# CLIMATE CHANGE ASSESSMENT

## I. BASIC PROJECT INFORMATION

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|---|---|
| **Project Title:** | Power Transmission Strengthening Project |
| **Project Cost** ($ million)**:** | $456.65 million, which includes $250.00 million financed by ADB and $206.65 million counterpart financing |
| **Location:** | Khyber Pakhtunkhwa, Pakistan |
| **Sector:** | Energy |
| **Theme:** | Power transmission |
| **Brief Description:** | The project aims to improve the coverage, efficiency, and quality of the power transmission service in Pakistan. The impact and outcome will be achieved through the following outputs:<br><br>**(i) Output 1: The NTDC 500 kilovolt transmission lines network expanded.** This output has two subprojects: (i) the procurement of goods to construct about 80 kilometers (km) of 500 kilovolt (kV) transmission line connecting Sangal to the 500 kV Maira switching station (subproject 1); and (ii) the procurement of goods to construct about 130 km of 500 kV transmission line connecting the 500 kV Maira switching station to the 500 kV Islamabad West substation, and about 20 km of 500 kV transmission line to the existing 500kV Karot substation (subproject 2).<br><br>**(ii) Output 2: The NTDC 220 kilovolt transmission lines network upgraded and expanded.** This output has two subprojects: (i) a turnkey contract to construct about 17 km of a new 220 kV transmission line (12 km overhead and 5 km underground) from the 220 kV Band Road substation to the 220 kV New Kot Lakhpat substation (subproject 3); and (ii) the procurement of goods to construct about 60 km of 220 kV transmission line from Mohmand HPP to the 220 kV Jamrud substation, about 67 km of 220 kV transmission line from Mohmand HPP to the existing 220kV Nowshera Industrial substation, and expansion of the 220 kV Nowshera industrial substation by adding two-line bays (subproject 4).<br><br>**(iii) Output 3: Capacity to mainstream gender equality and project community outreach of the NTDC strengthened.** The project aims to create gender-inclusive workplaces in the NTDC by developing guidelines for internships and mentorship, conducting awareness campaigns, establishing childcare centers, and providing technical training to female staff. Additionally, the project includes (i) livelihood skills development for women in the project area to improve their economic opportunities, and (ii) training programs for improving the coping capacity of the local communities to respond to climate change and disasters triggered by natural hazards.<br><br>**(iv) Output 4: Institutional, climate resilient system planning and operation, financial management, and project management capacity of NTDC strengthened.** This output supports the NTDC's institutional capacity development to promote climate-resilient system planning and operation; financial management capacity building; restructuring of the NTDC's Project Management Unit; implementation of the Transmission Master Plan; functional separation of the system operator; implementation of the project management dashboard; project management, implementation, and supervision, as well as development and adoption of the gender-inclusive recruitment guidelines to increase female job applications approval. |

ADB = Asian Development Bank, HPP = hydropower plant, km = kilometer, kV = kilovolt, NTDC = National Transmission & Despatch Company Limited.
Sources: ADB, NTDC, and Pakistan's Power Transmission Strengthening Project Climate Risk and Vulnerability Report.

## II. SUMMARY OF CLIMATE CHANGE FINANCE

| Project Financing | | Climate Finance | |
|---|---|---|---|
| Source | Amount ($ million) | Adaptation ($ million) | Mitigation ($ million) |
| **Asian Development Bank** | | | |
| Ordinary capital resources (regular loan) | 235.00 | 48.18 | 186.82 |
| Ordinary capital resources (concessional loan) | 15.00 | 15.00 | 0.00 |
| **Counterpart funding** | | | |
| National Transmission & Despatch Company Limited | 206.65 | 24.63 | 182.02 |

Source: Asian Development Bank.

## III. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

**A. Sensitivity of Project Component(s) to Climate or Weather Conditions and the Sea Level**

1. **Construction of transmission lines.** Transmission lines are prone to floods, landslides, storms and heat waves during the lifetime of operation. Erosion due to strong floods can destabilize transmission tower foundations and collapse transmission towers. Landslides can damage/remove transmission tower foundations resulting in collapse of transmission towers, damage transmission line tower super structures and reduce the clearance between transmission lines and the ground due to deposit of shifted soil/rocks. Strong winds during storms can destroy transmission towers and fall/throw trees on to transmission lines. Heat waves will force system operators to operate transmission lines at part load to ensure thermal operating limits are not violated, at times forcing load shedding in some areas.
2. **Expansion of transmission line bays.** Substation components are also prone to floods, storms and heat waves. Floods reaching substation equipment can cause damage to equipment and tripping of substations. Strong winds during storms can cause damage to superstructures at substations, while heat waves can force system operators to operate the substation at part load, maintaining operating temperatures below the maximum operating temperatures allowed.

**B. Climate Risk Screening**

1. **Increase in frequency and intensity of floods.** The frequency and intensity of floods in Pakistan is possible to increase in the RCP 2.6 scenario**,** while it is almost certain in the RCP 8.5 scenario by the period 2040**–**2059. Foundation designs and transmission line routes selected may become not suitable if floods increase in **the** future.
2. **Increase in storms.** Although project areas have not experienced storms regularly in the past, storms are possible to occur in the RCP 8.5 scenario by the period 2040**–**2059. Design strengths of transmission towers and substation superstructures may not be sufficient to withstand strong winds during storms. Furthermore, strong winds might uproot trees or break tree branches and throw them or other objects at transmission lines or towers causing damages or tripping them.
3. **Increase in landslides.** An increase in landslides is unlikely in the RCP 2.6 scenario**,** while it is possible in the RCP 8.5 scenario by the period 2040**–**2059. Damages to transmission line towers will cause disruptions in electricity supply. Restoration of transmission line towers will cost significantly and may require several days to several weeks. Reduction in transmission line clearance due to shifted earth and rocks may result in tripping of transmission lines due to flashover.
4. **Increase in heat waves.** The frequency and intensity of heat waves are possible to increase in the RCP 2.6 scenario, while they are likely to increase in the RCP 8.5 scenario by the period 2040–2059. Prolonged high temperatures during heat waves will cause operating temperature of transmission lines and substation equipment to increase beyond safe operating temperatures. Furthermore, transmission line sag will also increase and may exceed the design limits, posing danger to humans and animals entering the transmission line corridor.
5. **Rise in temperature.** Similar to heat waves, the ambient temperature is possible to increase in the RCP 2.6 scenario, while it is likely to increase in the RCP 8.5 scenario by the period 2040–2059. Transmission network losses may increase and transmission system capacities may decrease because of increase in ambient temperature.

Climate Risk Classification: *Medium*

**C. Climate Risk and Adaptation Assessment**

This assessment is based on climate risk studies carried out for Pakistan in general and adaptation measures undertaken by similar projects in the energy sector, and identifies specific measures required to adapt to the risks posed by climate impacts in specific project areas.

**Key climate risks to the relevant project components.** Transmission lines and substation elements are sensitive to floods, storms, landslides, heat waves, and rising temperature. The rating of each risk is assessed as follows:

- **Floods – *High*.** Increase in intensity and frequency of floods affect the strength of foundations and may cause damage to transmission line towers. This risk is relevant to all subprojects.
- **Storms – *High*.** Higher wind speeds during storms will affect superstructures of transmission lines and substations.
- **Landslides – *Medium*.** Some sections of transmission lines proposed in subprojects 1, 2, and 4 travel through mountainous terrains that are prone to landslides. Landslides can dislocate transmission line tower foundations, damage transmission line towers, and reduce the clearance between transmission lines and the ground.
- **Temperature rise – *Medium*.** The rise of temperature directly affects the lifetime of equipment. Moreover, the increase in electricity demand due to the increase in ambient temperature could stress the conductors. This risk is relevant to all subprojects.
- **Reduction in precipitation – *Low*.**

**Adaptation options identified and prioritized for managing the risks.** The following climate change adaptation options are recommended for consideration during the design phase of the project:

**Floods**

- Erosion due to stronger floods destabilize foundations. Design of foundations of transmission towers to withstand stronger floods will reduce the risk of floods.
- Study of flood levels and patterns along the transmission line route will assist transmission line designers to position transmission line towers in locations that will have a low risk of floods.
- Although transmission line and substation designs consider floods and erosion, the designs are required to be revisited and further improved considering the recent floods in Pakistan.

**Storms**

- Higher wind speeds during storms affect transmission towers. Adopting design standards for higher wind speeds will improve resilience. The present designs need to be improved.

**Landslides**

- Landslides can damage transmission line towers and affect the clearance between transmission lines and the ground. Improving transmission line tower foundations and construction of retaining walls (gabion walls) in landslide prone areas along the transmission line routes will improve resilience.

**Temperature rise**

- Conductors elongate because of the increase in temperature, which results in the reduction of ground clearance of transmission lines. This typically intensifies the risk of flashovers. By using higher-rated conductors, the sagging effect of transmission lines can be reduced. This has been already considered in transmission line designs.

In addition to adaptation measures related to the climate risks identified as relevant, the following nonstructural measures are recommended:

**Capacity building**

- Despite various policies on climate change adapted by the government, capacity on climate change and addressing climate change is low at the NTDC. It is recommended to conduct a needs assessment and capacity building as required at the NTDC.

**Updating of specifications**

- Design specifications used by the NTDC have not been updated for decades and are likely to be weak in the present and future climate contexts. It is recommended to revisit the design specifications and strengthen them to suit climate projections for Pakistan.

**D. Climate Risk Screening Tool and/or Procedure Used**

Risk screening and vulnerability assessment procedures adapted from ADB. 2013. *Guidelines for Climate Proofing Investment in the Energy Sector*. Manila.

NTDC = National Transmission & Despatch Company Limited, RCP = representative concentration pathway.
Source: Asian Development Bank.

## IV. CLIMATE ADAPTATION PLANS WITHIN THE PROJECT

| Adaptation Activity | Target Climate Risk | Estimated Adaptation Costs ($ million) | Adaptation Finance Justification |
|---|---|---|---|
| Improve tower foundations and construct gabion walls, where necessary, to protect transmission line towers and foundations; in addition, construct towers taller than the standard 500 kV transmission towers to maintain sufficient ground clearance in the event of a landslide/rock fall in the span between towers, where necessary | Landslides | 8.43 | Geohazard assessment studies carried out by the NTDC have revealed that 40% of the slopes in the transmission line routes of subprojects 1 and 2 are categorized as "steep slope," indicating high probability of landslides and rock fall. Furthermore, transmission lines proposed in subproject 4 also travel through mountainous terrains with steep slopes. It is recommended to improve transmission tower foundations, construct gabion walls, and increase tower heights, where necessary, to maintain the required clearance between the conductor and the ground.<br>Incremental cost is estimated at 5% of the total project cost. Design changes will help reduce extensive repairs after commissioning and minimizing transmission line outages. |
| Change the design of transmission tower foundations and structures to withstand stronger floods (50-year return period) and higher wind speeds | Floods and storms | 3.38 | Incremental cost is estimated at 2% of the total project cost. Design changes will help reduce extensive repairs after commissioning and minimizing transmission line outages. |
| Use underground cables to minimize the impacts of events, such as floods, strong winds, and heatwaves, and to improve system reliability | Floods and storms | 33.99 | A 5 km stretch of the transmission line from the Band Road Grid Substation in Lahore to New Kot Lakhpat Grid Substation in Lahore is proposed to be changed to an underground cable to improve system reliability. In addition, various operating restrictions that are applicable to overhead lines (due to sagging) that traverse through congested areas will not be applicable to this underground section, increasing the operating capacity. The adaptation cost is estimated as the incremental cost compared to the cost of an overhead transmission line. |
| Conduct various desk and onsite studies for transmission line route selection and substructure design for transmission lines and substations | Floods, strong winds, landslides, temperature rise, and heatwaves | 2.35 | The NTDC conducts various desk studies and onsite studies for the selection of transmission line routes, location of transmission towers, and design of transmission line towers and their foundations. Although, this is part of the NTDC's standard procedure, this helps in minimizing climate risks and improving resilience to climate change. Hence, the cost of such studies is considered as an adaptation cost. |
| Support capacity building (i) among communities to improve the ability to respond to climate change, and (ii) at the NTDC to improve climate resilience in infrastructure by considering climate change | All climate risks | 15.00 | Awareness and capacity among communities to cope with climate change is low in Pakistan. As a country vulnerable to climate change, resilience to climate change needs to be built among communities. Furthermore, planning and operation of the power system are carried out by the NTDC based on past events, while future |

| Adaptation Activity | Target Climate Risk | Estimated Adaptation Costs ($ million) | Adaptation Finance Justification |
|---|---|---|---|
| in system planning and operation | | | projections are not considered. Hence, capacity building on building and operating climate-resilient infrastructure in required for the NTDC. |

km = kilometer, kV = kilovolt, NTDC = National Transmission & Despatch Company Limited.
Source: Asian Development Bank.

## V. CLIMATE MITIGATION PLANS WITHIN THE PROJECT

| Mitigation Activity | Estimated GHG Emissions Reduction ($tCO_2e$/year)[a] | Estimated Mitigation Costs ($ million) | Mitigation Finance Justification |
|---|---|---|---|
| Expansion of transmission network to increase power supply | Based on the principle of conservativeness and limited methodology from the literature, the emission reduction was not assessed to avoid incorrect estimation and presentation of GHG mitigation benefits. The project demonstrated increasing mix of clean and renewable energy use, which limits the potential expansion of fossil-derived energy usage in the project site. | 156.98 | Subprojects 1, 2, and 4 will construct transmission lines and substation extensions that will increase the power supply. Therefore, subprojects 1, 2, and 4, in general, are considered mitigation projects as per the Common Principles for Climate Mitigation Finance Tracking. The entire cost of the three subprojects, excluding adaptation costs, is considered as mitigations costs.<br>Emission reduction benefits cannot be fully attributed to these three subprojects as they only complement the existing transmission system. Hence, the GHG emission reduction was not estimated.<br>Contribution by each subproject is as follows:<br>Subproject 1: $68.58 million<br>Subproject 2: $65.66 million<br>Subproject 4: $22.74 million |
| Increase transmission system capacity to increase electrification and system reliability | 13,716 | 29.84 | The project is implemented to increase electrification and system reliability, which will result to reduction in the use of alternative fuels at consumer premises, leading to a reduction in GHG emissions. The GHG emission reduction due to subproject 3 was estimated on a pro-rata basis according to the additional demand served. Mitigation financing related to subproject 3 was estimated as total cost of subproject 3 ($64.13 million) minus adaptation cost ($34.29 million). |

GHG = greenhouse gas, $tCO_2e$ = tons of carbon dioxide equivalent.
[a] Energy savings/year x emission factor = GHG emissions reduction.
Source: Asian Development Bank estimates.