02
	3	Operation of existing INPS at normal load when optimal import via NB-G line(398.5MW)	1230.05

Off-Peak Load	1	Operation of existing INPS at Off-Peak load (Base case)	1170.91
	2	Operation of existing INPS at Off-Peak load when import via NB-G line (25MW)	1097.85
	3	Operation of existing INPS at Off-Peak load when optimal import via NB-G line(350.6MW)	1026.30

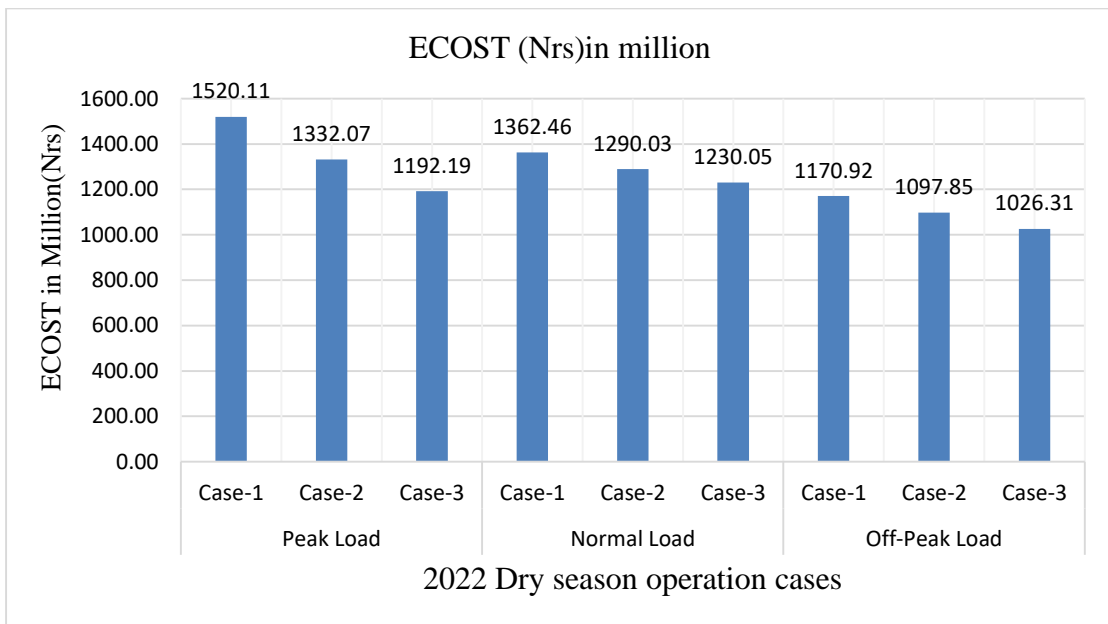


Figure 4. 15: ECOST for 2022 dry season operation cases of INPS.

Figure 4.15 provides a visual representation of the Expected Cost of Energy Not Served (ECOST) during dry season operations. Upon integrating power sourced from Gorakhpur through the NB-G 400kV transmission line into the pre-existing INPS system, a noteworthy reduction in ECOST is observed across all operational scenarios compared to the baseline setup. This reduction in ECOST is primarily attributed to the enhanced power supply facilitated by the NB-G transmission line from Gorakhpur. Consequently, this decline in ECOST signifies a significant financial achievement for the system, thereby bolstering the system's capacity to attract increased investments for further development in the transmission infrastructure.

For Wet Season operation:

$$EENS_{pu} = \frac{\text{Expected Energy Not Served (EENS)}}{\text{Total Energy Demanded (TED)}}$$

$$\text{Energy Index of Reliability (EIR)}_{pu} = 1 - EENS_{pu}$$

Table 4. 25: EENS, EENS_{p.u.} and EIR_{p.u.} for 2023 wet season different cases.

S.N.	Mode of operation: WetSeason	Load (MW)	Cases	EENS (MWhr)	EENS p.u	EIR = 1EENS p.u
1	Peak Load	2000.19	Case1	32252.97	0.001840748	0.998159252
2			Case-2	29696.98	0.001694872	0.998305128
3			Case-3	27629.4412	0.001576873	0.998423127
4	Normal Load	1799.68	Case-1	31795.42	0.002016811	0.997983189
5			Case-2	30674.91	0.001945736	0.998054264
6			Case-3	28471.50	0.001805972	0.998194028
7	Off-Peak Load	1600.19	Case-1	33938.27	0.002421107	0.997578893
8			Case-2	33209.00	0.002369083	0.997630917
9			Case-3	30188.97	0.002153637	0.997846363

Table 4.25 presents crucial reliability metrics for the Integrated Nepal Power System (INPS) specifically during the wet season. The focus is on three key indices: EENS (Expected Energy Not Supplied), EENS_{p.u.} (Expected Energy Not Supplied per unit), and EIR_{p.u.} (Energy Index of Reliability). A noteworthy trend is observed in Case 3, where there is a notable increase in the importation of power from Gorakhpur through

the New Butwal-Gorakhpur 400kV line. In this scenario, EENS is consistently lower when compared to Cases 1 and 2 across all load conditions. This reduction in Expected Energy Not Supplied indicates an enhanced level of reliability in the power system, suggesting that the increased importation of power from Gorakhpur contributes positively to meeting the demand during the wet season.

The rise in EIRp.u, the Energy Index of Reliability per unit, is linked to a simultaneous decrease in EENS p.u, Expected Energy Not Supplied per unit. This shift implies a favorable outcome – as the system imports more power from Gorakhpur, Energy Index of Reliability per unit improves due to a decrease in the expected energy not supplied per unit. This signifies a more efficient and reliable system operation.

In summary, the data in Table 4.24 underscores the advantageous impact of augmenting power importation from Gorakhpur via the New Butwal-Gorakhpur 400kV line during the wet season. This strategic approach contributes to a more reliable power system by reducing the expected energy not supplied and concurrently improving the energy index of reliability per unit.

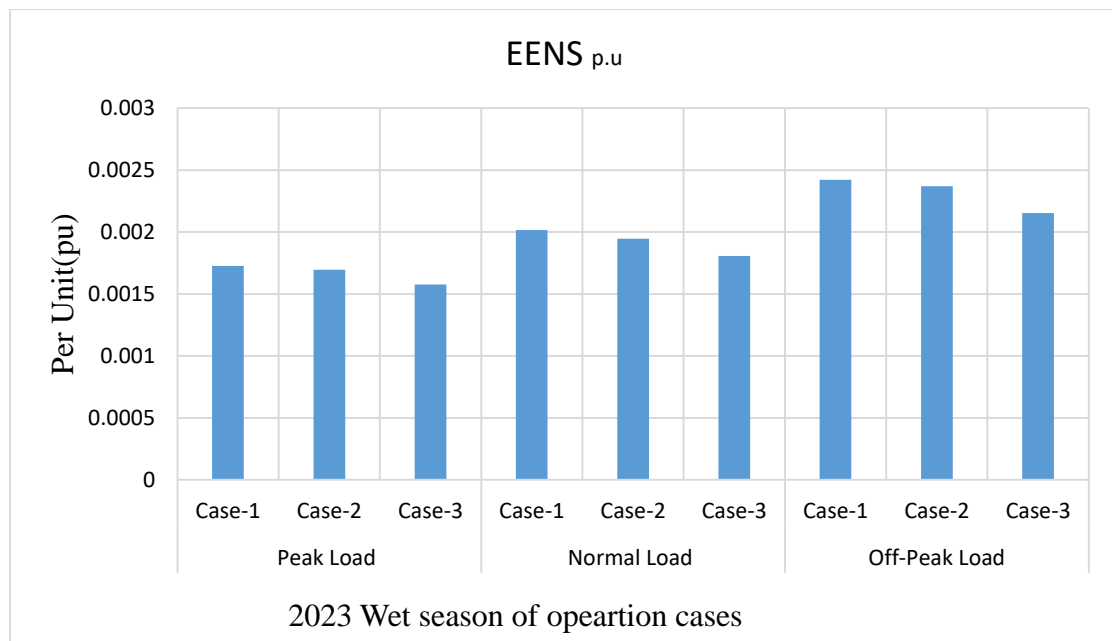


Figure 4. 16 : EENS p.u for wet peak operation of INPS.

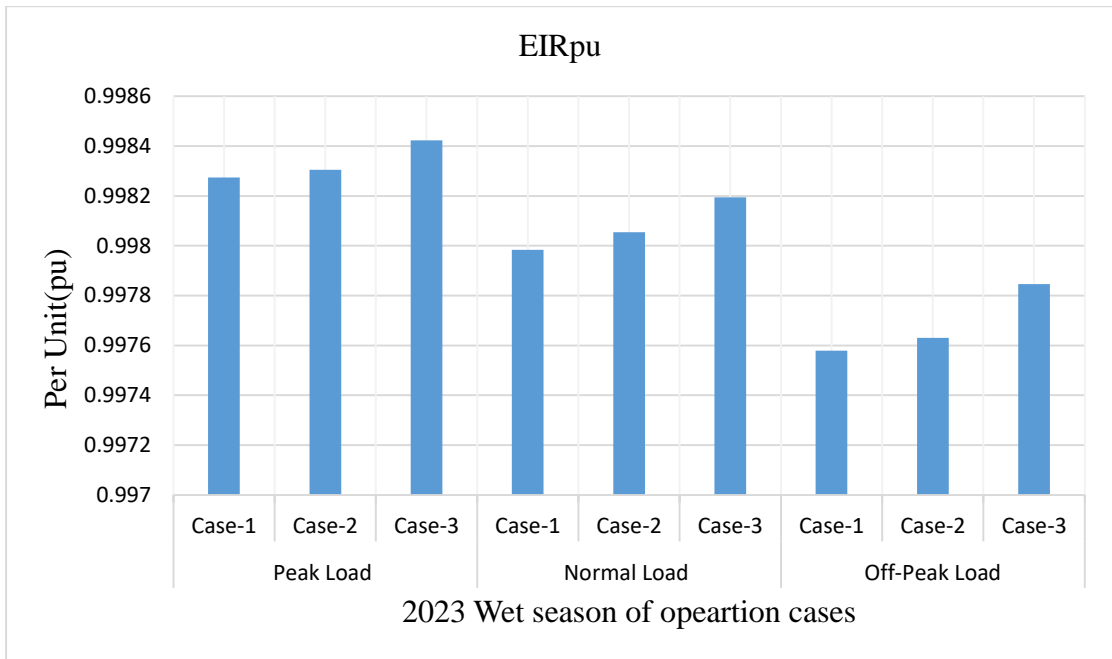


Figure 4. 17 :EIRp.u for wet peak operation of INPS.

Table 4. 26: ECOST for 2023 wet season operation of INPS.

Type of Load	Cases No.	2023 Wet Season Cases of Operation	ECOST (Nrs)in million
Peak Load	1	Operation of existing INPS at peak load (Base case)	2149.34
	2	Operation of existing INPS at peak load when export via NB-G line (25MW)	1979.01
	3	Operation of existing INPS at peak load when optimal import via NB-G line(26MW)	1841.23
Normal Load	1	Operation of existing INPS at normal load (Base case)	2118.85
	2	Operation of existing INPS at normal load when export via NB-G line (25MW)	2044.18

	3	Operation of existing INPS at normal load when optimal export via NB-G line(97MW)	1897.34
Off-Peak Load	1	Operation of existing INPS at Off-Peak load (Base case)	2261.65
	2	Operation of existing INPS at Off-Peak load when export via NB-G line (25MW)	2213.05
	3	Operation of existing INPS at Off-Peak load when optimal export via NB-G line(201.7MW)	2011.79

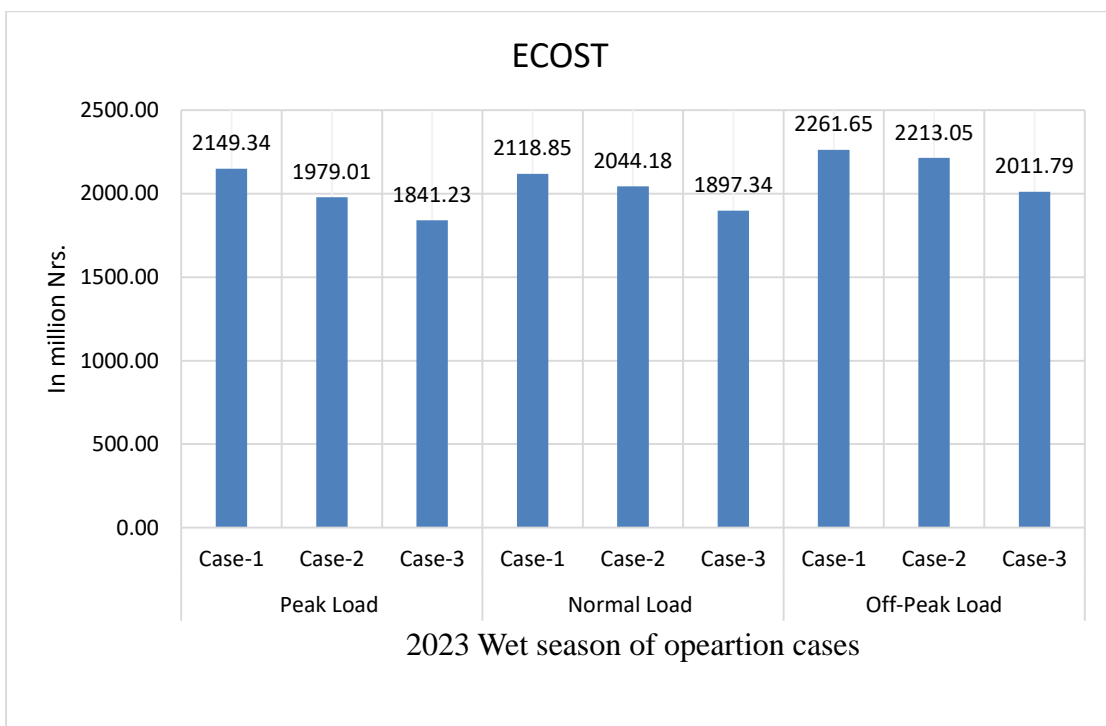


Figure 4. 18: ECOST for 2023 wet season operation of INPS.

The figure displayed in Figure 4.18 provides a clear representation of the Expected Cost of Energy Not Served (ECOST) during wet season operations. With the integration of power from Gorakhpur via the NB-G line into the existing system, there is a noteworthy reduction in the cost associated with the Expected Energy Not Supplied (ECOST) in all scenarios compared to the baseline mode of operation. This reduction in ECOST can be primarily attributed to the increased power supply into the system through the NB-G line from Gorakhpur. Therefore, the decrease in ECOST resulting from the incorporation of these transmission lines signifies a significant financial

accomplishment for the system. This achievement, in turn, reinforces the system's capacity to attract more investment for further enhancements in the transmission infrastructure.

CHAPTER 5. CONCLUSION AND RECOMMENDATION

Conclusion and Recommendation

The objective of research is to study of impact of New-Butwal-Gorakhpur 400 KV transmission line on the operation and reliability of INPS. For this study, the appropriate models were developed for operating INPS at different scenario in which detailed analysis had been carried out so as to meet the objective of the study.

The result is analysed in two seasons, Dry and wet. In dry season the energy is insufficient and needs to import. In wet season, surplus energy export to India. The findings in this research shows importance of NB-G line in the future of power system. Load of Dry season is categorized in three parts of day, peak load, Normal load and off-peak load. The peak load is 1900.93MW and the generation is 1301.76 MW. Power that needs to import is 716.36 MW. Without NB-G line 386.36 MW import from DM line and rest from 132KV line. The loss is 5.81%. When 25 MW imports from NB-G line loss drops to 5.23 %. When further import increased to 367.9 MW from NB-G line, the system loss reduced to 4.88%. Here loss seems to decrease. Overall the loss seems to decrease to 4.88% from 5.81%. In summary, the advantages of using high voltage for power transmission lines include reduced losses, increased efficiency, longer transmission distances, and reduced cost of conductors. The disadvantages include safety concerns, complexity, interference, and environmental impact. As we move from case 1 to case 3 EENS are decreased that means power system resilience increased and good for INPS. During Dry Season Normal load condition, 827.03 MW needs to import. Without NB-G loss is 5.11 % and with NB-G import 398.51MW loss reduced to 4.22 %. During off-peak load, 751.38 MW needs to import. Without NB-G loss is 4.62 and when import is 350.6 MW with NB-G line loss reduced to 3.92%.

In wet season, 353.54 MW power seems to export during peak time while considering the case1 ie the case when export is only via Dhalke-Muzzaffarpur(D-M) line, the system loss seems to be 146.26MW i.e. 5.85%. When considering the case 2 in which 25MW power is exported via New Butwal-Gorakhpur line the loss is reduced to 144.03 MW i.e. 5.76%. For optimal loss in the system, it is seen that during peak condition 26 MW power need to import inspite of wet season. For Wet Season Normal Load conditions 550.77MW power is surplus which need to export to avoid spill via only available export point D-M. In this condition system loss is 149.55MW i.e.5.98% While

from NB-G exporting 25 WM. The loss has decreased to 5.68%. While optimum power 97 MW is exporting from NB-G line then the loss is reduced to 5.36%. Overall loss reduced to 5.36 from 5.98%. Hence system loss decreased. when export through NB-G line. During wet season Off-Load condition, near about 750 MW seems to export. Without NB-G line loss is 6.73 % and while exporting 25 MW with NB-G line the loss is decreased to 6.42 %. When optimum power 201.7MW is exporting via NB-G line the loss is reduced to 5.35%. That is what we want to. Here, generation in western part is also surplus. NB-G line is easier to export this point. we can see this line reduces the loss by 1.38% of system loss. The integration of NB-G high voltage transmission lines into a power system have explored multi benefits such as reduced transmission losses, increased grid capacity, and the potential for economic growth, although the initial capital invest is high, in long term it outweighs the costs. Hence Following conclusions can be drawn from the study.

- The The simulation outcomes reveal that, in accordance with the model described in this thesis, the presence of both generators and loads is evident that there is deficit of power in dry season. To cater the demand, power need to import from available point at 132kV so loss is maximum. To minimize the loss, optimum power need to import from NewButwal-Gorakhpur line. Hence high voltage import is recommended for INPS operation.

For wet season Scenario: There are excess power in the network after supplying power for large domestic load as well as others load. Surplus power need to export to avoid spill. Hence NewButwal-Gorakhpur line is emerging to solution to export power. Hence NewButwal-Gorakhpur 400kV cross border line is recommended to export power for INPS operation.

- Many of the lines are over-loaded in existing INPS system scenario so need to reinforcement of the lines with HTLS or upgrade to high voltage for betterment of grid.

From the simulation and analysis of 2028 A.D. wet season at a time of maximum load scenario, it is seen that when New Butwal-Gorakhpur line is not constructed, the surplus power spill is 1302.94 MW and the system loss is 331.93MW i.e. 3.47%. In scenario 2 when New Butwal-Gorakhpur line is constructed, there in no surplus power so spill is zero and the system loss is reduced to 323.37MW i.e. 2.97%. The loss is reduced by

0.40 %. Line loading and bus voltages are under the specified limit. It is recommended to build and operate the NB-G line in fast track to prevent the spill of surplus power in coming future.

In conclusion, a reliable transmission infrastructure in Nepal is crucial for meeting the increasing energy demand, enhancing energy access, enabling power exchange and import/export, supporting renewable energy integration, ensuring grid stability and reliability, and promoting economic growth and development. By investing in and improving the transmission infrastructure, Nepal can establish a strong foundation for a sustainable and resilient electrical power system.

Recommendation for Further Works

1. The cost benefit analysis of the line is not performed so recommend for same analysis.
2. In this research, reliability indices were assessed using standard failure rate data for transmission lines. The findings suggest further investigation, specifically utilizing the exact failure rate data of transmission lines and other components from the INPS for more comprehensive insights.
3. Dynamic analysis, short circuit study, optimal capacitor placement and estimation of wheeling charge are not studied. The findings suggest further investigation on the above mentioned analysis.

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ANNEXES

Annex A: Reliability indices for dry season at peak scenario.

(I) Calculation of EPNS and EENS of Existing INPS at Dry peak season 2022. (i.e. Base CaseI)

S.N.	Bus		Volt (kV)	P. Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	41.64	0.01	35.00	14.58	9.5	138.47
2	Attariya	Phalampur	132	41.64	0.01	35.00	14.58	9.5	138.47
3	Balanch	Syaule SS	132	36.50	0.01	70.00	25.55	9.5	242.75
4	Balanch	Syaule SS	132	36.50	0.01	70.00	25.55	9.5	242.75
5	Bardaghat	N.Butwal	132	50.07	0.01	10.00	5.01	9.5	47.57
6	Bardaghat	N.Butwal	132	50.07	0.01	10.00	5.01	9.5	47.57
7	Bardaghat	Sardi	132	20.54	0.01	14.00	2.88	9.5	27.32
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	35.92	0.01	34.00	12.21	9.5	116.04
10	NBharatpur	Bardaghat	132	49.37	0.01	74.00	36.53	9.5	347.08
11	Bhaktapur	Lmosanghu	132	148.0	0.01	48.30	71.52	9.5	679.48
12	Bhaktapur	Lmosanghu	132	148.0	0.01	48.30	71.52	9.5	679.48
13	Kawasoti	Bharatpur	132	56.41	0.01	36.00	20.31	9.5	192.93
14	Burigaon	Kohalpur	132	26.29	0.01	55.29	14.54	9.5	138.09
15	Burigaon	Kohalpur	132	26.29	0.01	55.29	14.54	9.5	138.09
16	Butwal	Sunwal SS	132	41.87	0.01	13.00	5.44	9.5	51.71
17	Butwal	BB2	132	41.87	0.01	13.00	5.44	9.5	51.71
18	Mainahiya	Butwal	132	24.08	0.01	18.00	4.33	9.5	41.18
19	Mainahiya	Butwal	132	24.08	0.01	18.00	4.33	9.5	41.18
20	Motipur	Butwal	132	69.62	0.01	38.00	26.45	9.5	251.32
21	Motipur	Butwal	132	69.62	0.01	38.00	26.45	9.5	251.32
22	Chapur	Nabalpur	132	128.8	0.01	34.75	44.77	9.5	425.28
23	Chapur	Nabalpur	132	127.5	0.01	34.75	44.33	9.5	421.15
24	Damauli	Bharatpur	132	43.85	0.01	39.00	17.10	9.5	162.45
25	Dhalkebar	Mirchaiya	132	44.65	0.01	31.50	14.06	9.5	133.61
26	Dhalkebar	Mirchaiya	132	44.65	0.01	31.50	14.06	9.5	133.61
27	Dhalkebar	Muzafapur	400	189.1	0.002	140.0	52.96	18.8	995.67
28	Dhalkebar	Muzafapur	400	189.1	0.002	140.	52.96	18.8	995.67
29	Duhabi	Damak	132	22.87	0.01	48.90	11.18	9.5	106.25
30	Bardaghat	Gandak	132	46.24	0.01	14.00	6.47	9.5	61.50
31	Amarpur	Ilam	132	9.13	0.01	66.50	6.07	9.5	57.67
32	Amarpur	Ilam	132	9.13	0.01	66.50	6.07	9.5	57.67
33	Hetauda	Pathlaiya	132	66.70	0.01	37.00	24.68	9.5	234.46
34	Inariwa	Duhabi	132	169.8	0.01	10.00	16.98	9.5	161.32

35	Inariwa	Duhabi	132	3.54	0.01	10.00	0.35	9.5	3.36
36	Inaruwa	Tumlingtar	220	10.00	0.0035	106.0	3.71	35.5	131.68
37	Kohalpur	Kusum	132	6.75	0.01	48.30	3.26	9.5	30.98
38	Kul-3	Temi(15)	132	14.00	0.01	0.50	0.07	9.5	0.66
39	Kushaha	Inariwa	132	90.07	0.01	13.10	11.80	9.5	112.09
40	Inariwa	Kushaha	132	89.32	0.01	13.10	11.70	9.5	111.16
41	Dana	Kushma	220	10.31	0.0035	39.00	1.41	35.5	49.97
42	Dana	Kushma	220	10.31	0.0035	39.00	1.41	35.5	49.97
43	Kushma	Modi1kV	132	10.85	0.01	6.00	0.65	9.5	6.19
44	Kusum	Hapure SS	132	13.79	0.01	18.00	2.48	9.5	23.58
45	Lahan	Rupani	132	45.03	0.01	27.00	12.16	9.5	115.50
46	Lahan	Rupani	132	45.03	0.01	27.00	12.16	9.5	115.50
47	Ghorahi	Lamahi	132	13.00	0.01	13.00	1.69	9.5	16.05
48	Ghorahi	Lamahi	132	13.00	0.01	13.00	1.69	9.5	16.05
49	Lamahi	Jhimruk	132	4.19	0.01	49.49	2.07	9.5	19.71
50	Lekhnath	Damauli	132	30.04	0.01	45.00	13.52	9.5	128.42
51	Lumki	Burigaon	132	29.95	0.01	33.90	10.15	9.5	96.47
52	Lumki	Burigaon	132	29.95	0.01	33.90	10.15	9.5	96.47
53	Kirtipur SS	M-Mars	132	33.83	0.01	17.00	5.75	9.5	54.63
54	Mahendrana	Attariya	132	24.00	0.01	51.40	12.34	9.5	117.19
55	Mahendrana	Attariya	132	24.00	0.01	51.40	12.34	9.5	117.19
56	Matatirtha	Hetauda	132	24.29	0.01	36.24	8.80	9.5	83.62
57	New Modi	Modi	132	0.00	0.01	0.30	0.00	9.5	0.00
58	Sandhikharka	Motipur	132	6.84	0.01	37.00	2.53	9.5	24.04
59	Sandhikharka	Motipur	132	6.84	0.01	37.00	2.53	9.5	24.04
60	Motipur	Shivapur	132	59.71	0.01	23.00	13.73	9.5	130.46
61	Motipur	Shivapur	132	59.71	0.01	23.00	13.73	9.5	130.46
62	N Butwal	Sunwal SS	132	63.32	0.01	20.00	12.66	9.5	120.31
63	N Butwal	BB2	132	63.32	0.01	20.00	12.66	9.5	120.31
64	NMRS	Matatirtha	132	5.82	0.01	84.00	4.89	9.5	46.44
65	NMRS	Matatirtha	132	5.82	0.01	84.00	4.89	9.5	46.44
66	Nabalpur	Dhalkebar	132	141.1	0.01	34.75	49.03	9.5	465.80
67	Nabalpur	Dhalkebar	132	141.1	0.01	34.75	49.03	9.5	465.80
68	Lahachok	New Modi	132	5.94	0.01	20.00	1.19	9.5	11.28
69	Lahachok	New Modi	132	0.00	0.01	20.00	0.00	9.5	0.00
70	NewBharatpu	Hetauda	132	34.51	0.01	75.00	25.88	9.5	245.88
71	Kushma	N Butwal	220	13.55	0.0035	88.00	4.17	35.5	148.19
72	Kushma	N. Butwal	220	13.55	0.0035	88.00	4.17	35.5	148.19
73	New Modi	Pokhara	132	0.00	0.01	37.00	0.00	9.5	0.00
74	NewBharatpu	Marsyngdi	132	84.01	0.01	25.00	21.00	9.5	199.53
75	Pathlaiya	Chapur	132	109.9	0.01	30.68	33.73	9.5	320.41
76	Phalampur	Lumki	132	37.10	0.01	28.90	10.72	9.5	101.85
77	Phalampur	Lumki	132	37.10	0.01	28.90	10.72	9.5	101.85
78	Rupani	Kushaha	132	33.21	0.01	34.90	11.59	9.5	110.09
79	Rupani	Kushaha	132	33.21	0.01	34.90	11.59	9.5	110.09

80	Trishuli3B	Matatirtha	132	0.00	0.01	49.00	0.00	95	0.00
81	Trisuli3BH	Matatirtha	132	41.48	0.01	49.00	20.32	95	193.08
82	Samundartar	Trisuli3B	132	20.82	0.01	26.00	5.41	95	51.44
83	Samundartar	Trishuli3B	132	20.82	0.01	26.00	5.41	95	51.44
84	Lamosanghu	Khimti	132	24.01	0.01	40.00	9.61	95	91.25
85	SyauleSS	Attariya	132	31.71	0.01	60.00	19.03	95	180.77
86	SyauleSS	Attariya	132	31.71	0.01	60.00	19.03	95	180.77
87	Mirchaiya	Tingla	132	21.30	0.01	90.00	19.17	95	182.12
88	Mirchaiya	Tingla	132	21.30	0.01	90.00	19.17	95	182.12
89	Malekhu	Terminal(4)	132	13.76	0.01	0.20	0.03	95	0.26
90	Amlekhgunj	Simara	66	20.93	0.028	12.90	7.56	10.8	81.63
91	Amlekhgunj	Simara	66	20.93	0.028	12.90	7.56	10.8	81.63
92	Balaju	Chapali132	132	39.33	0.01	10.00	3.93	95	37.36
93	Balaju	Chapali132	132	39.33	0.01	10.00	3.93	95	37.36
94	Lainchaur	Balaju	66	31.75	0.028	2.00	1.78	10.8	19.20
95	Switchatar	Balaju	132	28.98	0.01	4.40	1.27	95	12.11
96	Balaju	Trisuli	66	12.03	0.028	29.00	9.77	10.8	105.49
97	Balaju	Trisuli	66	12.03	0.028	29.00	9.77	10.8	105.49
98	Banepa	Panchkhal	66	2.72	0.028	8.03	0.61	10.8	6.61
99	Baneshwor	Bhaktapur	66	52.08	0.028	8.24	12.02	10.8	129.77
100	Bhaktapur	Ch.Narayan	132	82.62	0.01	3.65	3.02	95	28.65
101	Bhaktapur	Ch.Narayan	132	82.62	0.01	3.65	3.02	95	28.65
102	Bhaktapur	Banepa	66	19.24	0.028	13.57	7.31	95	69.45
103	NewBharatpu	Bharatpur	132	62.27	0.01	0.50	0.31	95	2.96
104	Parwanipur	Birgunjs	66	23.82	0.028	9.00	6.00	10.8	64.82
105	Parwanipur	Birgunj	66	23.82	0.028	9.00	6.00	10.8	64.82
106	Butwal	KGA	132	84.01	0.01	58.00	48.73	95	462.90
107	Butwal	KGA	132	84.01	0.01	58.00	48.73	95	462.90
108	Chapali	Ch.Narayan	132	82.02	0.01	8.24	6.76	95	64.20
109	Chapali	Ch.Narayan	132	82.02	0.01	8.24	6.76	95	64.20
110	Chapali	Devighat	66	0.02	0.028	29.30	0.01	10.8	0.15
111	Chapali	Devighat	66	0.02	0.028	29.30	0.01	10.8	0.15
112	Chilime	Trisuli	66	19.65	0.028	10.00	5.50	10.8	59.42
113	Damak	Anammani	132	41.29	0.01	26.70	11.02	95	104.73
114	NMRS	Damauli	132	15.64	0.01	23.00	3.60	95	34.17
115	NMRS	Damauli	132	15.64	0.01	23.00	3.60	95	34.17
116	Ramnagar	Gandak	132	60.00	0.028	25.00	42.00	95	399.00
117	Hetauda	Amlekhgnj	66	22.08	0.028	20.17	12.47	10.8	134.68
118	Hetauda	Amlekhgnj	66	22.08	0.028	20.17	12.47	10.8	134.68
119	Bharatpur	Hetauda	132	0.00	0.01	70.85	0.00	95	0.00
120	Hetauda	Kamane	132	22.51	0.01	18.50	4.16	95	39.56
121	Hetauda	Ter(15)	132	12.35	0.01	5.24	0.65	95	6.15
122	Ter(15)	Kul-2	132	1.58	0.01	3.00	0.05	95	0.45
123	Damak	Ilam	132	23.31	0.01	31.50	7.34	95	69.76
124	Damak	Ilam	132	23.31	0.01	31.50	7.34	95	69.76

125	Kamane	Pathlaiya	132	64.09	0.01	18.50	11.86	95	112.64
126	Upr Khimti	Dhalkebar	220	42.78	0.0035	75.00	11.23	35.5	398.63
127	UppeKhimti	Dhalkebar	220	42.78	0.0035	75.00	11.23	35.5	398.63
128	Kohalpur	Kusum	132	6.75	0.01	48.30	3.26	95	30.98
129	Kul-1	Switchatar	66	23.26	0.028	32.86	21.40	10.8	231.11
130	Kul-1	Switchatar	66	23.26	0.028	32.86	21.40	10.8	231.11
131	Kul-2	Matatirtha	132	33.56	0.01	28.50	9.56	95	90.85
132	Hetauda	Kul-1	66	7.90	0.028	15.05	3.33	10.8	35.95
133	Hetauda	Kul-1	66	7.90	0.028	15.05	3.33	10.8	35.95
134	Kushaha	Kataiya	132	118.1	0.01	16.00	18.90	95	179.55
135	- Kushaha	Kataiya	132	0.00	0.01	13.00	0.00	95	0.00
136	- Kushaha	Kataiya	132	0.00	0.01	13.00	0.00	95	0.00
137	Kusum	Lamahi	132	15.73	0.01	47.50	7.47	95	70.97
138	Kusum	Lamahi	132	15.73	0.01	47.50	7.47	95	70.97
139	Lahachok	BB2	132	4.50	0.01	42.00	1.89	95	17.97
140	BB2	Lahachok	132	4.73	0.01	42.00	1.98	95	18.85
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
143	Lamahi	Shivapur	132	42.28	0.01	51.00	21.56	95	204.84
144	Lamahi	Shivapur	132	42.28	0.01	51.00	21.56	95	204.84
145	Lamosanghu	Bhotekoshi	132	21.41	0.01	24.65	5.28	95	50.15
146	BB1	Lamosang	132	292.9	0.01	45.84	134.29	95	1275.75
147	BB2	SyangjaSS	132	42.25	0.01	41.00	17.32	95	164.55
148	Marsyangdi	Terminal(4)	132	15.30	0.01	40.00	6.12	95	58.16
149	Terminal(4)	Switchatar	132	1.47	0.01	84.00	1.23	95	11.72
150	Switchatar	Matatirtha	132	48.28	0.01	4.40	2.12	95	20.18
151	Switchatar	Matatirtha	132	48.28	0.01	4.40	2.12	95	20.18
152	Mirchaiya	Lahan	132	55.30	0.01	27.68	15.31	95	145.41
153	Mirchaiya	Lahan	132	55.30	0.01	27.68	15.31	95	145.41
154	M-Mars	Damauli	132	63.64	0.01	58.00	36.91	95	350.66
155	Newchabil	Chapali	66	28.93	0.028	5.00	4.05	10.8	43.74
156	Newchabil	Chapali	132	28.93	0.01	5.00	1.45	95	13.74
157	M-Mars	NMRS	132	0.00	0.01	40.00	0.00	95	0.00
158	M-Mars	NMRS	132	83.21	0.01	40.00	33.28	95	316.20
159	NMRS	Marsyangdi	132	13.84	0.01	5.00	0.69	95	6.57
160	Marsyangdi	NMRS	132	13.83	0.01	5.00	0.69	95	6.57
161	Panchkhal	Sunkoshi	66	0.92	0.028	29.00	0.74	10.8	8.04
162	Panchkhal	Indrawati	66	4.01	0.028	28.00	3.15	10.8	33.99
163	Patan	Baneshwor	132	0.00	0.01	2.80	0.00	95	0.00
164	Pathlaiya	Parwanipu	132	39.25	0.01	16.59	6.51	95	61.86
165	Pathlaiya	parwnipurs	132	39.25	0.01	16.59	6.51	95	61.86
166	Pathlaiya	Chapur	132	109.93	0.01	30.68	33.73	95	320.41
167	Lekhnath	Pokhara	132	30.04	0.01	7.00	2.10	95	19.98
168	Parwanipur	Raxual Bus	132	79.16	0.01	13.00	10.29	95	97.77
169	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	10.8	0.01

170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
172	Switchatar	Patan	66	34.09	0.028	6.50	6.21	10.8	67.02
173	Switchatar	Balaju	66	0.09	0.028	4.40	0.01	10.8	0.11
174	Switchatar	Balaju	66	0.09	0.028	4.40	0.01	10.8	0.11
175	Switchatar	K-3	66	23.79	0.028	6.90	4.60	10.8	49.65
176	Teku	Switchatar	66	43.37	0.028	4.10	4.98	10.8	53.77
177	Switchatar	Patan	66	34.09	0.028	6.50	6.21	10.8	67.02
178	SyangjaSS	KGA	132	32.89	0.01	55.00	18.09	10.8	195.37
179	M.nagar	Terminal(2)	132	68.57	0.01	40.00	27.43	10.8	296.21
180	Teku	K-3	66	6.13	0.028	2.30	0.39	10.8	4.26
181	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total							21654		22809.2

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw.hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	20384.25
Cost of Energy (ECOST) = EENS x IEAR	10192.12
Cost of Energy (ECOST) in Nrs	1358406274.4 3
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1358406274.4 3

II) Calculation of EPNS and EENS of Existing INPS at normal load condition (case II)

Dry normal

	Bus						
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S.N	From	To	Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
1	Attariya	Phalampur	132	36.23	0.01	35.19	12.75	9.5	121.13
2	Attariya	Phalampur	132	36.23	0.01	35.19	12.75	9.5	121.13
3	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
4	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
5	Bardaghat	N Butwal	132	44.16	0.01	10.00	4.42	9.5	41.95
6	Bardaghat	N Butwal	132	44.16	0.01	10.00	4.42	9.5	41.95
7	Bardaghat	Sardi	132	17.31	0.01	14.00	2.42	9.5	23.02
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	26.79	0.01	34.00	9.11	9.5	86.53
10	NewBharat	Bardaghat	132	38.42	0.01	74.00	28.43	9.5	270.10
11	Bhaktapur	Lamosanghu	132	125.75	0.01	48.30	60.73	9.5	576.98
12	Bhaktapur	Lamosanghu	132	125.75	0.01	48.30	60.73	9.5	576.98
13	Kawasoti	Bharatpur	132	44.06	0.01	36.00	15.86	9.5	150.69
14	Burigaon	Kohalpur	132	23.36	0.01	55.29	12.92	9.5	122.71
15	Burigaon	Kohalpur	132	23.36	0.01	55.29	12.92	9.5	122.71
16	Butwal	Sunwal SS	132	52.35	0.01	13.00	6.81	9.5	64.65
17	Butwal	BB2	132	52.35	0.01	13.00	6.81	9.5	64.65
18	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
19	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
20	Motipur	Butwal	132	48.29	0.01	38.00	18.35	9.5	174.32
21	Motipur	Butwal	132	48.29	0.01	38.00	18.35	9.5	174.32
22	Chapur	Nabalpur	132	121.31	0.01	34.75	42.15	9.5	400.46
23	Chapur	Nabalpur	132	119.48	0.01	34.75	41.52	9.5	394.44
24	Damauli	Bharatpur	132	31.67	0.01	39.00	12.35	9.5	117.34
25	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.19
26	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.19
29	Duhabi	Damak	132	9.43	0.01	48.90	4.61	9.5	43.80
30	Bardaghat	Gandak	132	9.43	0.01	14.00	1.32	9.5	12.54
31	Amarpur	Ilam	132	85.41	0.01	66.50	56.80	9.5	539.56
32	Amarpur	Ilam	132	132.82	0.01	66.50	88.32	9.5	839.06
33	Amarpur	Pathlaiya	132	2.77	0.01	37.00	1.02	9.5	9.73
34	Inariwa	Duhabi	132	11.20	0.01	10.00	1.12	9.5	10.64
35	Inariwa	Duhabi	132	3.52	0.01	10.00	0.35	9.5	3.35
37	Kohalpur	Kusum	132	69.04	0.01	48.30	33.34	9.5	316.77
38	Kul-3	Ter(15)	132	68.64	0.01	0.50	0.34	9.5	3.26
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	9.5	12.83
40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	9.5	12.83
43	Kushma	Modil	132	20.64	0.01	6.00	1.24	9.5	11.77
44	Kusum	Hapure	132	20.64	0.01	18.00	3.72	9.5	35.30

45	Lahan	Rupani	132	10.96	0.01	27.00	2.96	9.5	28.10
46	Lahan	Rupani	132	10.96	0.01	27.00	2.96	9.5	28.10
47	Ghorahi Bus	Lamahi	132	2.51	0.01	13.00	0.33	9.5	3.10
48	Ghorahi Bus	Lamahi	132	25.17	0.01	13.00	3.27	9.5	31.09
49	Lamahi	Jhimruk	132	7.54	0.01	49.49	3.73	9.5	35.45
50	Lekhnath SS	Damauli	132	26.43	0.01	45.00	11.90	9.5	113.01
51	Lumki	Burigaon	132	26.43	0.01	33.90	8.96	9.5	85.13
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	9.5	108.93
53	Kirtipur SS	M-Mars	132	26.33	0.01	17.00	4.48	9.5	42.52
54	M.nagar	Attariya	132	26.33	0.01	51.40	13.53	9.5	128.57
55	M.nagar	Attariya	132	29.17	0.01	51.40	14.99	9.5	142.45
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Modi	Modi	132	5.76	0.01	0.30	0.02	9.5	0.16
58	Sandhikharka	Motipur	132	5.76	0.01	37.00	2.13	9.5	20.26
59	Sandhikharka	Motipur	132	39.94	0.01	37.00	14.78	9.5	140.37
60	Motipur	Shivapur	132	39.94	0.01	23.00	9.19	9.5	87.26
61	Motipur	Shivapur	132	70.67	0.01	23.00	16.25	9.5	154.42
62	New Butwal	Sunwal SS	132	70.67	0.01	20.00	14.13	9.5	134.28
63	New Butwal	BB2	132	0.96	0.01	20.00	0.19	9.5	1.83
64	NMRS	Matatirtha	132	0.96	0.01	84.00	0.81	9.5	7.68
65	NMRS	Matatirtha	132	131.30	0.01	84.00	110.29	9.5	1047.79
66	Nabalpur	Dhalkebar	132	131.30	0.01	34.75	45.63	9.5	433.46
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	9.5	19.59
68	Lahachok	New Modi	132	0.00	0.01	20.00	0.00	9.5	0.00
69	Lahachok	New Modi	132	37.26	0.01	20.00	7.45	9.5	70.80
70	NewBharatpur	Hetauda	132	14.26	0.01	75.00	10.69	9.5	101.58
73	New Modi	Pokhara	132	60.73	0.01	37.00	22.47	9.5	213.45
74	NewBharatpur	Marsyangd	132	109.66	0.01	25.00	27.42	9.5	260.44
75	Pathlaiya	Chapur	132	32.44	0.01	30.68	9.95	9.5	94.54
76	Phalampur	Lumki	132	32.44	0.01	28.90	9.37	9.5	89.05
77	Phalampur	Lumki	132	10.90	0.01	28.90	3.15	9.5	29.93
78	Rupani	Kushaha	132	10.90	0.01	34.90	3.80	9.5	36.14
79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	9.5	0.00
80	Trishuli3B Hub	Matatirtha	132	26.59	0.01	49.00	13.03	9.5	123.79
81	Trishuli3B Hub	Matatirtha	132	13.33	0.01	49.00	6.53	9.5	62.03
82	Samundartar	Trisuli3B H	132	13.33	0.01	26.00	3.46	9.5	32.91
83	Samundartar	Trisuli3B H	132	24.01	0.01	26.00	6.24	9.5	59.32
84	Lamosanghu	Khimti	132	21.71	0.01	40.00	8.69	9.5	82.52
85	Syaule SS	Attariya	132	21.71	0.01	60.00	13.03	9.5	123.77
86	Syaule SS	Attariya	132	21.60	0.01	60.00	12.96	9.5	123.13
87	Mirchaiya	Tingla	132	21.60	0.01	90.00	19.44	9.5	184.69
88	Mirchaiya	Tingla	132	11.60	0.01	90.00	10.44	9.5	99.19

89	Malekhu	Terminal(4)	132	17.59	0.01	0.20	0.04	9.5	0.33
92	Balaju	Chapali	132	43.24	0.01	10.00	4.32	9.5	41.07
93	Balaju	Chapali	132	26.77	0.01	10.00	2.68	9.5	25.43
95	Switchatar	Balaju1	132	7.98	0.01	4.40	0.35	9.5	3.34
100	Bhaktapur	Charayan	132	70.86	0.01	3.65	2.59	9.5	24.57
101	Bhaktapur	Charayan	132	70.86	0.01	3.65	2.59	9.5	24.57
103	Bhaktapur	Bharatpur	132	18.53	0.01	0.50	0.09	9.5	0.88
106	Butwal	KGA	132	39.86	0.01	58.00	23.12	9.5	219.66
107	Butwal	KGA	132	8.33	0.01	58.00	4.83	9.5	45.91
108	Chapali	Ch.Narayan	132	8.33	0.01	8.24	0.69	9.5	6.52
109	Chapali	Ch.Narayan	132	10.30	0.01	8.24	0.85	9.5	8.06
113	Damak	Anamani	132	228.32	0.01	26.70	60.96	9.5	579.14
114	NMRS	Damauli	132	228.32	0.01	23.00	52.51	9.5	498.88
115	NMRS	Damauli	132	18.48	0.01	23.00	4.25	9.5	40.39
118	Bharatpur	Hetauda	132	39.68	0.01	70.85	28.11	9.5	267.09
119	Hetauda	Kamane	132	10.71	0.01	18.50	1.98	9.5	18.83
120	Hetauda	Ter(15)	132	17.69	0.01	5.24	0.93	9.5	8.80
121	Terminal(15)	Kul-2	132	24.66	0.01	3.00	0.74	9.5	7.03
122	Damak	Ilam	132	24.66	0.01	31.50	7.77	9.5	73.79
123	Damak	Ilam	132	74.76	0.01	31.50	23.55	9.5	223.73
124	Kamane	Pathlaiya	132	35.36	0.01	18.50	6.54	9.5	62.15
127	Kohalpur	Kusum	132	48.24	0.01	48.30	23.30	9.5	221.36
128	Kul-1	Switchatar	132	3.52	0.01	32.86	1.16	9.5	11.00
131	Hetauda	Kul-1	132	33.67	0.01	15.05	5.07	9.5	48.14
134	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.22
135	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.22
136	Kusum	Lamahi	132	39.86	0.01	47.50	18.93	9.5	179.86
137	Kusum	Lamahi	132	4.03	0.01	47.50	1.92	9.5	18.21
138	Lahachok	BB2	132	4.03	0.01	42.00	1.69	9.5	16.10
139	BB2	Lahachok	132	4.47	0.01	42.00	1.88	9.5	17.85
140	Lainchaur	Newchabil	132	4.75	0.01	2.30	0.11	9.5	1.04
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
143	Lamahi	Shivapur	132	25.85	0.01	51.00	13.18	9.5	125.23
144	Lamosanghu	Bhotekoshi	132	25.85	0.01	24.65	6.37	9.5	60.53
145	BB1	Lamosanghu	132	21.41	0.01	45.84	9.82	9.5	93.26
146	BB2	SyangjaSS	132	234.99	0.01	41.00	96.35	9.5	915.29
147	Marsyangdi	Terminal(4)	132	8.76	0.01	40.00	3.50	9.5	33.29
148	Terminal(4)	Switchatar132kv	132	2.88	0.01	84.00	2.42	9.5	22.96
149	Switchatar	Matatirtha	132	37.83	0.01	4.40	1.66	9.5	15.81
150	Switchatar	Matatirtha	132	37.83	0.01	4.40	1.66	9.5	15.81
151	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	9.5	75.34
152	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	9.5	75.34

153	M-Mars	Damauli	132	49.22	0.01	58.00	28.55	95	271.18
154	Newchabil	Chapali	132	24.39	0.01	5.00	1.22	95	11.59
156	M-Mars	NMRS	132	0.00	0.01	40.00	0.00	95	0.00
157	M-Mars	NMRS	132	63.96	0.01	40.00	25.58	95	243.04
158	NMRS	Marsyangdi	132	15.51	0.01	5.00	0.78	95	7.37
159	Marsyangdi	NMRS	132	15.50	0.01	5.00	0.77	95	7.36
163	Pathlaiya	Parwanipur	132	24.81	0.01	16.59	4.12	95	39.11
164	Pathlaiya	Parwanipur	132	24.81	0.01	16.59	4.12	95	39.11
165	Pathlaiya	Chapur	132	109.66	0.01	30.68	33.64	95	319.62
166	Lekhnath	Pokhara	132	25.17	0.01	7.00	1.76	95	16.74
167	Terminal(1)	Gandak	132	60.00	0.01	0.10	0.06	95	0.57
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	95	0.00
177	SyangjaSS	KGA	132	5.34	0.01	55.00	2.94	95	27.92
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total							1899.09		19297.24

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	19297.24
Cost of Energy (ECOST) = EENS x IEAR	9648.62
Cost of Energy (ECOST) in Nrs	1285967855.63
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1285967855.63

III) Calculation of EPNS and EENS of Existing INPS at normal load when optimum power import via NB-G line (case III)

S.N	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTT R (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	1.63	0.01	35.19	0.57	9.5	5.44
2	Attariya	Phalampur	132	1.63	0.01	35.19	0.57	9.5	5.44
3	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
4	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
5	Bardaghat	N Butwal	132	103.74	0.01	10.00	10.37	9.5	98.55
6	Bardaghat	N Butwal	132	103.74	0.01	10.00	10.37	9.5	98.55
7	Bardaghat	Sardi	132	17.30	0.01	14.00	2.42	9.5	23.01
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	86.50	0.01	34.00	29.41	9.5	279.38
10	NewBharatpur	Bardaghat	132	81.02	0.01	74.00	59.95	9.5	569.57
11	Bhaktapur	Lamosanghu	132	90.10	0.01	48.30	43.52	9.5	413.44
12	Bhaktapur	Lamosanghu	132	90.10	0.01	48.30	43.52	9.5	413.44
13	Kawasoti	Bharatpur	132	69.23	0.01	36.00	24.92	9.5	236.75
14	Burigaon	Kohalpur	132	10.56	0.01	55.29	5.84	9.5	55.46
15	Burigaon	Kohalpur	132	10.56	0.01	55.29	5.84	9.5	55.46
16	Butwal	Sunwal SS	132	89.57	0.01	13.00	11.64	9.5	110.62
17	Butwal	BB2	132	89.57	0.01	13.00	11.64	9.5	110.62
18	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
19	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
20	Motipur	Butwal	132	84.44	0.01	38.00	32.09	9.5	304.82
21	Motipur	Butwal	132	84.44	0.01	38.00	32.09	9.5	304.82
22	Chapur	Nabalpur	132	77.86	0.01	34.75	27.06	9.5	257.03
23	Chapur	Nabalpur	132	77.14	0.01	34.75	26.81	9.5	254.66
24	Damauli	Bharatpur	132	11.82	0.01	39.00	4.61	9.5	43.79
25	Dhalkebar	Mirchaiya	132	80.45	0.01	31.50	25.34	9.5	240.76
26	Dhalkebar	Mirchaiya	132	80.45	0.01	31.50	25.34	9.5	240.76
27	Duhabi	Damak	132	8.83	0.002	140.0	2.47	18.8	46.50
28	Bardaghat	Gandak	132	10.29	0.002	140.0	2.88	18.8	54.19
29	Amarpur	Ilam	132	9.43	0.01	48.90	4.61	9.5	43.80
30	Amarpur	Ilam	132	9.43	0.01	14.00	1.32	9.5	12.54
31	Amarpur	Pathlaiya	132	7.90	0.01	66.50	5.25	9.5	49.89
32	Inariwa	Duhabi	132	132.91	0.01	66.50	88.38	9.5	839.66
33	Inariwa	Duhabi	132	2.77	0.01	37.00	1.02	9.5	9.73
34	Kohalpur	Kusum	132	11.20	0.01	10.00	1.12	9.5	10.64
35	Kul-3	Ter(15)	132	30.22	0.01	10.00	3.02	9.5	28.71
36	Kushaha	Inariwa	132	7.00	0.0035	106.00	2.60	35.5	92.19

37	Inariwa	Kushaha	132	69.10	0.01	48.30	33.37	9.5	317.04
38	Kushma	Modi1	132	68.69	0.01	0.50	0.34	9.5	3.26
39	Kusum	Hapure	132	10.31	0.01	13.10	1.35	9.5	12.83
40	Lahan	Rupani	132	10.31	0.01	13.10	1.35	9.5	12.83
41	Lahan	Rupani	132	11.57	0.0035	39.00	1.58	35.5	56.08
42	Ghorahi Bus	Lamahi	132	11.62	0.0035	39.00	1.59	35.5	56.30
43	Ghorahi Bus	Lamahi	132	82.73	0.01	6.00	4.96	9.5	47.15
44	Lamahi	Jhimruk	132	82.73	0.01	18.00	14.89	9.5	141.46
45	Lekhath SS	Damauli	132	10.96	0.01	27.00	2.96	9.5	28.10
46	Lumki	Bungaoon	132	10.96	0.01	27.00	2.96	9.5	28.10
47	Lumki	Bungaoon	132	2.53	0.01	13.00	0.33	9.5	3.12
48	Kirtipur SS	M-Mars	132	25.17	0.01	13.00	3.27	9.5	31.09
49	M.nagar	Attariya	132	7.54	0.01	49.49	3.73	9.5	35.45
50	M.nagar	Attariya	132	7.64	0.01	45.00	3.44	9.5	32.67
51	Matatirtha	Hetauda	132	7.64	0.01	33.90	2.59	9.5	24.61
52	NewModi	Modi	132	33.83	0.01	33.90	11.47	9.5	108.93
53	Sandhikharka	Motipur	132	8.67	0.01	17.00	1.47	9.5	14.00
54	Sandhikharka	Motipur	132	8.67	0.01	51.40	4.46	9.5	42.33
55	Motipur	Shivapur	132	2.43	0.01	51.40	1.25	9.5	11.87
56	Motipur	Shivapur	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Butwal	Sunwal SS	132	5.76	0.01	0.30	0.02	9.5	0.16
58	New Butwal	BB2	132	5.76	0.01	37.00	2.13	9.5	20.26
59	NMRS	Matatirtha	132	76.09	0.01	37.00	28.15	9.5	267.44
60	NMRS	Matatirtha	132	76.09	0.01	23.00	17.50	9.5	166.25
61	Nabalpur	Dhalkebar	132	109.07	0.01	23.00	25.09	9.5	238.33
62	Nabalpur	Dhalkebar	132	109.07	0.01	20.00	21.81	9.5	207.24
63	Lahachok	New Modi	132	47.40	0.01	20.00	9.48	9.5	90.06
64	Lahachok	New Modi	132	47.40	0.01	84.00	39.81	9.5	378.24
65	NewBharatpur	Hetauda	132	86.78	0.01	84.00	72.89	9.5	692.50
66	New Modi	Pokhara	132	86.78	0.01	34.75	30.16	9.5	286.48
67	NewBharatpur	Marsyangd	132	5.94	0.01	34.75	2.06	9.5	19.60
68	Pathlaiya	Chapur	132	0.00	0.01	20.00	0.00	9.5	0.00
69	Phalampur	Lumki	132	64.35	0.01	20.00	12.87	9.5	122.27
70	Phalampur	Lumki	132	14.26	0.01	75.00	10.69	9.5	101.58
71	Rupani	Kushaha	132	14.26	0.0035	88.00	4.39	35.5	155.88
72	Rupani	Kushaha	132	0.00	0.0035	88.00	0.00	35.5	0.00
73	Trishuli3B Hub	Matatirtha	132	26.32	0.01	37.00	9.74	9.5	92.52
74	Trishuli3B Hub	Matatirtha	132	68.52	0.01	25.00	17.13	9.5	162.73
75	Samundatar	Trisuli3BH	132	1.85	0.01	30.68	0.57	9.5	5.41
76	Samundatar	Trisuli3BH	132	1.85	0.01	28.90	0.54	9.5	5.09
77	Lamosanghu	Khimti	132	71.86	0.01	28.90	20.77	9.5	197.29
78	Syaule SS	Attariya	132	71.86	0.01	34.90	25.08	9.5	238.25

79	SyauleSS	Attariya	132	0.00	0.01	34.90	0.00	9.5	0.00
80	Mirchaiya	Tingla	132	26.59	0.01	49.00	13.03	9.5	123.80
81	Mirchaiya	Tingla	132	13.33	0.01	49.00	6.53	9.5	62.03
82	Malekhu	Terminal(4)	132	13.33	0.01	26.00	3.46	9.5	32.91
83	Balaju	Chapali	132	24.02	0.01	26.00	6.25	9.5	59.34
84	Balaju	Chapali	132	21.74	0.01	40.00	8.70	9.5	82.62
85	Switchatar	Balaju1	132	21.74	0.01	60.00	13.05	9.5	123.93
86	Bhaktapur	Charayan	132	21.60	0.01	60.00	12.96	9.5	123.12
87	Bhaktapur	Charayan	132	21.60	0.01	90.00	19.44	9.5	184.68
88	Bhaktapur	Bharatpur	132	11.60	0.01	90.00	10.44	9.5	99.19
89	Butwal	KGA	132	17.58	0.01	0.20	0.04	9.5	0.33
90	Butwal	KGA	132	17.58	0.028	12.90	6.35	10.8	68.59
91	Chapali	Ch.Narayan	132	8.15	0.028	12.90	2.94	10.8	31.77
92	Chapali	Ch.Narayan	132	8.15	0.01	10.00	0.81	9.5	7.74
93	Damak	Anamani	132	26.77	0.01	10.00	2.68	9.5	25.43
94	NMRS	Damauli	132	26.92	0.028	2.00	1.51	10.8	16.28
95	NMRS	Damauli	132	7.97	0.01	4.40	0.35	9.5	3.33
96	Bharatpur	Hetauda	132	7.97	0.028	29.00	6.47	10.8	69.91
97	Hetauda	Kamane	132	1.18	0.028	29.00	0.96	10.8	10.37
98	Hetauda	Ter(15)	132	43.90	0.028	8.03	9.87	10.8	106.61
99	Terminal(15)	Kul-2	132	14.84	0.028	8.24	3.42	10.8	36.97
100	Damak	Ilam	132	35.56	0.01	3.65	1.30	9.5	12.33
101	Damak	Ilam	132	35.56	0.01	3.65	1.30	9.5	12.33
102	Kamane	Pathlaiya	132	15.46	0.028	13.57	5.87	9.5	55.80
103	Kohalpur	Kusum	132	18.53	0.01	0.50	0.09	9.5	0.88
104	Kul-1	Switchatar	132	18.53	0.028	9.00	4.67	10.8	50.43
105	Hetauda	Kul-1	132	39.92	0.028	9.00	10.06	10.8	108.65
106	Kushaha	Kataiya	132	39.92	0.01	58.00	23.15	9.5	219.96
107	Kushaha	Kataiya	132	8.41	0.01	58.00	4.88	9.5	46.32
108	Kusum	Lamahi	132	8.41	0.01	8.24	0.69	9.5	6.58
109	Kusum	Lamahi	132	10.30	0.01	8.24	0.85	9.5	8.06
110	Lahachok	BB2	132	34.77	0.028	29.30	28.52	10.8	308.05
111	BB2	Lahachok	132	7.04	0.028	29.30	5.78	10.8	62.40
112	Lainchaur	Newchabil	132	7.04	0.028	10.00	1.97	10.8	21.30
113	Lamahi	Shivapur	132	204.23	0.01	26.70	54.53	9.5	518.03
114	Lamahi	Shivapur	132	204.23	0.01	23.00	46.97	9.5	446.24
115	Lamosanghu	Bhotekoshi	132	18.46	0.01	23.00	4.25	9.5	40.33
116	BB1	Lamosanghu	132	18.46	0.028	20.17	10.42	10.8	112.58
117	BB2	SyangjaSS	132	0.00	0.028	20.17	0.00	10.8	0.00
118	Marsyangdi	Terminal(4)	132	27.62	0.01	70.85	19.57	9.5	185.91
119	Terminal(4)	Switchatar132kv	132	15.96	0.01	18.50	2.95	9.5	28.05
120	Switchatar	Matatirtha	132	8.98	0.01	5.24	0.47	9.5	4.47

121	Switchatar	Matatirtha	132	24.64	0.01	3.00	0.74	9.5	7.02
122	Mirchaiya	Lahan	132	24.64	0.01	31.50	7.76	9.5	73.72
123	Mirchaiya	Lahan	132	7.31	0.01	31.50	2.30	9.5	21.87
124	M-Mars	Damauli	132	35.39	0.01	18.50	6.55	9.5	62.19
125	Newchabil	Chapali	132	43.32	0.0035	75.00	11.37	35.5	403.68
126	M-Mars	NMRS	132	6.64	0.0035	75.00	1.74	35.5	61.85
127	M-Mars	NMRS	132	6.64	0.01	48.30	3.21	9.5	30.46
128	NMRS	Marsyangdi	132	30.22	0.01	32.86	9.93	9.5	94.34
129	Marsyangdi	NMRS	132	13.28	0.028	32.86	12.22	10.8	131.97
130	Pathlaiya	Parwanipur	132	13.28	0.028	28.50	10.60	10.8	114.46
131	Pathlaiya	Parwanipur	132	7.02	0.01	15.05	1.06	9.5	10.03
132	Pathlaiya	Chapur	132	3.73	0.028	15.05	1.57	10.8	16.97
133	Lekhnath	Pokhara	132	3.73	0.028	13.00	1.36	10.8	14.66
134	Terminal(1)	Gandak	132	0.00	0.01	13.00	0.00	9.5	0.00
135	Terminal	Pokhara	132	0.00	0.01	13.00	0.00	9.5	0.00
136	SyangjaSS	KGA	132	0.00	0.01	47.50	0.00	9.5	0.00
137	Teku	K-3	66	38.09	0.01	47.50	18.09	9.5	171.89
138	Trisuli	Devighat	66	38.09	0.01	42.00	16.00	9.5	151.99
139	BB2	Lahachok 132kV	132	4.47	0.01	42.00	1.88	9.5	17.83
140	Lainchaur	Newchabil	132	4.76	0.01	2.30	0.11	9.5	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
143	Lamahi	Shivapur	132	60.37	0.01	51.00	30.79	9.5	292.48
144	Lamosanghu	Bhotekoshi	132	60.37	0.01	24.65	14.88	9.5	141.36
145	BB1	Lamosanghu	132	21.42	0.01	45.84	9.82	9.5	93.27
146	BB2	SyangjaSS	132	151.78	0.01	41.00	62.23	9.5	591.19
147	Marsyangdi	Ter(4)	132	43.14	0.01	40.00	17.25	9.5	163.91
148	Terminal(4)	Switchatar132kv	132	31.13	0.01	84.00	26.15	9.5	248.43
149	Switchatar1	Matatirtha	132	58.98	0.01	4.40	2.60	9.5	24.65
150	Switchatar132k	Matatirtha	132	58.98	0.01	4.40	2.60	9.5	24.65
151	Mirchaiya	Lahan	132	92.10	0.01	27.68	25.49	9.5	242.19
152	Mirchaiya	Lahan	132	92.10	0.01	27.68	25.49	9.5	242.19
153	M-Mars	Damauli	132	44.52	0.01	58.00	25.82	9.5	245.28
154	Newchabil	Chapali	132	24.39	0.01	5.00	1.22	9.5	11.59
155	Newchabil	Chapali	66	24.39	0.028	5.00	3.41	10.8	36.88
156	M-Mars	NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
157	M-Mars	NMRS	132	68.66	0.01	40.00	27.46	9.5	260.91
158	NMRS	Marsyangd	132	11.07	0.01	5.00	0.55	9.5	5.26
159	Marsyangdi(M	NMRS	132	11.07	0.01	5.00	0.55	9.5	5.26
160	Panchkhal	Sunkoshi	66	0.24	0.028	29.00	0.20	10.8	2.15
161	Panchkhal	Indrawati	66	3.98	0.028	28.00	3.12	10.8	33.71
162	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00

163	Pathlaiya	Parwanipur	132	65.21	0.01	16.59	10.82	9.5	102.77
164	Pathlaiya	Parwanipur	132	65.21	0.01	16.59	10.82	9.5	102.77
165	Pathlaiya	Chapur	132	68.52	0.01	30.68	21.02	9.5	199.70
166	LekhnathSS	Pokhara	132	25.17	0.01	7.00	1.76	9.5	16.74
167	Terminal(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	9.5	0.00
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	28.69	0.028	6.50	5.22	10.8	56.39
172	Switchatar	Balaju	66	1.56	0.028	4.40	0.19	10.8	2.08
173	Switchatar	Balaju	66	1.56	0.028	4.40	0.19	10.8	2.08
174	Switchatar	K-3	66	19.82	0.028	6.90	3.83	10.8	41.35
175	Teku	Switchatar	66	36.78	0.028	4.10	4.22	10.8	45.60
176	Switchatar	Patan	66	28.69	0.028	6.50	5.22	10.8	56.39
177	SyangaSS	KGA	132	5.39	0.01	55.00	2.96	9.5	28.16
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				5772.7	3		1847.83		18396.72

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	18396.72
Cost of Energy (ECOST) = EENS x IEAR	9198.36
Cost of Energy (ECOST) in Nrs	1225957120.75
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1225957120.75

Annex B: Reliability indices for dry season at normal load scenario.

Calculation of EPNS and EENS of Existing INPS at normal load condition (case I)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	36.24	0.01	35.19	12.75	9.5	121.14
2	Attariya	Phalampur	132	36.24	0.01	35.19	12.75	9.5	121.14
3	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
4	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
5	Bardaghat	N Butwal	132	56.86	0.01	10.00	5.69	9.5	54.01
6	Bardaghat	N Butwal	132	56.86	0.01	10.00	5.69	9.5	54.01
7	Bardaghat	Sardi	132	17.31	0.01	14.00	2.42	9.5	23.02
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	39.18	0.01	34.00	13.32	9.5	126.55
10	NewBharatpur	Bardaghat	132	51.97	0.01	74.00	38.46	9.5	365.38
11	Bhaktapur	Lamosangh	132	131.63	0.01	48.30	63.58	9.5	603.98
12	Bhaktapur	Lamosangh	132	131.63	0.01	48.30	63.58	9.5	603.98
13	Kawasoti	Bharatpur	132	56.45	0.01	36.00	20.32	9.5	193.06
14	Burigaon	Kohalpur	132	23.37	0.01	55.29	12.92	9.5	122.76
15	Burigaon	Kohalpur	132	23.37	0.01	55.29	12.92	9.5	122.76
16	Butwal	Sunwal	132	52.46	0.01	13.00	6.82	9.5	64.79
17	Butwal	BB2	132	52.46	0.01	13.00	6.82	9.5	64.79
18	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
19	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
20	Motipur	Butwal	132	48.34	0.01	38.00	18.37	9.5	174.51
21	Motipur	Butwal	132	48.34	0.01	38.00	18.37	9.5	174.51
22	Chapur	Nabalpur	132	130.19	0.01	34.75	45.24	9.5	429.77
23	Chapur	Nabalpur	132	128.03	0.01	34.75	44.49	9.5	422.66
24	Damauli	Bharatpur	132	36.86	0.01	39.00	14.37	9.5	136.56
25	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.20
26	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.20
27	Dhalkebar	Muzafapur	400	8.74	0.002	140.00	2.45	18.8	46.00
28	Dhalkebar	Muzafapur	400	49.41	0.002	140.00	13.84	18.8	260.10
29	Duhabi	Damak	132	9.43	0.01	48.90	4.61	9.5	43.80
30	Bardaghat	Gandak	132	9.43	0.01	14.00	1.32	9.5	12.54
31	Amarpur	Ilam	132	94.76	0.01	66.50	63.01	9.5	598.63
32	Amarpur	Ilam	132	132.82	0.01	66.50	88.32	9.5	839.07
33	Amarpur	Pathlaiya	132	2.77	0.01	37.00	1.02	9.5	9.73
34	Inariwa	Duhabi	132	11.20	0.01	10.00	1.12	9.5	10.64
35	Inariwa	Duhabi	132	3.54	0.01	10.00	0.35	9.5	3.36

36	Inariwa	Tumlingta	220	7.00	0.0035	106.00	2.60	35.5	92.19
37	Kohalpur	Kusum	132	69.04	0.01	48.30	33.34	9.5	316.78
38	Kul-3	Ter(15)	132	68.64	0.01	0.50	0.34	9.5	3.26
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	9.5	12.83
40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	9.5	12.83
41	Dana	Kushma	220	11.57	0.0035	39.00	1.58	35.5	56.07
42	Dana	Kushma	220	11.62	0.0035	39.00	1.59	35.5	56.31
43	Kushma	Modi I	132	20.64	0.01	6.00	1.24	9.5	11.76
44	Kusum	Hapure	132	20.64	0.01	18.00	3.72	9.5	35.29
45	Lahan	Rupani	132	10.96	0.01	27.00	2.96	9.5	28.10
46	Lahan	Rupani	132	10.96	0.01	27.00	2.96	9.5	28.10
47	Ghorahi Bus	Lamahi	132	2.56	0.01	13.00	0.33	9.5	3.16
48	Ghorahi Bus	Lamahi	132	25.17	0.01	13.00	3.27	9.5	31.09
49	Lamahi	Jhimruk	132	7.54	0.01	49.49	3.73	9.5	35.45
50	Lekhnath SS	Damauli	132	26.44	0.01	45.00	11.90	9.5	113.04
51	Lumki	Burigaon	132	26.44	0.01	33.90	8.96	9.5	85.16
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	9.5	108.93
53	Kirtipur SS	M-Mars	132	26.33	0.01	17.00	4.48	9.5	42.52
54	M.nagar	Attariya	132	26.33	0.01	51.40	13.53	9.5	128.57
55	M.nagar	Attariya	132	31.18	0.01	51.40	16.03	9.5	152.27
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Modi	Modi	132	5.76	0.01	0.30	0.02	9.5	0.16
58	Sandhikharka	Motipur	132	5.76	0.01	37.00	2.13	9.5	20.26
59	Sandhikharka	Motipur	132	39.99	0.01	37.00	14.80	9.5	140.56
60	Motipur	Shivapur	132	39.99	0.01	23.00	9.20	9.5	87.38
61	Motipur	Shivapur	132	70.81	0.01	23.00	16.29	9.5	154.73
62	New Butwal	Sunwal SS	132	70.81	0.01	20.00	14.16	9.5	134.54
63	New Butwal	BB2	132	6.69	0.01	20.00	1.34	9.5	12.71
64	NMRS	Matatirtha	132	6.69	0.01	84.00	5.62	9.5	53.38
65	NMRS	Matatirtha	132	140.46	0.01	84.00	117.99	9.5	1120.86
66	Nabalpur	Dhalkebar	132	140.46	0.01	34.75	48.81	9.5	463.69
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	9.5	19.59
68	Lahachok	New Modi	132	0.00	0.01	20.00	0.00	9.5	0.00
69	Lahachok	New Modi	132	48.45	0.01	20.00	9.69	9.5	92.06
70	NewBharatpur	Hetauda	132	14.26	0.01	75.00	10.69	9.5	101.58
71	Kushma	N Butwal	220	14.26	0.0035	88.00	4.39	35.5	155.88
72	Kushma	N Butwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	70.87	0.01	37.00	26.22	9.5	249.12
74	NewBharatpur	Marsyangd	132	117.89	0.01	25.00	29.47	9.5	279.99
75	Pathlaiya	Chapur	132	32.44	0.01	30.68	9.95	9.5	94.55
76	Phalampur	Lumki	132	32.44	0.01	28.90	9.38	9.5	89.07
77	Phalampur	Lumki	132	10.90	0.01	28.90	3.15	9.5	29.92

78	Rupani	Kushaha	132	10.90	0.01	34.90	3.80	9.5	36.14
79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	9.5	0.00
80	Trishuli3B Hub	Matatirtha	132	26.59	0.01	49.00	13.03	9.5	123.78
81	Trishuli3B Hub	Matatirtha	132	13.33	0.01	49.00	6.53	9.5	62.03
82	Samundartar	Trisuli3B H	132	13.33	0.01	26.00	3.46	9.5	32.91
83	Samundartar	Trisuli3B H	132	24.01	0.01	26.00	6.24	9.5	59.31
84	Lamosanghu	Khimti	132	21.71	0.01	40.00	8.68	9.5	82.51
85	Syaule SS	Attariya	132	21.71	0.01	60.00	13.03	9.5	123.76
86	Syaule SS	Attariya	132	21.60	0.01	60.00	12.96	9.5	123.13
87	Mirchaiya	Tingla	132	21.60	0.01	90.00	19.44	9.5	184.69
88	Mirchaiya	Tingla	132	11.60	0.01	90.00	10.44	9.5	99.19
89	Malekhu	Terminal(4)	132	17.59	0.01	0.20	0.04	9.5	0.33
90	Amlekhgunj	Simara	66	17.59	0.028	12.90	6.36	10.8	68.64
91	Amlekhgunj	Simara	66	48.95	0.028	12.90	17.68	10.8	190.94
92	Balaju	Chapali	132	48.95	0.01	10.00	4.89	9.5	46.50
93	Balaju	Chapali	132	26.77	0.01	10.00	2.68	9.5	25.43
94	Lainchaur	Balaju	66	51.06	0.028	2.00	2.86	10.8	30.88
95	Switchatar	Balaju1	132	7.97	0.01	4.40	0.35	9.5	3.33
96	Balaju	Trisuli	66	7.97	0.028	29.00	6.47	10.8	69.87
97	Balaju	Trisuli	66	1.10	0.028	29.00	0.89	10.8	9.65
98	Banepa	Panchkhal	66	43.90	0.028	8.03	9.87	10.8	106.61
99	Baneshwor	Bhaktapur	66	14.84	0.028	8.24	3.42	10.8	36.97
100	Bhaktapur	Charayan	132	76.66	0.01	3.65	2.80	9.5	26.58
101	Bhaktapur	Charayan	132	76.66	0.01	3.65	2.80	9.5	26.58
102	Bhaktapur	Banepa	66	61.55	0.028	13.57	23.39	9.5	222.17
103	Bhaktapur	Bharatpur	132	18.53	0.01	0.50	0.09	9.5	0.88
104	Parwanipur	Birgunj	66	18.53	0.028	9.00	4.67	10.8	50.43
105	Parwanipur	Birgunj	66	39.84	0.028	9.00	10.04	10.8	108.43
106	Butwal	KGA	132	39.84	0.01	58.00	23.11	9.5	219.53
107	Butwal	KGA	132	8.29	0.01	58.00	4.81	9.5	45.69
108	Chapali	Ch.Narayan	132	8.29	0.01	8.24	0.68	9.5	6.49
109	Chapali	Ch.Narayan	132	10.30	0.01	8.24	0.85	9.5	8.06
110	Chapali	Devighat	66	34.77	0.028	29.30	28.52	10.8	308.04
111	Chapali	Devighat	66	14.79	0.028	29.30	12.13	10.8	131.02
112	Chilime	Trisuli	66	14.79	0.028	10.00	4.14	10.8	44.72
113	Damak	Anamani	132	245.42	0.01	26.70	65.53	9.5	622.52
114	NMRS	Damauli	132	245.42	0.01	23.00	56.45	9.5	536.25
115	NMRS	Damauli	132	18.49	0.01	23.00	4.25	9.5	40.40
116	Hetauda	Amlekhgunj	66	18.49	0.028	20.17	10.44	10.8	112.79
117	Hetauda	Amlekhgunj	66	0.00	0.028	20.17	0.00	10.8	0.00
118	Bharatpur	Hetauda	132	46.30	0.01	70.85	32.80	9.5	311.60
119	Hetauda	Kamane	132	12.72	0.01	18.50	2.35	9.5	22.36

120	Hetauda	Ter(15)	132	19.70	0.01	5.24	1.03	9.5	9.81
121	Terminal(15)	Kul-2	132	24.66	0.01	3.00	0.74	9.5	7.03
122	Damak	Ilam	132	24.66	0.01	31.50	7.77	9.5	73.79
123	Damak	Ilam	132	81.42	0.01	31.50	25.65	9.5	243.65
124	Kamane	Pathlaiya	132	35.35	0.01	18.50	6.54	9.5	62.13
125	U Khimti	Dhalkebar	220	43.32	.0035	75.00	11.37	35.5	403.67
126	U Khimti	Dhalkebar	220	55.44	.0035	75.00	14.55	35.5	516.68
127	Kohalpur	Kusum	132	55.44	0.01	48.30	26.78	9.5	254.41
128	Kul-1	Switchatar	132	3.54	0.01	32.86	1.16	9.5	11.04
129	Kul-1	Switchatar	66	16.47	0.028	32.86	15.16	10.8	163.69
130	Kul-2	Matatirtha	66	16.47	0.028	28.50	13.15	10.8	141.97
131	Hetauda	Kul-1	132	35.68	0.01	15.05	5.37	9.5	51.02
132	Hetauda	Kul-1	66	0.52	0.028	15.05	0.22	10.8	2.38
133	Kushaha	Kataiya	66	0.52	0.028	13.00	0.19	10.8	2.06
134	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.22
135	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.22
136	Kusum	Lamahi	132	39.86	0.01	47.50	18.93	9.5	179.86
137	Kusum	Lamahi	132	4.02	0.01	47.50	1.91	9.5	18.14
138	Lahachok	BB2	132	4.02	0.01	42.00	1.69	9.5	16.04
139	BB2	Lahachok	132	4.48	0.01	42.00	1.88	9.5	17.86
140	Lainchaur	Newchabil	132	4.75	0.01	2.30	0.11	9.5	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
143	Lamahi	Shivapur	132	25.86	0.01	51.00	13.19	9.5	125.27
144	Lamosanghu	Bhotekoshi	132	25.86	0.01	24.65	6.37	9.5	60.55
145	BB1	Lamosanghu	132	21.41	0.01	45.84	9.82	9.5	93.25
146	BB2	SyangjaSS	132	249.40	0.01	41.00	102.25	9.5	971.40
147	Marsyangdi	Terminal(4)	132	4.59	0.01	40.00	1.84	9.5	17.44
148	Terminal(4)	Switchatar	132	7.04	0.01	84.00	5.91	9.5	56.18
149	Switchatar	Matatirtha	132	34.10	0.01	4.40	1.50	9.5	14.25
150	Switchatar	Matatirtha	132	34.10	0.01	4.40	1.50	9.5	14.25
151	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	9.5	75.34
152	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	9.5	75.34
153	M-Mars	Damauli	132	49.77	0.01	58.00	28.87	9.5	274.25
154	Newchabil	Chapali	132	24.39	0.01	5.00	1.22	9.5	11.59
155	Newchabil	Chapali	66	24.39	0.028	5.00	3.41	10.8	36.88
156	M-Mars	NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
157	M-Mars	NMRS	132	63.40	0.01	40.00	25.36	9.5	240.91
158	NMRS	Marsyangdi	132	18.61	0.01	5.00	0.93	9.5	8.84
159	Marsyangdi	NMRS	132	18.60	0.01	5.00	0.93	9.5	8.84
160	Panchkhal	Sunkoshi	66	0.24	0.028	29.00	0.20	10.8	2.15
161	Panchkhal	Indrawati	66	4.04	0.028	28.00	3.17	10.8	34.21

162	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00
163	Pathlaiya	Parwanipur	132	24.83	0.01	16.59	4.12	9.5	39.13
164	Pathlaiya	Parwanipur	132	24.83	0.01	16.59	4.12	9.5	39.13
165	Pathlaiya	Chapur	132	117.89	0.01	30.68	36.17	9.5	343.60
166	Lekhnath	Pokhara	132	25.17	0.01	7.00	1.76	9.5	16.74
167	Terminal(1)	Gandak	132	60.00	0.01	0.10	0.06	9.5	0.57
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	9.5	0.00
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	28.70	0.028	6.50	5.22	10.8	56.42
172	Switchatar	Balaju	66	0.19	0.028	4.40	0.02	10.8	0.25
173	Switchatar	Balaju	66	0.19	0.028	4.40	0.02	10.8	0.25
174	Switchatar	K-3	66	19.88	0.028	6.90	3.84	10.8	41.48
175	Teku	Switchatar	66	36.72	0.028	4.10	4.22	10.8	45.53
176	Switchatar	Patan	66	28.70	0.028	6.50	5.22	10.8	56.42
177	SyangjaSS	KGA	132	5.33	0.01	55.00	2.93	9.5	27.84
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total							2007.55		20384.25

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw.hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	20384.25
Cost of Energy (ECOST) = EENS x IEAR	10192.12
Cost of Energy (ECOST) in Nrs	1358406274.4 3
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1358406274.4 3

(II) Calculation of EPNS and EENS of Existing INPS at normal load case II

Dynamal

S.N.	Bus		Voltage (kV)	P.Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTT R (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	36.23	0.01	35.19	12.75	9.5	121.13
2	Attariya	Phalampur	132	36.23	0.01	35.19	12.75	9.5	121.13
3	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
4	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	9.5	169.60
5	Bardaghat	N Butwal	132	44.16	0.01	10.00	4.42	9.5	41.95
6	Bardaghat	N Butwal	132	44.16	0.01	10.00	4.42	9.5	41.95
7	Bardaghat	Sardi	132	17.31	0.01	14.00	2.42	9.5	23.02
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	26.79	0.01	34.00	9.11	9.5	86.53
10	NewBharat	Bardaghat	132	38.42	0.01	74.00	28.43	9.5	270.10
11	Bhaktapur	Lamosanghu	132	125.75	0.01	48.30	60.73	9.5	576.98
12	Bhaktapur	Lamosanghu	132	125.75	0.01	48.30	60.73	9.5	576.98
13	Kawasoti	Bharatpur	132	44.06	0.01	36.00	15.86	9.5	150.69
14	Burigaon	Kohalpur	132	23.36	0.01	55.29	12.92	9.5	122.71
15	Burigaon	Kohalpur	132	23.36	0.01	55.29	12.92	9.5	122.71
16	Butwal	Sunwal SS	132	52.35	0.01	13.00	6.81	9.5	64.65
17	Butwal	BB2	132	52.35	0.01	13.00	6.81	9.5	64.65
18	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
19	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	9.5	34.72
20	Motipur	Butwal	132	48.29	0.01	38.00	18.35	9.5	174.32
21	Motipur	Butwal	132	48.29	0.01	38.00	18.35	9.5	174.32
22	Chapur	Nabalpur	132	121.31	0.01	34.75	42.15	9.5	400.46
23	Chapur	Nabalpur	132	119.48	0.01	34.75	41.52	9.5	394.44
24	Damauli	Bharatpur	132	31.67	0.01	39.00	12.35	9.5	117.34
25	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.19
26	Dhalkebar	Mirchaiya	132	15.77	0.01	31.50	4.97	9.5	47.19
29	Duhabi	Damak	132	9.43	0.01	48.90	4.61	9.5	43.80
30	Bardaghat	Gandak	132	9.43	0.01	14.00	1.32	9.5	12.54
31	Amarpur	Ilam	132	85.41	0.01	66.50	56.80	9.5	539.56
32	Amarpur	Ilam	132	132.82	0.01	66.50	88.32	9.5	839.06
33	Amarpur	Pathlaiya	132	2.77	0.01	37.00	1.02	9.5	9.73
34	Inariwa	Duhabi	132	11.20	0.01	10.00	1.12	9.5	10.64
35	Inariwa	Duhabi	132	3.52	0.01	10.00	0.35	9.5	3.35
37	Kohalpur	Kusum	132	69.04	0.01	48.30	33.34	9.5	316.77
38	Kul-3	Ter(15)	132	68.64	0.01	0.50	0.34	9.5	3.26
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	9.5	12.83

40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	95	12.83
43	Kushma	Modi1	132	20.64	0.01	6.00	1.24	95	11.77
44	Kusum	Hapure	132	20.64	0.01	18.00	3.72	95	35.30
45	Lahan	Rupani	132	10.96	0.01	27.00	2.96	95	28.10
46	Lahan	Rupani	132	10.96	0.01	27.00	2.96	95	28.10
47	Ghorahi Bus	Lamahi	132	2.51	0.01	13.00	0.33	95	3.10
48	Ghorahi Bus	Lamahi	132	25.17	0.01	13.00	3.27	95	31.09
49	Lamahi	Jhimruk	132	7.54	0.01	49.49	3.73	95	35.45
50	Lekhnath SS	Damauli	132	26.43	0.01	45.00	11.90	95	113.01
51	Lumki	Burigaon	132	26.43	0.01	33.90	8.96	95	85.13
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	95	108.93
53	Kiritipur SS	M-Mars	132	26.33	0.01	17.00	4.48	95	42.52
54	Mnagar	Attariya	132	26.33	0.01	51.40	13.53	95	128.57
55	Mnagar	Attariya	132	29.17	0.01	51.40	14.99	95	142.45
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	95	0.00
57	New Modi	Modi	132	5.76	0.01	0.30	0.02	95	0.16
58	Sandhikharka	Motipur	132	5.76	0.01	37.00	2.13	95	20.26
59	Sandhikharka	Motipur	132	39.94	0.01	37.00	14.78	95	140.37
60	Motipur	Shivapur	132	39.94	0.01	23.00	9.19	95	87.26
61	Motipur	Shivapur	132	70.67	0.01	23.00	16.25	95	154.42
62	New Butwal	Sunwal SS	132	70.67	0.01	20.00	14.13	95	134.28
63	New Butwal	BB2	132	0.96	0.01	20.00	0.19	95	1.83
64	NMRS	Matatirtha	132	0.96	0.01	84.00	0.81	95	7.68
65	NMRS	Matatirtha	132	131.30	0.01	84.00	110.29	95	1047.79
66	Nabalpur	Dhalkebar	132	131.30	0.01	34.75	45.63	95	433.46
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	95	19.59
68	Lahachok	New Modi	132	0.00	0.01	20.00	0.00	95	0.00
69	Lahachok	New Modi	132	37.26	0.01	20.00	7.45	95	70.80
70	NewBharatpur	Hetauda	132	14.26	0.01	75.00	10.69	95	101.58
73	New Modi	Pokhara	132	60.73	0.01	37.00	22.47	95	213.45
74	NewBharatpur	Marsyangd	132	109.66	0.01	25.00	27.42	95	260.44
75	Pathlaiya	Chapur	132	32.44	0.01	30.68	9.95	95	94.54
76	Phalampur	Lumki	132	32.44	0.01	28.90	9.37	95	89.05
77	Phalampur	Lumki	132	10.90	0.01	28.90	3.15	95	29.93
78	Rupani	Kushaha	132	10.90	0.01	34.90	3.80	95	36.14
79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	95	0.00
80	Trishuli3B Hub	Matatirtha	132	26.59	0.01	49.00	13.03	95	123.79
81	Trishuli3B Hub	Matatirtha	132	13.33	0.01	49.00	6.53	95	62.03
82	Samundartar	Trisuli3B H	132	13.33	0.01	26.00	3.46	95	32.91
83	Samundartar	Trisuli3B H	132	24.01	0.01	26.00	6.24	95	59.32
84	Lamosanghu	Khimti	132	21.71	0.01	40.00	8.69	95	82.52
85	Syaule SS	Attariya	132	21.71	0.01	60.00	13.03	95	123.77

86	Syaule SS	Attariya	132	21.60	0.01	60.00	12.96	95	123.13
87	Mirchaiya	Tingla	132	21.60	0.01	90.00	19.44	95	184.69
88	Mirchaiya	Tingla	132	11.60	0.01	90.00	10.44	95	99.19
89	Malekhu	Terminal(4)	132	17.59	0.01	0.20	0.04	95	0.33
92	Balaju	Chapali	132	43.24	0.01	10.00	4.32	95	41.07
93	Balaju	Chapali	132	26.77	0.01	10.00	2.68	95	25.43
95	Switchatar	Balaju 1	132	7.98	0.01	4.40	0.35	95	3.34
100	Bhaktapur	Charayan	132	70.86	0.01	3.65	2.59	95	24.57
101	Bhaktapur	Charayan	132	70.86	0.01	3.65	2.59	95	24.57
103	Bhaktapur	Bharatpur	132	18.53	0.01	0.50	0.09	95	0.88
106	Butwal	KGA	132	39.86	0.01	58.00	23.12	95	219.66
107	Butwal	KGA	132	8.33	0.01	58.00	4.83	95	45.91
108	Chapali	Ch.Narayan	132	8.33	0.01	8.24	0.69	95	6.52
109	Chapali	Ch.Narayan	132	10.30	0.01	8.24	0.85	95	8.06
113	Damak	Anamani	132	228.32	0.01	26.70	60.96	95	579.14
114	NMRS	Damauli	132	228.32	0.01	23.00	52.51	95	498.88
115	NMRS	Damauli	132	18.48	0.01	23.00	4.25	95	40.39
118	Bharatpur	Hetauda	132	39.68	0.01	70.85	28.11	95	267.09
119	Hetauda	Kamane	132	10.71	0.01	18.50	1.98	95	18.83
120	Hetauda	Ter(15)	132	17.69	0.01	5.24	0.93	95	8.80
121	Terminal(15)	Kul-2	132	24.66	0.01	3.00	0.74	95	7.03
122	Damak	Ilam	132	24.66	0.01	31.50	7.77	95	73.79
123	Damak	Ilam	132	74.76	0.01	31.50	23.55	95	223.73
124	Kamane	Pathlaiya	132	35.36	0.01	18.50	6.54	95	62.15
127	Kohalpur	Kusum	132	48.24	0.01	48.30	23.30	95	221.36
128	Kul-1	Switchatar	132	3.52	0.01	32.86	1.16	95	11.00
131	Hetauda	Kul-1	132	33.67	0.01	15.05	5.07	95	48.14
134	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	95	49.22
135	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	95	49.22
136	Kusum	Lamahi	132	39.86	0.01	47.50	18.93	95	179.86
137	Kusum	Lamahi	132	4.03	0.01	47.50	1.92	95	18.21
138	Lahachok	BB2	132	4.03	0.01	42.00	1.69	95	16.10
139	BB2	Lahachok	132	4.47	0.01	42.00	1.88	95	17.85
140	Lainchaur	Newchabil	132	4.75	0.01	2.30	0.11	95	1.04
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	95	0.00
143	Lamahi	Shivapur	132	25.85	0.01	51.00	13.18	95	125.23
144	Lamosanghu	Bhotekoshi	132	25.85	0.01	24.65	6.37	95	60.53
145	BB1	Lamosanghu	132	21.41	0.01	45.84	9.82	95	93.26
146	BB2	SyangjaSS	132	234.99	0.01	41.00	96.35	95	915.29
147	Marsyangdi	Terminal(4)	132	8.76	0.01	40.00	3.50	95	33.29
148	Terminal(4)	Switchatar132kv	132	2.88	0.01	84.00	2.42	95	22.96
149	Switchatar	Matatirtha	132	37.83	0.01	4.40	1.66	95	15.81

150	Switchatar	Matatirtha	132	37.83	0.01	4.40	1.66	95	15.81
151	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	95	75.34
152	Mirchaiya	Lahan	132	28.65	0.01	27.68	7.93	95	75.34
153	M-Mars	Damauli	132	49.22	0.01	58.00	28.55	95	271.18
154	Newchabil	Chapali	132	24.39	0.01	5.00	1.22	95	11.59
156	M-Mars	NMRS	132	0.00	0.01	40.00	0.00	95	0.00
157	M-Mars	NMRS	132	63.96	0.01	40.00	25.58	95	243.04
158	NMRS	Marsyangdi	132	15.51	0.01	5.00	0.78	95	7.37
159	Marsyangdi	NMRS	132	15.50	0.01	5.00	0.77	95	7.36
163	Pathlaiya	Parwanipur	132	24.81	0.01	16.59	4.12	95	39.11
164	Pathlaiya	Parwanipur	132	24.81	0.01	16.59	4.12	95	39.11
165	Pathlaiya	Chapur	132	109.66	0.01	30.68	33.64	95	319.62
166	Lekhnath	Pokhara	132	25.17	0.01	7.00	1.76	95	16.74
167	Terminal(1)	Gandak	132	60.00	0.01	0.10	0.06	95	0.57
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	95	0.00
177	SyangjaSS	KGA	132	5.34	0.01	55.00	2.94	95	27.92
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total							1899.09		19297.24

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	19297.24
Cost of Energy (ECOST) = EENS x IEAR	9648.62
Cost of Energy (ECOST) in Nrs	1285967855.63
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1285967855.63

(III) Calculation of EPNS and EENS of Existing INPS at normal load when optimum power import via NB-G line (case III)

S.N.	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	1.63	0.01	35.19	0.57	95	5.44
2	Attariya	Phalampur	132	1.63	0.01	35.19	0.57	95	5.44
3	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	95	169.60
4	Balanch	Syaule SS	132	25.50	0.01	70.00	17.85	95	169.60
5	Bardaghat	N Butwal	132	103.74	0.01	10.00	10.37	95	98.55
6	Bardaghat	N Butwal	132	103.74	0.01	10.00	10.37	95	98.55
7	Bardaghat	Sardi	132	17.30	0.01	14.00	2.42	95	23.01
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	95	0.00
9	Kawasoti	Bardaghat	132	86.50	0.01	34.00	29.41	95	279.38
10	NewBharatpur	Bardaghat	132	81.02	0.01	74.00	59.95	95	569.57
11	Bhaktapur	Lamosanghu	132	90.10	0.01	48.30	43.52	95	413.44
12	Bhaktapur	Lamosanghu	132	90.10	0.01	48.30	43.52	95	413.44
13	Kawasoti	Bharatpur	132	69.23	0.01	36.00	24.92	95	236.75
14	Burigaon	Kohalpur	132	10.56	0.01	55.29	5.84	95	55.46
15	Burigaon	Kohalpur	132	10.56	0.01	55.29	5.84	95	55.46
16	Butwal	Sunwal SS	132	89.57	0.01	13.00	11.64	95	110.62
17	Butwal	BB2	132	89.57	0.01	13.00	11.64	95	110.62
18	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	95	34.72
19	Mainahiya	Butwal	132	20.30	0.01	18.00	3.65	95	34.72
20	Motipur	Butwal	132	84.44	0.01	38.00	32.09	95	304.82
21	Motipur	Butwal	132	84.44	0.01	38.00	32.09	95	304.82
22	Chapur	Nabalpur	132	77.86	0.01	34.75	27.06	95	257.03
23	Chapur	Nabalpur	132	77.14	0.01	34.75	26.81	95	254.66
24	Damauli	Bharatpur	132	11.82	0.01	39.00	4.61	95	43.79
25	Dhalkebar	Mirchaiya	132	80.45	0.01	31.50	25.34	95	240.76
26	Dhalkebar	Mirchaiya	132	80.45	0.01	31.50	25.34	95	240.76
27	Duhabi	Damak	132	8.83	0.002	14.00	2.47	18.8	46.50
28	Bardaghat	Gandak	132	10.29	0.002	14.00	2.88	18.8	54.19
29	Amarpur	Ilam	132	9.43	0.01	48.90	4.61	95	43.80
30	Amarpur	Ilam	132	9.43	0.01	14.00	1.32	95	12.54
31	Amarpur	Pathlaiya	132	7.90	0.01	66.50	5.25	95	49.89
32	Inariwa	Duhabi	132	132.91	0.01	66.50	88.38	95	839.66
33	Inariwa	Duhabi	132	2.77	0.01	37.00	1.02	95	9.73
34	Kohalpur	Kusum	132	11.20	0.01	10.00	1.12	95	10.64
35	Kul-3	Ter(15)	132	30.22	0.01	10.00	3.02	95	28.71
36	Kushaha	Inariwa	132	7.00	0.0035	106.00	2.60	35.5	92.19

37	Inariwa	Kushaha	132	69.10	0.01	48.30	33.37	95	317.04
38	Kushma	Modi I	132	68.69	0.01	0.50	0.34	95	3.26
39	Kusum	Hapure	132	10.31	0.01	13.10	1.35	95	12.83
40	Lahan	Rupani	132	10.31	0.01	13.10	1.35	95	12.83
41	Lahan	Rupani	132	11.57	0.0035	39.00	1.58	35.5	56.08
42	Ghorahi Bus	Lamahi	132	11.62	0.0035	39.00	1.59	35.5	56.30
43	Ghorahi Bus	Lamahi	132	82.73	0.01	6.00	4.96	95	47.15
44	Lamahi	Jhimruk	132	82.73	0.01	18.00	14.89	95	141.46
45	Lekhnath SS	Damauli	132	10.96	0.01	27.00	2.96	95	28.10
46	Lumki	Burigaon	132	10.96	0.01	27.00	2.96	95	28.10
47	Lumki	Burigaon	132	2.53	0.01	13.00	0.33	95	3.12
48	Kirtipur SS	M-Mars	132	25.17	0.01	13.00	3.27	95	31.09
49	M.nagar	Attariya	132	7.54	0.01	49.49	3.73	95	35.45
50	M.nagar	Attariya	132	7.64	0.01	45.00	3.44	95	32.67
51	Matatirtha	Hetauda	132	7.64	0.01	33.90	2.59	95	24.61
52	New Modi	Modi	132	33.83	0.01	33.90	11.47	95	108.93
53	Sandhikharka	Motipur	132	8.67	0.01	17.00	1.47	95	14.00
54	Sandhikharka	Motipur	132	8.67	0.01	51.40	4.46	95	42.33
55	Motipur	Shivapur	132	2.43	0.01	51.40	1.25	95	11.87
56	Motipur	Shivapur	132	0.00	0.01	36.24	0.00	95	0.00
57	New Butwal	Sunwal SS	132	5.76	0.01	0.30	0.02	95	0.16
58	New Butwal	BB2	132	5.76	0.01	37.00	2.13	95	20.26
59	NMRS	Matatirtha	132	76.09	0.01	37.00	28.15	95	267.44
60	NMRS	Matatirtha	132	76.09	0.01	23.00	17.50	95	166.25
61	Nabalpur	Dhalkebar	132	109.07	0.01	23.00	25.09	95	238.33
62	Nabalpur	Dhalkebar	132	109.07	0.01	20.00	21.81	95	207.24
63	Lahachok	New Modi	132	47.40	0.01	20.00	9.48	95	90.06
64	Lahachok	New Modi	132	47.40	0.01	84.00	39.81	95	378.24
65	NewBharatpur	Hetauda	132	86.78	0.01	84.00	72.89	95	692.50
66	New Modi	Pokhara	132	86.78	0.01	34.75	30.16	95	286.48
67	NewBharatpur	Marsyangd	132	5.94	0.01	34.75	2.06	95	19.60
68	Pathlaiya	Chapur	132	0.00	0.01	20.00	0.00	95	0.00
69	Phalampur	Lumki	132	64.35	0.01	20.00	12.87	95	122.27
70	Phalampur	Lumki	132	14.26	0.01	75.00	10.69	95	101.58
71	Rupani	Kushaha	132	14.26	0.0035	88.00	4.39	35.5	155.88
72	Rupani	Kushaha	132	0.00	0.0035	88.00	0.00	35.5	0.00
73	Trishuli3B Hub	Matatirtha	132	26.32	0.01	37.00	9.74	95	92.52
74	Trishuli3B Hub	Matatirtha	132	68.52	0.01	25.00	17.13	95	162.73
75	Samundatar	Trisuli3B H	132	1.85	0.01	30.68	0.57	95	5.41
76	Samundatar	Trisuli3B H	132	1.85	0.01	28.90	0.54	95	5.09
77	Lamosanghu	Khimti	132	71.86	0.01	28.90	20.77	95	197.29
78	Syaule SS	Attariya	132	71.86	0.01	34.90	25.08	95	238.25

79	SyauleSS	Attariya	132	0.00	0.01	34.90	0.00	95	0.00
80	Mirchaiya	Tingla	132	26.59	0.01	49.00	13.03	95	123.80
81	Mirchaiya	Tingla	132	13.33	0.01	49.00	6.53	95	62.03
82	Malekhu	Terminal(4)	132	13.33	0.01	26.00	3.46	95	32.91
83	Balaju	Chapali	132	24.02	0.01	26.00	6.25	95	59.34
84	Balaju	Chapali	132	21.74	0.01	40.00	8.70	95	82.62
85	Switchatar	Balaju1	132	21.74	0.01	60.00	13.05	95	123.93
86	Bhaktapur	Charayan	132	21.60	0.01	60.00	12.96	95	123.12
87	Bhaktapur	Charayan	132	21.60	0.01	90.00	19.44	95	184.68
88	Bhaktapur	Bharatpur	132	11.60	0.01	90.00	10.44	95	99.19
89	Butwal	KGA	132	17.58	0.01	0.20	0.04	95	0.33
90	Butwal	KGA	132	17.58	0.028	12.90	6.35	10.8	68.59
91	Chapali	Ch.Narayan	132	8.15	0.028	12.90	2.94	10.8	31.77
92	Chapali	Ch.Narayan	132	8.15	0.01	10.00	0.81	95	7.74
93	Damak	Anamani	132	26.77	0.01	10.00	2.68	95	25.43
94	NMRS	Damauli	132	26.92	0.028	2.00	1.51	10.8	16.28
95	NMRS	Damauli	132	7.97	0.01	4.40	0.35	95	3.33
96	Bharatpur	Hetauda	132	7.97	0.028	29.00	6.47	10.8	69.91
97	Hetauda	Kamane	132	1.18	0.028	29.00	0.96	10.8	10.37
98	Hetauda	Ter(15)	132	43.90	0.028	8.03	9.87	10.8	106.61
99	Terminal(15)	Kul-2	132	14.84	0.028	8.24	3.42	10.8	36.97
100	Damak	Ilam	132	35.56	0.01	3.65	1.30	95	12.33
101	Damak	Ilam	132	35.56	0.01	3.65	1.30	95	12.33
102	Kamane	Pathlaiya	132	15.46	0.028	13.57	5.87	95	55.80
103	Kohalpur	Kusum	132	18.53	0.01	0.50	0.09	95	0.88
104	Kul-1	Switchatar	132	18.53	0.028	9.00	4.67	10.8	50.43
105	Hetauda	Kul-1	132	39.92	0.028	9.00	10.06	10.8	108.65
106	Kushaha	Kataiya	132	39.92	0.01	58.00	23.15	95	219.96
107	Kushaha	Kataiya	132	8.41	0.01	58.00	4.88	95	46.32
108	Kusum	Lamahi	132	8.41	0.01	8.24	0.69	95	6.58
109	Kusum	Lamahi	132	10.30	0.01	8.24	0.85	95	8.06
110	Lahachok	BB2	132	34.77	0.028	29.30	28.52	10.8	308.05
111	BB2	Lahachok	132	7.04	0.028	29.30	5.78	10.8	62.40
112	Lainchaur	Newchabil	132	7.04	0.028	10.00	1.97	10.8	21.30
113	Lamahi	Shivapur	132	204.23	0.01	26.70	54.53	95	518.03
114	Lamahi	Shivapur	132	204.23	0.01	23.00	46.97	95	446.24
115	Lamosanghu	Bhotekoshi	132	18.46	0.01	23.00	4.25	95	40.33
116	BB1	Lamosanghu	132	18.46	0.028	20.17	10.42	10.8	112.58
117	BB2	SyangjaSS	132	0.00	0.028	20.17	0.00	10.8	0.00
118	Marsyangdi	Terminal(4)	132	27.62	0.01	70.85	19.57	95	185.91
119	Terminal(4)	Switchatar132kv	132	15.96	0.01	18.50	2.95	95	28.05
120	Switchatar	Matatirtha	132	8.98	0.01	5.24	0.47	95	4.47

121	Switchatar	Matatirtha	132	24.64	0.01	3.00	0.74	95	7.02
122	Mirchaiya	Lahan	132	24.64	0.01	31.50	7.76	95	73.72
123	Mirchaiya	Lahan	132	7.31	0.01	31.50	2.30	95	21.87
124	M-Mars	Damauli	132	35.39	0.01	18.50	6.55	95	62.19
125	Newchabil	Chapali	132	43.32	0.0035	75.00	11.37	35.5	403.68
126	M-Mars	NMRS	132	6.64	0.0035	75.00	1.74	35.5	61.85
127	M-Mars	NMRS	132	6.64	0.01	48.30	3.21	95	30.46
128	NMRS	Marsyangdi	132	30.22	0.01	32.86	9.93	95	94.34
129	Marsyangdi	NMRS	132	13.28	0.028	32.86	12.22	10.8	131.97
130	Pathlaiya	Parwanipur	132	13.28	0.028	28.50	10.60	10.8	114.46
131	Pathlaiya	Parwanipur	132	7.02	0.01	15.05	1.06	95	10.03
132	Pathlaiya	Chapur	132	3.73	0.028	15.05	1.57	10.8	16.97
133	Lekhnath	Pokhara	132	3.73	0.028	13.00	1.36	10.8	14.66
134	Terminal(1)	Gandak	132	0.00	0.01	13.00	0.00	95	0.00
135	Terminal	Pokhara	132	0.00	0.01	13.00	0.00	95	0.00
136	SyangjaSS	KGA	132	0.00	0.01	47.50	0.00	95	0.00
137	Teku	K-3	66	38.09	0.01	47.50	18.09	95	171.89
138	Trisuli	Devighat	66	38.09	0.01	42.00	16.00	95	151.99
139	BB2	Lahachok 132kV	132	4.47	0.01	42.00	1.88	95	17.83
140	Lainchaur	Newchabil	132	4.76	0.01	2.30	0.11	95	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	95	0.00
143	Lamahi	Shivapur	132	60.37	0.01	51.00	30.79	95	292.48
144	Lamosanghu	Bhotekoshi	132	60.37	0.01	24.65	14.88	95	141.36
145	BB1	Lamosanghu	132	21.42	0.01	45.84	9.82	95	93.27
146	BB2	SyangjaSS	132	151.78	0.01	41.00	62.23	95	591.19
147	Marsyangd	Ter(4)	132	43.14	0.01	40.00	17.25	95	163.91
148	Terminal(4)	Switchatar 132kv	132	31.13	0.01	84.00	26.15	95	248.43
149	Switchatar	Matatirtha	132	58.98	0.01	4.40	2.60	95	24.65
150	Switchatar	Matatirtha	132	58.98	0.01	4.40	2.60	95	24.65
151	Mirchaiya	Lahan	132	92.10	0.01	27.68	25.49	95	242.19
152	Mirchaiya	Lahan	132	92.10	0.01	27.68	25.49	95	242.19
153	M-Mars	Damauli	132	44.52	0.01	58.00	25.82	95	245.28
154	Newchabil	Chapali	132	24.39	0.01	5.00	1.22	95	11.59
155	Newchabil	Chapali	66	24.39	0.028	5.00	3.41	10.8	36.88
156	M-Mars	-NMRS	132	0.00	0.01	40.00	0.00	95	0.00
157	M-Mars	NMRS	132	68.66	0.01	40.00	27.46	95	260.91
158	NMRS	Marsyangdi	132	11.07	0.01	5.00	0.55	95	5.26
159	Marsyangdi	NMRS	132	11.07	0.01	5.00	0.55	95	5.26
160	Panchkhal	Sunkoshi	66	0.24	0.028	29.00	0.20	10.8	2.15
161	Panchkhal	Indrawati	66	3.98	0.028	28.00	3.12	10.8	33.71
162	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00

163	Pathlaiya	Parwanipur	132	65.21	0.01	16.59	10.82	95	102.77
164	Pathlaiya	Parwanipur	132	65.21	0.01	16.59	10.82	95	102.77
165	Pathlaiya	Chapur	132	68.52	0.01	30.68	21.02	95	199.70
166	Lekhnath SS	Pokhara	132	25.17	0.01	7.00	1.76	95	16.74
167	Terminal(1)	Gandak	132	0.00	0.01	0.10	0.00	95	0.00
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	95	0.00
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	28.69	0.028	6.50	5.22	10.8	56.39
172	Switchatar	Balaju	66	1.56	0.028	4.40	0.19	10.8	2.08
173	Switchatar	Balaju	66	1.56	0.028	4.40	0.19	10.8	2.08
174	Switchatar	K-3	66	19.82	0.028	6.90	3.83	10.8	41.35
175	Teku	Switchatar	66	36.78	0.028	4.10	4.22	10.8	45.60
176	Switchatar	Patan	66	28.69	0.028	6.50	5.22	10.8	56.39
177	SyangjaSS	KGA	132	5.39	0.01	55.00	2.96	95	28.16
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				5772.7	3		1847.83		18396.72

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	18396.72
Cost of Energy (ECOST) = EENS x IEAR	9198.36
Cost of Energy (ECOST) in Nrs	1225957120.75
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1225957120.75

Annex C: Reliability indices for dry season at off-peak load scenario.

(I) Calculation of EPNS and EENS of Existing INPS at dry Off-Peak load

(Base Case i.e. case I)

S.N	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	38.36	0.01	35.19	13.50	95	128.22
2	Attariya	Phalampur	132	38.36	0.01	35.19	13.50	95	128.22
3	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	95	143.00
4	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	95	143.00
5	Bardaghat	NeButwal	132	64.40	0.01	10.00	6.44	95	61.18
6	Bardaghat	NButwal	132	64.40	0.01	10.00	6.44	95	61.18
7	Bardaghat	Sardi	132	12.97	0.01	14.00	1.82	95	17.25
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	95	0.00
9	Kawasoti	Bardaghat	132	43.02	0.01	34.00	14.63	95	138.96
10	NewBharatp	Bardaghat	132	54.26	0.01	74.00	40.15	95	381.46
11	Bhaktapur	amosangh	132	104.76	0.01	48.30	50.60	95	480.71
12	Bhaktapur	Lamosang	132	104.76	0.01	48.30	50.60	95	480.71
13	Kawasoti	Bharatpur	132	55.97	0.01	36.00	20.15	95	191.43
14	Burigaon	Kohalpur	132	28.50	0.01	55.29	15.76	95	149.71
15	Burigaon	Kohalpur	132	28.50	0.01	55.29	15.76	95	149.71
16	Butwal	Sunwal	132	62.75	0.01	13.00	8.16	95	77.50
17	Butwal	BB2	132	62.75	0.01	13.00	8.16	95	77.50
18	Mainahiya	Butwal	132	17.40	0.01	18.00	3.13	95	29.76
19	Mainahiya	Butwal	132	17.40	0.01	18.00	3.13	95	29.76
20	Motipur	Butwal	132	35.79	0.01	38.00	13.60	95	129.21
21	Motipur	Butwal	132	35.79	0.01	38.00	13.60	95	129.21
22	Chapur	Nabalpur	132	116.36	0.01	34.75	40.44	95	384.14
23	Chapur	Nabalpur	132	112.82	0.01	34.75	39.20	95	372.44
24	Damauli	Bharatpur	132	32.80	0.01	39.00	12.79	95	121.52
25	Dhalkebar	Mirchaiya	132	4.48	0.01	31.50	1.41	95	13.40
26	Dhalkebar	Mirchaiya	132	4.48	0.01	31.50	1.41	95	13.40
27	Dhalkebar	Muzafapur	400	9.05	0.002	140.0	2.53	18.8	47.62
28	Dhalkebar	Muzafapur	400	52.17	0.002	140.0	14.61	18.8	274.62
29	Duhabi	Damak	132	9.83	0.01	48.90	4.81	95	45.67
30	Bardaghat	Gandak	132	9.83	0.01	14.00	1.38	95	13.08
31	Amarpur	Ilam	132	72.84	0.01	66.50	48.44	95	460.17
32	Amarpur	Ilam	132	64.92	0.01	66.50	43.17	95	410.13
33	Hetauda	Pathlaiya	132	64.92	0.01	37.00	24.02	95	228.19

34	Inariwa 1	Duhabi	132	12.80	0.01	10.00	1.28	95	12.16
35	Inariwa 2	Duhabi	132	5.34	0.01	10.00	0.53	95	5.07
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.0	0.00	35.5	0.00
37	Kohalpur	Kusum	132	63.68	0.01	48.30	30.76	95	292.22
38	Kul-3	Temin(15	132	63.35	0.01	0.50	0.32	95	3.01
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	95	12.83
40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	95	12.83
41	Dana220kV	Kushma	220	12.54	0.0035	39.00	1.71	35.5	60.76
42	Dana220kV	Kushma	220	8.71	0.0035	39.00	1.19	35.5	42.21
43	Kushma	Modi	132	12.44	0.01	6.00	0.75	95	7.09
44	Kusum	Hapure	132	12.44	0.01	18.00	2.24	95	21.26
45	Lahan	Rupani	132	8.22	0.01	27.00	2.22	95	21.08
46	Lahan	Rupani	132	8.22	0.01	27.00	2.22	95	21.08
47	Ghorahi	Lamahi	132	1.11	0.01	13.00	0.14	95	1.38
48	Ghorahi	Lamahi	132	18.68	0.01	13.00	2.43	95	23.06
49	Lamahi	Jhimruk	132	5.66	0.01	49.49	2.80	95	26.59
50	Lekhnath S	Damauli	132	30.88	0.01	45.00	13.89	95	131.99
51	Lumki	Burigaon	132	30.88	0.01	33.90	10.47	95	99.43
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	95	108.93
53	Kirtipur SS	M-Mars	132	28.50	0.01	17.00	4.84	95	46.02
54	Mahendrana	Attariya	132	28.50	0.01	51.40	14.65	95	139.16
55	Mahendrana	Attariya	132	10.31	0.01	51.40	5.30	95	50.35
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	95	0.00
57	New Modi	Modi	132	4.32	0.01	0.30	0.01	95	0.12
58	Sandhikhark	Motipur	132	4.32	0.01	37.00	1.60	95	15.20
59	Sandhikhark	Motipur	132	29.53	0.01	37.00	10.93	95	103.80
60	Motipur	Shivapur	132	29.53	0.01	23.00	6.79	95	64.52
61	Motipur	Shivapur	132	79.19	0.01	23.00	18.21	95	173.03
62	NeButwal	Sunwal	132	79.19	0.01	20.00	15.84	95	150.46
63	NeButwal	BB2	132	21.86	0.01	20.00	4.37	95	41.54
64	NMRS	Matatirtha	132	21.86	0.01	84.00	18.37	95	174.47
65	NMRS	Matatirtha	132	123.14	0.01	84.00	103.43	95	982.63
66	Nabalpur	Dhalkebar	132	123.14	0.01	34.75	42.79	95	406.51
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	95	19.60
68	Lahachok	NeModi	132	0.00	0.01	20.00	0.00	95	0.00
69	Lahachok	NeModi	132	54.07	0.01	20.00	10.81	95	102.73
70	NeBharatp	Hetauda	132	15.20	0.01	75.00	11.40	95	108.29
71	Kushma	NButwal	220	15.20	0.0035	88.00	4.68	35.5	166.17
72	Kushma	NButwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	63.76	0.01	37.00	23.59	95	224.13
74	NewBharatp	Marsyangd	132	102.48	0.01	25.00	25.62	95	243.40
75	Pathlaiya	Chapur	132	35.43	0.01	30.68	10.87	95	103.28

76	Phalampur	Lumki	132	35.43	0.01	28.90	10.24	95	97.29
77	Phalampur	Lumki	132	5.16	0.01	28.90	1.49	95	14.16
78	Rupani	Kushaha	132	5.16	0.01	34.90	1.80	95	17.10
79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	95	0.00
80	Trishuli3B	Matatirtha	132	26.60	0.01	49.00	13.03	95	123.82
81	Trishuli3B	Matatirtha	132	13.33	0.01	49.00	6.53	95	62.03
82	Samundartar	Trishulihub	132	13.33	0.01	26.00	3.46	95	32.91
83	Samundartar	TrishulHu	132	24.02	0.01	26.00	6.25	95	59.33
84	Lamosangh	Khimti	132	18.71	0.01	40.00	7.48	95	71.08
85	Syaule SS	Attariya	132	18.71	0.01	60.00	11.22	95	106.63
86	Syaule SS	Attariya	132	22.00	0.01	60.00	13.20	95	125.41
87	Mirchaiya	Tingla	132	22.00	0.01	90.00	19.80	95	188.11
88	Mirchaiya	Tingla	132	8.70	0.01	90.00	7.83	95	74.39
89	Malekhu	Terminal(4	132	6.24	0.01	0.20	0.01	95	0.12
90	Amlekhgunj	Simara	66	6.24	0.028	12.90	2.25	10.8	24.33
91	Amlekhgunj	Simara	66	56.05	0.028	12.90	20.25	10.8	218.66
92	Balaju	Chapali	132	56.05	0.01	10.00	5.61	95	53.25
93	Balaju	Chapali	132	14.65	0.01	10.00	1.47	95	13.92
94	Lainchaur	Balaju	66	82.04	0.028	2.00	4.59	10.8	49.62
95	Switchata	Balaju	132	8.99	0.01	4.40	0.40	95	3.76
96	Balaju	Trisuli	66	8.99	0.028	29.00	7.30	10.8	78.85
97	Balaju	Trisuli	66	1.49	0.028	29.00	1.21	10.8	13.09
98	Banepa	Panchkhal	66	24.03	0.028	8.03	5.40	10.8	58.36
99	Baneshwor	Bhaktapur	66	5.91	0.028	8.24	1.36	10.8	14.74
100	Bhaktapu	Ch.narayan	132	75.62	0.01	3.65	2.76	95	26.22
101	Bhaktapu	Ch.narayan	132	75.62	0.01	3.65	2.76	95	26.22
102	Bhaktapur	Banepa	66	59.22	0.028	13.57	22.50	95	213.77
103	NewBharatp	Bharatpur	132	19.40	0.01	0.50	0.10	95	0.92
104	Parwanipur	Birgunj	66	19.40	0.028	9.00	4.89	10.8	52.80
105	Parwanipur	Birgunj	66	18.90	0.028	9.00	4.76	10.8	51.43
106	Butwal	KGA	132	18.90	0.01	58.00	10.96	95	104.11
107	Butwal	KGA	132	1.35	0.01	58.00	0.78	95	7.42
108	Chapali	Changunar	132	1.35	0.01	8.24	0.11	95	1.05
109	Chapali	Changunar	132	10.30	0.01	8.24	0.85	95	8.06
110	Chapali	Devighat	66	26.01	0.028	29.30	21.34	10.8	230.49
111	Chapali	Devighat	66	14.45	0.028	29.30	11.86	10.8	128.06
112	Chilime	Trisuli	66	14.45	0.028	10.00	4.05	10.8	43.71
113	Damak	Anamani	132	208.43	0.01	26.70	55.65	95	528.67
114	NMRS	Damauli	132	208.43	0.01	23.00	47.94	95	455.41
115	NMRS	Damauli	132	6.72	0.01	23.00	1.55	95	14.69
116	Hetauda	Amlekhgu	66	6.72	0.028	20.17	3.80	10.8	41.01
117	Hetauda	Amlekhgu	66	0.00	0.028	20.17	0.00	10.8	0.00

118	Bharatpur	Hetauda	132	3096	0.01	70.85	21.94	95	208.38
119	Hetauda	Kamane	132	10.21	0.01	18.50	1.89	95	17.95
120	Hetauda	Terma(15)	132	10.21	0.01	5.24	0.53	95	5.08
121	Teral(15)	Kul-2	132	26.29	0.01	3.00	0.79	95	7.49
122	Damak	Ilam	132	26.29	0.01	31.50	8.28	95	78.68
123	Damak	Ilam	132	63.68	0.01	31.50	20.06	95	190.57
124	Kamane	Pathlaiya	132	38.69	0.01	18.50	7.16	95	68.01
125	UppKhimti	Dhalkebar	220	44.76	0.0035	75.00	11.75	35.5	417.12
126	UppKhimti	Dhalkebar	220	51.09	0.0035	75.00	13.41	35.5	476.11
127	Kohalpur	Kusum	132	51.09	0.01	48.30	24.68	95	234.44
128	Kul-1	Switchatar	132	5.34	0.01	32.86	1.75	95	16.65
129	Kul-1	Switchatar	66	5.75	0.028	32.86	5.29	10.8	57.11
130	Kul-2	Matatirtha	66	5.75	0.028	28.50	4.59	10.8	49.53
131	Hetauda	Kul-1	132	10.20	0.01	15.05	1.54	95	14.59
132	Hetauda	Kul-1	66	3.01	0.028	15.05	1.27	10.8	13.68
133	Kushaha	Kataiya	66	3.01	0.01	13.00	0.39	95	3.71
134	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	95	49.23
135	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	95	49.23
136	Kusum	Lamahi	132	39.86	0.01	47.50	18.93	95	179.87
137	Kusum	Lamahi	132	0.34	0.01	47.50	0.16	95	1.55
138	Lahachok	BB2	132	0.34	0.01	42.00	0.14	95	1.37
139	BB2	Lahachok	132	4.49	0.01	42.00	1.89	95	17.93
140	Lainchaur	Newchabil	132	4.74	0.01	2.30	0.11	95	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	95	0.00
143	Lamahi	Shivapur	132	17.41	0.01	51.00	8.88	95	84.36
144	Lamosangh	Bhotekoshi	132	17.41	0.01	24.65	4.29	95	40.77
145	BB1	Lamosang	132	21.42	0.01	45.84	9.82	95	93.27
146	BB2	SyangjaSS	132	180.69	0.01	41.00	74.08	95	703.79
147	Marsyangdi	Terma(4)	132	9.31	0.01	40.00	3.72	95	35.36
148	Terminal(4)	Switchatar	132	18.05	0.01	84.00	15.16	95	144.05
149	Switchatar	Matatirtha	132	1.67	0.01	4.40	0.07	95	0.70
150	Switchatar	Matatirtha	132	1.67	0.01	4.40	0.07	95	0.70
151	Mirchaiya	Lahan	132	17.82	0.01	27.68	4.93	95	46.86
152	Mirchaiya	Lahan	132	17.82	0.01	27.68	4.93	95	46.86
153	M-Mars	Damauli	132	35.40	0.01	58.00	20.53	95	195.07
154	Newchabil	Chapali	132	14.45	0.028	5.00	2.02	10.8	21.84
155	Newchabil	Chapali	66	14.45	0.028	5.00	2.02	10.8	21.84
156	M-Mars	-NMRS	132	0.00	0.01	40.00	0.00	95	0.00
157	M-Mars	NMRS	132	42.76	0.01	40.00	17.11	95	162.50
158	NMRS	Marsyangd	132	25.39	0.01	5.00	1.27	95	12.06
159	Marsyangdi	NMRS	132	25.37	0.01	5.00	1.27	95	12.05

160	Panchkhal	Sunkoshi	66	1.13	0.028	29.00	0.92	10.8	9.89
161	Panchkhal	Indrawati	66	4.04	0.028	28.00	3.16	10.8	34.18
162	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00
163	Pathlaiya	Parwanipu	132	30.88	0.01	16.59	5.12	9.5	48.67
164	Pathlaiya	Parwanipu	132	30.88	0.01	16.59	5.12	9.5	48.67
165	Pathlaiya	Chapur	132	102.48	0.01	30.68	31.44	9.5	298.70
166	Lekhnath	Pokhara	132	18.68	0.01	7.00	1.31	9.5	12.42
167	Terminal(1)	Gandak	132	60.00	0.01	0.10	0.06	9.5	0.57
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	9.5	0.00
169	Simara	Parwanipu	66	8.05	0.01	9.60	0.77	10.8	8.35
170	Simara	arwanipur	66	8.05	0.028	9.60	2.17	10.8	23.38
171	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
172	Switchatar	Balaju	66	6.81	0.028	4.40	0.84	10.8	9.06
173	Switchatar	Balaju	66	6.81	0.028	4.40	0.84	10.8	9.06
174	Switchatar	K-3	66	13.26	0.028	6.90	2.56	10.8	27.66
175	Teku	Switchatar	66	24.07	0.028	4.10	2.76	10.8	29.84
176	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
177	SyangjaSS	KGA	132	0.53	0.01	55.00	0.29	9.5	2.75
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				5286.0	2		1725.74		17571.63

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	17571.63
Cost of Energy (ECOST) = EENS x IEAR	8785.82
Cost of Energy (ECOST) in Nrs	1170973755.7 9
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1170973755.7 9

(II) Calculation of EPNS and EENS of Existing INPS at dry Off-Peak load when 25MW power import from NB-G line (Base Case i.e. case II)

S.N.	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	38.36	0.01	35.19	13.50	9.5	128.23
2	Attariya	Phalampur	132	38.36	0.01	35.19	13.50	9.5	128.23
3	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	9.5	143.00
4	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	9.5	143.00
5	Bardaghat	NeButwal	132	51.78	0.01	10.00	5.18	9.5	49.19
6	Bardaghat	NButwal	132	51.78	0.01	10.00	5.18	9.5	49.19
7	Bardaghat	Sardi	132	12.97	0.01	14.00	1.82	9.5	17.25
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	30.76	0.01	34.00	10.46	9.5	99.35
10	NewBharatpu	Bardaghat	132	40.48	0.01	74.00	29.96	9.5	284.60
11	Bhaktapur	Lamosangh	132	99.11	0.01	48.30	47.87	9.5	454.75
12	Bhaktapur	Lamosangh	132	99.11	0.01	48.30	47.87	9.5	454.75
13	Kawasoti	Bharatpur	132	43.71	0.01	36.00	15.74	9.5	149.49
14	Burigaon	Kohalpur	132	28.50	0.01	55.29	15.76	9.5	149.71
15	Burigaon	Kohalpur	132	28.50	0.01	55.29	15.76	9.5	149.71
16	Butwal	Sunwal SS	132	62.75	0.01	13.00	8.16	9.5	77.49
17	Butwal	BB2	132	62.75	0.01	13.00	8.16	9.5	77.49
18	Mainahiya.SS	Butwal	132	17.40	0.01	18.00	3.13	9.5	29.76
19	Mainahiya.SS	Butwal	132	17.40	0.01	18.00	3.13	9.5	29.76
20	Motipur	Butwal	132	35.78	0.01	38.00	13.60	9.5	129.18
21	Motipur	Butwal	132	35.78	0.01	38.00	13.60	9.5	129.18
22	Chapur	Nabalpur	132	107.29	0.01	34.75	37.28	9.5	354.18
23	Chapur	Nabalpur	132	104.15	0.01	34.75	36.19	9.5	343.82
24	Damauli	Bharatpur	132	27.74	0.01	39.00	10.82	9.5	102.79
25	Dhalkebar	Mirchaiya	132	4.48	0.01	31.50	1.41	9.5	13.41
26	Dhalkebar	Mirchaiya	132	4.48	0.01	31.50	1.41	9.5	13.41
27	Dhalkebar	Muzafapur	400	9.05	0.002	140.0	2.53	18.8	47.63
28	Dhalkebar	uzafapur	400	52.19	0.002	140.0	14.61	18.8	274.74
29	Duhabi	Damak	132	9.83	0.01	48.90	4.81	9.5	45.67
30	Bardaghat	Gandak	132	9.83	0.01	14.00	1.38	9.5	13.08
31	Amarpur	Ilam	132	64.14	0.01	66.50	42.66	9.5	405.23
32	Amarpur	Ilam	132	64.92	0.01	66.50	43.17	9.5	410.12
33	Hetauda	Pathlaiya	132	64.92	0.01	37.00	24.02	9.5	228.19
34	Inariwa 1	Duhabi	132	12.80	0.01	10.00	1.28	9.5	12.16
35	Inariwa 2	Duhabi	132	5.34	0.01	10.00	0.53	9.5	5.07
36	Inaruwa	unlingtar	220	0.00	0.0035	106.0	0.00	35.5	0.00

37	Kohalpur	Kusum	132	63.68	0.01	48.30	30.76	9.5	292.21
38	Kul-3	ermin(15)	132	63.35	0.01	0.50	0.32	9.5	3.01
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	9.5	12.83
40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	9.5	12.83
41	Dana220kV	Kushma	220	12.54	0.0035	39.00	1.71	35.5	60.76
42	Dana220kV	Kushma	220	8.71	0.0035	39.00	1.19	35.5	42.21
43	Kushma	Modi	132	12.44	0.01	6.00	0.75	9.5	7.09
44	Kusum	Hapure SS	132	12.44	0.01	18.00	2.24	9.5	21.28
45	Lahan	Rupani	132	8.22	0.01	27.00	2.22	9.5	21.08
46	Lahan	Rupani	132	8.22	0.01	27.00	2.22	9.5	21.08
47	Ghorahi Bus	Lamahi	132	1.09	0.01	13.00	0.14	9.5	1.35
48	Ghorahi Bus	Lamahi	132	18.68	0.01	13.00	2.43	9.5	23.06
49	Lamahi	Jhimruk	132	5.66	0.01	49.49	2.80	9.5	26.59
50	Lekhnath SS	Damauli	132	30.88	0.01	45.00	13.89	9.5	131.99
51	Lumki	Burigaon	132	30.88	0.01	33.90	10.47	9.5	99.44
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	9.5	108.93
53	Kirtipur SS	M-Mars	132	28.50	0.01	17.00	4.84	9.5	46.02
54	Mahendranag	Attariya	132	28.50	0.01	51.40	14.65	9.5	139.16
55	Mahendranag	Attariya	132	8.30	0.01	51.40	4.26	9.5	40.51
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Modi	Modi	132	4.32	0.01	0.30	0.01	9.5	0.12
58	Sandhikharka	Motipur	132	4.32	0.01	37.00	1.60	9.5	15.20
59	Sandhikharka	Motipur	132	29.52	0.01	37.00	10.92	9.5	103.77
60	Motipur	Shivapur	132	29.52	0.01	23.00	6.79	9.5	64.50
61	Motipur	Shivapur	132	79.19	0.01	23.00	18.21	9.5	173.04
62	New Butwal	Sunwal	132	79.19	0.01	20.00	15.84	9.5	150.47
63	New Butwal	BB2	132	16.16	0.01	20.00	3.23	9.5	30.70
64	NMRS	Matatirtha	132	16.16	0.01	84.00	13.57	9.5	128.95
65	NMRS	Matatirtha	132	113.88	0.01	84.00	95.66	9.5	908.80
66	Nabalpur	Dhalkebar	132	113.88	0.01	34.75	39.58	9.5	375.96
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	9.5	19.60
68	Lahachok	Nmodi	132	0.00	0.01	20.00	0.00	9.5	0.00
69	Lahachok	New Modi	132	42.69	0.01	20.00	8.54	9.5	81.10
70	NewBharatpu	Hetauda	132	15.20	0.01	75.00	11.40	9.5	108.28
71	Kushma	NeButwal	220	15.20	0.0035	88.00	4.68	35.5	166.17
72	Kushma	NButwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	53.61	0.01	37.00	19.84	9.5	188.45
74	NewBharatp	Marsyangd	132	94.02	0.01	25.00	23.50	9.5	223.29
75	Pathlaiya	Chapur	132	35.44	0.01	30.68	10.87	9.5	103.28
76	Phalampur	Lumki	132	35.44	0.01	28.90	10.24	9.5	97.29
77	Phalampur	Lumki	132	5.16	0.01	28.90	1.49	9.5	14.18
78	Rupani	Kushaha	132	5.16	0.01	34.90	1.80	9.5	17.12

79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	9.5	0.00
80	Trishuli3BH	Matatirtha	132	26.60	0.01	49.00	13.03	9.5	123.82
81	Trishuli3BH	Matatirtha	132	13.33	0.01	49.00	6.53	9.5	62.03
82	Samundartar	Trishulihub	132	13.33	0.01	26.00	3.46	9.5	32.91
83	Samundartar	TrishulHub	132	24.02	0.01	26.00	6.25	9.5	59.34
84	Lamosanghu	Khimti	132	18.71	0.01	40.00	7.48	9.5	71.08
85	SyauleSS	Attariya	132	18.71	0.01	60.00	11.22	9.5	106.63
86	SyauleSS	Attariya	132	22.00	0.01	60.00	13.20	9.5	125.41
87	Mirchaiya	Tingla	132	22.00	0.01	90.00	19.80	9.5	188.12
88	Mirchaiya	Tingla	132	8.70	0.01	90.00	7.83	9.5	74.39
89	Malekhu	Temin(4)	132	7.03	0.01	0.20	0.01	9.5	0.13
90	Amlekhgunj	Simara	66	7.03	0.028	12.90	2.54	10.8	27.44
91	Amlekhgunj	Simara	66	50.52	0.028	12.90	18.25	10.8	197.09
92	Balaju	Chapali	132	50.52	0.01	10.00	5.05	9.5	48.00
93	Balaju	Chapali	132	14.65	0.01	10.00	1.47	9.5	13.92
94	Lainchaur	Balaju	66	71.58	0.028	2.00	4.01	10.8	43.29
95	Switchata	Balaju	132	8.98	0.01	4.40	0.40	9.5	3.75
96	Balaju	Trisuli	66	8.98	0.028	29.00	7.29	10.8	78.74
97	Balaju	Trisuli	66	1.49	0.028	29.00	1.21	10.8	13.09
98	Banepa	Panchkhal	66	24.03	0.028	8.03	5.40	10.8	58.36
99	Baneshwor	Bhaktapur	66	5.91	0.028	8.24	1.36	10.8	14.74
100	Bhaktapu	Chnarayan	132	70.04	0.01	3.65	2.56	9.5	24.29
101	Bhaktapu	Ch.narayan	132	70.04	0.01	3.65	2.56	9.5	24.29
102	Bhaktapur	Banepa	66	51.47	0.028	13.57	19.55	9.5	185.77
103	NewBharatpu	Bharatpur	132	19.40	0.01	0.50	0.10	9.5	0.92
104	Parwanipur	Birgunj	66	19.40	0.028	9.00	4.89	10.8	52.80
105	Parwanipur	Birgunj	66	18.89	0.028	9.00	4.76	10.8	51.42
106	Butwal	KGA	132	18.89	0.01	58.00	10.96	9.5	104.10
107	Butwal	KGA	132	1.35	0.01	58.00	0.78	9.5	7.42
108	Chapali	Changunar	132	1.35	0.01	8.24	0.11	9.5	1.05
109	Chapali	Changunar	132	10.30	0.01	8.24	0.85	9.5	8.06
110	Chapali	Devighat	66	26.01	0.028	29.30	21.34	10.8	230.48
111	Chapali	Devighat	66	12.18	0.028	29.30	9.99	10.8	107.92
112	Chilime	Trisuli	66	12.18	0.028	10.00	3.41	10.8	36.83
113	Damak	Anamani	132	192.02	0.01	26.70	51.27	9.5	487.07
114	NMRS	Damauli	132	192.02	0.01	23.00	44.17	9.5	419.57
115	NMRS	Damauli	132	7.53	0.01	23.00	1.73	9.5	16.45
116	Hetauda	Amlekhgu	66	7.53	0.028	20.17	4.25	10.8	45.91
117	Hetauda	mlekhgunj	66	0.00	0.028	20.17	0.00	10.8	0.00
118	Bharatpur	Hetauda	132	24.75	0.01	70.85	17.54	9.5	166.61
119	Hetauda	Kamane	132	8.21	0.01	18.50	1.52	9.5	14.44
120	Hetauda	Temin(15)	132	8.21	0.01	5.24	0.43	9.5	4.09

121	Terminal(15)	Kul-2	132	26.29	0.01	3.00	0.79	9.5	7.49
122	Damak	Ilam	132	26.29	0.01	31.50	8.28	9.5	78.68
123	Damak	Ilam	132	57.45	0.01	31.50	18.10	9.5	171.91
124	Kamane	Pathlaiya	132	38.69	0.01	18.50	7.16	9.5	68.00
125	UppKhimti	Dhalkebar	220	44.76	0.0035	75.00	11.75	35.5	417.12
126	UppeKhimti	Dhalkebar	220	44.53	0.0035	75.00	11.69	35.5	414.97
127	Kohalpur	Kusum	132	44.53	0.01	48.30	21.51	9.5	204.33
128	Kul-1	Switchatar	132	5.34	0.028	32.86	4.91	10.8	53.02
129	Kul-1	Switchatar	66	5.40	0.028	32.86	4.97	10.8	53.67
130	Kul-2	Matatirtha	66	5.40	0.01	28.50	1.54	9.5	14.62
131	Hetauda	Kul-1	132	8.21	0.028	15.05	3.46	10.8	37.36
132	Hetauda	Kul-1	66	2.66	0.028	15.05	1.12	10.8	12.10
133	Kushaha	Kataiya	66	2.66	0.01	13.00	0.35	9.5	3.28
134	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.23
135	Kushaha	Kataiya	132	39.86	0.01	13.00	5.18	9.5	49.23
136	Kusum	Lamahi	132	39.86	0.01	47.50	18.93	9.5	179.86
137	Kusum	Lamahi	132	0.34	0.01	47.50	0.16	9.5	1.55
138	Lahachok	BB2	132	0.34	0.01	42.00	0.14	9.5	1.37
139	BB2	Lahachok	132	4.49	0.01	42.00	1.89	9.5	17.93
140	Lainchaur	Newchabil	132	4.74	0.01	2.30	0.11	9.5	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
143	Lamahi	Shivapur	132	17.40	0.01	51.00	8.87	9.5	84.30
144	Lamosanghu	Bhotekoshi	132	17.40	0.01	24.65	4.29	9.5	40.75
145	BB1	Lamosang	132	21.42	0.01	45.84	9.82	9.5	93.27
146	BB2	SyangjaSS	132	167.57	0.01	41.00	68.70	9.5	652.68
147	Marsyangdi	Terminal(4)	132	5.27	0.01	40.00	2.11	9.5	20.01
148	Terminal(4)	Switchatar	132	13.99	0.01	84.00	11.75	9.5	111.65
149	Switchatar	Matatirtha	132	2.11	0.01	4.40	0.09	9.5	0.88
150	Switchatar	Matatirtha	132	2.11	0.01	4.40	0.09	9.5	0.88
151	Mirchaiya	Lahan	132	17.82	0.01	27.68	4.93	9.5	46.87
152	Mirchaiya	Lahan	132	17.82	0.01	27.68	4.93	9.5	46.87
153	M-Mars	Damauli	132	34.86	0.01	58.00	20.22	9.5	192.08
154	Newchabil	Chapali	132	14.45	0.028	5.00	2.02	10.8	21.84
155	Newchabil	Chapali	66	14.45	0.028	5.00	2.02	10.8	21.84
156	M-Mars	-NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
157	M-Mars	NMRS	132	43.31	0.01	40.00	17.32	9.5	164.57
158	NMRS	Marsyangd	132	22.23	0.01	5.00	1.11	9.5	10.56
159	Marsyangdi	NMRS	132	22.22	0.01	5.00	1.11	9.5	10.55
160	Panchkhal	Sunkoshi	66	1.13	0.028	29.00	0.92	10.8	9.89
161	Panchkhal	Indrawati	66	4.04	0.028	28.00	3.16	10.8	34.18
162	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00

163	Pathlaiya	Parwanipur	132	30.03	0.01	16.59	4.98	9.5	47.32
164	Pathlaiya	Parwanipur	132	30.03	0.01	16.59	4.98	9.5	47.32
165	Pathlaiya	Chapur	132	94.02	0.01	30.68	28.84	9.5	274.03
166	Lekhnath	Pokhara	132	18.68	0.01	7.00	1.31	9.5	12.42
167	Terminal(1)	Gandak	132	60.00	0.01	0.10	0.06	9.5	0.57
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	9.5	0.00
169	Simara	Parwanipur	66	7.26	0.01	9.60	0.70	10.8	7.53
170	Simara	Parwanipur	66	7.26	0.028	9.60	1.95	10.8	21.08
171	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
172	Switchatar	Balaju	66	6.53	0.028	4.40	0.80	10.8	8.69
173	Switchatar	Balaju	66	6.53	0.028	4.40	0.80	10.8	8.69
174	Switchatar	K-3	66	13.26	0.028	6.90	2.56	10.8	27.66
175	Teku	Switchatar	66	24.07	0.028	4.10	2.76	10.8	29.84
176	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
177	SyangjaSS	KGA	132	0.53	0.01	55.00	0.29	9.5	2.75
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
			Total	4971.19			1618.49		16506.24

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	16506.24
Cost of Energy (ECOST) = EENS x IEAR	8253.12
Cost of Energy (ECOST) in Nrs	1099975555.36
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1099975555.36

(III). Calculation of EPNS and EENS of Existing INPS at dry Off-Peak load when optimum power import from NB-G line (Base Case i.e. case III)

S.N	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MITT R (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	3.63	0.01	35.19	1.28	9.5	12.13
2	Attariya	Phalampur	132	3.63	0.01	35.19	1.28	9.5	12.13
3	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	9.5	143.00

4	Balanch	Syaule SS	132	21.50	0.01	70.00	15.05	95	143.00
5	Bardaghat	NeButwal	132	85.14	0.01	10.00	8.51	95	80.89
6	Bardaghat	NButwal	132	85.14	0.01	10.00	8.51	95	80.89
7	Bardaghat	Sardi	132	12.97	0.01	14.00	1.82	95	17.25
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	95	0.00
9	Kawasoti	Bardaghat	132	72.73	0.01	34.00	24.73	95	234.90
10	NewBharat	Bardaghat	132	68.19	0.01	74.00	50.46	95	479.35
11	Bhaktapur	Lamosang	132	69.29	0.01	48.30	33.47	95	317.96
12	Bhaktapur	Lamosang	132	69.29	0.01	48.30	33.47	95	317.96
13	Kawasoti	Bharatpur	132	59.77	0.01	36.00	21.52	95	204.42
14	Burigaon	Kohalpur	132	5.55	0.01	55.29	3.07	95	29.15
15	Burigaon	Kohalpur	132	5.55	0.01	55.29	3.07	95	29.15
16	Butwal	Sunwal	132	99.40	0.01	13.00	12.92	95	122.76
17	Butwal	BB2	132	99.40	0.01	13.00	12.92	95	122.76
18	Mainahiya	Butwal	132	17.40	0.01	18.00	3.13	95	29.76
19	Mainahiya	Butwal	132	17.40	0.01	18.00	3.13	95	29.76
20	Motipur	Butwal	132	71.55	0.01	38.00	27.19	95	258.28
21	Motipur	Butwal	132	71.55	0.01	38.00	27.19	95	258.28
22	Chapur	Nabalpur	132	67.99	0.01	34.75	23.63	95	224.44
23	Chapur	Nabalpur	132	67.70	0.01	34.75	23.52	95	223.48
24	Damauli	Bharatpur	132	11.81	0.01	39.00	4.61	95	43.77
25	Dhalkebar	Mirchaiya	132	68.21	0.01	31.50	21.49	95	204.11
26	Dhalkebar	Mirchaiya	132	68.21	0.01	31.50	21.49	95	204.11
27	Dhalkebar	Muzafapu	400	8.88	0.002	140.0	2.49	18.8	46.75
28	Dhalkebar	Muzafapu	400	7.39	0.002	140.0	2.07	18.8	38.89
29	Duhabi	Damak	132	9.83	0.01	48.90	4.81	95	45.67
30	Bardaghat	Gandak	132	9.83	0.01	14.00	1.38	95	13.08
31	Amarpur	Ilam	132	15.20	0.01	66.50	10.11	95	96.02
32	Amarpur	Ilam	132	65.01	0.01	66.50	43.23	95	410.71
33	Hetauda	Pathlaiya	132	65.01	0.01	37.00	24.05	95	228.52
34	Inariwa 1	Duhabi	132	12.80	0.01	10.00	1.28	95	12.16
35	Inariwa 2	Duhabi	132	28.49	0.01	10.00	2.85	95	27.07
36	Inaruwa	Tumlingta	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	63.79	0.01	48.30	30.81	95	292.70
38	Kul-3	Termin(15	132	63.44	0.01	0.50	0.32	95	3.01
39	Kushaha	Inariwa	132	10.31	0.01	13.10	1.35	95	12.83
40	Inariwa	Kushaha	132	10.31	0.01	13.10	1.35	95	12.83
41	Dana220kV	Kushma	220	12.54	0.0035	39.00	1.71	35.5	60.76
42	Dana220kV	Kushma	220	8.71	0.0035	39.00	1.19	35.5	42.21
43	Kushma	Modi	132	74.15	0.01	6.00	4.45	95	42.26
44	Kusum	Hapure	132	74.15	0.01	18.00	13.35	95	126.79

45	Lahan	Rupani	132	8.22	0.01	27.00	2.22	95	21.08
46	Lahan	Rupani	132	8.22	0.01	27.00	2.22	95	21.08
47	Ghorahi Bus	Lamahi	132	1.20	0.01	13.00	0.16	95	1.48
48	Ghorahi B	Lamahi	132	18.68	0.01	13.00	2.43	95	23.06
49	Lamahi	Jhimruk	132	5.66	0.01	49.49	2.80	95	26.59
50	Lekhnath SS	Damauli	132	3.35	0.01	45.00	1.51	95	14.32
51	Lumki	Burigaon	132	3.35	0.01	33.90	1.14	95	10.79
52	Lumki	Burigaon	132	33.83	0.01	33.90	11.47	95	108.93
53	Kirtipur SS	M-Mars	132	6.50	0.01	17.00	1.11	95	10.50
54	Mahendrana	Attariya	132	6.50	0.01	51.40	3.34	95	31.75
55	Mahendrana	Attariya	132	17.24	0.01	51.40	8.86	95	84.17
56	Matairtha	Hetauda	132	0.00	0.01	36.24	0.00	95	0.00
57	New Modi	Modi	132	4.32	0.01	0.30	0.01	95	0.12
58	Sandhikhark	Motipur	132	4.32	0.01	37.00	1.60	95	15.20
59	Sandhikhark	Motipur	132	65.29	0.01	37.00	24.16	95	229.48
60	Motipur	Shivapur	132	65.29	0.01	23.00	15.02	95	142.65
61	Motipur	Shivapur	132	117.16	0.01	23.00	26.95	95	256.00
62	NeButwal	Sunwal	132	117.16	0.01	20.00	23.43	95	222.61
63	NButwal	BB2	132	27.70	0.01	20.00	5.54	95	52.64
64	NMRS	Matairtha	132	27.70	0.01	84.00	23.27	95	221.07
65	NMRS	Matairtha	132	74.81	0.01	84.00	62.84	95	596.95
66	Nabalpur	Dhalkebar	132	74.81	0.01	34.75	25.99	95	246.95
67	Nabalpur	Dhalkebar	132	5.94	0.01	34.75	2.06	95	19.60
68	Lahachok	NModi	132	0.00	0.01	20.00	0.00	95	0.00
69	Lahachok	NeModi	132	50.85	0.01	20.00	10.17	95	96.61
70	NBharatpur	Hetauda	132	15.20	0.01	75.00	11.40	95	108.28
71	Kushma	NButwal	220	15.20	0.0035	88.00	4.68	35.5	166.17
72	Kushma	NeButwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	25.25	0.01	37.00	9.34	95	88.75
74	NewBharat	Marsyang	132	57.43	0.01	25.00	14.36	95	136.39
75	Pathlaiya	Chapur	132	1.00	0.01	30.68	0.31	95	2.92
76	Phalampur	Lumki	132	1.00	0.01	28.90	0.29	95	2.75
77	Phalampur	Lumki	132	65.96	0.01	28.90	19.06	95	181.08
78	Rupani	Kushaha	132	65.96	0.01	34.90	23.02	95	218.67
79	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	95	0.00
80	Trishuli3B	Matairtha	132	26.60	0.01	49.00	13.03	95	123.82
81	Trishuli3B	Maairtha	132	13.33	0.01	49.00	6.53	95	62.03
82	Samundarta	Trishulihu	132	13.33	0.01	26.00	3.46	95	32.91
83	Samundarta	TrishulHu	132	24.02	0.01	26.00	6.25	95	59.34
84	Lamosangh	Khimti	132	18.70	0.01	40.00	7.48	95	71.07

85	Syaule SS	Attariya	132	18.70	0.01	60.00	11.22	95	106.60
86	Syaule SS	Attariya	132	22.00	0.01	60.00	13.20	95	125.39
87	Mirchaiya	Tingla	132	22.00	0.01	90.00	19.80	95	188.09
88	Mirchaiya	Tingla	132	8.70	0.01	90.00	7.83	95	74.39
89	Malekhu	Temial(4	132	15.44	0.01	0.20	0.03	95	0.29
90	Amlekhgun	Simara	66	15.44	0.028	12.90	5.58	10.8	60.23
91	Amlekhgun	Simara	66	21.14	0.028	12.90	7.63	10.8	82.45
92	Balaju	Chapali	132	21.14	0.01	10.00	2.11	95	20.08
93	Balaju	Chapali	132	14.65	0.01	10.00	1.47	95	13.92
94	Lainchaur	Balaju	66	14.23	0.028	2.00	0.80	10.8	8.61
95	Switchata	Balaju	132	8.99	0.01	4.40	0.40	95	3.76
96	Balaju	Trisuli	66	8.99	0.028	29.00	7.30	10.8	78.87
97	Balaju	Trisuli	66	1.49	0.028	29.00	1.21	10.8	13.09
98	Banepa	Panchkhal	66	24.03	0.028	8.03	5.40	10.8	58.36
99	Baneshwor	Bhaktapur	66	5.91	0.028	8.24	1.36	10.8	14.74
100	Bhaktapu	Ch.naraya	132	40.49	0.01	3.65	1.48	95	14.04
101	Bhaktapu	Ch.naraya	132	40.49	0.01	3.65	1.48	95	14.04
102	Bhaktapur	Banepa	66	12.26	0.028	13.57	4.66	95	44.26
103	NeBharatpu	Bharapur	132	19.41	0.01	0.50	0.10	95	0.92
104	Parwanipur	Birgunj	66	19.41	0.028	9.00	4.89	10.8	52.82
105	Parwanipur	Birgunj	66	18.91	0.028	9.00	4.76	10.8	51.45
106	Butwal	KGA	132	18.91	0.01	58.00	10.97	95	104.17
107	Butwal	KGA	132	1.35	0.01	58.00	0.78	95	7.42
108	Chapali	Changunara	132	1.35	0.01	8.24	0.11	95	1.05
109	Chapali	Changuna	132	10.30	0.01	8.24	0.85	95	8.06
110	Chapali	Devighat	66	26.01	0.028	29.30	21.34	10.8	230.49
111	Chapali	Devighat	66	5.55	0.028	29.30	4.55	10.8	49.18
112	Chilime	Trisuli	66	5.55	0.028	10.00	1.55	10.8	16.78
113	Damak	Anarmani	132	181.60	0.01	26.70	48.49	95	460.62
114	NMRS	Damauli	132	181.60	0.01	23.00	41.77	95	396.79
115	NMRS	Damauli	132	16.13	0.01	23.00	3.71	95	35.25
116	Hetauda	Amlekhgu	66	16.13	0.028	20.17	9.11	10.8	98.39
117	Hetauda	Amlekhgu	66	0.00	0.028	20.17	0.00	10.8	0.00
118	Bharatpur	Hetauda	132	31.91	0.01	70.85	22.61	95	214.78
119	Hetauda	Kamane	132	16.93	0.01	18.50	3.13	95	29.76
120	Hetauda	Termin(15)	132	16.94	0.01	5.24	0.89	95	8.43
121	Terminl(15)	Kul-2	132	26.27	0.01	3.00	0.79	95	7.49
122	Damak	Ilam	132	26.27	0.01	31.50	8.27	95	78.61
123	Damak	Ilam	132	0.83	0.01	31.50	0.26	95	2.47
124	Kamane	Pathlaiya	132	38.70	0.01	18.50	7.16	95	68.02
125	UpKhimti	Dhalkebar	220	44.76	0.0035	75.00	11.75	35.5	417.12
126	UpKhimti	Dhalkebar	220	11.34	0.0035	75.00	2.98	35.5	105.69

127	Kohalpur	Kusum	132	11.34	0.01	48.30	5.48	9.5	52.04
128	Kul-1	Switchatar	132	28.49	0.01	32.86	9.36	9.5	88.95
129	Kul-1	Switchatar	66	0.78	0.028	32.86	0.72	10.8	7.73
130	Kul-2	Matatirtha	66	0.78	0.028	28.50	0.62	10.8	6.70
131	Hetauda	Kul-1	132	16.95	0.01	15.05	2.55	9.5	24.23
132	Hetauda	Kul-1	66	1.97	0.028	15.05	0.83	10.8	8.95
133	Kushaha	Kataiya	66	1.97	0.028	13.00	0.72	10.8	7.73
134	Kushaha	Kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
135	Kushaha	Kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
136	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
137	Kusum	Lamahi	132	34.42	0.01	47.50	16.35	9.5	155.30
138	Lahachok	BB2	132	34.42	0.01	42.00	14.45	9.5	137.32
139	BB2	Lahachok	132	4.49	0.01	42.00	1.89	9.5	17.92
140	Lainchaur	Newchabil	132	4.74	0.01	2.30	0.11	9.5	1.04
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
143	Lamahi	Shivapur	132	51.88	0.01	51.00	26.46	9.5	251.35
144	Lamosangh u	Bhotokosh i	132	51.88	0.01	24.65	12.79	9.5	121.48
145	BB1	Lamosang	132	21.42	0.01	45.84	9.82	9.5	93.28
146	BB2	SyangjaSS Teml(4)	132	101.19	0.01	41.00	41.49	9.5	394.14
147	Marsyangdi		132	25.87	0.01	40.00	10.35	9.5	98.30
148	Terminal(4)	Switchatar	132	17.02	0.01	84.00	14.30	9.5	135.83
149	Switchatar	Matatirtha	132	20.49	0.01	4.40	0.90	9.5	8.56
150	Switchatar	Matatirtha	132	20.49	0.01	4.40	0.90	9.5	8.56
151	Mirchaiya	Lahan	132	80.63	0.01	27.68	22.32	9.5	212.02
152	Mirchaiya	Lahan	132	80.63	0.01	27.68	22.32	9.5	212.02
153	M-Mars	Damauli	132	30.63	0.01	58.00	17.77	9.5	168.79
154	Newchabil	Chapali	132	14.45	0.01	5.00	0.72	9.5	6.86
155	Newchabil	Chapali	66	14.45	0.028	5.00	2.02	10.8	21.84
156	M-Mars	-NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
157	M-Mars	NMRS	132	47.53	0.01	40.00	19.01	9.5	180.62
158	NMRS	Marsyang	132	1.84	0.01	5.00	0.09	9.5	0.87
159	Marsyangdi	NMRS	132	1.84	0.01	5.00	0.09	9.5	0.87

160	Panchkhal	Sunkoshi	66	1.13	0.028	29.00	0.92	10.8	9.89
161	Panchkhal	Indrawati	66	4.04	0.028	28.00	3.16	10.8	34.18
162	Patan	Baneshwo	66	0.00	0.028	2.80	0.00	10.8	0.00
163	Pathlaiya	Parwanipu	132	61.93	0.01	16.59	10.27	9.5	97.61
164	Pathlaiya	Parwanipu	132	61.93	0.01	16.59	10.27	9.5	97.61
165	Pathlaiya	Chapur	132	57.43	0.01	30.68	17.62	9.5	167.38
166	Lekhnath	Pokhara	132	18.68	0.01	7.00	1.31	9.5	12.42
167	Terminal(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
168	Terminal	Pokhara	132	0.50	0.01	0.10	0.00	9.5	0.00
169	Simara	Parwanipu	66	1.02	0.01	9.60	0.10	10.8	1.06
170	Simara	Parwanipu	66	1.02	0.028	9.60	0.27	10.8	2.96
171	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
172	Switchatar	Balaju	66	5.92	0.028	4.40	0.73	10.8	7.87
173	Switchatar	Balaju	66	5.92	0.028	4.40	0.73	10.8	7.87
174	Switchatar	K-3	66	13.26	0.028	6.90	2.56	10.8	27.66
175	Teku	Switchatar	66	24.07	0.028	4.10	2.76	10.8	29.84
176	Switchatar	Patan	66	15.66	0.028	6.50	2.85	10.8	30.79
177	SyangaSS	KGA	132	0.53	0.01	55.00	0.29	9.5	2.75
178	Teku	K-3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				4938.88			1541.67		15394.76

Table 4.5 Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	15394.76
Cost of Energy (ECOST) = EENS x IEAR	7697.38
Cost of Energy (ECOST) in Nrs	1025906582.74
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1025906582.74

Annex D: Reliability indices for wet season at peak load scenario.

- (I) Calculation of EPNS and EENS of Existing INPS at Wet Season Peak load Scenario (Base Case i.e. case I)

S.N	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTT R (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	47.67	0.01	35.19	16.78	9.5	159.37
2	Attariya	Phalampur	132	47.67	0.01	35.19	16.78	9.5	159.37
3	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	NButwal	132	18.43	0.01	10.00	1.84	9.5	17.50
6	Bardaghat	NeButwal	132	18.43	0.01	10.00	1.84	9.5	17.50
7	Bardaghat	Sardi	132	22.60	0.01	14.00	3.16	9.5	30.06
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	kawasoti	Bardaghat	132	2.60	0.01	34.00	0.88	9.5	8.38
10	NewBharatp	Bardaghat	132	10.08	0.01	74.00	7.46	9.5	70.85
11	Bhaktapur	Lamosangh	132	114.40	0.01	48.30	55.25	9.5	524.91
12	Bhaktapur	Lamosangh	132	114.40	0.01	48.30	55.25	9.5	524.91
13	kawasoti	Bharatpur	132	19.94	0.01	36.00	7.18	9.5	68.20
14	Burigaon	Kohalpur	132	30.22	0.01	55.29	16.71	9.5	158.72
15	Burigaon	Kohalpur	132	30.22	0.01	55.29	16.71	9.5	158.72
16	Butwal	Sunwal	132	13.70	0.01	13.00	1.78	9.5	16.91
17	Butwal	BB2	132	13.70	0.01	13.00	1.78	9.5	16.91
18	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
19	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
20	Motipur Bu	Butwal	132	77.75	0.01	38.00	29.54	9.5	280.68
21	Motipur Bu	Butwal	132	77.75	0.01	38.00	29.54	9.5	280.68
22	Chapur	Nabalpur	132	77.35	0.01	34.75	26.88	9.5	255.35
23	Chapur	Nabalpur	132	77.46	0.01	34.75	26.92	9.5	255.73
24	Damauli	Bharatpur	132	58.70	0.01	39.00	22.89	9.5	217.50
25	Dhalkebar	Mirchaiya	132	24.46	0.01	31.50	7.71	9.5	73.21
26	Dhalkebar	Mirchaiya	132	24.46	0.01	31.50	7.71	9.5	73.21
27	Duhabi	Damak	132	118.55	0.01	48.90	57.97	9.5	550.74
28	Bardaghat	Gandak	132	11.16	0.01	14.00	1.56	9.5	14.84
29	Amapur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
30	Amapur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
31	Hetauda Bus	pathlaiya	132	46.35	0.01	37.00	17.15	9.5	162.92
32	Inariwa(1)	Duhabi	132	46.72	0.01	10.00	4.67	9.5	44.38
33	Inariwa(1)	Duhabi	132	0.97	0.01	10.00	0.10	9.5	0.92
34	Inaruwa	Tumlingtar	220	53.11	0.0035	106.00	19.70	35.5	699.45
35	Kohalpur	kusum	132	8.10	0.01	48.30	3.91	9.5	37.16

36	Kul3	Terai(15)	132	0.00	0.01	0.50	0.00	9.5	0.00
37	kushaha	Inariwa	132	9.93	0.01	13.10	1.30	9.5	12.35
38	Inariwa(1)	kushaha	132	9.91	0.01	13.10	1.30	9.5	12.33
39	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
40	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
41	Kushma	Modi	132	41.69	0.01	6.00	2.50	9.5	23.76
42	kusum	Hapure SS	132	7.58	0.01	18.00	1.36	9.5	12.96
43	Lahan	Rupani	132	24.81	0.01	27.00	6.70	9.5	63.65
44	Lahan	Rupani	132	24.81	0.01	27.00	6.70	9.5	63.65
45	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
46	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
47	Lamahi	Jhimruk	132	3.17	0.01	49.49	1.57	9.5	14.91
48	Lekhnath	Damauli	132	35.21	0.01	45.00	15.85	9.5	150.54
49	Lumki	Burigaon	132	33.53	0.01	33.90	11.37	9.5	107.98
50	Lumki	Burigaon	132	33.53	0.01	33.90	11.37	9.5	107.98
51	Kirtipur	Mmrns	132	126.50	0.01	17.00	21.51	9.5	204.30
52	Mahendrana	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24
53	Mahendrana	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24
54	Matairtha	Hetauda	132	51.19	0.01	36.24	18.55	9.5	176.25
55	New Modi	Modi I	132	0.00	0.01	0.30	0.00	9.5	0.00
56	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
57	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
58	Motipur Bu	shivapur	132	66.85	0.01	23.00	15.37	9.5	146.06
59	Motipur Bu	shivapur	132	66.85	0.01	23.00	15.37	9.5	146.06
60	New Butwal	Sunwal	132	36.64	0.01	20.00	7.33	9.5	69.62
61	New Butwal	BB2	132	36.64	0.01	20.00	7.33	9.5	69.62
62	NMRS	Matairtha	132	52.70	0.01	84.00	44.27	9.5	420.56
63	NMRS	Matairtha	132	52.70	0.01	84.00	44.27	9.5	420.56
64	Nabalpur	Dhalkebar	132	96.47	0.01	34.75	33.52	9.5	318.48
65	Nabalpur	Dhalkebar	132	96.47	0.01	34.75	33.52	9.5	318.48
66	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
67	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
68	NewBharatp	Hetauda	132	52.78	0.01	75.00	39.58	9.5	376.05
69	Kushma220k	NeButwal	220	55.62	0.0035	88.00	17.13	35.5	608.17
70	Kushma220k	Ne Butwal	220	55.62	0.0035	88.00	17.13	35.5	608.17
71	New Modi	Pokhara	132	0.00	0.01	37.00	0.00	9.5	0.00

72	NewBharatpur	Marsyangdi	132	93.61	0.01	25.00	23.40	9.5	222.31
73	pathlaiya	Chapur	132	63.28	0.01	30.68	19.41	9.5	184.44
74	Phalampur	Lumki	132	41.44	0.01	28.90	11.98	9.5	113.77
75	Phalampur	Lumki	132	41.44	0.01	28.90	11.98	9.5	113.77
76	Rupani	kushaha	132	12.09	0.01	34.90	4.22	9.5	40.08
77	Rupani	kushaha	132	12.09	0.01	34.90	4.22	9.5	40.08
78	Trishuli3B	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
79	Trishuli3B	Matatirtha	132	64.67	0.01	49.00	31.69	9.5	301.04
80	Samundartar	Trusuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28
81	Samundartar	Trusuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28
82	Lamosanghu	Khimti	132	81.64	0.01	40.00	32.65	9.5	310.21
83	Syaule	Attariya	132	74.38	0.01	60.00	44.63	9.5	423.98
84	Syaule	Attariya	132	74.38	0.01	60.00	44.63	9.5	423.98
85	Mirchaiya	Tingla	132	67.24	0.01	90.00	60.52	9.5	574.90
86	Mirchaiya	Tingla	132	67.24	0.01	90.00	60.52	9.5	574.90
87	Malekhu	Termi(4)	132	15.14	0.01	0.20	0.03	9.5	0.29
88	Amlekhgunj	Simara	66	23.05	0.028	12.90	8.33	10.8	89.93
89	Amlekhgunj	Simara	66	23.05	0.028	12.90	8.33	10.8	89.93
90	Balaju Bus	chapali	132	36.80	0.01	10.00	3.68	9.5	34.96
91	Balaju Bus	chapali	132	36.80	0.01	10.00	3.68	9.5	34.96
92	Lainchaur	Balaju	66	26.49	0.028	2.00	1.48	10.8	16.02
93	Switchatar	Balaju	132	32.14	0.01	4.40	1.41	9.5	13.44
94	Balaju	Trisuli	66	24.07	0.028	29.00	19.54	10.8	211.06
95	Balaju	Trisuli	66	24.07	0.028	29.00	19.54	10.8	211.06
96	Banepa	Panchkhal	66	12.88	0.028	8.03	2.90	10.8	31.28
97	Baneshwor	Bhaktapur	66	37.42	0.028	8.24	8.63	10.8	93.25
98	Bhaktapur	chapali	132	66.12	0.01	11.89	7.86	9.5	74.68
99	Bhaktapur13	chapali	132	66.12	0.01	11.89	7.86	9.5	74.68
100	Bhaktapur	Banepa	66	1.60	0.028	13.57	0.61	10.8	6.58
101	NBharatpu	Bharatpur	132	23.18	0.01	0.50	0.12	9.5	1.10
102	Parwanipur	Birgunj	66	26.26	0.028	9.00	6.62	10.8	71.46
103	Parwanipur	BirgunjS	66	26.26	0.028	9.00	6.62	10.8	71.46
104	Butwal	KGA	132	130.02	0.01	58.00	75.41	9.5	716.39
105	Butwal	KGA	132	130.02	0.01	58.00	75.41	9.5	716.39
106	Chapali	Devighat	66	4.40	0.028	29.30	3.61	10.8	38.97
107	Chapali	Devighat	66	4.40	0.028	29.30	3.61	10.8	38.97
108	Termi(2)	Trisuli	66	32.10	0.028	10.00	8.99	10.8	97.07
109	Damak	Anamani	132	40.12	0.01	26.70	10.71	9.5	101.77
110	NMRS	Damauli	132	0.93	0.01	23.00	0.21	9.5	2.03

111	NMRS	Damauli	132	0.93	0.01	23.00	0.21	9.5	2.03
112	Dhalkebar	Muzzafapu	400	178.51	0.002	140.00	49.98	18.8	939.67
113	Dhalkebar	Muzafapur	400	178.51	0.002	140.00	49.98	18.8	939.67
114	Hetauda	Amlekhgu	66	24.38	0.028	20.17	13.77	10.8	148.73
115	Hetauda	Amlekhgu	66	24.38	0.028	20.17	13.77	10.8	148.73
116	Bharatpur	Hetauda	132	0.00	0.01	70.85	0.00	9.5	0.00
117	Hetauda	Kamane	132	62.06	0.01	18.50	11.48	9.5	109.07
118	Hetauda	Termini(15)	132	49.84	0.01	5.24	2.61	9.5	24.81
119	Termini(15)	Kul2	132	49.93	0.01	3.00	1.50	9.5	14.23
120	Damak	Ilam	132	96.87	0.01	31.50	30.51	9.5	289.88
121	Damak	Ilam	132	96.87	0.01	31.50	30.51	9.5	289.88
122	Kamane	pathlaiya	132	16.17	0.01	18.50	2.99	9.5	28.42
123	UpKhimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
124	UppeKhimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
125	Kohalpur	kusum	132	8.10	0.01	48.30	3.91	9.5	37.16
126	Kul1	Switchatar	66	0.27	0.028	32.86	0.24	10.8	2.65
127	Kul1	Switchatar	66	0.27	0.028	32.86	0.24	10.8	2.65
128	Kul2	Matatirtha	132	49.99	0.01	28.50	14.25	9.5	135.35
129	Hetauda	Kul1	66	10.05	0.028	15.05	4.24	10.8	45.75
130	Hetauda	Kul1	66	10.05	0.028	15.05	4.24	10.8	45.75
131	kushaha	kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
132	kushaha	kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
133	kushaha	kataiya	132	0.00	0.01	1.00	0.00	9.5	0.00
134	kusum	Lamahi	132	15.71	0.01	47.50	7.46	9.5	70.87
135	kusum	Lamahi	132	15.71	0.01	47.50	7.46	9.5	70.87
136	Lahachok	BB2	132	13.90	0.01	42.00	5.84	9.5	55.44
137	BB2	Lahachok	132	14.03	0.01	42.00	5.89	9.5	55.99
138	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
139	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
140	Lamahi	shivapur	132	45.47	0.01	51.00	23.19	9.5	220.29
141	Lamahi	shivapur	132	45.47	0.01	51.00	23.19	9.5	220.29
142	Lamosanghu	Bhotekoshi	132	69.31	0.01	24.65	17.09	9.5	162.31
143	Singati	Lamosang	132	80.50	0.01	45.84	36.90	9.5	350.56
144	BB2	SyangjaSS	132	141.16	0.01	41.00	57.88	9.5	549.82
145	Marsyangdi	Termini(4)	132	46.65	0.01	40.00	18.66	9.5	177.28
146	Termini(4)	Switchatar	132	31.00	0.01	84.00	26.04	9.5	247.37
147	Switchatar	Matatirtha	132	27.14	0.01	4.40	1.19	9.5	11.35
148	Switchatar	Matatirtha	132	27.14	0.01	4.40	1.19	9.5	11.35
149	Mirchaiya	Lahan	132	31.37	0.01	27.68	8.68	9.5	82.48
150	Mirchaiya	Lahan	132	31.37	0.01	27.68	8.68	9.5	82.48
151	MMrs	Damauli	132	122.19	0.01	58.00	70.87	9.5	673.27
152	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	9.5	10.35

153	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	95	10.35
154	Mmrs	NMRS	132	0.00	0.01	40.00	0.00	95	0.00
155	Mmrs	NMRS	132	177.91	0.01	40.00	71.16	95	676.07
156	NMRS	Marsyangd	132	29.19	0.01	5.00	1.46	95	13.86
157	Marsyangdi	NMRS	132	29.15	0.01	5.00	1.46	95	13.85
158	Panchkhal	Sunkoshi	66	5.36	0.028	29.00	4.35	10.8	47.00
159	Panchkhal	Indrawati	66	12.11	0.028	28.00	9.49	10.8	102.53
160	Patan	Banehwar	66	0.00	0.028	2.80	0.00	10.8	0.00
161	pathlaiya	Chapur	132	63.28	0.01	30.68	19.41	95	184.44
162	pathlaiya	Parwanipur	132	87.53	0.01	16.59	14.52	95	137.95
163	pathlaiya	Parwanipur	132	87.53	0.01	16.59	14.52	95	137.95
164	Lekhnath	Pokhara	132	35.21	0.01	7.00	2.46	95	23.42
165	Termi(1)	Gandak	132	0.00	0.01	0.10	0.00	95	0.00
166	Termi	Pokhara	132	1.50	0.01	0.10	0.00	95	0.01
167	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
168	Simara	Pawanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
169	Switchatar	Patan	66	26.52	0.028	6.50	4.83	10.8	52.13
170	Switchatar	Balaju	66	12.66	0.028	4.40	1.56	10.8	16.85
171	Switchatar	Balaju	66	12.66	0.028	4.40	1.56	10.8	16.85
172	Switchatar	K3	66	24.79	0.028	6.90	4.79	10.8	51.72
173	Teku	Switchatar	66	43.13	0.028	4.10	4.95	10.8	53.47
174	Switchatar	Patan	66	26.52	0.028	6.50	4.83	10.8	52.13
175	Syangja	KGA	132	126.85	0.01	55.00	69.77	95	662.79
176	Teku	K3	66	9.29	0.028	2.30	0.60	10.8	6.46
177	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				7432.4	3	5529.2	2650.22		32252.97

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	32252.97
Cost of Energy (ECOST) = EENS x IEAR	16126.49
Cost of Energy (ECOST) in Nrs	2149338061.32
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2149338061.32

(II) Reliability indices of existing INPS at wet peak load when export via. NB-G line (case II)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F.rate (λ)/yrkm	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	47.74	0.01	35.19	16.80	9.5	159.59
2	Attariya	Phalampur	132	47.74	0.01	35.19	16.80	9.5	159.59
3	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	New Butwal	132	7.74	0.01	10.00	0.77	9.5	7.36
6	Bardaghat	New Butwal	132	7.74	0.01	10.00	0.77	9.5	7.36
7	Bardaghat	Sardi	132	22.59	0.01	14.00	3.16	9.5	30.05
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	kawasoti	Bardaghat	132	6.83	0.01	34.00	2.32	9.5	22.06
10	NewBharatpur	Bardaghat	132	22.34	0.01	74.00	16.53	9.5	157.06
11	Bhaktapur	Lamosanghu	132	114.48	0.01	48.30	55.29	9.5	525.27
12	Bhaktapur	Lamosanghu	132	114.48	0.01	48.30	55.29	9.5	525.27
13	kawasoti	Bharatpur	132	29.37	0.01	36.00	10.57	9.5	100.43
14	Burigaon	Kohalpur	132	30.28	0.01	55.29	16.74	9.5	159.07
15	Burigaon	Kohalpur	132	30.28	0.01	55.29	16.74	9.5	159.07
16	Butwal	Sunwal	132	11.95	0.01	13.00	1.55	9.5	14.76
17	Butwal	BB2	132	11.95	0.01	13.00	1.55	9.5	14.76
18	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
19	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
20	Motipur	Butwal	132	77.17	0.01	38.00	29.32	9.5	278.57
21	Motipur	Butwal	132	77.17	0.01	38.00	29.32	9.5	278.57
22	Chapur	Nabalpur	132	88.36	0.01	34.75	30.70	9.5	291.69
23	Chapur	Nabalpur	132	87.84	0.01	34.75	30.53	9.5	289.99
24	Damauli	Bharatpur	132	62.12	0.01	39.00	24.23	9.5	230.16
25	Dhalkebar	Mirchaiya	132	24.47	0.01	31.50	7.71	9.5	73.22
26	Dhalkebar	Mirchaiya	132	24.47	0.01	31.50	7.71	9.5	73.22
27	Duhabi	Damak	132	118.56	0.01	48.90	57.98	9.5	550.77
28	Bardaghat	Gandak	132	11.15	0.01	14.00	1.56	9.5	14.83
29	Amapur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
30	Amapur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
31	Hetauda Bus	pathlaiya	132	34.27	0.01	37.00	12.68	9.5	120.47
32	Inariwa (1)	Duhabi	132	46.71	0.01	10.00	4.67	9.5	44.38
33	Inariwa (1)	Duhabi	132	0.97	0.01	10.00	0.10	9.5	0.92
34	Inaruwa	Tumlingtar	220	53.11	0.0035	106.00	19.70	35.5	699.46
35	Kohalpur	kusum	132	8.04	0.01	48.30	3.88	9.5	36.89
36	Kul3	Temi(15)	132	0.00	0.01	0.50	0.00	9.5	0.00
37	kushaha	Inariwa	132	9.92	0.01	13.10	1.30	9.5	12.35
38	Inariwa (1)	kushaha	132	9.90	0.01	13.10	1.30	9.5	12.32

39	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
40	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
41	Kushma	Modi	132	41.69	0.01	6.00	2.50	9.5	23.76
42	kusum	Hapure SS	132	7.58	0.01	18.00	1.36	9.5	12.96
43	Lahan	Rupani	132	24.81	0.01	27.00	6.70	9.5	63.64
44	Lahan	Rupani	132	24.81	0.01	27.00	6.70	9.5	63.64
45	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
46	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
47	Lamahi	Jhimruk	132	3.57	0.01	49.49	1.77	9.5	16.81
48	Lekhnath	Damauli	132	35.21	0.01	45.00	15.85	9.5	150.53
49	Lumki	Burigaon	132	33.60	0.01	33.90	11.39	9.5	108.21
50	Lumki	Burigaon	132	33.60	0.01	33.90	11.39	9.5	108.21
51	Kirtipur	Mms	132	126.50	0.01	17.00	21.51	9.5	204.30
52	Mahendranagar	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24
53	Mahendranagar	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24
54	Matatirtha	Hetauda	132	46.13	0.01	36.24	16.72	9.5	158.80
55	New Modi	Modi I	132	0.00	0.01	0.30	0.00	9.5	0.00
56	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
57	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
58	Motipur Bus	shivapur	132	66.26	0.01	23.00	15.24	9.5	144.78
59	Motipur Bus	shivapur	132	66.26	0.01	23.00	15.24	9.5	144.78
60	New Butwal	Sunwal	132	34.86	0.01	20.00	6.97	9.5	66.24
61	New Butwal	BB2	132	34.86	0.01	20.00	6.97	9.5	66.24
62	NMRS	Matatirtha	132	48.09	0.01	84.00	40.40	9.5	383.77
63	NMRS	Matatirtha	132	48.09	0.01	84.00	40.40	9.5	383.77
64	Nabalpur	Dhalkebar	132	107.52	0.01	34.75	37.36	9.5	354.97
65	Nabalpur	Dhalkebar	132	107.52	0.01	34.75	37.36	9.5	354.97
66	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
67	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
68	NewBharatpur	Hetauda	132	42.47	0.01	75.00	31.85	9.5	302.57
69	Kushma220kV	New Butwal	220	55.63	0.0035	88.00	17.13	35.5	608.28
70	Kushma220kV	New Butwal	220	55.63	0.0035	88.00	17.13	35.5	608.28
71	New Modi	Pokhara	132	0.00	0.01	37.00	0.00	9.5	0.00
72	NewBharatpur	Marsyangdi	132	102.22	0.01	25.00	25.55	9.5	242.76
73	pathlaiya	Chapur	132	73.61	0.01	30.68	22.58	9.5	214.55
74	Phalampur	Lumki	132	41.51	0.01	28.90	12.00	9.5	113.96
75	Phalampur	Lumki	132	41.51	0.01	28.90	12.00	9.5	113.96
76	Rupani	kushaha	132	12.09	0.01	34.90	4.22	9.5	40.07
77	Rupani	kushaha	132	12.09	0.01	34.90	4.22	9.5	40.07
78	Trusuli3bH	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
79	Trusuli3bH	Matatirtha	132	64.67	0.01	49.00	31.69	9.5	301.06
80	Samundartar	Trisuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28

81	Samundartar	Trusuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28
82	Lamosanghu	Khimti	132	81.66	0.01	40.00	32.66	9.5	310.30
83	Syaule	Attariya	132	74.41	0.01	60.00	44.65	9.5	424.16
84	Syaule	Attariya	132	74.41	0.01	60.00	44.65	9.5	424.16
85	Mirchaiya	Tingla	132	67.24	0.01	90.00	60.52	9.5	574.92
86	Mirchaiya	Tingla	132	67.24	0.01	90.00	60.52	9.5	574.92
87	Malekhu	Temni(4)	132	15.14	0.01	0.20	0.03	9.5	0.29
88	Amlekhgunj	Simara	66	23.05	0.028	12.90	8.33	10.8	89.92
89	Amlekhgunj	Simara	66	23.05	0.028	12.90	8.33	10.8	89.92
90	Balaju Bus	chapali	132	36.95	0.01	10.00	3.69	9.5	35.10
91	Balaju Bus	chapali	132	36.95	0.01	10.00	3.69	9.5	35.10
92	Lainchaur	Balaju	66	26.49	0.028	2.00	1.48	10.8	16.02
93	Switchatar	Balaju	132	32.79	0.01	4.40	1.44	9.5	13.71
94	Balaju	Trisuli	66	24.07	0.028	29.00	19.54	10.8	211.07
95	Balaju	Trisuli	66	24.07	0.028	29.00	19.54	10.8	211.07
96	Banepa	Panchkhal	66	12.88	0.028	8.03	2.90	10.8	31.29
97	Baneshwor	Bhaktapur	66	37.42	0.028	8.24	8.63	10.8	93.25
98	Bhaktapur132	chapali	132	66.20	0.01	11.89	7.87	9.5	74.78
99	Bhaktapur132	chapali	132	66.20	0.01	11.89	7.87	9.5	74.78
100	Bhaktapur	Banepa	66	1.61	0.028	13.57	0.61	10.8	6.59
101	NewBharatpur	Bharatpur	132	29.84	0.01	0.50	0.15	9.5	1.42
102	Parwanipur	BirgunjSS	66	26.25	0.028	9.00	6.62	10.8	71.45
103	Parwanipur	BirgunjSS	66	26.25	0.028	9.00	6.62	10.8	71.45
104	Butwal	KGA	132	130.94	0.01	58.00	75.94	9.5	721.47
105	Butwal	KGA	132	130.94	0.01	58.00	75.94	9.5	721.47
106	Chapali	Devighat	66	4.46	0.028	29.30	3.66	10.8	39.47
107	Chapali	Devighat	66	4.46	0.028	29.30	3.66	10.8	39.47
108	Temni(2)	Trisuli	66	32.10	0.028	10.00	8.99	10.8	97.07
109	Damak	Anamani	132	40.12	0.01	26.70	10.71	9.5	101.77
110	NMRS	Damauli	132	0.57	0.01	23.00	0.13	9.5	1.25
111	NMRS	Damauli	132	0.57	0.01	23.00	0.13	9.5	1.25
112	Dhalkebar	Muzzafapur	400	166.92	0.002	140.00	46.74	18.8	878.65
113	Dhalkebar	Muzzafapur	400	166.92	0.002	140.00	46.74	18.8	878.65
114	Hetauda	Amlekhgunj	66	24.37	0.028	20.17	13.77	10.8	148.67
115	Hetauda	Amlekhgunj	66	24.37	0.028	20.17	13.77	10.8	148.67
116	Bharatpur	Hetauda	132	0.00	0.01	70.85	0.00	9.5	0.00
117	Hetauda Bus	Kamane	132	53.23	0.01	18.50	9.85	9.5	93.55
118	Hetauda Bus	Temni(15)	132	44.97	0.01	5.24	2.36	9.5	22.38
119	Temni(15)	Kul2	132	45.04	0.01	3.00	1.35	9.5	12.84
120	Damak	Ilam	132	96.87	0.01	31.50	30.51	9.5	289.89
121	Damak	Ilam	132	96.87	0.01	31.50	30.51	9.5	289.89
122	Kamane	pathlaiya	132	7.42	0.01	18.50	1.37	9.5	13.04

123	Upper Khimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
124	Upper Khimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
125	Kohalpur	kusum	132	8.04	0.01	48.30	3.88	9.5	36.89
126	Kul1	Switchatar	66	0.91	0.028	32.86	0.84	10.8	9.05
127	Kul1	Switchatar	66	0.91	0.028	32.86	0.84	10.8	9.05
128	Kul2	Matatirtha	132	45.09	0.01	28.50	12.85	9.5	122.08
129	Hetauda	Kul1	66	9.49	0.028	15.05	4.00	10.8	43.19
130	Hetauda	Kul1	66	9.49	0.028	15.05	4.00	10.8	43.19
131	kushaha	katariya	132	0.00	0.01	13.00	0.00	9.5	0.00
132	kushaha	katariya	132	0.00	0.01	13.00	0.00	9.5	0.00
133	kushaha	katariya	132	0.00	0.01	1.00	0.00	9.5	0.00
134	kusum	Lamahi	132	15.65	0.01	47.50	7.43	9.5	70.63
135	kusum	Lamahi	132	15.65	0.01	47.50	7.43	9.5	70.63
136	Lahachok	BB2	132	13.99	0.01	42.00	5.88	9.5	55.83
137	BB2	Lahachok	132	13.94	0.01	42.00	5.85	9.5	55.62
138	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
139	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
140	Lamahi	shivapur	132	45.22	0.01	51.00	23.06	9.5	219.07
141	Lamahi	shivapur	132	45.22	0.01	51.00	23.06	9.5	219.07
142	Lamosanghu	Bhotekoshi	132	69.32	0.01	24.65	17.09	9.5	162.33
143	Singati	Lamosanghu	132	80.50	0.01	45.84	36.90	9.5	350.56
144	BB2	SyangjaSS	132	141.17	0.01	41.00	57.88	9.5	549.84
145	Marsyangdi	Termi(4)	132	43.60	0.01	40.00	17.44	9.5	165.67
146	Termi(4)	Switchatar	132	28.01	0.01	84.00	23.53	9.5	223.53
147	Switchatar	Matatirtha	132	27.72	0.01	4.40	1.22	9.5	11.59
148	Switchatar	Matatirtha	132	27.72	0.01	4.40	1.22	9.5	11.59
149	Mirchaiya	Lahan	132	31.36	0.01	27.68	8.68	9.5	82.47
150	Mirchaiya	Lahan	132	31.36	0.01	27.68	8.68	9.5	82.47
151	Mms	Damauli	132	122.60	0.01	58.00	71.11	9.5	675.51
152	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	9.5	10.35
153	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	9.5	10.35
154	Mms	NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
155	Mms	NMRS	132	177.51	0.01	40.00	71.00	9.5	674.53
156	NMRS	Marsyangdi	132	32.12	0.01	5.00	1.61	9.5	15.25
157	Marsyangdi	NMRS	132	32.07	0.01	5.00	1.60	9.5	15.23
158	Panchkhal	Sunkoshi	66	5.36	0.028	29.00	4.35	10.8	47.01
159	Panchkhal	Indrawati	66	12.11	0.028	28.00	9.50	10.8	102.55
160	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00
161	pathlaiya	Chapur	132	73.61	0.01	30.68	22.58	9.5	214.55
162	pathlaiya	Parwanipur	132	87.51	0.01	16.59	14.52	9.5	137.92
163	pathlaiya	Parwanipur	132	87.51	0.01	16.59	14.52	9.5	137.92
164	Lekhnath	Pokhara	132	35.21	0.01	7.00	2.46	9.5	23.42

165	Termi(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
166	Termi	Pokhara	132	1.50	0.01	0.10	0.00	9.5	0.01
167	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
168	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
169	Switchatar	Patan	66	26.52	0.028	6.50	4.83	10.8	52.12
170	Switchatar	Balaju	66	12.49	0.028	4.40	1.54	10.8	16.62
171	Switchatar	Balaju	66	12.49	0.028	4.40	1.54	10.8	16.62
172	Switchatar	K3	66	24.78	0.028	6.90	4.79	10.8	51.70
173	Teku	Switchatar	66	43.14	0.028	4.10	4.95	10.8	53.48
174	Switchatar	Patan	66	26.52	0.028	6.50	4.83	10.8	52.12
175	Syangja	KGA	132	127.23	0.01	55.00	69.98	9.5	664.78
176	Teku	K3	66	9.30	0.028	2.30	0.60	10.8	6.47
177	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total							2650.57		32196.98

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	32196.98
Cost of Energy (ECOST) = EENS x IEAR	16098.49
Cost of Energy (ECOST) in Nrs	2145606749.00
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2145606749.00

(III) Reliability indices of existing INPS at wet peak load when optimum export via. NB-G line (case III)

S.N.	Bus		Voltage (kV)	P.Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	47.74	0.01	35.19	16.80	9.5	159.61
2	Attariya	Phalampur	132	47.74	0.01	35.19	16.80	9.5	159.61
3	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule SS	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	NeButwal	132	33.40	0.01	10.00	3.34	9.5	31.73
6	Bardaghat	NButwal	132	33.40	0.01	10.00	3.34	9.5	31.73
7	Bardaghat	Sardi	132	22.59	0.01	14.00	3.16	9.5	30.05
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	kawasoti	Bardaghat	132	17.78	0.01	34.00	6.05	9.5	57.44
10	NewBharatpu	Bardaghat	132	4.60	0.01	74.00	3.41	9.5	32.35

11	Bhaktapur	Lamosangh	132	114.78	0.01	48.30	55.44	9.5	526.65
12	Bhaktapur	Lamosangh	132	114.7	0.01	48.30	55.44	9.5	526.65
13	kawasoti	Bharatpur	132	4.75	0.01	36.00	1.71	9.5	16.26
14	Burigaon	Kohalpur	132	30.29	0.01	55.29	16.75	9.5	159.10
15	Burigaon	Kohalpur	132	30.29	0.01	55.29	16.75	9.5	159.10
16	Butwal	Sunwal	132	11.77	0.01	13.00	1.53	9.5	14.53
17	Butwal	BB2	132	11.77	0.01	13.00	1.53	9.5	14.53
18	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
19	Mainahiya	Butwal	132	26.49	0.01	18.00	4.77	9.5	45.30
20	Motipur	Butwal	132	77.13	0.01	38.00	29.31	9.5	278.42
21	Motipur	Butwal	132	77.13	0.01	38.00	29.31	9.5	278.42
22	Chapur	Nabalpur	132	61.67	0.01	34.75	21.43	9.5	203.58
23	Chapur	Nabalpur	132	61.19	0.01	34.75	21.26	9.5	202.00
24	Damauli	Bharatpur	132	52.78	0.01	39.00	20.58	9.5	195.55
25	Dhalkebar	Mirchaiya	132	24.50	0.01	31.50	7.72	9.5	73.32
26	Dhalkebar	Mirchaiya	132	24.50	0.01	31.50	7.72	9.5	73.32
27	Duhabi	Damak	132	118.60	0.01	48.90	57.99	9.5	550.94
28	Bardaghat	Gandak	132	11.15	0.01	14.00	1.56	9.5	14.83
29	Amarpur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
30	Amarpur	Ilam	132	40.91	0.01	66.50	27.20	9.5	258.42
31	Hetauda Bus	pathlaiya	132	58.08	0.01	37.00	21.49	9.5	204.16
32	Inariwa (1)	Duhabi	132	46.68	0.01	10.00	4.67	9.5	44.34
33	Inariwa (1)	Duhabi	132	0.97	0.01	10.00	0.10	9.5	0.92
34	Inaruwa	Tumlingtar	220	53.11	0.0035	106.0	19.70	35.5	699.48
35	Kohalpur	kusum	132	8.03	0.01	48.30	3.88	9.5	36.87
36	Kul3	Tem(15)	132	0.00	0.01	0.50	0.00	9.5	0.00
37	kushaha	Inariwa	132	9.91	0.01	13.10	1.30	9.5	12.33
38	Inariwa (1)	kushaha	132	9.88	0.01	13.10	1.29	9.5	12.30
39	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
40	Dana	Kushma	220	37.25	0.0035	39.00	5.08	35.5	180.50
41	Kushma	Modi	132	41.69	0.01	6.00	2.50	9.5	23.76
42	kusum	Hapure SS	132	7.58	0.01	18.00	1.36	9.5	12.96
43	Lahan	Rupani	132	24.80	0.01	27.00	6.69	9.5	63.60
44	Lahan	Rupani	132	24.80	0.01	27.00	6.69	9.5	63.60
45	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
46	Ghorahi Bus	Lamahi	132	16.82	0.01	13.00	2.19	9.5	20.77
47	Lamahi	Jhimruk	132	3.58	0.01	49.49	1.77	9.5	16.83
48	Lekhnath	Damauli	132	35.21	0.01	45.00	15.84	9.5	150.52
49	Lumki	Burigaon	132	33.61	0.01	33.90	11.39	9.5	108.23
50	Lumki	Burigaon	132	33.61	0.01	33.90	11.39	9.5	108.23
51	Kirtipur	Mms	132	126.50	0.01	17.00	21.51	9.5	204.30
52	ahendranagar	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24

53	Mahendrana	Attariya	132	11.31	0.01	51.40	5.81	9.5	55.24
54	Matatirtha	Hetauda	132	57.92	0.01	36.24	20.99	9.5	199.41
55	New Modi	Modi1	132	0.00	0.01	0.30	0.00	9.5	0.00
56	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
57	Sandhikharka	Motipur	132	7.52	0.01	37.00	2.78	9.5	26.44
58	Motipur	shivapur	132	66.22	0.01	23.00	15.23	9.5	144.70
59	Motipur B	shivapur	132	66.22	0.01	23.00	15.23	9.5	144.70
60	New Butwal	Sunwal	132	34.67	0.01	20.00	6.93	9.5	65.88
61	New Butwal	BB2	132	34.67	0.01	20.00	6.93	9.5	65.88
62	NMRS	Matatirtha	132	58.72	0.01	84.00	49.33	9.5	468.59
63	NMRS	Matatirtha	132	58.72	0.01	84.00	49.33	9.5	468.59
64	Nabalpur	Dhalkebar	132	80.02	0.01	34.75	27.81	9.5	264.18
65	Nabalpur	Dhalkebar	132	80.02	0.01	34.75	27.81	9.5	264.18
66	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
67	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
68	NewBharatp	Hetauda	132	67.40	0.01	75.00	50.55	9.5	480.23
69	Kushma	NButwal	220	55.63	0.0035	88.00	17.13	35.5	608.29
70	Kushma220k	NButwal	220	55.63	0.0035	88.00	17.13	35.5	608.29
71	New Modi	Pokhara	132	0.00	0.01	37.00	0.00	9.5	0.00
72	NewBharat	Marsyangdi	132	83.94	0.01	25.00	20.99	9.5	199.37
73	pathlaiya	Chapur	132	47.73	0.01	30.68	14.64	9.5	139.11
74	Phalampur	Lumki	132	41.51	0.01	28.90	12.00	9.5	113.98
75	Phalampur	Lumki	132	41.51	0.01	28.90	12.00	9.5	113.98
76	Rupani	kushaha	132	12.07	0.01	34.90	4.21	9.5	40.02
77	Rupani	kushaha	132	12.07	0.01	34.90	4.21	9.5	40.02
78	Trusuli3bH	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
79	Trusuli3bH	Matatirtha	132	64.67	0.01	49.00	31.69	9.5	301.05
80	Samundartar	Trisuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28
81	Samundartar	Trusuli3bH	132	32.50	0.01	26.00	8.45	9.5	80.28
82	Lamosanghu	Khimti	132	81.74	0.01	40.00	32.70	9.5	310.63
83	Syaule	Attariya	132	74.42	0.01	60.00	44.65	9.5	424.18
84	Syaule	Attariya	132	74.42	0.01	60.00	44.65	9.5	424.18
85	Mirchaiya	Tingla	132	67.25	0.01	90.00	60.53	9.5	575.01
86	Mirchaiya	Tingla	132	67.25	0.01	90.00	60.53	9.5	575.01
87	Malekhu	Temni(4)	132	15.14	0.01	0.20	0.03	9.5	0.29
88	Amlekhgunj	Simara	66	28.54	0.028	12.90	10.31	10.8	111.33
89	Amlekhgunj	Simara	66	28.54	0.028	12.90	10.31	10.8	111.33
90	Balaju Bus	chapali	132	37.47	0.01	10.00	3.75	9.5	35.60
91	Balaju Bus	chapali	132	37.47	0.01	10.00	3.75	9.5	35.60
92	Lainchaur	Balaju	66	26.49	0.028	2.00	1.48	10.8	16.02
93	Switchatar	Balaju	132	32.88	0.01	4.40	1.45	9.5	13.75
94	Balaju	Trisuli	66	24.02	0.028	29.00	19.51	10.8	210.67

95	Balaju	Trisuli	66	24.02	0.028	29.00	19.51	10.8	210.67
96	Banepa	Panchkhal	66	12.90	0.028	8.03	2.90	10.8	31.32
97	Baneshwor	Bhaktapur	66	37.42	0.028	8.24	8.63	10.8	93.25
98	Bhaktapur	chapali	132	66.52	0.01	11.89	7.91	9.5	75.14
99	Bhaktapu	chapali	132	66.52	0.01	11.89	7.91	9.5	75.14
100	Bhaktapur	Banepa	66	1.62	0.028	13.57	0.62	10.8	6.65
101	NBharatpur	Bharatpur	132	13.58	0.01	0.50	0.07	9.5	0.64
102	Parwanipur	Birgunj SS	66	26.23	0.028	9.00	6.61	10.8	71.37
103	Parwanipur	Birgunj SS	66	26.23	0.028	9.00	6.61	10.8	71.37
104	Butwal	KGA	132	131.06	0.01	58.00	76.02	9.5	722.15
105	Butwal	KGA	132	131.06	0.01	58.00	76.02	9.5	722.15
106	Chapali	Devighat	66	4.62	0.028	29.30	3.79	10.8	40.94
107	Chapali	Devighat	66	4.62	0.028	29.30	3.79	10.8	40.94
108	Termi(2)	Trisuli	66	32.10	0.028	10.00	8.99	10.8	97.07
109	Damak	Anamani	132	40.12	0.01	26.70	10.71	9.5	101.77
110	NMRS	Damauli	132	3.66	0.01	23.00	0.84	9.5	7.99
111	NMRS	Damauli	132	3.66	0.01	23.00	0.84	9.5	7.99
112	Dhalkebar	Muzzafapur	400	195.83	0.002	140.0	54.83	18.8	1030.82
113	Dhalkebar	Muzzafapur	400	195.83	0.002	140.0	54.83	18.8	1030.82
114	Hetauda	Amlekhgun	66	30.12	0.028	20.17	17.01	10.8	183.72
115	Hetauda	Amlekhgun	66	30.12	0.028	20.17	17.01	10.8	183.72
116	Bharatpur	Hetauda	132	0.00	0.01	70.85	0.00	9.5	0.00
117	Hetauda Bu	Kamane	132	70.65	0.01	18.50	13.07	9.5	124.16
118	Hetauda B	Termi(15)	132	56.34	0.01	5.24	2.95	9.5	28.04
119	Termi(15)	Kul2	132	56.45	0.01	3.00	1.69	9.5	16.09
120	Damak	Ilam	132	96.88	0.01	31.50	30.52	9.5	289.92
121	Damak	Ilam	132	96.88	0.01	31.50	30.52	9.5	289.92
122	Kamane	pathlaiya	132	24.71	0.01	18.50	4.57	9.5	43.43
123	Up Khimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
124	UpKhimti	Dhalkebar	220	311.70	0.0035	75.00	81.82	35.5	2904.65
125	Kohalpur	kusum	132	8.03	0.01	48.30	3.88	9.5	36.87
126	Kul1	Switchatar	66	1.76	0.028	32.86	1.62	10.8	17.50
127	Kul1	Switchatar	66	1.76	0.028	32.86	1.62	10.8	17.50
128	Kul2	Matatirtha	132	56.52	0.01	28.50	16.11	9.5	153.02
129	Hetauda	Kul1	66	12.37	0.028	15.05	5.21	10.8	56.32
130	Hetauda	Kul1	66	12.37	0.028	15.05	5.21	10.8	56.32
131	kushaha	kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
132	kushaha	kataiya	132	0.00	0.01	13.00	0.00	9.5	0.00
133	kushaha	kataiya	132	0.00	0.01	1.00	0.00	9.5	0.00
134	kusum	Lamahi	132	15.65	0.01	47.50	7.43	9.5	70.61
135	kusum	Lamahi	132	15.65	0.01	47.50	7.43	9.5	70.61
136	Lahachok	BB2	132	13.99	0.01	42.00	5.88	9.5	55.83

137	BB2	Lahachok	132	13.94	0.01	42.00	5.86	9.5	55.63
138	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
139	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
140	Lamahi	shivapur	132	45.21	0.01	51.00	23.06	9.5	219.04
141	Lamahi	shivapur	132	45.21	0.01	51.00	23.06	9.5	219.04
142	Lamosanghu	Bhotekoshi	132	69.36	0.01	24.65	17.10	9.5	162.43
143	Singati	Lamosang	132	80.50	0.01	45.84	36.90	9.5	350.56
144	BB2	SyangjaSS	132	141.17	0.01	41.00	57.88	9.5	549.85
145	Marsyangdi	Termi(4)	132	50.86	0.01	40.00	20.34	9.5	193.25
146	Termi(4)	Switchatar	132	35.13	0.01	84.00	29.51	9.5	280.37
147	Switchatar	Matatirtha	132	26.34	0.01	4.40	1.16	9.5	11.01
148	Switchatar	Matatirtha	132	26.34	0.01	4.40	1.16	9.5	11.01
149	Mirchaiya	Lahan	132	31.34	0.01	27.68	8.68	9.5	82.42
150	Mirchaiya	Lahan	132	31.34	0.01	27.68	8.68	9.5	82.42
151	Mms	Damauli	132	121.53	0.01	58.00	70.49	9.5	669.63
152	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	9.5	10.35
153	Newchabil	Chapali	132	21.78	0.01	5.00	1.09	9.5	10.35
154	Mms	NMRS	132	0.00	0.01	40.00	0.00	9.5	0.00
155	Mms	NMRS	132	178.60	0.01	40.00	71.44	9.5	678.66
156	NMRS	Marsyangd	132	26.28	0.01	5.00	1.31	9.5	12.48
157	Marsyangdi	NMRS	132	26.24	0.01	5.00	1.31	9.5	12.46
158	Panchkhal	Sunkoshi	66	5.36	0.028	29.00	4.35	10.8	47.02
159	Panchkhal	Indrawati	66	12.12	0.028	28.00	9.50	10.8	102.61
160	Patan	Baneshwor	66	0.00	0.028	2.80	0.00	10.8	0.00
161	pathlaiya	Chapur	132	47.73	0.01	30.68	14.64	9.5	139.11
162	pathlaiya	Parwanipur	132	82.02	0.01	16.59	13.61	9.5	129.27
163	pathlaiya	Parwanipur	132	82.02	0.01	16.59	13.61	9.5	129.27
164	Lekhnath	Pokhara	132	35.21	0.01	7.00	2.46	9.5	23.41
165	Termi(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
166	Termi	Pokhara	132	1.50	0.01	0.10	0.00	9.5	0.01
167	Simara	Parwanipu	66	5.33	0.028	9.60	1.43	10.8	15.46
168	Simara	Parwanipu	66	5.33	0.028	9.60	1.43	10.8	15.46
169	Switchatar	Patan	66	26.51	0.028	6.50	4.83	10.8	52.11
170	Switchatar	Balaju	66	12.92	0.028	4.40	1.59	10.8	17.19
171	Switchatar	Balaju	66	12.92	0.028	4.40	1.59	10.8	17.19
172	Switchatar	K3	66	24.74	0.028	6.90	4.78	10.8	51.63
173	Teku	Switchatar	66	43.16	0.028	4.10	4.96	10.8	53.52
174	Switchatar	Patan	66	26.51	0.028	6.50	4.83	10.8	52.11
175	Syangja	KGA	132	127.29	0.01	55.00	70.01	9.5	665.07
176	Teku	K3	66	9.33	0.028	2.30	0.60	10.8	6.49
177	Trisuli	Devighat	66	0.00	0.028	4.56	0.00	10.8	0.00
Total				7485.50		5529.21	2677.83		30629.44

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	30629.44
Cost of Energy (ECOST) = EENS x IEAR	15314.72
Cost of Energy (ECOST) in Nrs	2041145964.30
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2041145964.30

Annex E: Reliability indices for wet season at normal load scenario.

(I) Reliability indices of existing INPS at wet Normal load (Base case i.e. I)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	50.51	0.01	35.19	17.77	95	168.86
2	Attariya	Phalampur	132	50.51	0.01	35.19	17.77	95	168.86
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	95	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	95	533.10
5	Bardaghat	New Butwal	132	53.03	0.01	10.00	5.30	95	50.38
6	Bardaghat	New Butwal	132	53.03	0.01	10.00	5.30	95	50.38
7	Bardaghat	Sardi	132	20.33	0.01	14.00	2.85	95	27.04
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	95	0.00
9	Kawasoti	Bardaghat	132	34.62	0.01	34.00	11.77	95	111.83
10	NewBharatpur	Bardaghat	132	27.80	0.01	74.00	20.57	95	195.41
11	Bhaktapur	Lamosanghu	132	115.53	0.01	48.30	55.80	95	530.10
12	Bhaktapur	Lamosanghu	132	115.53	0.01	48.30	55.80	95	530.10
13	Kawasoti	Bharatpur	132	17.72	0.01	36.00	6.38	95	60.61
14	Burigaon	Kohalpur	132	34.51	0.01	55.29	19.08	95	181.24
15	Burigaon	Kohalpur	132	34.51	0.01	55.29	19.08	95	181.24
16	Butwal	Sunwal	132	18.12	0.01	13.00	2.36	95	22.38
17	Butwal	BB2	132	18.12	0.01	13.00	2.36	95	22.38
18	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	95	40.77
19	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	95	40.77
20	Motipur	Butwal	132	54.19	0.01	38.00	20.59	95	195.61
21	Motipur	Butwal	132	54.19	0.01	38.00	20.59	95	195.61
22	Chapur	Nabalpur	132	6.24	0.01	34.75	2.17	95	20.60
23	Chapur	Nabalpur	132	8.37	0.01	34.75	2.91	95	27.63
24	Damauli	Bharatpur	132	48.39	0.01	39.00	18.87	95	179.29

25	Dhalkebar	Mirchaiya	132	42.42	0.01	31.50	13.36	95	126.95
26	Dhalkebar	Mirchaiya	132	42.42	0.01	31.50	13.36	95	126.95
27	Dhalkebar	Muzzafapur	400	116.98	0.002	140.00	32.76	18.8	615.80
28	Dhalkebar	Muzzafapur	400	9.64	0.002	140.00	2.70	18.8	50.73
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	95	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	95	54.40
31	Amarpur	Ilam	132	130.11	0.01	66.50	86.52	95	821.94
32	Amarpur	Ilam	132	22.02	0.01	66.50	14.64	95	139.12
33	Hetauda	Pathlaiya	132	0.46	0.01	37.00	0.17	95	1.61
34	Inariwa(1)	Duhabi	132	53.11	0.01	10.00	5.31	95	50.45
35	Inariwa(1)	Duhabi	132	3.29	0.01	10.00	0.33	95	3.12
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	3.95	0.01	48.30	1.91	95	18.10
38	Kul3	Tem(15)	132	3.96	0.01	0.50	0.02	95	0.19
39	Kushaha	Inariwa(1)	132	37.25	0.01	13.10	4.88	95	46.36
40	Inariwa(1)	Kushaha	132	37.25	0.01	13.10	4.88	95	46.36
41	Dana	Kushma	220	42.19	0.0035	39.00	5.76	35.5	204.44
42	Dana	Kushma	220	6.82	0.0035	39.00	0.93	35.5	33.04
43	Kushma	Modi	132	9.35	0.01	6.00	0.56	95	5.33
44	Kusum	Hapure	132	9.35	0.01	18.00	1.68	95	15.98
45	Lahan	Rupani	132	13.25	0.01	27.00	3.58	95	33.98
46	Lahan	Rupani	132	13.25	0.01	27.00	3.58	95	33.98
47	Ghorahi	Lamahi	132	4.33	0.01	13.00	0.56	95	5.34
48	Ghorahi	Lamahi	132	31.43	0.01	13.00	4.09	95	38.82
49	Lamahi	Jhimruk	132	8.86	0.01	49.49	4.38	95	41.64
50	Lekhath	Damauli	132	14.03	0.01	45.00	6.31	95	59.97
51	Lumki	Burigaon	132	13.90	0.01	33.90	4.71	95	44.75
52	Lumki	Burigaon	132	279.55	0.01	33.90	94.77	95	900.29
53	Kirtipur	MMars	132	279.55	0.01	17.00	47.52	95	451.47
54	Mahendranagar	Attariya	132	89.32	0.01	51.40	45.91	95	436.17
55	Mahendranagar	Attariya	132	89.32	0.01	51.40	45.91	95	436.17
56	Matatirtha	Hetauda	132	37.58	0.01	36.24	13.62	95	129.39
57	New Modi	Modi	132	37.58	0.01	0.30	0.11	95	1.07
58	Sandhikharka	Motipur	132	126.50	0.01	37.00	46.81	95	444.65
59	Sandhikharka	Motipur	132	10.18	0.01	37.00	3.77	95	35.79
60	Motipur	Shivapur	132	10.18	0.01	23.00	2.34	95	22.25
61	Motipur	Shivapur	132	92.96	0.01	23.00	21.38	95	203.11
62	New Butwal	Sunwal	132	0.00	0.01	20.00	0.00	95	0.00
63	New Butwal	BB2	132	6.77	0.01	20.00	1.35	95	12.86
64	NMRS	Matatirtha	132	6.77	0.01	84.00	5.69	95	54.02
65	NMRS	Matatirtha	132	44.38	0.01	84.00	37.28	95	354.12
66	Nabalpur	Dhalkebar	132	44.38	0.01	34.75	15.42	95	146.49

67	Nabalpur	Dhalkebar	132	2.41	0.01	34.75	0.84	95	7.96
68	Lahachok	New Modi	132	2.41	0.01	20.00	0.48	95	4.58
69	Lahachok	New Modi	132	69.13	0.01	20.00	13.83	95	131.35
70	NewBharatpur	Hetauda	132	69.13	0.01	75.00	51.85	95	492.56
71	Kushma	New Butwal	220	20.23	0.0035	88.00	6.23	35.5	221.22
72	Kushma	New Butwal	220	20.23	0.0035	88.00	6.23	35.5	221.22
73	New Modi	Pokhara	132	8.99	0.01	37.00	3.33	95	31.60
74	NewBharatpur	Marsyangdi	132	8.99	0.01	25.00	2.25	95	21.35
75	Pathlaiya	Chapur	132	101.84	0.01	30.68	31.25	95	296.83
76	Phalampur	Lumki	132	56.12	0.01	28.90	16.22	95	154.08
77	Phalampur	Lumki	132	56.12	0.01	28.90	16.22	95	154.08
78	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	95	0.00
79	Rupani	Kushaha	132	70.03	0.01	34.90	24.44	95	232.17
80	Trishuli3B Hub	Matatirtha	132	11.35	0.01	49.00	5.56	95	52.83
81	Trishuli3B Hub	Matatirtha	132	44.79	0.01	49.00	21.95	95	208.49
82	Samundartar	Trisuli3B H	132	44.79	0.01	26.00	11.64	95	110.63
83	Samundartar	Trisuli3B H	132	2.02	0.01	26.00	0.53	95	4.99
84	Lamosanghu	Khimti	132	2.02	0.01	40.00	0.81	95	7.68
85	Syaule	Attariya	132	0.00	0.01	60.00	0.00	95	0.00
86	Syaule	Attariya	132	64.67	0.01	60.00	38.80	95	368.60
87	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	95	277.88
88	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	95	277.88
89	Malekhu	Tem(4)	132	81.65	0.01	0.20	0.16	95	1.55
90	Amlekhgunj	Simara	66	74.73	0.028	12.90	26.99	10.8	291.53
91	Amlekhgunj	Simara	66	74.73	0.028	12.90	26.99	10.8	291.53
92	Balaju	Chapali	132	67.41	0.01	10.00	6.74	95	64.04
93	Balaju	Chapali	132	67.41	0.01	10.00	6.74	95	64.04
94	Lainchaur	Balaju	66	13.62	0.028	2.00	0.76	10.8	8.24
95	Switchatar	Balaju	132	20.71	0.01	4.40	0.91	95	8.66
96	Balaju	Trisuli	66	20.71	0.028	29.00	16.82	10.8	181.61
97	Balaju	Trisuli	66	47.53	0.028	29.00	38.59	10.8	416.80
98	Banepa	Panchkhal	66	47.53	0.028	8.03	10.69	10.8	115.41
99	Baneshwor	Bhaktapur	66	23.84	0.028	8.24	5.50	10.8	59.41
100	Bhaktapur	Ch.Narayan	132	38.62	0.01	3.65	1.41	95	13.39
101	Bhaktapur	Ch.Narayan	132	24.34	0.01	3.65	0.89	95	8.44
102	Bhaktapur	Banepa	66	24.34	0.028	13.57	9.25	95	87.86
103	NewBharatpur	Bharatpur	132	13.85	0.01	0.50	0.07	95	0.66
104	Parwanipur	Birgunj	66	33.68	0.028	9.00	8.49	10.8	91.67
105	Parwanipur	Birgunj	66	73.23	0.028	9.00	18.45	10.8	199.30
106	Butwal	KGA	132	73.23	0.01	58.00	42.47	95	403.50
107	Butwal	KGA	132	3.70	0.01	58.00	2.15	95	20.39
108	Chapali	Ch.Narayan	132	10.83	0.01	8.24	0.89	95	8.48

109	Chapali	Ch.Narayan	132	27.46	0.01	8.24	2.26	9.5	21.49
110	Chapali	Devighat	66	27.46	0.028	29.30	22.53	10.8	243.28
111	Chapali	Devighat	66	130.98	0.028	29.30	107.46	10.8	1160.52
112	Chilime kV	Trisuli	66	130.98	0.028	10.00	36.67	10.8	396.08
113	Damak	Anamani	132	72.76	0.01	26.70	19.43	9.5	184.56
114	NMRS	Damauli	132	72.76	0.01	23.00	16.74	9.5	158.99
115	NMRS	Damauli	132	4.84	0.01	23.00	1.11	9.5	10.58
116	Hetauda	Amlekhgunj	66	4.84	0.028	20.17	2.73	10.8	29.53
117	Hetauda	Amlekhgunj	66	32.10	0.028	20.17	18.13	10.8	195.79
118	Bharatpur	Hetauda	132	46.42	0.01	70.85	32.89	9.5	312.46
119	Hetauda	Kamane	132	8.33	0.01	18.50	1.54	9.5	14.64
120	Hetauda	Tem(15)	132	8.33	0.01	5.24	0.44	9.5	4.15
121	Tem(15)	Kul2	132	21.84	0.01	3.00	0.66	9.5	6.22
122	Damak	Ilam	132	21.84	0.01	31.50	6.88	9.5	65.35
123	Damak	Ilam	132	0.00	0.01	31.50	0.00	9.5	0.00
124	Kamane	Pathlaiya	132	115.21	0.01	18.50	21.31	9.5	202.48
125	Upper Khimti	Dhalkebar	220	89.56	0.0035	75.00	23.51	35.5	834.62
126	Upper Khimti	Dhalkebar	220	89.87	0.0035	75.00	23.59	35.5	837.46
127	Kohalpur	Kusum	132	97.66	0.01	48.30	47.17	9.5	448.09
128	Kul1	Switchatar	132	97.66	0.01	32.86	32.09	9.5	304.85
129	Kul1	Switchatar	66	79.87	0.028	32.86	73.49	10.8	793.70
130	Kul2	Matatirtha	132	128.44	0.01	28.50	36.61	9.5	347.75
131	Hetauda	Kul1	132	141.91	0.01	15.05	21.36	9.5	202.89
132	Hetauda	Kul1	66	311.70	0.028	15.05	131.35	10.8	1418.58
133	Kushaha	Kataiya	66	311.70	0.028	13.00	113.46	10.8	1225.36
134	Kushaha	Kataiya	132	3.29	0.01	13.00	0.43	9.5	4.06
135	Kushaha	Kataiya	132	1.22	0.01	13.00	0.16	9.5	1.51
136	Kusum	Lamahi	132	1.22	0.01	47.50	0.58	9.5	5.52
137	Kusum	Lamahi	132	90.04	0.01	47.50	42.77	9.5	406.32
138	Lahachok	BB2	132	12.06	0.01	42.00	5.07	9.5	48.12
139	BB2	Lahachok	132	12.06	0.01	42.00	5.07	9.5	48.12
140	Lainchaur	Newchabil	132	0.00	0.01	2.30	0.00	9.5	0.00
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	66	0.00	0.028	51.00	0.00	10.8	0.00
143	Lamahi	Shivapur	132	3.54	0.01	51.00	1.80	9.5	17.13
144	Lamosanghu	Bhotekoshi	132	3.54	0.01	24.65	0.87	9.5	8.28
145	BB1	Lamosanghu	132	0.00	0.01	45.84	0.00	9.5	0.00
146	BB2	Syangja	132	0.00	0.01	41.00	0.00	9.5	0.00
147	Marsyangdi	Tem(4)	132	27.61	0.01	40.00	11.04	9.5	104.91
148	Tem(4)	Switchatar	132	27.61	0.01	84.00	23.19	9.5	220.30
149	Switchatar	Matatirtha	132	69.39	0.01	4.40	3.05	9.5	29.00
150	Switchatar	Matatirtha	132	80.50	0.01	4.40	3.54	9.5	33.65

151	Mirchaiya	Lahan	132	56.24	0.01	27.68	15.57	95	147.89
152	Mirchaiya	Lahan	132	41.88	0.01	27.68	11.59	95	110.13
153	MMars	Damauli	132	2.11	0.01	58.00	1.22	95	11.62
154	Newchabil	Chapali	132	2.11	0.01	5.00	0.11	95	1.00
155	Newchabil	Chapali	66	14.44	0.028	5.00	2.02	10.8	21.83
156	MMars	NMRS	132	14.44	0.01	40.00	5.78	95	54.88
157	MMars	NMRS	132	120.44	0.01	40.00	48.18	95	457.68
158	NMRS	Marsyangdi	132	19.60	0.01	5.00	0.98	95	9.31
159	Marsyangdi	NMRS	132	19.60	0.01	5.00	0.98	95	9.31
160	Panchkhal	Sunkoshi	66	0.00	0.028	29.00	0.00	10.8	0.00
161	Panchkhal	Indrawati	66	179.70	0.028	28.00	140.88	10.8	1521.53
162	Patan	Baneshwor	66	21.76	0.028	2.80	1.71	10.8	18.43
163	Pathlaiya	Parwanipur	132	21.74	0.01	16.59	3.61	95	34.27
164	Pathlaiya	Parwanipur	132	5.82	0.01	16.59	0.96	95	9.17
165	Pathlaiya	Chapur	132	12.16	0.01	30.68	3.73	95	35.43
166	Lekhnath	Pokhara	132	0.00	0.01	7.00	0.00	95	0.00
167	Tem(1)	Gandak	132	11.35	0.01	0.10	0.01	95	0.11
168	Tem	Pokhara	132	31.43	0.01	0.10	0.03	95	0.30
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	1.50	0.028	9.60	0.40	10.8	4.35
171	Switchatar	Patan	66	0.00	0.028	6.50	0.00	10.8	0.00
172	Switchatar	Balaju	66	0.00	0.028	4.40	0.00	10.8	0.00
173	Switchatar	Balaju	66	23.85	0.028	4.40	2.94	10.8	31.73
174	Switchatar	K3	66	23.55	0.028	6.90	4.55	10.8	49.14
175	Teku	Switchatar	66	23.55	0.028	4.10	2.70	10.8	29.20
176	Switchatar	Patan	66	22.72	0.028	6.50	4.13	10.8	44.66
177	Syangja	KGA	132	38.39	0.01	55.00	21.11	95	200.59
178	Teku	K3	66	23.85	0.028	2.30	1.54	10.8	16.59
179	Trisuli	Devighat	66	7.94	0.028	4.56	1.01	10.8	10.95
Total				0.00			2755.35		29295.42

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw/hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	29295.42
Cost of Energy (ECOST) = EENS x IEAR	14647.71

Cost of Energy (ECOST) in Nrs	1952246474.1 7
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1952246474.1 7

(II) Reliability indices of existing INPS at wet Normal load (case II)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	50.63	0.01	35.19	17.82	9.5	169.25
2	Attariya	Phalampur	132	50.63	0.01	35.19	17.82	9.5	169.25
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	New Butwal	132	42.03	0.01	10.00	4.20	9.5	39.93
6	Bardaghat	New Butwal	132	42.03	0.01	10.00	4.20	9.5	39.93
7	Bardaghat	Sardi	132	20.33	0.01	14.00	2.85	9.5	27.04
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	24.77	0.01	34.00	8.42	9.5	80.00
10	NewBharatpur	Bardaghat	132	16.16	0.01	74.00	11.96	9.5	113.62
11	Bhaktapur	Lamosanghu	132	115.64	0.01	48.30	55.85	9.5	530.61
12	Bhaktapur	Lamosanghu	132	115.64	0.01	48.30	55.85	9.5	530.61
13	Kawasoti	Bharatpur	132	7.86	0.01	36.00	2.83	9.5	26.89
14	Burigaon	Kohalpur	132	34.65	0.01	55.29	19.16	9.5	182.01
15	Burigaon	Kohalpur	132	34.65	0.01	55.29	19.16	9.5	182.01
16	Butwal	Sunwal	132	19.48	0.01	13.00	2.53	9.5	24.06
17	Butwal	BB2	132	19.48	0.01	13.00	2.53	9.5	24.06
18	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	9.5	40.77
19	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	9.5	40.77
20	Motipur	Butwal	132	53.82	0.01	38.00	20.45	9.5	194.30
21	Motipur	Butwal	132	53.82	0.01	38.00	20.45	9.5	194.30
22	Chapur	Nabalpur	132	15.55	0.01	34.75	5.40	9.5	51.33
23	Chapur	Nabalpur	132	17.05	0.01	34.75	5.93	9.5	56.30
24	Damauli	Bharatpur	132	51.82	0.01	39.00	20.21	9.5	191.98
25	Dhalkebar	Mirchaiya	132	42.44	0.01	31.50	13.37	9.5	127.00
26	Dhalkebar	Mirchaiya	132	42.44	0.01	31.50	13.37	9.5	127.00
27	Dhalkebar	Muzzafapur	400	117.00	0.002	140.00	32.76	18.8	615.90
28	Dhalkebar	Muzzafapur	400	9.64	0.002	140.00	2.70	18.8	50.73
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	9.5	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	9.5	54.40
31	Amarpur	Ilam	132	119.01	0.01	66.50	79.14	9.5	751.85
32	Amarpur	Ilam	132	22.00	0.01	66.50	14.63	9.5	139.00
33	Hetauda	Pathlaiya	132	0.46	0.01	37.00	0.17	9.5	1.61
34	Inariwa (1)	Duhabi	132	53.11	0.01	10.00	5.31	9.5	50.46
35	Inariwa (1)	Duhabi	132	3.44	0.01	10.00	0.34	9.5	3.27

36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	3.95	0.01	48.30	1.91	9.5	18.15
38	Kul3	Tem(15)	132	3.97	0.01	0.50	0.02	9.5	0.19
39	Kushaha	Inariwa (1)	132	37.25	0.01	13.10	4.88	9.5	46.36
40	Inariwa (1)	Kushaha	132	37.25	0.01	13.10	4.88	9.5	46.36
41	Dana	Kushma	220	42.19	0.0035	39.00	5.76	35.5	204.47
42	Dana	Kushma	220	6.82	0.0035	39.00	0.93	35.5	33.04
43	Kushma	Modi	132	9.34	0.01	6.00	0.56	9.5	5.32
44	Kusum	Hapure	132	9.34	0.01	18.00	1.68	9.5	15.97
45	Lahan	Rupani	132	13.25	0.01	27.00	3.58	9.5	33.98
46	Lahan	Rupani	132	13.25	0.01	27.00	3.58	9.5	33.98
47	Ghorahi	Lamahi	132	4.39	0.01	13.00	0.57	9.5	5.42
48	Ghorahi	Lamahi	132	31.43	0.01	13.00	4.09	9.5	38.82
49	Lamahi	Jhimruk	132	8.86	0.01	49.49	4.38	9.5	41.64
50	Lekhnath	Damauli	132	14.02	0.01	45.00	6.31	9.5	59.92
51	Lumki	Burigaon	132	13.91	0.01	33.90	4.72	9.5	44.81
52	Lumki	Burigaon	132	270.52	0.01	33.90	91.71	9.5	871.20
53	Kirtipur	MMars	132	270.52	0.01	17.00	45.99	9.5	436.88
54	Mahendranagar	Attariya	132	89.29	0.01	51.40	45.90	9.5	436.02
55	Mahendranagar	Attariya	132	89.29	0.01	51.40	45.90	9.5	436.02
56	Matatirtha	Hetauda	132	37.72	0.01	36.24	13.67	9.5	129.87
57	New Modi	Modi	132	37.72	0.01	0.30	0.11	9.5	1.08
58	Sandhikharka	Motipur	132	126.50	0.01	37.00	46.81	9.5	444.65
59	Sandhikharka	Motipur	132	10.18	0.01	37.00	3.77	9.5	35.79
60	Motipur	Shivapur	132	10.18	0.01	23.00	2.34	9.5	22.25
61	Motipur	Shivapur	132	88.18	0.01	23.00	20.28	9.5	192.68
62	New Butwal	Sunwal	132	0.00	0.01	20.00	0.00	9.5	0.00
63	New Butwal	BB2	132	6.77	0.01	20.00	1.35	9.5	12.86
64	NMRS	Matatirtha	132	6.77	0.01	84.00	5.69	9.5	54.02
65	NMRS	Matatirtha	132	44.01	0.01	84.00	36.97	9.5	351.23
66	Nabalpur	Dhalkebar	132	44.01	0.01	34.75	15.29	9.5	145.30
67	Nabalpur	Dhalkebar	132	1.04	0.01	34.75	0.36	9.5	3.43
68	Lahachok	New Modi	132	1.04	0.01	20.00	0.21	9.5	1.98
69	Lahachok	New Modi	132	64.70	0.01	20.00	12.94	9.5	122.92
70	NewBharatpur	Hetauda	132	64.70	0.01	75.00	48.52	9.5	460.97
71	Kushma	New Butwal	220	29.24	0.0035	88.00	9.01	35.5	319.73
72	Kushma	New Butwal	220	29.24	0.0035	88.00	9.01	35.5	319.73
73	New Modi	Pokhara	132	8.99	0.01	37.00	3.33	9.5	31.60
74	NewBharatpur	Marsyangdi	132	8.99	0.01	25.00	2.25	9.5	21.35
75	Pathlaiya	Chapur	132	92.07	0.01	30.68	28.25	9.5	268.33
76	Phalampur	Lumki	132	56.13	0.01	28.90	16.22	9.5	154.10
77	Phalampur	Lumki	132	56.13	0.01	28.90	16.22	9.5	154.10

78	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	9.5	0.00
79	Rupani	Kushaha	132	78.44	0.01	34.90	27.38	9.5	260.07
80	Trishuli3B Hub	Matatirtha	132	2.31	0.01	49.00	1.13	9.5	10.76
81	Trishuli3B Hub	Matatirtha	132	44.92	0.01	49.00	22.01	9.5	209.10
82	Samundartar	Trisuli3B H	132	44.92	0.01	26.00	11.68	9.5	110.95
83	Samundartar	Trisuli3B H	132	2.03	0.01	26.00	0.53	9.5	5.01
84	Lamosanghu	Khimti	132	2.03	0.01	40.00	0.81	9.5	7.71
85	Syaule	Attariya	132	0.00	0.01	60.00	0.00	9.5	0.00
86	Syaule	Attariya	132	64.67	0.01	60.00	38.80	9.5	368.63
87	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	9.5	277.88
88	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	9.5	277.88
89	Malekhu	Tem(4)	132	81.68	0.01	0.20	0.16	9.5	1.55
90	Amlekhgunj	Simara	66	74.80	0.028	12.90	27.02	10.8	291.78
91	Amlekhgunj	Simara	66	74.80	0.028	12.90	27.02	10.8	291.78
92	Balaju	Chapali	132	67.41	0.01	10.00	6.74	9.5	64.04
93	Balaju	Chapali	132	67.41	0.01	10.00	6.74	9.5	64.04
94	Lainchaur	Balaju	66	13.62	0.028	2.00	0.76	10.8	8.24
95	Switchatar	Balaju	132	20.71	0.01	4.40	0.91	9.5	8.66
96	Balaju	Trisuli	66	20.71	0.028	29.00	16.81	10.8	181.59
97	Balaju	Trisuli	66	47.69	0.028	29.00	38.72	10.8	418.21
98	Banepa	Panchkhal	66	47.69	0.028	8.03	10.72	10.8	115.80
99	Baneshwor	Bhaktapur	66	23.84	0.028	8.24	5.50	10.8	59.41
100	Bhaktapur	Ch.Narayan	132	39.48	0.01	3.65	1.44	9.5	13.69
101	Bhaktapur	Ch.Narayan	132	24.33	0.01	3.65	0.89	9.5	8.44
102	Bhaktapur	Banepa	66	24.33	0.028	13.57	9.25	9.5	87.83
103	NewBharatpur	Bharatpur	132	13.86	0.01	0.50	0.07	9.5	0.66
104	Parwanipur	Birgunj	66	33.68	0.028	9.00	8.49	10.8	91.67
105	Parwanipur	Birgunj	66	73.35	0.028	9.00	18.48	10.8	199.62
106	Butwal	KGA	132	73.35	0.01	58.00	42.54	9.5	404.14
107	Butwal	KGA	132	3.70	0.01	58.00	2.15	9.5	20.41
108	Chapali	Ch.Narayan	132	4.28	0.01	8.24	0.35	9.5	3.35
109	Chapali	Ch.Narayan	132	27.45	0.01	8.24	2.26	9.5	21.49
110	Chapali	Devighat	66	27.45	0.028	29.30	22.52	10.8	243.21
111	Chapali	Devighat	66	131.85	0.028	29.30	108.17	10.8	1168.27
112	Chilime kV	Trisuli	66	131.85	0.028	10.00	36.92	10.8	398.73
113	Damak	Anamani	132	72.89	0.01	26.70	19.46	9.5	184.88
114	NMRS	Damauli	132	72.89	0.01	23.00	16.76	9.5	159.26
115	NMRS	Damauli	132	4.88	0.01	23.00	1.12	9.5	10.66
116	Hetauda	Amlekhgunj	66	4.88	0.028	20.17	2.75	10.8	29.75
117	Hetauda	Amlekhgunj	66	32.10	0.028	20.17	18.13	10.8	195.79
118	Bharatpur	Hetauda	132	46.42	0.01	70.85	32.89	9.5	312.46
119	Hetauda	Kamane	132	6.83	0.01	18.50	1.26	9.5	12.00

120	Hetauda	Tem(15)	132	6.83	0.01	5.24	0.36	9.5	3.40
121	Tem(15)	Kul2	132	21.83	0.01	3.00	0.65	9.5	6.22
122	Damak	Ilam	132	21.83	0.01	31.50	6.88	9.5	65.33
123	Damak	Ilam	132	0.00	0.01	31.50	0.00	9.5	0.00
124	Kamane	Pathlaiya	132	107.22	0.01	18.50	19.84	9.5	188.43
125	Upper Khimti	Dhalkebar	220	85.10	0.0035	75.00	22.34	35.5	793.05
126	Upper Khimti	Dhalkebar	220	85.37	0.0035	75.00	22.41	35.5	795.56
127	Kohalpur	Kusum	132	97.66	0.01	48.30	47.17	9.5	448.12
128	Kul1	Switchatar	132	97.66	0.01	32.86	32.09	9.5	304.87
129	Kul1	Switchatar	66	72.07	0.028	32.86	66.31	10.8	716.15
130	Kul2	Matatirtha	132	128.84	0.028	28.50	102.81	10.8	1110.35
131	Hetauda	Kul1	132	141.92	0.01	15.05	21.36	9.5	202.90
132	Hetauda	Kul1	66	311.70	0.028	15.05	131.35	10.8	1418.58
133	Kushaha	Kataiya	66	311.70	0.028	13.00	113.46	10.8	1225.36
134	Kushaha	Kataiya	132	3.44	0.01	13.00	0.45	9.5	4.25
135	Kushaha	Kataiya	132	0.57	0.01	13.00	0.07	9.5	0.70
136	Kusum	Lamahi	132	0.57	0.01	47.50	0.27	9.5	2.55
137	Kusum	Lamahi	132	85.53	0.01	47.50	40.62	9.5	385.93
138	Lahachok	BB2	132	11.49	0.01	42.00	4.83	9.5	45.86
139	BB2	Lahachok	132	11.49	0.01	42.00	4.83	9.5	45.86
140	Lainchaur	Newchabil	132	0.00	0.01	2.30	0.00	9.5	0.00
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	66	0.00	0.028	51.00	0.00	10.8	0.00
143	Lamahi	Shivapur	132	3.38	0.01	51.00	1.72	9.5	16.38
144	Lamosanghu	Bhotekoshi	132	3.38	0.01	24.65	0.83	9.5	7.92
145	BB1	Lamosanghu	132	0.00	0.01	45.84	0.00	9.5	0.00
146	BB2	Syangja	132	0.00	0.01	41.00	0.00	9.5	0.00
147	Marsyangdi	Tem(4)	132	27.42	0.01	40.00	10.97	9.5	104.20
148	Tem(4)	Switchatar	132	27.42	0.01	84.00	23.03	9.5	218.81
149	Switchatar	Matatirtha	132	69.40	0.01	4.40	3.05	9.5	29.01
150	Switchatar	Matatirtha	132	80.50	0.01	4.40	3.54	9.5	33.65
151	Mirchaiya	Lahan	132	53.19	0.01	27.68	14.72	9.5	139.87
152	Mirchaiya	Lahan	132	38.92	0.01	27.68	10.77	9.5	102.35
153	MMars	Damauli	132	2.62	0.01	58.00	1.52	9.5	14.44
154	Newchabil	Chapali	132	2.62	0.01	5.00	0.13	9.5	1.25
155	Newchabil	Chapali	66	14.43	0.028	5.00	2.02	10.8	21.82
156	MMars	NMRS	132	14.43	0.01	40.00	5.77	9.5	54.84
157	MMars	NMRS	132	120.84	0.01	40.00	48.34	9.5	459.21
158	NMRS	Marsyangdi	132	19.60	0.01	5.00	0.98	9.5	9.31
159	Marsyangdi	NMRS	132	19.60	0.01	5.00	0.98	9.5	9.31
160	Panchkhal	Sunkoshi	66	0.00	0.028	29.00	0.00	10.8	0.00
161	Panchkhal	Indrawati	66	179.29	0.028	28.00	140.57	10.8	1518.12

162	Patan	Baneshwor	66	24.54	0.028	2.80	1.92	10.8	20.78
163	Pathlaiya	Parwanipur	132	24.51	0.01	16.59	4.07	9.5	38.62
164	Pathlaiya	Parwanipur	132	5.82	0.01	16.59	0.97	9.5	9.17
165	Pathlaiya	Chapur	132	12.16	0.01	30.68	3.73	9.5	35.44
166	Lekhnath	Pokhara	132	0.00	0.01	7.00	0.00	9.5	0.00
167	Term(1)	Gandak	132	2.31	0.01	0.10	0.00	9.5	0.02
168	Term	Pokhara	132	31.43	0.01	0.10	0.03	9.5	0.30
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	1.50	0.028	9.60	0.40	10.8	4.35
171	Switchatar	Patan	66	0.00	0.028	6.50	0.00	10.8	0.00
172	Switchatar	Balaju	66	0.00	0.028	4.40	0.00	10.8	0.00
173	Switchatar	Balaju	66	23.85	0.028	4.40	2.94	10.8	31.73
174	Switchatar	K3	66	23.27	0.028	6.90	4.50	10.8	48.56
175	Teku	Switchatar	66	23.27	0.028	4.10	2.67	10.8	28.85
176	Switchatar	Patan	66	22.71	0.028	6.50	4.13	10.8	44.64
177	Syangja	KGA	132	38.40	0.028	55.00	59.13	10.8	638.60
178	Teku	K3	66	23.85	0.028	2.30	1.54	10.8	16.59
179	Trisuli	Devighat	66	7.95	0.028	4.56	1.01	10.8	10.96
			Total	0.00			2817.85		29174.91

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	29174.91
Cost of Energy (ECOST) = EENS x IEAR	14587.45
Cost of Energy (ECOST) in Nrs	1944215676.49
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1944215676.49

(III) Reliability indices of existing INPS at wet Normal load (case III)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	50.68	0.01	35.19	17.84	9.5	169.44
2	Attariya	Phalampur	132	50.68	0.01	35.19	17.84	9.5	169.44
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	New Butwal	132	6.56	0.01	10.00	0.66	9.5	6.23

6	Bardaghat	New Butwal	132	6.56	0.01	10.00	0.66	9.5	6.23
7	Bardaghat	Sardi	132	20.33	0.01	14.00	2.85	9.5	27.04
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	9.59	0.01	34.00	3.26	9.5	30.96
10	NewBharatpur	Bardaghat	132	20.32	0.01	74.00	15.03	9.5	142.82
11	Bhaktapur	Lamosanghu	132	115.85	0.01	48.30	55.96	9.5	531.60
12	Bhaktapur	Lamosanghu	132	115.85	0.01	48.30	55.96	9.5	531.60
13	Kawasoti	Bharatpur	132	26.49	0.01	36.00	9.54	9.5	90.59
14	Burigaon	Kohalpur	132	34.72	0.01	55.29	19.20	9.5	182.37
15	Burigaon	Kohalpur	132	34.72	0.01	55.29	19.20	9.5	182.37
16	Butwal	Sunwal	132	19.86	0.01	13.00	2.58	9.5	24.53
17	Butwal	BB2	132	19.86	0.01	13.00	2.58	9.5	24.53
18	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	9.5	40.77
19	Mainahiya	Butwal	132	23.84	0.01	18.00	4.29	9.5	40.77
20	Motipur	Butwal	132	53.75	0.01	38.00	20.42	9.5	194.04
21	Motipur	Butwal	132	53.75	0.01	38.00	20.42	9.5	194.04
22	Chapur	Nabalpur	132	48.61	0.01	34.75	16.89	9.5	160.48
23	Chapur	Nabalpur	132	48.75	0.01	34.75	16.94	9.5	160.95
24	Damauli	Bharatpur	132	64.25	0.01	39.00	25.06	9.5	238.06
25	Dhalkebar	Mirchaiya	132	42.66	0.01	31.50	13.44	9.5	127.66
26	Dhalkebar	Mirchaiya	132	42.66	0.01	31.50	13.44	9.5	127.66
27	Dhalkebar	Muzzafapur	400	117.34	0.002	140.00	32.86	18.8	617.68
28	Dhalkebar	Muzzafapur	400	9.64	0.002	140.00	2.70	18.8	50.73
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	9.5	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	9.5	54.40
31	Amapur	Ilam	132	80.10	0.01	66.50	53.27	9.5	506.03
32	Amapur	Ilam	132	21.67	0.01	66.50	14.41	9.5	136.91
33	Hetauda	Pathlaiya	132	0.45	0.01	37.00	0.17	9.5	1.59
34	Inariwa (1)	Duhabi	132	53.12	0.01	10.00	5.31	9.5	50.47
35	Inariwa (1)	Duhabi	132	3.51	0.01	10.00	0.35	9.5	3.34
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	4.13	0.01	48.30	1.99	9.5	18.95
38	Kul3	Tem(15)	132	4.15	0.01	0.50	0.02	9.5	0.20
39	Kushaha	Inariwa (1)	132	37.25	0.01	13.10	4.88	9.5	46.36
40	Inariwa (1)	Kushaha	132	37.25	0.01	13.10	4.88	9.5	46.36
41	Dana	Kushma	220	42.20	0.0035	39.00	5.76	35.5	204.47
42	Dana	Kushma	220	6.82	0.0035	39.00	0.93	35.5	33.04
43	Kushma	Modi	132	9.16	0.01	6.00	0.55	9.5	5.22
44	Kusum	Hapure	132	9.16	0.01	18.00	1.65	9.5	15.67
45	Lahan	Rupani	132	13.25	0.01	27.00	3.58	9.5	33.98
46	Lahan	Rupani	132	13.25	0.01	27.00	3.58	9.5	33.98
47	Ghorahi	Lamahi	132	4.25	0.01	13.00	0.55	9.5	5.25

48	Ghorahi	Lamahi	132	31.43	0.01	13.00	4.09	9.5	38.82
49	Lamahi	Jhimuk	132	8.86	0.01	49.49	4.38	9.5	41.64
50	Lekhnath	Damauli	132	14.15	0.01	45.00	6.37	9.5	60.48
51	Lumki	Burigaon	132	13.78	0.01	33.90	4.67	9.5	44.37
52	Lumki	Burigaon	132	237.56	0.01	33.90	80.53	9.5	765.08
53	Kirtipur	MMars	132	237.56	0.01	17.00	40.39	9.5	383.67
54	Mahendranagar	Attariya	132	89.26	0.01	51.40	45.88	9.5	435.84
55	Mahendranagar	Attariya	132	89.26	0.01	51.40	45.88	9.5	435.84
56	Matatirtha	Hetauda	132	37.79	0.01	36.24	13.69	9.5	130.10
57	New Modi	Modi	132	37.79	0.01	0.30	0.11	9.5	1.08
58	Sandhikharka	Motipur	132	126.50	0.01	37.00	46.81	9.5	444.65
59	Sandhikharka	Motipur	132	10.18	0.01	37.00	3.77	9.5	35.79
60	Motipur	Shivapur	132	10.18	0.01	23.00	2.34	9.5	22.25
61	Motipur	Shivapur	132	72.15	0.01	23.00	16.59	9.5	157.65
62	New Butwal	Sunwal	132	0.00	0.01	20.00	0.00	9.5	0.00
63	New Butwal	BB2	132	6.77	0.01	20.00	1.35	9.5	12.86
64	NMRS	Matatirtha	132	6.77	0.01	84.00	5.69	9.5	54.02
65	NMRS	Matatirtha	132	43.94	0.01	84.00	36.91	9.5	350.64
66	Nabalpur	Dhalkebar	132	43.94	0.01	34.75	15.27	9.5	145.06
67	Nabalpur	Dhalkebar	132	0.61	0.01	34.75	0.21	9.5	2.02
68	Lahachok	New Modi	132	0.61	0.01	20.00	0.12	9.5	1.17
69	Lahachok	New Modi	132	50.55	0.01	20.00	10.11	9.5	96.04
70	NewBharatpur	Hetauda	132	50.55	0.01	75.00	37.91	9.5	360.14
71	Kushma	New Butwal	220	61.99	0.0035	88.00	19.09	35.5	677.83
72	Kushma	New Butwal	220	61.99	0.0035	88.00	19.09	35.5	677.83
73	New Modi	Pokhara	132	8.99	0.01	37.00	3.33	9.5	31.59
74	NewBharatpur	Marsyangdi	132	8.99	0.01	25.00	2.25	9.5	21.35
75	Pathlaiya	Chapur	132	57.85	0.01	30.68	17.75	9.5	168.62
76	Phalampur	Lumki	132	56.13	0.01	28.90	16.22	9.5	154.11
77	Phalampur	Lumki	132	56.13	0.01	28.90	16.22	9.5	154.11
78	Rupani	Kushaha	132	0.00	0.01	34.90	0.00	9.5	0.00
79	Rupani	Kushaha	132	103.58	0.01	34.90	36.15	9.5	343.40
80	Trishuli3B Hub	Matatirtha	132	29.86	0.01	49.00	14.63	9.5	139.00
81	Trishuli3B Hub	Matatirtha	132	44.98	0.01	49.00	22.04	9.5	209.39
82	Samundartar	Trisuli3BH	132	44.98	0.01	26.00	11.70	9.5	111.10
83	Samundartar	Trisuli3BH	132	2.21	0.01	26.00	0.57	9.5	5.45
84	Lamosanghu	Khimti	132	2.21	0.01	40.00	0.88	9.5	8.38
85	Syaule	Attariya	132	0.00	0.01	60.00	0.00	9.5	0.00
86	Syaule	Attariya	132	64.68	0.01	60.00	38.81	9.5	368.68
87	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	9.5	277.88
88	Mirchaiya	Tingla	132	32.50	0.01	90.00	29.25	9.5	277.88
89	Malekhu	Tem(4)	132	81.74	0.01	0.20	0.16	9.5	1.55

90	Amlekhgunj	Simara	66	74.83	0.028	12.90	27.03	10.8	291.89
91	Amlekhgunj	Simara	66	74.83	0.028	12.90	27.03	10.8	291.89
92	Balaju	Chapali	132	67.45	0.01	10.00	6.75	9.5	64.08
93	Balaju	Chapali	132	67.45	0.01	10.00	6.75	9.5	64.08
94	Lainchaur	Balaju	66	13.62	0.028	2.00	0.76	10.8	8.24
95	Switchatar	Balaju	132	20.70	0.01	4.40	0.91	9.5	8.65
96	Balaju	Trisuli	66	20.70	0.028	29.00	16.81	10.8	181.56
97	Balaju	Trisuli	66	47.98	0.028	29.00	38.96	10.8	420.74
98	Banepa	Panchkhal	66	47.98	0.028	8.03	10.79	10.8	116.50
99	Baneshwor	Bhaktapur	66	23.84	0.028	8.24	5.50	10.8	59.41
100	Bhaktapur	Ch.Narayan	132	41.67	0.01	3.65	1.52	9.5	14.45
101	Bhaktapur	Ch.Narayan	132	24.30	0.01	3.65	0.89	9.5	8.43
102	Bhaktapur	Banepa	66	24.30	0.028	13.57	9.23	9.5	87.71
103	NewBharatpur	Bharatpur	132	13.87	0.01	0.50	0.07	9.5	0.66
104	Parwanipur	Birgunj	66	33.68	0.028	9.00	8.49	10.8	91.67
105	Parwanipur	Birgunj	66	73.57	0.028	9.00	18.54	10.8	200.23
106	Butwal	KGA	132	73.57	0.01	58.00	42.67	9.5	405.38
107	Butwal	KGA	132	3.71	0.01	58.00	2.15	9.5	20.46
108	Chapali	Ch.Narayan	132	18.59	0.01	8.24	1.53	9.5	14.56
109	Chapali	Ch.Narayan	132	27.44	0.01	8.24	2.26	9.5	21.48
110	Chapali	Devighat	66	27.44	0.028	29.30	22.51	10.8	243.14
111	Chapali	Devighat	66	132.11	0.028	29.30	108.38	10.8	1170.55
112	Chilime kV	Trisuli	66	132.11	0.028	10.00	36.99	10.8	399.50
113	Damak	Anamani	132	73.14	0.01	26.70	19.53	9.5	185.51
114	NMRS	Damauli	132	73.14	0.01	23.00	16.82	9.5	159.80
115	NMRS	Damauli	132	4.91	0.01	23.00	1.13	9.5	10.73
116	Hetauda	Amlekhgunj	66	4.91	0.028	20.17	2.77	10.8	29.95
117	Hetauda	Amlekhgunj	66	32.10	0.028	20.17	18.13	10.8	195.79
118	Bharatpur	Hetauda	132	46.41	0.01	70.85	32.88	9.5	312.38
119	Hetauda	Kamane	132	1.24	0.01	18.50	0.23	9.5	2.18
120	Hetauda	Tem(15)	132	1.24	0.01	5.24	0.06	9.5	0.62
121	Tem(15)	Kul2	132	21.82	0.01	3.00	0.65	9.5	6.22
122	Damak	Ilam	132	21.82	0.01	31.50	6.87	9.5	65.30
123	Damak	Ilam	132	0.00	0.01	31.50	0.00	9.5	0.00
124	Kamane	Pathlaiya	132	79.30	0.01	18.50	14.67	9.5	139.37
125	Upper Khimti	Dhalkebar	220	69.95	0.0035	75.00	18.36	35.5	651.82
126	Upper Khimti	Dhalkebar	220	70.12	0.0035	75.00	18.41	35.5	653.45
127	Kohalpur	Kusum	132	97.78	0.01	48.30	47.23	9.5	448.65
128	Kul1	Switchatar	132	97.78	0.01	32.86	32.13	9.5	305.23
129	Kul1	Switchatar	66	44.65	0.028	32.86	41.08	10.8	443.67
130	Kul2	Matatirtha	132	128.90	0.028	28.50	102.86	10.8	1110.89
131	Hetauda	Kul1	132	141.91	0.01	15.05	21.36	9.5	202.90

132	Hetauda	Kull	66	311.70	0.028	15.05	131.35	10.8	1418.58
133	Kushaha	Kataiya	66	311.70	0.028	13.00	113.46	10.8	1225.36
134	Kushaha	Kataiya	132	3.51	0.01	13.00	0.46	9.5	4.34
135	Kushaha	Kataiya	132	1.53	0.01	13.00	0.20	9.5	1.88
136	Kusum	Lamahi	132	1.53	0.01	47.50	0.72	9.5	6.88
137	Kusum	Lamahi	132	70.22	0.01	47.50	33.36	9.5	316.88
138	Lahachok	BB2	132	9.52	0.01	42.00	4.00	9.5	37.97
139	BB2	Lahachok	132	9.52	0.01	42.00	4.00	9.5	37.97
140	Lainchaur	Newchabil	132	0.00	0.01	2.30	0.00	9.5	0.00
141	Lainchaur	Newchabil	66	0.00	0.028	2.30	0.00	10.8	0.00
142	Lamahi	Shivapur	66	0.00	0.028	51.00	0.00	10.8	0.00
143	Lamahi	Shivapur	132	3.31	0.01	51.00	1.69	9.5	16.04
144	Lamosanghu	Bhotekoshi	132	3.31	0.01	24.65	0.82	9.5	7.75
145	BB1	Lamosanghu	132	0.00	0.01	45.84	0.00	9.5	0.00
146	BB2	Syangja	132	0.00	0.01	41.00	0.00	9.5	0.00
147	Marsyangdi	Tem(4)	132	27.42	0.01	40.00	10.97	9.5	104.18
148	Tem(4)	Switchatar	132	27.42	0.01	84.00	23.03	9.5	218.78
149	Switchatar	Matatirtha	132	69.39	0.01	4.40	3.05	9.5	29.01
150	Switchatar	Matatirtha	132	80.50	0.01	4.40	3.54	9.5	33.65
151	Mirchaiya	Lahan	132	43.17	0.01	27.68	11.95	9.5	113.51
152	Mirchaiya	Lahan	132	29.12	0.01	27.68	8.06	9.5	76.59
153	MMars	Damauli	132	4.89	0.01	58.00	2.84	9.5	26.94
154	Newchabil	Chapali	132	4.89	0.01	5.00	0.24	9.5	2.32
155	Newchabil	Chapali	66	14.26	0.028	5.00	2.00	10.8	21.55
156	MMars	NMRS	132	14.26	0.01	40.00	5.70	9.5	54.17
157	MMars	NMRS	132	122.18	0.01	40.00	48.87	9.5	464.29
158	NMRS	Marsyangdi	132	19.60	0.01	5.00	0.98	9.5	9.31
159	Marsyangdi	NMRS	132	19.60	0.01	5.00	0.98	9.5	9.31
160	Panchkhal	Sunkoshi	66	0.00	0.028	29.00	0.00	10.8	0.00
161	Panchkhal	Indrawati	66	177.96	0.028	28.00	139.52	10.8	1506.80
162	Patan	Baneshwor	66	32.48	0.028	2.80	2.55	10.8	27.50
163	Pathlaiya	Parwanipur	132	32.43	0.01	16.59	5.38	9.5	51.12
164	Pathlaiya	Parwanipur	132	5.82	0.01	16.59	0.97	9.5	9.17
165	Pathlaiya	Chapur	132	12.16	0.01	30.68	3.73	9.5	35.45
166	Lekhnath	Pokhara	132	0.00	0.01	7.00	0.00	9.5	0.00
167	Tem(1)	Gandak	132	29.86	0.01	0.10	0.03	9.5	0.28
168	Tem	Pokhara	132	31.43	0.01	0.10	0.03	9.5	0.30
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	1.50	0.028	9.60	0.40	10.8	4.35
171	Switchatar	Patan	66	0.00	0.028	6.50	0.00	10.8	0.00
172	Switchatar	Balaju	66	0.00	0.028	4.40	0.00	10.8	0.00
173	Switchatar	Balaju	66	23.84	0.028	4.40	2.94	10.8	31.72

174	Switchatar	K3	66	22.44	0.028	6.90	4.33	10.8	46.82
175	Teku	Switchatar	66	22.44	0.028	4.10	2.58	10.8	27.82
176	Switchatar	Patan	66	22.70	0.028	6.50	4.13	10.8	44.62
177	Syangja	KGA	132	38.40	0.028	55.00	59.14	10.8	638.72
178	Teku	K3	66	23.84	0.028	2.30	1.54	10.8	16.58
179	Trisuli	Devighat	66	7.95	0.028	4.56	1.02	10.8	10.97
Total				0.00			2766.42		27971.50

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	27971.50
Cost of Energy (ECOST) = EENS x IEAR	13985.75
Cost of Energy (ECOST) in Nrs	1864020760.0 0
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	1864020760.0 0

Annex F: Reliability indices for wet season at Off-Peak load scenario

(I) Reliability indices of existing INPS at wet Off-Peak load (Base case ie caseI)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	53.44	0.01	35.19	18.81	9.5	178.66
2	Attariya	Phalampur	132	53.44	0.01	35.19	18.81	9.5	178.66
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	New Butwal	132	79.70	0.01	10.00	7.97	9.5	75.71
6	Bardaghat	New Butwal	132	79.70	0.01	10.00	7.97	9.5	75.71
7	Bardaghat	Sardi	132	18.07	0.01	14.00	2.53	9.5	24.03
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	62.32	0.01	34.00	21.19	9.5	201.30
10	NewBharatpur	Bardaghat	132	57.03	0.01	74.00	42.20	9.5	400.94
11	Bhaktapur	Lamosanghu	132	117.34	0.01	48.30	56.67	9.5	538.39
12	Bhaktapur	Lamosanghu	132	117.34	0.01	48.30	56.67	9.5	538.39
13	Kawasoti	Bharatpur	132	47.29	0.01	36.00	17.02	9.5	161.74
14	Burigaon	Kohalpur	132	38.91	0.01	55.29	21.51	9.5	204.35
15	Burigaon	Kohalpur	132	38.91	0.01	55.29	21.51	9.5	204.35
16	Butwal	Sunwal	132	42.42	0.01	13.00	5.51	9.5	52.39
17	Butwal	BB2	132	42.42	0.01	13.00	5.51	9.5	52.39
18	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
19	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
20	Motipur	Butwal	132	38.99	0.01	38.00	14.82	9.5	140.75
21	Motipur	Butwal	132	38.99	0.01	38.00	14.82	9.5	140.75
22	Chapur	Nabalpur	132	63.45	0.01	34.75	22.05	9.5	209.45
23	Chapur	Nabalpur	132	61.44	0.01	34.75	21.35	9.5	202.84
24	Damauli	Bharatpur	132	39.74	0.01	39.00	15.50	9.5	147.25
25	Dhalkebar	Mirchaiya	132	60.23	0.01	31.50	18.97	9.5	180.23
26	Dhalkebar	Mirchaiya	132	60.23	0.01	31.50	18.97	9.5	180.23
27	Dhalkebar	Muzzafapur	400	126.89	0.002	140.00	35.53	18.8	667.97
28	Dhalkebar	Muzzafapur	400	8.12	0.002	140.00	2.27	18.8	42.76
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	9.5	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	9.5	54.40
31	Amarpur	Ilam	132	201.08	0.01	66.50	133.72	9.5	1270.30
32	Amarpur	Ilam	132	2.83	0.01	66.50	1.88	9.5	17.89
33	Hetauda	Pathlaiya	132	0.06	0.01	37.00	0.02	9.5	0.21
34	Inariwa (1)	Duhabi	132	53.16	0.01	10.00	5.32	9.5	50.50

35	Inariwa (1)	Duhabi	132	1098	0.01	10.00	1.10	9.5	10.43
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	17.89	0.01	48.30	8.64	9.5	82.08
38	Kul3	Tem(15)	132	17.93	0.01	0.50	0.09	9.5	0.85
39	Kushaha	Inariwa (1)	132	37.25	0.01	13.10	4.88	9.5	46.36
40	Inariwa (1)	Kushaha	132	37.25	0.01	13.10	4.88	9.5	46.36
41	Dana	Kushma	220	42.70	0.0035	39.00	5.83	35.5	206.90
42	Dana	Kushma	220	6.06	0.0035	39.00	0.83	35.5	29.37
43	Kushma	Modi	132	6.01	0.01	6.00	0.36	9.5	3.43
44	Kusum	Hapure	132	6.01	0.01	18.00	1.08	9.5	10.28
45	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21
46	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21
47	Ghorahi	Lamahi	132	5.17	0.01	13.00	0.67	9.5	6.38
48	Ghorahi	Lamahi	132	27.66	0.01	13.00	3.60	9.5	34.17
49	Lamahi	Jhimruk	132	7.87	0.01	49.49	3.90	9.5	37.02
50	Lekhnath	Damauli	132	41.75	0.01	45.00	18.79	9.5	178.48
51	Lumki	Burigaon	132	41.75	0.01	33.90	14.15	9.5	134.46
52	Lumki	Burigaon	132	126.50	0.01	33.90	42.88	9.5	407.39
53	Kirtipur	MMars	132	9.05	0.01	17.00	1.54	9.5	14.62
54	Mahendranagar	Attariya	132	9.05	0.01	51.40	4.65	9.5	44.20
55	Mahendranagar	Attariya	132	125.31	0.01	51.40	64.41	9.5	611.87
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Modi	Modi	132	6.02	0.01	0.30	0.02	9.5	0.17
58	Sandhikharka	Motipur	132	6.02	0.01	37.00	2.23	9.5	21.16
59	Sandhikharka	Motipur	132	30.27	0.01	37.00	11.20	9.5	106.39
60	Motipur	Shivapur	132	30.27	0.01	23.00	6.96	9.5	66.14
61	Motipur	Shivapur	132	23.94	0.01	23.00	5.51	9.5	52.31
62	New Butwal	Sunwal	132	23.94	0.01	20.00	4.79	9.5	45.49
63	New Butwal	BB2	132	82.99	0.01	20.00	16.60	9.5	157.68
64	NMRS	Matatirtha	132	82.99	0.01	84.00	69.71	9.5	662.26
65	NMRS	Matatirtha	132	50.25	0.01	84.00	42.21	9.5	401.01
66	Nabalpur	Dhalkebar	132	50.25	0.01	34.75	17.46	9.5	165.89
67	Nabalpur	Dhalkebar	132	8.99	0.01	34.75	3.12	9.5	29.67
68	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
69	Lahachok	New Modi	132	140.42	0.01	20.00	28.08	9.5	266.79
70	NewBharatpur	Hetauda	132	56.62	0.01	75.00	42.46	9.5	403.42
71	Kushma	New Butwal	220	56.62	0.0035	88.00	17.44	35.5	619.08
72	Kushma	New Butwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	51.87	0.01	37.00	19.19	9.5	182.33
74	NewBharatpur	Marsyangdi	132	79.32	0.01	25.00	19.83	9.5	188.39
75	Pathlaiya	Chapur	132	79.32	0.01	30.68	24.34	9.5	231.19
76	Phalampur	Lumki	132	80.38	0.01	28.90	23.23	9.5	220.69

77	Phalampur	Lumki	132	48.25	0.01	28.90	13.94	9.5	132.46
78	Rupani	Kushaha	132	48.25	0.01	34.90	16.84	9.5	159.96
79	Rupani	Kushaha	132	16.11	0.01	34.90	5.62	9.5	53.42
80	Trishuli3B Hub	Matatirtha	132	16.11	0.01	49.00	7.89	9.5	75.00
81	Trishuli3B Hub	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
82	Samundartar	Trisuli3B H	132	64.70	0.01	26.00	16.82	9.5	159.81
83	Samundartar	Trisuli3B H	132	32.50	0.01	26.00	8.45	9.5	80.28
84	Lamosanghu	Khimti	132	32.50	0.01	40.00	13.00	9.5	123.50
85	Syaule	Attariya	132	81.81	0.01	60.00	49.09	9.5	466.31
86	Syaule	Attariya	132	75.15	0.01	60.00	45.09	9.5	428.33
87	Mirchaiya	Tingla	132	75.15	0.01	90.00	67.63	9.5	642.50
88	Mirchaiya	Tingla	132	67.74	0.01	90.00	60.97	9.5	579.20
89	Malekhu	Tem(4)	132	67.74	0.01	0.20	0.14	9.5	1.29
90	Amlekhgunj	Simara	66	12.11	0.028	12.90	4.38	10.8	47.26
91	Amlekhgunj	Simara	66	18.42	0.028	12.90	6.65	10.8	71.85
92	Balaju	Chapali	132	18.42	0.01	10.00	1.84	9.5	17.50
93	Balaju	Chapali	132	42.66	0.01	10.00	4.27	9.5	40.53
94	Lainchaur	Balaju	66	42.66	0.028	2.00	2.39	10.8	25.80
95	Switchatar	Balaju	132	15.00	0.01	4.40	0.66	9.5	6.27
96	Balaju	Trisuli	66	43.91	0.028	29.00	35.66	10.8	385.08
97	Balaju	Trisuli	66	24.70	0.028	29.00	20.06	10.8	216.61
98	Banepa	Panchkhal	66	24.70	0.028	8.03	5.55	10.8	59.98
99	Baneshwor	Bhaktapur	66	14.73	0.028	8.24	3.40	10.8	36.72
100	Bhaktapur	Ch.Narayan	132	56.17	0.01	3.65	2.05	9.5	19.48
101	Bhaktapur	Ch.Narayan	132	5.69	0.01	3.65	0.21	9.5	1.97
102	Bhaktapur	Banepa	66	37.57	0.028	13.57	14.27	9.5	135.61
103	NewBharatpur	Bharatpur	132	67.37	0.01	0.50	0.34	9.5	3.20
104	Parwanipur	Birgunj	66	67.37	0.028	9.00	16.98	10.8	183.36
105	Parwanipur	Birgunj	66	24.41	0.028	9.00	6.15	10.8	66.43
106	Butwal	KGA	132	24.41	0.01	58.00	14.16	9.5	134.49
107	Butwal	KGA	132	133.17	0.01	58.00	77.24	9.5	733.79
108	Chapali	Ch.Narayan	132	133.17	0.01	8.24	10.97	9.5	104.25
109	Chapali	Ch.Narayan	132	5.14	0.01	8.24	0.42	9.5	4.03
110	Chapali	Devighat	66	5.14	0.028	29.30	4.22	10.8	45.57
111	Chapali	Devighat	66	32.10	0.028	29.30	26.33	10.8	284.42
112	Chilime kV	Trisuli	66	41.20	0.028	10.00	11.54	10.8	124.58
113	Damak	Anamani	132	14.98	0.01	26.70	4.00	9.5	38.01
114	NMRS	Damauli	132	14.98	0.01	23.00	3.45	9.5	32.74
115	NMRS	Damauli	132	372.74	0.01	23.00	85.73	9.5	814.43
116	Hetauda	Amlekhgunj	66	372.74	0.028	20.17	210.51	10.8	2273.49
117	Hetauda	Amlekhgunj	66	19.42	0.028	20.17	10.97	10.8	118.46
118	Bharatpur	Hetauda	132	19.42	0.01	70.85	13.76	9.5	130.72

119	Hetauda	Kamane	132	0.00	0.01	18.50	0.00	9.5	0.00
120	Hetauda	Term(15)	132	164.46	0.01	5.24	8.62	9.5	81.87
121	Term(15)	Kul2	132	120.02	0.01	3.00	3.60	9.5	34.21
122	Damak	Ilam	132	120.53	0.01	31.50	37.97	9.5	360.69
123	Damak	Ilam	132	98.68	0.01	31.50	31.08	9.5	295.29
124	Kamane	Pathlaiya	132	98.68	0.01	18.50	18.26	9.5	173.43
125	Upper Khimti	Dhalkebar	220	131.83	0.0035	75.00	34.61	35.5	1228.49
126	Upper Khimti	Dhalkebar	220	130.50	0.0035	75.00	34.26	35.5	1216.08
127	Kohalpur	Kusum	132	142.66	0.01	48.30	68.90	9.5	654.58
128	Kul1	Switchatar	132	311.70	0.01	32.86	102.42	9.5	973.03
129	Kul1	Switchatar	66	311.70	0.028	32.86	286.79	10.8	3097.32
130	Kul2	Matatirtha	132	10.98	0.028	28.50	8.76	10.8	94.62
131	Hetauda	Kul1	132	9.37	0.01	15.05	1.41	9.5	13.40
132	Hetauda	Kul1	66	9.37	0.028	15.05	3.95	10.8	42.64
133	Kushaha	Kataiya	66	120.82	0.028	13.00	43.98	10.8	474.99
134	Kushaha	Kataiya	132	20.54	0.01	13.00	2.67	9.5	25.37
135	Kushaha	Kataiya	132	20.54	0.01	13.00	2.67	9.5	25.37
136	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
137	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
138	Lahachok	BB2	132	0.00	0.01	42.00	0.00	9.5	0.00
139	BB2	Lahachok	132	4.88	0.01	42.00	2.05	9.5	19.45
140	Lainchaur	Newchabil	132	4.88	0.01	2.30	0.11	9.5	1.07
141	Lainchaur	Newchabil	66	14.20	0.028	2.30	0.91	10.8	9.88
142	Lamahi	Shivapur	66	13.72	0.028	51.00	19.59	10.8	211.58
143	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
144	Lamosanghu	Bhotekoshi	132	6.20	0.01	24.65	1.53	9.5	14.51
145	BB1	Lamosanghu	132	15.86	0.01	45.84	7.27	9.5	69.05
146	BB2	Syangja	132	15.86	0.01	41.00	6.50	9.5	61.76
147	Marsyangdi	Term(4)	132	69.48	0.01	40.00	27.79	9.5	264.03
148	Term(4)	Switchatar	132	80.50	0.01	84.00	67.62	9.5	642.39
149	Switchatar	Matatirtha	132	63.68	0.01	4.40	2.80	9.5	26.62
150	Switchatar	Matatirtha	132	50.68	0.01	4.40	2.23	9.5	21.18
151	Mirchaiya	Lahan	132	16.04	0.01	27.68	4.44	9.5	42.17
152	Mirchaiya	Lahan	132	16.04	0.01	27.68	4.44	9.5	42.17
153	MMars	Damauli	132	2.26	0.01	58.00	1.31	9.5	12.45
154	Newchabil	Chapali	132	2.26	0.01	5.00	0.11	9.5	1.07
155	Newchabil	Chapali	66	118.90	0.028	5.00	16.65	10.8	179.78
156	MMars	NMRS	132	20.53	0.01	40.00	8.21	9.5	78.03
157	MMars	NMRS	132	20.53	0.01	40.00	8.21	9.5	78.03
158	NMRS	Marsyangdi	132	0.00	0.01	5.00	0.00	9.5	0.00
159	Marsyangdi	NMRS	132	181.27	0.01	5.00	9.06	9.5	86.10
160	Panchkhal	Sunkoshi	66	16.11	0.028	29.00	13.08	10.8	141.28

161	Panchkhal	Indrawati	66	16.10	0.028	28.00	12.62	10.8	136.31
162	Patan	Baneshwor	66	6.28	0.028	2.80	0.49	10.8	5.32
163	Pathlaiya	Parwanipur	132	12.14	0.01	16.59	2.01	9.5	19.14
164	Pathlaiya	Parwanipur	132	26.14	0.01	16.59	4.34	9.5	41.20
165	Pathlaiya	Chapur	132	80.38	0.01	30.68	24.66	9.5	234.28
166	Lekhnath	Pokhara	132	27.66	0.01	7.00	1.94	9.5	18.40
167	Tem(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
168	Tem	Pokhara	132	1.50	0.01	0.10	0.00	9.5	0.01
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	7.99	0.028	6.50	1.45	10.8	15.71
172	Switchatar	Balaju	66	22.72	0.028	4.40	2.80	10.8	30.23
173	Switchatar	Balaju	66	22.72	0.028	4.40	2.80	10.8	30.23
174	Switchatar	K3	66	20.00	0.028	6.90	3.86	10.8	41.73
175	Teku	Switchatar	66	34.31	0.028	4.10	3.94	10.8	42.54
176	Switchatar	Patan	66	7.99	0.028	6.50	1.45	10.8	15.71
177	Syangja	KGA	132	7.24	0.028	55.00	11.15	10.8	120.40
178	Teku	K3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	7.95	0.028	4.56	1.02	10.8	10.97
Total				0.00			3171.55		33938.27

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	33938.27
Cost of Energy (ECOST) = EENS x IEAR	16969.13
Cost of Energy (ECOST) in Nrs	2261646183.0 7
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2261646183.0 7

(II) Reliability indices of existing INPS at wet Off-Peak load (caseII)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F. rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	53.44	0.01	35.19	18.81	9.5	178.66
2	Attariya	Phalampur	132	53.44	0.01	35.19	18.81	9.5	178.66
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10

5	Bardaghat	New Butwal	132	67.34	0.01	10.00	6.73	9.5	63.97
6	Bardaghat	New Butwal	132	67.34	0.01	10.00	6.73	9.5	63.97
7	Bardaghat	Sardi	132	18.07	0.01	14.00	2.53	9.5	24.03
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	50.59	0.01	34.00	17.20	9.5	163.42
10	NewBharatpur	Bardaghat	132	44.89	0.01	74.00	33.22	9.5	315.56
11	Bhaktapur	Lamosanghu	132	117.37	0.01	48.30	56.69	9.5	538.55
12	Bhaktapur	Lamosanghu	132	117.37	0.01	48.30	56.69	9.5	538.55
13	Kawasoti	Bharatpur	132	35.57	0.01	36.00	12.80	9.5	121.63
14	Burigaon	Kohalpur	132	38.91	0.01	55.29	21.51	9.5	204.35
15	Burigaon	Kohalpur	132	38.91	0.01	55.29	21.51	9.5	204.35
16	Butwal	Sunwal	132	42.44	0.01	13.00	5.52	9.5	52.41
17	Butwal	BB2	132	42.44	0.01	13.00	5.52	9.5	52.41
18	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
19	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
20	Motipur	Butwal	132	38.99	0.01	38.00	14.82	9.5	140.75
21	Motipur	Butwal	132	38.99	0.01	38.00	14.82	9.5	140.75
22	Chapur	Nabalpur	132	53.66	0.01	34.75	18.65	9.5	177.13
23	Chapur	Nabalpur	132	52.08	0.01	34.75	18.10	9.5	171.92
24	Damauli	Bharatpur	132	43.86	0.01	39.00	17.11	9.5	162.51
25	Dhalkebar	Mirchaiya	132	60.24	0.01	31.50	18.98	9.5	180.28
26	Dhalkebar	Mirchaiya	132	60.24	0.01	31.50	18.98	9.5	180.28
27	Dhalkebar	Muzzafapur	400	126.90	0.002	140.00	35.53	18.8	668.03
28	Dhalkebar	Muzzafapur	400	8.12	0.002	140.00	2.27	18.8	42.76
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	9.5	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	9.5	54.40
31	Amarpur	Ilam	132	188.62	0.01	66.50	125.43	9.5	1191.59
32	Amarpur	Ilam	132	2.84	0.01	66.50	1.89	9.5	17.95
33	Hetauda	Pathlaiya	132	0.06	0.01	37.00	0.02	9.5	0.21
34	Inariwa (1)	Duhabi	132	53.16	0.01	10.00	5.32	9.5	50.50
35	Inariwa (1)	Duhabi	132	10.98	0.01	10.00	1.10	9.5	10.43
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	17.89	0.01	48.30	8.64	9.5	82.10
38	Kul3	Tem(15)	132	17.94	0.01	0.50	0.09	9.5	0.85
39	Kushaha	Inariwa (1)	132	37.25	0.01	13.10	4.88	9.5	46.36
40	Inariwa (1)	Kushaha	132	37.25	0.01	13.10	4.88	9.5	46.36
41	Dana	Kushma	220	42.70	0.0035	39.00	5.83	35.5	206.90
42	Dana	Kushma	220	6.06	0.0035	39.00	0.83	35.5	29.37
43	Kushma	Modi	132	6.01	0.01	6.00	0.36	9.5	3.43
44	Kusum	Hapure	132	6.01	0.01	18.00	1.08	9.5	10.28
45	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21
46	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21

47	Ghorahi	Lamahi	132	5.16	0.01	13.00	0.67	9.5	6.38
48	Ghorahi	Lamahi	132	27.66	0.01	13.00	3.60	9.5	34.17
49	Lamahi	Jhimruk	132	7.87	0.01	49.49	3.90	9.5	37.02
50	Lekhnath	Damauli	132	41.75	0.01	45.00	18.79	9.5	178.48
51	Lumki	Burigaon	132	41.75	0.01	33.90	14.15	9.5	134.46
52	Lumki	Burigaon	132	126.50	0.01	33.90	42.88	9.5	407.39
53	Kirtipur	MMars	132	9.05	0.01	17.00	1.54	9.5	14.62
54	Mahendranagar	Attariya	132	9.05	0.01	51.40	4.65	9.5	44.20
55	Mahendranagar	Attariya	132	120.08	0.01	51.40	61.72	9.5	586.36
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00
57	New Modi	Modi	132	6.02	0.01	0.30	0.02	9.5	0.17
58	Sandhikharka	Motipur	132	6.02	0.01	37.00	2.23	9.5	21.16
59	Sandhikharka	Motipur	132	30.27	0.01	37.00	11.20	9.5	106.40
60	Motipur	Shivapur	132	30.27	0.01	23.00	6.96	9.5	66.14
61	Motipur	Shivapur	132	23.96	0.01	23.00	5.51	9.5	52.35
62	New Butwal	Sunwal	132	23.96	0.01	20.00	4.79	9.5	45.52
63	New Butwal	BB2	132	78.34	0.01	20.00	15.67	9.5	148.85
64	NMRS	Matatirtha	132	78.34	0.01	84.00	65.81	9.5	625.19
65	NMRS	Matatirtha	132	40.90	0.01	84.00	34.36	9.5	326.38
66	Nabalpur	Dhalkebar	132	40.90	0.01	34.75	14.21	9.5	135.02
67	Nabalpur	Dhalkebar	132	8.99	0.01	34.75	3.12	9.5	29.67
68	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
69	Lahachok	New Modi	132	129.25	0.01	20.00	25.85	9.5	245.58
70	NewBharatpur	Hetauda	132	56.62	0.01	75.00	42.47	9.5	403.42
71	Kushma	New Butwal	220	56.62	0.0035	88.00	17.44	35.5	619.08
72	Kushma	New Butwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	60.33	0.01	37.00	22.32	9.5	212.07
74	NewBharatpur	Marsyangdi	132	79.32	0.01	25.00	19.83	9.5	188.38
75	Pathlaiya	Chapur	132	79.32	0.01	30.68	24.33	9.5	231.17
76	Phalampur	Lumki	132	70.46	0.01	28.90	20.36	9.5	193.46
77	Phalampur	Lumki	132	48.25	0.01	28.90	13.94	9.5	132.46
78	Rupani	Kushaha	132	48.25	0.01	34.90	16.84	9.5	159.96
79	Rupani	Kushaha	132	16.11	0.01	34.90	5.62	9.5	53.42
80	Trishuli3B Hub	Matatirtha	132	16.11	0.01	49.00	7.90	9.5	75.01
81	Trishuli3B Hub	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
82	Samundartar	Trisuli3B H	132	64.70	0.01	26.00	16.82	9.5	159.81
83	Samundartar	Trisuli3B H	132	32.50	0.01	26.00	8.45	9.5	80.28
84	Lamosanghu	Khimti	132	32.50	0.01	40.00	13.00	9.5	123.50
85	Syaule	Attariya	132	81.82	0.01	60.00	49.09	9.5	466.36
86	Syaule	Attariya	132	75.15	0.01	60.00	45.09	9.5	428.33
87	Mirchaiya	Tingla	132	75.15	0.01	90.00	67.63	9.5	642.50
88	Mirchaiya	Tingla	132	67.75	0.01	90.00	60.98	9.5	579.27

89	Malekhu	Tem(4)	132	67.75	0.01	0.20	0.14	9.5	1.29
90	Amlekhgunj	Simara	66	12.11	0.028	12.90	4.38	10.8	47.26
91	Amlekhgunj	Simara	66	18.42	0.028	12.90	6.65	10.8	71.85
92	Balaju	Chapali	132	18.42	0.01	10.00	1.84	9.5	17.50
93	Balaju	Chapali	132	42.90	0.01	10.00	4.29	9.5	40.75
94	Lainchaur	Balaju	66	42.90	0.028	2.00	2.40	10.8	25.94
95	Switchatar	Balaju	132	15.29	0.01	4.40	0.67	9.5	6.39
96	Balaju	Trisuli	66	44.78	0.028	29.00	36.36	10.8	392.68
97	Balaju	Trisuli	66	24.69	0.028	29.00	20.05	10.8	216.52
98	Banepa	Panchkhal	66	24.69	0.028	8.03	5.55	10.8	59.95
99	Baneshwor	Bhaktapur	66	14.74	0.028	8.24	3.40	10.8	36.72
100	Bhaktapur	Ch.Narayan	132	56.07	0.01	3.65	2.05	9.5	19.44
101	Bhaktapur	Ch.Narayan	132	5.69	0.01	3.65	0.21	9.5	1.97
102	Bhaktapur	Banepa	66	30.09	0.028	13.57	11.43	9.5	108.61
103	NewBharatpur	Bharatpur	132	67.47	0.01	0.50	0.34	9.5	3.20
104	Parwanipur	Birgunj	66	67.47	0.028	9.00	17.00	10.8	183.62
105	Parwanipur	Birgunj	66	24.41	0.028	9.00	6.15	10.8	66.43
106	Butwal	KGA	132	24.41	0.01	58.00	14.16	9.5	134.49
107	Butwal	KGA	132	133.19	0.01	58.00	77.25	9.5	733.89
108	Chapali	Ch.Narayan	132	133.19	0.01	8.24	10.98	9.5	104.26
109	Chapali	Ch.Narayan	132	5.14	0.01	8.24	0.42	9.5	4.03
110	Chapali	Devighat	66	5.14	0.028	29.30	4.22	10.8	45.56
111	Chapali	Devighat	66	32.10	0.028	29.30	26.33	10.8	284.42
112	Chilime kV	Trisuli	66	41.20	0.028	10.00	11.54	10.8	124.58
113	Damak	Anamani	132	13.16	0.01	26.70	3.51	9.5	33.37
114	NMRS	Damauli	132	13.16	0.01	23.00	3.03	9.5	28.75
115	NMRS	Damauli	132	363.70	0.01	23.00	83.65	9.5	794.69
116	Hetauda	Amlekhgunj	66	363.70	0.028	20.17	205.41	10.8	2218.38
117	Hetauda	Amlekhgunj	66	19.42	0.028	20.17	10.97	10.8	118.46
118	Bharatpur	Hetauda	132	19.42	0.01	70.85	13.76	9.5	130.72
119	Hetauda	Kamane	132	0.00	0.01	18.50	0.00	9.5	0.00
120	Hetauda	Tem(15)	132	155.61	0.01	5.24	8.15	9.5	77.46
121	Tem(15)	Kul2	132	115.17	0.01	3.00	3.46	9.5	32.82
122	Damak	Ilam	132	115.64	0.01	31.50	36.43	9.5	346.04
123	Damak	Ilam	132	98.68	0.01	31.50	31.09	9.5	295.31
124	Kamane	Pathlaiya	132	98.68	0.01	18.50	18.26	9.5	173.44
125	Upper Khimti	Dhalkebar	220	123.25	0.0035	75.00	32.35	35.5	1148.58
126	Upper Khimti	Dhalkebar	220	130.51	0.0035	75.00	34.26	35.5	1216.16
127	Kohalpur	Kusum	132	142.66	0.01	48.30	68.90	9.5	654.58
128	Kul1	Switchatar	132	311.70	0.01	32.86	102.42	9.5	973.03
129	Kul1	Switchatar	66	311.70	0.028	32.86	286.79	10.8	3097.32
130	Kul2	Matatirtha	132	10.98	0.028	28.50	8.76	10.8	94.62

131	Hetauda	Kull	132	8.62	0.01	15.05	1.30	9.5	12.33
132	Hetauda	Kull	66	8.62	0.028	15.05	3.63	10.8	39.24
133	Kushaha	Kataiya	66	115.91	0.028	13.00	42.19	10.8	455.65
134	Kushaha	Kataiya	132	19.84	0.01	13.00	2.58	9.5	24.50
135	Kushaha	Kataiya	132	19.84	0.01	13.00	2.58	9.5	24.50
136	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
137	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
138	Lahachok	BB2	132	0.00	0.01	42.00	0.00	9.5	0.00
139	BB2	Lahachok	132	4.88	0.01	42.00	2.05	9.5	19.45
140	Lainchaur	Newchabil	132	4.88	0.01	2.30	0.11	9.5	1.07
141	Lainchaur	Newchabil	66	14.20	0.028	2.30	0.91	10.8	9.88
142	Lamahi	Shivapur	66	13.72	0.028	51.00	19.59	10.8	211.58
143	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
144	Lamosanghu	Bhotekoshi	132	5.91	0.01	24.65	1.46	9.5	13.84
145	BB1	Lamosanghu	132	15.86	0.01	45.84	7.27	9.5	69.06
146	BB2	Syangja	132	15.86	0.01	41.00	6.50	9.5	61.77
147	Marsyangdi	Tem(4)	132	69.49	0.01	40.00	27.79	9.5	264.05
148	Tem(4)	Switchatar	132	80.50	0.01	84.00	67.62	9.5	642.39
149	Switchatar	Matatirtha	132	60.27	0.01	4.40	2.65	9.5	25.19
150	Switchatar	Matatirtha	132	47.35	0.01	4.40	2.08	9.5	19.79
151	Mirchaiya	Lahan	132	15.28	0.01	27.68	4.23	9.5	40.19
152	Mirchaiya	Lahan	132	15.28	0.01	27.68	4.23	9.5	40.19
153	MMars	Damauli	132	2.26	0.01	58.00	1.31	9.5	12.46
154	Newchabil	Chapali	132	2.26	0.01	5.00	0.11	9.5	1.07
155	Newchabil	Chapali	66	119.39	0.028	5.00	16.71	10.8	180.51
156	MMars	NMRS	132	20.39	0.01	40.00	8.16	9.5	77.49
157	MMars	NMRS	132	20.39	0.01	40.00	8.16	9.5	77.49
158	NMRS	Marsyangdi	132	0.00	0.01	5.00	0.00	9.5	0.00
159	Marsyangdi	NMRS	132	180.79	0.01	5.00	9.04	9.5	85.87
160	Panchkhal	Sunkoshi	66	18.71	0.028	29.00	15.19	10.8	164.05
161	Panchkhal	Indrawati	66	18.69	0.028	28.00	14.66	10.8	158.29
162	Patan	Baneshwor	66	6.28	0.028	2.80	0.49	10.8	5.32
163	Pathlaiya	Parwanipur	132	12.14	0.01	16.59	2.01	9.5	19.14
164	Pathlaiya	Parwanipur	132	26.04	0.01	16.59	4.32	9.5	41.04
165	Pathlaiya	Chapur	132	70.46	0.01	30.68	21.62	9.5	205.37
166	Lekhnath	Pokhara	132	27.66	0.01	7.00	1.94	9.5	18.40
167	Tem(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
168	Tem	Pokhara	132	1.50	0.01	0.10	0.00	9.5	0.01
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	8.05	0.028	6.50	1.46	10.8	15.82
172	Switchatar	Balaju	66	22.37	0.028	4.40	2.76	10.8	29.77

173	Switchatar	Balaju	66	22.37	0.028	4.40	2.76	10.8	29.77
174	Switchatar	K3	66	20.00	0.028	6.90	3.86	10.8	41.72
175	Teku	Switchatar	66	34.32	0.028	4.10	3.94	10.8	42.55
176	Switchatar	Patan	66	8.05	0.028	6.50	1.46	10.8	15.82
177	Syangja	KGA	132	7.24	0.028	55.00	11.15	10.8	120.44
178	Teku	K3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	7.95	0.028	4.56	1.02	10.8	10.97
Total				0.00			3101.26		33209.00

Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kw/hr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	33209.00
Cost of Energy (ECOST) = EENS x IEAR	16604.50
Cost of Energy (ECOST) in Nrs	2213048012.60
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2213048012.60

(III) Reliability indices of existing INPS at wet Off-Peak load (caseIII)

S.N.	Bus		Voltage (kV)	P. Flow (MW)	F.rate (λ)/yr/km	Line length (km)	EPNS (MW/yr)	MTTR (hr)	EENS (MWhr/yr)
	From	To							
1	Attariya	Phalampur	132	53.47	0.01	35.19	18.82	9.5	178.75
2	Attariya	Phalampur	132	53.47	0.01	35.19	18.82	9.5	178.75
3	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
4	Balanch	Syaule	132	80.17	0.01	70.00	56.12	9.5	533.10
5	Bardaghat	New Butwal	132	20.81	0.01	10.00	2.08	9.5	19.77
6	Bardaghat	New Butwal	132	20.81	0.01	10.00	2.08	9.5	19.77
7	Bardaghat	Sardi	132	18.07	0.01	14.00	2.53	9.5	24.04
8	Bardaghat	Sardi	132	0.00	0.01	14.00	0.00	9.5	0.00
9	Kawasoti	Bardaghat	132	35.22	0.01	34.00	11.97	9.5	113.75
10	NewBharatpur	Bardaghat	132	45.06	0.01	74.00	33.34	9.5	316.75
11	Bhaktapur	Lamosanghu	132	117.50	0.01	48.30	56.75	9.5	539.17
12	Bhaktapur	Lamosanghu	132	117.50	0.01	48.30	56.75	9.5	539.17
13	Kawasoti	Bharatpur	132	50.25	0.01	36.00	18.09	9.5	171.84
14	Burigaon	Kohalpur	132	38.94	0.01	55.29	21.53	9.5	204.56

15	Burigaon	Kohalpur	132	38.94	0.01	55.29	21.53	9.5	204.56
16	Butwal	Sunwal	132	42.36	0.01	13.00	5.51	9.5	52.32
17	Butwal	BB2	132	42.36	0.01	13.00	5.51	9.5	52.32
18	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
19	Mainahiya	Butwal	132	21.20	0.01	18.00	3.82	9.5	36.25
20	Motipur	Butwal	132	38.95	0.01	38.00	14.80	9.5	140.59
21	Motipur	Butwal	132	38.95	0.01	38.00	14.80	9.5	140.59
22	Chapur	Nabalpur	132	26.13	0.01	34.75	9.08	9.5	86.26
23	Chapur	Nabalpur	132	24.85	0.01	34.75	8.64	9.5	82.05
24	Damauli	Bharatpur	132	75.20	0.01	39.00	29.33	9.5	278.60
25	Dhalkebar	Mirchaiya	132	60.31	0.01	31.50	19.00	9.5	180.48
26	Dhalkebar	Mirchaiya	132	60.31	0.01	31.50	19.00	9.5	180.48
27	Dhalkebar	Muzzafapur	400	126.94	0.002	140.00	35.54	18.8	668.19
28	Dhalkebar	Muzzafapur	400	8.12	0.002	140.00	2.27	18.8	42.76
29	Duhabi	Damak	132	40.91	0.01	48.90	20.00	9.5	190.02
30	Bardaghat	Gandak	132	40.91	0.01	14.00	5.73	9.5	54.40
31	Amarpur	Ilam	132	91.51	0.01	66.50	60.86	9.5	578.13
32	Amarpur	Ilam	132	2.87	0.01	66.50	1.91	9.5	18.15
33	Hetauda	Pathlaiya	132	0.06	0.01	37.00	0.02	9.5	0.21
34	Inariwa (1)	Duhabi	132	53.17	0.01	10.00	5.32	9.5	50.51
35	Inariwa (1)	Duhabi	132	11.03	0.01	10.00	1.10	9.5	10.47
36	Inaruwa	Tumlingtar	220	0.00	0.0035	106.00	0.00	35.5	0.00
37	Kohalpur	Kusum	132	17.91	0.01	48.30	8.65	9.5	82.16
38	Kul3	Tem(15)	132	17.96	0.01	0.50	0.09	9.5	0.85
39	Kushaha	Inariwa (1)	132	37.25	0.01	13.10	4.88	9.5	46.36
40	Inariwa (1)	Kushaha	132	37.25	0.01	13.10	4.88	9.5	46.36
41	Dana	Kushma	220	42.70	0.0035	39.00	5.83	35.5	206.90
42	Dana	Kushma	220	6.06	0.0035	39.00	0.83	35.5	29.37
43	Kushma	Modi	132	6.00	0.01	6.00	0.36	9.5	3.42
44	Kusum	Hapure	132	6.00	0.01	18.00	1.08	9.5	10.27
45	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21
46	Lahan	Rupani	132	11.78	0.01	27.00	3.18	9.5	30.21
47	Ghorahi	Lamahi	132	5.22	0.01	13.00	0.68	9.5	6.45
48	Ghorahi	Lamahi	132	27.66	0.01	13.00	3.60	9.5	34.16
49	Lamahi	Jhimruk	132	7.87	0.01	49.49	3.90	9.5	37.02
50	Lekhnath	Damauli	132	41.78	0.01	45.00	18.80	9.5	178.63
51	Lumki	Burigaon	132	41.78	0.01	33.90	14.16	9.5	134.57
52	Lumki	Burigaon	132	126.50	0.01	33.90	42.88	9.5	407.39
53	Kirtipur	MMars	132	9.05	0.01	17.00	1.54	9.5	14.62
54	Mahendranagar	Attariya	132	9.05	0.01	51.40	4.65	9.5	44.20
55	Mahendranagar	Attariya	132	80.18	0.01	51.40	41.21	9.5	391.51
56	Matatirtha	Hetauda	132	0.00	0.01	36.24	0.00	9.5	0.00

57	New Modi	Modi	132	6.02	0.01	0.30	0.02	9.5	0.17
58	Sandhikharka	Motipur	132	6.02	0.01	37.00	2.23	9.5	21.16
59	Sandhikharka	Motipur	132	30.22	0.01	37.00	11.18	9.5	106.24
60	Motipur	Shivapur	132	30.22	0.01	23.00	6.95	9.5	66.04
61	Motipur	Shivapur	132	23.91	0.01	23.00	5.50	9.5	52.24
62	New Butwal	Sunwal	132	23.91	0.01	20.00	4.78	9.5	45.43
63	New Butwal	BB2	132	43.60	0.01	20.00	8.72	9.5	82.83
64	NMRS	Matatirtha	132	43.60	0.01	84.00	36.62	9.5	347.90
65	NMRS	Matatirtha	132	37.06	0.01	84.00	31.13	9.5	295.73
66	Nabalpur	Dhalkebar	132	37.06	0.01	34.75	12.88	9.5	122.34
67	Nabalpur	Dhalkebar	132	8.99	0.01	34.75	3.12	9.5	29.67
68	Lahachok	New Modi	132	8.99	0.01	20.00	1.80	9.5	17.08
69	Lahachok	New Modi	132	43.86	0.01	20.00	8.77	9.5	83.33
70	NewBharatpur	Hetauda	132	56.62	0.01	75.00	42.46	9.5	403.41
71	Kushma	New Butwal	220	56.62	0.0035	88.00	17.44	35.5	619.08
72	Kushma	New Butwal	220	0.00	0.0035	88.00	0.00	35.5	0.00
73	New Modi	Pokhara	132	121.49	0.01	37.00	44.95	9.5	427.02
74	NewBharatpur	Marsyangdi	132	79.31	0.01	25.00	19.83	9.5	188.35
75	Pathlaiya	Chapur	132	79.31	0.01	30.68	24.33	9.5	231.15
76	Phalampur	Lumki	132	8.93	0.01	28.90	2.58	9.5	24.51
77	Phalampur	Lumki	132	48.28	0.01	28.90	13.95	9.5	132.54
78	Rupani	Kushaha	132	48.28	0.01	34.90	16.85	9.5	160.06
79	Rupani	Kushaha	132	16.11	0.01	34.90	5.62	9.5	53.41
80	Trishuli3B Hub	Matatirtha	132	16.11	0.01	49.00	7.89	9.5	74.99
81	Trishuli3B Hub	Matatirtha	132	0.00	0.01	49.00	0.00	9.5	0.00
82	Samundartar	Trisuli3B H	132	64.71	0.01	26.00	16.82	9.5	159.83
83	Samundartar	Trisuli3B H	132	32.50	0.01	26.00	8.45	9.5	80.28
84	Lamosanghu	Khimti	132	32.50	0.01	40.00	13.00	9.5	123.50
85	Syaule	Attariya	132	81.85	0.01	60.00	49.11	9.5	466.57
86	Syaule	Attariya	132	75.16	0.01	60.00	45.10	9.5	428.42
87	Mirchaiya	Tingla	132	75.16	0.01	90.00	67.65	9.5	642.63
88	Mirchaiya	Tingla	132	67.79	0.01	90.00	61.01	9.5	579.60
89	Malekhu	Tem(4)	132	67.79	0.01	0.20	0.14	9.5	1.29
90	Amlekhgunj	Simara	66	12.11	0.028	12.90	4.38	10.8	47.26
91	Amlekhgunj	Simara	66	18.42	0.028	12.90	6.65	10.8	71.85
92	Balaju	Chapali	132	18.42	0.01	10.00	1.84	9.5	17.50
93	Balaju	Chapali	132	44.49	0.01	10.00	4.45	9.5	42.27
94	Lainchaur	Balaju	66	44.49	0.028	2.00	2.49	10.8	26.91
95	Switchatar	Balaju	132	17.11	0.01	4.40	0.75	9.5	7.15
96	Balaju	Trisuli	66	50.65	0.028	29.00	41.13	10.8	444.21
97	Balaju	Trisuli	66	24.63	0.028	29.00	20.00	10.8	216.01
98	Banepa	Panchkhal	66	24.63	0.028	8.03	5.54	10.8	59.81

99	Baneshwor	Bhaktapur	66	14.74	0.028	8.24	3.40	10.8	36.73
100	Bhaktapur	Ch.Narayan	132	54.99	0.01	3.65	2.01	9.5	19.07
101	Bhaktapur	Ch.Narayan	132	5.69	0.01	3.65	0.21	9.5	1.97
102	Bhaktapur	Banepa	66	26.52	0.028	13.57	10.07	9.5	95.71
103	NewBharatpur	Bharatpur	132	68.16	0.01	0.50	0.34	9.5	3.24
104	Parwanipur	Birgunj	66	68.16	0.028	9.00	17.18	10.8	185.51
105	Parwanipur	Birgunj	66	24.41	0.028	9.00	6.15	10.8	66.43
106	Butwal	KGA	132	24.41	0.01	58.00	14.16	9.5	134.49
107	Butwal	KGA	132	133.10	0.01	58.00	77.20	9.5	733.38
108	Chapali	Ch.Narayan	132	133.10	0.01	8.24	10.97	9.5	104.19
109	Chapali	Ch.Narayan	132	5.13	0.01	8.24	0.42	9.5	4.01
110	Chapali	Devighat	66	5.13	0.028	29.30	4.21	10.8	45.42
111	Chapali	Devighat	66	32.10	0.028	29.30	26.33	10.8	284.42
112	Chilime kV	Trisuli	66	41.20	0.028	10.00	11.53	10.8	124.58
113	Damak	Anamani	132	0.86	0.01	26.70	0.23	9.5	2.19
114	NMRS	Damauli	132	0.86	0.01	23.00	0.20	9.5	1.89
115	NMRS	Damauli	132	286.18	0.01	23.00	65.82	9.5	625.30
116	Hetauda	Amlekhgunj	66	286.18	0.028	20.17	161.62	10.8	1745.51
117	Hetauda	Amlekhgunj	66	19.42	0.028	20.17	10.97	10.8	118.48
118	Bharatpur	Hetauda	132	19.42	0.01	70.85	13.76	9.5	130.74
119	Hetauda	Kamane	132	0.00	0.01	18.50	0.00	9.5	0.00
120	Hetauda	Tem(15)	132	86.14	0.01	5.24	4.51	9.5	42.88
121	Tem(15)	Kul2	132	77.62	0.01	3.00	2.33	9.5	22.12
122	Damak	Ilam	132	77.83	0.01	31.50	24.52	9.5	232.90
123	Damak	Ilam	132	98.70	0.01	31.50	31.09	9.5	295.37
124	Kamane	Pathlaiya	132	98.70	0.01	18.50	18.26	9.5	173.47
125	Upper Khimti	Dhalkebar	220	55.24	0.0035	75.00	14.50	35.5	514.77
126	Upper Khimti	Dhalkebar	220	130.53	0.0035	75.00	34.26	35.5	1216.38
127	Kohalpur	Kusum	132	142.66	0.01	48.30	68.90	9.5	654.58
128	Kul1	Switchatar	132	311.70	0.01	32.86	102.42	9.5	973.03
129	Kul1	Switchatar	66	311.70	0.028	32.86	286.79	10.8	3097.32
130	Kul2	Matatirtha	132	11.03	0.028	28.50	8.80	10.8	95.03
131	Hetauda	Kul1	132	3.22	0.01	15.05	0.48	9.5	4.60
132	Hetauda	Kul1	66	3.22	0.028	15.05	1.36	10.8	14.64
133	Kushaha	Kataiya	66	77.95	0.028	13.00	28.37	10.8	306.43
134	Kushaha	Kataiya	132	14.57	0.01	13.00	1.89	9.5	18.00
135	Kushaha	Kataiya	132	14.57	0.01	13.00	1.89	9.5	18.00
136	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
137	Kusum	Lamahi	132	0.00	0.01	47.50	0.00	9.5	0.00
138	Lahachok	BB2	132	0.00	0.01	42.00	0.00	9.5	0.00
139	BB2	Lahachok	132	4.92	0.01	42.00	2.07	9.5	19.65
140	Lainchaur	Newchabil	132	4.92	0.01	2.30	0.11	9.5	1.08

141	Lainchaur	Newchabil	66	14.20	0.028	2.30	0.91	10.8	9.88
142	Lamahi	Shivapur	66	13.72	0.028	51.00	19.59	10.8	211.60
143	Lamahi	Shivapur	132	0.00	0.01	51.00	0.00	9.5	0.00
144	Lamosanghu	Bhotekoshi	132	4.09	0.01	24.65	1.01	9.5	9.57
145	BB1	Lamosanghu	132	15.78	0.01	45.84	7.23	9.5	68.72
146	BB2	Syangja	132	15.78	0.01	41.00	6.47	9.5	61.46
147	Marsyangdi	Tem(4)	132	69.50	0.01	40.00	27.80	9.5	264.11
148	Tem(4)	Switchatar	132	80.50	0.01	84.00	67.62	9.5	642.39
149	Switchatar	Matatirtha	132	35.40	0.01	4.40	1.56	9.5	14.80
150	Switchatar	Matatirtha	132	23.00	0.01	4.40	1.01	9.5	9.61
151	Mirchaiya	Lahan	132	9.24	0.01	27.68	2.56	9.5	24.29
152	Mirchaiya	Lahan	132	9.24	0.01	27.68	2.56	9.5	24.29
153	MMars	Damauli	132	2.26	0.01	58.00	1.31	9.5	12.46
154	Newchabil	Chapali	132	2.26	0.01	5.00	0.11	9.5	1.07
155	Newchabil	Chapali	66	122.89	0.028	5.00	17.20	10.8	185.81
156	MMars	NMRS	132	19.48	0.01	40.00	7.79	9.5	74.02
157	MMars	NMRS	132	19.48	0.01	40.00	7.79	9.5	74.02
158	NMRS	Marsyangdi	132	0.00	0.01	5.00	0.00	9.5	0.00
159	Marsyangdi	NMRS	132	177.28	0.01	5.00	8.86	9.5	84.21
160	Panchkhal	Sunkoshi	66	37.81	0.028	29.00	30.70	10.8	331.58
161	Panchkhal	Indrawati	66	37.77	0.028	28.00	29.61	10.8	319.82
162	Patan	Baneshwor	66	6.28	0.028	2.80	0.49	10.8	5.32
163	Pathlaiya	Parwanipur	132	12.15	0.01	16.59	2.02	9.5	19.14
164	Pathlaiya	Parwanipur	132	24.97	0.01	16.59	4.14	9.5	39.35
165	Pathlaiya	Chapur	132	8.93	0.01	30.68	2.74	9.5	26.02
166	Lekhnath	Pokhara	132	27.66	0.01	7.00	1.94	9.5	18.40
167	Tem(1)	Gandak	132	0.00	0.01	0.10	0.00	9.5	0.00
168	Tem	Pokhara	132	1.50	0.01	0.10	0.00	9.5	0.01
169	Simara	Parwanipur	66	0.00	0.01	9.60	0.00	10.8	0.00
170	Simara	Parwanipur	66	0.00	0.028	9.60	0.00	10.8	0.00
171	Switchatar	Patan	66	8.58	0.028	6.50	1.56	10.8	16.87
172	Switchatar	Balaju	66	20.07	0.028	4.40	2.47	10.8	26.70
173	Switchatar	Balaju	66	20.07	0.028	4.40	2.47	10.8	26.70
174	Switchatar	K3	66	19.99	0.028	6.90	3.86	10.8	41.70
175	Teku	Switchatar	66	34.32	0.028	4.10	3.94	10.8	42.56
176	Switchatar	Patan	66	8.58	0.028	6.50	1.56	10.8	16.87
177	Syangja	KGA	132	7.25	0.028	55.00	11.17	10.8	120.59
178	Teku	K3	66	0.00	0.028	2.30	0.00	10.8	0.00
179	Trisuli	Devighat	66	7.95	0.028	4.56	1.02	10.8	10.97
Total							2835.52		30188.97

Table 4.5 Calculation of Cost of Unserved Energy ECOST

Interrupted Energy Assessment Rate (IEAR) in dollar per Kwhr.	0.50
Price of 1 dollar in Nrs.	133.28
Expected Energy Not Supplied(EENS)	30188.97
Cost of Energy (ECOST) = EENS x IEAR	15094.48
Cost of Energy (ECOST) in Nrs	2011792708.6 6
Total Cost of Unserved Energy (ECOST) or Total ECOST in Nrs.	2011792708.6 6

Annex G: Existing INPS Generation data

Name of Power House	Terminal Busbar	Bus Type	Active Power MW	Reactive Power Mvar	Apparent Power MVA	Power Factor
Balefi	Khimti 132kV	PQ	36	0	36	1
Bijaypur	BB2	PQ	4.5	0	4.5	1
Chameliya	Balanch	PQ	30	6.091753	30.61224	0.98
Chepe	Kirtipur SS	PQ	8.5	0	8.5	1
ChhandiKhola	Mms	PQ	2	0	2	1
Chilime	Terminal(2)	PV	22.1	-16.64747	27.66854	0.798741
Diesel Plant	-Hetauda 66kV Bus	PQ	0	0	0	1
Dordi12	Kirtipur SS	PQ	12	0	12	1
Dordi27MW	Kirtipur SS	PQ	27	0	27	1
Down Piluwa	Tumlingtar 132kV	PQ	10.03	6.216035	11.8	0.85
Dudhkoshi-Solu	Tingla132kV	PQ	86	12.25431	86.86868	0.99
Ghalemikhola(1)	Dana 132kV	PQ	5	0	5	1
Ghar Khola	Dana 132kV	PQ	14	6.780511	15.55556	0.9
Ghattekhola	Khimti 132kV	PQ	5	0	5	1
Handikhola	Lamosanghu	PQ	0.997	0	0.997	1
Hewa	Tumlingtar 132kV	PQ	4.5	2.788849	5.294117	0.85
Indrawati-III	Lamosanghu	PQ	7.5	0	7.5	1
Iwa khola	Amarpur 132kV	PQ	9.9	-3.253972	10.42105	0.95
JhimrukHEP	Jhimruk	PV	12	23.17517	26.09767	0.4598112
JiriKhola	Lamosanghu	PQ	2.4	0	2.4	1
KGA(NEA)	KGA	PQ	144	54.61954	154.0107	0.935
Kabeli B-1 Cascade	Amarpur 132kV	PQ	9.94	-1.48663	10.05056	0.989
Kabli B-1	Amarpur 132kV	PV	25	-10.57669	27.14528	0.9209703
Kalangagad	Balanch	PV	63.83	28.91383	70.07338	0.9109023
Khanikhola	Kul-1	PQ	2	0	2	1
KhitniHEP	BB2	PQ	60	0	60	1
KhudiKhola	Mms	PQ	4	0	4	1
Kul-2(1)	- Kul-2	PV	0	0	0	1
Kul-3(3)	- Kul-3	PV	0	0	0	1
Kulekhani-1	- Kul-1	PV	0	0	0	1
L-Kharekhola	Khimti 132kV	PQ	11	0	11	1
Likhu IV	Upper Khimti 220 kV	PQ	52.4	0	52.4	1
Likhu2	BB2	PQ	55	0	55	1
LikhuA	Singati	PQ	33	0	33	1
Lower Jogmai	Ilam	PQ	6.2	3.842415	7.294117	0.85
Lower Likhu	Singati	PQ	28.5	0	28.5	1
Lower Tadi	Samundartar	PQ	5	0	5	1
LowerModi-2	Modi132kV	PQ	20	0	20	1
M-Marsyangdi	Mms	PV	70	19.49969	72.66525	0.9633216
M-chaku	Indrawati	PQ	1.8	1.11554	2.117647	0.85

Mai Beni	Ilam	PQ	9.51	5.893768	11.18824	0.85
Mai Cascade	Ilam	PQ	7	4.338211	8.235294	0.85
Mai Khola	Ilam	PQ	22	13.63438	25.88235	0.85
MaicascadeHP	Ilam	PQ	8	4.957953	9.411764	0.8500001
Mailung	Trisuli	PQ	3	1.859233	3.529412	0.8500001
Mandu	Kul-1	PV	22	22.15515	31.2226	0.7046178
Mathilo Solu	Tingla 132kV	PQ	19.5	3.959642	19.89796	0.98
Maya Khola	Tumlingtar 132kV	PQ	15	9.296165	17.64706	0.85
Mid Solu	Tingla 132kV	PQ	9.5	0	9.5	1
Middle Modi	New Modi 132kV	PQ	18	-2.56486	18.18182	0.99
Mistrikhola(1)	Dana 132kV	PQ	42	22.6692	47.72727	0.88
Molun Khola	Lahan	PQ	7	0	7	1
Namarjun Madi	BB2	PQ	11.88	0	11.88	1
Naugadh Khola	Balanch	PQ	66.5	-12.79118	67.71901	0.981999
Nyadi HEP	Mmrs	PQ	30	0	30	1
Phawakhola	Ilam	PQ	5	0	5	1
Pikhuwa khola	Amarpur 132kV	PQ	6.37	0	6.37	1
Piluwa Khola	Tumlingtar 132kV	PQ	3	1.859233	3.529412	0.8500001
Piluwa-I khola	Ilam	PQ	4	2.478977	4.705882	0.8500001
Puwa NEA	Ilam	PQ	6.2	3.842415	7.294117	0.85
Richet Khola	NMRS	PQ	4.98	0	4.98	1
Ridi	KGA	PQ	2.4	0.788842	2.526316	0.95
Rudi A	BB2	PQ	8.8	0	8.8	1
Rudi B	BB2	PQ	6.6	0	6.6	1
Sabha Khola	Tumlingtar 132kV	PQ	5	3.098722	5.882353	0.85
Sanima Mai	Ilam	PV	22	12.41927	25.26338	0.8708257
Sanjen	Terminal(2)	PQ	10	6.197445	11.76471	0.8499999
Sapsup Khola	Lahan	PQ	6.6	0	6.6	1
Singati HEP	Khimti 132kV	PQ	25	0	25	1
Sipring	Lamosanghu	PQ	10	0	10	1
Solukhola	Tingla 132kV	PQ	23.5	0	23.5	1
Super Dordi	Kirtipur SS	PQ	54	0	54	1
Super Mai Cascade	Ilam	PQ	3.8	0	3.8	1
Super Mai-A	Ilam	PQ	9.6	5.949545	11.29412	0.85
Super Madi	BB2	PQ	44	0	44	1
Suri Khola	Khimti 132kV	PQ	6.4	0	6.4	1
Synchronous Machine	- kataiya	PQ	0	0	0	1
Tadi	Trisuli	PQ	3	1.859233	3.529412	0.8500001
Taksar Pikhuwa(1)	- Tingla 132kV	PQ	0	0	0	1
Tallo hewa khola	Amarpur 132kV	PQ	22.1	5.538778	22.7835	0.97
Thapakhola	Dana 132kV	PQ	13.5	0	13.5	1
Thungun-thosne	Kul-1	PQ	4.36	0	4.36	1
Tinau	- Butwal	PQ	0	0	0	1
Trishuli 3A	Samundartar	PQ	60	15.03741	61.85567	0.97
Trishuli 3B	- Trishuli 3B Hub	PQ	0	0	0	1

U Khimti I & II	Singati	PQ	19	0	19	1
UTKHEP	Upper Khimti 220 kV	PV	456	23.99046	456.6306	0.9986189
Upper Bhotekhoshi	Bhotekhoshi	PQ	45	17.78514	48.3871	0.93
Upper Chaku	Bhotekhoshi	PQ	22.2	10.75195	24.66667	0.9
Upper Chhyangdi	Mms	PQ	4	0	4	1
Upper Dordi	Kirtipur SS	PQ	25	0	25	1
Upper Hewa Khola	Tumlingtar 132kV	PQ	8.5	5.267827	10	0.85
Upper Khorunga	Tumlingtar 132kV	PQ	7.5	-4.648082	8.823529	0.85
Upper Mardi	BB2	PQ	7	0	7	1
Upper Rawa	Tingla 132kV	PQ	3	0	3	1
Upper Sange Khola	Mms	PQ	2.4	0	2.4	1
UpperHewa	Amarpur 132kV	PQ	8.5	0	8.5	1
UpperMaiC	Ilam	PQ	4.1	0	4.1	1
UpperMarsyangdi	Mms	PQ	50	0	50	1
UpperPuwa	Ilam	PQ	3	1.859233	3.529412	0.8500001
Upperhugdi	KGA	PQ	5	0	5	1
Uppermadi	BB2	PQ	25	0	25	1
Uppermai	Ilam	PQ	12	-1.709907	12.12121	0.99
XB	- shivapur	PQ	0	0	0	1
XB_NEPALJUNG	-kusum	PQ	0	0	0	1
aandhikhola	KGA	PQ	9.4	3.08963	9.894736	0.95
aankhukhola	Marsyangdi	PQ	8.4	0	8.4	1
baramchi	Lamosanghu	PQ	4.2	0	4.2	1
bhairavkunda	Indrawati	PQ	3	1.859233	3.529412	0.8500001
chake	Lamosanghu	PQ	2.83	0	2.83	1
chakukhola	Bhotekhoshi	PQ	3	0	3	1
chandrawati	Trisuli	PQ	2	1.239488	2.352941	0.8500001
daraudiA	Marsyangdi	PQ	6	3.718465	7.058823	0.8500001
devighatnea	Devighat	PV	14.1	26.60102	30.10688	0.4683315
gandakhep	Gandak	PQ	4	2.478977	4.705882	0.8500001
indrawatinea	Indrawati	PQ	7.5	4.648082	8.823529	0.85
jogmai	Ilam	PQ	7.6	4.710057	8.941176	0.85
lowermodi	Modi 132kV	PQ	10	0	10	1
mardi and others	Lahachok 132kV	PQ	10	0	10	1
marsyangdiNea	Marsyangdi	PQ	69	42.76236	81.17647	0.85
midim	Mms	PQ	3	0	3	1
modinea	Modi 132kV	PQ	14.8	9.172215	17.41176	0.85
myadkukhola	BB2	PQ	13	0	13	1
panauti	- Bhaktapur 132	PV	0	0	0	1
phewa	Pokhara	PQ	1	0.6197442	1.176471	0.8500001
puwakhola1	Ilam	PQ	4	2.478977	4.705882	0.8500001
radhi khola	Mms	PQ	4.4	0	4.4	1
sanima.sunkoshi	Lamosanghu	PQ	2.5	0	2.5	1
seti	Terminal	PQ	1.5	0.9296163	1.764706	0.8500001
siurikhola	Mms	PQ	5	0	5	1

sunkoshinea	Sunkoshi	PQ	10.05	6.22843	11.82353	0.85
tatopani	Modi132kV	PQ	2	0	2	1
thoppalkhola	Marsyangdi	PQ	1.65	1.022578	1.941176	0.85
trisuliNEA	Trisuli	PV	16.67	10.93161	19.93462	0.8362338

Annex H: 2028 A.D. Generation data

Name of Power House	Active Power(MW)	Reactive Power(MVAR)	Power Factor	Name of Power House	Active Power(MW)	Reactive Power(MVAR)	Power Factor
Api	8.5	0	1	UpperDordi-A	25	1.9E-07	1
Badigadkhola	21	0	1	UpperHewa	14.9	-1E-08	1
BajhangUpperSeti	80	-21.08	0.967	UpperKhudi	26	2.2E-07	1
BeriBabaiDiversion	48	2E-07	1	UpperMadi	25	1E-07	1
Bijaypur	4.5	2E-08	1	UpperMaiC	6.1	0	1
BudiGanga	20	5E-08	1	UpperMarsyangdi	50	3.3E-07	1
Chameliya	30	-2.682	0.996	UpperModiA	42	2.9E-07	1
ChameliyaChhetigad	85	-16.08	0.983	UpperPuwa	3	0	1
ChhandiKhola	2	1E-08	1	UpperSanigad	10.7	2E-08	1
Chilime	22.1	1E-08	1	UpperTamakoshi	456	119.7054	0.967228
DordiKhola	17	1E-07	1	Upperhugdi	5	2E-08	1
DurbangMyagdi	25	4E-07	1	Upperkamali	917.6	7.376131	0.999968
Hewa	4.5	0	1	Uppermadi	25	1E-07	1
JhimrukHEP	12	-2E-08	1	Uppermai	12	0	1
JiriKhola	2.4	6E-08	1	aandhikhola	9.4	3E-08	1
KGA(NEA)	144	44.547	0.955	aandhikholastorage	180	80.39727	0.913062
KGKowan	180	27.001	0.989	aankhukhola	8.4	4E-08	1
KabeliA	37.6	-7E-08	1	apsuwa khola	50	1.2E-07	1
Kalanga	15.325	3E-08	1	arun3	300	-32.4645	0.994196
KhaniKhola-1	40	2E-07	1	baramchi	4.2	-2E-08	1
KhaniKhola	2	0	1	bhairavkunda	3	0	1
KhareHPP	24.1	9E-08	1	chake	2.83	-1E-08	1
KhitmiHEP	60	-31.38	0.886	chakukhola	3	-1E-08	1
KhudiKhola	4	3E-08	1	chandrawati	4	0	1
Kul-2(1)	0	0	1	daramkhola	2.5	1E-08	1
Kulekhani-1	60	-40.99	0.826	daraudiA	6	3E-08	1
Likhu-1	77	-27.11	0.943	devighatnea	14.1	8.738396	0.85
Likhu-2	55	-15.95	0.96	gandakhep	15	7.264834	0.9
Likhu-A	52.4	-14.73	0.963	ghunsa	78	-3.69615	0.998879

Likhukhola-A	51	-14.08	0.964	indrawatinea	75	4.648082	0.85
LowerManangmarsyangdi	140	3.1308	1	jogmai	7.6	0	1
M-Marsyangdi	70	1.4225	1	kabelB1	25	-5E-08	1
M-chaku	1.8	0	1	kaligandakiupper	73.90004	27.99459	0.93515
MaiCascade	7	0	1	khanikholadolakha	30	1.2E-07	1
MaiKhola	4.5	0	1	lapche(1)	160	1.537838	0.999954
MaicascadeHP	8	0	1	lowerarun	659	-142.039	0.977551
Mailung	5	0	1	lowernodi	10	5E-08	1
MakariGad	10	0	1	lowersolu	81.99999	8.326766	0.994884
Manangmarsyangdi	282	12.652	0.999	mardi	4.8	2E-08	1
MistriKhola	42	5E-07	1	marsyangdiNea	69	-44.4117	0.840876
MolunKhola	7	0	1	marsyangdibesi	50	3.8E-07	1
Nalsaugad	121	-51.02	0.921	midletamor	54	-3.21959	0.998227
NaugadhGad	8.5	0	1	midim	3	2E-08	1
NilgiriKhola	38	5E-07	1	modinea	14.8	9.172215	0.85
NyadiKhola	30	3E-07	1	myadkukhola	13	5E-08	1
Phawakhola	5	0	1	myagdikhola	32	4.9E-07	1
Piluwa	3	0	1	nyadikhola	30	2.9E-07	1
PuwaNEA	6.2	-3.842	0.85	panauti	2.4	0	1
RahughatHp	40	6E-07	1	phewa	1	0.484323	0.9
Rahughatmanagle	37	6E-07	1	puwakhola1	4	0	1
Ruru-Banchu	14	2E-07	1	radhi khola	4.4	3E-08	1
Ruru-Banchu2	12	1E-07	1	ridi	2.4	1E-08	1
SabhaKhola	3.3	0	1	sanima sunkoshi	2.5	-1E-08	1
Sanigad	10.7	2E-08	1	sardikhola	4	0	1
SanimaMai	22	-1E-08	1	seti	1.5	0.726486	0.89999
Sipring	10	2E-07	1	simbuwa	53.7	-1.75729	0.99946
SoluHp	23.5	-3E-08	1	siurikhola	5	3E-08	1
Solukholaduchkoshi	186	38.85	0.979	sunkoshinea	10.05	6.22843	0.85
SuperDordikha	49.6	4E-07	1	tamakoshi5	87.00001	41.96631	0.900688
SuperVadi	44	2E-07	1	tamor mewa	128	-17.3809	0.990906
Tadi	5	0	1	tamorstorage	762	90.79	0.992977
TanahuSeti	140	77.087	0.876	tatopani	2	1E-08	1
Thungun-thosne	4.36	1E-08	1	thapakhola	11.2	5E-08	1
Tila1	440	64.863	0.989	thoppalkhola	1.65	1E-08	1
Tila2	420	59.384	0.99	thulibheri	121	-50.2876	0.923426

Tinau	1.024	0	1	thulibheri1	110	-39.2577	0.941818
UMarsyangdi-1	138	10.795	0.997	trisuliNEA	24	14.87386	0.85
UMarsyangdi-2	600	166.03	0.964	upperarun	725	-26.0564	0.999355
UMyagdi	20	3E-07	1	upperchepe	11	6E-08	1
URahughat	48.5	7E-07	1	upperlapche	52	0.162472	0.999995
UT3A	60	-40.09	0.832	uppermodi	19.4	9E-08	1
Upper Khalangad(hp	38.46	7E-08	1	westsetihp	750	107.001	0.989976
UpperDaraudi-1	10	5E-08	1				

Annex I: 2028A.D. Transmission Line Data

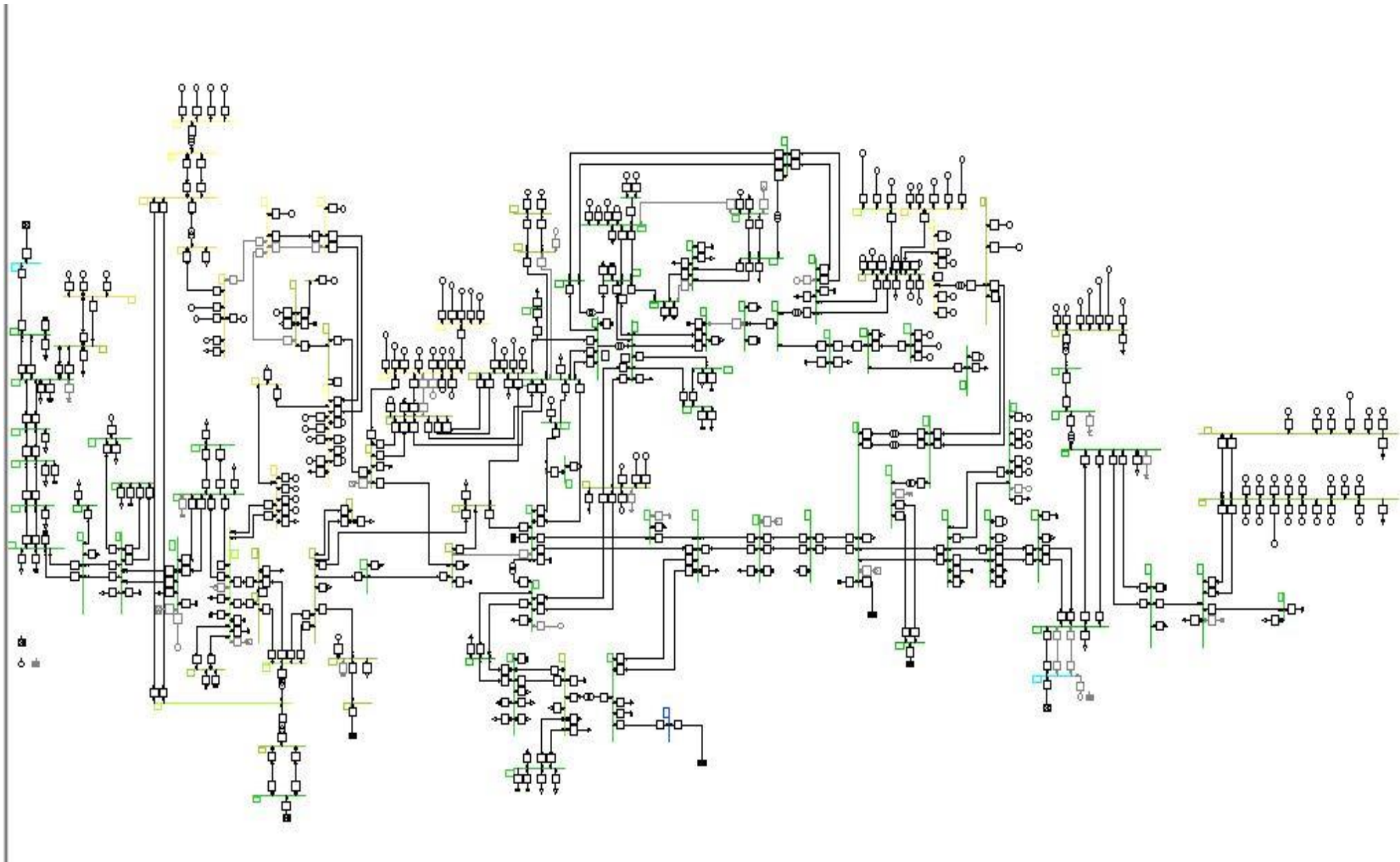
Name	Type TypLine, TypTow, TypGeo, TypCab sys	Lengt h km	Name	Type TypLine, TypTow, TypGeo, TypCab sys	Lengt h km
Attari-Phalam	132kVBEAR	35.19	inaruwa-damak400(1)	MOOSE400newquad	80
Attari-Phalam(1)	132kVBEAR	35.19	inaruwa-newbasantpur	MOOSE220twin	6.5
Balanch-Attari	132kVBEAR	130	inaruwa- newbasantpur(1)	MOOSE220twin	6.5
Balanch-Attari(1)	132kVBEAR	130	jagadulla-nalgad	MOOSE400twin	40
Balanch-UpperKalangad	BISON132newtwin	54	jagadulla-nalgad(1)	MOOSE400twin	40
Balanch-UpperKalangad(1)	BISON132newtwin	54	kamane-pathlaiya	132kVBEAR	30.093
Burigaon-Kohal	132kVBEAR	55.29	kamane-pathlaiya(1)	132kVBEAR	30.093
Burigaon-Kohal(1)	132kVBEAR	55.29	kawasoti-bharatpur	Panther132	28.7
Damauli-Kusma400	MOOSE400newquad	69	kgalekhnath	132kVDuck	48
Damauli-Kusma400(1)	MOOSE400newquad	69	kgalekhnath(1)	132kVDuck	48
Dodhara-Maintada	MOOSE400newquad	86	khadbari-baneshwor	MOOSE220twin	10
Dodhara-Maintada(1)	MOOSE400newquad	86	khadbari-baneshwor(1)	MOOSE220twin	10
Kohal-Kusum	132kVBEAR	48.3	khadbari-sitalpati	BISON220newtwin	24
Line	Zebra220twin	70	khadbari-sitalpati(1)	BISON220newtwin	24
Line(1)	Zebra220twin	70	khimti-dhalke	BISON220	58
Line(2)	MOOSE400twin	180	khimti-dhalke400	BISON400newquad	75
Line(3)	MOOSE400twin	180	khimti-dhalke400(1)	BISON400newquad	75
Lumki-Burigaon	132kVBEAR	33.9	khudi-damauli220	BISON220newtwin	60
Lumki-Burigaon(1)	132kVBEAR	33.9	khudi-damauli220(1)	BISON220newtwin	60
Mahen-Attari	132kVBEAR	51.4	khudi-udipur220	BISON220newtwin	16
Mahen-Attari(1)	132kVBEAR	51.4	khudi-udipur220(1)	BISON220newtwin	16
Maintada-Kohalpur400	MOOSE400newquad	31	kohal-kusum	132kVBEAR	48.3
Maintada-Kohalpur400(1)	MOOSE400newquad	31	ku1-switch66	WOLF66	32.86
Maintada-Phulbari	MOOSE400newquad	62	kul1-switch66	WOLF66	32.86
Maintada-Phulbari(1)	MOOSE400newquad	62	kul2-matatirtha	132kVBEAR	28.5

Maintada132-Kohalpur	BISON132	61	kule2-matatirtha	132kVBEAR	28.5
Maintada132-Kohalpur(1)	BISON132	61	kulekhani1-hetauda	WOLF66	15.05
Phalam-Lumki	132kVBEAR	28.9	kulekhani1-hetauda(1)	WOLF66	15.05
Phalam-Lumki(1)	132kVBEAR	28.9	kushaha-duhabi	132kVBEAR	28.7
Phulkot-Dodhara	MOOSE400newquad	80	kushaha-kataiya	132kVBEAR	15
Phulkot-Dodhara(1)	MOOSE400newquad	80	kusma-aadhikhola220	BISON220newtwin	76
Umadi-Lekhnath220	BISON220newtwin	6.5	kusma-aadhikhola220(1)	BISON220newtwin	76
UpperKalangad-WestSeti	BISON132newtwin	64	kusma-umodi	BISON132	6.5
UpperKalangad-WestSeti(1)	BISON132newtwin	64	kusum-lamahi	132kVBEAR	47.5
Westseti-bajhang	BISON400twin	60	kusum-lamahi(1)	132kVBEAR	47.5
Westseti-bajhang(1)	BISON400twin	60	lahan-duhabi	132kVBEAR	86.4
aadhikhola-butwal220	BISON220newtwin	76	lahan-kushaha	132kVBEAR	61.9
aadhikhola-butwal220(1)	BISON220newtwin	76	lainchaur-newchabil	PANTHER66	2.3
amlekh-simara	WOLF66	12.9	lainchaur-newchabil(1)	PANTHER66	2.3
amlekh-simara(1)	WOLF66	12.9	lamahi-jhim	DOG132	49.49
arun3-sitalpati	BISON220newtwin	9	lamahi-shivpur	132kVBEAR	51
arun3-sitalpati(1)	BISON220newtwin	9	lamahi-shivpur(1)	132kVBEAR	51
attariya-dodhara	MOOSE400newquad	68	lamosanghu-bhotekoshi	132kVBEAR	24.65
attariya-dodhara(1)	MOOSE400newquad	68	lamosanghu-khimti	132kVBEAR	45.84
attariya-westseti	MOOSE400newquad	144	lapsiphedi-barhabise	MOOSE400newquad	60
attariya-westseti(1)	MOOSE400newquad	144	lapsiphedi-barhabise(1)	MOOSE400newquad	60
balaju-chapali	132kVBEAR	10	lekhnath-damauli	132kVWolf	45
balaju-chapali(1)	132kVBEAR	10	lekhnath-damauli220	MOOSE220	40
balaju-lainchaur	PANTHER66	2	lekhnath-damauli220(1)	MOOSE220	40
balaju-switchatar132	132kVBEAR	4.4	likhu-khimti132	BISON132newtwin	6.5
balaju66-trisuli	DOG66kV	29	likhu-khimti132(1)	BISON132newtwin	6.5
balaju66-trisuli(1)	DOG66kV	29	manang-marsyangdi220	Zebra220twin	27
banepa-panchkahl	PANTHER66	8.03	manang-marsyang0(1)	Zebra220twin	27
baneshwor-bhaktapur	WOLF66	8.24	mars-Mmars	132kVDuck	31.92
baneshwor-newbasantpur	MOOSE220twin	21	mars-switchatar	132kVDuck	80.7
baneshwor-newbasantpur(1)	MOOSE220twin	21	matatirtha-switchatar	132kVBEAR	4.4
bardaghat-kawasoti	Panther132	46.4	matatirtha-switchatar(1)	132kVBEAR	4.4
barhabise-khimti400	MOOSE400newquad	46	mirchaiya-dhalkebar400	MOOSE400newquad	64
barhabise-khimti400(1)	MOOSE400newquad	46	mirchaiya-dhalkebar4(1)	MOOSE400newquad	64
barhabise-tamakoshi220	MOOSE220twin	92	mirchaiya-dudhkoshi	MOOSE400newquad	81
barhabise-tamakoshi220(1)	MOOSE220twin	92	mirchaiya-dudhkoshi(1)	MOOSE400newquad	81
bhaktapur-changu	132kVBEAR	3.65	mirchaiya-inaruwa400	MOOSE400newquad	64
bhaktapur-changu(1)	132kVBEAR	3.65	mirchaiya-inaruwa400(1)	MOOSE400newquad	64
bhaktapur-lamosanghu	132kVBEAR	48.3	mirchaiya-lahan	132kVBEAR	27.68

bhaktapur-amosanghu(1)	132KVBEAR	48.3	mirchaiya-lahan(1)	132KVBEAR	27.68
bhaktapurbanepa	WOLF66	13.57	nalgad-bafikot	MOOSE400newquad	26
bharatpur-mars	132KVBEAR	25.49	nalgad-bafikot(1)	MOOSE400newquad	26
birgunj-parwani	WOLF66	9	nalgad-maintara	MOOSE400newquad	70
birgunj-parwani(1)	WOLF66	9	nalgad-maintara(1)	MOOSE400newquad	70
burtibang-shivpur	BISON132	6.5	newbasantpur-tamor	MOOSE220twin	23
burtibang-shivpur(1)	BISON132	6.5	newbasantpur-tamor(1)	MOOSE220twin	23
butwal-bardaghat	132KVBEAR	43	newchabil-chapali	DOG66kV	5
butwal-bardaghat(1)	132KVBEAR	43	newchabil-chapali(1)	DOG66kV	5
butwal-hga	132KVDuck	58	newmars-bharatpur220	Zebra220twin	32
butwal-hga(1)	132KVDuck	58	nmars-bharatpur220(1)	Zebra220twin	32
butwal-phulbari400	MOOSE400newquad	229	panchkahl-sunkoshi	PANTHER66	27.44
butwal-phulbari400(1)	MOOSE400newquad	229	panchkhal-indrawati	PANTHER66	12.38
chapali-changu	132KVBEAR	8.24	patan-baneshwor	WOLF66	2.8
chapali-changu(1)	132KVBEAR	8.24	pathlaiya-chapur	132KVBEAR	30.68
chapali-devighat	DOG66kV	29.3	pathlaiya-chapur(1)	132KVBEAR	30.68
chapali-devighat(1)	DOG66kV	29.3	pathlaiya-parwani	132KVBEAR	16.59
chapuri-dhalkebar	132KVBEAR	69.48	pathlaiya-parwani(1)	132KVBEAR	16.59
chapuri-dhalkebar(1)	132KVBEAR	69.48	phulkot-mugukamali	MOOSE400newquad	71
chilime-trisuli	BEAR66	0.1	phulkot-mugukamali(1)	MOOSE400newquad	71
dadakhet-rahughat	BISON220newtwin	15	pr-lekhnath	DOG132	7
dadakhet-rahughat(1)	BISON220newtwin	15	pr-modi	132KVBEAR	37
damak-anamani	132KVBEAR	26.7	rahughat-kusma220	Zebra220twin	30
damauli-bharatpur	132KVWolf	39	rahughat-kusma220(1)	Zebra220twin	30
damauli-butwal400	MOOSE400newquad	75	ramnagarimpline	132KVBEAR	0.1
damauli-butwal400(1)	MOOSE400newquad	75	ratamate-lapsiphedi	MOOSE400newquad	28
damauli-ratamate400	MOOSE400newquad	79	ratamate-lapsiphedi(1)	MOOSE400newquad	28
damauli-ratamate400(1)	MOOSE400newquad	79	seti-pr	132KVWolf	0.1
dana-rahughat	BISON220newtwin	20	shivpur-butwal	132KVBEAR	63.33
dana-rahughat(1)	BISON220newtwin	20	shivpur-butwal(1)	132KVBEAR	63.33
dhalke-muzza	MOOSE400	39	simara-parwani66	WOLF66	9.6
dhalke-muzza(1)	MOOSE400	39	simara-parwani66(1)	WOLF66	9.6
dhalkebar-mirchaiya	132KVBEAR	31.5	switch-patan	WOLF66	6.5
dhalkebar-mirchaiya(1)	132KVBEAR	31.5	switch66-balaju66	WOLF66	4.4
dudhkoshi-tingla	MOOSE400newquad	45	switch66-balaju66(1)	WOLF66	4.4
dudhkoshi-tingla(1)	MOOSE400newquad	45	switch66-k3	WOLF66	6.9
duhabi-damak	132KVBEAR	48.9	switch66-teku	BEAR66	4.1
dunai-jagadulla	BISON400twin	50	swtch-patan	WOLF66	6.5
dunai-jagadulla(1)	BISON400twin	50	tamakoshi-khimti220	MOOSE220twin	46
gandak-bardaghat	Panther132	14	tamakoshi-khimti220(1)	MOOSE220twin	46
gandak-bardaghat(1)	Panther132	14	tamakoshi-lapche	BISON220newtwin	15
hangpang-arun	MOOSE400newquad	46	tamakoshi-lapche(1)	BISON220newtwin	15
hangpang-arun(1)	MOOSE400newquad	46	teku-k3	WOLF66	2.3

hangpang-inaruwa400	MOOSE400newquad	101	tingla-arun	MOOSE400newquad	62
hangpang-inaruwa400(1)	MOOSE400newquad	101	tingla-arun(1)	MOOSE400newquad	62
hangpang-newbasantapur220	BISON220newtwin	46	tingla-mirchaiya132	BISON132newtwin	65
hangpang-nbasantapur220	BISON220newtwin	46	tingla-mirchaiya132(1)	BISON132newtwin	65
hetauda-amlekhgunj	WOLF66	20.17	tingla-newkhimti	MOOSE400newquad	57
hetauda-amlekhgunj(1)	WOLF66	20.17	tingla-newkhimti(1)	MOOSE400newquad	57
hetauda-bharatpur	Panther132	70.85	trisuli-devighat	WOLF66	4.56
hetauda-kamane	132KVBEAR	30.09	udipur-newmars220	Zebra220twin	31
hetauda-kamane(1)	132KVBEAR	30.09	udipur-newmars220(1)	Zebra220twin	31
hetauda-kul2	132KVBEAR	8.24	upperarun-arun	MOOSE400twin	18
hetauda-kul2(1)	132KVBEAR	8.24	upperarun-arun(1)	MOOSE400twin	18
hetauda-ratamate400	MOOSE400newquad	90	westseti-dodhara	MOOSE400newquad	109
hetauda-ratamate400(1)	MOOSE400newquad	90	westseti-dodhara(1)	MOOSE400newquad	109
ilam-damak	132KVBEAR	31.5	westseti-phulkot	MOOSE400newquad	87
inaruwa-damak400	MOOSE400newquad	80	westseti-phulkot(1)	MOOSE400newquad	87

(I) Single Line Diagram of Existing INPS(2023A.D.)



(II) Single Line Diagram of 2028 A.D. Scenario

