PROJECT CLIMATE RISK ASSESSMENT AND MANAGEMENT REPORT

I. Basic Project Information

Project Title: Nepal: Power Transmission and Distribution Efficiency Enhancement
Project Budget: $150 million
Locations: Lapsiphedi, Changunarayan, Chapagaun, Jorpati, Phutang, Barhabise, Ratnapark, and Maharajganj, Nepal
Sector: Energy
Theme: Power transmission and distribution
Brief Description *(particularly highlighting aspects of the project that could be affected by weather/climate conditions)***:** The project will enhance the distribution capacity and improve reliability and quality of electricity supply in the Kathmandu Valley by reducing distribution system overloads and technical and commercial losses, and strengthening associated transmission lines through Nepal Electricity Authority (NEA). The project will also support the implementation of other system efficiency upgrades and energy efficiency measures such as advanced grid operations software, distribution system automation, and smart metering.

II. Summary of Climate Risk Screening and Assessment

(Initial climate risk screening can be carried out using AWARE for Projects. Upon the completion of this initial screening, a report will be generated with risks ranked for different climate hazards and advice for possible next steps provided. Mission leaders for projects ranked at medium or high risk could arrange for more detailed climate risk assessments, to further identify the nature, level of risks, and more critically, options to manage such risks within the context of the proposed project.)

A. **Sensitivity of project component(s) to climate/weather conditions and sea level**
[describe how climate/weather condition (e.g. temperature and seasonal contrast, rainfall amount and seasonality, wind, solar radiation, etc.) and sea level could affect the relevant project component(s)]

Project components	*Sensitivity to climate/weather conditions and sea level*
1. Substations – Construction of one (220/132/11 kV) gas insulated substations at Laphsiphedi and Barhabise. – Construction 4 gas insulated substations (132/11 kV) at Changunarayan, Chapagaun, Jorpati and Phutang. 2. Distribution network rehabilitation – Rehabilitation of 300 km medium voltage and 600 km of low voltage distribution systems constructed and/or rehabilitated – Installation of 1,000 distribution transformers with total estimated capacity of 200 MVA. 3. Enhancement of operational and financial performance of NEA distribution centers. – Deploy 90,000 smart meters and other smart grid elements in the distribution system. 4. Capacity building of NEA staff to operate and manage advanced distribution system, intelligent energy network (Smart Grid) technology and Gender Equality and Social Inclusion (GESI) aspects in electricity access and end users awareness programme.	1. Temperature increase could affect transmission and distribution cables, substations (infrastructure, switching gear, etc.), and transformers by reducing the electricity carrying capacity of lines and increasing losses within substations and transformers. De-rating of transformers could occur at –1% load per 1°C rise. Decreased conductivity of overhead lines and underground cables could occur as resistance increases at about 0.4% per 1°C degree rise which leads to a decrease of 0.5 to 1% line load capacity. Sag of overhead lines of up to 4.5 cm could also occur per 1°C rise at conductor surface for 35°C ambient temperature and span of 400 meters. 2. Precipitation and flooding could affect transmission towers, distribution cables (if underground), substations (infrastructure, switching gear, etc.), and transformers due to inundation of above-ground components, and erosion that could expose underground components and disturb the structural integrity of facilities. 3. Drought can increase dust and lightning damage. 4. High wind speeds could damage transmission and distribution cables, towers (pylons) and poles. 5. Extreme events (flood, typhoons, drought) could damage facilities as well as control systems through loss of ICT service or reduced quality of service. 6. Earthquakes could cause strong ground movement, landslides and ground subsidence that can damage transmission and distribution infrastructure.

B. Climate Risk Screening

[Identify potential risks of projected climate change to climate-sensitive project component(s).This could be derived from the Aware for Projects risk screening report.]

Risk topic	Description of the risk
1. Rising temperatures	– Based on projected changes in temperature in Nepal, by the end of the 21st century, seasonal maximum temperature increase of 4.5˚C in spring and 3.3˚C in summer, while seasonal minimum temperature increase of 5.4˚C in winter and 3.4˚C in summer[1] – Increased thermal expansion of power lines, reducing the amount of power that can be securely transported – Increased capital costs for building new transmission and distribution infrastructure to support greater demand – Change in performance of underground cabling systems – Weathering, accelerated damage, and aging of equipment and structures
2. Increase precipitation	– Based on projected changes in rainfall in Nepal, overall annual precipitation decreases by 2% of the baseline amount by 2020s, however it increases by 6% and 12% of the baseline by 2050s and 2080s, respectively[2] – Disruptions in power distribution due to damage to infrastructure due to flooding and flood-induced landslides
3. Extreme weather events (floods and wind storms)	– It is likely that climate change in Nepal will increase the frequency and magnitude of extreme weather events[3] – Strong winds damaging overhead distribution lines – Increased health and safety concerns – Increase in repair and maintenance costs
4. Landslide/avalanche	– Strong ground movement due to earthquake causing infrastructure to collapse and damaging facilities, considering the project locations in Kathmandu Valley

Climate Risk Classification *[Low, Medium and High] [If available, please annex the Aware for Projects risk screening report to this appendix]* Low

C. Climate risk assessment

Transmission and distribution lines could be sensitive to earthquake, landslide induced both by earthquake and intense precipitation, and extreme winds. The location of the facilities such as the substations may also be sensitive to flooding that can result to erosion and scouring of foundation base, and submergence of equipment. Although Glacial Lake Outburst Floods (GLOFs) have been reported in Nepal, this phenomenon is not included as a possible threat to the project since Bagmati river system is not one of those included in the reported GLOFs events. Given that there are no transmission lines to be constructed, considering the technology of gas-insulated compact type and locations of the substations and distribution systems enhancement to be within Kathmandu city, no major threat from the climate change perspective is included for this project.

III. Climate Risk Management Response within the Project

(Describe project activities, outputs, indicators and/or targets aimed to address identified climate risks and budgetary allocations, and other adaptive measures to be included/considered in the project design to address climate risks identified)

The level of climate risk (including geologic hazard) assessed for this project is high, in particular from earthquake, landslides both from earthquake and precipitation-induced floods, and strong winds.

The following climate change adaptation options are recommended for consideration during the detailed design phase of the project[4]:

<u>Increased precipitation and flooding</u>

[1] Government of Nepal Ministry of Science, Technology and Environment. 2014. *Nepal Second National Communications to the United Nations Framework Convention on Climate Change*. http://unfccc.int/resource/docs/natc/nplnc2.pdf

[2] Ibid.

[3] Ibid.

[4] Asian Development Bank. 2012. *Climate Risk and Adaptation in the Electric Power Sector*. https://www.adb.org/sites/default/files/publication/29889/climate-risks-adaptation-power-sector.pdf

- Build a resilient high-capacity transmission system.
- Design improved flood protection measures for equipment mounted at ground level in substations, including drainage design that accounts for rainfall projections in the area.
- Forbid the construction of power lines near dikes and ban “permanent” trees next to existing dikes.
- Protect masts, antennae, switch boxes, aerials, overhead wires, and cables from precipitation (water ingress, snow melt); wind; snow (weight); unstable ground conditions (flooding, subsidence); and changes in humidity.

High wind speeds
- Reinforce existing transmission and distribution structures and build underground distribution systems.
- Require higher design standards for distribution poles.

Extreme events (flood, typhoons, drought)
- Increase the system’s ability to return to normal operations rapidly if outages do occur.
- Change routes of overhead lines along roads away from trees, rigorously prune trees, use covered and/or insulated conductors, and use more underground cables, especially in wooded areas.
- Allow increased rerouting during times of disruption.
- Include lightning protection (earth wires, spark gaps) in the distribution network.
- Design redundancy into the information and communication technology (ICT) systems.
- Develop and use “smart transformers” and “smart grids.”

Temperature Increase
- Specify more effective cooling for substations and transformers.
- Specify certified ICT components that are resilient to higher temperatures and humidity.

With respect to the risk from geologic hazards, the project design must conform to established earthquake-resilient standards.

Appropriate adaptation measures will be employed to increase the project's adaptive capacity to climate variabilities and geologic hazards.