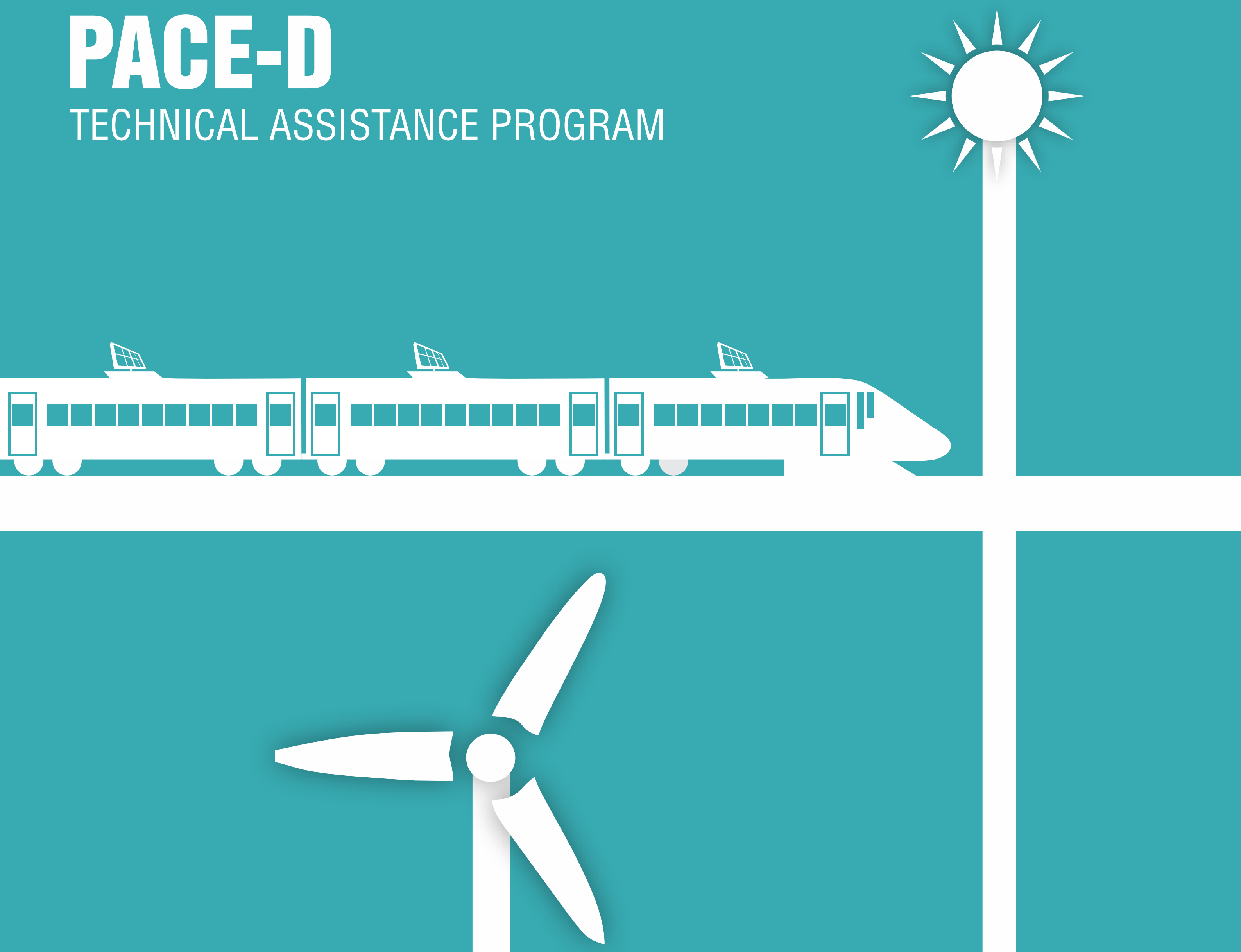
# PACE-D

TECHNICAL ASSISTANCE PROGRAM



# Indian Railways

LEARNING REPORT

USAID
FROM THE AMERICAN PEOPLE

GOVERNMENT OF INDIA
MINISTRY OF NEW
AND RENEWABLE ENERGY

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| Acronyms | Definition |
|---|---|
| AMC | Annual Maintenance Contracts |
| CEL | Central Electronics Limited |
| CFA | Central Financial Assistance |
| CAPEX | Capital Expenditure |
| DBFOT | Debt Build Finance Operate Transfer |
| DISCOM | Distribution Companies |
| EPC | Engineering, Procurement and Construction |
| GW | Gigawatt |
| IR | Indian Railways |
| INR | Indian Rupees |
| Km | Kilometer |
| kWp | Kilowatts peak |
| kWh | Kilowatt hour |
| MOP | Ministry of Power |
| MP | Madhya Pradesh |
| MNRE | Ministry of New and Renewable Energy |
| MU | Million Units |
| MW | Megawatt |
| Mwp | Megawatt Peak |
| NTKM | Net Ton Km |
| OA | Open Access |
| O&M | Operations And Maintenance |
| PACE-D | Partnership to Advance Clean Energy - Deployment |
| PV | Photovoltaic |
| PPA | Power Purchase Agreement |
| RE | Renewable Energy |
| RCF | Railway Coach Factory |
| REMC | Railways Energy Management Centre |
| REMCL | Railway Energy Management Company Limited |
| RFP | Request for Proposal |
| RESCO | Renewable Energy Service Company |
| RPO | Renewable Purchase Obligation |
| RWF | Rail Wheel Factory |
| SECI | Solar Energy Corporation of India |
| SPD | Solar Project Developer |
| TA | Technical Assistance |
| Twh | Terawatt Hour |
| U.S. | United States |
| USAID | United States Agency for International Development |

# Introduction

## LARGE INSTITUTIONS AS A BACKBONE TO INDIA'S ECONOMIC DEVELOPMENT

India's energy demand has been increasing rapidly, driven by urbanization, robust economic growth, and push towards infrastructure development. The installed capacity for electricity generation grew at 10.3 percent annually over the last five years, to meet the growing demand and historic supply shortfalls. Large institutions, such as the Indian Railways (IR), public sector oil companies like Indian Oil, and others have historically played a critical role in providing support for economic development. In a rapidly urbanizing India, these large institutions continue to play a central role; however, they must adapt and become more efficient to secure long-term competitiveness. Energy security is driving various institutions towards adoption of new methods and mechanisms to meet their energy needs via onsite and offsite generation of renewable energy (RE), and its import using several options such as net metering and direct purchase from electricity markets. These institutions should ensure that they are capable of providing service to the consumers in the most competitive manner while promoting the concept of sustainable development.

## INDIAN RAILWAYS' ENERGY PROFILE

IR is the world's second largest railway network, with 66,000 route-kilometer (km) and 7,200 stations carrying 23 million passengers per day. It is the largest consumer of electricity in India, consuming nearly 18 billion units annually. It also consumes around 2.9 billion liters of diesel annually for traction, which translates to nearly two percent of the country's total electricity generation and 3.2 percent of the total diesel consumption in the transport sector.

## ENERGY USE IN RAILWAYS

IR's demand for electricity is expected to more than double to 49 billion units by 2030 due to increasing freight volume, passenger load, and track electrification (Figure 1). IR has been gradually shifting away from diesel to electricity as the primary source of energy as a part of its strategy to control spiraling energy costs, reduce dependency on imported diesel, and reduce pollution. IR plans to electrify additional 1,000 route-km from 2016 to 2020.

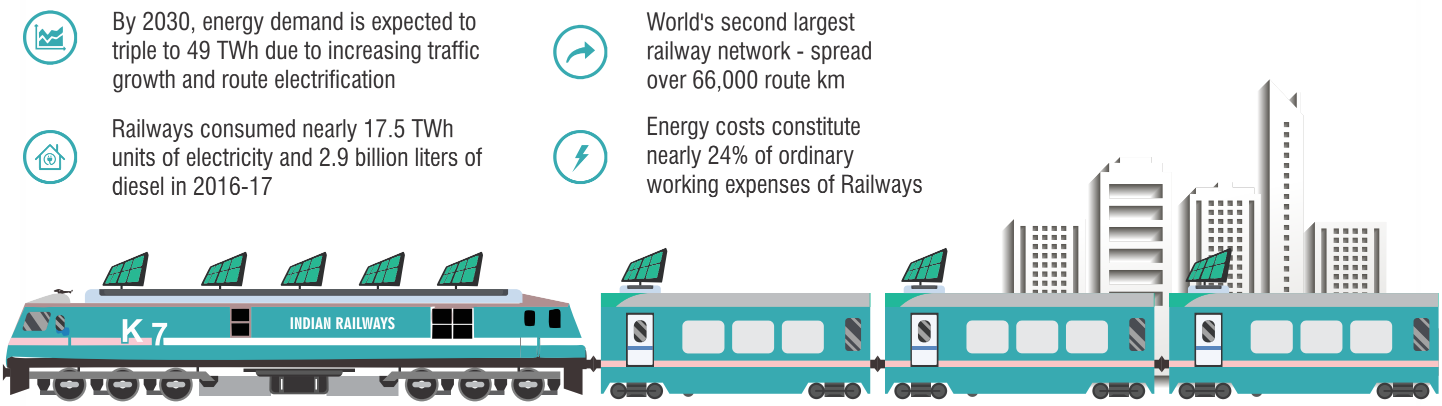



Figure 1: Indian Railways - A Snapshot

IR's energy consumption can primarily be classified into two segments by end-usage — traction and non-traction. Traction use includes energy for running trains using both electricity and diesel. Non-traction use includes electricity consumption in buildings, stations, factories, workshops, and use for street lighting, water pumping, and housing.

1 unit = 1 kilowatt hour (kWh).

Source: www.freepik.com

## Traction Use

Traction energy requirement is primarily met by diesel, and to a lesser extent, by electricity. Traction accounts for 86 percent of total electricity consumed by IR, which stood at nearly 15 billion units in 2016. Presently, IR has 28,000 route-km of electrified tracks, 65 percent of freight traffic, and 51 percent of passenger traffic is carried by these electrified routes.

Source: http://trainweb.org/

## Non-Traction Use

The IR network includes a large number of buildings such as factories, workshops, offices, and housing for staff. This load is called non-traction load and consumes around 2.5 billion units of electricity annually. Consumption of non-traction energy has largely been static since 2008, as a result of adoption of energy conservation efforts and replacement of old equipment with more energy efficient machinery. However, IR incurs higher commercial rate electricity tariffs for energy use for non-traction applications. Use of decentralized technologies such as solar rooftop and storage offers a huge potential for enhancing energy security and reducing costs through onsite generation and consumption.

# KEY ENERGY CHALLENGES FOR INDIAN RAILWAYS

## Growing Electricity Demand

IR has seen a steady growth in traffic over the last few decades. Passenger-km travel is expected to increase by 8.9 percent annually from 1,047 billion passenger-km in 2012 to 4,857 billion passenger-km in 2030. Similarly, freight demand, measured in net ton km (NTKM), is also expected to increase by 9.7 percent annually from 2,053 billion NTKM in 2012 to 10,867 billion NTKM by 2030.

To meet this requirement, IR spent about INR 12,635 crore on electricity in 2014-15, nearly 83 percent of which was for traction use. Traction demand grew at four percent annually over the last decade, driven by growth in traffic and increased use of electric locomotives made possible by route electrification. Non-traction electricity demand too has grown (albeit slowly) along with number of stations, buildings, and factories required to service the growth in traffic. At current trends, IR's overall electricity demand will triple by 2030. The historic growth trend for traction and non-traction loads is depicted in Figure 2.

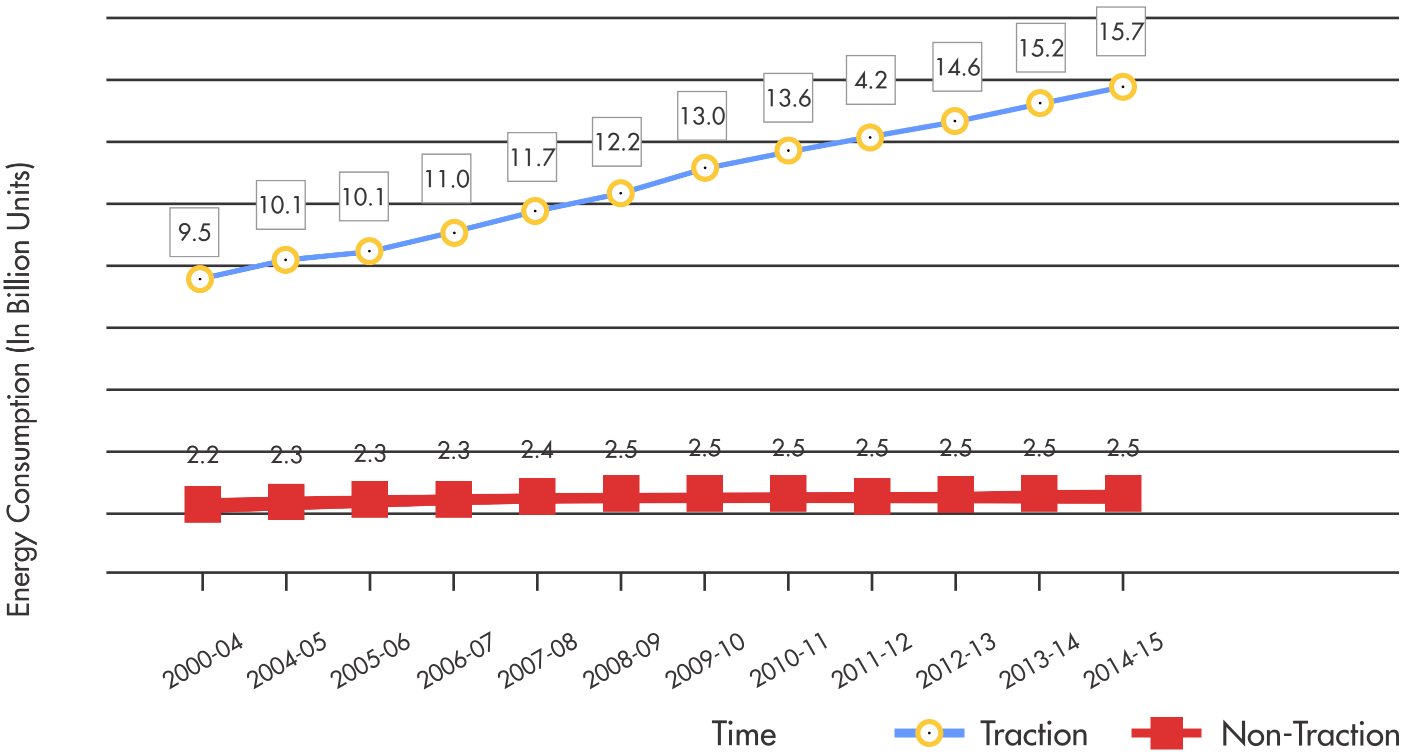
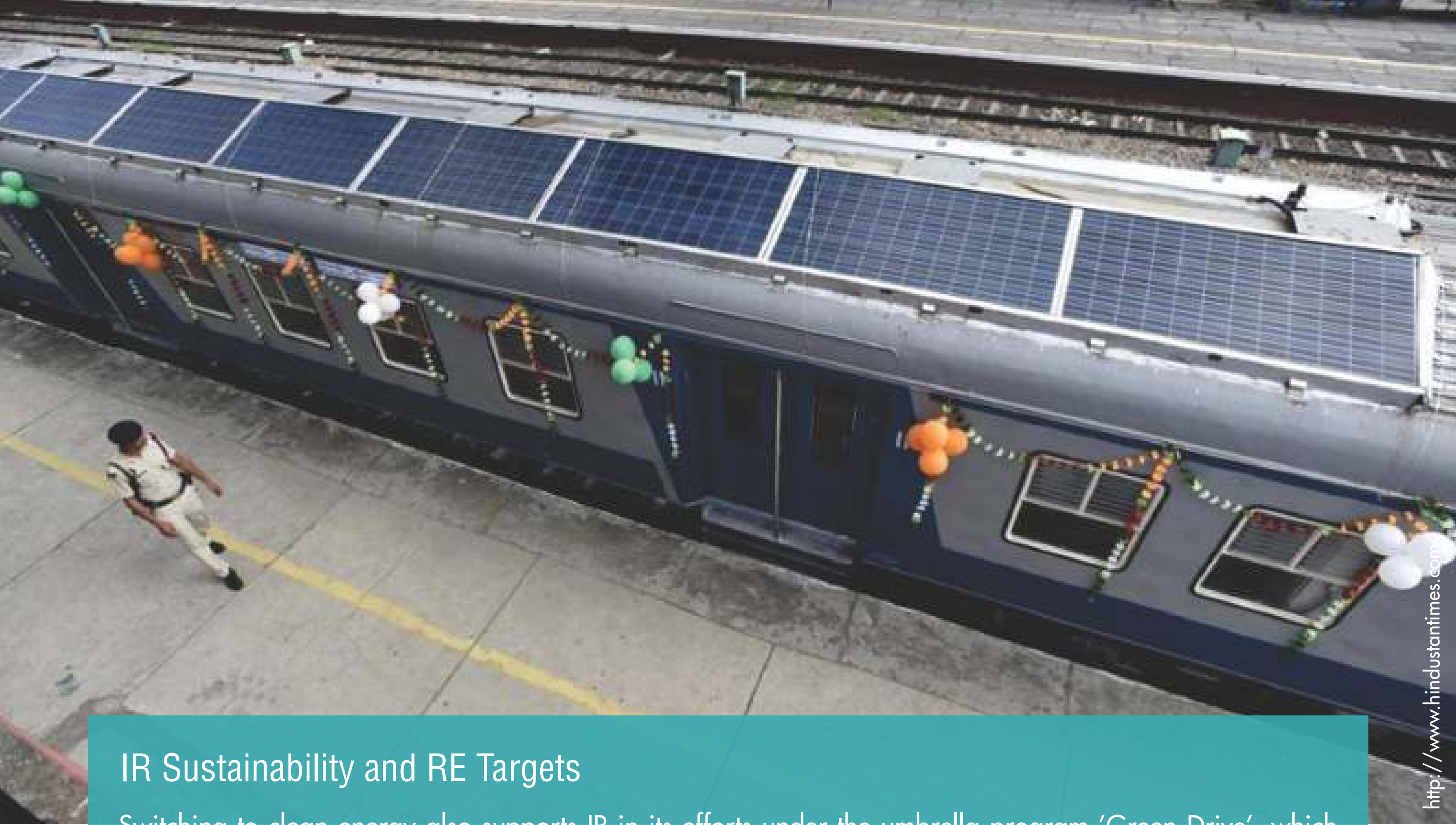



Figure 2 : Historic Energy Consumption for Traction and Non-Traction Applications

## Indian Railways as a Deemed Distribution Licensee

The Electricity Act, 2003, provides 'deemed distribution licensee' status to IR, treating it at par with electricity distribution companies. As a deemed distribution licensee, IR can act as a bulk power consumer, and directly procure power from electricity generators and undertake transmission and distribution of electricity for its operations. IR has entered long-term power purchase contracts, resulting in economies of scale, and reduced energy costs. Procuring power as a licensee is projected to help IR save over INR 4,000 crore annually against a business-as-usual approach. As a deemed distribution licensee, IR will have to procure power at the transmission level, which means that it will act as a deemed licensee mostly to traction load. For non-traction load, IR can act as an open access (OA) consumer where (in states where it operates) its installations meet its non-traction requirements. In case the non-traction load centers cannot be transited to OA, IR will have to stay on as a consumer of the distribution company. Here, the best option for IR is to install as much solar rooftop as possible to minimize the dependence on the utility grid.




## IR Sustainability and RE Targets

Switching to clean energy also supports IR in its efforts under the umbrella program 'Green Drive', which includes efforts to promote efficiency, reduce working expenses, and address climate change impact of its operations. As a part of its Green Drive, IR plans to install 5 gigawatt (GW) of solar power by 2025, with 1.1 GW from solar rooftop projects and remaining 3.9 GW from utility-scale ground-mounted projects. Additionally, IR plans to install 168 megawatt (MW) of wind capacity. So far, it has installed 36.5 MW wind projects, 14 MW of ground-mounted solar projects and is in the process of deploying 120 MW of solar rooftop projects. IR present goals for electrification and RE are presented in Figure 3.

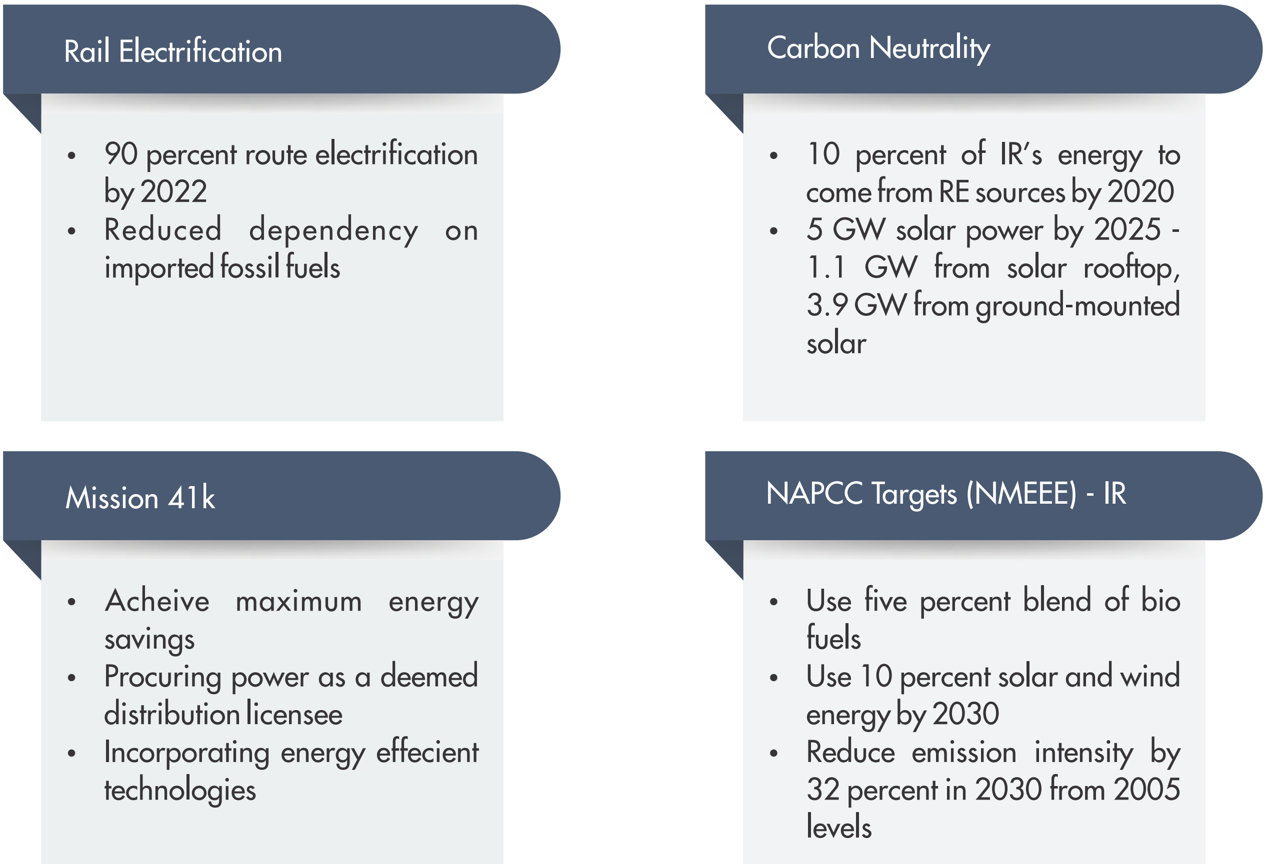



Figure 3 : Electrification and RE Targets for Indian Railways

# Towards a Comprehensive RE Procurement Strategy

India has set an ambitious target for both reducing carbon emissions and deploying a significant amount of clean energy. In line with its commitments under the Paris Agreement, India has pledged to reduce its emission intensity by 33 to 35 percent from 2005 levels by 2030. The Government of India has set a target of achieving 175 GW of RE capacity by 2022 and a long-term goal of transitioning to non-fossil fuel-based energy for 40 percent of its cumulative electricity generation capacity by 2030. Of the 175 GW RE target by 2022, 100 GW will come from solar projects, of which 40 GW, is expected from rooftop installations.

Rapid deployment of solar energy is being made possible by India's ambitious targets. This has opened several avenues for IR to meet their energy needs while taking advantage of falling solar costs. The modular nature of renewable technologies, particularly solar and wind energy, implies that they can serve both, as a decentralized source of generation to meet non-traction needs, as well as larger centralized production on remote facilities to meet traction needs. IR has two options for procuring clean energy to meet its needs:

- Direct, on-site production of RE, e.g., solar rooftop.
- Purchase of power from power producers through OA.

## ON-SITE PRODUCTION THROUGH SOLAR ROOFTOP

Presently, India has taken significant strides toward deployment of solar rooftop, nearing 2 GW of installed capacity, which grew at over 80 percent in 2017. Advancements in technology, improvements in solar panel efficiency, decreasing component costs, strong policy push by the government, deployment of new business and implementation models, and strong action by stakeholders have helped accelerate adoption of solar rooftop. Rapid adoption has also been driven by falling costs of solar rooftop, coupled with increase in grid tariff for commercial and industrial consumers.

In order to further propel the market, the government has instituted multiple enablers, such as 30 percent capital subsidy for residential, institutional, and social sector customers, accelerated depreciation benefit of 40 percent, financing of systems by banks under priority sector lending, and reduced interest rates. This policy push has played a pivotal role in transforming the solar rooftop sector, which is expected to grow fivefold in the next four years. IR stands to benefit from falling costs of solar rooftop, and has instituted a large-scale plan for deployment of solar rooftop across its network.

## PURCHASE OF POWER THROUGH OPEN ACCESS

As a deemed distribution licensee, IR can procure RE directly from solar, wind, hydro, and biomass energy generators. Of these, solar and wind are most favorable, due to their short development time, low prices, and a conducive policy environment supporting growth. IR has a large potential for on-site generation of solar energy on its building rooftops and land parcels. Likewise, it has the option of directly procuring electricity from power producers through long-term contracts and power trading markets.

Bulk loads, both for traction and non-traction use, form major consumption points for IR. 85 percent of energy demand by IR is from traction load centers. For non-traction applications, bulk loads consisting of rail factories, workshops, warehouses, processing plants, constitute major consumption points. Electricity requirement for bulk load centers should be met with large-scale generation, due to space constraints and high concentration of demand. To ensure reliable supply and to meet enormous fraction of total consumption from RE sources, it is essential for IR to develop a strategy to source RE power from all possible sources, including direct purchase of renewable power.

According to market analysis firm Bridge to India, source:
https://economictimes.indiatimes.com/industry/energy/power/bridge-to-india-cuts-rooftop-solar-forecast-to-10-8-gw-by-2021/articleshow/61918332.cms

# Partnership to Advance Clean Energy-Deployment Technical Assistance to Indian Railways

## BACKGROUND

The Partnership to Advance Clean Energy - Deployment (PACE-D) Technical Assistance (TA) Program is a flagship bilateral program under the United States (U.S.)-India Energy Cooperation. The six-year initiative is led by the U.S. Agency for International Development and the U.S. Department of State, implemented in partnership with the Ministry of Power (MOP) and the Ministry of New and Renewable Energy (MNRE). The Program focusses on three key components: RE, energy efficiency, and cleaner fossil technologies, with an overall aim of accelerating the deployment of clean energy in India. As a part of its RE interventions, the Program has been providing TA to IR since 2014, to scale up the organization's adoption of clean technologies such as RE and energy efficiency with long-term goal of decarbonizing IR's operations and reducing the cost of energy.

## Key Goals of the Program

- Accelerate clean energy deployment in India.
- Develop pilots, which are scalable, replicable, and have high potential for implementation.

*The Program worked with IR as a key focus organization, as development of solar rooftop in Railways offered significant potential for impact and scaled up replication aligned with the Program's goals.*

## IDENTIFYING INDIAN RAILWAYS AS A KEY PUBLIC-SECTOR PILOT PARTNER

One of the key focus areas of the Program was to facilitate the creation of a strong market eco-system for adoption of RE technologies, demonstrated through replicable, scalable pilots, which can spur demand and encourage other stakeholders to enter the market. In its initial phase, the Program undertook a detailed study to identify specific technologies, market segments, and market players who could benefit from deploying the pilots. The findings, which were summarized in a strategy report, highlighted decentralized energy options for large institutional players and public-sector companies such as IR and Indian Oil Corporation.

The selected organizations had significant applications and savings potential for decentralized RE as they paid high tariffs for electricity. These players also had access to adequate technical and financial resources, and significant rooftop space. Initially, the Program interacted with Solar Energy Corporation of India (SECI), who was in the process of developing numerous tenders focused on deployment of decentralized, solar rooftop projects. Over a period of time, subsequent conversations resulted in the Program initiating its collaboration to help scale up of rooftop implementation across IR. The Program initiated a detailed engagement with Northern Railways and the Railway Board, and started working towards the development of solar rooftop capacity totaling over 150 MW across India, tendered directly by IR.

## Indian Railways as a Key Actor for Scaling Up Solar Rooftop in India

Experience gathered from solar rooftop implementation for Railways can be applied to other large-scale and public sector enterprises. The following key characteristics make Railways a strong candidate:

- Large number of load centers:
  - Traction loads for freight and passenger traffic operations.
  - Non-traction loads for railway stations, factories, workshops, hospitals, etc.
- Diverse load profile from small buildings to large factories.
- Wide visibility of rooftop projects, e.g., railway stations, reservation centers, etc.
- High utility electricity rates, including charges for distribution losses, cross subsidy, utility surcharges, etc.

Other organizations which can adopt similar approach towards large-scale solar rooftop deployment include public sector oil companies, defense agencies, and state departments. e.g., health, municipal corporations, warehousing corporations, etc.

## SETTING THE VISION

The Program initiated the work with IR in 2014. The initial engagement was related to the deployment of solar rooftop on IR stations with an objective of solarizing them and also bringing down their cost of energy. The initial discussions under the engagement were on understanding the challenges faced by the organization in adopting solar rooftop projects. IR had adopted an initial target of deploying 500 MW of solar rooftop across the country. While IR wanted to deploy solar rooftop projects, it did not want to make huge investments associated with these projects. IR was interested in procuring solar rooftop-based power at a rate cheaper than that of grid; however, it felt that the technology and operation cost was not something it wanted on its hands.

The Program worked with IR to develop the procurement approach and business models needed to deploy solar photovoltaic (PV) using power procurement model used worldwide and by many projects in India. For installation on such a scale, the goal was to choose a model with easy and scalable approach, which leveraged economies of scale, and maximize savings. The Program developed a discussion paper on various business and implementation models for solar rooftop deployment, comparing the long term costs and benefits of each model. Based on detailed discussions, IR zeroed in on the third party-based Renewable Energy Service Company (RESCO) model as its preferred approach. Under this model, RESCOs would be specialized as solar rooftop developers who will build-own-operate these solar rooftop projects for the customers, which in this case will be IR. This model allowed IR to leverage scale, without making huge upfront investment, and lays the onus of technology and project performance on third-party RESCO. Subsequently, IR requested the Program to provide assistance in institutionalizing this solar rooftop deployment initiative under the RESCO model. The overall approach for the engagement is highlighted in Figure 4.

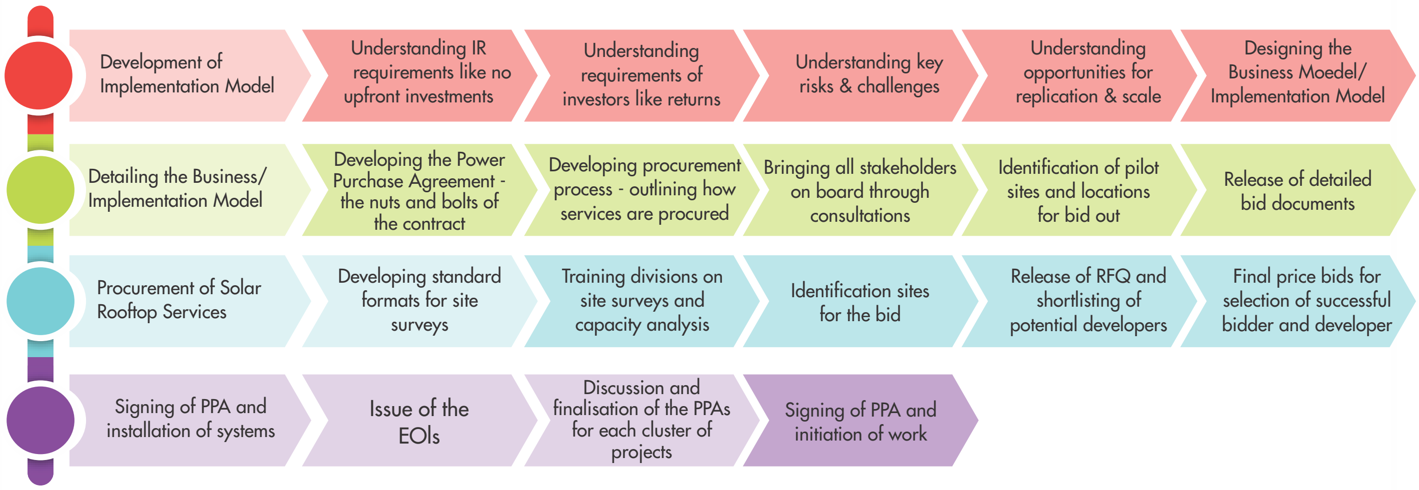



Figure 4 : Approach for the Program's Engagement for Solar Rooftop Deployment with Indian Railways

# The Program's Contribution to Indian Railways' Solar Rooftop Program

As a part of its clean energy commitments, IR was exploring ways to increase deployment of RE. The modular nature of solar rooftop energy and the possibility of procurement in small quantities made solar rooftop an attractive option to meet the demand for non-traction loads. IR has a network of 8,495 stations, categorized from highest to lowest ranking, depending on annual earnings, train passes, and functional operations. The Program assisted IR with an assessment of rooftop capacities for each station category, and proposed a capacity estimation chart (Appendix V). This analysis helped to establish IR's estimated solar rooftop potential at 500 megawatt peak (MWp).

Railways faced execution challenges due to decentralized nature of solar rooftop, as projects were deployed spanning across its nationwide network. IR lacked prior experience in deployment of RE, and did not have the tools and expertise necessary to execute projects on their own. The Program collaborated with IR to provide critical assistance in strategizing for a way forward, and institutionalizing the process of RE deployment for IR. The Program provided assistance to IR in the following ways:

- **Developing a Deployment Strategy:** IR, as an organization, was a new entrant in the RE sector and lacked the expertise required for aggressive foray. In order to adopt RE, IR had to minimize its risk and financial exposure. Based on the type of rooftop projects, the program assisted IR by developing a deployment approach, incorporating the strategies, and business models as discussed in Table 1.

| | RESCO Model | CAPEX Model |
|---|---|---|
| Business Model | • IR allot or lease rooftop space for rooftop project deployment.<br>• RESCO designs, develops, owns, and operates the project.<br>• IR purchases energy as a service from RESCO. | • IR develops and owns Rooftop Project for captive consumption, under net metering, wherever available.<br>• IR's operations and maintenance (O&M) service providers maintain the plant for a fee. |
| Advantages for Railways | • Preferred model for stations and buildings with large rooftops, which are attractive for RESCO developers.<br>• IR has no liabilities, except for procuring power.<br>• Least financial implication for IR. | • Can be deployed in any capacity, but cost constraints make it the preferred model for smaller stations with rooftop capacities below 25 kWp, which are unattractive for RESCO developers. |
| Risks | • IR shall enter into long term contracts to procure at competitive tariffs, tying it to one supplier.<br>• RESCO model is not suitable for smaller buildings and remote locations. | • No guarantees of system performance.<br>• The technology and operational risk is entirely borne by the IR.<br>• IR are responsible for regular maintenance. |
| Mitigation | • Performance guarantee by RESCO assures IR of generation.<br>• RESCOs are specialized organizations and better positioned to maintain systems, manage technology, and operational risks. | • Ensuring proper O&M and Annual Maintenance Contracts (AMC) are signed with reliable service providers. |

Table 1 : Type of Business Models for Solar Rooftop Projects

- **Simplifying Procurement and Deployment Process:** Having a simple, robust, comprehensive, and effective approach was essential to create a procurement framework that could be easily adopted across the organization. The available procurement processes for IR centered on the procurement of railway infrastructure such as rolling stock or tracks. IR had no understanding of the challenges in procuring solar rooftop power (even through Delhi Metro Rail Corporation had been procuring solar rooftop power for almost a year prior to this). The Program worked with IR to customize IR's procurement process to suit the needs of solar rooftop. This included looking at the detailed procurement process document and contracts used by IR, editing and customizing these documents, providing detailed understanding of the need for edits and customization, and detailed deliberations on the impact of these changes on the two parties involved. This whole process was long and arduous and took close to a year to complete. However, by year-end, IR had a set of documents and process which could be used by the entire network to procure solar rooftop power. This approach helped skill the organization (especially the Railway Board) with the expertise necessary for independent execution of subsequent stages of procurement. This included definition of criteria for eligibility and process of selection of bidders.

- **Designing Site Assessment Templates:** To ascertain the aggregated rooftop details at station premises, the Program developed a standard rooftop site assessment template, capturing all the essential details required for project cost estimation.

## DEVELOPING MODEL CONTRACT DOCUMENTS

By combining standard public-private partnership documents with IR procurement guidelines and RE procurement best practices, the Program developed model procurement and contract document, known as PPAs for IR that not only safeguards IR's interest, but also ensures a conducive business environment for developers and financiers.

The Program assisted IR in drafting tender documents based on standard model Debt Build Finance Operate Transfer (DBFOT) approach, divided into a two-stage process of Request for Proposals (RFP), followed by Request for Quotation. The Program helped develop bid documents for implementation of solar rooftop projects under both, Capital Expenditure (CAPEX) as well as RESCO models. The documents were based on Ministry of Finance draft document for Public Private Partnership projects, and continue to be used by IR.

## POWER PURCHASE AGREEMENT

The PPA acts as a legally binding agreement between IR and Solar Project Developer (SPD) for fulfilling all obligations and matters incidental to the development of solar project. The Program designed a PPA for tenure of 25 years from the date of commissioning. The provisions for power purchase of electricity for IR includes:

- Providing access to the roof, including access and permission to construct and operate the solar rooftop project at identified site.
- Financing and constructing the project.
- O&M and management of the project.
- Receiving payments as per electricity supply to IR in accordance with the mentioned provisions.
- Performing and fulfilling developer obligations as per good industry practice.
- Ensuring net metering with local distribution company.

In addition, certain key characteristics included based on the recommendations by the Program are as follows:

- Buyout Agreement — In case of payment default by IR, it would commit to purchase the plant from the developer at a predetermined price.
- Innovation Agreement — The plant would novate to the bank.
- Compensation to Railways — In case the plant underperforms based on a pre-determined formula.

The silent features of Model Contract are listed in Tables 2 and 3 respectively.

| PPA | Tariffs | Billing and Payment Cycle | Generation Shortfall Protection | Deemed Generation | Performance Bank Guarantee | Other Features |
|---|---|---|---|---|---|---|
| • 25-year term<br>• Design<br>• Finance<br>• Procurement<br>• Construction<br>• Commission<br>• O&M | • Inclusive of taxes<br>• No annual escalation | • Payment terms (30 days)<br>• ESCROW account | Developer liable to pay for shortfall in generation | Protection for developer in case IR are unable to offtake power | Provided to IR for initial period of project, to weed out non-serious players | • The IR obligations<br>• Developer obligations<br>• Force majeure<br>• Termination warranty |

Table 2 : Salient Features of Solar Rooftop Procurement Documents Developed by the Program

| Features | Description |
|---|---|
| Tariff | The Program recommended that IR should negotiate constant tariffs for the entire duration of PPA. Tariffs quoted by the developer were inclusive of all taxes and duties. |
| Billing and Payment Cycle | The payment cycle included payment terms for 30 working days, provision for IR to pay interest calculated at two percent above the bank rate on the amounts payable beyond the due date. |
| Shortfall in Generation | The PPA included a schedule of expected electricity production, defined under a minimum Capacity Utilization Factor clause. In case of shortfall, developer is held liable to pay compensation against shortfall and also any penalty accruing to IR for not being able to meet its Renewable Purchase Obligation (RPO). |
| Deemed Generation | In case of commissioning delay caused by IR, the developer is eligible for deemed generation. |
| Generation Guarantee and Penalties | Developer provides IR with a performance bank guarantee to protect IR against loss in generation due to poor plant performance. |
| Party Obligations | The PPA includes dedicated sections which outline obligations for key actors, whose roles are critical for fulfilment of the project.<br>Obligations are clearly defined for the SPD, IR, and IR Electrical Engineer. |
| Dispute Resolution | These clauses define mechanisms for addressing dispute between the parties during the PPA term. It provides clear details about the role of arbitrator and formation of dispute resolution committee etc. |
| Force Majeure | This clause defines conditions which can be considered under force majeure, with details about obligations, remedies, and exemptions for the SPD and IR. |
| Termination | These clauses provide definition and conditions to be considered under termination, including details about obligations, remedies, and exemptions for the SPD and IR during termination. |
| Technical Specifications, Standards, and Testing Procedure | These clauses include technical details of solar rooftop plant equipment, testing procedures, specifications in line with recommendations from the SECI, and modified as per IR requirements. |

| | |
|---|---|
| Insurance and Warranties | These provide details about the equipment insurance, workforce requirements, and warranties by the SPD. These are also in line with SECI's specifications and modified as per IR's requirements. |
| Safety and HSE | These provide information about safety and procedure details of all the equipment, workforce to be maintained by the SPD during project life. |
| Timelines | These provide detailed timelines and processes to complete the project. |

Table 3 : Other Features of Standard Solar Rooftop Procurement Documents

The Key Milestones of Collaboration are Highlighted in Figure 5.

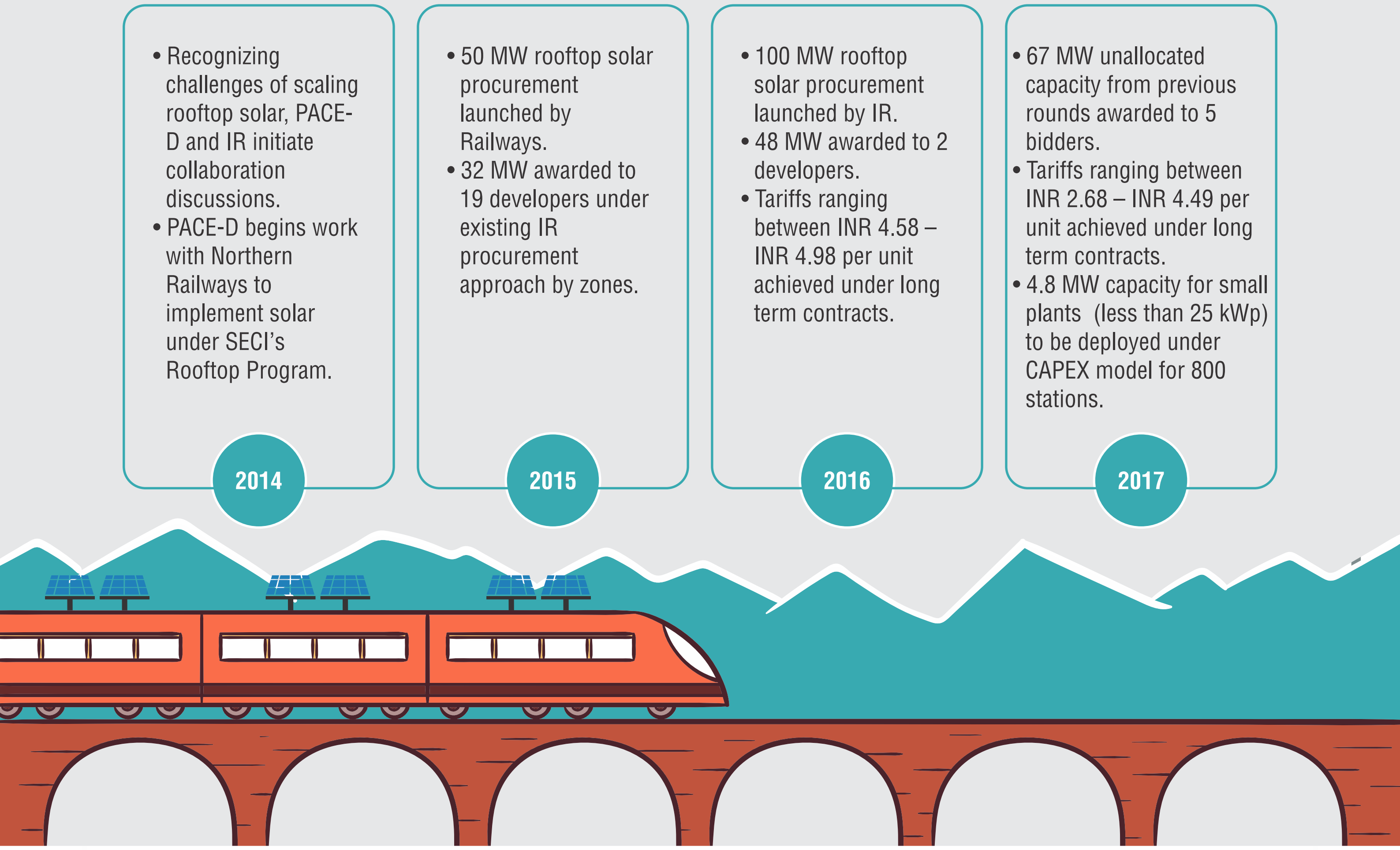



Figure 5 : Chronology of the Program's Engagement with Indian Railways for Deployment of Solar Rooftop

## SUPPORT TO 50 MW ROOFTOP PROJECT

This was the first of its kind large-scale rooftop program launched by IR. The project was considered as a pilot to help IR gain expertise and refine execution in future. The Program worked with IR to develop basic framework to roll out the solar rooftop program via RESCO route. The Program assisted IR in developing a detailed cost benefit analysis for RESCO models, while identifying key risks that RESCO model posed to IR along with specific risk mitigation mechanisms.

To collectively bid rooftop capacities, stations had to be aggregated. IR proposed cumulating stations along six major routes. A total rooftop potential of 50 MW from stations along these routes was collectively tendered. Tenders for selected stations were floated at the respective zonal level. The Program prepared the standard model contract documents to be used in the bidding process and shared with zonal heads. IR preferred a route-wise approach, for the following reasons:

- **Efficient and Faster Project Execution:** Projects installed along a single railway line would have a benefit of easier site surveys, assessment, man power deployment, and procurement. This would accelerate project execution.
- **Central Warehousing:** Setting up a warehouse along the railway route could expedite equipment storage, deployment, and procurement process for all project sites.
- **Faster Transportation:** Transportation time and cost would be significantly reduced for equipment and man power necessary for project locations along a railway route.
- **Effective Monitoring, O&M:** All project sites along a single rail route would be easier for O&M of rooftop projects.
- **Promoting IR's Green Initiative and Tourism:** Rooftop projects installed on successive stations along a Railway line can boost IR's green energy initiative and promote tourism.

## Route-wise Analysis

The Program assisted IR in mapping stations along six major routes. These routes, highlighted with respective rooftop capacity and number of stations, are shown in Figure 6. The stations along with the selected routes were also mapped with their respective station categories to arrive at the total rooftop potential of 178 MW. Number of stations and their categories are shown in Figure 7. Route-wise mapping helped IR assess total rooftop capacity availability, and it initiated the process to tender out 50 MW along the selected routes. IR availed Central Financial Assistance (CFA) from MNRE for its project. CFA helped developers meet 15 percent of project cost through subsidy, thereby supporting the execution process. For subsequent rooftop project tender of 100 MW, MNRE shifted from central subsidy to an achievement linked incentive.

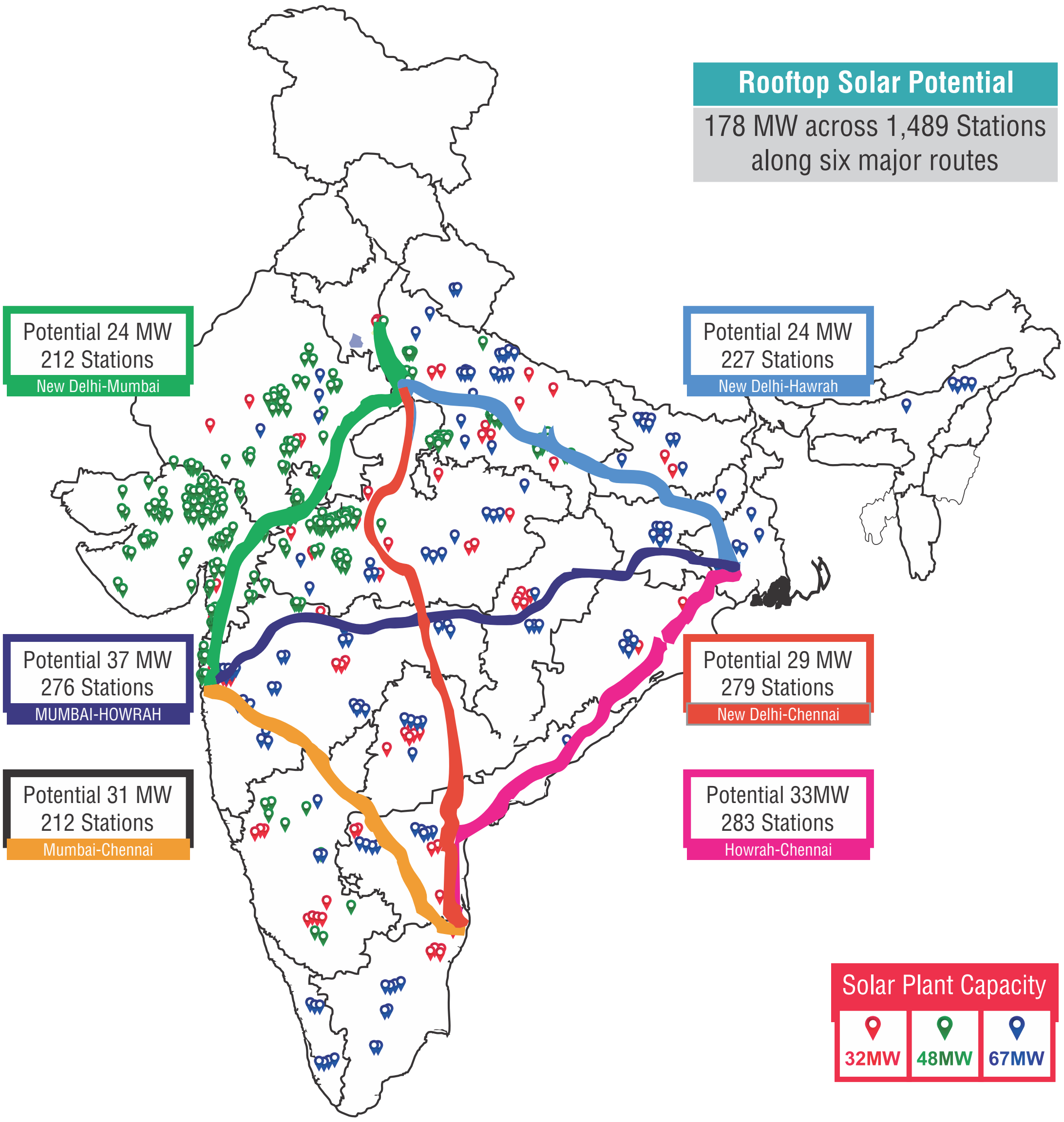



Figure 6 : Route-wise Analysis for Station Rooftops

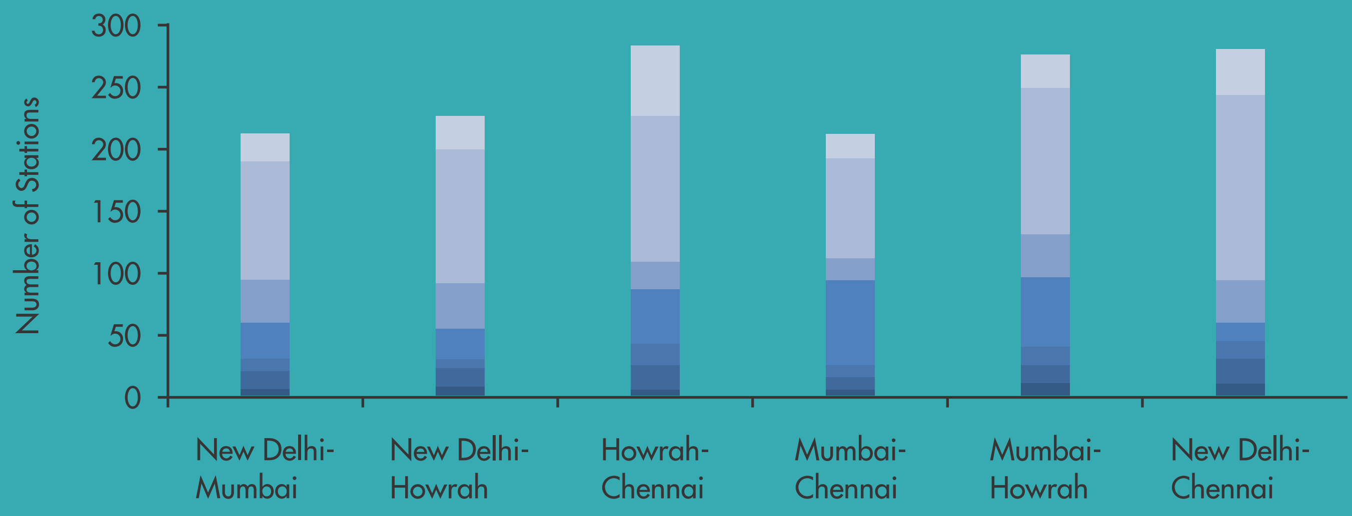



Figure 7 : Category-wise Distribution of Stations along Six Selected Routes

## Bidding Results

The assigned Zonal Railways successfully tendered out their respective capacities, allocating 31.25 MW out of the total 50 MW to 19 developers across 13 zones and two rail factories. The average tariff discovered across all zones was INR 4.45. The 50 MW rooftop project was a learning experience for IR, and helped the organization acquire necessary skills and expertise to execute solar rooftop projects in future. The capacities successfully bid and the list of awardees is included in Appendix I.

The Program's continuous engagement with IR in execution of 50 MW rooftop project served as a learning platform for both IR and the Program. The decentralized approach to procurement of solar rooftop helped provide valuable insights regarding the challenges and complexities of large-scale IR operations. Learnings from this pilot project helped IR redesign its strategy for developing a better refined and comprehensive tender for subsequent rounds of procurement.

## Key Learning from the 50 MW Tender

- Decentralized procurement led to delays in the process. Zones took up bidding process as per availability of resources and their seriousness to adopt solar rooftop. This resulted in protracting the bidding process.
- As a result of zonal execution, several tenders were simultaneously floated by various zones, each with small capacities on offer. This stretched the developers thin, and some developers were unable to apply for concurrent tenders.
- Developers reported a preference for tenders with large capacity. Coordinating for tenders with small total capacity on offer failed to attract sophisticated bidders.
- Zonal level procurement made it difficult for IR to track tendering and monitor overall progress of implementation.

# SUPPORT TO 100 MW ROOFTOP PROJECT

Based on the learning from initial phase (50 MW project), the Railway Board decided to continue efforts to scale up solar rooftop through another 100 MW tender for stations along key rail routes (Figures 4 and 5).

## Change in Strategy

Based on the learning from 50 MW scheme, the Railway Board chose to change its strategy to a centralized procurement process for this phase, and appointed Railways Energy Management Centre (REMC) as the procurement agency. The Program assisted Railway Board in undertaking detailed analysis of routes, identified potential challenges to this approach, and helped build capacity of REMC to conduct bidding. The Program also modified model documents based on the learning from previous phase, incorporating feedback from Zonal Railways. The Program assisted REMC to collect data, select stations, and arranged a new CFA structure from MNRE in the form of achievement linked incentive. This was a marked shift from the subsidy-based approach taken in the previous tender.

## Bidding Results

The bid allocation of 100 MW consisted of rooftops from 16 zones, a factory (Railway Coach Factory (RCF) Kapurthala) and a metro facility (Kolkata Metro). No bids were received for seven zones and Kolkata Metro. The seven developers placed bids for sites in nine zones and the RCF building respectively. Two developers were awarded 48 MW capacity for five zones and the RCF building respectively. For the remaining seven zones, no winning bidders were selected due to the following reasons:

- North Frontier Railways did not award the allocated capacity because of the discrepancy in capacity offered in tender (2MW) versus total capacity as per site details (1.55 MW).
- West Central Railways did not award the allocated capacity because of the discrepancy in capacity offered in tender (1MW) versus the total capacity as per site details (1.5 MW).
- South Eastern Railways and Southern Railways did not award the allocated capacity due to bidder disqualification on technical grounds.

The tender for coach factory was awarded but subsequently canceled due to net metering restrictions in the State of Punjab. At the time of tendering, state regulations prevented solar rooftop net metering for systems larger than 1 MW. The Punjab government has subsequently modified its policy for net metering allowing rooftop up to 10 MW, and the approval is pending from the regulator. It is expected that RCF rooftop facility will be retendered for a rooftop installation in future. The capacities successfully bid and the tariffs realized are included in Appendix I.

## Key Learning from 100 MW Tender

The 100 MW tender was a significant change in the strategy by Railways, and the first procurement executed by REMC. It involved complex coordination with respective zones, for large rooftop capacity tender. Overall, the tender received lukewarm response from developers, and faced implementation challenges, which provided several insights for Railways about centralized procurement. The key learning from this phase included the following:

- Through the bidding process, it was learned that developers are not interested in working on smaller rooftop sites, when bids are under the RESCO model. Resource requirement for installing and operating solar rooftop plants changes marginally with size. This means small size plants are more resource intensive than large size plants and thus uneconomical for developers.
- Competing bidding process for 1 GW solar rooftop tender by SECI, which ran concurrently with the REMCL procurement stretched the capacity of developers, and adversely affected bidding. Developers, resources, and capital were tied up in bidding for the two large solar rooftop programs. Requirement for submission of earnest money deposits for bid participation and capacity constraint for several developers limited their capacity to bid for IR projects.
- Some winning bids did not result in signing of a PPA between the developer and IR. This was due to the challenges related to net metering regulations, preventing large buildings from installation of solar rooftop. It is expected that as states gather more experience with solar rooftop and net metering regulations are streamlined, this challenge will be addressed.

## SUPPORT TO 67 MW ROOFTOP PROJECT

The key learning from the 100 MW rooftop program were analyzed and incorporated for launching a new tender for 67 MW, under Phase 2, to reallocate the capacity which could not be developed in the first two rounds. Like the earlier tender of 100 MW, this bidding too was undertaken centrally through REMC. The cumulative tendered capacity of 67 MW consisted of untendered rooftop capacities from the previous two tenders, i.e., 50 MW and 100 MW tenders, and additional capacities submitted by Zonal Railways to REMCL.

### Change in Strategy

- Due to the addition of untendered sites from previous two tenders, the CFA was split into three categories:
  - Category 1 — For untendered sites under 100 MW tender, subsidy from MNRE was under Achievement Linked Incentive mechanism.
  - Category 2 — For untendered sites under 50 MW tender, subsidy from MNRE was 15 percent of project cost.
  - Category 3 — For additional capacities, where no subsidy was provided.
- It was observed that one of the primary reasons for low response from the developers was the bundling of small rooftops in the same tender along with rooftops with larger capacity. Based on this, all rooftop sites with a potential less than 25 kWp were filtered and excluded from the tenders to be developed through a separate mechanism.

### Bidding Results

The bidding was successful and resulted in allocating 67 MW capacity to five project developers. Bidding resulted in the lowest tariff of INR 2.39 per unit in special category states. Non-subsidy tariff was discovered to be INR 4.46 and INR 3.49 for Category 1. The results are analyzed in Figure 8.

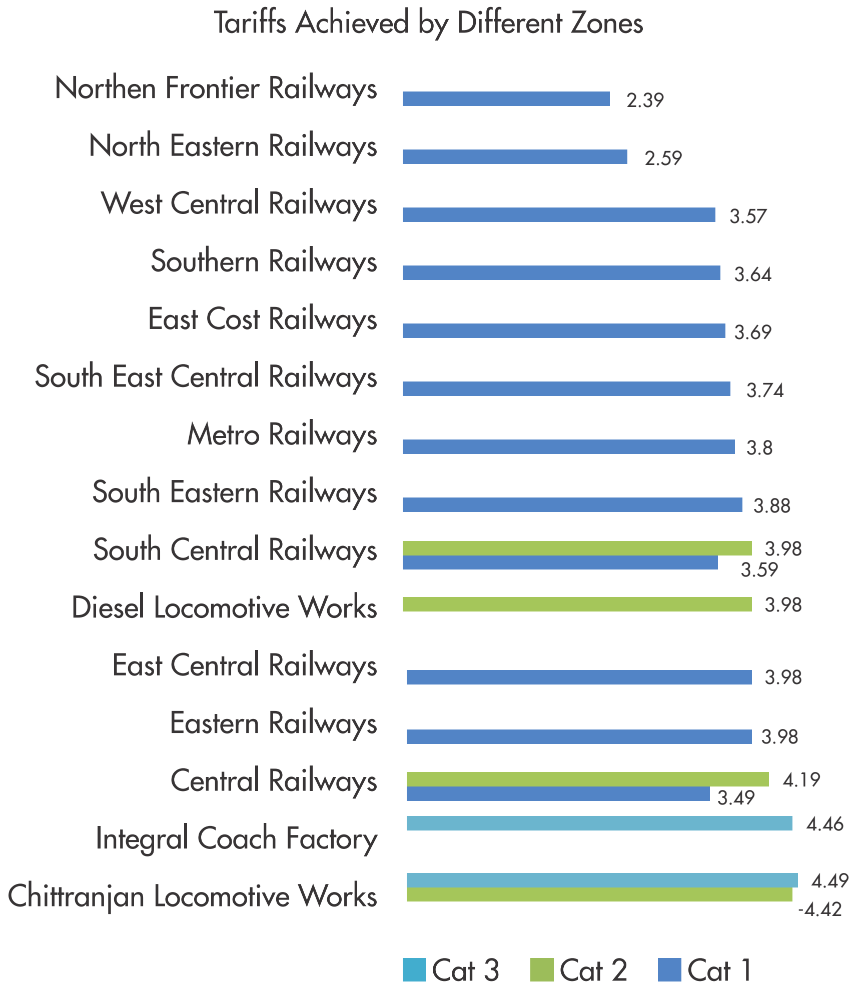



Figure 8 : Lowest Tariff Amongst Offered Zonal Capacities in 67 MW Tender

## Key Learning

The successful bidding of all the capacities in 67 MW project validates the consideration of excluding small rooftop capacities from previous tenders. It also helped IR conclude that small rooftop should be executed through CAPEX route, where IR invests in the project.

## SUPPORT TO 4.75 MW ROOFTOP PROJECT (SMALL STATIONS)

Based on the learning, IR decided to deploy smaller capacities through CAPEX mode and requested support from the Program to develop standard bidding documents for the procurement of solar rooftop equipment. The Program has developed the required documentation and IR is now in the process of procuring solar rooftop systems for 4.8 MW capacities from 800 stations across India. The Program assisted IR in developing agreements for EPC and O&M from standard bidding documents for procuring solar rooftop under CAPEX model.

# RE Procurement Strategy

With the mission to achieve RE goals, IR accomplished a remarkable progress on deployment of solar rooftop. However, generation through small-scale renewables can only contribute to a fraction of the organization's RE targets. Traction and non-traction bulk loads are major consumption points for IR. Almost, 85 percent of total energy demand by IR is from traction load centers. For non-traction applications, bulk loads consisting of rail factories, workshops, warehouses, and processing plants constitute major consumption. The electricity requirement for bulk load centers can only be partially met by solar rooftop, because space constraints and high concentration of demand is making rooftop projects unviable for meeting total demand. To ensure reliable supply and to meet greater fraction of total consumption from RE sources, it is essential for IR to develop a strategy to source RE power from all possible sources, including direct purchase of renewable power.

## Need for Procurement Strategy

Solar and wind prices have fallen rapidly, breaching grid parity, making these sources competitive with conventional energy. The average utility traction and non-traction rates paid by IR in seven states are depicted in Figure 9. The figure also shows expected range of cost of generation from solar, wind, and solar rooftop.

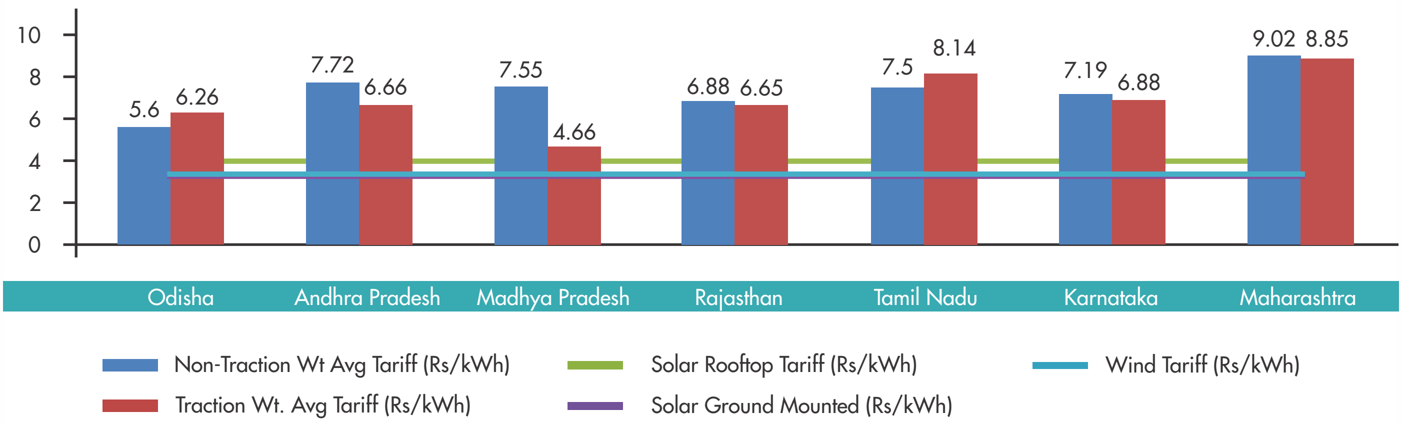



Figure 9 : Average Traction and Non-Traction Utility Rates in Seven States

It is evident from Figure 9 that RE technologies offer the cheapest cost option for IR to procure power. However, adoption of these technologies is complex due to certain challenges, hindering adoption.

- **Capital Investment:** Falling component prices have resulted in decreasing RE costs over the years. However, the initial CAPEX requirement is still substantial, and a deterrent to quick adoption.

- **Regulatory Framework:** The central government has laid down model regulatory guidelines to accelerate RE adoption in states. Although most states have a regulatory framework in place, the terms, conditions, and provisions differ from state to state. This makes RE procurement challenging.

- **Net Metering Regulations:** Solar rooftop capacities are constrained by net metering regulation in states. Most states allow rooftop capacity lesser than and equal to the sanctioned load at metering point, with a maximum limit of 1 MW. Capacities are also constrained by grid infrastructure available at the distribution transformer level.

- **OA:** IR is a deemed distribution licensee, and has the option of directly purchasing power from energy generators through an energy exchange. However, OA charges applicable to direct purchase differ according to state regulations. As a result, the landed cost of power differs depending on the location of the point where power is injected into the grid, and where it is withdrawn, making procurement through this route complex.

- **Scheduling Complexities:** RE generation pattern is seasonal and varies during the day. This infirm nature of power causes scheduling complexities for matching with the demand pattern for IR.

- **Reluctance from Distribution Company (DISCOM):** IR is a high valued customer for all state DISCOMs. With timely payments and bulk consumption, most DISCOMs are reluctant to lose IR as their customer. The shift adversely affects their revenue stream and profitability.

The Program assisted IR in better understanding the RE procurement options, by carrying out a study on OA regulations. The study focused on deriving the landed cost of power from wind and solar generation plants for traction and non-traction bulk loads in seven states as shown in Figure 10.

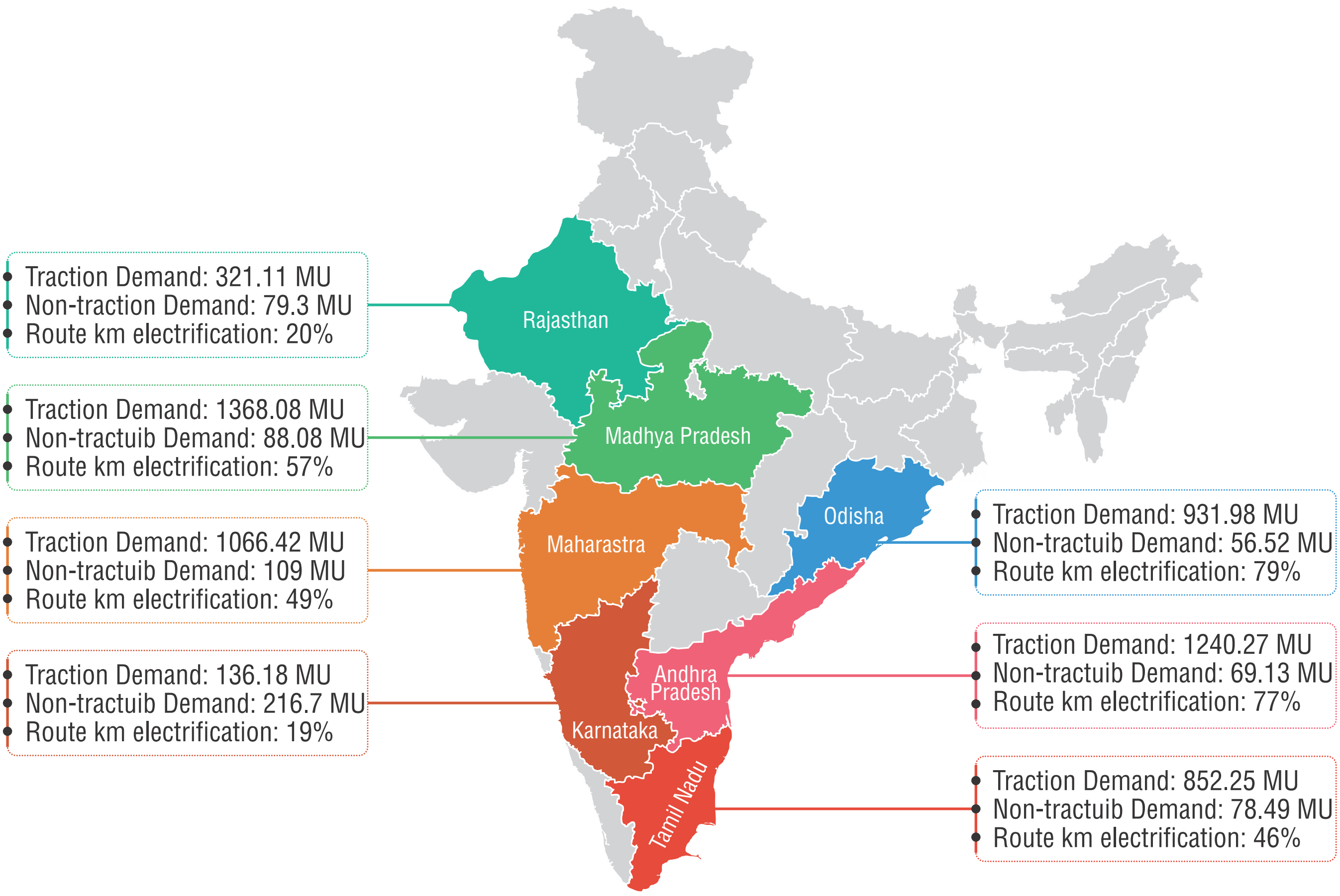



Figure 10 : RE Procurement Strategy for Selected States

# Design of Procurement Strategy

A procurement strategy was developed for each of the selected states, considering the following key elements:

- **Total Energy Demand for IR in State:** The Program first plotted total traction and non-traction energy consumption demand in the respective state (Figure 9).

- **Devise RPO Targets:** Based on IR's target of eight percent solar RPO and 12.5 percent non-solar RPO by 2022, year-wise RPO requirement milestone was developed for them.

- **Analyze Existing RE Potential in State:** The Program analyzed the existing RE potential in the state. It also considered projects under pipeline and mapped the energy quantum supplied against RE targets.

- **Evaluate Supply Options:** With targets in place, IR researched various supply options possible in the state. The following supply options were proposed:
  - o Solar rooftop projects for supplementing non-traction loads.
  - o Ground-mounted solar projects for meeting RPO for traction loads.
  - o Ground-mounted solar projects to supply power through OA for non-traction bulk loads.
  - o Wind energy projects for meeting non-solar RPO targets.
  - o Wind energy projects for supplying power through OA for non-bulk loads.

- **Estimate OA Power Procurement:** Power procurement from solar and wind projects for traction load centers is through OA via inter-state as well and intra-state transmission network. The cheapest landed cost option for each state was derived and mapped against IR's year-wise targets. The mapping helped quantify the requirement for power procurement necessary for IR to meet its targets. Total capacity addition for 2022 was also calculated.

- **Estimate Rooftop Power Potential:** Based on the assessment of total rooftop potential from stations in a state, the year-wise strategy for solar rooftop installation was devised. The key learnings from rooftop deployment were incorporated in subsequent rounds of procurement.

- **Cost Offset for Bulk Load Centers:** Based on the data provided by IR, a strategy to procure power through OA for bulk load centers was also considered. Utility rates paid by IR were substantially higher than landed cost options from solar and wind projects in all states. This translated to huge savings in electricity bills for IR. The development of RE procurement portfolio is shown in Figure 11.

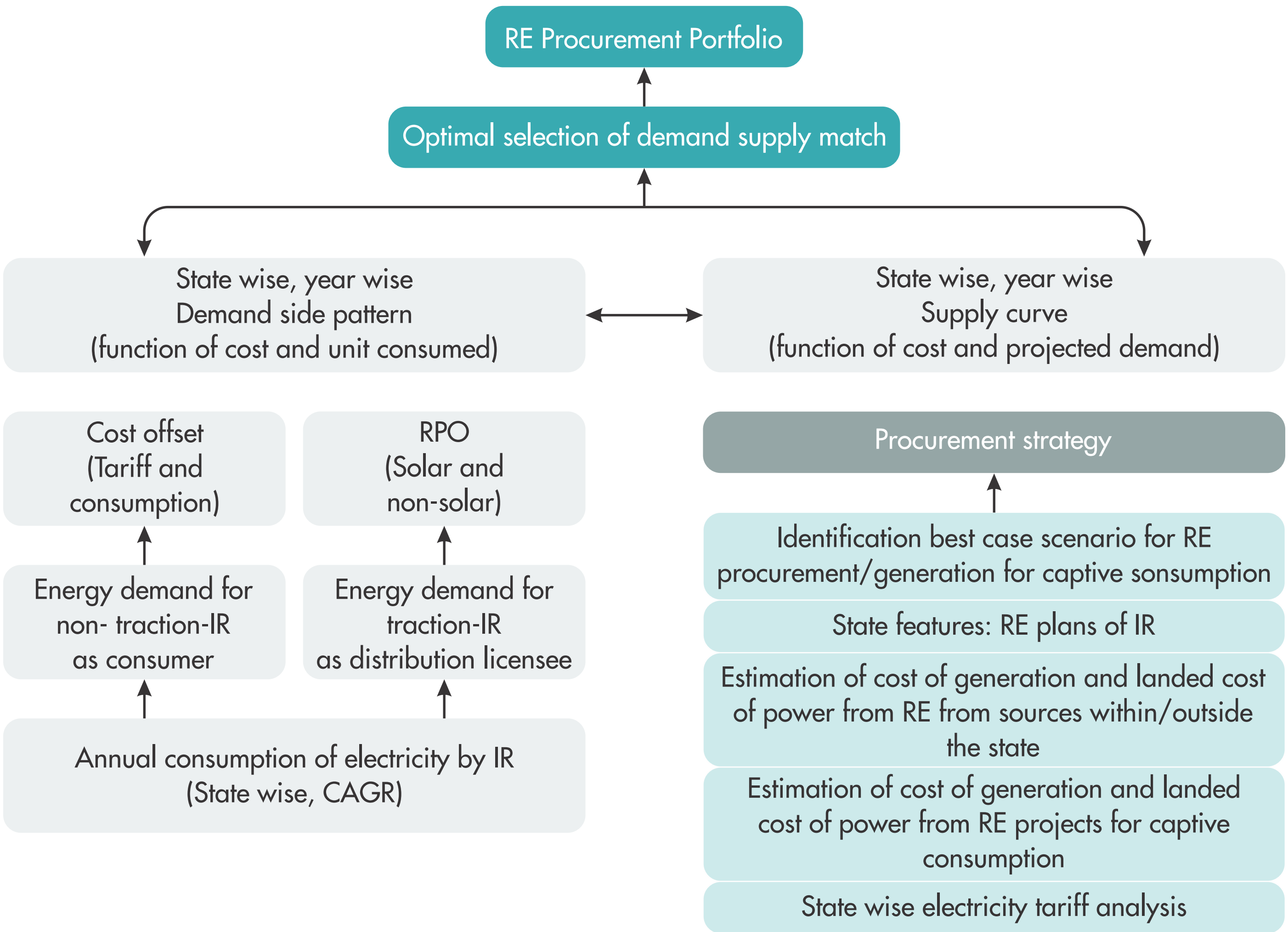



Figure 11: RE Procurement Portfolio for IR

# RE Mix for Selected States

The RE procurement strategy for IR includes five approaches, depending on specific applications. These approaches can be used for meeting the RPO targets, and reducing energy costs. A summary of strategies are presented in Table 4, listing RE options in each state.

Table 4: Different Procurement Options for Various States for IR

| State | RE Type and End Use of Procured/Generated Power | | | | |
|---|---|---|---|---|---|
| | Solar Rooftop Projects Set Up on IR Buildings for Non-Traction Load | Ground-Mounted Solar Projects Through OA (Meeting SPO Target) | Ground-Mounted Solar Projects Through OA to Supplement Heavy Loads | Wind Projects Through OA (Meeting Non-Solar RPO) | Wind Projects Through OA to Supplement Heavy Loads |
| Odisha | ✓ | ✓ | – | ✓ | – |
| Andhra Pradesh | ✓ | ✓ | – | ✓ | ✓ |
| Madhya Pradesh | ✓ | ✓ | – | ✓ | – |
| Rajasthan | ✓ | ✓ | – | ✓ | – |
| Tamil Nadu | ✓ | ✓ | – | ✓ | ✓ |
| Karnataka | ✓ | ✓ | ✓ | ✓ | ✓ |
| Maharashtra | ✓ | ✓ | – | ✓ | ✓ |

The procurement strategy for seven states were summarized through a RE mix blueprint for each state. The RE mix for the suggested states to be achieved by 2022 is presented in Figure 12.

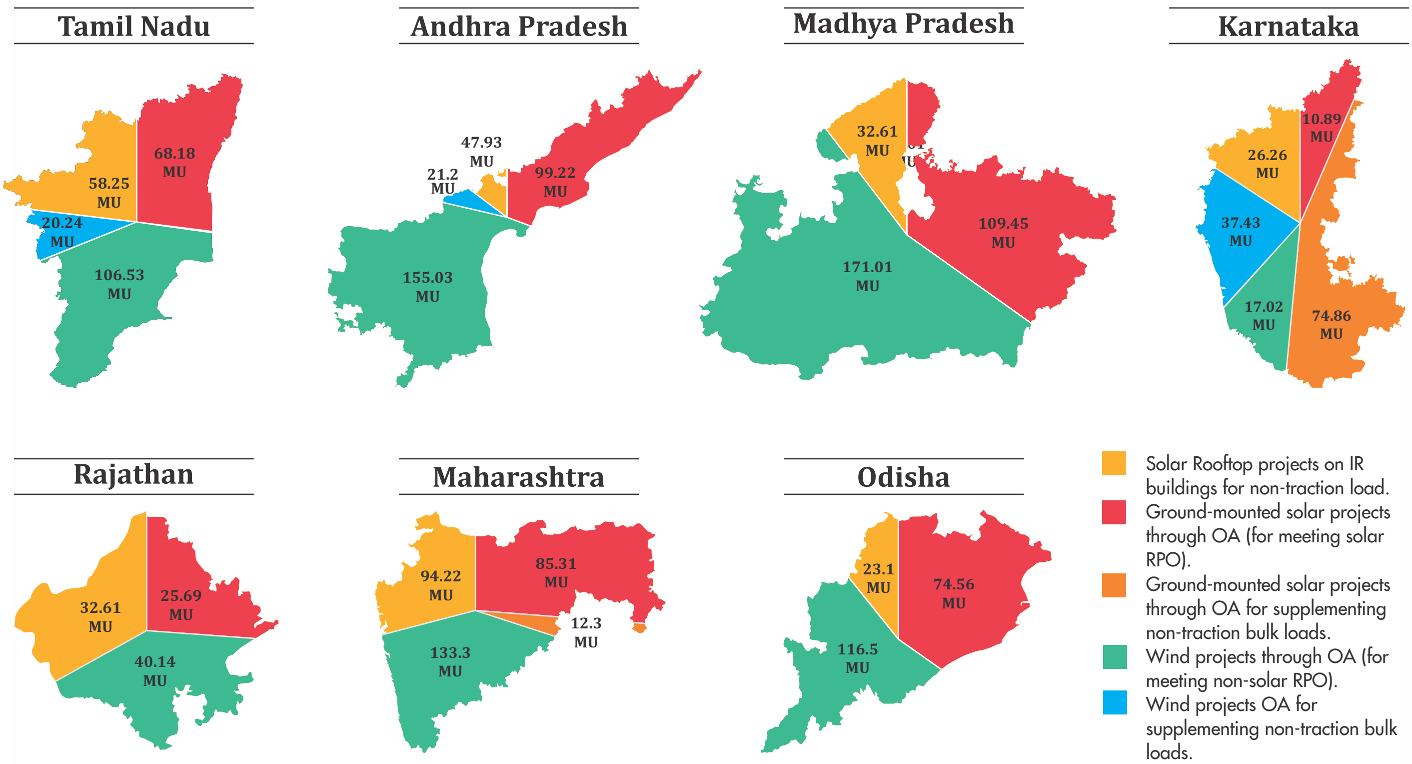



Figure 12 : RE Mix for 2022 Suggested for the Selected Seven States

# RE Savings Envisaged

The strategy discussed in this report for the selected seven states provides an insight into potential savings that can be achieved through RE. The following assumptions have been considered for calculating savings:

- Landed cost of power for solar and wind for each state have been assumed to be fixed throughout the span of projection (i.e., from 2018-2022). This enables us to foresee the worst-case scenario, as the cost of generation for both solar and wind is likely to decrease.
- The utility tariff for 2016-17 is assumed to be constant throughout the years. Escalation in utility rates over the years is not considered. This approach provides us with a conservative estimate of the potential savings. However, in all likelihood, the utility tariffs are bound to increase over the span of projection.
- Rooftop tariff is considered constant for each state for the period in consideration. This leads to a conservative estimate of savings as the rooftop PV prices will fall in future. The cost of power from solar rooftop is considered to be INR 3.95 per kilowatt hour (kWh).

The saving estimations made in this section are conservative as the price difference between electricity drawn from utility and RE will increase over time. Three cases have been considered to construct the quantum of savings for IR by adopting the procurement strategy. The total savings for IR in 2021-22 is shown in Figure 13.

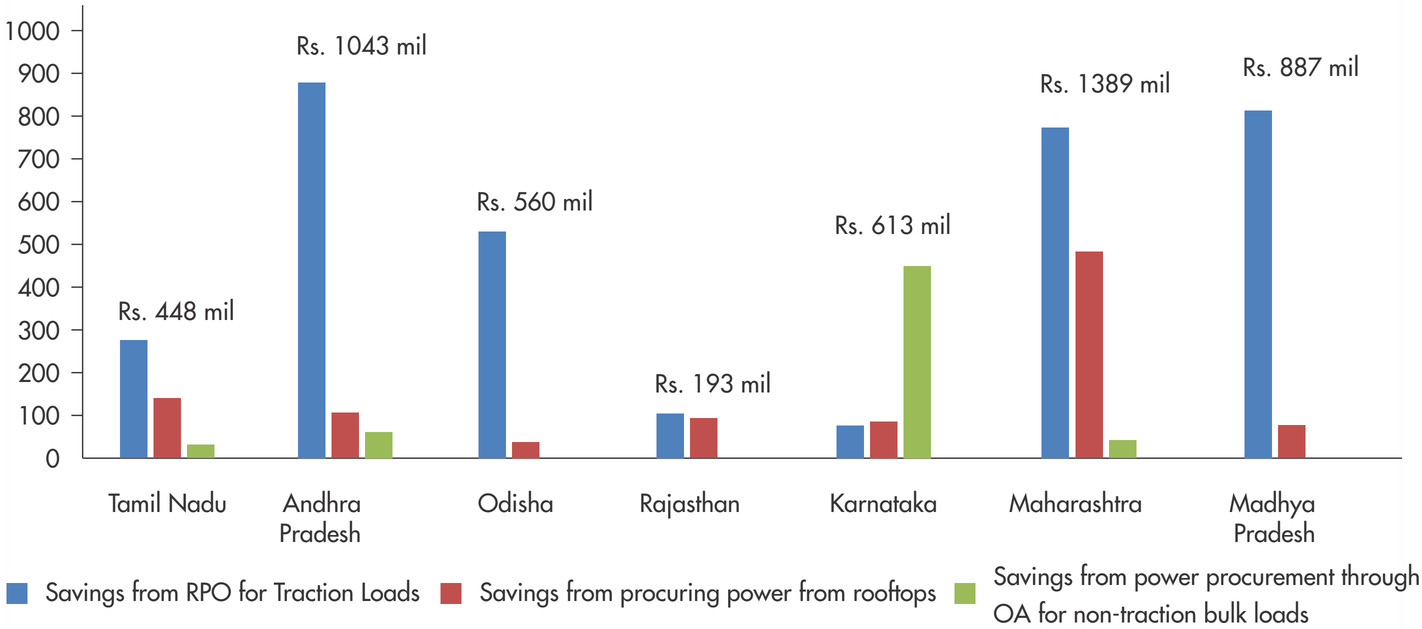



Figure 13: Total RE Savings Envisaged in 2021-22

The total savings as a result of this strategy is quantified using the following three cases:

- **Savings from RPO for Traction Loads:** The saving of IR as a result of RPO compliance for the selected states were analyzed. For arriving at savings for each state, it is assumed that IR meets its RPO targets by purchasing power at prevailing RE prices. The difference in the cost of procurement from utility vis-à-vis procuring the equivalent energy from RE is estimated, and savings quantified.

- **Savings from Rooftop Solar:** The savings incurred are due to cost of power offset due to solar rooftop projects. All states under consideration have DISCOM electricity rates that are well above current solar rooftop tariffs. The tariffs considered is the average of lowest cost tariff discovered in latest rooftop tenders floated by IR.

- **Savings from Procurement through Open Access:** Non-traction bulk load centers consist of large workshops, warehouses and factories. These load centers consume electricity from state utilities at commercial tariffs. IR can meet this demand by procuring power through Open Access RE projects. Due to non-availability of non-traction bulk data for some of the states, the savings have been estimated only for Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra.

- **Savings from RPO for Traction Loads:** The saving of IR as a result of RPO compliance for the selected states were analyzed. For arriving at savings for each state, it is assumed that IR meets its RPO targets by purchasing power at prevailing RE prices. The difference in the cost of procurement from utility vis-à-vis procuring the equivalent energy from RE is estimated, and savings quantified.

- **Savings from Rooftop Solar:** The savings incurred are due to cost of power offset due to solar rooftop projects. All states under consideration have DISCOM electricity rates that are well above current solar rooftop tariffs. The tariffs considered is the average of lowest cost tariff discovered in latest rooftop tenders floated by IR.

- **Savings from Procurement Through Open Access:** Non-traction bulk load centers consist of large workshops, warehouses and factories. These load centers consume electricity from state utilities at commercial tariffs. IR can meet this demand by procuring power through Open Access RE projects. Due to non-availability of non-traction bulk data for some of the states, the savings have been estimated only for Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra.

# Appendix

## Capacities Bid and Respective Winning Bidders for 50 MW Solar Rooftop Tender Conducted by Zonal Railways

| Railways | Capacity (MW) Awarded | Solar Developers |
|---|---|---|
| NR | 05 | Vivaan Solar Pvt. Ltd. |
| NCR | 01 | Renew Solar Energy Pvt. Ltd. |
| SECR | 0.75 | Renew Solar Energy Pvt. Ltd. |
| ECoR | 01 | Renew Solar Energy Pvt. Ltd. |
| SWR | 01 | Renew Distributed Solar Power Ltd. |
| SER | 02 | Renew Solar Energy Pvt. Ltd. |
| ER | 0.50 | Sun Crack |
| WCR | 01 | Forth Partner Energy Pvt. Ltd. Hyderabad |
| | 02 | Madhav Infra Projects Ltd, Vadodara |
| | 0.50 | Amplus Energy Solutions Pvt. Ltd. |
| | 0.50 | Renew Solar Energy Pvt. Ltd. |
| ICF | 02 | Select Energy Systems Ltd., Chennai |
| WR | 04 | Hero Solar Energy Pvt. Ltd. |
| SCR | 04 | Renew Solar Energy Pvt. Ltd. |
| ECR | 01 | Real Value Engineering and Services |
| NWR | 01 | Renew Solar Energy Pvt. Ltd. |
| NER | 0.50 | Neel Metal Products Ltd. |
| | 01 | Fourth Partner Energy Pvt. Ltd. Hyderabad |
| | 0.50 | Surya International |
| RWF | 02 | |
| Total Capacity | 31.25 | |

Table 6: Capacities Bid and Respective Winning Bidders for 50 MW Solar Rooftop Tender

## II. Description and Logic Behind the Plan

| RE Procurement/ Option | Capacity Addition/ Procurement of Electricity | Logic/Comment |
|---|---|---|
| Rooftop PV | During 2017-2018, 4.50 MU would be procured (3MW equivalent) | • IR has rolled out bids of equivalent capacity of 3 MW under 150 MW bids through REMCL and 100 MW bid through CEL. These are under RESCO models and target the larger stations. |
| | During 2018-19, 13.50 MU would be procured | • Stations above 250 kW capacity, with cumulative capacity of 6 MW, will be targeted. |
| | During Year 2019-20, 32.61 MU would be procured | • After targeting the larger stations in the state, IR shall utilize its smaller stations falling under the categories, B and C, which amount to a total potential of 6 MW. |
| | – | • The remaining 2.5 MW capacity can be added by installing solar PV rooftop on stations with capacity 10 kW (this can be implemented under CAPEX model). |
| Solar Ground-Mounted Projects | During 2017-22, IR would meet all SPO requirement of 10.89 MU | • The total RPO target to be met from supplying power to the traction load by 2022 is 10.81 MU. As there areexemptions on the transmission wheeling charges, losses and banking charges till March 31, 2018, it is recommended that IR procures the entire power required under RPO targets till 2021-22 in 2017-18 with minimum cost of power per kWh. |
| Solar Ground-Mounted Projects—OA Workshops | During 2017-18, IR would procure 74.86 MU | • Rail Wheel Factory is a non-traction bulk consumer in the state; it can procure power from solar energy through OA, to save on its electricity bills. Due to the exemption on solar energy in the state, IR should plan to procure 74.86 MU (half of energy demand of Rail Wheel Factory - RWF) in 2017-18 to optimize on savings. |
| Wind OA Traction (Non-Solar RPO Targets) | During 2017-22, IR wouldmeet all non-SPO requirement of 17.02 MU | • The non-solar RPO targets will be met by wind power procured under OA in Karnataka. The wind power procured yearly will be equivalent to the power procurement required to meet the non-solar RPO target as mentioned in Table 6-7. |
| Wind OA Non–Traction Workshops | During 2018-19, IR wouldprocure 37.43 MU | • According to IR's plan for reducing electricity consumption at RWF, wind power through OA shall also be used, in addition to the procurement from ground mounted solar, to augment the energy bills. IR will supplement additional one-fourth demand of RWF through wind power projects. |

Table 7: Savings for 2011-22 (in Millions)

## III.Analysis of Landed Cost for RE Options

| | Traction load | | Non-Traction load | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | Solar PV | Wind | Solar PV (Station) | Solar PV (workshops) | Wind (Station Load) | Wind (Workshop Load) | |
| CASE I | -0.04 | 0.11 | 0.99 | 0.80 | 0.99 | 0.80 | Options not feasible but feasible when the cost of power generation in MP can be reduced by INR 2.50 to 3.00 per kWh. |
| CASE II | 0.47 | 0.62 | 1.52 | 1.33 | 1.52 | 1.33 | |
| CASE III | 2.86 | 2.60 | 5.11 | 3.56 | 4.94 | 3.39 | Feasible options to meet traction and non-traction loads by procuring solar and wind power through OA route |
| CASE IV | 2.86 | 2.60 | 5.11 | 3.56 | 4.89 | 3.39 | |

Table 8: Savings for 2011-22 (in Millions)

## IV. Zone Wise Allocation of Capacity for Solar Rooftop Projects Along with Selected Routes

| Route | Solar Rooftop Capacity Allocated to Zones (MWp) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NR | ER | WR | SR | CR | NCR | ECR | ECOR | WCR | SCR | SER | SECR | Total |
| New Delhi-Mumbai | 3.55 | - | 16.15 | - | - | 1.08 | - | - | 3.02 | - | - | - | 23.8 |
| New Delhi-Howrah | 1.77 | 9.45 | - | - | - | 6.60 | 6.62 | - | - | - | - | - | 24.44 |
| Howrah-Chennai | - | - | - | 4.85 | - | - | - | 9.76 | - | 8.37 | 8.73 | - | 31.71 |
| Mumbai-Chennai | - | - | - | 9.57 | 17.92 | - | - | - | - | 3.99 | - | - | 31.48 |
| Mumbai-Howrah | - | 1 | - | - | 19.04 | - | - | - | - | - | 10.67 | 6.30 | 37.01 |
| New Delhi-Chennai | 2.53 | - | - | 4.85 | 3.18 | 6.93 | - | - | 4.175 | 7.19 | - | - | 28.85 |
| Cumulative | 7.85 | 10.45 | 16.15 | 19.27 | 40.14 | 14.61 | 6.62 | 9.76 | 7.19 | 19.55 | 19.40 | 6.30 | 177.29 |

Table 9: Allocation of Capacity for Solar Rooftop Projects

## V. Rooftop Capacity Estimation Chart for Station Categories

| Station Category Classification | Number of Stations | Estimated Solar Capacity at Station Building | Total Capacity (MWp) |
|---|---|---|---|
| A-1 | 75 | 1 Mwp | 75 |
| A | 332 | 500 kWp | 166 |
| B | 302 | 250 kWp | 75.5 |
| C | 483 | 250 kWp | 120.75 |
| D | 983 | 10 kWp | 9.83 |
| E | 4,158 | 10 kWp | 41.58 |
| F | 2,162 | 1 kWp | 2.162 |
| **Total** | **8,495** | | **490.82** |

Table 10: Estimation Charges for Station Categories

# About the PACE-D TA Program

The USAID PACE-D TA Program is a part of the overall Partnership to Advance Clean Energy (PACE) initiative, the flagship program under the U.S.-India Energy Dialogue. The six year program is being implemented in collaboration with the Ministry of Power and Ministry of New and Renewable Energy. In the first five years, the Program focused on three key components: energy efficiency, renewable energy and cleaner fossil technologies, with the overall aim of accelerating the deployment of clean energy, expanding U.S.-India trade and investment linkages, and facilitating knowledge exchange. The Program's focus in the sixth year is largely on accelerating solar rooftop deployment across eight states: Andhra Pradesh, Assam, Haryana, Maharashtra, Punjab, Telangana, Uttar Pradesh and West Bengal, covering 15 utilities. The objectives of this scope of activities are to:

- Help utilities in quickly administering best practices, developing new, innovative and customized business models and developing streamlined access for consumers for implementing grid-connected solar PV rooftop projects.
- Train manpower at all the levels of utilities, and new entrepreneurs for scaling-up of rooftop solar PV power.
- Support MNRE in designing and establishing national level initiatives to support rooftop solar PV scale-up.

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