JICA-assisted **ENERGY SECTOR PROJECTS** in India

Japan International Cooperation Agency

Table of Contents

List of Energy Sector Projects

ODA LOAN PROJECTS	DATE OF LOAN AGREEMENT
Nagarjunasagar Hydroelectric Power Station Expansion Project	13/06/1978
Paithan Hydroelectric Project	08/10/1978
Chandrapur Thermal Power Station Expansion Project	06/02/1981
Western Yamuna Canal Hydroelectric Project	19/03/1981
Nagarjunasagar Hydroelectric Power Station Project (Stage II)	15/10/1981
Lower Borpani Hydro Electric Project	15/10/1981
Hirakud Hydroelectric Project	15/10/1981
Lower Mettur Hydro Electric Project	15/10/1981
Tamil Nadu State Micro Hydro Power Stations Construction Project	23/02/1983
Eastern Gandak Canal Hydroelectric Project	26/12/1984
Anpara B Thermal Power Station Construction Project	26/12/1984
Gas Pipeline Project	26/12/1984
Ujjani Hydroelectric Project	25/11/1985
Gas Pipeline Project (II)	25/11/1985
Sardar Sarovar (Narmada) Hydroelectric Project	25/11/1985
Teesta Canal Hydroelectric Project	18/12/1986
Gas Pipeline Project (III)	18/12/1986
Assam Gas Turbine Power Station and Transmission Line Construction Project	18/03/1987
Purulia Pumped Storage Project (E/S)	10/02/1988
Srisailam Left Bank Power Station Project (Phase I)	02/10/1988
Assam Gas Turbine Power Station and Transmission Line Construction Project (II)	02/10/1988
Anpara B Thermal Power Station Construction Project (II)	02/10/1988
Raichur Thermal Power Station Expansion Project	15/12/1988
Ghatghar Pumped Storage Project	15/12/1988
Modernization Project of Burnpur Steel Works (E/S)	06/01/1989
Kolaghat Thermal Power Station Fly-ash Utilization Project (E/S)	27/03/1990
Gandhar Gas Based Combined Cycle Power Project (I)	27/03/1990
Basin Bridge Gas Turbine Project	27/03/1990
Bhavani Kattalai Barrage Hydro Electric Project (I)	27/03/1990
Teesta Canal Hydroelectric Project (II)	23/01/1991
Anpara B Thermal Power Station Construction Project (III)	23/01/1991
Power System Improvement and Small Hydro Project	23/01/1991
Anpara Power Transmission System Project (I)	13/06/1991
Gandhar Gas Based Combined Cycle Power Project (II)	09/01/1992
Anpara B Thermal Power Station Construction Project (IV)	12/03/1992
Hydrocarbon Sector Program	12/03/1992
Gandhar Gas Based Combined Cycle Power Project (III)	21/12/1992
Srisailam Power Transmission System Project	21/12/1992
Bakreswar Thermal Power Project	24/01/1994
Faridabad Gas Based Power Station and Associated Transmission System Project	24/01/1994
Anpara B Thermal Power Station Construction Project (V)	24/01/1994
Bakreswar Thermal Power Station Unit 3 Extension Project	28/02/1995
Purulia Pumped Storage Project	28/02/1995
Srisailam Left Bank Power Station Project (II)	28/02/1995
Srisailam Power Transmission System Project (II)	28/02/1995
Kothagudem'A' Thermal Power Station Rehabilitation Project	28/02/1995
Assam Gas Turbine Power Station and Transmission Line Construction Project (3)	28/02/1995
Pipavav Port Ship-breaking Project	25/01/1996
Anpara Power Transmission System Project (II)	25/01/1996
Dhauliganga Hydroelectric Power Plant Construction Project (I)	25/01/1996
West Bengal Transmission System Project	25/02/1997
Simhadri Thermal Power Station Project	25/02/1997
Umiam Hydro Power Station Renovation Project	25/02/1997
Tuirial Hydro-electric Power Station Project	25/02/1997
Northern India Transmission System Project	25/02/1997
Bakreswar Thermal Power Station Project (II)	12/12/1997
Simhadri and Vizag Transmission-System Project	12/12/1997
Srisailam Left Bank Power Station Project (III)	12/12/1997
Dhauliganga Hydroelectric Power Plant Construction Project (II)	12/12/1997
Bakreswar Thermal Power Station Unit 3 Extension Project (II)	24/03/1999
Simhadri Thermal Power Station Project (II)	30/03/2001
Simhadri Thermal Power Station Project (III)	13/02/2002
West Bengal Transmission System Project (II)	10/05/2002
Simhadri and Vizag Transmission System Project (II)	05/10/2002

ODA LOAN PROJECTS	DATE OF LOAN AGREEMENT
Bakreswar Thermal Power Station Units Extension Project	31/03/2003
Simhadri Thermal Power Station Project (IV)	31/03/2003
Purulia Pumped Storage Project (II)	31/03/2004
Umiam Stage 2 Hydro Power Station Renovation and Modernisation Project	31/03/2004
Dhauliganga Hydroelectric Power Plant Construction Project (III)	31/03/2004
North Karanpura Super Thermal Power Project (I)	31/03/2005
Purulia Pumped Storage Project (III)	31/03/2006
Rural Electrification Project	31/03/2006
Transmission System Modernisation and Strengthening Project in Hyderabad Metropolitan Area	30/03/2007
Bangalore Distribution Upgradation Project	30/03/2007
Maharashtra Transmission System Project	14/09/2007
Haryana Transmission System Project	10/03/2008
Micro, Small And Medium Enterprises Energy Saving Project	21/11/2008
Andhra Pradesh Rural High Voltage Distribution System Project	16/06/2011
Madhya Pradesh Transmission System Modernisation Project	16/06/2011
Micro, Small and Medium Enterprises Energy Saving Project (Phase II)	16/06/2011
New and Renewable Energy Development Project	16/06/2011
Tamil Nadu Transmission System Improvement Project	28/09/2012
Micro, Small and Medium Enterprises Energy Saving Project (Phase III)	09/01/2014
New and Renewable Energy Development Project (Phase II)	09/01/2014
Haryana Distribution System Upgradation Project	31/03/2014
Odisha Transmission System Improvement Project	15/05/2015
Transmission System Strengthening Project in Madhya Pradesh	03/03/2016
Project for Renovation and Modernisation of Umiam-Umtru Stage 3 Hydroelectric Power Station	03/03/2016
Project for the Construction of Turga Pumped Storage at Purulia District in West Bengal	11/02/2018
Project for Renovation and Modernisation of Umiam-Umtru Stage III Hydroelectric Power Station	30/10/2018
Project for Community-Based Forest Management and Livelihoods Improvement in Meghalaya	27/03/2020

TECHNICAL COOPERATION PROJECTS	DURATION
Master Plan Study on Pumped Storage Hydroelectric Power Development in Maharashtra	1993-1997
Development Study on the Improvement of Power Distribution System of Andhra Pradesh	2003-2005
Study on Enhancing Efficiency of Operating Thermal Power Plants in NTPC - India	2008-2010
Energy Conservation Technique	2008-2013
Research Partnership for the Application of Low Carbon Technology for Sustainable Development	2010-2014
Training on Energy Conservation Technique	2014-2016
Dispatch of Power Sector Advisor	2021

GRANT, PRIVATE SECTOR INVESTMENT AND FINANCE (PSIF), AND SURVEY	FISCAL YEAR OF AGREEMENT
Project for the Improvement of Power Supply in Andaman and Nicobar Islands (GRANT)	2022
Research Partnership for the Application of Low Carbon Technology for Sustainable Development (SATREPS)	2010
Data Collection Survey for Cross-Border Electricity Trade (CBET) in BBIN* Region (Survey)	2020
Tata Cleantech Capital Limited (TCCL) (PSIF)	2021
Neev Fund II (PSIF)	2021

Key
ODA Loans
Technical Cooperation Projects
Grant, PSIF and Survey

Message from the Chief Representative, JICA India Office

As climate change poses extensive threat to human security, stability, and prosperity across countries, urgent actions are needed to address common challenges that cause considerable damage to natural ecosystems and the global economy. The fifth largest economy in the world, India is a frontrunner among developing nations on the global stage, and its contributions to geopolitical and climate interventions are becoming increasingly significant. For instance, at a time when the global landscape is grappled with multifaceted challenges, India took on the baton of G20 Presidency. The successful outcomes of the G20 summit under India's leadership, are a testimony of the nation's commitment to deliver consistently on the global turf for creating a better future for all.

A decade ago, India embarked on its energy transition journey, and there has been no looking back. Over the years, concerted efforts have resulted in a combined installed capacity of 180.79 GW, making it 4th largest in Renewable Energy Installed Capacity (including large hydropower), globally . While installed capacity of Wind power is 44.73GW, that of Solar Power is 73.31GW, underscoring India's renewables prowess. However, the country has set itself some more ambitious goals such as producing five million tonnes of green hydrogen by 2030, which will be supported by 125 GW of renewable energy capacity. While an offshore target of 30 GW by 2030 has been set for wind Energy, with potential sites identified, 50 solar parks with an aggregate capacity of 37.49 GW have been approved.

As India's RE sector expands, so does the need for ensuring grid stability to ensure uninterrupted power supply. There is also a growing significance of increasing renewable sources to accomplish its ambitious climate action and RE goals. JICA has been supporting India's energy projects for a long time. To date, we have supported the installation of 11.8 GW energy capacity, including 7 GW in the renewable sector. JICA's support to projects in Telangana, Andhra Pradesh, Haryana, Madhya Pradesh, Maharashtra, West Bengal, Meghalaya, Odisha, and Uttarakhand for the modernisation of transmission and distribution lines has helped in promoting energy efficiency in the country.

Along with providing ODA loans and grants, we have also appointed a JICA Energy Expert at the Central Electricity Authority (CEA) in 2021 with the aim of helping India achieve its targets under the National Electricity Plan (NEP). We hope our technical cooperation will enable energy optimisation and conservation in better, more sustainable ways.

JICA understands that electricity is crucial to India's socioeconomic development. As India's energy sector continues to flourish, we are keen on playing a more active part by supporting projects that contribute to the nation's inclusive and sustainable development, thereby helping it achieve just energy transition.

SAITO Mitsunori,

Chief Representative,
JICA India Office

1. www.psuconnect.in/news/India-ranked-3rd-largest-primary-energy-consumer-in-the-world/31843/

Introduction: Energy Sector Team

WATANABE Jun: Senior Representative

India's commendable efforts have paved the way for bold economic reforms and policies to uplift underserved communities. Over the past 60 years, JICA has proudly partnered with the Government of India and state governments to combat poverty, foster investments, and develop crucial infrastructure. As the third-largest energy consumer globally, India's power sector plays a pivotal role in driving sustainable growth for the world. Through our unwavering support, we continue to contribute to India's energy projects, empowering its progress and prosperity.

Shashi Khanna: Additional Chief Development Specialist

Access to affordable and uninterrupted electricity is crucial for economic progress. JICA recognises the immense potential of India's power sector and stands ready to extend support. Our focus areas include devising a roadmap for India's energy transition till 2070, enhancing energy efficiency, integrating renewable energy sources into the grid, and improving the overall power supply quality. Through collaborative efforts, we can achieve sustainable development and ensure a brighter future for all Indians. We at JICA, will continue to support India through reliable and cleaner energy solutions.

Aditi Puri: Principal Development Specialist

I am excited to be part of India's journey towards a sustainable and inclusive power sector. India's energy consumption ranks third globally, highlighting the need for a strong and reliable infrastructure. JICA has been a steadfast supporter of India's energy projects, working closely with the government and stakeholders. We are committed to leveraging our expertise to address the challenges and opportunities in the power sector. Through collaboration, innovation, and knowledge exchange, we can create an energy landscape that propels India's growth while protecting the environment.

HINO Kunro: Representative

India's energy sector is brimming with potential. From transitioning to renewable energy to adapting environment friendly means of power generation, the nation, with its ambitious plans is aiming to fulfill the energy requirements of its vast population and industries. At the same time, India is playing a significant role in being the voice of clean energy transition, working with like-minded global partners in solving the challenges of access to reliable power for all. I believe, the Japan-India partnership in the energy sector stands to benefit India's energy infra along with a long-term impact on the global development in this domain.

SAKURAI Noriko: Project Formulation Advisor

A strong energy ecosystem is essential for the deeper development of a progressing country like India. Challenges such as significant peak energy shortages in the country owing to inadequate generation, transmission & distribution losses, and inefficient use of electricity still stand in the way of realising its full potential. I believe that even the remotest part of India should get access to reliable and clean energy. As mentioned in the SDGs, I am glad to be part of this journey where projects are designed to "ensuring access to affordable, reliable, sustainable and modern energy for all".

Mahua Mukherjee: Senior Project Officer

Electricity is crucial for India's socioeconomic development. Recognising the importance of reliable and clean energy, with the use of alternative resources the governments of Japan and India are working towards strengthening the energy ecosystem of the country. I am happy to be part of the JICA-India energy team who is working to support India's decarbonisation and renewable energy initiatives and contributing to the nation's development.

Surabhi Sondhi: Senior Project Officer

Reducing the dependence on coal powered energy generation is key for ensuring a clean environment for a better future for all. Japan and India are making concerted efforts and remain at the forefront of decarbonising the power sector with alternatives such as solar, wind and hydrogen. As part of JICA India's energy initiatives in the country, I am pleased to participate in what I believe would be the most successful energy transition journey in the progressive world.

ISHIKAWA Saya, Representative

India stands at the forefront of the world's shared journey to wean away from fossil fuels as much as possible and steer the wheel toward increasing renewable energy consumption. The country's impressive efforts for bringing about energy transition with solar, wind, and hydrogen is a testament to its commitment in making it a success story for a greener future. We, at JICA, are happy to support India in its quest to building the infrastructure needed for developing its renewable energy capacity, through various ODA loans and technical support.

An Overview of India's Power Sector

Cognisant of the fact that energy access is essential for economic growth and poverty alleviation, India aims to provide reliable and affordable energy to all households. The growth of India's power sector since independence has been quite remarkable, with almost a hundred-fold increase in generation capacity. However, the demand for power has largely outstripped the supply.

Today, India's power generation sources range across conventional sources such as coal, lignite, natural gas, oil, hydro, and nuclear power, as well as viable non-conventional sources such as wind, solar, and agricultural and domestic waste. The Government of India's focus on providing "power for all" has accelerated capacity addition and improved electricity access from 89.53%[2] of the population in 2016 to 97.80% in 2019, according to World Bank data.

Today, India is the world's third-largest producer and consumer of electricity, with an installed power capacity of 407.79 GW as of September 2022, including renewable energy capacity of 164.93 GW (representing 40.4% of the total installed power capacity). Within non-fossil-fuel-based energy, solar power contributes the largest share with an installed capacity of almost 60.81 GW, followed by wind power with 41.66 GW, and biomass with 10.206 GW, while hydropower contributes 46.85 GW, and small hydropower accounts for 4.89 GW. Under the Union Budget for financial year 2022-23, the Central Government announced the issuance of sovereign green bonds and conferred infrastructure status to all energy storage systems, including grid-scale battery systems. Furthermore, an amount of Rs 19,500 crore (US$ 2.57 billion) was allocated for a Production Linked Incentive Scheme (PLI) to boost manufacturing of high-efficiency solar modules.

India plans to add 500 GW of renewable energy to the electricity grid by 2030 in a bid to curb air pollution, decarbonise the power sector, and reduce the dependence on coal. In 2020, India was ranked fourth in the world in terms of wind power generation capacity, fifth in solar power, and fourth in renewable power installed capacity overall. It is the only G20 nation that is on track to achieve the targets under the Paris Agreement.

However, as India works towards a better energy future, it will need to address some long-standing challenges. Even today, there are significant peak energy shortages in the country owing to inadequate generation, transmission and distribution losses, and inefficient use of electricity. Consistently high levels of technical and commercial losses; the lack of a commercial approach in the management of utilities; and unsustainable cross subsidies have made the operations of distribution companies financially unviable. Meanwhile, inadequacies in distribution networks have resulted in an inferior quality of power supply.

2. www.jica.go.jp/Resource/india/english/office/topics/press211214.html

India’s Power Sector Policies and Regulations

There have been several changes in India’s energy system over the years. The foundation of these changes was laid by the Electricity Act 2003, which replaced the Electricity Act 1910, the Electricity Supply Act 1948, and the Electricity Regulatory Commission Act 1998. This set into motion the transformation of India’s energy sector.

The Electricity Act 2003 aimed to foster competition, protect consumer interests, and provide power for all. It covered several important aspects including a National Electricity Policy (NEP); rural electrification; open access in transmission; phased open access in distribution; mandatory State Electricity Regulatory Commissions (SERCs); license-free generation and distribution; power trading; mandatory metering; and stringent penalties for electricity theft. It emphasised the assessment of demand as an important pre-requisite for planning capacity addition.

The Act, in its objectives and substantive provisions, made the promotion of renewable energy an explicit obligation of regulatory institutions and power utilities. This was subsequently reinforced by the National Electricity Policy 2005 and other regulatory and policy measures, including institutional support to solar generation (through initiatives such as the Jawaharlal Nehru National Solar Mission, the International Solar Alliance, and the establishment of Solar Energy Corporation of India Limited), and a green energy incentive (including Renewable Energy Certificates and feed-in tariffs). Furthermore, the Indian Electricity Grid Code (IEGC) makes provisions for renewable energy and renewable power obligations for distribution companies (DISCOMs), thus giving renewable energy its due place in the national grid. There have been amendments to the Electricity Act – once in 2003, and then in 2007. These amendments were made to stimulate commercial growth in the sector and increase synergies between the Centre and the States.

The Energy Conservation (Amendment) Bill 2022 was yet another key moment for India’s power sector. The amendments under the Bill focus on the imminent integration of renewable energy into the grid as well as India’s climate change commitments. The Bill aimed to reduce India’s fossil fuel-based energy consumption by defining the minimum share of renewable energy to be consumed by various establishments. It incentivises the use of clean energy by promoting carbon credit marketplaces. The Bill also had provisions for ramping up the adoption of green hydrogen as an alternative to fossil fuels. Furthermore, it sought to regulate energy consumption by equipment, appliances, buildings, and industries, and amend the energy conservation code for buildings to make it an “energy conservation and sustainable building code”. The Bill was anchored in the spirit of reformation and has several measures aimed at uplifting DISCOMs too. The Bill empowered SERCs to adjudge penalties under the Energy Conservation Act, 2001 and added that SERCs may also make regulations for discharging their functions.

The above policy and regulatory changes will help India deliver on its updated Nationally Determined Contributions (NDCs), under which it aims to reduce the emission intensity of its GDP by 45 percent by 2030 from 2005 levels, and source 50 percent of electricity from non-fossil sources.

JICA's Cooperation Policy and Approach in India's Energy Sector

As the world moves towards decarbonisation, India has announced that it will become a net-zero emitter by 2070. In the medium term, India has set itself a target of 500 GW of installed renewable energy capacity by 2030 and to have 50% of its installed capacity from clean sources. At the same time, the country is strongly promoting energy efficiency and keeping the energy tariffs affordable to encourage sustainable economic growth.

The hallmark of India's ongoing energy transition is the use of renewable energy, such as solar and wind power, for which there is huge potential in the country. Although the unit price of electricity from renewable energy has become cheaper, there are still some challenges that need to be addressed in terms of supply and demand and the stability of the power supply.

The introduction of renewable energy into the power grid can lead to instability in frequency and voltage. From the point of view of both safety and productivity, it is important to ensure that the power supply is of stable frequency and voltage and has minimum interruptions. As the output of solar and wind power generation systems varies with the weather conditions, it is necessary to accordingly adjust the output of thermal and hydroelectric power generation to ensure grid stability. Furthermore, it is important to have means for storing solar and wind power during times of surplus generation, so that it can be released into the grid when needed.

JICA is willing to offer support in ways that consider the prevailing circumstances and are in line with the Government of India's policies and regulations. This includes support in areas such as developing a roadmap for India's energy transition till 2070; using energy efficiently; ensuring stable supply of electricity with the addition of renewable energy into the grid; and improving the quality of power supply.

High-performance heat pumps and high-performance boilers can help with using energy efficiently. The use of pumped storage, hydro power plants, green hydrogen, and Battery Energy Storage Systems (BESS) can play a big role in ensuring stable supply of electricity when the energy mix has a high share of renewable energy. Green hydrogen can be used for co-firing existing coal-fired power plants, while bioenergy and Carbon Capture Utilisation and Storage (CCUS) can help with decarbonisation.

JICA will support India's decarbonisation and renewable energy initiatives through schemes such as Policy Lending, Two Step Loan, Project Loan, Technical Cooperation (including Capacity Building and Policy Advocacy), and Private Sector Investment Finance (PSIF).

Recent ODA Loan Projects

- Haryana Transmission System Project (FY2007)
- Haryana Distribution Upgradation Project (FY2013)

- Madhya Pradesh Transmission System Modernisation Project (FY2011)
- Madhya Pradesh Transmission System Strengthening Project (FY2015)

- Maharashtra Transmission System Project (FY2007)

- Bangalore Distribution Upgradation Project (FY2006)

- Tamil Nadu Transmission Svstem Improvement Project (FY2012)

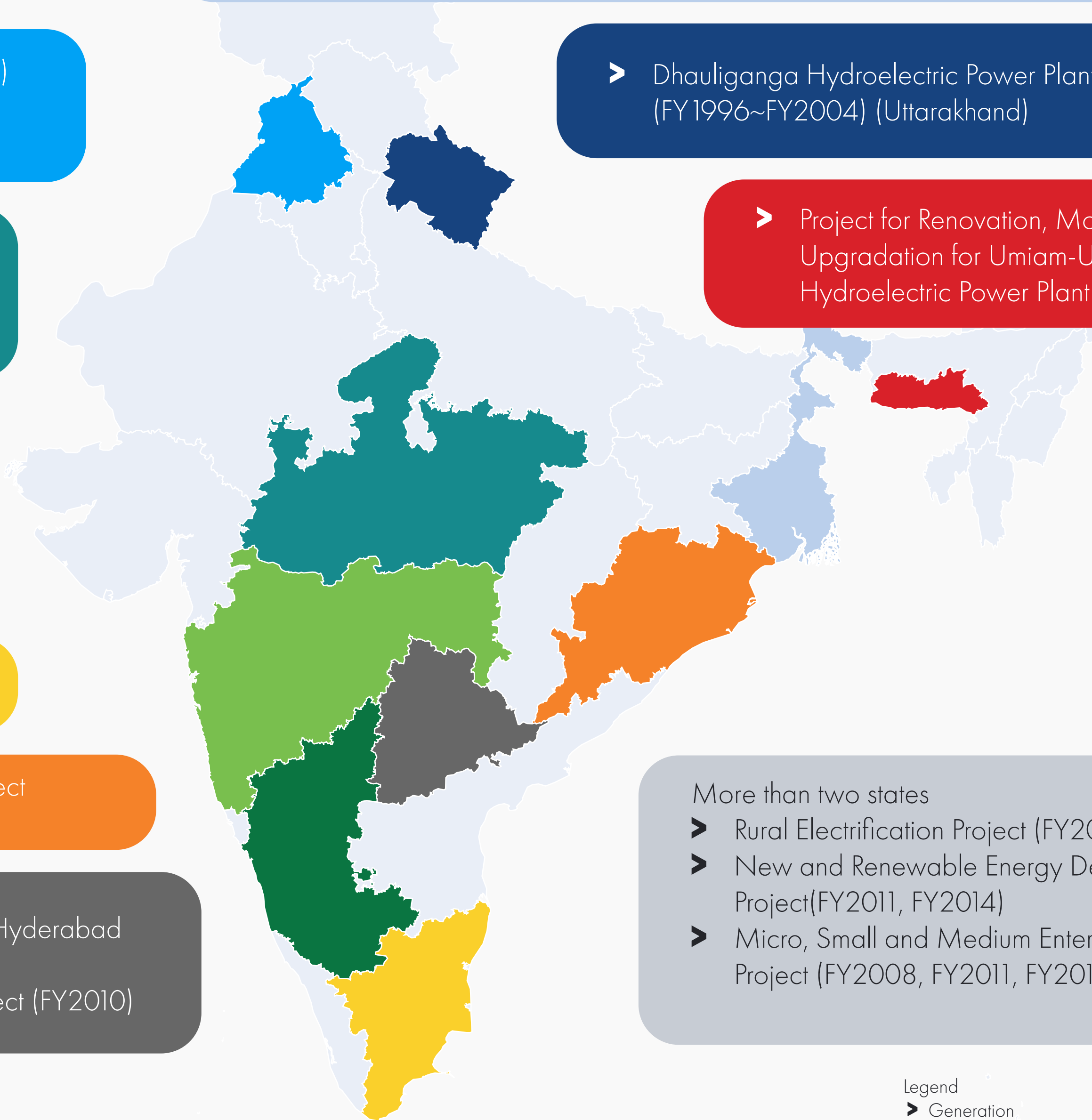
- Odisha Transmission System Improvement Project (FY2015)

- Transmission System Modernisation Project in Hyderabad (FY2006)
- AP Rural High Voltage Distribution System Project (FY2010)

> Purulia Pumped Storage Project (FY1994, FY2004, FY2005)
> Project for the Construction of Turga Pumped Storage (FY2018)

> Dhauliganga Hydroelectric Power Plant Construction Project (FY1996~FY2004) (Uttarakhand)

> Project for Renovation, Modernisation and Upgradation for Umiam-Umtru Stage III Hydroelectric Power Plant (FY2018)



More than two states

> Rural Electrification Project (FY2005)
> New and Renewable Energy Development Project(FY2011, FY2014)
> Micro, Small and Medium Enterprises Energy Saving Project (FY2008, FY2011, FY2014)

Legend
> Generation
o Transmission and Distribution

1 Transmission System Modernisation and Strengthening Project in Hyderabad Metropolitan Area

Date of Loan Agreement: March 30, 2007
Loan Amount: 23,697 million Yen
Executing Agency: Transmission Corporation of Telangana Limited (TSTRANSCO)
Project Status: Completed (May 2018)

Summary: The objective of this project was to improve the reliability and quality of the power supply by strengthening the transmission system in the Hyderabad Metropolitan Area, thereby contributing to local economic development and improving in the living standards of the residents. The project was largely consistent with the India's development policy and development needs, and with Japan's ODA policy. Hence, its relevance is high. While the project cost was lower than planned, the project period was longer due to delays in obtaining road cutting permissions for laying underground transmission lines; the bifurcation of the state in 2014; and changes in the locations of sub-stations.

Outcomes/Results: The stability, reliability and capacity of the power supply have improved. The voltage fluctuation ratio, power outage times, and transmission loss rate have all declined while the amount of power supply has increased. The substations constructed under this project are functioning well. The project has also positively contributed to economic development, business activities, job creation and an improvement in the living standards of residents in the Hyderabad Metropolitan Area. The effectiveness and impact of the project is thus significantly high.

Appealing Points:

- The voltage fluctuation ratio of electricity transmitted from the substations constructed under the project has hovered between +3% and -1.5% since FY2015-16. This improved significantly with the achievement of the target number (± 4.09%) compared to the ratio at the time of the project appraisal (± 6.87%). Thus, it can be said that the power supply has been stable. This also meets Telangana's and the executing agency's standard criteria for voltage fluctuation ratio of less than or equal to ±10%.
- The reliability of the power supply in the project area has improved, as is evident from the huge reduction in the number of annual power outages in the project area: two in FY2015-16, five in FY2016-17, and three in FY2017-18, compared with 71 when the project was envisaged.
- The transmission loss rate of 3.25% in FY2017-18 was significantly lower than the target transmission losses of 4.0%. This was due to the large expansion of the transmission network system after the state bifurcation. The project was a big factor in reducing transmission loss rate.
- The electricity supply in the project area in FY2017-18 was 17,250 GWh, exceeding the target level of 16,329 GWh, which improved the capability to supply electricity.

2 Andhra Pradesh and Telangana Rural High Voltage Distribution System Project

Date of Loan Agreement: June 16, 2011
Loan Amount: 18,590 million Yen
Executing Agency: Southern Power Distribution Company of Andhra Pradesh Limited; Northern Power Distribution Company of Telangana Limited; Southern Power Distribution Company of Telangana Limited
Project Status: Completed (January 2016)

Summary: The objective of the project was to improve the reliability and quality of power supply for agricultural services and reduce distribution losses by converting Low Voltage Distribution System (LVDS) to High Voltage Distribution Lines (HVDS) in the rural areas of Andhra Pradesh and Telangana. This would ensure stable energy supply in the state, enhance agricultural production efficiency, and lift the living standards of the rural population. The target area comprised 16 districts.

Outcomes/Results:

- Most of the indicators of the operation and effectiveness of the project such as distribution loss; reduction in failure of DTRs; the rate of unauthorised irrigation pump sets; and improvement in voltage profile, were achieved. In terms of impact, yields increased for most of the farmers due to a decrease in failures of irrigation pumps, resulting in less repair costs. Electricity was used judiciously. The effectiveness and impact of the project were thus high.
- In terms of the efficiency of the project, there was a change in the material and capacity of the distribution transformer (DTR), which is one of the desired outputs of the project. The material was changed because it was less likely to be stolen and also more economical than the originally planned material. This resulted in the project period significantly exceeding the plan and lowering the efficiency of the project slightly.

Appealing Points:

- The project aimed to improve energy efficiency by reducing distribution loss, reduce Greenhouse Gas (GHG) emissions, and mitigate climate change. The executing agency proactively thought of registering the project for the Clean Development Mechanism (CDM).
- The project entailed an HVDS Improvement Plan (the installation of approximately 69,000 km high-voltage distribution lines and approximately 195,000 units transformers, and the conversion of LVDS to HVDS). Out of all the rural areas in the two states covered under the plan, the project focused on those areas that would significantly benefit from the project activities.
- Procurement of equipment (high-voltage distribution lines, small-capacity transformers, supporters, and low-voltage lines).
- Civil works associated with the installation.

3 Haryana Transmission System Project

Date of Loan Agreement: March 10, 2008
Loan Amount: 20,902 million Yen
Executing Agency: Rural Electrification Corporation Limited (REC) and Haryana Vidyut Prasaran Nigam Limited (HVPN)
Project Status: Completed (May 2017)

Summary: The objective of this project was to ensure stable power supply to meet the rapidly growing demand by developing an intra-state transmission and substation system in Haryana, which would contribute to economic growth and improve the living conditions of the people in the region. The relevance of the project is high, as the objective is consistent with India's development policies and development needs as well as with the Japanese ODA policies.

Outcomes/Results: This project had a positive impact on regional economic development. It reduced operation and maintenance costs for backup power generators and increased the productivity of bulk electricity users in Gurugram. A more stable power supply has been achieved, which has improved productivity and service for corporate customers. For example, there has been a 5% increase in sales and production in the iron manufacturing industry. In hotels, the in-house power generation now automatically switches on whenever there is a power outage. There is a time lag ranging from some seconds to a few minutes before the power is switched on, which has led to complaints from some hotel guests. However, such complaints have decreased over time.

The standard of living of people in villages in the central part of the state has improved because of an increase in power supply and reduction in voltage fluctuations. The notable impacts include: (I) improved access to information through TV, radio, mobile phones and the internet; (II) improvement in educational opportunities with students now being able to study at home during the night; (III) a reduction in domestic working hours resulting from the use of home electrical appliances; and (IV) improved safety at night. No negative impact on the natural environment has been observed. Land acquisition for the project was appropriately executed, in accordance with the applicable laws and regulations. There was no resident resettlement. No major problem has been observed in the institutional, technical, or financial aspects, or in the status of the operation-and-maintenance system. The sustainability of the project impact is therefore high, and the project has been evaluated as highly satisfactory.

Appealing Points:

- This project has seen the new construction or expansion of substations in 19 locations and the construction of 582.7 km of power transmission lines. These are equivalent to 4.5% of HVPN's overall substation facilities and 5.6% of the total power transmission lines (there were 418 substations and approximately 15,000 km power transmission lines overall in HVPN as of the end of August 2017).

- In terms of the structure of project implementation, the project steering committee, consisting of the related departments from REC and HVPN, got together every six months to ensure smooth implementation of the project. Project-monitoring, decision-making and coordination between related departments were all carried out smoothly. The REC Haryana office in Panchkula took charge of monitoring the project regularly.
- During project implementation, the contractor took the necessary mitigation measures to reduce soil erosion and noise and to mitigate negative impact on air and water.

4 Bangalore Distribution Upgradation Project

Date of Loan Agreement: March 30, 2007
Loan Amount: 10,643 million Yen
Executing Agency: Bangalore Electricity Supply Company Limited (BESCOM)
Project Status: Completed (September 2021)

Summary: The project aimed to improve the reliability of electricity supply through the reduction of outage duration by the development of a Distribution Automation System (DAS) and related facilities in Bangalore, thereby contributing to local economic development and improvement of the living standards of residents. The DAS system has been delivered, installed, commissioned and is in commercial operation. The most important and significant function of the system – Fault Detection, Isolation, and Restoration (FDIR) – was designed with the express aim of leveraging modern automation technology to reduce customer outage times to internationally recognised "best-of-class" levels. Potential additions to the system are functions such as Load Shed and Restore and Operator Training Simulator. Furthermore, to provide a mission-critical disaster recovery capability, the DAS encompassed a Backup Control Center and a Main Control Center.

Outcomes/Results: Accidental outage duration per customer was 16.16 hours in the year of project completion (FY2019), 22.76 hours one year after completion (FY2020), and 32.93 hours two years after project completion (FY2021), compared to the target of 31.4 hours. Peak load was 3,081 MW in the year of project completion, 2,832 MW one year after, and 2,882 MW two years after project completion, exceeding the target of 2,630 MW. Distribution loss was 7.33% in FY2021, which exceeded the target. Electricity consumption was 18,786.6 GWh in the year of project completion, 16,545.3 GWh one year later, and 12,232.6 GWh two years after project completion, compared to the target of 12,326 GWh.

Appealing Points:

- BESCOM was honoured on 29 November 2019 with the SKOCH AWARD for ENERGY in Gold Category for the Distribution Automation System Project. The BESCOM DAS team's efforts in implementation this technology-driven project have been recognised at the national level. Several national and international visitors, who have visited the DAS control centers, have appreciated the dedication of the staff there.
- BESCOM has assimilated the lessons, which they have learned through the integration of DAS, into their work process. Now that their operations have demonstrated the benefits of implementing DAS, they are willing to share their experience with other DISCOMs to promote DAS installation through JICA.

5 Madhya Pradesh Transmission System Modernisation Project

Date of Loan Agreement: June 16, 2011
Loan Amount: 18,475 million Yen
Executing Agency: Madhya Pradesh Power Transmission Company Limited (MPPTCL)
Project Status: Completed (February 2021)

Summary: The project sought to ensure reliable transmission of electricity and avoid overloading of transmission systems in Madhya Pradesh and the Western Region after the planned expansion of power generation, by modernising transmission system throughout Madhya Pradesh. For implementing the Project, MPPTCL employed the latest technology available in the field of Extra High Voltage (EHV) substations and EHV transmission line system. The project involved:

- Construction of 220kV and 132kV transmission lines
- Construction of new 220kV and 132 kV substations
- Construction of 400kV, 220kV and 132 kV transformer and feeder bays
- Addition/augmentation of transformers and reactors in 400kV, 220kV and 132kV substations

Outcomes/Results: As the project components were designed for strengthening the transmission system for future increase in power generation, the slight delays involved in the execution of a few components did not have any adverse effects as such. Reliable power transmission was ensured through the existing grid-connected transmission system. Though the project was sensitive, its implementation did not have any adverse environmental impact. The overall evaluation of the project's outcome is marked as satisfactory.

Appealing Points:

- This was the first project carried out on a turnkey basis by MPPTCL. Earlier, contracts for procurement of material and construction were awarded separately. Though costly, awarding contracts on a turnkey basis reduces the size of the workforce required to handle big projects. This was the case here too. It also made the project monitoring easier. To get competitive prices and to maintain strict quality checks, high-value items such as power transformers and reactors were procured separately.
- Apart from the high cost involved, turnkey contracts run the risk of time overrun and termination in case of non-performance by the contractors. However, with close monitoring and timely decision-making, such risks can be reduced. Nowadays almost all big projects are carried out in turnkey mode. The JICA project helped MPPTCL transition from its earlier bidding process to a turnkey mode.

6 Transmission System Strengthening Project in Madhya Pradesh

Date of Loan Agreement: March 31, 2016
Loan Amount: 15,457 million Yen
Executing Agency: Madhya Pradesh Power Transmission Company Limited (MPPTCL)
Project Status: Ongoing

Summary: This project aimed to ensure the stable operation of the transmission system by developing new and expanding the existing power transmission lines and substations in Madhya Pradesh, thereby contributing to the improvement of the power supply-demand balance in the state. The existing transmission network of MPPTCL needed to be expanded to cater to the increased demand resulting from rural electrification and increase in commercial loads. The project was required to deliver electricity to meet the demand during the 13th Five-Year Plan Period, when generation capacity was expected to increase from 16,143 MW to more than 22,163 MW (State share).

Outcomes/Results: The Project increased the transformer capacity by 2,268 MVA. It also supplied a transmission line length of 400 kV level by 10 circuit km, 220 kV level by 410 circuit km, and 132 kV level by 698 circuit km. The project contributed to decreasing the transmission system losses by 0.98%, while the additional energy served because of the creation of additional transformation capacity of 1,326 MVA was to the order of 5561.626 MU.

Appealing Points:

- During construction, the contractors monitored the quality of air, water, and soil as well as the levels of noise and vibration. Meanwhile, MPPTCL supervised the compensation process for the loss of livelihood before and during the construction period. Although some ethnic minorities, as designated under India's laws, live in and around the project sites, no specific impact on them has been identified during the discussions held with them.
- The compensation towards loss of crops and trees during the construction stage is paid to the impacted people as per the Electricity Act (2003).

7 Maharashtra Transmission System Project

Date of Loan Agreement: September 14, 2007
Loan Amount: 16,749 million Yen
Executing Agency: Maharashtra State Electricity Transmission Company Limited (MSETCL)
Project Status: Completed (March 2015)

Summary: The objective of this project was to ensure stable power supply to meet the fast-growing demand by strengthening intra-state transmission systems in Maharashtra, thereby contributing to local economic development and improvement in the standard of living of the state's citizens. Under the project, substation facilities such as transformers and peripheral equipment were augmented at 110 substations in four zones (Vashi, Pune, Karad, and Nasik) in the western part of the state. After the approval on expanding the project scope in March 2011, equipment that had deteriorated was replaced at 95 substations in four zones (including 52 substations that were also within the original project scope). The selection of the targeted substations and equipment to be replaced, as per the expanded scope, was made according to the results of analysis in MSETCL's Life Extension Scheme. Compared to the 48 man-months (M/M) (24 each for Japanese consultants and local consultants) planned in the project appraisal, 35 M/M were provided for consulting services.

Outcomes/Results: The intra-state transmissions systems were strengthened with the addition of 6611.5 MVA through the augmentation of 180 power transformers. Replacement of old, deteriorated substation equipment enhanced the reliability, availability, and quality of power supply in Maharashtra. In the ex post evaluation, it was found that the population of the four target areas (indirect beneficiaries) was estimated as 85.48 million, based on the results of the census in 2011. Thus, the number of indirect beneficiaries of the project was 39% more than the number (61.64 million) finalised during the project appraisal. This underlines the extent of the indirect impact of the project.

Appealing Points:

- In a beneficiary survey to examine the qualitative effects (situation of power supply) and impact (improvement in living conditions) of the project, wherein the respondents were asked about the degree of satisfaction regarding the electric power supply after project completion, 24% of the residents and 16% of the private companies and public institutions chose "very satisfied" on the satisfaction scale, while 76% of the residents and 84% of private companies and public institutions chose "satisfied". The respondents identified voltage stability and a decrease in the frequency of outages as reasons for their satisfaction. Notably, no one said they were "somewhat satisfied" or "not satisfied".
- A two-week-long overseas training session was held three times in Japan during the project period, wherein the trainees visited facilities such as a central load dispatch control center, substations, and the construction site of the distribution grid, to learn about the practical aspects of introducing TQM in Japan and the latest technology in transmission and distribution systems.

8 Tamil Nadu Transmission System Improvement Project

Date of Loan Agreement: September 28, 2012
Loan Amount: 60,740 million Yen
Executing Agency: Tamil Nadu Transmission Corporation Limited (TANTRANSCO)
Project Status: Ongoing

Summary: The project aims to ensure reliable transmission of expanded volume of electricity and avoid overloading of transmission system after the planned expansion of power generation in Tamil Nadu and ultimately in the Southern Region, by improving transmission system throughout the state. The power demand is growing at a Compounded Annual Growth Rate (CAGR) of 8-10% due to rapid industrial growth in the state. The projected peak demand as per the 17th Electric Power Survey (EPS) was 14,224 MW by the 11th Plan end (2011-12) and 21,976 MW (considering 9.09% growth) by 12th Plan end (2016-17). To meet the projected demand indicated above, steps have already been initiated for augmenting the generation capacity through power projects of around 36,180 MW. Accordingly, the transmission network needs to be strengthened to evacuate and handle the additional capacities of generation as and when they are added to the system.

Outcomes/Results: 440kV and 230kV substations and associated transmission lines are being constructed and installed in seven circles in Tamil Nadu, enhancing the reliability of the transmission system.

Appealing Points:

- The project accommodates the need of expanded power capacity and rapid network expansion in Tamil Nadu, a state that is seeing rapid industrial growth and contributes to the economic development of southern parts of India.

9 West Bengal Transmission System Project (I) and (II)

Date of Loan Agreement: February 25, 1997 (Phase I) and May 10, 2002 (Phase II)
Loan Amount: 11,087 million Yen (Phase I) and 3,127 million Yen (Phase II)
Executing Agency: West Bengal State Electricity Transmission Company Ltd. (WBSETCL)
Project Status: Completed: May 2004 (Phase I), August 2009 (Phase II)

Summary: This project's objective was to enhance the reliability of the transmission network system to reduce transmission losses and voltage fluctuations in West Bengal. This was to be achieved through the provision of a robust electricity transmission network, the construction of new substations, and the expansion of existing substations. This would contribute to industrial development, employment creation and improvement of people's living standards through rural electrification and promotion of home electric appliances in the state.

Outcomes/Results: According to information obtained from WBSETCL, the electricity supply in West Bengal has improved and the number of outages has sharply decreased. The project has been highly relevant to India's development plans and development needs. The facilities provided under the project have been operated well. The project has greatly improved the reliability of the transmission network system, and reduced both transmission losses and voltage fluctuations. It has contributed to sustaining the rapidly increasing energy consumption through the improvement of the transmission network system, including the construction and augmentation of 31 substations. The sustainability of the project is deemed high in organisational, technological, and financial terms, and the O&M condition of project facilities and equipment is good. In view of these outcomes, the project is evaluated to be highly satisfactory.

Appealing Points:

- In 2007-08, when unbundling took place, the transmission loss in the transmission network of WBSETCL was around 4%. This improved year on year, reaching 3.8% in 2009-2010. West Bengal is thus doing better than the national average of between 5% and 5.5%.
- Distribution loss in the state improved from 24.6% in 2007-08 to 24.3% in 2009-2010.
- The actual project cost was 13,385 million Yen – only 47.3% of the planned project cost of 28,322 million Yen. The amount disbursed as the Japanese ODA assistance loan was 12,736 million Yen (or 89.6%) of the approved budget of 14,214 million Yen.
- JICA has conducted the Special Assistance for Project Implementation for the West Bengal Transmission System Project (II), in which total quality management (TQM) was introduced and acquired by WBSETCL staff. WBSETCL created "quality circles" at the substation level to improve management. The heightened sense of responsibility and increased awareness amongst the staff of the necessity of improving operation and maintenance has contributed to winning the ISO9001:2000 certification and other Indian awards.

10 Rural Electrification Project (Andhra Pradesh, Madhya Pradesh, and Maharashtra)

Date of Loan Agreement: March 31, 2006
Loan Amount: 20, 629 million Yen
Executing Agency: Rural Electrification Corporation (REC), Andhra Pradesh Southern Power Distribution Company Limited (APSPDCL), Andhra Pradesh North Power Distribution Company Limited (APNPDCL), Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL), Andhra Pradesh Central Power Distribution Company Limited (APCPDCL), Madhya Pradesh Poorv Kshetra Vidyut Vitran Co. Ltd (MP Poorv. KVVCL), Madhya Pradesh Paschim Kshetra Vidyut Vitran Co. Ltd (MP Pas. KVVCL), Madhya Pradesh Madhya Kshetra Vidyut Vitran Co. Ltd (MP Madh. KVVCL) and Maharashtra state Electricity Distribution Company Limited (MSEDCL) – all referred to as 'discoms'.
Project Status: Completed (August 2012)

Summary: As per the 2001 census, around 87.6% of urban households had access to electricity as compared to only 43.5% of rural households. Since then, India has made tremendous progress in rural and household electrification under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY). For this, projects for creation of 33/11 KV sub stations such as the present project funded under JICA, have helped in creating the necessary backbone infrastructure to help discoms provide last-mile connectivity to everyone. The states of Madhya Pradesh and Andhra Pradesh have made tremendous progress in building up their power infrastructure. A further 72 projects with an outlay of Rs 9,264 crores have been approved for Phase-2 of the 11th Plan projects. In addition, 39 projects with an outlay of Rs 2,718 crore have been sanctioned under the 12th Plan of Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY).

Outcomes/Results: The targeted states under the project have achieved almost 100% electrification in villages and have shown considerable improvement in their power sector status and overall electrification levels. The electrification levels in villages and households in Madhya Pradesh are over 97% and 58% respectively, while Andhra Pradesh has achieved over 89% and 100% electrification of its villages and households respectively.

Appealing Points:

- The substations and lines established from the loan facility are a part of the overall sub transmission system of the utilities and are used for the distribution and supply of power to the rural and urban areas where they are located. They are fully functional and are now a part of the backbone infrastructure for providing electricity access to all villages in the three states.
- The installed infrastructure is being used for power evacuation and supply. The three targeted states are not facing any power shortages.
- Discoms were given the responsibility for the establishment and improvement of structures to achieve efficient operation and maintenance (O&M) and bill collection to manage the financial burden arising from the project and maintain their own profitability. REC monitored the O&M system for the project in each discom, as and when necessary.

- Discoms are maintaining the fully operational infrastructure and collection tariffs.

11 Umiam Hydro Power Station Renovation Project

Name of the Project:
(1) Umiam Hydro Power Station Renovation Project
(2) Umiam Stage 2 Hydro Power Station Renovation and Modernisation Project
(3) Project for Renovation and Modernisation of Umiam-Umtru Stage 2I Hydroelectric Power Station

Date of Loan Agreement: (1) February 25, 1997; (2) March 31, 2004; (3) October 29, 2018

Loan Amount: (1): 1,700 million Yen; (2): 1,964 million Yen; (3): 5,497 million Yen

Executing Agency: President of India / Meghalaya state Electricity Board (MeSEB)

Project Status: (1): Completed (June 2004) / (2): Completed (June 2012) / (3): Ongoing

Summary: The objectives of this project were to increase power and energy production as well as to improve power generation efficiency in Meghalaya through the renovation and modernisation of Umiam Power Station Stage I (9 MW × 4 units, operation launched in 1965), which would contribute to the economic growth of the state and improvement in the living conditions of the people.

Outcomes/Results: Due to a marked reduction in precipitation, the water level in the Umiam Reservoir has dropped continuously over the previous three years. As a result, neither the annual output nor the plant load factor have achieved 100% of the target. However, the maximum output target of 100% was achieved, and since the annual output and the plant load factor both achieved around 80% of the target, this plant is deemed to have a certain level of effectiveness. It is impossible to determine accurately the impact that this project has had on economic development and people's living conditions, as the scope of the project is limited to the renovation of the power plant. However, through the renovation of a power station that was highly likely to be put out of commission due to aging, the effective handling of the growing demand for power, and the visible positive impact this project has had on the living conditions of the local people, the project has had a significantly large impact.

Appealing Points:

- Umiam Power Station Stage-I accounts for 20% of the total electricity generation capacity of the Meghalaya State Electricity Board and serves as the third most important power station in Meghalaya after Umiam Power Station Stage-3 and Stage-IV. The project is thus valuable in the sense that it ensured stable production of 36 MW of electricity through the renovation of a power plant that was about to be decommissioned due to aging.

- Moreover, considering the economic development plan based on the Industrialisation Policy in 1997 and the subsequent increase in the demand for power, the impact of the project on the industrialisation and modernisation of Meghalaya is quite significant.

- The impact that a power generation project has on the living conditions of the people depends, among other factors, on the condition in which the generated power is transmitted and delivered. Consequently, it is impossible to accurately determine the impact of this project in that sense, as its scope was limited to the renovation of power plants. However, judging from the fact that a community with a market, a school, and a medical facility had developed around Umiam Power Station 1, and that the executing agency and residents have stated that their living conditions improved, it can be said that the project has made a significant contribution in that area.

- The installed capacity of Umiam Umtru Stage-3 HEPP is 60 MW, consisting of two units of 30 MW each. The HEPP accounts for a significant 17% of the total installed capacity of Meghalaya Power Generation Corporation Limited (MePGCL). The plant started operations in 1979, but its performance has been deteriorating over 15 years due to breakdown of the runners, the electro-mechanical equipment, and so on. The plant is expected to be forced to stop operation soon, considering that runner breakdowns have become increasingly frequent in recent years. Renovation of the plant is, therefore, an immediate requirement for the state.

12 Dhauliganga Hydroelectric Power Plant Construction Project (I) (II) (III)

Date of Loan Agreement: Phase I: January 25, 1996; Phase 2: December 12, 1997; Phase 3: March 31, 2004
Loan Amount: Phase I: 5,665 million Yen; Phase 2: 16,316 million Yen; Phase 3: 13,890 million Yen
Executing Agency: National Hydro Electric Power Corporation Private Limited (NHPC Ltd).
Project Status: Completed: Phase I: May 2002; Phase II: September 2004; Phase III: July 2009

Summary: The objective of this project was to cope with the growing power and energy demand in the northern region of India by constructing a 280 MW (4 X 70 MW) hydroelectric power plant on the river of Dhauliganga, a tributary of Sarda river in the Darchula sub-division of Pithoragarh District, Uttarakhand state. This would contribute to the improvement of people's living standards, industrial development, employment creation, and diversification of power generation in the region.

Outcomes/Results: The project was effective and achieved its objectives with key operation and effect indicators such as maximum output, plant load factor, availability factor, and electric energy production meeting the targets. There were other positive impacts too, such as improvements in the natural environment and in people's living conditions in the upstream area. Although there were some changes in design – such as the dam type – the project outputs were realised as planned. The project's organisational, technical, and financial sustainability was high. It was operated well, and the facilities were maintained well.

Appealing Points:

- The maximum output met the figures planned every year, while the plant load factor almost reached or exceeded the planned figures. The availability factor also met the target. According to the NHPC annual report, the average availability factor among all hydroelectric power plants owned by NHPC was 84.1% in 2009-2010 and 85.2% in 2010-11. Those for Dhauliganga Power Station were much higher.
- The total unplanned outage hours from 2007-08 to 2009-2010 remained within the estimated hours. Power production reached around 90% of the estimate every year and exceeded the designed figure (1,134 GWh per year). Hence, there has been no major effect on the operation of the power plant. There were no unplanned outages due to human errors or any other factors.
- Although the total outage hours far exceeded the plan from 2005-06 to 2008-09, they have been lower than the estimates since 2009-2010. It should be noted that this did not affect the amount of energy production. The main reasons for the planned outages were the annual maintenance of four units of generation facilities; lower demand for power generation during the dry season; miscellaneous maintenance of equipment/parts that had broken down; and silt flushing of the reservoir every 15 days during the monsoons.
- The total volume of water inflow to the reservoir of the Dhauliganga Power Station remained at 70% to 90% of the estimates. The hydro utilisation factor was 64.9% in 2010-11 and 84.55% in 2009-2010, against the estimate of 61.26%. There has been no major effect, up till now, and the annual energy production target has been achieved. The volume of silt in the reservoir exceeded the estimate in 2006-07 and 2007-08 but has been at merely 10% of the estimate since 2009-2010.
- According to NHPC, the sharp decline in sedimentation since 2009-2010 is the result of successful implementation of the catchment area treatment work, soil conservation work, riverbank protection work, check-dam construction etc. (all of which were planned at the beginning of project design) together with a reduction of deforestation though improvements in local people's traditional ways of living and livelihood means. Silt reduction in the reservoir is essential for a fully functioning power plants and electric energy production, which significantly contributes to the project sustainability.

13 Purulia Pumped Storage Project (I) (II) (III)

Date of Loan Agreement: Phase 1: February 28, 1995; Phase II: March 31, 2004; Phase III: March 31, 2006
Loan Amount: Phase I: 20,520 million Yen; Phase II: 23,578 million Yen; Phase III: 17,963 million Yen
Executing Agency: West Bengal State Electricity Distribution Company Ltd (WBSEDCL)
Project Status: Completed (February 2008)

Summary: During the year 1992 in West Bengal, power demand used to fluctuate significantly during the night-time off peak and the day-evening peak in the course of a day. To meet the peak-time demand of power and generate electricity efficiently and economically, it was necessary that the demand curve be flattened. So, to strengthen peak-time power supply capacity, a pumped storage project of 900 MW (4 x 225 MW generating units) capacity with related transmission and substation facilities was developed at Ayodhya hills in Purulia district, West Bengal. The projects also contributed to considerable economic development in the region.

Outcomes/Results: The installed capacity and annual generation in India's eastern region had decreased gradually since 1951, compared to the overall installed capacity and annual generation in India. During the year 1992, the per capita electricity consumption in the eastern region was only 50% of the national average.

To improve the poor hydro-thermal mix of 18:82 in the eastern region, more emphasis on hydro was needed to achieve an optimum hydro-thermal mix of 40:60. The implementation of the aforesaid project accelerated the development of hydro resources in the Eastern region.

West Bengal and the eastern region had a thermal power generation system with very small hydro power capacity. The peak demand was suppressed due to shortage of generating capacity, whereas there was surplus during midnight and early morning. The frequency varied widely between 53 Hz and 47 Hz against its desirable band (50.5 Hz to 49.5 Hz). The electricity-driven motors and plants in industries suffered from low-voltage damage and operated at low efficiencies. However, with the developments of new power sources being undertaken, the peak supply shortage was resolved after the project's completion.

Appealing Points:

- There was power shortage of about 1,400 MW in India's eastern region and about 350 MW in West Bengal at peak time in 1988-89. In the eastern region, the power demand growth rate was pegged to reach high levels soon.
- The peak availability and the peak load of West Bengal, along with the power supply position of West Bengal was almost the same as that of the eastern region. From the daily load curve of the eastern region, it was preferable to operate pumped storage power plants for electric power supply at the peak time in the evening, which would continue for about six hours daily.
- Purulia Pumped Storage Power Station was originally expected to be put into service in 2000-2001. From the study's result, the pumped storage plant would be fully operational on peak hours in the dry season. The surplus capacity of the pumped storage plant on other days was used as reserve capacity.
- According to the trends of peak demand and peak availability in the eastern region from 1990-2001 to 2004-05 forecasted and planned by the Central Electricity Authority (CEA), it was difficult to match peak availability with the peak demand during the aforesaid period.
- Because of this situation, it was desirable for Purulia Pumped Storage Project to reach the commissioning stage as early as possible. It takes about 9-10 years for such a pumped storage project to be completed from the initial stage.

Lower Dam at the Purulia Pumped Storage Project

ODA Loans | Pumped Storage

14 Project for the Construction of Turga Pumped Storage (I)

Draft Tunnel Investigation at the Project for the Construction of Turga Pumped Storage (I)

Date of Loan Agreement: November 2, 2018
Loan Amount: 29,442 million Yen
Executing Agency: West Bengal State Electricity Distribution Company Ltd (WBSEDCL)
Project Status: Ongoing

Summary: The aim of the project is to strengthen the response capability to power supply and demand fluctuation and improve the stability of the power supply by constructing pumped storage power facilities, thereby contributing to the industrial development, and living standard improvement in the West Bengal state.

Outcomes/Results: Currently, India's fossil fuel requirements, which make up 90% of primary energy supply, are being met by imports. The central government announced the "175 GW renewable initiatives" in 2014, placing renewable energy at the center of improving energy security, prevention of global warming, and identifying it as an important tool to resolve deficit of electricity power supply and to enhance rural electrification. This initiative had set the target of generation from renewable energy at 175 GW by 2022. Herein, each state has been allocated their target installation amount of renewable energy power, and the target for West Bengal state is set as 5,386MW.

With higher installation of renewable power, such as solar power, in the grid, it may bring a certain level of difficulties in securing the stability of power supply because the present practice of real time unbalance management may not be sufficient for handling large scale uncertainty in renewable power. Power supply sources which can offer ancillary services to the power system, such as pumped storage power, can contribute to improving the power supply stability in such circumstances.

Appealing Points

- The project forms two reservoirs at two different levels and a water conductor system, which connects the two reservoirs through an underground powerhouse. During peak hours, power will be generated by depleting the upper reservoir's water reserve, which passes through the waterway and the generator and turbines installed at the powerhouse and stored in the lower reservoir. During off peak hours, the excess power will be fed back to pump the water from lower reservoir to upper reservoir.

- One of the main components of the project is to install two variable speed pump turbines together with the other two fixed speed pump turbines. The variable speed pump turbines can supply frequency control function both during generation and pumping operations. As previously explained, the present practice of real time unbalance management may not be sufficient for handling large scale uncertainty in renewable power, therefore, it is essential for the grid to be always equipped with frequency control capabilities. Considering the possible stoppage of each turbine by regular maintenance, accidents, etc., it is necessary to have more than one variable speed pump turbines in accordance with the "N -1 contingency" (meaning it can withstand the loss of any one item of the plant without loss of its function).

- The energy saved was examined by comparative analysis from another aspect. The energy conservation achieved by the project was estimated to be approximately 28% to 39% depending on the equipment type, through calculation using the monitoring results of operation and effect indicators provided by technical assistance.

- Results obtained by monitoring averaged about 39%, so the assumed energy conservation effect was generally on target. Further, according to the results of beneficiary surveys, 94% of the responses were that the energy was saved by the project. Depending on the response, energy conservation ranged from 5% to 60%, and averaged 18.4%. Also, 99% of the respondents stated that they were satisfied with the performance of the equipment acquired. Among the responses were three instances of companies that had been a target for monitoring of operation and effects indicators by the technical assistance. All stated that there was an energy saving effect. From the above, it is judged that the project generally had an energy conservation effect.

15 Micro, Small and Medium Enterprises Energy Saving Project (I) (II) (III)

Date of Loan Agreement: Phase I - November 2008; Phase II - June 2011; Phase III - September 2014
Loan Amount: Phase I - 30,000 million Yen; Phase II - 30,000 million Yen; Phase III - 30,000 million Yen
Executing Agency: Small Industries Development Bank of India (SIDBI)
Project Status: Completed (Dec 2021)

Summary: The objective of the project was to promote energy saving among Micro, Small, and Medium Enterprises (MSMEs) by providing them medium-term and long-term financial assistance needed for their energy saving initiatives, strengthening the loan appraisal capacity of SIDBI, the executing agency and Participating Financial Institutions (PFIs), and strengthening their awareness towards energy saving, thereby contributing to environmental improvement and economic development in the country as well as addressing climate change.

Outcomes/Results: The Micro, Small and Medium Enterprises Energy Saving Project provided MSMEs in India for their energy saving efforts. It also enhanced loan appraisal capacity of the SIDBI and other PFIs and promoted awareness about energy saving among the MSMEs. The project was in line with the development policy and development needs of India as well as the ODA policy of Japan. One of the project's key outcomes was the positive impact related to the amount of energy consumption, that was reduced through the energy saving loan. It was higher than planned. This also had a significant impact on the environment. Moreover, from the perspective of the sustainable development of the MSMEs, there has been some increase in profitability, and the competitiveness of the MSMEs has been strengthened through energy saving initiatives.

Appealing Points:

- As an example of energy saving loan contributing to environmental improvement, SIDBI has provided a loan to a taxi association to procure over 800 compressed natural gas (CNG) taxis. Furthermore, Delhi Financial Corporation (DFC), a PFI, has extended loans to over 500 auto-rickshaws to convert from diesel to liquid petroleum gas (LPG) fuel. Compared to diesel, LPG emits a lower number of harmful gases after combustion. Therefore, the project has contributed to improving the environmental conditions.
- According to SIDBI, out of 2,133 end users, 34% of them have utilised financial assistance from the project to establish new businesses, thereby contributing to generating new employment opportunities.

16 PPP Infrastructure Financing Project

Date of Loan Agreement: March 11, 2016
Loan Amount: 50,000 million Yen
Executing Agency: India Infrastructure Finance Company Limited (IIFCL)
Project Status: Ongoing

Summary: The project intends to contribute to economic growth in India through the utilisation of private funds in the country, by providing long-term funds necessary to the implementing organisations via IIFCL and other financial institutions, for promoting infrastructure development. It envisages providing long-term funds for infrastructure development to implementing organisations of Public Private Partnership (PPP) infrastructure development as end users and intermediate financial institutions, through Two Step Loan via IIFCL, the Implementing Agency. As for financing methods by IIFCL, there is direct finance (co-finance), take out finance (purchase and succession of infrastructure loan credit) and refinance (back finance to infrastructure finance via other financial institutions).

Outcomes/Results:

To promote infrastructure development through PPP, JICA has been providing financial assistance named "Public Private Partnership Infrastructure Financing Project" to IIFCL through concessional loan since 2016. The project has been focusing on supporting PPP projects in the energy sector (transmission lines as well as renewable energy) but also envisages supporting development of several other sectors like road, transport, water, health etc.

Appealing Points:

- The project promotes PPP based infrastructure development in India, by providing long term finance to viable infrastructure projects through IIFCL, thereby contributing to sustainable economic development in the country.
- With other donors such as the World Bank and Asian Development Bank, which have supported IIFCL, the project assumes to seek active coordination with other donors through relevant donor meetings.
- As for the geographical distribution of the projects that IIFCL previously supported, the target states for Delhi-Mumbai Industrial Corridor Plan and Chennai-Bengaluru Industrial Corridor Plan, accounted for 53.2% based on approved amount. To encourage Japanese companies launch their buisness, the project assumes that more than 50% of the total amount of Yen loans that will be disbursed to finance these target states.

17 New and Renewable Energy Development Project (Phase I and II)

Date of Loan Agreement: Phase I - June 2011; Phase II - September 2014
Loan Amount: Phase I - 30,000 million Yen; Phase II - 30,000 million Yen
Executing Agency: Indian Renewable Energy Development Agency Ltd. (IREDA)
Project Status: Completed (March 2021)

Summary: The objective of this project was to secure stable and diversified source of power supply against the increasing energy demand in India, by promoting new and renewable energy development projects and energy efficiency and conservation in the country, through IREDA financing, thereby contributing to environmental conservation, sustainable economic development in the country and mitigation of global climate change.

Outcomes/Results: To promote the development of renewable energy in India, JICA provided financial assistance named "New and Renewable Energy Development Project" to the IREDA through concessional loans since 2011. Phase I of this project primarily supported the development of wind, solar, biomass, energy efficiency and conservation sectors. During the implementation of phase I, a need to strengthen IREDA's capacity with respect to new and proven technologies in the renewable energy (RE) sector was identified.

Phase II of this project started in 2014, focused mainly on supporting the capacity building of IREDA's main/regional office(s) on new and renewable energy technologies, financial instruments and to improve their visibility as a financial institution in the RE sector. This improvement in IREDA's visibility was meant to increase the financial off take of the JICA credit lines awarded to IREDA. The project also includes development of an IT-based project management system for project monitoring and evaluating performance. PwC India provides Special Assistance on Project Implementation (SAPI) for the project.

The project aimed to provide medium- and long-term funding for new and renewable energy power generation and energy efficiency promotion projects in India, confronting a shortage of electric power generation capacity, by means of a Two-Step Loan through IREDA, thereby contributing to the securing of electric power supply, diversifying its source, and alleviating the environmental burden. This project focused on responding to the growth of energy demand resulting from rapid economic growth and to improve the environment which is consistent with both, the policy and development needs of India and the development assistance policy of Japan. Wind and solar power projects funded through IREDA were being operated as planned. This is recognised as substitution for thermal power generation, which is the main source of electricity in India, thereby, reducing coal and other fossil fuel consumption, resulting in reduction of CO_2 emission. Further, employment creation impact at the sub-project sites indicated a high level of effectiveness and impact of the project.

Appealing Points:

- Calculation of CO_2 emission reduction resulting from replacement of coal and oil as fuel for power generation by the sub-projects yielded the annual value of about 909,000 CO_2-equivalent tons. Thus, the project significantly contributed to alleviating climate change.
- IREDA has indicated that each sub-project has had a socio-economic impact on its local community through creation of employment opportunities. Each sub-project created jobs opportunities during construction and subsequent operation.
- As the project replaced coal and oil as fuel, they work to abate emission of SO_2, NO_x, and fine particles and hence are conducive to improvement of the atmosphere.

18 Project for the Improvement of Power Supply in Andaman and Nicobar Islands

Date of Grant Agreement: March 30, 2022
Grant Amount: 4,000 million Yen
Executing Agency: Andaman and Nicobar Administration
Project Status: Ongoing

Summary: The objective of the project is to utilise the power generated from renewable energy sources and stabilise the power supply in South Andaman. This is being done introducing necessary equipment and facilities such as storage battery system (30MW / 15MWh), grid interconnection cassette, Supervisory Control and Data Acquisition (SCADA), buildings etc. for energy storage, thereby contributing to the improvement of industrial competitiveness in Andaman and Nicobar Islands.

Outcomes/Results: This project is assisting power development policy and plan of Andaman and Nicobar Administration through reduction of the carbon footprint by gradually replacing diesel-based power generation with greener energy. Within three years of completion of the project, carbon emissions are expected to reduce by 2,683 tons per year compared to in the year 2020. This project will contribute to achieving India's goal of achieving net zero carbon emissions by 2070 announced at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26).

Appealing Points:

- The project's scope includes construction of facilities, procurement and installation of equipment, and consulting services.
- The electricity supply that covers the Andaman and Nicobar Islands is going through a transitional period, moving away from outdated diesel engine generators –which have become less reliable with low generation efficiency and frequent breakdowns, affecting even industrial activities – towards renewable energy which emit less carbon dioxide.
- Since solar power generates most of its electricity during the daytime when power demand is not high, effective use of this electricity requires the necessary equipment and capacity to store the surplus during the daytime and release it during peak hours at nighttime. Therefore, it is necessary to introduce storage batteries in South Andaman Island, the largest of the Andaman and Nicobar Islands.

19 Research Partnership for the Application of Low Carbon Technology for Sustainable Development

Adoption Fiscal Year: FY2009 (4 years)
Project Amount: 255 million Yen
Executing Agency: The Energy and Resources Institute (TERI)
Project Status: Completed (March 2014)

Summary: India's high economic growth led to a dramatic growth in demand for energy, as well. However, expanding consumption of energy introduced several environmental burdens. For example, aged thermal power plants with lower efficiency of power generation and more emissions of hazardous substances, caused more air pollution compared to the new power generation facilities with environment friendly technologies. Besides, emissions of greenhouse gas (GHG) such as CO2 considerably increased, and there were concerns about the further rapid deterioration of GHG emission in future. The introduction of low carbon technologies for accelerating concrete countermeasures to reduce GHG emission was necessary. Through selection of low carbon technologies (LCTs) to be applied, implementation and evaluation of pilot projects, and formulation of application schemes of LCTs, the project aimed at proposing a framework for promotion of LCTs in India, thereby contributing to promotion of application of LCTs in the country.

Outcomes/Results: Through the project, policy recommendations for the Governments of India and Japan for the promotion of the low carbon technologies introduced by the project were drafted and research paper/ articles were published. In addition, research results of the project were presented at international conferences and domestic conference in India. TERI identified seven LCTs. Also, significant energy savings by the identified LTCs were estimated in the range of 15-20% with co-benefits of reduction of CO2 emissions as well as SOx and NOx. High capital and operation and maintenance (O&M) costs have been constraining the application of the Green Hydrogen Technology (GHT) and Electric Heat Tracing (EHT) technologies demonstrated by the project, which were based on the technologies by Japanese companies. The heat pump technologies from the Indian domestic and international players have been utilised by the Indian private sector.

Appealing Points:

- The collaboration with TERI and the government institutions, such as the Gujarat Energy Development Agency (GEDA) and the Maharashtra Energy Development Agency (MEDA), have been promoted by the Japan-India Matchmaking Platform (JITMAP) initiative for promoting Japan's LCTs in India through capacity building and awareness building workshops.
- In addition, the Bureau of Energy Efficiency (BEE) was involved in promotion of energy efficient technologies at the national level under the partnership with the Japanese governmental institutions such as Energy Conservation Centre Japan (ECCJ) and the New Energy and Industrial Technology Development Organisation (NEDO). Also, BEE prepared energy conservation guidelines for industries with knowledge support from ECCJ. The collaboration between India and Japan for promotion of LCTs, which can be energy efficient as well at the industry level has strengthened mutually beneficial trade and commercial ties between the two countries.

20 Data Collection Survey for Cross-Border Electricity Trade (CBET) in BBIN* Region

Survey Period: November 2020 – March 2023

Summary: In the South Asian region, India and Bangladesh have a power supply structure centered on thermal power generation. In Bangladesh's Power System Master Plan (PSMP 2016), coal-fired thermal power and gas-fired thermal power (including LNG (Liquefied Natural Gas)) are positioned as base-load sources to provide a stable power supply. In contrast Bhutan and Nepal have been confirmed to have abundant potential hydropower. Bhutan's potential hydropower capacity is estimated to be about 30 GW, but as of July 2020, installed hydropower plants amounted to only 2.3 GW (about 8% of the potential hydropower). Nepal's potential hydropower capacity is estimated to be 83 GW, with 42 GW economically developable and usable. Electricity demand in these countries peaked at 399 MW (FY2018) in Bhutan and 1,508 MW (FY2018) in Nepal, figures which are smaller than their respective potential hydropower. If these countries can develop hydropower and import and export power through cross-border interconnection lines, they can secure stable base-load power sources in the region, diversify power sources, and contribute to climate change mitigation.

The Governments of Bangladesh and India, respectively, have a policy on the introduction and use of renewable energy as a means of reducing greenhouse gas emissions and diversifying power sources. However, if such variable renewable energy is introduced into the power system in large quantities, it is expected that system instability and demand-supply imbalances will occur, and it will be difficult to ensure the quality of electric power due to frequency fluctuations and other factors. Furthermore, although Nepal and Bhutan have abundant potential hydropower, the seasonal fluctuation of hydropower generation makes it difficult to always maintain a stable balance with domestic demand. The integration of these countries' power systems, through efficient development and wide-area power interchanges, will increase grid capacity and equalise the supply-demand gap between regions. This will help create an environment that will facilitate the introduction of renewable energy into the grid and ensure a stable supply of power at the same time.

Under such circumstances, India, which is considered to play a central role in power interchanges among BBIN countries, is developing the cross-border electric power interchange system (Guidelines (December 2018), Regulations (March 2019), and Procedures (June 2019)) in recent years. The momentum for cross-border power interchanges in the region is increasing.

Outcomes/Results: Information on the export and import of power through cross-border interconnection lines (hereinafter, "cross-border power interchange") in BBIN region is collected, and various issues, risks, and possibilities in the development are analysed. Additionally, information on trends and results in cooperation from other donors is collected and a direction for cooperation toward the realisation of cross-border power interchange in South Asia is compiled. The regional demand-supply balance is also analysed by focusing on a feasibility analysis of the cross-border interconnected power transmission line business mainly in each country of the BBIN group (Bangladesh, Bhutan, India, and Nepal), and including Myanmar and Sri Lanka.

Appealing Points:

- Several priority projects are selected, and their action plans are proposed to guide next steps such as feasibility studies to promote power export to Bangladesh and pumped storage potential survey in Meghalaya, India.
- Regional energy storage system is considered and proposed.
- Ammonia co-firing project for thermal power plants is proposed to support de-carbonisation efforts in the country.
- Joint workshop to share challenges and discuss possible solutions for the future of regional power trade and enhancement of stability of the regional power supply is conducted in the BBIN Region.

*BBIN : Bangladesh, Bhutan, India, and Nepal

21 Tata Cleantech Capital Limited (TCCL)

Date of Investment Agreement: March 25, 2021
Loan Amount: 10,000 million Yen
Executing Agency: Tata Cleantech Capital Limited (TCCL)

Summary: JICA signed a Loan Agreement for a maximum amount of 10,000 million Yen with Indian non-banking financial company, Tata Cleantech Capital Limited (TCCL). The aim is to support the company to offer loans to businesses across India that focus on renewable energy generation, e-mobility solutions as well as energy efficiency, to help mitigate the effects of climate change by reducing the emission of greenhouse gas (GHG) in India following the Green Loan Principles. This loan will be provided through the Private Sector Investment Finance scheme of JICA and is co-financed with the Sumitomo Mitsui Banking Corporation (SMBC).

Appealing Points: JICA's loan will support TCCL to mitigate the impact of climate change by offering green finance, which will contribute to decrease the emission of GHG in India. It will also contribute to SDGs (Sustainable Development Goals) Goals 7 and 13. JICA will continue its support for climate change initiatives in the world and continue to mobilise private finance for this sector.

Grant, PSIF, and Survey | PSIF

22 Neev Fund II

Date of Investment Agreement: December 24, 2021
Investment Amount: 3.2 billion Yen
Fund Manager: SBICAP Ventures Limited

Summary: JICA signed a 2.14 billion Indian rupee (approximately 3.2 billion Yen) investment agreement with the SVL-SME Fund (commonly known as Neev II Fund), whose fund manager is SBICAP Ventures Limited (SVL), a group company of India's largest state-owned bank, State Bank of India (SBI). JICA's investment will be appropriated for investment in Small and Medium-sized Enterprises (SMEs) that are engaged in solving environmental and social concerns in India.

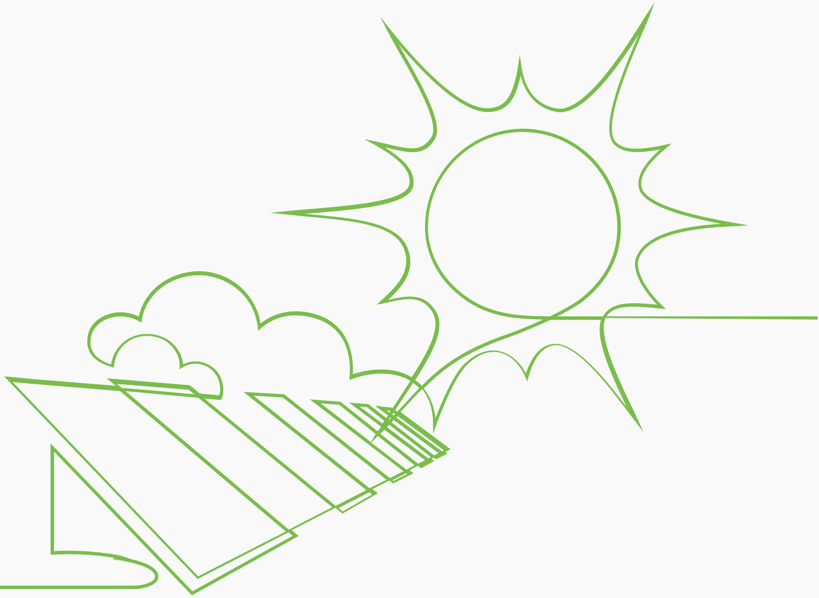
Appealing Points: Neev II Fund is an impact investment fund that pursues environmental and social impacts together with economic returns from its investments. It is characterised by the cooperation of global and local financial institutions to support improvement in the ESG (Environment, Sustainability and Governance) response of its investments and its impact assessment system. Neev II Fund is one of the first private equity fund operating in the Indian SME space focused on climate action, environment sustainability and social impact. Neev II Fund will invest in Indian SMEs offering solutions critical to the success of global climate action. On 7 February 2022, SBICAP Ventures Limited received the Tokyo Financial Award (ESG Investment Category) for Neev Funds. The Tokyo Metropolitan Government established the "Tokyo Financial Award" in 2018 to boost the city's reputation as an international financial center. Neev II Fund has invested in Blue Planet, Chakr Innovation, GPS renewables and Hygenco as of the end of December 2022. The brief business outlines of the companies are as follows:

Blue Planet: Blue Planet is a waste management company focusing on end-to-end waste management such as handling segregated waste, value addition and value accretive processing of all waste and waste products. The company aggregates different technologies catering to the waste management space and creating an end-to-end platform.

Chakr Innovation: The company manufactures retrofit emission control devices ("RECD") for diesel engine generators. The technology used by the firm is a novel emission control system that has achieved a reduction of over 70% of key pollutants, with minuscule power consumption and without any negative impact on the efficiency of the diesel generator. Of the multiple patents filed on the product, one Indian patent filed in 2016 was granted. The technology is also successfully tested by one of the 5 National Labs recognised by Central Pollution Control Board ("CPCB") and was the first company to receive a "Type Approval" certificate, thereby validating its technology.

Hygenco - Electrolyser to produce Green Hydrogen under the NEEV Fund

Chakr Innocation - Emission Control Device for Diesel Generators under the Neev Fund



JICA Expert as Power Sector Advisor to the Central Electricity Authority

Under the Joint Statement of the 10th Japan-India Energy Dialogue released in December 2019, it was agreed that an individual expert from JICA would be appointed as an advisor to the power sector. The aim is to support the Government of India's ambitious energy transition plans. In keeping with this, an expert from JICA has been appointed as the power sector advisor to the Central Electricity Authority (CEA) since 2021. The expert supports formulation and implementation of various strategies towards clean energy transition including energy storage, establishment of new ancillary market, and enhancement of more efficient and stable grid network. The expert also helps to strengthen the capacity of the CEA and other organisations in the power sector to implement such policies and strategies and to identify and propose new projects for JICA's assistance.

Activities of the expert:

- To review and analyse the entire power sector including sector optimisation, update status of power resource diversification, operation of power system, donors' activities, among others.
- To monitor ongoing works and short term and long-term plan in the sector including the ones related to climate change and critically analyse those in comparison with the government policy and plans such as the National Electricity Plan (NEP), clean energy transition policy and energy storage policy, to identify the gaps and advise CEA with feasible recommendations.
- To propose and support the execution of policies based on NEP and other policies and strategies for clean energy transition and net-zero by utilising Japanese knowledge and experience.
- Strengthen capacity of the CEA and other organisations in the power sector and provide advice on formulating new pumped storage power plant projects and the optimal operation of pumped storage power plant through mutual discussion with the Ministry of Power and related organisations.
- To propose and formulate new projects and then support the projects to be implemented by the Government of India and/or JICA through research, analysis, and training.

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