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Report No: ICR00004912

# IMPLEMENTATION COMPLETION AND RESULTS REPORT

Loan Number 7787-IN

ON A

LOAN

IN THE AMOUNT OF US$1,000 MILLION

TO THE

POWER GRID CORPORATION OF INDIA LIMITED

FOR THE

FIFTH POWER SYSTEM DEVELOPMENT PROJECT

August 13, 2020

Energy and Extractives Global Practice
South Asia Region

CURRENCY EQUIVALENTS

| Year | Annual Average Exchange Rate to US$ |
|---|---|
| 2009 | 48.41 |
| 2010 | 45.73 |
| 2011 | 46.67 |
| 2012 | 53.44 |
| 2013 | 58.60 |
| 2014 | 61.03 |
| 2015 | 64.15 |
| 2016 | 67.20 |
| 2017 | 65.12 |
| 2018 | 68.39 |
| 2019 | 70.42 |

Currency Unit = Indian Rupees (INR)

FISCAL YEAR
April 1 – March 31

**ABBREVIATIONS AND ACRONYMS**

| | |
|---|---|
| AC | Alternating Current |
| AIS | Air Insulated Substations |
| CAS | Country Strategy |
| CEA | Central Electricity Authority |
| CERC | Central Electricity Regulatory Commission |
| COVID-19 | Coronavirus Disease 2019 |
| CPS | Country Partnership Strategy |
| CSR | Corporate Social Responsibility |
| DC | Direct Current |
| D/C | Double Circuit |
| DMR | Dedicated Metallic Return |
| EHV | Extra High Voltage |
| ER | Eastern Region |
| ERM | Enterprise Risk Management |
| ERP | Enterprise Resource Planning |
| ERR | Economic Rate of Return |
| ERSS V | Eastern Region System Strengthening V |
| ESPP | Environment and Social Policy and Procedures |
| FMR | Financial Monitoring Report |
| FPO | Follow-on Public Offering |
| GDP | Gross Domestic Product |
| GIS | Gas Insulated Substations |
| GPS | Global Positioning System |
| GOI | Government of India |
| GRI | Global Reporting Initiative |
| HVDC | High-Voltage Direct Current |

| | |
|---|---|
| HTLS | High-Temperature Low-Sag |
| ICR | Implementation Completion and Results Report |
| ICT | Information and Communications Technology |
| ISR | Implementation Status and Results Report |
| IPMCS | Integrated Project Management and Control Systems |
| KPI | Key Performance Indicator |
| LILO | Loop-In Loop-Out |
| M&E | Monitoring and Evaluation |
| MoF | Ministry of Finance |
| MoP | Ministry of Power |
| MTR | Midterm Review |
| NDC | Nationally Determined Contribution |
| NER | North Eastern Region |
| NHAI | National Highways Authority of India |
| NLDC | National Load Dispatch Center |
| NoA | Notice of Award |
| NR | Northern Region |
| NRSS 24 | Northern Region System Strengthening XXIV |
| NRSS 25 | Northern Region System Strengthening XXV |
| NRSS 26 | Northern Region System Strengthening XXVI |
| PAD | Project Appraisal Document |
| PAP | Project-Affected Person |
| PDO | Project Development Objective |
| PIP | Project Implementation Plan |
| POSOCO | Power System Operation Corporation Limited |
| POWERGRID | Power Grid Corporation of India Limited |
| PPP | Purchasing Power Parity |
| PSDP II | Second Power System Development Project |
| PSDP III | Third Power System Development Project |
| PSDP IV | Fourth Power System Development Project |
| PSDP IV AF | Additional Financing to Fourth Power System Development Project |
| PSDP V | Fifth Power System Development Project |
| QPR | Quarterly Progress Report |
| RoE | Return on Equity |
| ROW | Right-Of-Way |
| RRVPNL | Rajasthan Rajya Vidyut Prasaran Nigam Limited |
| S/C | Single Circuit |
| SR | Southern Region |
| SS | System Strengthening |
| SRSS 13 | Southern Region System Strengthening XIII |
| SRSS 17 | Southern Region System Strengthening XVII |
| TBCB | Tariff-Based Competitive Bidding |
| UCS | Use of Country Systems |
| UHV | Ultra-High Voltage |
| UMPP | Ultra Mega Power Plant |
| WR | Western Region |

| | |
|---|---|
| Regional Vice President: | Hartwig Schafer |
| Country Director: | Junaid Kamal Ahmad |
| Regional Director: | Guangzhe Chen |
| Practice Manager: | Demetrios Papathanasiou |
| Task Team Leader(s): | Surbhi Goyal, Debabrata Chattopadhyay |
| ICR Main Contributor: | Ahmed El-Hamri, Anthony Granville, Shraddha Suresh |

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## DATA SHEET

## BASIC INFORMATION

### Product Information

| Project ID | Project Name |
|---|---|
| P115566 | Fifth Power System Development Project |
| **Country** | **Financing Instrument** |
| India | Investment Project Financing |
| **Original EA Category** | **Revised EA Category** |
| Full Assessment (A) | Full Assessment (A) |

### Organizations

| Borrower | Implementing Agency |
|---|---|
| Power Grid Corporation of India Limited | Power Grid Corporation of India Limited |

### Project Development Objective (PDO)

Original PDO

The project development objective is to strengthen India's electricity transmission system in order to increase reliable power exchange between regions and states.

## FINANCING

| | Original Amount (US$) | Revised Amount (US$) | Actual Disbursed (US$) |
|---|---|---|---|
| **World Bank Financing** | | | |
| IBRD-77870 | 1,000,000,000 | 1,000,000,000 | 1,000,000,000 |
| **Total** | **1,000,000,000** | **1,000,000,000** | **1,000,000,000** |
| **Non-World Bank Financing** | | | |
| Borrower/Recipient | 562,000,000 | 1,158,000,000 | 1,158,000,000 |
| **Total** | **562,000,000** | **1,158,000,000** | **1,158,000,000** |
| **Total Project Cost** | **1,562,000,000** | **2,158,000,000** | **2,158,000,000** |

## KEY DATES

| Approval | Effectiveness | MTR Review | Original Closing | Actual Closing |
|---|---|---|---|---|
| 22-Sep-2009 | 08-Jan-2010 | 26-Oct-2013 | 30-Jun-2015 | 31-May-2019 |

## RESTRUCTURING AND/OR ADDITIONAL FINANCING

| Date(s) | Amount Disbursed (US$M) | Key Revisions |
|---|---|---|
| 23-May-2014 | 507.40 | Change in Results Framework<br>Change in Loan Closing Date(s)<br>Reallocation between Disbursement Categories<br>Change in Implementation Schedule |
| 23-May-2017 | 808.64 | Change in Loan Closing Date(s) |

## KEY RATINGS

| Outcome | Bank Performance | M&E Quality |
|---|---|---|
| Satisfactory | Highly Satisfactory | High |

## RATINGS OF PROJECT PERFORMANCE IN ISRs

| No. | Date ISR Archived | DO Rating | IP Rating | Actual Disbursements (US$M) |
|---|---|---|---|---|
| 01 | 09-Apr-2010 | Satisfactory | Satisfactory | 12.00 |
| 02 | 15-May-2010 | Satisfactory | Satisfactory | 12.00 |
| 03 | 12-Dec-2010 | Satisfactory | Satisfactory | 19.51 |
| 04 | 28-Jun-2011 | Satisfactory | Satisfactory | 71.03 |
| 05 | 27-Dec-2011 | Satisfactory | Satisfactory | 129.38 |
| 06 | 25-Apr-2012 | Satisfactory | Moderately Satisfactory | 188.23 |
| 07 | 20-Nov-2012 | Satisfactory | Moderately Satisfactory | 239.14 |
| 08 | 18-Jun-2013 | Satisfactory | Moderately Satisfactory | 337.55 |
| 09 | 28-Dec-2013 | Satisfactory | Moderately Satisfactory | 413.72 |
| 10 | 12-Mar-2014 | Moderately Satisfactory | Moderately Satisfactory | 468.72 |
| 11 | 28-Jun-2014 | Moderately Satisfactory | Moderately Satisfactory | 528.23 |
| 12 | 27-Dec-2014 | Satisfactory | Satisfactory | 592.61 |
| 13 | 24-Jul-2015 | Satisfactory | Satisfactory | 677.61 |
| 14 | 18-Mar-2016 | Satisfactory | Satisfactory | 767.80 |
| 15 | 28-Nov-2016 | Satisfactory | Satisfactory | 786.67 |
| 16 | 07-Jun-2017 | Satisfactory | Satisfactory | 808.64 |
| 17 | 15-Dec-2017 | Satisfactory | Satisfactory | 851.21 |
| 18 | 14-Jun-2018 | Satisfactory | Satisfactory | 921.03 |
| 19 | 26-Oct-2018 | Satisfactory | Satisfactory | 1000.00 |

## SECTORS AND THEMES

### Sectors

| Major Sector/Sector | (%) |
|---|---|
| **Energy and Extractives** | **100** |
| Energy Transmission and Distribution | 100 |

### Themes

| Major Theme/ Theme (Level 2)/ Theme (Level 3) | (%) |
|---|---|
| **Private Sector Development** | **43** |
| Jobs | 33 |
| Job Creation | 33 |
| Public Private Partnerships | 10 |
| **Urban and Rural Development** | **66** |
| Urban Development | 33 |
| Urban Infrastructure and Service Delivery | 33 |
| Rural Development | 33 |
| Rural Infrastructure and service delivery | 33 |

## ADM STAFF

| Role | At Approval | At ICR |
|---|---|---|
| Regional Vice President: | Isabel M. Guerrero | Hartwig Schafer |
| Country Director: | N. Roberto Zagha | Junaid Kamal Ahmad |
| Director: | John Henry Stein | Guangzhe Chen |
| Practice Manager: | Salman Zaheer | Demetrios Papathanasiou |
| Task Team Leader(s): | Julia M. Fraser, Gevorg Sargsyan | Surbhi Goyal, Debabrata Chattopadhyay |
| ICR Contributing Author: | | Ahmed El-Hamri |

# I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

## A. CONTEXT AT APPRAISAL

### Context

1. **Country background.** India's gross domestic product (GDP) growth has slowed in the past three years. Growth has moderated from an average of 7.4 percent during FY2016–FY2019 to an estimated 4.2 percent in FY2019/20. The growth deceleration was due mostly to unresolved domestic issues (impaired balance sheets in the banking and corporate sectors), which were compounded by stress in the nonbanking segment of the financial sector and a marked decline in consumption on the back of weak rural income growth.

2. Since the 2000s, India has made remarkable progress in reducing absolute poverty. Between FY2012 and FY2015, poverty declined from 21.6 percent to an estimated 13.4 percent at the international poverty line (US$1.90 per person per day in 2011 purchasing power parity [PPP]), continuing the earlier trend of rapid poverty reduction. Owing to robust economic growth, more than 90 million people escaped extreme poverty and improved their living standards during this period. Despite this success, poverty remains widespread. In 2015, 176 million Indians were living in extreme poverty, while 659 million—half the population—were below the higher poverty line commonly used for lower-middle-income countries (US$3.20 per person per day in 2011 PPP).

3. **Sector background.** The actual electricity generation for FY2010 was 771.2 billion units (BU) representing a rate of growth of around 6.6 percent over actual generation of 723.8 BU for the previous year (FY2009).[1] A higher growth rate would have been recorded, but there were challenges such as delays in synchronization of new generating units, long duration of forced outages of some of the existing thermal units, inadequate availability of coal, and insufficient rainfall in the catchment areas of the reservoirs of hydropower stations. At appraisal, in 2009, India's investments in the transmission sector were focused on improving the performance of the existing network as well as providing the much-needed capacity to transfer electricity from surplus regions to deficit ones. Majority of such investments were coming through the Power Grid Corporation of India Limited (POWERGRID), the Central Transmission Utility of the country, which was the borrower as well as the project implementing agency for the World Bank's project. The proposed schemes were conceived by POWERGRID to further this agenda and increase its electricity transmission capacity.

4. As completed projects came online and allowed POWERGRID to increase its electricity transmission capacity, there still was a deficit of 12.7 percent between peak demand and peak consumption met. India's exploitable energy resources were concentrated in certain pockets because some regions did not have adequate natural resources for electricity plants to meet demand whereas others had abundant natural resources. Therefore, POWERGRID embarked on a strategy to develop a national transmission grid so that it could transport power from resource-rich to deficit areas as well as to facilitate scheduled/unscheduled exchange of power. Furthermore, challenges with regard to the

[1] See Operation Performance of Generating Stations in the Country during the Year 2009-10: An Overview, Table 1 by the Central Electricity Authority (CEA).

availability of right-of-way (ROW) for constructing a transmission system led to the creation of high capacity 'transmission highways'. The objective was to avoid such constraints to become a bottleneck in successful harnessing of natural resources that would necessitate strengthening of the transmission network in future. A perspective transmission plan was put in place for strengthening the regional grids and enhancing the interregional power transfer capacity of the National Grid. By November 30, 2009, about 20,800 Megawatts (MW) of interregional power transfer capacity of the National Grid had been established.

5. Over time, POWERGRID has emerged as a globally recognized transmission utility through consistently improving upon its institutional capacity across technical, procurement, social, environment, and financial management aspects. POWERGRID now operates one of the largest transmission networks in the world and is sharing its expertise through international consulting and construction services for transmission projects in South Asia (Afghanistan, Nepal, and Sri Lanka) and in Africa (Kenya and Nigeria).

6. The World Bank Group's programmatic lending support to POWERGRID has led to the development of high-capacity transmission corridors which contributed toward increased interregional capacity of the National Grid from 1,500 MW in 1999 to 9,500 MW in 2006 and, correspondingly, significantly expanded the network of transmission lines from 35,119 circuit kilometer (ckm) to 55,121 ckm. In 2006, at the time of the Third Power System Development Project (PSDP III) preparation, the interregional transmission capacity facilitated energy exchange of almost 35 BU across India, with 20 BU or 57 percent being transferred through three interregional lines financed by the World Bank (Second Power System Development Project [PSDP II]). This is equivalent to offsetting the need for 6,800 MW of new generation capacity.

7. During 2009–2019, the energy sector has experienced impressive growth and improvements.[2] Through a major national program, electricity access has been expanded to nearly every household, from only 56 percent of households in 2001, but reliable electricity supply remains a major barrier to development of industry and business. Energy demand in India is expected to grow faster than in any other country in the world over the medium to long term. In this context, the power transmission sector in India acted as a link in supplying electricity to the end consumers. The Fifth Power System Development Project (PSDP V) is part of a series of investments that focused on delivering electricity to all parts of India. Therefore, transmission planning has become a continuous process of identification of transmission system addition requirements and their timing. These transmission requirements are due to (a) new generation additions in the system, (b) increase in demand, and (c) system strengthening that is necessary to achieve reliability as per the planning criteria under continuously evolving load generation scenario.

8. **The World Bank's rationale and alignment with the Country Strategy (CAS)[3].** The 2009–2012 CAS did include policies that were formulated to support the country's ambition to increase GDP growth (specifically to absorb the decline of growth during 2007–2009) as well as to allow investments to improve infrastructure for India's energy production capacity and expansion of the national transmission system.

[2] See the Annual Report 2018–2019 of the Ministry of Power (MoP). Average peak deficit and energy deficit stood at 11.9 percent and 11 percent, respectively, in 2008/09, while the same numbers stood at 0.8 percent and 0.6 percent, respectively, in 2018/19. Further, it is noted that as of March 2020, India is the third largest producer of electricity at 370 gigawatts (GW) (https://pib.gov.in/Pressreleaseshare.aspx?PRID=1607174 and CEA's http://www.cea.nic.in/reports/monthly/executivesummary/2020/exe_summary-03.pdf).

[3] Report No. 46509-IN

The objectives under Pillar I (Cluster A - Making growth inclusive and Cluster B - Bridging the infrastructure gap) of the CAS did incorporate investments in energy infrastructure to improve access to electricity by the suburban and the rural population and provide the business sector adequate energy. Furthermore, all policy actions contained in the India's 12th five-year plan (2012–2017) have also stressed the need for positive transformation in the power sector in tandem with higher rates of GDP growth. These were also included in the 2013–2017 Country Partnership Strategy (CPS)[4] which was closely aligned with India's development vision for 2030. It is this framework that has established a continuous process of transmission value chain development focusing on the provision of 24×7 electricity supply.

**Box 1. Impact of COVID-19**

Against this backdrop, the outbreak of the coronavirus disease 2019 (COVID-19) and the public health responses adopted to counter it have significantly altered the growth trajectory of the economy, which is now expected to contract in FY2021. On the fiscal side, the general government deficit is expected to widen significantly to over 10 percent of GDP in FY2021, owing to weak activity and revenues as well as higher spending needs. However, the current account balance is expected to improve in FY2021, reflecting mostly a sizeable contraction in imports and a large decline in oil prices. Given this, India's foreign exchange reserves are expected to remain comfortable (equivalent to over 10 months of imports). COVID-19 is likely to further moderate the rate of poverty reduction and risks people falling back into poverty. The poorest households are also more vulnerable to the threat of contagion, as they are more likely to live and work in conditions where social distancing is difficult and are likely to spend a greater share of their budget on out-of-pocket health care expenditures if they fall sick. Government schemes to increase food allocations under the public distribution system and income support through direct transfers, social pensions, and rural workfare programs are likely to contain these impacts to an extent.

**Theory of Change (Results Chain)**

9. The transmission sector has been expanding exponentially for more than the past two decades and going through a transformation process that has contributed toward establishing a robust structure for its reliable operations. The elements of this structure included a dynamic operational infrastructure that relied on the building and expansion of assets ranging from the grid network to operational technologies used to deliver electricity and the managerial framework needed to ensure its financial and economic profitability. It is the existence of this structure that has led to its sustained development. The sector's evolvement required that investments be made on existing and new lines to link regions using innovative and adequate technologies to ensure a sustained transmission capacity.[5] Technological developments for transmission lines using high-voltage direct current (HVDC), especially higher voltage ratings of 765 kilovolts (kV) and above, are considered of great relevance to reduce land requirement and transmission losses. More emphasis was also placed on the use of gas insulated substations (GIS) which need only approximately 35 percent of the space required for conventional air insulated substations (AIS). All of this was done to adopt more innovative technologies with reduced environmental impact by these grid assets. With advancement of technologies in transmission, there was a need to supplement public investment by private investment and the 11$^{th}$ five-year plan charted the path for the same.

10. The Project Development Objective (PDO) was defined within a context of implementing physical components to generate the much-needed output in terms of growth in power exchange between and

[4] Report No. 76176-IN
[5] See India's 12th Five-Year Plan by the Government of India (GOI)'s Planning Commission.

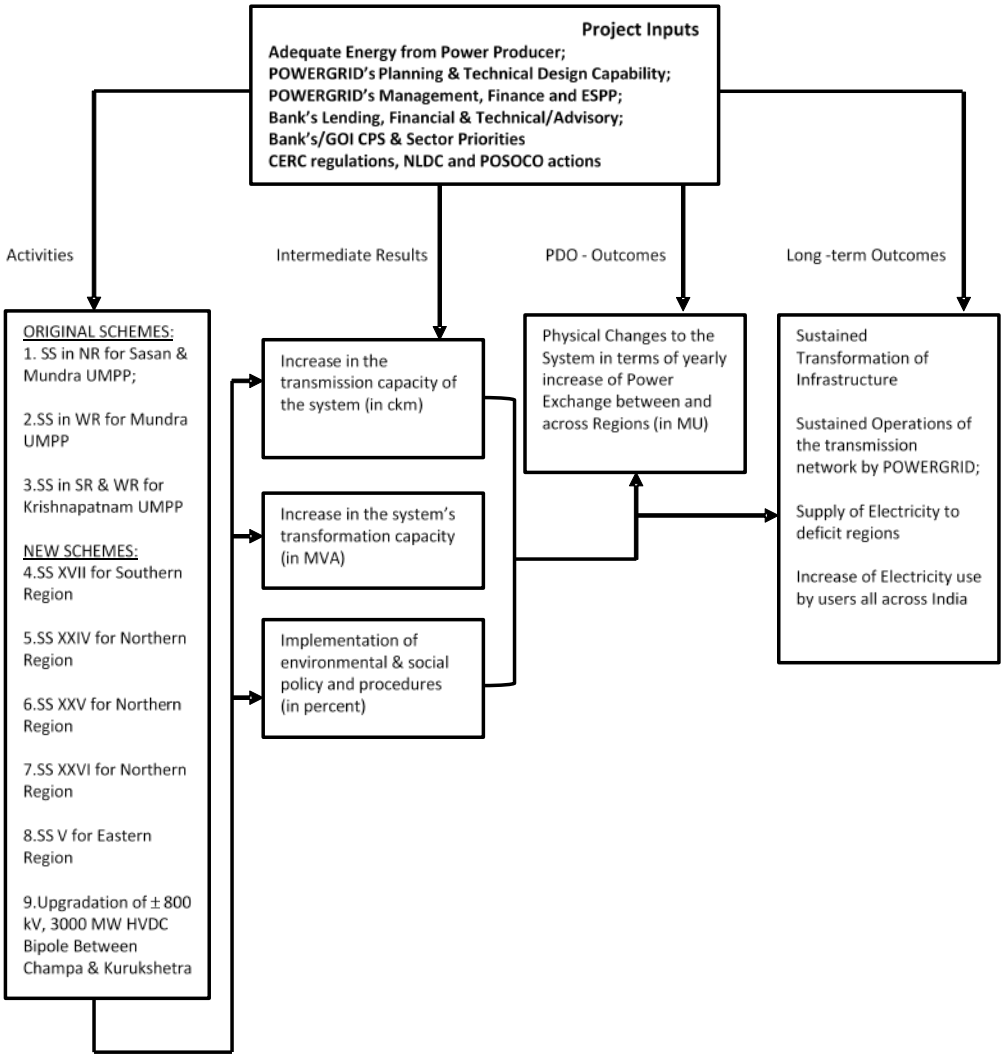
across regions, and the physical transformation needed by the system in place. This consisted of investments in nine transmission schemes to allow transfer of energy and the key changes in terms of (a) the growth in power exchange between regions in million units (MUs), (b) an increase in the transmission capacity in ckm, and (c) an increase in the transformation capacity in megavolt amperes (MVA).

11. In 2009, the National Load Dispatch Center (NLDC) began supervising regional load dispatch centers, scheduling and dispatching electricity, and monitoring operations of the National Grid. By the end of 2013, each of the country's five regional grids was interconnected to operate at a synchronous frequency to more efficiently transfer power from generation sources to load centers. India has also more than doubled the length and capacity of its high-capacity HVDC lines (such system improvements have taken place since 2002), as these lines experience reduced losses over long distances than alternating current (AC) lines. The synchronous grid also played an important role in maintaining grid stability during the 'Lights-Out' event in the country on April 5, 2020.

12. **Inputs leading to the Results Chain.** The inputs/conditions for the Theory of Change are (a) the existing sectoral structure, namely, POWERGRID and its capabilities, (b) the investments made throughout the project, and (c) the available financing (the World Bank, POWERGRID, and the GOI).

13. The PDO (and the key outcome indicator) is expressed as quantitative physical changes to the system in terms of yearly increase of power exchange between and across regions (in MU). The Results Chain implies that longer-term outcomes are expected to occur beyond the project's closing. It addresses the project's contribution toward POWERGRID's higher-level objectives for the sector. The Results Chain also identifies any critical assumptions and external factors that might affect or contribute to the outcomes (see figure 1). The sector's capabilities and POWERGRID's unique capacities (technical, managerial, and financial) were paramount to the continued sustainability of the project's capacity to strengthen the transmission system in the power-deficit regions and increase in interregional transmission capacity. POWERGRID has been able to maintain availability of its system more than 99 percent for past many years ensuring sustainability of the investments made.

**Figure 1. Theory of Change (Results Chain)**




*Note:* CERC = Central Electricity Regulatory Commission; ESPP = Environment and Social Policy and Procedures; NR = Northern Region; POSOCO = Power System Operation Corporation Limited; SR = Southern Region; SS = System Strengthening; UMPP = Ultra Mega Power Plant; WR = Western Region.

**Project Development Objective (PDO)**

14. The PDO is 'to strengthen India's electricity transmission system in order to increase reliable power exchange between regions and states. The project has successfully achieved its objectives. The exchange of electricity is sustained by a well-designed national transmission grid that has been expanded by the project's schemes.

**Key Expected Outcomes and Outcome Indicators**

15. To achieve the PDO, the project aimed at strengthening the transmission system in the power-deficit regions and increase interregional transmission capacity. The key outcome indicator to measure performance in achieving the development objective was growth in the power exchange between the regions (measured in MU). Since PSDP III, this power exchange increased by six times from about 31,000 MU in FY2005 to over 181,000 MU in FY2019.

**Components**

16. The project consisted of only one component: transmission system strengthening, comprising five regional schemes, which after restructuring increased to nine schemes, for strengthening of the transmission system and/or facilitating interregional power exchange for the National Grid. The project included planning, design, engineering, procurement, and implementation of these schemes. POWERGRID selected the least-cost technical and economic option among the various alternatives studied for each of the investment schemes (see annex 7 for detailed description of the schemes).

17. **Transmission system strengthening in the WR for Sasan UMPP.** The objectives of this scheme were to (a) provide adequate transmission system for reliable transfer of power to constituents of the WR, (b) help maintain system stability and security of the combined grid under all operating conditions, and (c) increase the power transmission capacity of the National Grid. Estimated cost was US$200 million.

18. **Transmission system strengthening in the NR for Sasan and Mundra UMPPs.** The objectives of this scheme were to (a) provide an adequate transmission network to distribute power to the bulk consumption points and major load centers with reliability and security and (b) increase the transformation capacity at various substations along with interconnecting links in the NR. Estimated cost was US$282 million.

19. **Transmission system strengthening in the WR for Mundra UMPP.** The objectives of this system were to (a) provide adequate transmission system for reliable transfer of power to constituents of the WR, (b) help maintain system stability and security of the combined grid (comprising the WR, NR, Eastern Region [ER], and North Eastern Region [NER]) under all operating conditions, and (c) increase the power transmission capacity of the National Grid. Estimated cost was US$366 million.

20. **Transmission system strengthening in the SR and WR for Krishnapatnam UMPP.** The objectives of the scheme were to (a) enhance interregional transmission capacity to export surplus power of the SR, (b) strengthen the transmission system in the SR and WR for reliable transfer of power, and (c) help reduce transmission losses. Estimated cost was US$538 million.

21. **Transmission system for South-West Interconnector.** The objective of this scheme was to enhance the interregional power transfer capacity between the SR and WR by 1,000 MW, thereby utilizing the surplus power in the SR to be transferred to the power-deficit WR. Estimated cost was US$176 million.

## B. SIGNIFICANT CHANGES DURING IMPLEMENTATION (IF APPLICABLE)

**Revised PDOs and Outcome Targets**

22. The PDO for the project was not revised.

**Revised PDO Indicators**

23. In May 2014, the project underwent a restructuring to utilize about US$433 million, which was triggered by significant cost savings resulting from the combined effects of a highly competitive market, the continuing devaluation of the Indian rupee against the US dollar since the loan approval, the withdrawal of one of the schemes on technical grounds (South-West Interconnector), revision in design of one of the other schemes (system strengthening in the SR for Krishnapatnam UMPP) due to delayed generation project, and the financial regulatory requirements to maintain a debt-equity ratio at 70:30 for all the schemes financed by POWERGRID. Given this, the restructuring led to (a) inclusion of four new schemes, (b) extension of current loan closing date by 23 months, and (c) swapping of schemes between PSDP V and Additional Financing to Fourth PSDP (PSDP IV AF) to also allow full utilization of the funds available under the latter project (mapped near completion scheme under PSDP V to PSDP IV AF).

24. This change was reflected in the amended Loan Agreement that finally consisted of the construction of the transmission schemes as listed below. Refer to annex 3 for original and estimated cost for these nine schemes:

(a) System strengthening in the NR for Sasan and Mundra UMPP (NR for Sasan and Mundra) (original)

(b) System strengthening in the WR for Mundra UMPP (WR for Mundra) (original)

(c) System strengthening in the SR and WR for Krishnapatnam UMPP (SR and WR for Krishnapatnam) (original)

(d) SR system strengthening XVII (SRSS 17) for improving the synchronous connection between the SR and the rest of the National Grid (partly shifted from PSDP IV AF)

(e) NR system strengthening XXIV (NRSS 24) for reliable transfer of power to various load centers in this region (shifted from PSDP IV AF[6])

(f) NR system strengthening XXV (NRSS 25) for transfer of power from power plants, mostly in ER, via WR to NR (new)

[6] As per the restructuring request from the Department of Economic Affairs, the proposal was to include two schemes—NRSS 24 and NRSS 26—under PSDP IV AF, but since the commissioning schedule of the two schemes proposed in the restructuring request was going beyond the loan closing date of PSDP IV AF (July 2014), these two schemes were added under PSDP V. This was possible only after moving another scheme (system strengthening in WR for Sasan UMPP) that was originally envisioned under PSDP V to PSDP IV AF, taking advantage of the portfolio approach.

(g) NR system strengthening XXVI (NRSS 26) for transfer of power from hydro projects within NR and other plants in ER to NR (new)

(h) ER system strengthening V (ERSS V) (new)

(i) Upgrading the transmission capacity of the HVDC bipole line between Champa (Chhattisgarh) and Kurukshetra (Haryana) up to 6,000 MW (Champa-Kurukshetra) (new).

25. **There was no change to the PDO, but the key performance indicators (KPIs) were revised** to consider the commissioning and the operational performance of the new schemes as well as the closing date of the project that was extended from June 30, 2015, to May 31, 2017, and then to May 31, 2019, through second restructuring in May 2017. As such the KPIs for the main component of the restructured project were defined as follows (tables 1 to 5).

**Table 1. Growth in Power Exchange between and across Regions (MU, thousands)**

| | Baseline | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 46.0 | 50.0 | 52.0 | 54.0 | 56.0 | 68.0 | 70.0 | 72.0 | 75.0 | 140.0 | 150.0 |
| Actual | | 52.4 | 56.7 | 59.0 | 65.9 | 78.4 | 84.4 | 117.0 | 138.1 | 150.0 | 181.7 |

**Table 2. Growth in Transmission Capacity (ckm, thousands)**

| | Baseline | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 71.4 | 80.0 | 84.0 | 88.0 | 91.0 | 107.0 | 114.0 | 121.0 | 125.0 | 144.0 | 150.0 |
| Actual | | 75.0 | 82.4 | 93.0 | 100.2 | 106.8 | 115.6 | 129.4 | 139.1 | 148.1 | 153.1 |

**Table 3. Growth in Transformation Capacity (MVA, thousands)**

| | Baseline | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 79.5 | 82.0 | 85.0 | 88.0 | 90.0 | 185.0 | 200.0 | 215.0 | 222.0 | 300.0 | 320.0 |
| Actual | | 83.0 | 93.1 | 124.5 | 164.8 | 205.9 | 231.7 | 254.8 | 289.5 | 331.6 | 365.3 |

**Table 4. Social - Percent of Project-affected Persons (PAPs) Rehabilitated**

| | Baseline | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 0 | 5.0 | 85.0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Actual | | 2.8 | 70.3 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 5. Environment - Cumulative Transmission Capacity (MW) Per Meter Width of ROW within Forest Areas**

| | Baseline | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 18.6 | 19.5 | 20.0 | 20.5 | 21.0 | 21.25 | 21.5 | 21.5 | 21.7 | 24.9 | 25.2 |
| Actual | | 19.5 | 20.9 | 20.5 | 21.0 | 22.2 | 23.1 | 23.9 | 24.6 | 25.1 | 25.6 |

**Revised Components**

26. There was no change in the project components.

**Other Changes**

27. None.

**Rationale for Changes and Their Implication on the Original Theory of Change**

28. Since there was no change in the PDO and monitoring of the KPIs due to the above two restructurings, there was no change in the 'Theory of Change'.

## II. OUTCOME

### A. RELEVANCE OF PDOs

**Assessment of Relevance of PDOs and Rating**

29. **Relevance of objectives, design, and implementation.** The PDO is 'highly' relevant to the priorities of POWERGRID, the MoP, the GOI and its agencies, the generators/power producers, and the states.

30. **World Bank support.** The World Bank's support for this project was highly relevant and the PDO reflects the importance of achieving further expansion and transformation in India's power sector infrastructure. As in the PSDP series of projects, this project's design continued to reflect sector priorities and focused on the need for more investments in transmission to successfully transmit the power generated (by large-scale generation capacity infusion planned in the country) from surplus to deficit regions and hence optimally utilizing the available limited resources. In partnership with POWERGRID, a key participant in several sector reform initiatives in India, the World Bank has been able to design, implement, and adapt a project, among many, that ensures the funding of much-needed physical investments in parallel with institutional transformation. This has become even more important with synchronization of the SR grid with the rest of the grid to make it truly one National Grid. The PSDP series spread over two decades reiterates the commitments of the GOI and POWERGRID to achieve long-term sustainability of the National Grid as they have continuously invested in the upgrading of the transmission infrastructure and connecting the regions.

(a) Table 6 reflects the sector diagnostic showing that there was an annual congestion in the power exchange from FY2010 to FY2017. Although power curtailment caused by transmission constraints has gradually declined since FY2015, a significant amount of electricity continues to be lost to congestion in the electric network. Such bottlenecks occurred in many regions including the NR and SR. Further increase in transmission capacity would have helped remove congestion in the network.

**Table 6. Transmission Congestion Hinders the Evacuation of Power in India**

| FY | Unconstrained Power Transaction (TWh) | Actual Power Transaction (TWh) | Unsold Electricity Because of Congestion (TWh) | Share of Unsold Electricity in Unconstrained Power Transaction (%) |
|---|---|---|---|---|
| 2010 | 8.10 | 7.08 | 1.01 | 12.50 |
| 2011 | 14.26 | 13.54 | 0.72 | 5.00 |
| 2012 | 17.08 | 14.83 | 2.25 | 13.20 |
| 2013 | 27.67 | 23.02 | 4.65 | 16.80 |
| 2014 | 35.62 | 30.03 | 5.59 | 15.70 |
| 2015 | 31.61 | 28.46 | 3.14 | 9.90 |
| 2016 | 36.36 | 34.20 | 2.16 | 5.90 |
| 2017 | 41.60 | 40.08 | 1.52 | 3.70 |

*Source:* CERC report (2017);
*Note:* TWh = Terawatt-hours.

(b) Analytically, this project was linked to a long-term strategy aiming at strengthening and expanding the national transmission network. Its design was based on the achievements of previous investments in the sector and according to the policy framework of the GOI and POWERGRID. The Results Chain clearly demonstrates the underlying strategy of the sector as well as the links between the investments and the results on the ground. The PDO was defined as the strengthening of the transmission system to address the existing imbalance between supply and demand of energy. As such, the PDO was highly relevant under the objectives and investment priorities of the 11th and the 12th five-year plans. Investment programs were considered as platforms for economic growth and social development. The energy transmission sector needed to expand its infrastructure to supply the needed energy to people who were not connected to the National Grid and those who faced frequent disruptions.

(c) **A Project Review was held on March 17, 2009 and corroborated the PDO.** This review agreed on issues associated with the design of the project including the PDO, the KPI, the inclusion of pilot schemes of 1,200 kV towers, the project's economic justification, and the financing alternatives. This review also approved the Use of Country Systems (UCS) as well as POWERGRID's capability in managing the implementation of the project through timely compliance of the respective project (or scheme) implementation plans (PIP). The project did not carry any specific technical risks, given that POWERGRID had demonstrated capabilities in transmission system development and mostly use of proven technologies as demonstrated during the entire PSDP series.

(d) **KPIs were defined to focus on the expected improvements resulting from the investment.** The aggregated indicators do reflect the contribution of each scheme financed under the loan, especially after restructuring extended the project from five to nine schemes. The resulting structural transformation of the transmission system is sustained through efficient operations of the infrastructure by POWERGRID.

## B. ACHIEVEMENT OF PDOs (EFFICACY)

### Assessment of Achievement of the Objective/Outcome

31. **Completion of project schemes (transmission system strengthening).** All the packages under all the schemes have been awarded and the entire loan has been disbursed. Of the nine schemes, the following eight have been commissioned:

(a) NR for Sasan and Mundra (January 2017)

(b) SR and WR for Krishnapatnam (April 2016)

(c) SRSS 17 (December 2015)

(d) NRSS 25 (October 2016)

(e) NRSS 26 (May 2015)

(f) NRSS 24 (March 2018)

(g) Champa-Kurukshetra (March 2020)

(h) ERSS V (July 2020)

32. **One last scheme is targeted for commissioning by September 2020.** The scheme on 'system strengthening WR for Mundra UMPP', which pertains to 1,200 kV transmission system, is facing challenges in terms of availability of skilled manpower to handle construction of the transmission system at such a high voltage, which is the highest and the first of its kind in the world. Further, the scheme is also facing severe ROW issues for past many years. With the recent COVID-19 outbreak, the movement of labor and equipment has further delayed the commissioning of the scheme and is not expected to be completed before September 2020. However, POWERGRID will continue to supervise and later operate it in a manner that is satisfactory to the GOI and the World Bank. POWERGRID will continue to report on the progress of this scheme till its commissioned. It is also pertinent to mention that one scheme 'SR System Strengthening XIII (SRSS 13)' stood incomplete at the time of the closing of PSDP IV AF due to severe ROW issues, and hence it was agreed that the monitoring of the progress of its physical implementation would be continued under PSDP V. After persistent efforts by POWERGRID and close coordination with the local authorities, this scheme was commissioned in January 2020.

33. **Quantitative target achievements.** As noted in the previous projects, POWERGRID continued to achieve and in fact surpassed the KPI targets planned at appraisal of PSDP V as well. As POWERGRID continues to display a strong operational performance, the PDO indicator (inter-regional power exchange) and all other KPIs have outperformed their end-of-the-year targets for 2010–2019. A growth of about 135,717 MU (294.86 percent) in power exchange across regions has been observed in comparison to a baseline FY2009 of 46,027 MU. It is to be noted that the PDO indicator has outperformed the target for FY2019 by 21.16 percent (see table 7).

**Table 7. KPIs for FY2009 (Baseline) and FY2019 (End of Project)**

| Indicator | Units | Baseline (FY2009[a]) | FY2019 | |
|---|---|---|---|---|
| | | Actual | Target | Actual |
| Inter-regional power exchange | MU | 46,027 | 150,000 | 181,744 |
| Transmission capacity | ckm | 71,447 | 150,000 | 153,128 |
| Transformation capacity | MVA | 79,522 | 320,000 | 366,097 |
| Percent of PAPs rehabilitated | percent | 0[b] | 100 | 100 |
| Cumulative transmission capacity per meter width of ROW within forest areas[c] | MW/meter | 18.6 | 25.2 | 25.64 |

*Source:* Implementation Support Mission Aide Memoire May 2019.
*Note:* a. Fiscal year here is POWERGRID's fiscal year ending on March 31.
b. No involuntary land acquisition was involved, and land purchased was only on the 'willing buyer, willing seller' basis.
c. Indicator has been calculated considering 2004–2005 as a base year.

34. **Expansion in transmission capacity.** Achievements in this capacity have been surpassed and have thrusted POWERGRID to own and operate about 153,074 ckm of extra high voltage (EHV) transmission lines (March 2019). An addition of about 81,624 ckm (114.24 percent) has been achieved in transmission capacity with respect to baseline FY2009 of 71,447 ckm. Furthermore, transmission lines covered under the PSDP V loan has contributed about 4,100 ckm of 765 kV and 400 kV lines toward transmission capacity addition, which makes the contribution from this loan about 5 percent of such total capacity added since the baseline year (FY2009). All these accomplishments have ensured the sector to sustain a strong national transmission grid.

35. **Growth in transformation capacity.** Transformation capacity of POWERGRID's network is about 365,074 MVA. An addition of about 285,552 MVA (359.08 percent) has been achieved in transformation capacity with respect to baseline FY2009 of 79,522 MVA. Under the PSDP V loan, about 8,000 MVA transformation capacity has been added, which is about 2.8 percent of such total capacity added since the baseline year (FY2009).

36. Beyond the project and the above KPIs, POWERGRID has continued to expand and has brought advanced technologies to the sector. Some of POWERGRID's such achievements are as follows:

(a) In 2014, POWERGRID developed a smart grid pilot project in the country through open collaboration at Puducherry where it was an adviser-cum-consultant for implementation of such a pilot.

(b) With the vision of setting up a world class laboratory for carrying out research and development in power transmission, POWERGRID has established POWERGRID Advanced Research and Technology Center at Manesar, Gurgaon, with sophisticated laboratories for power system analysis, advanced equipment diagnostics, smart grid in transmission and distribution, energy efficiency, power system control and automation, material science, and engineering design.

(c) Further, POWERGRID is also establishing a transmission line research lab to carry out validation of transmission line design and subsequent optimization. In the quest to achieve

fully digitized substations, POWERGRID is in the process of introducing process bus technology for substations.

(d) POWERGRID is playing a catalyst role in the formation of the South Asian Association for Regional Cooperation grid for effective utilization of resources for mutual benefits. Transmission links with Bhutan, Nepal, and Bangladesh already exist and are being further strengthened.

(e) POWERGRID is in the process of mapping pollution intensity of various regions of the country on a geographical map. This activity shall enable efficient and effective transmission line designs, particularly in high-pollution and fog-affected areas.

(f) POWERGRID diversified into the telecom business under the brand name 'POWERTEL' to expand its revenue stream by installing overhead optic fiber network using optical ground wire, leveraging its existing countrywide transmission infrastructure.

**Justification of Overall Efficacy Rating**

37. **Rating the relevance of the PDO.** The assessment of the relevance of the PDO is High as there were no deficiencies in the manner the PDO was determined in relation to India's CPS. Thus, the project and its subsequent design change provided clear evidence of the alignment of the PDO with the CPS' objectives.

38. **Efficacy of the PDO.** The efficacy of the PDO is rated High. The project's long-term development impact and efficacy are demonstrated by the achievements realized through completion of all but one scheme. Nevertheless, the project's long-term development impact and efficacy are demonstrated by the project's success in surpassing the physical targets and delivering the required transmission infrastructure. The results reflect that the transformation of the transmission sector led by advanced technologies is highly sustainable. The inclusion of energy production from generation projects in energy-surplus regions demonstrates that electricity transmission investments will continue to contribute to the overall system reliability. Further, it must also be noted that increasing interregional transfers is not an end but serves the purpose of improving the security, reliability, and efficiency of power supply and resource use in the country. This is reflected in the reduction in energy demand and peak demand numbers in recent years (as noted in footnote 2).

## C. EFFICIENCY

**Assessment of Efficiency and Rating**

39. **Economic analysis of investment schemes.** As per the Project Appraisal Document (PAD)/PIP methodology, economic benefits from reduced transmission losses (derived from load flow studies) for six schemes[7] have been valued at the opportunity cost of the energy saved (the average cost of alternate supply from thermal generation). For two schemes (SRSS 17 and Champa-Kurukshetra), economic benefits from the transfer of power among regions have been considered based on the difference between the

[7] The six schemes are (a) NR for Sasan and Mundra, (b) SR and WR for Krishnapatnam, (c) NRSS 24, (d) NRSS 25, (e) NRSS 26, and (f) WR for Mundra.

cost of generation in the two regions. For the ERSS V scheme, economic benefits include (a) the avoided cost of localized oil fuel-based generation through the supply of secured power from the grid and (b) reduced transmission losses valued at the average cost of alternate supply from thermal generation. In addition, the results for a tenth scheme (SRSS 13)[8] are also presented here. As mentioned above, this scheme was originally funded under the closed PSDP IV AF loan but was still under implementation at the time of preparation of its Implementation Completion and Results (ICR) Report. The economic rate of return (ERR) for the schemes identified in the PAD (for original schemes) and the Restructuring Paper (for new schemes) varied between 13.2 percent and 25.7 percent in the base case while it ranged from 9.5 percent to 17.8 percent in the worst case. The base case ERRs were higher than the opportunity cost of capital of 12 percent.

40. Using the same methodology as at appraisal, actual cost figures, economic benefits at updated values, and applicable tariffs, the ERR estimates after project completion were calculated. The ERR varies between 8.09 percent (for WR for Mundra, which is still under construction) and 15.06 percent (for SR and WR for Krishnapatnam). In all cases, except for SRSS 17 and SR and WR for Krishnapatnam, the ERR is below the opportunity cost of capital of 12 percent. The main reason was for low figures is delays in commissioning of most of these schemes due to ROW issues that became acute in the last decade that led to issuance of 'Guidelines for payment of compensation towards damages in regard to ROW for transmission lines'[9] by MoP in 2015.

41. **Financial analysis of investment schemes.** The return on equity (RoE) has been taken as a proxy for the financial rate of return as was taken during the appraisal. The same methodology as during appraisal was adopted to calculate the RoE at completion. The RoE for the schemes identified in the PAD and the Restructuring Paper varied between 15.7 percent and 22.5 percent in the base case while it ranged from 11.4 percent to 17.1 percent in the worst case. The RoE at completion varies between 10.16 percent (for WR for Mundra) and 21.22 percent (for SRSS 17).

42. Financial analysis was also carried out at an entity level and it was observed that all the financial ratios (presented in annex 4) are robust during the project implementation period (2009–2019). POWERGRID continues to comfortably comply with all the financial and legal covenants—debt-equity ratio was always less than 80:20, self-financing ratio was always greater than 20 percent, and accounts receivable over the project life were also always lower than three months of billing.

43. The efficiency rating is Substantial given that such results are expected in an operations sector, especially infrastructure projects that are linear in nature and traverse through large land areas. Project operations after completion will confirm the profitability in the schemes of the investments. Continuity of efficient operations by POWERGRID should be ensured by its financial and technical management system.

## D. JUSTIFICATION OF OVERALL OUTCOME RATING

44. The overall outcome rating of the project is Satisfactory on the basis of its high relevance to the sector's objectives and achievement of its physical targets as well as the relative efficiency in the

[8] With economic benefits from reduced transmission losses (derived from load flow studies) valued at the opportunity cost of the energy saved (the average cost of alternate supply from thermal generation), as per the PIP methodology.
[9] See: https://powermin.nic.in/sites/default/files/uploads/RoW_Guidelines_15102015.pdf

implementation process. In addition, POWERGRID's performance has significantly improved as it took on the transmission operations of new and upgraded infrastructure over the past two decades. It has strengthened its technical, managerial, and institutional capacities further over the time. Apart from building on the PSDP series, it is further noted that POWERGRID has also established a National Transmission Asset Monitoring Center at Manesar, Gurgaon, to allow remote monitoring of most of its substations. This really helped POWERGRID during the COVID-19 pandemic as well. Further, POWERGRID has developed a smart grid throughout India. It set up a world-class laboratory for carrying out research and development in power transmission at Manesar, Gurgaon. These transformations and achievements have helped POWERGRID improve its performance over the time. The Satisfactory rating is also justified by the sustainability of the project components. In the coming years, POWERGRID's role will become more important with further development of the electricity trading market as the transmission schemes financed by this loan as well as by the previous loans will enable transfer of large quantities of power across and between the regions of the country.

## E. OTHER OUTCOMES AND IMPACTS (IF ANY)

### Gender

45. Development and strengthening of the National Grid, including under PSDP V, through reliable and stable operation of regional grids facilitates the timely transfer of power from surplus regions to deficit regions leading to optimal utilization of scarce energy resources. This is also reflected in the decline in average peak deficit and energy deficit (see footnote 2) implying an increase in the availability of electricity to the Indian people, especially in regions where power availability has been constrained by the lack of adequate transmission systems. Although POWERGRID's network does not link directly to the end consumer, it facilitates power evacuation from central sector generating stations and interregional power exchange, resulting in increased availability to and access to reliable electricity by the connected consumers. Furthermore, corporate social responsibility (CSR) activities of POWERGRID are continuously focused toward initiatives that promote inclusive growth and address the basic needs of the underprivileged and weaker sections of the society (see paragraphs 64-66 and annex 8). The impact assessment of Rehabilitation Action Plan implementation in various substation areas reflect that womenfolk of the villages were happy with the frequent health camps being organized by POWERGRID. Most of the women agreed that the project has resulted in improved living conditions such as toilet, water supply, and separate kitchen that have not only brought in safety but also given them a life of dignity. The meaningful participation of community members has been the hallmark of POWERGRID's consultation process. In all consultations, women participation is ensured so that their needs are also taken care of. This has resulted in creating infrastructure that specifically addresses the needs of women. POWERGRID's inclusion strategy aims at "inclusion of everyone and prevention of discrimination" and goes an extra mile to make workforce homogeneous and foster the culture of mutual respect. Due to locational constraints, the sector is traditionally dominated by a male working force, and therefore POWERGRID has made additional efforts to render the workplace so gender is balanced. The representation of women in POWERGRID has improved from 5.95 percent in FY2010 to 8.05 percent in FY2020. POWERGRID's 'Conduct, Discipline and Appeal Rules' have a clause against sexual harassment of women in the workplace and ensures no discrimination on the basis of gender.

**Institutional Strengthening**

46. The two-decade partnership between the World Bank and POWERGRID has led to adoption of good practices by the latter since its inception. POWERGRID's institutional and managerial capacity has been strengthened through targeted World Bank support and strengthening of internal audit department, development/implementation of an organization-wide enterprise risk management (ERM) framework, and enterprise resource planning (ERP) aimed at improving corporate governance and financial accountability. Consistent improvement on such aspects has led POWERGRID to successful listing on stock exchanges, both Indian and international. Its operational structure has been considerably strengthened through various tools and processes such as Integrated Project Management and Control Systems (IPMCS) and ERP.

47. Furthermore, its environmental responsibility has enabled POWERGRID to address any residual environmental or social impacts associated with its activities following the cardinal principles of avoidance, minimization, and mitigation as outlined in its ESPP. Additionally, it has taken a policy decision to secure land for its substations through direct purchase on a 'willing buyer, willing seller' basis on market/negotiated rate to ensure community participation and smooth implementation of the project. POWERGRID has adopted preventive measures to reduce the number of fatalities in its work areas. Such measures include the promotion of mechanization for better and safe working conditions at the site (use of tractor for final sagging not permitted now); contractual provisions (bids to be considered nonresponsive if there are two or more fatalities in the work area of the same contractor, signing of safety pact, provision of penalties if the fatality is unreported by the contractor, and so on); setting up of the Apex Safety Board headed by Chairman and Managing Director; and payment of additional compensation to the legal heirs of the victims over and above the compensation prescribed by the Employee Compensation Act.

**Mobilizing Private Sector Financing**

48. The mobilization of private sector finance has taken place mostly in the thermal and solar energy generation subsector. As the Electricity Act of 2003 put in place the mechanism to allow for such a trend, more remains to be done in the areas of electricity production, suitable tariff determination, and structural design for private sector participation. PSDP V has been designed with a view to increasing private generation so that deficit reduction can be accomplished, and electricity transmission can be increased to deficit regions. The contribution of private sector-driven, large-scale generation projects such as UMPPs has been a positive one and are being replicated now in renewable energy sector. In 2011, the GOI introduced tariff-based competitive bidding (TBCB) for all transmission projects, which was made possible only with a strong foundation of the National Grid as a backbone and strong entities such as POWERGRID. Private participation in the central transmission sector has increased from 5,220 ckm (in FY2011) to 27,796 ckm (in FY2020), an increase of more than five times. POWERGRID also now bids under TBCB route and competes with the private sector players in bagging any project. POWERGRID continues to excel over its competitors under TBCB. As on March 31, 2019, POWERGRID had secured 13 transmission projects, which is more than 30 percent of the projects floated under TBCB since January 2011 when the regime was changed from cost-plus basis to TBCB.

**Poverty Reduction and Shared Prosperity**

49. This project will increase the availability of electricity for basic uses to the Indian people and contribute to an increase in consumers' connection rate to the system, especially in regions where power availability has been constrained by the lack of adequate transmission system. CSR activities of POWERGRID are focused on initiatives that promote inclusive growth and address the basic needs of the underprivileged and weaker sections of the society. Various CSR initiatives such as improvement in facilities at public health care/educational institutions and scholarship/financial assistance to the deprived students had been undertaken for improving the quality of life of the underprivileged population. Initiatives such as installation of solar streetlights and development of sanitation and drinking water facilities, community centers, and toilets in school helped in creating a sense of security among the women and girl students. CSR skill development initiatives by imparting livelihood-oriented skill development training through the reputed institution such as Indo-German Institute for Advanced Technology and Indo Danish Tool Room helped in creating new opportunities for self-employment among unemployed youths. Confronting issues of inadequate skilled manpower in construction activities, operations and maintenance, and implementation of new technologies for overall skill development in the country, particularly in the area of power transmission line construction, POWERGRID has been conducting capacity-building programs with the help of contractors/suppliers of transmission line construction. Cumulatively, about 4,332 persons have been trained till end of March 2019 (see paragraphs 64-66 and annex 8 for further details).

**Other Unintended Outcomes and Impacts**

50. **Strengthening of system reliability**. POWERGRID's efficient operation and maintenance of transmission systems is essential to the capacity to restore power in the quickest possible time to remote areas in the event of any natural disasters such as super cyclones, floods, and so on through the deployment of emergency restoration systems.

## III. KEY FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOME

### A. KEY FACTORS DURING PREPARATION

51. Appraisal was based on the implementation and results of many preceding successful projects such as PSDP III, PSDP IV, and PSDP IV AF. Lessons from these projects were included in the appraisal process and these helped to fine-tune the design and the implementation process. The project review that was held on March 17, 2009, gave the green light to approve the PDO and the investments as well the World Bank's continued assistance to POWERGRID.

### B. KEY FACTORS DURING IMPLEMENTATION

52. Fourteen implementation support missions including a midterm review (MTR) that focused on project implementation. Beyond missions, the World Bank team conducted the visits to the sites in between, held regular meetings with POWERGRID at corporate as well as site offices, and ensured that the quarterly progress reports (QPRs) submitted by POWERGRID were exhaustive and timely. POWERGRID's technical performance during implementation was Satisfactory as demonstrated through the interventions detailed in the following paragraphs.

53. **Corrective engineering actions and restructuring.** POWERGRID had always considered the World Bank as its partner and was always willing to discuss the technical and other issues being faced during project implementation. POWERGRID has been able to deal with many constraints and challenges in the construction, operation, and maintenance of transmission systems through the design of schemes and mitigation of problems by apprehending issues linked to ROW through forests, agricultural land, urban areas, industrial establishments, and other infrastructure. The use of high-capacity power transmission corridors to provide adequate power transfer requirement and land availability and acquisition for substations were integral factors while developing the transmission network in the country.

54. POWERGRID has also been able to maintain a high level of transmission system availability through the introduction and deployment of new technologies in the Indian power system. Some of these corrective measures are the following:

(a) To achieve considerable reduction in ROW requirement per MW of power transfer, adoption of higher voltage levels (for instance, HVDC in place of high-voltage AC), specially designed towers, synchronization of HVDC bipoles, and new technologies are being adopted by POWERGRID. Such technological initiatives taken by POWERGRID also included the latest procedures and survey techniques for route design and alignment that allowed to asses ROW requirements while optimizing the cost of transmission line (which in turn is based on selection of the shortest route, optimum number of foundations based on the type of terrain/landslides/submergence/number of river-crossing/ accessibility of the site and law and order status at the site). Addressing of such aspects upfront during site selection stage often has led to avoiding environmentally sensitive areas and settlements at the execution stage.[10]

(b) POWERGRID adopted higher voltage technologies (such as 765 kV direct current (DC), ±800 kV HVDC) for bulk power transfer. This is especially important to the SR, for instance, where an ultra-high voltage (UHV) ±800 kV, 6,000 MW HVDC link between Raigarh and Pugalur is under construction. Another example is the construction of ±320 kV HVDC voltage source converter technology substation, which is being fed by a partly overhead line using narrow-based towers and partly underground to take care of ROW issues while allowing transfer of 2,000 MW power to Kerala. POWERGRID has also established a 1,200 kV UHV AC (the highest transmission voltage in the world) National Test Station at Bina using indigenously developed equipment. This has facilitated availability of UHV class equipment in India (long-term field operation and tests are being carried out for performance monitoring of 1,200 kV UHV AC equipment).

(c) Use of high-performance conductors in existing and new lines that can carry more power within the same transmission corridor while avoiding the need to create a new parallel corridor has also helped in conservation of scarce land, ROW, and forest resources. Keeping in view these advantages, initiatives have already been taken by POWERGRID for reconductoring of some of the existing lines where power flow constraints were

[10] POWERGRID has been using modern techniques for route alignment, that is, geographic information system/global positioning system (GPS), satellite imaging, and so on, which helped in detailed mapping of ROW, ground profiling along with geographical details of the location, and site constraints.

experienced. This has resulted in the use of twin high-temperature low-sag (HTLS) conductors instead of quadruple/triple-bundle aluminum conductor steel-reinforced cables in multi-circuit stretches. Moreover, POWERGRID's selection of appropriate design of towers and its proper construction was not only important for speedy implementation of projects and safe and reliable operation of the power system but also assumed great significance in the cost of the project and conservation of ROW. A large number of tower designs (approximately 200) for different wind zones, configurations, complexities, and voltage levels have been developed in-house and successfully tested by POWERGRID toward its effort to address problems in densely populated urban areas, conservation of forest, and scarce ROW.

(d) To manage scarce land for construction of substations to avoid/minimize private land acquisition and issues related to rehabilitation and resettlement, POWERGRID has constantly upgraded and improvised by investing in new technologies. For instance, GIS requires substantially lesser land area in comparison to the conventional AIS. Furthermore, in many substations, where additional capacities (bays) had to be created, POWERGRID used hybrid technology—AIS extended with gas insulated switchgear. These designs have been implemented in Sundergarh, Muzzafarpur, Gaya, Gwalior, and Malerkotla substations.

(e) POWERGRID played an important role in simplification of forest clearance process for linear projects. Given that it was a very lengthy and cumbersome process, obtaining forest clearance has been a big challenge for timely completion of projects. However, POWERGRID's concerted efforts and many proactive decisions taken by the Ministry of Environment, Forests, and Climate Change/GOI have resulted in simplification of forest clearance process to a large extent, particularly for linear projects including transmission lines. Moreover, making forest clearance process online and time bound also helped in expediting the process by the concerned forest officials.

## IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

### A. QUALITY OF MONITORING AND EVALUATION (M&E)

**M&E Design**

55. Arrangements for M&E of the project consisted of targets that were linked to the completion of the transmission schemes and their impacts over a given time frame. The M&E framework focused on annual monitoring and regular reporting of the progress in achievement of the PDO and project outputs. The targets for completion of investment projects consisted of physical achievements as well as their impacts on the performance of the transmission system and the resulting contribution to the energy sector. In addition, and as in other proceeding projects, the design of the M&E framework was intended to provide a comprehensive view on POWERGRID's performance in every aspect. To this effect, indicators additional to KPIs and covenanted targets were also agreed upon with the World Bank to objectively measure improvements in power sector performance as well as POWERGRID's corporate performance. During the MTR of PSDP V in September 2013, the monitoring of the additional indicators at corporate as well as sectoral levels (such as employee productivity, availability of transmission system, number of

trippings per line attributable to POWERGRID, private sector participation in central transmission sector, and so on) were brought in to allay concerns linked to the slower disbursement of PSDP V. The quarterly financial monitoring report (FMR) included the detailed contracts monitoring report and physical monitoring report, which were essential for both the World Bank and POWERGRID to take corrective actions when required.

**M&E Implementation**

56. PSPD V benefitted from the M&E measures undertaken during earlier PSDP projects, and hence, data collection was in line with the PAD guidelines and the borrower's information system. The data collected for progress achieved on outcome (growth in power exchange) and outputs indicators (transmission and transformation capacities) were monitored through an agreed reporting format. The IPMCS provided POWERGRID with the capacity to carry out real-time monitoring of the physical installation of transmission lines and the NLDC provided continuous monitoring and data for power exchanges and transfers. POWERGRID established and provided the World Bank with a monthly report on billing and collection, QPRs, quarterly FMRs, annual information about progress on key entity and sectoral performance indicators, audited annual financial statements (within six months of the end of each financial year), and other information as the World Bank required. These arrangements were working in a satisfactory manner in earlier projects/loans and were continued and replicated for PSDP V as well. In addition, the World Bank team periodically conducted site visits as part of the implementation support missions as well as outside the missions, to monitor compliance with the project design with a special emphasis on environmental and social safeguards and to engage in discussions regarding benefits achieved from the investments. The World Bank team also interacted regularly with various project stakeholders including the MoP and the Ministry of Finance (MoF), which have a keen interest in seeing sustained, high performance from POWERGRID.

**M&E Utilization**

57. In addition to POWERGRID's own scoreboard that provided decision-makers with a retrospective analysis on performance and inputs for planning purposes, it produced and submitted QPRs containing M&E data to the World Bank for review every quarter. As in PSDP IV, PSDP V quarterly reports resulted in discussions on all aspects of the project ranging from procurement, engineering, safeguards, financial management, and finance. These reports also provided close monitoring of covenanted targets such as the debt-equity ratio, the self-financing ratio, and payment of arrears.

58. **Continuous implementation of the ERP system.** POWERGRID has been enhancing its operational capabilities through the deployment of an integrated ERP system. The system has been deployed to integrate processes and data pertaining to key business processes of the organization. Among others, the key objective for setting up the ERP system includes integration and standardization of various business processes and hence the flow of information. The full deployment of ERP in the organization was completed by February 2015.

**Justification of Overall Rating of Quality of M&E**

59. The overall quality of M&E is rated High. This rating is based on the systematic use by the borrower's QPR methodology that provided timely and highly relevant project data during the

implementation. The provision of continuous implementation indicators by POWERGRID in tandem with the use of ERP shows that the implementation of the project followed the World Bank's M&E conditions. Further, the rating is High because the M&E system that was put in place contributed to an efficient follow-up by the World Bank team and POWERGRID. It also helped instill a high degree of proactivity during the implementation of the project. The project contributed toward bridging the infrastructure gap and hence was in clear alignment with the World Bank's CAS/CPF.

## B. ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

60. **Environmental and social mitigation and adaptation.** In reference to its commitment to comply with such standards, POWERGRID has also been proactive in the area of environmental preservation through the adoption of new and modern technologies, which has helped the company by putting it firmly on the path of sustainable development. In addition to technologies indicated earlier, adoption of tools such as remote sensing and GPS has resulted in the selection of the most optimum route for the transmission lines, thus avoiding/minimizing environmentally sensitive areas such as forests, protected areas, important wetlands, important bird and biodiversity areas, elephant corridors, and so on. Another key initiative to reduce environment footprint includes upgrade of existing lines by reconductoring them with advanced conductors to enhance the carrying capacity of such lines. This has helped in saving a lot of forest and tree cover which might have been affected, if new lines were to be constructed for such enhanced transmission of power. Aspects linked to the environmental and social safeguards associated during PSDP V have been addressed in accordance with the corporate ESPP developed by POWERGRID in 1998 and subsequently updated in 2005 and 2009 along with active support from the World Bank. This ESPP is revised from time to time. The corporate ESPP is in compliance with the World Bank's safeguards policies and its provisions and is systematically applied to all POWERGRID projects regardless of the source of financing. The ESPP outlines POWERGRID's approach and commitment to deal with the environmental and social issues relating to its transmission schemes and lays out management procedures to address them. POWERGRID's ESPP was adopted by the World Bank as a pilot under UCS (OP 4.00) under PSDP V.

61. Pursuant to its commitment for PSDP V, POWERGRID became the first public sector undertaking in the power sector of the country to come out with a separate 'sustainability report' in 2010 following internationally accepted Global Reporting Initiative (GRI) Guidelines. Continuing its journey further, POWERGRID has been publishing sustainability reports biennially and already disclosed its fifth sustainability report covering reporting period FY2015–FY2017 in July 2018. This is the third consecutive sustainability report rated A+/Core. It has been prepared in accordance with Global Reporting Initiative (GRI-G4) Guideline and also externally assured by an accredited independent agency.

62. POWERGRID is implementing ±800 kV HVDC systems, 765 kV DC lines, and 1,200 kV UHV AC systems to minimize ROW and environmental problems. In addition, efforts are being made to switch to high-performance conductors in existing and new lines which involve lower sag as against conventional conductors at higher operating temperatures, thereby resulting in reduction of tower weight and increase in span and consequently reduction of the total steel requirement resulting in lower carbon footprint. These latest technologies will have wide influence in minimizing environmental and social impact of high-voltage transmission lines, and these initiatives will show extensive results in optimization of ROW and its associated environmental and social impact.

63. **Land requirement and resettlement and rehabilitation assistance.** PSDP V undertook substantially large-scale interventions across the country—13 large substations (7 new, 4 extensions, and 2 upgrades) involving about 1,000 acres of land and 20 transmission lines running about 7,308 ckm. One of them, Champa-Kurukshetra UHV DC, is as long as 1,288 km (2,576 ckm). Given this massive spread, requirements of the lands and the associated issues were highly varied and challenging. Hence, POWERGRID deployed several innovative social intercessions which meant redefining methods of securing of lands, interfacing with the local communities, people-friendly resettlement and rehabilitation, as well as inclusive benefit distribution. For the first time, POWERGRID successfully adopted voluntary land purchases on the 'willing buyer, willing seller' basis (in Aurangabad and Kolhapur). Several state governments and state entities have now adopted the 'willing buyer, willing seller' or 'mutually agreed land compensation' method to save time and judiciary processes. In another case of Panchkula substation, apart from the compensation amount, POWERGRID has adopted the principle of annuity, with annual increase in the amount to counter inflation, to ensure that landowners get a steady source of income on annual basis. Designing has been done such as to avoid tribal and other densely populated habitations. Consultation and consent together with transparency have remained the basic tenets in securing lands.

64. **POWERGRID's CSR initiatives.** POWERGRID developed a CSR policy enabling it to contribute to the society at large with emphasis on socioeconomic and integral development of areas/communities primarily in and around its areas of operations. CSR activities of POWERGRID are focused toward initiatives that promote inclusive growth and address the basic needs of the underprivileged and weaker sections of the society. The organization addresses the issues of community development with thrust on health, education, sanitation, skill development, infrastructure creation for rural development, environmental sustainability, and so on primarily around its areas of transmission operations. A large number of women, girls, scheduled caste/scheduled tribe/minority, and poor and marginalized section of the population were benefitted from the POWERGRID's CSR initiatives.

65. POWERGRID came out with CSR policy in 2009 that was revised in 2013 and 2014, which was subsequently amended from time to time to align it with the Department of Public Enterprises Guidelines on CSR and Sustainability and the Companies Act 2013. POWERGRID has a dedicated board-level CSR committee in line with the requirements of the Companies Act 2013. POWERGRID is required to spend 2 percent annually of the average net profit made during the last three immediately preceding financial years on CSR.[11]

66. During project implementation, POWERGRID discharged its CSR, by committing itself to contributing to the society, through initiatives that have positive impact on society at large, especially the community in the neighborhood of its operations. Confidence building measures and community development works under the umbrella of CSR has ensured smooth processes in most cases thus benefiting not just the PAPs but the entire nearby communities. Impact assessment studies carried out

[11] The focus areas of the company's CSR activities during FY2019 were education and health initiatives besides infrastructure development in rural areas such as construction of community centers, internal roads, culverts, and projects such as installation of solar streetlights, drinking water facilities, and so on. The main objective of its CSR initiatives is improvement in the quality of life of marginalized and underprivileged sections of the society residing around its areas of operation. With this approach, the company carries out various CSR activities with thrust on rural development, infrastructural development, skill development, health, education, and the environment.

indicate that the PAPs as well as the local communities have benefitted significantly relative to the pre-project situation (see annex 8 for details).

67. POWERGRID has strategies and initiatives to address global environmental issues such as climate change and it has taken various initiatives for mitigating the same to fulfill its commitment toward the goal of sustainable development and to meet the GOI's Nationally Determined Contribution (NDC) target under the Paris Agreement. Some major initiatives in this regard are as follows:

(a) Following the cardinal principle of avoidance, minimization as per the ESPP, involvement of forest land in its transmission line project has been progressively reduced from 6 percent in 1998 to 2.26 percent at present, thus playing a major role in preserving the precious carbon sink in line with the GOI's commitment to the Paris Agreement. It is estimated that approximately 1.25 million tons (mt) of $CO_2$ absorption was achieved through saved forest annually.

(b) POWERGRID is also playing a key role in the integration of renewable energy resources by establishing high-capacity 'Green Energy Corridors' dedicated for renewable energy including solar parks across the country. This initiative not only reduced the dependency on thermal generation but also provided a boost to renewable generation by providing reliable grid connectivity which was earlier thought to be a major impediment for renewable energy development. Such transmission corridors will facilitate the transfer of 43 GW of renewable energy against an NDC target of 75 GW.

(c) Recognizing the importance of solar power in combating climate change and in line with the GOI's commitment toward the Paris Agreement, POWERGRID has been installing solar streetlighting and solar systems in its substation locations and office establishments. It is in the process of installing 5 MW rooftop solar systems covering more than 50 locations in its premises. This initiative will result in further saving of 7–8 MU of grid-connected energy per year, further reducing atmospheric emission by approximately 35,916 mt of $CO_2$ per year.

(d) In line with the GOI's e-mobility mission toward lowering vehicular emission and to ensure energy sustainability, POWERGRID has been using e-vehicles for its day-to-day official transportation. POWERGRID is also developing electric vehicle charging stations across India to facilitate e-mobility solutions in road transport covering two-wheelers, rickshaws/autos, taxis, cars, buses, and so on.

68. **Fiduciary compliance.** The financial management performance under PSDP V remained largely satisfactory. The FMRs and annual audit reports were submitted on a regular basis. Implementation of the ERP in POWERGRID facilitated further strengthening of its reporting and internal controls. POWERGRID was conferred 'Navratna' status by the GOI in May 2008, implying a greater commercial and financial autonomy for the company. POWERGRID entered the capital market with an Initial Public Offering in FY2008 with 10 percent of fresh issue of existing paid-up capital along with the divestment of 5 percent of the GOI's shareholding. In FY2011, POWERGRID floated a Follow-on Public Offering (FPO) comprising fresh issue of 10 percent paid-up capital along with divestment of 10 percent of the GOI's shareholding. The FPO received overwhelming response and was oversubscribed by 14.84 times, reflecting sound corporate governance policies of the company. In December 2013, POWERGRID again

issued its second FPO constituting 13 percent of existing paid-up capital along with simultaneous disinvestment of 4 percent of the GOI's sharing holding and was oversubscribed 6.7 times. The shares are listed on the National Stock Exchange and Bombay Stock Exchange. In January 2013, the company made its maiden foray into foreign currency markets and raised US$500 million through issuance of 10-year foreign currency notes at an attractive coupon rate of 3.8 percent per year and was oversubscribed nearly 19 times. The bonds are listed on the Singapore stock exchange.

## C. BANK PERFORMANCE

**Quality at Entry**
Rating: Highly Satisfactory

69. The World Bank's performance during identification, preparation, and appraisal of the project is rated Highly Satisfactory. Acquiring valuable experience through previous PSDP projects and combined with its knowledge of the Indian power sector, the World Bank formulated a targeted PDO keeping with the strategic transformation of the transmission subsector sustained by POWERGRID's operational and institutional capabilities. The World Bank established a strong partnership and good working relationship with all the sector's stakeholders including the CERC, POSOCO, MoP, MoF, and Power Trading Corporation of India. This helped the World Bank team, POWERGRID, and GOI authorities define feasible component options and set up an implementation framework in line with the World Bank's procurement and applicable safeguards. The definition of the PDO focused on outcomes for which POWERGRID was held accountable and risk assessment focused on appropriate risks while the ratings were realistic.

70. The preparation team also ensured that all required steps were taken by the GOI and POWERGRID, including the final PIP incorporating details of investment subprojects. The project ensured that lessons from previous operations and India's Detailed Implementation Review were considered by the borrower and the project team. The World Bank team also carried out safeguards and compliance measures assessment during the preparation phase, including a financial management assessment (refer to annex 7 of the PAD). The World Bank also ensured that the borrower had an established and effective ESPP framework needed for project implementation. In addition, the ESPP assessment made sure that POWERGRID provided the initial environmental assessment reports including Environment Management Plans and Rehabilitation Action Plans for the project. Moreover, a number of required measures were established to ensure that quality at entry contributed to successful implementation.

**Quality of Implementation Support**
Rating: Satisfactory

71. The World Bank's performance during project's implementation is rated Satisfactory. Since loan effectiveness, the World Bank team carried out 14 implementation support missions, including field visits over the 10-year implementation period. Beyond missions, the World Bank team conducted the visits to the sites in between, held regular meetings with POWERGRID at corporate as well as site offices, and ensured that the QPRs were exhaustive and timely. Adequate budget and staff resources were allocated as the project was effectively supervised and closely monitored, including through delegation of day-to-day project implementation support responsibilities to Delhi-based staff, which proved highly effective. Project's implementation support was strengthened by a systematic collaboration between the World Bank and POWERGRID's project teams with a significant skills mix. Proactivity was high as the World Bank

team was continuously developing and implementing correctives measures to deal with implementation problems including procurement, technical design, and ROW. The World Bank team was continuously involved in all the aspects of implementation to ensure that physical investments were carried out and that disbursements occurred as planned. Submission of progress reports, FMRs, and safeguards compliance reports ensured that project implementation support provided both parties with indicators to allow them to track progress and take corrective actions when needed. The World Bank's project implementation support tracking system (Implementation Status and Results Reports [ISRs] and mission Aide Memoires) provided much-needed status information about the project and required implementation ratings and compliance with covenants. Continuous involvement by the World Bank's team and POWERGRID was instrumental in ensuring that the project components were successfully implemented with a Moderately Satisfactory disbursement rate (because of various implementation delays due to restructuring and critical issues of ROW).

72. The MTR for PSDP V was carried out in September 2013, and at that time, the PDO and implementation progress were rated Satisfactory and all KPIs had surpassed their planned targets for that year. However, due to local currency devaluation versus the US dollar and the resulting cost savings, the project was restructured in May 2014 to cancel two schemes, add four new schemes, and swapping schemes between PSDP V and PSDP IV AF to the main component. The project's closing date was then extended to May 31, 2017, and then to May 31, 2019, to adjust for implementation and disbursements schedules of the loan. The World Bank team was continuously involved with POWERGRID to resolve delays due to forest clearances and ROW issues. Most of these issues were resolved and project implementation activities proceeded toward completion according to the planned schedule. The financial management aspects were also closely monitored such as strengthening of the internal audit department according to the World Bank's recommendation. The ICR mission took place in June 2019, however ICR completion date was extended to allow for completion of the balance four schemes (two promoted pioneering transmission technologies). With this extension, three of the four schemes stand completed and have contributed to successful achievement of the PDO. Furthermore, POWERGRID submitted monthly progress reports during the period since the loan closing date to allow for transparent monitoring and reporting of the balance schemes.

**Justification of Overall Rating of Bank Performance**
Rating: Highly Satisfactory

73. The World Bank's performance during identification, preparation, and appraisal of the project is rated Highly Satisfactory. The World Bank did carry out a well-defined appraisal of the project. This was a repeat project that was financed in tandem with the borrower and the World Bank team was able to make the necessary improvements and take corrective actions (in all project aspects) so that the project achieves its PDO in line with the World Bank's overall objective for the transmission sector. The World Bank had acquired valuable experience through all the projects in the PSDP series, which expanded its knowledge of the Indian power sector and resulted in the formulation of a targeted PDO while keeping with the strategic transformation of the transmission sector. The World Bank's actions were sustained by POWERGRID's operational and institutional capabilities. This helped set up an implementation framework in line with the World Bank's procurement and applicable safeguards. The definition of the PDO focused on outcomes for which POWERGRID was held accountable and risk assessment focused on appropriate risks while the ratings were realistic.

### D. RISK TO DEVELOPMENT OUTCOME

74. The overall level of risk to the development outcome is rated Low. This assessment is based on the sustainability of the physical investments financed by the loan as well as on the financial, operational, and technical strength of POWERGRID. POWERGRID has an adaptive technical, operational, and corporate structure that allows it to operate its infrastructure efficiently. The low risk level is also based on the sustainability of POWERGRID's enhanced institutional capacity and managerial performance which should enable the company to continue to achieve high performance levels. The reliability of the grid has been enhanced (see paragraphs 53-54).

## V. LESSONS AND RECOMMENDATIONS

75. Programmatic engagement with key public sector institutions help in laying strong foundations for the sector.

(a) During the period of the series of PSDP projects, the World Bank has provided close support to POWERGRID in its institutional development. The World Bank's programmatic engagement over an extended period, anchored in the PSDP financing, has not only supported POWERGRID in the development of its business systems and its technical development but also in the broader areas of corporate governance, strategic planning, and commercial performance. POWERGRID is now a highly performing, publicly listed corporate entity and is recognized globally for its best-of-class corporate performance.

(b) It is important to recognize that PSDP V is the last in a series of financing and capacity development engagements with POWERGRID which commenced since its inception. The success of this operation is in part due to the longevity of the World Bank's engagement with POWERGRID, and the results achieved through the operation should be seen as a subset of the broader results achieved through the World Bank's long-term programmatic relationship with POWERGRID.

(c) The World Bank's engagement with POWERGRID, for over two decades now, has contributed toward building a self-sustainable organization that has moved leaps and bounds on technological advancements. Since the inception of POWERGRID and through systematic engagement through investment support, POWERGRID achieved many pioneering feats, such as introducing sustainability reports on safeguards, introducing 1,200 kV technology, and laying strong national network, among others.

(d) POWERGRID also worked on bringing the lessons learned under World Bank engagement to non-World Bank-funded projects as well, and this was reflected when at the beginning of PSDP V, in 2009, POWERGRID's ESPP was certified for UCS by the World Bank. This increased its visibility and ownership across the organization. It was highlighted in the fund-raising prospectus to potential investors and subsequently was also accepted by the Asian Development Bank's Country Safeguard System Assessment.

(e) POWERGRID's commercial performance has allowed it to progressively gain access to commercial financing and move beyond the requirement for multilateral development bank

financing support, demonstrating how long-term engagement has helped develop an institution capable of crowding in private capital in its own right. POWERGRID's success has also given the GOI sufficient confidence to open its transmission market to TBCB allowing POWERGRID to now compete for the right to develop India's transmission infrastructure with other private developers.

(f) POWERGRID is responsible for transmission of almost half of the electric power generated in India, and its procurement processes were assessed and accepted under UCS as well. This move was on the basis that this will have a significant impact on the procurement in the country to the extent that it applies to public utilities.

(g) Programmatic engagement helps in easing out the business processes and results in stronger organizations and successful projects. The implementation of the PSDP series and remarkable achievement of its PDO have demonstrated the effectiveness of its design and management. It has also shown that investments in the transmission infrastructure of India have been able to improve the energy transfer between regions while at the same time, fulfill the needs of electricity consumers, including households, industries, and service institutions. The project shows the replicability of its design for other countries in the region.

(h) The World Bank has also learned a number of important lessons through its programmatic engagement with POWERGRID:

- The importance of a 'financing plus' approach through engagement with public institutions. Anchoring an engagement through financing while adding value through ongoing capacity development along with technical assistance throughout the life of the partnership is extremely important.

- The importance of longevity in the World Bank's engagement with public institutions, allowing longer-term development of strong corporate and commercial performance to the point that access to other sources of financing becomes more easily available.

- Maximizing Finance for Development sometimes takes time. In the case of POWERGRID, the World Bank's leveraging was realized progressively as POWERGRID developed an increasingly strong balance sheet and increased its capacity to access commercial funds.

(i) The success of PSDP V should be considered in the context of the overall success of the World Bank's engagement with POWERGRID over several decades and considered as a model for institutional development. The World Bank is currently replicating this success through its financing, technical assistance, and programmatic engagement with other public institutions operating in India's power sector, including the Solar Energy Corporation of India, the India Renewable Energy Development Agency, and the State Bank of India. In each of these cases, the World Bank is drawing on these important lessons learned from the PSDP programmatic engagement, culminating in PSDP V.

76. With an increase in pressure on land, its opportunity cost has gone up significantly in the recent past and hence has amplified the issues linked to it.

(a) Major delays were caused by ROW issues. POWERGRID projects are critical to the transmission network, but as PSDP V implementation shows, these projects are not simple to commission. A couple of projects, especially the SRSS 17 scheme, got delayed considerably in commissioning as a few kilometers in between could not be connected due to resistance from the community demanding higher compensation. Persistent efforts of POWERGRID and close working with the local administration helped overcome such challenges and the line was ultimately commissioned. Similar issues were also noted in the WR for Mundra scheme that is yet to be commissioned (targeted by September 2020).

(b) POWERGRID adopts a strategy to minimize its impact and hence lays an emphasis on careful selection of alignment through rigorous application of environmental criteria that can have multiple benefits, including beyond the project. POWERGRID selects the most optimum routes for all lines either with no forest or with minimum forest area involvement while completely avoiding the environmentally sensitive areas such as national parks, wildlife sanctuaries, biosphere reserves, and so on.

(c) CSR activities addressing the overall local community needs make a huge difference in interfacing with the communities and incentivizing them to buy into the projects. Effective and continuous monitoring, as a part of the overall project monitoring, is important.

77. Technical advancements play a critical role in overcoming some of the abovementioned challenges, but still there is a long way to go as new challenges keep coming through.

(a) Paralleling of the bipoles in the ±800 kV Champa-Kurukshetra line has no doubt been a major challenge to the project. There are other places where parallel operations of HVDC bipoles have been deployed; for instance, in Manitoba Hydro (Canada), the parallel operation of Nelson River bipoles I and II were commissioned in 1985. POWERGRID through M/s ABB had commissioned the 6,000 MW North-East Agra multiterminal +800 kV HVDC parallel operation of two bipoles in 2017, though this is electrode based and not a metallic return. Bringing lessons from international experience may have helped in expediting the timelines under the Champa-Kurukshetra project.

(b) Some of such first-mover risks while introducing new technologies (such as 1,200 kV transmission lines) were absorbed by POWERGRID and the World Bank supported it as its partner of preference.

(c) Upgrading of the transmission lines using HTLS conductors to transmit power without having to replace or reinforce the existing tower structures is a promising solution and quite beneficial, especially as the same ROW will still be used. Similarly, adoption of GIS against the conventional AIS is helping reduce land requirement for substations.

(d) Transmission lines were designed anticipating future growth given the challenges in acquiring ROW. For instance, the 400 kV Wardha to Aurangabad transmission line was

designed with the capability of 1,200 kV towers, which has locked in future expansion programs without tower replacement.

(e) Given the increasing severity of ROW issues, underground transmission lines hold a promising future because of the reduced ROW and near-zero visibility, as many people still believe the myth that power lines affect childbirth negatively and have a radioactive impact on humans.

78. Procurement is significant in ensuring sustainability and deepening of the sector.

(a) Under this loan, procurement for transmission system projects were carried out which were either uniquely positioned or pertained to emerging transmission technologies in India. For example, an upgrade of the ±800 kV, 3,000 MW HVDC bipole between Champa and Kurukshetra to 6,000 MW is the single largest package awarded under the loan. Furthermore, the initial period of the project involved procurement of plant and equipment and goods packages for 765 kV voltage level, which was an emerging voltage level in transmission system in India at that time. The procurement documents were developed in consultation with the World Bank and detailed deliberations on various aspects were carried out before launching the tenders. POWERGRID continued to fine-tune these tenders incorporating lessons learned from the previous procurement processes. This was also based on consultations with vendors to allay their concerns and increase competition in the market leading to deepening of the sector.

(b) Efficiency and effectiveness in procurement start with consistent bidding documentation. Under the PSDP projects, standard bidding documents for various package categories were prepared as agreed with the World Bank and incorporating package-specific changes. The similar approach has also been adopted in case of procurement of various packages under domestic funding in POWERGRID. At present, POWERGRID maintains model bidding documents for various package categories under domestic funding which facilitates preparation of consistent bidding documents in the shortest possible time frame.

79. Robust corporate governance and financial management aspects bring confidence in the utility, allowing it to access financial markets beyond boundaries. Over the last two decades, POWERGRID has made significant achievements in strengthening its corporate governance and financial management. The milestones included undertaking a corporate governance and financial accountability assessment, listing on the stock exchange, strengthening internal audit function, and implementing ERP and ERM. Strengthening of the corporate governance practices is a journey and would require continuous monitoring and periodic assessments on each of the initiatives and taking actions to further improve these. POWERGRID has followed this approach and would need to continue doing so.

## ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

### A. RESULTS INDICATORS

#### A.1 PDO Indicators

**Objective/Outcome:** Growth in power exchange between and across regions (Millions kWh)

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised Target | Actual Achieved at Completion |
|---|---|---|---|---|---|
| Growth in power exchange between and across regions (Millions kWh) | Gigawatt-hour (GWh) | 46027.00<br>31-Mar-2009 | 70000.00<br>31-Mar-2015 | 150000.00<br>31-Mar-2019 | 181744.00<br>31-Mar-2019 |

**Comments (achievements against targets):**
A growth of about 135,717 Million Units (MU) (294.86 percent) in power exchange across regions has been observed in comparison to a baseline FY2009 of 46,027 MU. It The PDO indicator has outperformed the end-project target for FY2019 by 21.16 percent.

#### A.2 Intermediate Results Indicators

**Component:** Transmission System Stregthening Schemes

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised Target | Actual Achieved at Completion |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Implementation of ESPP - Environment - Cumulative transmission capacity (MW) per meter width of right-of-way within forest area | Text | 18.6 MW/metre<br>31-Mar-2009 | 21.5 MW/metre<br>31-Mar-2015 | 25.2 MW/metre<br>31-Mar-2019 | 25.64 MW/metre<br>31-Mar-2019 |

**Comments (achievements against targets):**
The indicator outperformed it's end-project (FY2019) target.

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised Target | Actual Achieved at Completion |
|---|---|---|---|---|---|
| Transmission lines constructed or rehabilitated under the project | Kilometers | 0.00<br>31-Mar-2009 | 0.00<br>31-Mar-2015 | | 4100.00<br>31-Mar-2019 |
| Transmission lines rehabilitated under the project | Kilometers | 0.00<br>31-Mar-2009 | 0.00<br>31-Mar-2015 | | 0.00<br>31-Mar-2019 |
| Transmission lines constructed under the project | Kilometers | 0.00<br>31-Mar-2009 | 3628.00<br>31-Mar-2015 | | 4100.00<br>31-Mar-2019 |

**Comments (achievements against targets):**
Transmission lines covered under the PSDP V loan has contributed about 4,100 ckm of 765 kilo-volts (kV) and 400 kV lines towards transmission capacity addition, which makes the contribution from this loan to be about 5% of such total capacity added since the baseline year (FY2009).

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised Target | Actual Achieved at Completion |
|---|---|---|---|---|---|
| Implementation of ESPP - Social (percent of PAPs rehabilitated) | Percentage | 0.00<br>31-Mar-2009 | 100.00<br>31-Mar-2015 | 100.00<br>31-Mar-2019 | 100.00<br>31-Mar-2019 |

**Comments (achievements against targets):**
The targets were achieved.

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised Target | Actual Achieved at Completion |
|---|---|---|---|---|---|
| Growth in transformation capacity (MVA) | Text | 79522 MVA<br>31-Mar-2009 | 200000 MVA<br>31-Mar-2015 | 320000 MVA<br>31-Mar-2019 | 365282 MVA<br>31-Mar-2019 |

**Comments (achievements against targets):**
An addition of about 285,552 MVA (359.08 percent) has been achieved in transformation capacity with respect to baseline FY2009 of 79,522 MVA. Under the PSDP V loan, about 8,000 MVA transformation capacity has been added, which is about 2.8 percent of such total capacity added since the baseline year (FY2009).

| Indicator Name | Unit of Measure | Baseline | Original Target | Formally Revised | Actual Achieved at Completion |
|---|---|---|---|---|---|

| | | | | Target | |
|---|---|---|---|---|---|
| Growth in transmission capacity (circuit km) | Text | 71,447 ckt-km<br>31-Mar-2009 | 114000 ckm<br>31-Mar-2015 | 150000 ckm<br>31-Mar-2019 | 153074 ckm<br>31-Mar-2019 |

**Comments (achievements against targets):**
Transmission lines covered under the PSDP V loan has contributed about 4,100 ckm of 765 kV and 400 kV lines towards transmission capacity addition, which makes the contribution from this loan to be about 5% of such total capacity added since the baseline year (FY2009). All these accomplishments have ensured the sector to sustain a strong national transmission grid.

## B. KEY OUTPUTS BY COMPONENT

| | |
|---|---|
| **Objective:** The PDO is to strengthen India's electricity transmission system in order to increase reliable power exchange between regions and states. | |
| **Outcome Indicators** | 1. Growth in power exchange between and across regions (Millions kWh/MU) |
| **Intermediate Results Indicators** | 1. Growth in transformation capacity (MVA)<br>2. Growth in transmission capacity (circuit km)<br>3. Implementation of ESPP - Environment - Cumulative transmission capacity (MW) per meter width of right-of-way within forest area<br>4. Implementation of ESPP - Social (percent of PAPs rehabilitated) |
| **Key Outputs by Component (linked to the achievement of the Objective)** | 1. The KPIs indicate that the project achieved and surpassed the physical targets that were planned at appraisal. As POWERGRID continues to display a strong operational performance, The PDO indicator (inter-regional power exchange) as well as all other KPIs have outperformed their end-of-the-year targets for the period 2010-2019.<br>2. Growth in inter-regional power exchange: A growth of about 135,717 MUs (294.86 percent) in power exchange across regions has been observed in comparison to a baseline FY2009 of 46,027 MU. It is to be noted that the PDO indicator has outperformed the target for FY2019 by 21.16 percent.<br>3. Expansion in Transmission Capacity: Achievements in this capacity have been surpassed and have thrusted POWERGRID to own and operate about 153,074 ckm of EHV transmission lines (March 2019). An addition of about 81,624 ckm (114.24 percent) has been achieved in transmission capacity with respect to baseline FY2009 of 71,447 ckm. Furthermore, transmission lines covered under the loan has contributed about 4,100 ckm of 765 kV and 400 kV lines toward transmission capacity addition. All these accomplishments have ensured the sector to sustain a strong national transmission grid.<br>4. Growth in Transformation Capacity: Transformation capacity of POWERGRID's network is about 365,074 MVA. An addition of about 285,552 MVA (359.08 percent) has been achieved in transformation capacity with respect to baseline FY2009 of 79,522 MVA. Under the PSDP V loan, about 8,000 MVA transformation capacity has been added. |

## ANNEX 2. BANK LENDING AND IMPLEMENTATION SUPPORT

### A. TASK TEAM MEMBERS

| Name | Role |
|---|---|
| **Preparation** | |
| Julia M. Fraser | Task Team Leader |
| Gevorg Sargsyan | Sr. Infrastructure Specialist/co-TTL |
| Surbhi Goyal | Operations Analyst |
| Ayse Cansiz | Power Engineer |
| Manoj Jain | Sr. Financial Management Specialist |
| Savinay Grover | Financial Management Analyst |
| Ramola Bhuyan | Consultant |
| Gaurav D. Joshi | Environmental Specialist |
| Mohammed Hasan | Social Development Specialist |
| Sushil Bahl | Sr. Procurement Specialist |
| Yash Gupta | ET Consultant |
| Neelima Kapur | Team Assistant |
| **Project Implementation Support/ICR** | |
| Surbhi Goyal, Debabrata Chattopadhyay | Task Team Leader(s) |
| Arun Kumar Kolsur | Procurement Specialist(s) |
| Savinay Grover | Financial Management Specialist |
| Boonsri Prasertwaree Kim | Team Member |
| Sangeeta Patel | Procurement Team |
| Geeta Shivdasani | Procurement Team |
| Suryanarayana Satish | Social Specialist |
| Shaukat Javed | Team Member |
| Latha Sridhar | Procurement Team |
| Radha Narayan | Procurement Team |
| Ritika Rodrigues | Team Member |

| | |
|---|---|
| Payal Malik Madan | Procurement Team |
| Gaurav D. Joshi | Environmental Specialist |
| Parthapriya Ghosh | Team Member |

## B. STAFF TIME AND COST

| Stage of Project Cycle | Staff Time and Cost | |
|---|---|---|
| | No. of staff weeks | US$ (including travel and consultant costs) |
| **Preparation** | | |
| FY09 | 37.998 | 141,247.95 |
| FY10 | 17.791 | 67,988.20 |
| **Total** | **55.79** | **209,236.15** |
| **Supervision/ICR** | | |
| FY10 | 24.942 | 88,913.09 |
| FY11 | 23.354 | 112,223.16 |
| FY12 | 17.965 | 95,754.01 |
| FY13 | 39.648 | 293,577.56 |
| FY14 | 26.824 | 115,742.64 |
| FY15 | 13.015 | 49,954.70 |
| FY16 | 29.819 | 160,484.16 |
| FY17 | 22.910 | 90,018.74 |
| FY18 | 18.039 | 89,476.19 |
| FY19 | 15.018 | 99,947.47 |
| FY20 | 13.350 | 96,311.43 |
| **Total** | **244.88** | **1,292,403.15** |

## ANNEX 3. PROJECT COST BY COMPONENT

**Table 3.1. Project Cost by Component (US$, million equivalent)**

| Components | Amount at Appraisal[a] | Actual at Project Closing |
|---|---|---|
| Transmission system strengthening | 1,362 | 2,158 |
| **Total baseline cost** | **1,362** | **2,158[b]** |
| Physical contingencies | 125 | n.a. |
| Price contingencies | 75 | n.a. |
| **Total project costs** | **1,562** | **2,158** |
| Front-end fee | 0 | n.a. |
| Front-end fee IBRD | 0 | n.a. |
| **Total IBRD Financing Required** | **1,000** | **1,000** |

*Note:* a. Includes five schemes at the time of appraisal (and not the schemes after restructuring).
b. Reasons for the change in cost include (a) the dropping of one scheme, (b) the swapping of another scheme with PSDP IV AF, and (c) the addition of five new schemes under PSDP V. Balance funds came from POWERGRID's internal resources and/or from other lenders.

**Table 3.2. Disbursements by Schemes (US$, millions)**

| S No | Schemes | Amount at Appraisal[a] | Actual at Project Closing | Disbursements under PSDP V |
|---|---|---|---|---|
| 1. | WR for Mundra UMPP | 366 | 330 | 137.94 |
| 2. | NR for Sasan and Mundra UMPP | 282 | 216 | 142.91 |
| 3. | SR and WR for Krishnapatnam UMPP | 538 | 323 | 169.61 |
| 4. | NRSS 24 | 40 | 135[b] | 13.20 |
| 5. | NRSS 25 | 142 | 102 | 18.51 |
| 6. | NRSS 26 | 177 | 114 | 26.64 |
| 7. | SRSS 17 | 392 | 213 | 142.72 |
| 8. | ERSS V | 308 | 218 | 19.98 |
| 9. | Champa-Kurukshetra | 880 | 507 | 328.49 |
| | **Total** | **3,125** | **2,158** | **1,000.00 (100 percent)** |

*Note:* a. Includes three schemes identified at the time of appraisal and six schemes added later through restructuring. Hence, there is a difference in 'amount at appraisal' numbers in tables 3.1 and 3.2.
b. There has been a considerable change in the scope of the NRSS 24 scheme. The actual cost for the components that were identified (under this scheme) during the PIP stand at US$44.7 million.

## ANNEX 4. EFFICIENCY ANALYSIS

1. Economic and financial analyses have been conducted for the schemes which were funded under PSDP V, as well as for the SRSS-13 scheme, which was also included under PSDP V for monitoring physical works of the scheme but was originally funded under the closed PSDP IV. The list of schemes covered under the analysis is as follows:

(a) System strengthening in the NR for Sasan and Mundra UMPP (NR for Sasan and Mundra)

(b) System strengthening in the SR and WR for Krishnapatnam UMPP (SR and WR for Krishnapatnam)

(c) SR system strengthening XVII (SRSS 17)

(d) NR system strengthening XXIV (NRSS 24)

(e) NR system strengthening XXV (NRSS 25)

(f) NR system strengthening XXVI (NRSS 26)

(g) ER system strengthening V (ERSS V)

(h) SR system strengthening XIII (SRSS 13) - originally funded under the closed PSDP IV loan

(i) Champa-Kurukshetra HVDC bipole scheme under 'Transmission System Strengthening in WR-NR Transmission Corridor' (Champa-Kurukshetra)

(j) System strengthening in the WR for Mundra UMPP (WR for Mundra)

2. As in the appraisal methodology (see annex 9 of the PAD), investment schemes for PSDP V are also considered as stand-alone projects with their own technical parameters, financing, and implementation arrangements. The ex post economic and financial analysis consisted of the determination of the ERR and RoE based on actual cost data, CERC tariff regulations, and the methodology followed at the time of appraisal or PIP approval.

**Economic Analysis**

3. As per the PAD/PIP methodology, economic benefits from reduced transmission losses (derived from load flow studies) for six schemes[12] have been valued at the opportunity cost of the energy saved (the average cost of alternate supply from thermal generation). For two schemes (SRSS 17 and Champa-Kurukshetra), economic benefits from the transfer of power among regions have been considered based on the difference between the cost of generation in the two regions. For the ERSS V scheme, economic benefits include (a) the avoided cost of localized oil-fuel based generation through the supply of secured

[12] The six schemes are (a) NR for Sasan and Mundra, (b) SR and WR for Krishnapatnam, (c) NRSS 24, (d) NRSS 25, (e) NRSS 26, and (f) WR for Mundra.

power from the grid and (b) reduced transmission losses valued at the average cost of alternate supply from thermal generation. In addition, the results for a tenth scheme (SRSS 13)[13] are presented in the following paragraphs. This scheme was originally funded under the closed PSDP IV loan but was still under implementation at the time of preparation of the ICR for the PSDP IV loan. For each scheme, ERRs have been calculated for two cases: (a) assuming the same opportunity cost of energy saved that was considered at the time of appraisal or PIP approval (that is, 'economic benefits at PIP values') and (b) considering the updated opportunity cost of energy saved from thermal generation (that is, 'economic benefits at updated values').

4. **Results.** The ex post ERRs (under 'ERR at ICR') are presented in table 4.1 and have been compared with the ex ante ERRs calculated for each scheme at the appraisal stage/while preparing the PIPs. Ex ante ERRs are presented for the following scenarios: (a) base case; (b) comparable case; and (c) worst case in which there is a cost escalation of 20 percent, delay in project commissioning by two years, reduction in the RoE by 1 percent, and reduction in foreign exchange rate by 10 percent.

**Table 4.1. Schemewise Economic Analysis**

| Name of the Scheme | ERR as in PAD/PIP (%) | | | ERR at ICR (%) | | Remarks |
|---|---|---|---|---|---|---|
| | Base-case Scenario | Worst-case Scenario (Cost Escalation by 20%, Delay of 2 Years) | Comparable Case Scenario | Economic Benefits at PIP Values | Economic Benefits at Updated Values | |
| SRSS 17 | 18.85 | 13.03 | Same as base-case scenario | 20.38 | 13.86 | Outperformed. |
| SR and WR for Krishnapatnam | 16.36 | 12.25 | Delay of 1 year: 15.38 | 16.40 | 15.06 | Outperformed. |
| Champa-Kurukshetra | 20.97 | 14.72 | Delay of 1 year: 18.36 | 19.74 | 11.26 | ERR is robust as there was a reduction in cost of about 19% even though the scheme was delayed by about 2 years and 10 months compared to the original commissioning date. |
| NRSS 26 | 13.33 | 9.53 | Cost escalation by 10% and delay of 1 year: 11.29 | 11.88 | 9.86 | ERR is low as there was a cost escalation of about 9% and the scheme was delayed by about 2 months compared to the original commissioning date. |
| NRSS 25 | 13.20 | 9.53 | Cost escalation by 10% and | 10.26 | 8.38 | ERR is low as the scheme was delayed by around 7 months compared to the |

[13] With economic benefits from reduced transmission losses (derived from load flow studies) valued at the opportunity cost of the energy saved (the average cost of alternate supply from thermal generation), as per the PIP methodology.

| Name of the Scheme | ERR as in PAD/PIP (%) | | | ERR at ICR (%) | | Remarks |
|---|---|---|---|---|---|---|
| | Base-case Scenario | Worst-case Scenario (Cost Escalation by 20%, Delay of 2 Years) | Comparable Case Scenario | Economic Benefits at PIP Values | Economic Benefits at Updated Values | |
| | | | delay of 1 Year: 11.19 | | | original commissioning date and there was a cost escalation of about 24%. |
| NRSS 24[14] | 25.67 | 17.83 | Same as worst-case scenario | 12.63 | 8.84 | ERR is low as the scheme was delayed by around 3 years and 4 months compared to the original commissioning date, and there was a cost escalation of about 58%. |
| ERSS V | 14.66 | 10.77 | Same as worst-case scenario | 9.16 | 8.82 | ERR is low as the scheme was delayed by more than 4 years compared to the original commissioning date, and there was a cost escalation of nearly 35%. |
| SRSS 13 | 21.77 | 14.86 | Same as worst-case scenario | 7.25 | 10.93 | ERR is low as the scheme was delayed by around 5 years and 7 months compared to the original commissioning date, and there was a cost escalation of about 116%. |
| NR for Sasan and Mundra | 16.31 | 12.07 | Same as worst-case scenario | 10.09 | 9.36 | ERR is low as the scheme was delayed by nearly 4.5 years compared to the original commissioning date, and there was a cost escalation of about 15%. |
| WR for Mundra[15] | 19.51 | 13.41 | Same as worst-case scenario | 8.68 | 8.09 | ERR is low as the scheme was delayed by around 8 years compared to the original commissioning date, and there was a cost escalation of about 34%. |

5. The SRSS 17 scheme was delayed by around seven months compared to the original commissioning date as per the Restructuring Paper. However, there was a reduction in cost of about 11

[14] Due to considerable changes in the scope of the NRSS 24 scheme, the calculations for this scheme are based on updated cost estimates for the scope identified in the PIP for the sake of comparability.
[15] Calculations based on commissioning by the end of September 2020.

percent. Delays were mainly caused by (a) a delay in land acquisition for the Narendra (New Kudgi) GIS; (b) severe ROW issues for the loop-in loop-out (LILO) of Kolhapur-Mapusa line at Kolhapur (new) due to stiff resistance from land owners; and (c) for Kolhapur (new) substation, although the Notice of Award (NoA) was issued to M/s PINGGAO (a contractor) on February 5, 2013, disagreement regarding the scope necessitated rebidding, and the contract was finally awarded on February 12, 2014. The scheme had an ex ante ERR of 18.85 percent in the base case and 13.03 percent in the worst case. The comparable ex post ERR outperformed the base case.

6. The SR and WR for Krishnapatnam scheme was delayed by about 1.5 years compared to the original commissioning date. However, there was a reduction in cost of about 20 percent. Delays were mainly caused by (a) a delay in land acquisition for the new 765/400 kV Pune GIS, which took about 31 months from the application submission date, and (b) severe ROW problems at various locations. This scheme has special significance since it has enabled synchronous connectivity between the SR and WR. With the commissioning of the Raichur-Sholapur 765 kV single circuit (S/C) line in December 2013, the entire National Grid is now operating at one frequency. The scheme had an ex ante ERR of 16.36 percent in the base case and 12.25 percent in the worst case. The comparable ex post ERR outperformed the base case.

7. The Champa-Kurukshetra scheme was delayed by about 2 years and 10 months compared to the original commissioning date as per the Restructuring Paper. However, there was a reduction in cost of about 19 percent. Delays were mainly caused by (a) a delay in land acquisition/handing over of land for the Champa HVDC station, (b) complexities involved in dedicated metallic return (DMR) technology, (c) issues related to off-shore supplies, and (d) software modifications required to remove the various bugs/shortcomings observed in the existing bipole I software and to make it compatible for parallel operation with bipole II. The scheme had an ex ante ERR of 20.97 percent in the base case and 14.72 percent in the worst case. The comparable ex post ERR is close to the base case.

8. The NRSS 26 scheme was delayed by about two months compared to the original commissioning date, and there was a cost escalation of about 9 percent. The scheme had an ex ante ERR of 13.33 percent in the base case and 9.53 percent in the worst case. The comparable ex post ERR is between the base case and the worst case.

9. The NRSS 25 scheme was delayed by around seven months compared to the original commissioning date, and there was a cost escalation of about 24 percent. The delay was caused by (a) severe ROW problems faced during the construction of the Jaipur-Bhiwani 765 kV S/C line at multiple locations and (b) delay in forest clearance which was received 15 months after the submission of the proposal. The scheme had an ex ante ERR of 13.20 percent in the base case and 9.53 percent in the worst case. The comparable ex post ERR is between the base case and the worst case.

10. The NRSS 24 scheme was delayed by around three years and four months compared to the original commissioning date, and there was a cost escalation of about 58 percent. There were delays in obtaining forest clearances, which took about 11–42 months for approval, and delays were also caused by ROW issues. POWERGRID faced severe protests from villagers and Kisan Unions during the construction of the Dehradun-Abdullapur 400 kV double circuit (D/C) quad line. The scheme had an ex ante ERR of 25.67 percent in the base case and 17.83 percent in the worst case. The comparable ex post ERR is below the estimate for the worst case.

11. The ERSS V scheme was delayed by more than four years compared to the original commissioning date, and there was a cost escalation of nearly 35 percent. Delays were mainly caused by (a) severe ROW issues faced by POWERGRID mainly in the Rajarhat and Purnea areas, (b) damage done by the local people at Rajarhat substation rendering Information and Communications Technology (ICT) systems defective, and (c) poor performance of M/s EMC (a contractor). In addition, the CEA inspection and charging of the Rajarhat-Purnea (PG) 400 kV D/C line were delayed as a result of the nationwide lockdown due to COVID-19. The scheme had an ex ante ERR of 14.66 percent in the base case and 10.77 percent in the worst case. The comparable ex post ERR is below the estimate for the worst case.

12. The SRSS 13 scheme was delayed by around five years and seven months compared to the original commissioning date, and there was a cost escalation of about 116 percent. The commissioning of the scheme was delayed due to severe ROW issues affecting the 400 kV D/C (quad) Madhugiri-Yelahanka line. Attention is also drawn to the issuance of compensation to be paid for ROW as per MoP guidelines, in addition to tree and crop compensation, which contributed to the rise in costs. The scheme had an ex ante ERR of 21.77 percent in the base case and 14.86 percent in the worst case. The comparable ex post ERR is below the estimate for the worst case.

13. The NR for Sasan and Mundra scheme was delayed by nearly 4.5 years compared to the original commissioning date, and there was a cost escalation of about 15 percent. Reasons for the delay were (a) delays in obtaining statutory clearances from government agencies such as the Railways and National Highways Authority of India (NHAI) for the Agra-Sikar 400 kV D/C (quad) line and (b) severe ROW problems affecting the Sikar-Ratangarh (Rajasthan Rajya Vidyut Prasaran Nigam Limited [RRVPNL]) 400 kV D/C line and the Sikar-Jaipur 400 kV D/C line. The scheme had an ex ante ERR of 16.31 percent in the base case and 12.07 percent in the worst case. The comparable ex post ERR is below the estimate for the worst case.

14. The WR for Mundra scheme was delayed by around eight years compared to the original commissioning date, and there was a cost escalation of about 34 percent. Reasons for the delay were (a) poor performance of the implementation agency with respect to the Wardha-Aurangabad 400 kV D/C line, (b) severe ROW issues, (c) scarcity of skilled and expert labor for carrying out stringing work of 1,200 kV line and (d) the nationwide lockdown due to COVID-19. The scheme had an ex ante ERR of 19.51 percent in the base case and 13.41 percent in the worst case. The comparable ex post ERR is below the estimate for the worst case.

**Financial Analysis**

15. The financial analysis for the schemes is presented in table 4.2, and the rate of RoE has been considered as a proxy. The same proxy/benchmark RoE of 15.5 percent that was considered at appraisal was considered here as well, based on CERC tariff regulations. The schemewise RoE at the time of appraisal/PIP approval is compared with that at completion across three cases: (a) base case, (b) comparable case, and (c) worst case (in which there is a cost escalation of 20 percent, delay in project commissioning by two years, reduction in the RoE by 1 percent, and reduction in foreign exchange rate by 10 percent).

**Table 4.2. Schemewise Financial Analysis**

| Name of the Scheme | RoE as in PAD/PIP (%) | | | RoE at ICR (%) | Remark |
|---|---|---|---|---|---|
| | Base-case Scenario | Worst-case Scenario (Cost Escalation by 20%, Delay of 2 years, RoE Lower by 1%) | Comparable Case Scenario | | |
| SRSS 17 | 19.53 | 14.82 | Same as base-case scenario | 21.22 | Outperformed the benchmark RoE. |
| SR and WR for Krishnapatnam | 20.24 | 14.90 | Delay of 1 year: 17.71 | 17.94 | Outperformed the benchmark RoE. |
| Champa-Kurukshetra | 16.46 | 11.35 | Delay of 1 year: 12.84 | 15.49 | The RoE is just below the benchmark. The scheme was delayed by about 2 years and 10 months compared to the original commissioning date. There was a reduction in cost of about 19%. |
| NRSS 26 | 19.25 | 12.38 | Cost escalation by 10% and delay of 1 year: 15.84 | 16.73 | Outperformed the benchmark RoE. |
| NRSS 25 | 20.90 | 14.13 | Cost escalation by 10% and delay of 1 year: 17.63 | 15.40 | The RoE is just below the benchmark. The scheme was delayed by around 7 months compared to the original commissioning date. There was a cost escalation of about 24%. |
| NRSS 24[16] | 15.68 | 12.04 | Same as worst-case scenario | 14.58 | The RoE is low as the scheme was delayed by around 3 years and 4 months compared to the original commissioning date. There was a cost escalation of about 58%. |
| ERSS V | 18.36 | 13.08 | Same as worst-case scenario | 10.72 | The RoE is low as the scheme was delayed by more than 4 years compared to the original commissioning date. There was a cost escalation of nearly 35%. |
| SRSS 13 | 16.88 | 14.83 | Same as worst-case scenario | 10.78 | The RoE is low as the scheme was delayed by around 5 years and 7 months compared to the original commissioning date. There was a cost escalation of about 116%. |
| NR for Sasan and Mundra | 22.47 | 16.84 | Same as worst-case | 11.66 | The RoE is low as the scheme was delayed by nearly 4.5 years |

[16] Due to considerable changes in the scope of the NRSS 24 scheme, the calculations for this scheme are based on updated cost estimates for the scope identified in the PIP for the sake of comparability.

| Name of the Scheme | RoE as in PAD/PIP (%) | | | RoE at ICR (%) | Remark |
|---|---|---|---|---|---|
| | Base-case Scenario | Worst-case Scenario (Cost Escalation by 20%, Delay of 2 years, RoE Lower by 1%) | Comparable Case Scenario | | |
| | | | scenario | | compared to the original commissioning date. There was a cost escalation of about 15%. |
| WR for Mundra[17] | 21.49 | 17.05 | Same as worst-case scenario | 10.16 | The RoE is low as the scheme was delayed by around 8 years compared to the original commissioning date. There was a cost escalation of about 34%. |

16. The RoE is higher than the benchmark rate of 15.5 percent for three schemes (SRSS 17, SR and WR for Krishnapatnam, and NRSS 26). For the Champa-Kurukshetra scheme and the NRSS 25 scheme, the RoE is just below 15.5 percent. For five schemes (NRSS 24, ERSS V, SRSS 13, NR for Sasan and Mundra, and WR for Mundra UMPP) the RoE is below 15.5 percent, mainly as a result of delays in the commissioning of these schemes.

*Financial Analysis of Entity*

17. The financial analysis at the entity level was carried out at the appraisal and completion stages using the same principles. Table 4.3 lays out the actual financial details at the entity level. POWERGRID has been a profit-making entity since its inception and continued to demonstrate the same during the implementation period of PSPD V (2009–2019) as well. Net profit increased from US$277 million in FY2009 by more than 5.5 times to US$1,629 million in FY2019. The main financial risk to POWERGRID continues to be the risk of nonpayment by off-taking utilities. The risk of recovering past debts has been mitigated through the signing of tripartite agreements between the Reserve Bank of India, state governments, and the GOI. The tripartite agreements of some states/union territories are valid till 2026 and some are valid till 2031. In addition, POWERGRID continues to adopt the Letter of Credit mechanism to ensure payment of current monthly bills by the off-taking utilities. The RoE at entity level stood at 17 percent in FY2019 given that POWERGRID is increasingly focusing on expediting the capitalization of its assets.

[17] Calculations based on commissioning by the end of September 2020.

**Table 4.3: Financial Summary at Entity Level (2009-2019)**

**POWER SYSTEM DEVELOPMENT PROJECT V (PSDP V)**
**Financial Summary (Figures in US$ Million)**

| Description | Actual | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| ***PROFIT AND LOSSES*** | | | | | | | | | | | |
| Operating Revenues | 1,006 | 1,230 | 1,492 | 1,768 | 2,185 | 2,577 | 2,915 | 3,483 | 4,357 | 5,044 | 5,839 |
| Operating Expenses | 372 | 547 | 581 | 677 | 831 | 1,012 | 1,231 | 1,405 | 1,766 | 2,116 | 2,465 |
| Profit before Tax | 365 | 431 | 627 | 754 | 925 | 1,027 | 1,031 | 1,236 | 1,557 | 1,684 | 1,883 |
| Net profit | 277 | 335 | 442 | 534 | 694 | 737 | 816 | 975 | 1,233 | 1,352 | 1,629 |
| ***CASH FLOW*** | | | | | | | | | | | |
| Operating Cash flow post tax | 1,089 | 1,085 | 912 | 1,050 | 1,850 | 2,502 | 2,466 | 2,479 | 3,537 | 3,587 | 3,795 |
| Capital Expenditure | 1,501 | 1,584 | 2,152 | 2,596 | 3,598 | 4,324 | 3,909 | 3,427 | 3,908 | 3,767 | 3,057 |
| Pre-financing cash flow | (412) | (499) | (1,240) | (1,546) | (1,748) | (1,823) | (1,443) | (948) | (371) | (180) | 738 |
| Financing | 1,097 | 1,205 | 2,167 | 2,355 | 2,958 | 3,810 | 2,911 | 2,820 | 2,838 | 3,189 | 4,518 |
| Cash Available for Debt Service | 684 | 706 | 927 | 808 | 1,210 | 1,987 | 1,468 | 1,871 | 2,467 | 3,009 | 5,256 |
| debt service | 495 | 470 | 737 | 848 | 1,063 | 1,307 | 1,652 | 1,738 | 1,928 | 2,491 | 3,240 |
| dividend paid | 97 | 97 | 125 | 181 | 257 | 228 | 202 | 217 | 261 | 598 | 889 |
| Increase in cash balances | 92 | 139 | 66 | (220) | (111) | 452 | (386) | (84) | 277 | (281) | 349 |
| Cash C/F | 398 | 537 | 603 | 383 | 272 | 724 | 336 | 253 | 529 | 249 | 597 |
| ***BALANCE SHEET ITEMS*** | | | | | | | | | | | |
| Net Block | 5,103 | 5,256 | 6,102 | 7,813 | 10,066 | 11,992 | 14,703 | 18,843 | 22,214 | 25,182 | 26,862 |
| WIP | 2,178 | 3,348 | 4,365 | 5,455 | 6,582 | 8,743 | 9,228 | 7,675 | 6,384 | 5,406 | 5,678 |
| Total Fixed Assets | 7,281 | 8,604 | 10,467 | 13,268 | 16,648 | 20,735 | 23,931 | 26,518 | 28,598 | 30,588 | 32,540 |
| Investments | 261 | 238 | 229 | 211 | 188 | 164 | 128 | 1,004 | 1,525 | 2,117 | 1,777 |
| Total Current asset | 1,363 | 1,578 | 1,719 | 1,309 | 1,382 | 1,985 | 1,893 | 2,587 | 3,081 | 3,999 | 6,088 |
| **Total Assets** | **8,905** | **10,420** | **12,415** | **14,788** | **18,219** | **22,883** | **25,951** | **30,108** | **33,205** | **36,704** | **40,405** |
| Total Equity | 2,433 | 2,645 | 3,530 | 3,873 | 4,321 | 5,665 | 6,269 | 7,200 | 8,190 | 9,012 | 10,359 |
| Borrowings | 4,666 | 5,437 | 6,464 | 8,484 | 10,850 | 13,192 | 15,384 | 15,374 | 19,213 | 21,346 | 23,244 |
| Current Liabilities | 1,717 | 2,222 | 2,232 | 2,169 | 2,726 | 3,626 | 3,893 | 6,265 | 4,094 | 4,123 | 5,148 |
| Total Debt | 6,383 | 7,660 | 8,696 | 10,653 | 13,577 | 16,818 | 19,277 | 21,639 | 23,307 | 25,469 | 28,392 |
| **Total Equity and Liability** | **8,905** | **10,420** | **12,415** | **14,788** | **18,219** | **22,883** | **25,951** | **30,108** | **33,205** | **36,704** | **40,405** |
| ***FINANCIAL RATIOS*** | | | | | | | | | | | |
| Operating Ratio | 37% | 44% | 39% | 38% | 38% | 39% | 42% | 40% | 41% | 42% | 42% |
| Net income as % of Revenue | 28% | 27% | 30% | 30% | 32% | 29% | 28% | 28% | 28% | 27% | 28% |
| Return on Equity | 11% | 13% | 13% | 14% | 16% | 13% | 13% | 14% | 15% | 15% | 17% |
| Self Financing Ratio (3 year average) | 35% | 25% | 30% | 37% | 23% | 27% | 22% | 31% | 30% | 27% | 47% |
| Debt Service Coverage | 1.28 | 1.45 | 1.24 | 1.29 | 1.27 | 1.20 | 1.02 | 1.20 | 1.34 | 1.18 | 1.04 |
| Current ratio | 0.75 | 0.74 | 0.92 | 0.56 | 0.43 | 0.46 | 0.36 | 0.40 | 0.45 | 0.46 | 0.56 |
| Debt:Equity Ratio | 68:32 | 71:29 | 68:32 | 68:32 | 71:29 | 70:30 | 71:29 | 71:29 | 70:30 | 71:29 | 71:29 |

## ANNEX 5. BORROWER, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

| Reference in Draft ICR | Observations from POWERGRID or GoI | Observations | Bank Team's Response |
|---|---|---|---|
| Section I.A, Para 4 | POWERGRID | Replace 'acquiring' with 'to ensure availability of' in the sentence – 'Furthermore, challenges with regard to the *availability of* right-of-way (ROW) for constructing a transmission system necessitated…' | Incorporated. |
| Section I.A, Theory of Change, Para 9 | POWERGRID | POWERGRID confirmed that in case of 400/220kV substation having transformer and line connection in air, difference in space required between AIS and GIS generally vary between 35 percent and 45 percent. So, approximately 35 percent can be taken as a difference. | Thanks for the confirmation. |
| Section I.A, Para 10 | POWERGRID | Editorial change | Incorporated. |
| Figure 1, Theory of Change | POWERGRID | Editorial change | Incorporated. |
| Table 5: Environment KPI | POWERGRID | Actual figures for FY2010 and FY2011 were changed from 19.5 and 20.9 to 20.0 and 20.2, respectively. But it was later clarified that the original values in ICR were correct. | No change. |
| Section II.A, Para 28 | POWERGRID | Editorial change | Incorporated. |
| Section II.B, Para 30, point h | POWERGRID | POWERGRID confirmed the date of commissioning of ERSS V as July 12, 2020 | Incorporated. |
| Section II.E, Para 44 | POWERGRID | Updated the latest numbers in the following sentence – 'The representation of women in POWERGRID has improved from 5.95 percent in FY2010 *to 8.05 percent in* | Incorporated. |

| Reference in Draft ICR | Observations from POWERGRID or GoI | Observations | Bank Team's Response |
|---|---|---|---|
| | | *FY2020*.' | |
| Section III.B, point e | POWERGRID | Editorial change | Incorporated. |
| Section IV.B, Para 59 | POWERGRID | To add highlighted section in the following sentence 'ESPP developed by POWERGRID in 1998 *and subsequently updated in 2005 & 2009* along with an active support from the Bank.' | Incorporated. |
| Section IV.B, Para 61 | POWERGRID | Deleted the repeated para on Sustainability Report. | Incorporated |
| Section IV.B, Para 63 | POWERGRID | To add '…and 20 transmission running about 7308 ckm.' Also change the Champa-Kurukshetra line length from 1300 km to 1288 km. | Incorporated. |
| Section IV.C, Para 70 | POWERGRID | Editorial Change. | Incorporated. |
| Section IV.C, Para 72 | POWERGRID | Editorial Change. | Incorporated. |
| Section V, Para 76.a | POWERGRID | To add highlighted section in the following sentence '…as a few kilometers in between could not be connected due to resistance from the community *demanding higher compensation*.' | Incorporated. |
| Annex 4, Para 11 | POWERGRID | Editorial Change. | Incorporated. |
| Annex 4, Para 17 | POWERGRID | Updated the sentence on tripartite agreement as – 'The tripartite agreements of some States/UTs are valid till 2026 & some are valid till 2031.' | Incorporated. |
| Annex 7, Para 9 | POWERGRID | Editorial Change. | Incorporated. |
| Annex 8 | POWERGRID | Updated the numbers in the annex and added the information in the annex. | Incorporated |

## ANNEX 6. SUPPORTING DOCUMENTS

1. Financial and economic models at completion for the ten schemes
2. File Note on the PSDP V ICR Economic and Financial Analysis
3. POWERGRID's Completion Report for the project, June 2020
4. Project Appraisal Document for PSDP V
5. Restructuring Papers for PSDP V
6. Aide Memoires
7. Implementation Status Reports
8. CAS for 2009–2012
9. CPS for 2013–2017

## ANNEX 7. DETAILED DESCRIPTION OF THE SCHEMES

1. The project consisted of only one component: transmission system strengthening, comprising five regional schemes, which after restructuring increased to nine schemes, for strengthening of the transmission system and/or facilitating interregional power exchange for the National Grid. The project included planning, design, engineering, procurement, and implementation of these schemes. POWERGRID selected the least-cost technical and economic option among the various alternatives studied for each of the investment schemes. The following is the list of final schemes (nine in number) that were supported by the project (after restructuring):

(a) System strengthening in the NR for Sasan and Mundra UMPP (NR for Sasan and Mundra) (original)

(b) System strengthening in the WR for Mundra UMPP (WR for Mundra) (original)

(c) System strengthening in the SR and WR for Krishnapatnam UMPP (SR and WR for Krishnapatnam) (original)

(d) SR system strengthening XVII (SRSS 17) for improving the synchronous connection between the SR and the rest of the National Grid (partly shifted from PSDP IV AF)

(e) NR system strengthening XXIV (NRSS 24) for reliable transfer of power to various load centers in this region (shifted from PSDP IV AF)

(f) NR system strengthening XXV (NRSS 25) for transfer of power from power plants, mostly in ER, via WR to NR (new)

(g) NR system strengthening XXVI (NRSS 26) for transfer of power from hydro projects within NR and other plants in ER to NR (new)

(h) ER system strengthening V (ERSS V) (new),

(i) Upgrading the transmission capacity of the HVDC bipole line between Champa (Chhattisgarh) and Kurukshetra (Haryana) up to 6,000 MW (Champa-Kurukshetra) (new).

2. **NR for Sasan and Mundra scheme.** This scheme was approved originally at the time of appraisal. The original commissioning target was by August 2012 but it was finally commissioned in January 2017. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) **400 kV D/C (quad) Agra-Sikar line.** Implementation of the line got delayed due to delay in obtaining statutory clearances from government agencies such as railways/NHAI. POWERGRID has made best efforts and commissioned the transmission line in

December 2013 involving time overrun of 16 months from the original approved schedule.

(ii) **400 kV D/C Sikar-Ratangarh (RRVPNL, the state transmission utility) line along with bays.** Implementation of Sikar-Ratangarh (RRVPNL) 400 kV D/C line got delayed due to severe ROW problems faced along the route of the line. Therefore, the first and second circuits of the transmission line were commissioned in February 2015 with a time overrun of 29 months from the original target date.

(iii) **400 kV D/C Sikar-Jaipur line.** The commissioning of this line also got delayed due to severe ROW problems faced along the route of the line. The work of foundation, erection, and stringing in the affected locations could be completed only under police protection against unlawful obstruction by the villagers.

(b) **Major benefits of the scheme:**

(i) On commissioning of 400 kV D/C Agra-Sikar transmission line, adequate transmission arrangement was established for dispersal of power pooled at Agra from Sasan and Mundra UMPP projects to NR constituents.

(ii) Further, 400 kV D/C Agra-Sikar transmission line is connected to the rest of the grid by 400 kV D/C line to Ratangarh and Jaipur making strong interconnection of Rajasthan with the rest of the grid.

3. **WR for Mundra scheme.** This scheme was approved originally at the time of appraisal. The original commissioning target was by September 2012 and it is targeted for commissioning by September 2020. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) 400 kV D/C (quad) Wardha-Aurangabad line (upgradable to 1,200 kV) was initially delayed due to poor performance of the implementation agency and severe ROW issues. POWERGRID is still facing severe ROW issues, which is being resolved with the help of local administration. There is also scarcity of skilled and expert labor for carrying out stringing work of 1,200 kV line. Recently, work is completely halted due to nationwide lockdown called by the GOI due to the COVID-19 pandemic. Completion of the project is anticipated by September 2020.

(b) **Major benefits of the scheme:**

(i) Large part of the demand in the northern part of Gujarat is to be met from Mundra UMPP, which would result in large quantum of power transfer from generation projects in eastern part of the WR toward major load centers in its central/western parts. For this, necessary system strengthening in the east-west corridor of the WR is required. Keeping this in view, a high-capacity corridor toward the western part of the

WR, that is, 400 kV DC quad Wardha-Aurangabad line (upgradable to 1,200 kV level) along with establishment of new 400/200 kV substation at Aurangabad, is under implementation in this project. This scheme is critical as it finances the deployment of the first 1,200 kV transmission line in the world and its successful completion will confirm POWERGRID's leadership position in the area.

4. **SR and WR for Krishnapatnam scheme.** This scheme was approved originally at the time of appraisal. The original commissioning target was by October 2014 but it was finally commissioned in April 2016. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) 765 kV SC Sholapur-Pune (GIS), LILO of 400 kV Parli-Pune at Pune (GIS), and LILO of 400 kV Aurangabad-Pune line at Pune (GIS). The delay was mainly attributable to delay in acquisition of land for new substation at 765/400 kV Pune (GIS), which took about 31 months from the date of submission of application to revenue authorities, and severe ROW problems at various locations of the lines from land owners. After persistent efforts of POWERGRID and with active support from the local administration, it could commission the two components—765 kV SC Sholapur-Pune (GIS) and LILO of 400 kV Parli-Pune at Pune (GIS)—in March 2015 with a delay of four months from the original approved schedule. LILO of 400 kV Aurangabad-Pune line at Pune (GIS) was commissioned in April 2016.

(b) **Major benefits of the scheme.** The project has a significant importance toward synchronous connectivity between the SR and WR. Commissioning of the 765 kV SC Raichur-Sholapur lines in December 2013 has facilitated in establishing first synchronous interconnection of the SR with rest of the grid. With this interconnection, the entire nation is now operating at one frequency across the nation. With the commissioning of 765 kV SC Raichur-Sholapur lines the total transfer capability between the SR and rest of the grid has increased by about 2,200 MW. Further, this link has facilitated in meeting the power transfer requirements of the SR and helped in meeting the demand of the SR beneficiaries.

5. **SRSS 17.** Some components of this scheme were shifted from PSDP IV AF during restructuring of the project. The original commissioning target as per the Restructuring Paper was by May 2015 and POWERGRID was able to commission it in December 2015. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays.** All the elements under the project were progressively commissioned by December 2015 with an overall delay of seven months from the original approved schedule due to following reasons:

(i) **Delay in land acquisition at Narendra (New Kudgi) GIS.** Complete possession of land from the Karnataka Industrial Area Development Board was taken only by February 28, 2014, after 24 months from the date of application.

(ii) Severe ROW issues were faced during the construction of the LILO of Kolhapur-Mapusa line at Kolhapur (new) due to stiff resistance from landowners. The construction work at the affected locations was stopped from May 2015 to August 2015 causing a delay of four months.

(iii) For Kolhapur (new) substation, the NoA was issued to M/s PINGGAO in February 2013. However even after persistent follow-up, M/s PINGGAO refused to accept the NoA due to disagreement regarding the scope. Therefore, fresh bids were invited again in August 2013 and the contract was awarded in February 2014. Efforts were made by POWERGRID to minimize the initial delay due to which the Kolhapur substation was commissioned in November 2015 with a time overrun of eight months.

(b) **Major benefits of the scheme.** With the commissioning of 765 kV D/C Narendra (new)-Kolhapur (new) line, the total transfer capability between the SR and the rest of the grid increased by 1,000 MW. The interregional link has facilitated additional import of power from the rest of the grid to the SR grid to the extent of 1,000 MW and facilitated in meeting the demand of SR beneficiaries. The link has also enhanced the stability of the interregional links under outage of one of the transmission lines.

6. **NRSS 24.** This scheme was shifted from PSPD IV AF to PSDP V after restructuring. The original commissioning target was by November 2014 but it was finally commissioned in March 2018. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) 400 kV D/C (quad) Dehradun-Abdullapur line. Implementation of this transmission line got delayed mainly due to delays in obtaining forest clearances, which took about 11–42 months as well as ROW issues in the route of the line. During construction of the line, POWERGRID faced severe protests from villagers and farmers unions. ROW issues were resolved with rigorous follow-up by POWERGRID and assistance from local administrative authorities and the line was commissioned in March 2018.

(b) **Major benefits of the scheme.** On commissioning of 400 kV D/C (quad) Dehradun-Abdullapur transmission line, Dehradun in the eastern part of the NR is now connected to Abdullapur in the western part of the NR. This improved system reliability of the NR particularly during foggy conditions and further established reliable transfer of power to various load centers in the NR.

7. **NRSS 25.** This scheme was added during restructuring of the project. The original commissioning target was by March 2016 while it was finally commissioned in October 2016. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) 765 kV S/C Jaipur-Bhiwani line. There was a marginal delay of seven months from the originally approved schedule. The implementation of transmission line got delayed due to severe ROW problems faced during construction of line at multiple locations and delays in obtaining forest clearance, which was received after 15 months from the submission of the proposal.

(b) **Major benefits of the scheme.** With increase in installed generation capacity in the state of Rajasthan and large quantum of import of power from the WR side, the power was required to be transferred out of Rajasthan. Therefore, 765 kV SC (second circuit) Jaipur-Bhiwani has enabled the transfer of power from Rajasthan to Bhiwani (Haryana). For further transfer of power beyond Bhiwani, 400 kV D/C Bhiwani-Hisar line and LILO of 400 kV D/C Bhiwadi-Moga at Hisar were commissioned under this scheme. The commissioning of this scheme has facilitated transfer of power beyond Jaipur (Rajasthan) in a reliable and secure manner.

8. **NRSS 26.** This scheme was added during restructuring of the project. The original commissioning date for this scheme was March 2015 while the actual commissioning was achieved in May 2015. The scheme was commissioned with a minor delay of two months. The major benefits from the scheme are as follows.

(a) **Major benefits of the scheme.** Upon commissioning of 765 kV S/C Meerut-Moga line, the power flow from western Uttar Pradesh toward Haryana/Punjab/Jammu and Kashmir was established with further strengthening the NR grid for reliable and secure power transfer. Several generation projects that have come up/are being planned to come up in the ER have NR as beneficiary. Power from these projects would also be evacuated through Meerut substation through 765 kV Balia-Lucknow-Bareilly-Meerut line.

9. **ERSS V (new).** This scheme was added during restructuring of the project. The original commissioning target was by April 2016 but it was finally commissioned in July 2020. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme.

(a) **Reasons for delays:**

(i) The scheme initially got delayed due to severe ROW issues faced by POWERGRID mainly in Rajarhat (West Bengal) and Purnea (Bihar) areas. Apart from this, damage done by local people in Rajarhat substation rendering ICT systems defective, restoration works of various foundations, and poor performance of M/s EMC, further delayed the scheme.

(b) **Major benefits of the scheme.** With commissioning of this scheme, a high-capacity corridor between southern and northern parts of West Bengal to meet the present as well as future load demand in Rajarhat and surrounding areas (close to Kolkata, capital of West Bengal) has now been established. Keeping in view the ROW problems in West Bengal, triple snowbird conductor line having higher power carrying capacity has been deployed rather

than twin moose conductor in the 400 kV D/C Rajarhat-Purnea line, which would help meet the long-term system requirement.

10. **Champa-Kurukshetra scheme.** This scheme was added during restructuring of the project. The original commissioning target as per the Restructuring Paper was by the end of May 2017, but it was finally commissioned in March 2020. The following are the reasons for delay from the originally approved schedule as well as major benefits from the scheme:

a. **Reasons for delays:**

(i) As per investment approval, the project was scheduled to be commissioned by March 2018. However, the commissioning of HVDC terminals was initially delayed due to delay in land acquisition/handing over of land for Champa HVDC station, complexities involved in DMR technology, and issues related to off-shore supplies. Given this, the overall Revised Implementation Schedule I of the project was later approved as March 2019.

(ii) It is pertinent to mention that software of existing bipole I had stand-alone features, that is, without parallel operation with bipole II (covered under PSDP V). The software needed to be modified for making it compatible for parallel operation. Therefore, the testing platform of bipole II (with two sets of bipole replica) was also utilized for making bipole I software compatible for parallel operation. Due to this, a lot of time elapsed for the start of parallel operation test of bipole II. Further, due to various bugs/shortcomings as observed in present bipole I software during its operation and during on-load commissioning tests, software modifications in bipole I were required. A similar kind of modification was also carried out for software of bipole II. This involved a lot of time in intermediate finalization of software and testing/validation during the development stage of bipole II software.

(iii) In view of the above and also considering replacement of faulty parts (wall bushings and voltage dividers) by M/s GE (a contractor), commissioning of bipole II (that is, pole III and pole IV) in Revised Implementation Schedule II of the scheme was approved as June 2019 and December 2019, respectively.

(iv) However, the development and testing of the software (Version 4) took more time and commissioning of pole III could be done only in October 2019 with a delay of about three months from the earlier anticipated commissioning schedule of June 2019. Software (Version 5) for parallel operation of bipole II with bipole I having features such as power oscillation damping, frequency control, master power coordination, and reclose feature for DC switches and software (Version 6) with additional features such as switchgear configurations, signal supervision, and pre-charge module for parallel pole deblock was developed and commissioning of the last element under the project, that is, Pole IV, was achieved in March 2020.

b. **Major benefits of the scheme.** The scheme included an upgrade of the ± 800 kV, 3,000 MW HVDC bipole between Champa and Kurukshetra to 6,000 MW, which has facilitated strengthening of NR-WR transmission corridor for dispersal of power with reliability and

security. This scheme stands out in terms of being the first in the world to deploy DMR conductor in place of conventional ground electrode resulting in saving of the land (about 75-85 acres); the second ±800 kV line in the country (after ±800 kV Biswanath-Chariyali transmission line); and Champa substation being the largest substation in the country (built on an area of 276 acres as it also houses 765/400 kV HVAC substation) and hence a major pooling station for transfer of 6,000 MW of power from the WR to NR.

## ANNEX 8. POWERGRID's KEY CORPORATE SOCIAL RESPONSIBILITY ACTIVITIES AND GENDER INITIATIVES

1. This annex provides a brief about the range of CSR activities and gender initiatives undertaken by POWERGRID across a number of areas at the corporate level.

2. Rural development:

   (a) Constructing community centers, open shed, roads, culverts, drains, classrooms in schools, drinking water system, developing ponds, and so on in villages in Angul District, Odisha.

   (b) Improving rural livelihoods through farmer-centric integrated watershed management where POWERGRID has undertaken establishment of 'Model Sites of Learning' in two locations in Kudgi (Karnataka) and Kurnool (Andhra Pradesh), of about 5,000 hectares (ha) each, for five years with effect from 2013/14 with the following objectives:

      (i) To harness the potential of rainfed areas by adopting integrated water source management approach

      (ii) To enhance water availability and its (green and blue water) use efficiency for diversifying the livelihood systems in the target villages by adopting integrated water resource management approach

      (iii) To build capacity of the farmers in the region for improving rural livelihoods through knowledge sharing and dissemination strategy.

3. Skill development:

   (a) Skill development training to over 5,000 youths spread across 33 locations across the country under partnership with the National Skill Development Corporation.

   (b) Imparting Skill Development Training Program to 360 youths at Indo-Danish Tool Rooms at Jamshedpur (Jharkhand) and Patna (Bihar).

   (c) Skill Development Program in computer numerical control (CNC) turning and milling, condensed course in tool and die making, certificate course in fitter trade, and certificate course in welding technology to 125 villagers near POWERGRID's substation of Gujarat and Madhya Pradesh.

   (d) A short-term vocational Skill Development Training Program for 560 underprivileged/unemployed youth in association with Central Institute of Plastics Engineering and Technology.

   (e) Placement-linked Skill Development Program for 300 unemployed/unskilled youth in SR Transmission System-II (SRTS-II) through ITCOT Consultancy and Services Limited, Tamil Nadu.

(f) A total of 25 capacity-building and skill development training programs conducted for 500 beneficiaries at various locations of ER-II (Rangpo, Jorethang, and Gangtok in Sikkim; Siliguri, Birpara, Subhashgram, Maithon, Dalkhola, Berhampore, and Malda in West Bengal; and Sundergarh, Indravati, Jeypore, Baripada, and Angul in Odisha).

(g) Skill development training on transmission line tower erection and stringing.

(h) Vocational training programs for 400 rural women on fruit and vegetable processing by Krishi Vigyan Kendra, Utukur, Kadapa.

(i) A tailoring program for five months (two months of orientation and three months for certification) at POWERGRID Township Gurgaon (Haryana) for underprivileged children.

(j) Training in vocational skills will be imparted to around 20 girls, and on successful completion of the course, a certificate along with a sewing machine and associated accessories for tailoring required for self-employment is provided.

4. Health:

(a) Construction of 10-storied, 325-bedded Dharmshala at All India Institute of Medical Sciences, New Delhi, for providing shelter to patients and their attendants.

(b) Preventive health checkup camps at 99 locations across India. More than 25,000 persons enrolled and benefitted.

(c) Investigations such as hemoglobin, blood sugar, electrocardiogram, pulmonary function test, blood pressure, eye checkup by physician doctors/consultants, and so on, were undertaken in these camps.

(d) Supply of aids and appliances to around 2,500 disabled persons at 9 locations through Artificial Limbs Manufacturing Corporation of India.

(e) Aids and appliances distributed to 1,751 persons in 8 camps.

(f) Ambulances distribution to various government hospitals.

5. Education:

(a) Construction of 9,437 toilets in 4,244 schools under ‘Swachh Vidyalaya Abhiyaan’.

(b) Construction of toilets in government schools in 170 blocks in 23 districts in the seven states of Andhra Pradesh, Assam, Bihar, Chhattisgarh, Madhya Pradesh, Odisha, and Uttar Pradesh.

(c) Construction of 40 room (120 bedded) boys hostel at Pt. Ravishankar Shukla University, Raipur, Chhattisgarh. The hostel has been completed and handed over to the university.

(d) Scholarship to 850 students of Assam and Manipur, who became orphans due to militancy/communal violence, through the National Foundation for Communal Harmony (Ministry of Home Affairs).

(e) Distribution of 10,000 solar lanterns to school children in Bihar, Jharkhand, and Odisha for better education.

(f) Installation of 14 solar hand pumps for providing solar drinking water facility to far-off hostels of the Tribal Development Department in district Jashpur, Chhattisgarh.

(g) Organized 'RIGI-CHINGI Patashala' for rural and backward class school students in Raipur, Chhattisgarh.

6. Environmental sustainability:

(a) Installation of solar photovoltaic lights in various villages.

(b) Chirang Reserve Forest with plantation of 50,000 saplings was successfully undertaken by POWERGRID in association with the Eco-Task Force of the Indian Army and the Bodoland Territorial Council.

(c) Renovation of Bhairobaba Talab, Bilaspur, Chhattisgarh.

7. Some success stories in CSR of POWERGRID at the corporate level are the following:

(a) **Towards an Independent and Sustainable Future: A Case on Women Empowerment.** Mrs. Uttam Sahu, a resident of Santarapur village, Angul, Odisha, is the widow of late Susil Rath who used to work in Rajasthan as a mason. She has two children (the older son is 8 years old and the younger daughter is 6 years old). In March 2012, her husband died of a heart attack. At that time her family was staying in Rajasthan. After her husband's death, she left her in-laws' house along with her children and started living with her father. During that time, she was worried about her livelihood, children's education, and their future. In February 2014, she came to know about skill development training programs to be organized at Angul under POWERGRID's CSR initiative, which also offered post-training employment opportunity. She grabbed the opportunity and applied for the training program. Eventually she got selected for the skill development training on ready-made garments which was a three-month course. During the training, she proved herself to be a serious and sincere learner. She quickly learned the art of cutting cloth, stitching, and designing ready-made garments.

The management session taken by the officials of POWERGRID, M/s Webcon, industrial promotion officer at Angul, and bank manager of Odisha Gramya Bank helped instill the required confidence and motivated her to start her own business. After the training, she received guidance from POWERGRID and M/s Webcon, and started her own home-based enterprise and at present she is earning INR 3,500 per month from tailoring of blouses, petticoats, salwars, and school dresses for children. She intelligently utilized the stipend amount to purchase a sewing machine and used toolkits, given after the training, as start-up

assets. At present, Mrs. Uttam Sahu is happy because she is able to provide better education and better food and see the smiling faces of her children. She is thankful to POWERGRID for helping her become independent and providing a road map for a secure future for her and her family.

(b) **Story of reclamation of Chirang Reserve Forest, Kokrajhar, Assam.** The story started with POWERGRID looking out for an appropriate vendor to undertake large-scale plantation in the north-eastern region. During the hunt, a small article appeared in a newspaper about an institution known as Eco-Task Force, based in Kokrajhar District, which was undertaking large-scale plantation. After a series of discussions, a pilot project was initiated for planting 10,000 saplings toward reclamation of Chirang Reserve Forest. Obtaining saplings in large numbers was proving to be a bottleneck for large-scale plantation, and therefore setting up of a nursery, capable of generating saplings in millions, was felt essential. This dream was soon converted to reality with the Bodoland Development Autonomous Development Council coming forward and allotting 100 hectares of land for the said nursery. POWERGRID chipped in with the requisite funds and the Eco-Task Force with the management. Very soon, the nursery was up and running, yielding an estimated 1 million saplings. With the supply of saplings assured, the project of reclamation of forest cover received a major boost and 100,000 saplings were planted in an area of 100 hectares of Chirang Reserve Forest. The said plot of land is fenced and protected. Gradually the saplings are growing to become full-scale trees and hopefully, the Chirang Reserve Forest will reclaim its lost glory.

(c) **The band of boys.** A group of friends in their early 20s belonging to villages near Kancheepuram in Tamil Nadu, often used to spend time together gazing at the transmission line towers passing through the lush green paddy fields near their village, wishing to scale their mighty heights someday. Their dreams soon turned into reality when they studied for three months, all expenses paid, the Capacity-Building Training Program of Power Transmission Line Tower Erection being conducted by POWERGRID with forward integration with employment. Today all the boys are gainfully employed with the contractors/subcontractors of POWERGRID, after successfully completing their training program, and are earning adequately to provide for their families. Similar programs are being conducted at two other locations in Salakati, Assam, and Nagpur, Maharashtra.

8. **Gender related initiatives by POWERGRID - a glimpse**: Gender Diversity is valued at POWERGRID and it is an inclusive and representative dimension in the organization. POWERGRID respects this aspect as an essential facet and try to leverage it for maximum organizational performance. POWERGRID's Inclusion Strategy aims at "inclusion of everyone and prevention of discrimination" and goes an extra mile to make workforce homogeneous and foster the culture of mutual respect. Due to locational constraints, the sector was traditionally dominated by male working force, and therefore POWERGRID has made additional efforts to the workplace so gender is balanced. The representation of women in POWERGRID has improved from 5.95 percent in 2010 to 8.05 percent in 2020. POWERGRID values and celebrates gender differences and try to nurture the workplace where all can thrive. POWERGRID tries to make a comfortable working place for the female workforce and is evident from the following:

(a) Conduct and Disciplinary Rules: POWERGRID's 'Conduct, Discipline and Appeal Rules' has a clause against sexual harassment of women in the workplace and ensures no discrimination on the basis of gender.

(b) Mahila Samiti: Mahila Samiti is formed at Regional, Divisional, Group Office level and wherever Company has a township to provide a forum for interaction for female employees and female members of the families of employees with a view to enriching their social life. The Samiti regularly conducts meetings, organizes festivals and programs and engages all women employees and the families in a fruitful manner.

(c) Women Professional Circle and Women Cell: POWERGRID organizes these women circles to support each other at the personal and professional front. This is a free and open platform to discuss the relevant work /professional topics concerning all women. White papers and reports are prepared after that on the topic discussed.