United Nations Development Programme
India
GLOBAL ENVIRONMENT FACILITY
PROJECT DOCUMENT

Project Title: Improving Energy Efficiency in the Indian Railways System
UNDAF Outcome(s): By 2012, the most vulnerable, including women and girls, and government at all levels have enhanced abilities to prepare, respond and recover from disasters and environmental changes

UNDP Strategic Plan Environment and Sustainable Development Primary Outcome: Strengthened national capacities to mainstream of environment and efficient energy usage concerns into national development plans and implementation systems.

UNDP Strategic Plan Secondary Outcome: Countries develop and use market mechanisms to support environmental management.

Expected CP Outcome: Progress towards national commitment under multilateral agreements

Expected CPAP Output: Supporting national development objectives with co-benefits of mitigating climate change

Implementing Partner: Indian Railways (IR), Ministry of Railways

Brief Description

Indian Railways (IR), one of the largest rail networks in the world, is an energy intensive organization which utilized about 14.1 billion kWh electricity (about 2.4% of India's total electricity consumed) in 2007-08. With traffic growth estimated at 8-9% in the next decade, projected electricity demand is estimated to grow at about 9%. Therefore, IR is developing a long-term Energy Efficiency and Conservation Program to reduce energy consumption and the emission of greenhouse gases by progressively introducing energy saving technologies and measures in both the traction and non-traction systems.

The implementation of this Energy Efficiency and Conservation Program may be however undermined or slowed-down by a number of factors or barriers, including: (1) weak institutional arrangement and institutional capacity to implement energy efficiency (EE) technologies and measures; (2) lack of in-house technical information on existing EE options and opportunities, and technical skills to implement them; (3) lack of proper incentives to favour the adoption and implementation of EE measures; (4) limited number of EE technologies and measures tested and available in India, among other barriers.

The proposed project aims at improving energy efficiency in the Indian Railways system (and thereby reducing GHG emissions) by removing some of the key barriers that prevent the wide adoption of energy efficiency technologies and measures in the IR system. Specifically, this project aims at achieving the stated objective by (1) institutional capacity development and technical training on EE, (2) implementation of proven EE technologies and measures to build capacity and confidence on EE; (3) pilot demonstration of EE technologies and measures to prove their applicability in the Indian environment; and (4) Information and knowledge sharing.

The institutional framework in IR will be strengthened by establishing an EE 'Centre of Excellence' as a resource and service centre for IR's zonal and other units, to institutionalize EE, create awareness among the IR staff and sensitize them on EE and propose appropriate EE technologies, and establish EE benchmarks.

The proposed project strives to save 0.142 billion kWh and 0.117 million tonnes CO_2 by 2013 through direct interventions (1.168 tCO_2 cumulatively over 10-year investment lifetime). Cumulative indirect energy and CO_2 savings are estimated at about 4.05 (5.07 x 80% causality factor) billion kWh and 3.32 million tonnes CO_2 by 2020-21.

Programme Period:	2008-2012	Total resources required	USD 26,200,000
Atlas Award ID:	00060440	Total allocated resources:	USD 26,200,000
Project ID:	00076108	• Regular	
PIMS #	4044	• Other:	
Umbrella Project:	Programmatic framework for EE in India (ID: 3538)	o GEF	USD 5,200,000
		o Government and others	USD 20,000,000
Start date:	November 2010	o In-kind	USD 1,000,000
End Date	December 2013		
Management Arrangements:	National Implementation		
PAC Meeting Date	7 November 2008		

Agreed by (Government): _____

Agreed by (Implementing Partner): _____

Agreed by (UNDP): _____

ACRONYMS AND ABBREVIATIONS

ABB	ASEA, Brown and Boveri & Cie
ASCB	Automatic-switched capacitor bank
AC/DC	Alternating Current (AC) Electricity
APR-PIR	Annual Project Report - Project Implementation Review
BEE	Bureau of Energy Efficiency
BS	Building Services
CAGR	Compound annual growth rate
CDM	Clean Development Mechanism
CFL	Compact Fluorescent Lamp
COFMOW	Central Organisation for Modernisation of Workshops
CO	UNDP Country Office
CO_2	Carbon Dioxide
COE	Centre of Excellence
CP	Country Programme
CPAP	Country Programme Action Plan
DEA	Department of Economic Affairs
DSM	Demand-side management
E&M	Energy and Management
EC	Energy Conservation
EE	Energy Efficiency
EECP	Energy Efficiency and Conservation Programme
EMS	Energy management system
ESCO	Energy service company
EMU	Electric Multiple Unit
ESMON	Energy-cum-speed monitoring system
FY	Fiscal Year
FYP	Five-Year Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GOI	Government of India
GHG	Greenhouse gas
GPS	Global Positioning System
GPSDAS	GPS-based Driver Advice System
GTKM	Gross Tonne-Kilometre (including tare weight)
HOG	Head-on Generation
IEA	International Energy Agency
IEP	Integrated Energy Policy
IGBT	Insulated-gate bipolar transistor
INR	Indian Rupee
IR	Indian Railways
IREDA	Indian Renewable Energy Development Agency
IRIEEN	Indian Railways Institute of Electrical Engineering
IRS	Indian Railways System
KMS	Knowledge Management and Sharing
kWh	kilowatt hour
LED	Light-Emitting Diode
LRDSS	Long-range decision support system

M&W	Material and workmanship
MCAS	Microprocessor-controlled air-conditioning system
MEPS	Minimum Energy Performance Standard
MOEF	Ministry of Environment and Forests
MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
Mtoe	Million tonnes of oil equivalent
NAPCC	National Action Plan on Climate Change
NGO	Non-governmental organization
NPC	National Project Coordinator
NPD	National Project Director
NT	Non-Traction
NTKM	Net tonne-kilometre (net: excluding tare weight)
PIMS	UNDP/GEF Project Information Management System
PMU	Project Management Unit
PMW	Pulse-Width Modulated
PPG	Project Preparatory Grant (GEF)
PSC	Project Steering Committee
PU	Production Unit
PV	Photovoltaic
R&D	Research and Development
RCU	UNDP Regional Coordination Unit
RDSO	Research, Designs and Standards Organization
RS	Rolling Stock
SERC	State Electricity Regulatory Commission
SME	Small and Medium-sized Enterprise
SNCF	French National Railways
tCO_2	Tonne of Carbon Dioxide
TEMS	Traction Energy Management System
TIRFAD	Technology Information Resource and Facilitation Desk
TOR	Terms of Reference
TPES	Total primary energy supply
TR	Traction
TRD	Traction power distribution
TSS	Traction substation
UIC	International Union of Railways
UN	United Nations
UNDAF	UN Development Assistance Framework
UNFCCC	UN Framework Convention on Climate Change
UNDP	UN Development Programme
USD	United States dollar (= 47 Indian Rupee)
VVVF	Variable voltage variable frequency
WDI	World Development Indicators
ZTC	Zonal Training Centre

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Part A. SITUATION ANALYSIS

1. CONTEXT AND GLOBAL SIGNIFICANCE: ENVIRONMENTAL, POLICY AND INSTITITIONAL SETUP

1.1 Energy consumption growth in India and climate change

1. Energy consumption in India is growing and is expected to continue to grow**.** India has the world's second largest population with more than 1.1 billion people and continues to grow at 1.4% per year (WDI, 2008)[1]. India's economy has grown with a sustained GDP growth rate of more than 9% during the past years, and is expected to continue to grow at high GDP growth rates in the future. To sustain its economic growth and to respond to the needs of its growing population, India's total primary energy consumption (measured using the Total Primary Energy Supply as a proxy) growing at a compound average annual growth rate of about 9% in the past years (IEA, 2009)[2] and is expected to continue to grow at similar pace. Similarly, India's electricity consumption has also increased at an annual rate of about 8-9% in the past years and, according to the India's Planning Commission (IEP, 2006)[3], is expected to continue to grow at similar rates for the next 20 years (see Figure 1 below) at a GDP growth rate of 9%.

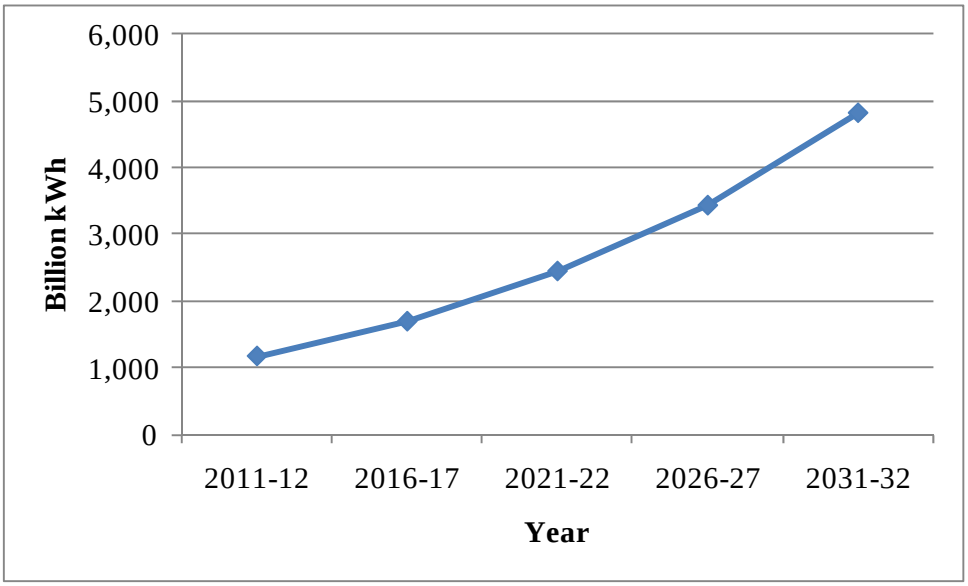

Figure 1: Projections for electricity requirements (2011-32)
Source: IEP (2006)

2. A direct consequence of the increase in energy consumption, India CO_2 emission has been rising in the past years and because of the predominant use of coal and other fossil fuels in the energy sector, is expected to continue to grow. It is estimated that the level of CO_2 emission grew from about 1,250 million tonnes in 2006 to 1,324 million in 2007 (i.e. 5.9% increase), contributing significantly to climate change.

[1] World Bank (2008), *World Development Indicators (WDI) online.*
[2] IEA (International Energy Agency) (2009), *World Energy Outlook 2009*, OECD/IEA, Paris.
[3] Integrated Energy Policy (August 2006), Planning Commission, Government of India.

1.2 Government policies, strategies and institutional set-up

3. India' strategy is to overcome these challenges, as described in the Integrated Energy Policy (IEP) and the National Action Plan on Climate Change (NAPCC), the two major documents outlines the Government strategy with regard to energy and climate change. The *Integrated Energy Policy* (IEP, 2006) puts emphasis on the need to increase energy security by reducing the import dependence to avoid price fluctuations. It outlines a number of strategic directions to achieve this objective, including increasing local coal production, improving energy efficiency and energy conservation in use and demand side management to reduce electricity demand, shifting freight traffic to railways, and expanding electrification of railways to reduce diesel needs. The *National Action Plan on Climate Change* (NAPCC, 2008) defines the key strategies and actions to address the causes of climate change and reduce the impact of climate change on India. The NAPCC is organized along eight priority programs, or 'national missions', which include the National Solar Mission, the National Mission for Energy Efficiency, the National Mission on Sustainable Habitat, among others. It is worth noticing that both the IEP and the NAPCC put at the centre of their strategies an increased use of energy efficiency and energy conservation measures.

Box 1 India strategies and institutional set-up to promote energy efficiency.

The main targets and strategies with regard to energy efficiency are set in the Five-Year Plans of the Government of India. The *Ninth Five-Year Plan* (1999-2003) provided the basis for the issuance of the Energy Conservation (EC) Act in 2001 and the establishment of the Bureau of Energy Efficiency as central institution for the implementation of an energy conservation program (see below). The *Tenth Five-Year Plan* (2003-2007) focused on the need for an efficient use of energy sources to achieve sustainable development, and provided the basis for the establishment of an appropriate institutional set-up for the provision of energy efficiency services, including the authorization of the Ministry of Power (MOP) to develop energy efficiency programs. The *Eleventh Five-Year Plan* (2007-2012) aims at enhancing rural energy access, and to this purpose it targets savings of 5% of energy consumption levels through the implementation of a set of energy efficiency interventions in all sectors, including the establishment of an appropriate set of incentives; the creation of an enabling institutional framework; the promotion of energy service companies (ESCOs); and the promotion of energy efficient technologies, including energy efficient lighting; mandatory audits of facilities with loads above 1 MW, etc.

The *Bureau of Energy Efficiency* (BEE) was established under the MOP to implement the EC Act 2001 and is responsible for implementation of energy efficiency and energy conservation measures in the country. The EC Act 2001 further mandates BEE to work with designated consumers and other agencies to enforce the provisions of the Act. Currently, there are no provisions in the budget of the central government to enforce checks and compliance to the EC Act besides limited capacity and experience to implement energy efficiency programmes at large scale.

1.3 Rationale for improving energy efficiency in the Indian Railways (IR)

4. Indian Railway (IR) is the single largest organization with the highest electricity consumption in India. It consumes about 2.4% of India's total electricity consumption. In the fiscal year (FY) 2007-08, Indian Railways consumed 14.1 billion kilowatt-hours (kWh), of which 11.7 billion (about 83%) for traction usages and 2.4 billion (17%) in non-traction usages (IR Year Book 2007-08).

5. It is estimated that the demand of electricity in this industry will grow in the coming years. First, in compliance with the Integrated Energy Policy, India plans to progressively shift freight traffic to railways. Passenger traffic is also expected to increase. Overall, it is estimated that the railway sector will have a growth in the total traffic (freight and passengers) of 8-9% in the next decade. Second, Indian Railways

has initiated an ambitious Electrification Plan to increase the electrification of its routes[4] converting diesel-fuelled traffic (which represented 36% and 53% of the freight and passenger traffic respectively in fiscal year 2007-08) into electric traffic, because electric traction is more efficient than diesel traction. According to this Plan, 80% of rail freight and 60% of passenger traffic will run on electric energy by 2031-32. It is estimated that the total demand of electricity in the railways sector will grow at a rate of more than 9% annually. The electricity consumption is projected to be about 100.5 billion kWh by 2031-32 with the electrification dominant scenario. Therefore, an enormous energy saving potential exists in the Indian Railways (IR) sector for implementing energy efficiency measures and energy conservation technologies.

6. In addition, the annual electricity bill of Indian Railways in FY2007-08 was about USD 1.272 billion (of which USD 1.071 billion for traction and about USD 0.201 billion for non-traction[5]). The operating costs represented 76% of the total costs. In FY 2007-08, energy cost represented about 24% of the ordinary working expenses of Indian Railways (electricity accounts for 14.6% of the total ordinary working expenses). Thus, the possibility of savings on electricity would have a positive effect on the operating margins of Indian Railways.

Box 2 Indian Railways

Indian Railways (IR) has a total state monopoly on India's rail transport. It is one of the largest and busiest rail networks in the world. It has a vast rail network, covering 6,909 stations over a total route length of more than 63,327 km, transporting more than 18 million passengers daily (6.52 billion passengers annually) and more than 2.2 million tonnes of freight daily. IR is the world's largest utility employer with more than 1.4 million employees. IR is managed through 16 Zones which are subdivided into 68 Divisions. There are six production units engaged in manufacturing rolling stock, wheels and axles and other ancillary components to meet IR requirements. In addition, a number of specialized units like the Research, Design and Standards Organisation (RDSO), training institutes and corporations have been set up that provide special services. IR is managed by the Railway Board[6] under the Ministry of Railways (an organizational chart of IR is reported in Annex E).

1.4 Assistance by UNDP in the area of environment and energy

7. The United Nations Development Assistance Framework (UNDAF) provides the overall framework and sets the objectives of the assistance of the United Nations to the Government of India for the period 2008-2012. The overarching objective of the UNDAF is "promoting social, economic and political inclusion for the most disadvantaged, especially women and girls". These objectives are in line with the national priorities of the Government of India's Eleventh Five Year Plan. Specifically on environmental sustainability, UNDAF states that "by 2012 the most vulnerable people, including women and girls and government at all levels have enhanced abilities to prepare, respond, and adapt/recover from sudden and slow onset disasters and environmental challenges" (Outcome 4).

8. UNDP is a key partner in the development and implementation of the UNDAF. UNDP is also the lead UN agency for the coordination of UN support in several thematic areas, including sustainable environmental management. Specifically in this area, UNDP supports government's efforts towards meeting commitments under multilateral agreements through a two-pronged approach involving leveraging of additional environmental finance and supporting activities on the ground that seek to safeguard environmental resources. A special focus of UNDP support is placed on energy efficiency as a means to contribute to reduction of greenhouse gas emissions in energy intensive industries, transport and commercial sectors.

4 Currently only 30% of the total route kilometres are electrified.

5 Non-traction purposes include workshops, stations, service buildings, colonies, street lighting, water pumping installations, and residential buildings.

6 Shared by a Chairman and with 6 Members (Electrical, Engineering, Traffic, Staff, Mechanical and Finance).

9. The Government of India, through its designated nodal department, the Department of Economic Affairs (DEA), ensures national ownership and provides direction of UNDP programme activities by approving and signing the Country Programme Action Plans (CPAP), the document that provides the overall cooperation framework for UNDP in India. The CPAP 2008-2012 emphasizes the need to ensure that growth is resource efficient and environmentally sustainable in sectors such as industry, infrastructure and agriculture, in line with the Government's Eleventh Five-Year Plan, and acknowledges that the multilateral environmental agreements to which India is a signatory - climate change, biodiversity, desertification, chemical management and ozone depleting substances - offer an enormous opportunity to address global environmental concerns through action at national and local levels. Particularly, the CPAP states that, within the framework of the UNFCCC, the Government of India and UNDP would work together to identify collaborative areas to address climate change.

10. In the area of climate change, UNDP has been supporting Government of India for the last several years by building capacities to increase energy efficiency and promote the use of renewable energy sources. Some of the most recent UNDP supported energy efficiency and renewable energy projects are described in the Table 1 below.

Table 1: Most recent UNDP supported energy efficiency and renewable energy projects in India

Title	Objectives	Duration	Source of Funding
Energy Efficiency Improvements in the Brick Industry	To reduce energy consumption by promoting the production and use of resource-efficient bricks	2009-13	GEF
Achieving reduction in GHG emissions through advanced energy efficiency technology in electric motors	To achieve energy savings through the introduction of energy efficiency technology in the motor industry	2008-11	GEF
Energy Conservation in Small Sector Tea Processing Units in Southern India	To reduce energy consumption from tea processing units	2008-12	GEF
Mokshda Green Cremation System for Energy and Environment Conservation	To remove barriers in the extension of energy efficient cremation systems	2009-12	GEF
Global Solar Water Heating Market Transformation Strengthening Initiative	To accelerate and strengthen the growth of solar water heater market demand and strengthen the supply chain	200-12	GEF
Removal of barriers to Biomass Power Generation - Phase I	To support the adoption of sustainable biomass power co-generation technologies	2007-10	GEF
Biomass Energy for Rural India	To build capacity among rural communities, NGOs, entrepreneurs, manufactures, financing institutions and policy-makers to promote bio-energy technologies	2002-10	GEF
Access to Clean Energy	To enhance access to clean and renewable energy in remote un-electrified villages	2009	Core

2. STAKEHOLDER ANALYSIS

11. The Project stake-holders identified, brief description and their role in the GEF project is given below:

Table 2: List of stakeholders involved in project

Stakeholder	Main role
Government entities	
Planning Commission, Government of India	The Planning Commission was set up by a resolution of the Government of India in March 1950 in pursuance of declared objectives of the Government to promote a rapid rise in the standard of living of the people by efficient exploitation of the resources of the country, increasing production and offering opportunities to all for employment in the service of the community. The Planning Commission has the responsibility of making assessment of all resources of the country, augmenting deficient resources, formulating plans for the most effective and balanced utilization of resources and determining priorities. Five Year Plans are formulated by Planning Commission. Inclusion of appropriate outcome of the project in the policy formulation such as Five Year Plans, etc. may be best affected through the Planning Commission. Therefore Planning Commission is an invited member to the Project Steering Committee (PSC) during the project implementation and their role will be like the other members of the PSC under the project.
Ministry of Environment and Forestry (MOEF)	MOEF is the nodal agency in the administrative structure of the Central Govt. for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. MOEF is also GEF focal point for GEF projects in India and thus liaise for overall coordination of the project.
Bureau of Energy Efficiency (BEE), MoP	BEE is a statutory body under Ministry of Power, Government of India. It was set up in set up in 2002, it is responsible for implementation of the Energy Conservation Act 2001 with the primary objective of promoting energy saving measures and in turn reducing energy intensity. BEE co-ordinates with designated consumers[7], designated agencies and other organizations and recognize, identify and utilize the existing resources and infrastructure, in performing the functions assigned to it under the Energy Conservation Act. The Energy Conservation Act provides for regulatory and promotional functions. BEE is the coordinator of umbrella programme on "Programmatic Framework Project for EE" under which the Improving EE in Indian Railways System is one of the projects. BEE is one of the PSC members during the project implementation (see Section 4.5). BEE will play a key role in risk mitigation, particularly in mitigating the risks to project implementation due to lack of manufacturers' interest in investing in EE products (see Annex A). BEE will also play a key facilitation role among partners.
Ministry of Power (MOP)	MOP is responsible for perspective planning, policy formulation, processing of projects for investment decision, monitoring of the implementation of power projects, the administration and enactment of legislation in regard to thermal, hydro power generation, transmission and distribution, rural electrification and energy efficiency and conservation. MoP will ultimately serve as central authority and guide BEE in meeting program objectives and in implementation of programmes listed in EC Act 2001. MoP will be informed on the project progress during the implementation so that the EE

[7] The Central Government identified nine energy intensive industries in 2007 as designated consumers under the Energy Conservation Act 2001: (1) Thermal Power Stations, (2) Fertilizer producers, (3) Cement producers, (4) Iron and Steel producers, (5) Chlor-Alkali, (6) Aluminum, (7) Railways, (8) Textile, and (9) Pulp and Paper.

Stakeholder	Main role
	efforts in Indian Railways are noted in their plans.
Ministry of Railways	The Ministry of Railways in India is in charge of the Indian Railways, the state-owned company that enjoys a monopoly in Rail transport in India.
Indian Railways (IR)	
Indian Railways (IR)	Indian Railways is the state-owned railway company of India, which owns and operates most of the country's rail transport. It is overseen by the Ministry of Railways of the Government of India. It is governed by the Railway Board, which is headed by Chairman Railway Board. IR has been appointed as the project implementing agency of this project. IR would be responsible for implementing the project, achieving the results outlined in the proposal. IR would be in addition responsible to liaise with UNDP, BEE, MoEF, DEA and other agencies as required to achieve the expected outcome of the project. IR would be finally responsible to implement the policy formulation activity under the project and also work on the advocacy and lobbying efforts that would ultimately secure the approval and enforcement of the formulated policies and associated implementing rules and regulations.
IR Board and Directorates	The Indian Railway Board is the apex body of the Indian Railways. It reports to the Indian Ministry of Railways. It has the following members currently; Chairman Railway Board: Member Electrical, Member Staff, Member Mechanical, Member Traffic, and Finance Commissioner. Important Directorates as related to EE are: Long-Range Decision Support Systems (LRDSS), Electrical Engineering, Planning, Tracks, Mechanical Engineering (Production Units) and Workshops. These directorates of Railway Board would provide logistical and technical support for the implementation of the project.
Zonal Railways	Indian Railways is divided into zones, which are further sub-divided into divisions. The number of zones in Indian Railways increased from six to eight in 1951, nine in 1952, and finally 16 in 2003. Each zonal railway is made up of a certain number of divisions, each having a divisional headquarters. There are a total of sixty-eight divisions. These 16 Zonal Railways manages Indian Railway operations within zone boundaries. Each Zone has zonal training centres (ZTCs) to impart training to the staff and a workshop where to repair and maintain their assets and rolling stock. Under this project, such zonal field units will function as implementer as well as develop training capacity and skills.
Indian Railway Production Units	Indian Railway production units take care of production of parts and are integral part of proper functioning of railway system in India. They are categorized (located in) as; locomotives (Chittaranjan, Patiala, Varanasi); coaching stock (Kapurtala and Chennai); axles and wheels (Bengaluru). Under this project, these units will function as project implementing partners.
RDSO (Research, Designs and Standards Organisation)	RDSO is the organization of Indian Railways (IR) responsible for research and design. It serves as the technical advisor to the Railway Board, Zonal Railways and Production Units. It is responsible for the development of new and improved designs, adoption, absorption of new technologies, development of standards and specifications for materials and equipment, technical investigation, statutory clearances, testing and providing consultancy services. IR procurement is based on the specifications that are released by RDSO. Under this project, RDSO would assist in framing/updating the technical requirements and specifications of the equipment.

Stakeholder	Main role
RITES Ltd	RITES, a Government of India Enterprise, provide comprehensive engineering, consultancy and project management services in the transport infrastructure sector. Export/leasing maintenance and rehabilitation of railway rolling stock, operation and maintenance of railway systems under concession agreements and BOT, BOOT and PPP projects that are specific to Railways. RITES have over 600 on-going projects in India besides over 30 projects overseas. RITES Ltd employ over 2000 staff including over 1200 specialists in the fields of engineering, management and planning. Besides full time professionals, RITES also has on its panel a large number of experts. Under this project, RITES Ltd will be one of the Responsible Party. RITES will assist the Project Management Unit at IR. They will provide the consultancy and Project Management support as requested by IR.
Central Organisation for Modernisation of Workshops (COFMOW)	COFMOW was established under the Ministry of Railways by the Govt. of India for modernizing Indian Railway workshops in 1979. The modernization project was funded through World Bank credits. COFMOW provides professional advice and a single window service in planning and procurement of machine tools and allied equipment. Under this project, COFMOW would assist in vendor development and absorption of EE technologies.
Central Training Institutes, Indian Railways	The Indian Railways employ approximately 1.4 million people (largest civilian employer in the world). The training of all the cadres is entrusted and shared between six Centralized Training Institutes namely (i) the Indian Railway Institute of Transportation Management (IRTM) in Lucknow for officers of the Traffic department, (ii) the Indian Railway Institute of Civil Engineering (RICEN) in Pune for civil engineers, (iii) the Indian Railway Institute of Signal and Telecommunications Engineering (IRISAT) in Secunderabad for engineers of S&T department, (iv) the Indian Railway Institute of Mechanical and Electrical Engineering & Jamalpur Gymkhana (IRIME) in Jamalpur for mechanical engineers; (v) the Indian Railway Institute of Electrical Engineering (IRIEEN) in Nasik for Electrical Engineers, (vi) the RPF Academy (IRT) in Lucknow for officers of the Railway Protection Force, and (vii) the Railway Staff College in Vadodara which functions as the apex training institute for the officers of all departments in general and Accounts, Personnel, Stores and Medical departments in particular. Under this project, these training institutions, primarily IRIEEN, will be involved in training their trainers through the project and further train the trainees. It is expected that the training content developed under the project will be suitably integrated in the regular training course.
Indian Railway Finance Corporation Limited (IRFC).	IRFC is a dedicated financing arm of the Ministry of Railways. Its objective is to raise money from the market to part finance the plan outlay of Indian Railways. The money made available will be used for acquisition of rolling stock assets and for meeting other developmental needs of the Indian Railways. IRFC will be informed of the project for possible future requirement in raising finance for EE measures.
Central Organization for Railway Electrification (CORE)	Central Organization for Railway Electrification (CORE) was set up in 1979 under the Ministry of Railways, at Allahabad. Its prime responsibility is to take up the electrification of the Indian Railways network. Under this project, CORE will absorb the EE technologies and assist in developing the technical requirement and relevant specifications.
Other organizations	
Manufactures and	The companies like Siemens, ABB, Bombardier, SNCF, Balfour Beatty etc. are in the

Stakeholder	Main role
their associations	business of manufacturing and supply equipments including energy appliances to IR. Under this project these companies are expected to produce and supply the energy efficient devices decided for intervention. They will also develop indigenous EE products developed through piloting them under the project.
International agencies: UIC, SNCF, etc.	Leading Centres of Excellence in industrialized countries, international agencies like International Union of Railways (UIC) or at country level (e.g., SNCF/ France) provide assistance on energy efficiency. Under this project, interaction with these centres will be held to obtain the know-how on EE technologies for railway systems and identify suitable options for India.

3. BASELINE, ENERGY EFFICIENCY SOLUTIONS AND BARRIER ANALYSIS

3.1 Baseline

12. Indian Railways (IR) is developing a long-term Energy Efficiency and Conservation Program (EECP) (2010-2032). The Program aims at progressively introducing a number of energy efficiency technologies and measures in the railways system (more details in par. 3.2). The objective of this Program is to save 10% of the electricity consumption in absolute terms by 2032, in line with the targets of national initiatives on energy conservation and climate change[8].

13. These figures represent the baseline of the project, against which the GEF alternative will be compared (see Section 8).

		2009-10	2012-13	2022-23	2031-32	Cumulative 2010/11-2022/23	Cumulative 2010/11-2031/32
Baseline scenario (i.e. with EECP)	Electricity consumption (billion kWh)	15.65	19.90	45.77	100.51	377.75	1,030.20
	CO_2 Production (million tonnes)	12.83	16.32	37.53	82.41	309.75	844.77

Assumptions:

- Total energy consumption growing at 8.82% CGAR/year due to increased traffic and progressing electrification routes
- Forecast of electricity consumption growth for traction operation and general services on base of 2007-08 at 4.5% CAGR per year
- Energy saving rate: 0.5% per year according to Internal Policy on Energy Saving i.e. EECP (i.e. 10% cumulatively by 2031-32)

[8] Key strategic elements of the Program included the following: (1) the development of a long-term vision, internal policies, directives, regulations, procedures and manuals on energy efficiency; (2) the establishment of an autonomous Center of Excellence within IR responsible for assessing and identifying specific EE technologies and measures, standards, performance criteria, material standards and specifications, etc., and promoting and monitoring the implementation of EE measures; (3) the preparation of annual plans for energy efficiency with specific targets and allocated budget; (4) the development and institutionalization of a monitoring and verification and audit system; (5) the development and institutionalization of an internal incentive system to promote and reward energy efficiency behaviors; (6) the institutionalization of energy efficiency and conservation awareness programs within the organization.

14. More specifically, due to the implementation of EECP, India is expected to move from the current[9] 15.7 billion kWh of electricity consumption in the railways sector to 100.5 billion kWh in 2031-32 (about 1,030 billion kWh cumulatively for the period 2010-2032). These figures are equivalent to about 12.8, 82.4 and 844 million tonnes of CO_2 respectively, assuming a 0.82 kg CO_2/kWh emission factor[10].

15. These figures represent the baseline of the project, against which the GEF alternative will be compared (see Section 8).

3.2 Energy efficiency solutions

16. The Energy Efficiency and Conservation Program (EECP) aims at progressively introducing or expanding the adoption of a number of traction and non-traction energy efficiency technologies and measures in the railways system to reduce energy consumption.

17. During project preparation phase, a number of energy efficiency technologies and measures that could potentially be introduced through the Program, or whose adoption can be widened, have been identified and vetted during stakeholder consultations. These technologies and measures have been divided into two categories each for traction (including rolling stock) and non-traction (see Table 3):

(1) Technologies and measures that have already been tested in India (in the railways sector or in other sectors) and proven to be successful, but have not been adopted on a large scale (traction and non-traction);

(2) Technologies and measures that have proven to be successful abroad, but have not yet been tested in India (traction and non-traction).

18. A list of the technologies identified is reported in the table below. A full list of these technologies and of their technical details is reported in Annex D.

Table 3: List of main technologies for energy efficiency improvement[11]

	EE technologies and measures already proven in India	**EE technologies and measures that have proven to be successful abroad, but have not yet been tested in India**
Traction	• Installation of Automatic Switched Capacitor Bank (ASCB) to reduce electrical losses in Traction Sub Stations (TSS) • Installation of LED (light-emitting diode) lights in coaches	• Installation of GPS-based 'driver advice system' (GPSDAS) and Energy Management System (EMS) to ensure safe and energy efficient driving • Installation of microprocessor controlled air-conditioning systems for AC couches • Installation of roof solar panels in coaches to generate electricity • Conduction of energy audits of rolling stock (locomotives) and coaches* • Introduction of HOG to provide on-board power through traction winding • Use of regeneration of electric locomotives energy during train operation by using braking energy • Adoption of 3-phase IGBT-based technology with regenerative features for EMUs and locomotives • Adoption of design improvement measures on rolling

[9] 2009-10, estimated.

[10] Central Electricity Authority (2009)

[11] Whenever labeled products exist, public procurement of energy efficient goods (appliances/equipments) would include star labeled products.

	EE technologies and measures already proven in India	EE technologies and measures that have proven to be successful abroad, but have not yet been tested in India
		stock units to improve payload-to-tare weight ratio • Adoption of design improvement measures on rolling stock units such as air-friction reduction measures on sides, top bogies, under-gear and aerodynamic features • Introduction of IGBT-based PWM static converters for auxiliary supply to coaches • Introduction of a traction-effort metering system to ascertain the brake binding
Non-traction	• Replacement of fluorescent tube lights with low energy consumption lights (T5 fluorescent tubes in place of T12 tubes for lighting for stations, workshops and railway offices) • Replacement of incandescent bulbs with CFLs bulbs for service buildings and railway quarters • Installation of VVVF (Variable Voltage Variable Frequency) drives for machine	• Installation of Energy Management System (EMS) for pumping installations • Installation of Building Management Systems (BMS) for stations, workshops and railway offices • Energy audits of stations, workshops and railway offices, etc.* • Support to energy testing laboratories* • Introduction of renewable energy systems (e.g. solar water heating systems) • Introduction of solar photovoltaic modules to electrify level crossing gates & gang huts • Installation of small wind mills electrify level crossing gates and gang huts • Introduction of LED lighting systems for general illumination • Introduction of energy consumption and life-cycle cost among the criteria for procurement

(*) Even if these activities cannot be properly considered technologies, they have been included as key critical activities to assess energy consumptions and promote energy efficiency measures.

19. Among the identified technologies and measures, only few are selected during the project preparation stage (i.e., PPG exercise) for implementation and to demonstrate how successfully these technologies and measures can be applied and implemented cost-effectively during the project duration. The list of the selected technologies and measures and of the criteria used for the selection is described in Section 4, par. 4.3.

3.1 Barrier analysis

20. Although there is a generally favourable tilt towards energy efficiency actions in India, evidence shows that the introduction and adoption of energy efficiency technologies and measures in the railways sector has been rather slow in the past years. On the basis of past trends, it is therefore possible that the implementation of the Energy Efficiency and Conservation Program in Indian Railways can be undermined or slowed down. Table 4 provides a detailed overview of the barriers identified.

Table 4: Overview of barriers to energy efficiency in Railways

(1) Institutional barriers	
· Lack of an EE Corporate Policy	IR has issued directives on EE, but there is no clear corporate policy on this subject. The implementation of EE measures is confined to individual initiatives of those individuals sensitive to the issue, rather than reflecting a

	corporate strategy.
· Lack of institutional set-up to promote and monitor EE measures	There is no office/unit/division within IR that has the institutional responsibility to identify, promote, and monitor the adoption and implementation of EE technologies and measures, collect and disseminate relevant information, and provide technical back-up.
· Lack of adequate capacity within training and testing facilities	Existing training and testing facilities do not have the proper equipment nor the technical capacity to test EE technologies and train IR staff
· Lack of consideration for EE measures and energy conservation practices in standard specifications for the purchase of material and equipment	The existing standard specifications for the procurement of material and equipment do not take into consideration the latest EE measures and energy conservation practices as a requirement
(2) Information and capacity barriers	
· Insufficient information/awareness among IR officials and staff about existing EE measures	Implementing field units do not have sufficient information/ documentation on EE technologies, cost-benefit-analyses, life-cycle-cost to make informed decisions with regard to the adoption of EE technologies and measures.
· Lack of proper technical skills and capacity among IR staff to assess, test and implement EE technologies and measures	Existing capacity among staff to assess, test and implement EE technologies and measures is weak. Several EE technology upgrades are complex and innovative. There are no specific training programs on EE. There are no frameworks or mechanisms to systematically transfer technologies, best practices, etc. within the organization.
(3) Incentive barriers	
· Lack of incentives to staff to implement EE measures	The existing regulatory framework within IR does not provide financial or non-financial incentives to staff to implement EE measures that already exist. There are no linkages between investment decisions and operational costs. The budget for investment costs (which includes costs for the introduction of EE technologies and measures) is different from the budget for the operational costs (e.g. recurrent expenses, electricity bills, etc.). As such, there is no incentive to contain operational costs through appropriate investment decisions. There is no mechanism to plough back the savings that result from the implementation of EE measures. Procurement decisions are mainly based on the price rather than on energy efficiency considerations.
· Lack of incentives to vendors and manufacturers to develop/retail EE products	Vendors and manufacturers tend to stick to the business of standard product line unless they are assured by a business potential or receive an incentive to develop/retail EE products
(4) Technology barriers	
· Limited adoption of proven EE technologies abroad	The applicability of several existing proven EE technologies abroad has not been tested in India, and therefore their adoption has been limited.
· Lack of specific R&D focused on EE	There is no specific R&D unit on EE. IR heavily depends on imported technology.
(5) Financial barriers	
· Lack of targeted budget to support the implementation of EE measures	The budget is allocated centrally by IR. There is no Head of Allocation for EE. In the preparation of the budget, priority is given to infrastructure (traction and non-traction) and maintenance costs, rather than on EE. Resources for the implementation of EE measures are therefore residual and not firmed.

	In a context in which the total budget allocation to IR is diminishing because of other Government priorities, the resources available for the implementation of EE measures are also diminishing.
· Lack of enabling framework to redirect the savings from EE measures implementation	The savings from the implementation of EE measures are not spent back for further implementation of EE measures.
· High capital intensive non-EE technologies with substantial residual life	Replacement of those non-EE technologies with new EE technologies is not economically justifiable until replacement is due.
· High investment costs of certain new EE technologies	High investment costs of certain new EE technologies coupled with the limited availability of resources may slow down the adoption rate of these technologies.

21. A number of factors or barriers have been identified during project preparation (including through a broad stakeholder consultation) as responsible for low absorption rate of energy efficiency technologies and measures. These barriers can be summarised in five broad categories:

(1) **Institutional barriers**: weak institutional arrangements and institutional capacity to promote and implement energy efficiency technologies and measures;

(2) **Information and capacity barriers**: lack of in-house information on existing energy efficiency options and opportunities, and of technical skills and capacity to implement them;

(3) **Incentive barriers**: lack of proper incentives to favour the adoption and implementation of energy efficiency measures;

(4) **Technology barriers**: limited number of energy efficiency technologies and measures tested and available in India vis-à-vis energy efficiency technologies and energy efficiency measures proven and adopted worldwide;

(5) **Financial barriers**: lack of adequate resources to adopt and implement energy efficiency technologies and measures or replace obsolete technologies and high investment costs.

Part B. PROJECT STRATEGY

4. PROJECT RATIONALE, DESIGN PRINCIPLES AND STRATEGIC CONSIDERATIONS

4.1 Project rationale and design principles

22. Indian Railways (IR) is intended to develop a long-term Energy Efficiency and Conservation Program (EECP) which aims at saving around 10% of the total energy consumption by 2032 by progressively introducing energy saving technologies and measures in both the traction and non-traction systems. However, the achievement of the Program objective may be undermined or slowed-down by the barriers described in Section 3.

23. The proposed GEF-supported project aims at supporting the implementation of the Indian Railways' Energy Efficiency and Conservation Program (EECP) by removing some of the key barriers identified above. More specifically, the proposed project plans to:

(1) Address 'institutional' and 'capacity' barriers by supporting institutional capacity development and technical training.

(2) Facilitate the adoption on a large scale of already proven energy efficiency technologies and measures by facilitating the dissemination of relevant information on existing technologies and measures, and implementing an appropriate incentive system.

(3) Address 'technology' barriers by piloting and testing energy efficiency technologies and measures (i.e. technologies and measures that have proven to be successful abroad), but have not yet been tested in India, to check their applicability in India.

(4) Facilitate the acquisition and dissemination of knowledge and lessons learnt.

24. The project will not address financial barriers.

25. Table 5 summarizes how the barriers identified in Section 3 will be specifically addressed through the project is reported below.

4.2 Strategic considerations: 'training of trainers' to address capacity gaps, and the role of TIRFAD in addressing information and awareness gaps

26. One of the key elements of the proposed project will be the capacity building component. The project will support a broad technical assistance program aiming at (i) raising awareness and building confidence among Indian Railways staff on energy efficiency measures, international benchmarks and best practices, and (ii) strengthening the capacity of IR staff, testing and training facilities/institutes, and vendors and manufactures in implementing energy efficiency technologies and measures. The capacity building component will include practical demonstrations in workshops, field technical visits, and trainings in the three major disciplines (rolling stock, traction power distribution, and building and general electrical services)[12]. It is estimated that about 2,000 staff (managers, supervisors and technical staff[13]) will benefit from the capacity building activities supported by the project.

[12] An example of the proposed training modules is reported in Annex F.

Table 5: Overview of barriers and options supported by the project

Barrier	Measures supported by the project to address the identified barriers
(1) Institutional barriers	
· Lack of an EE Corporate Policy · Lack of institutional set-up to promote and monitor EE measures	The project will support the creation of a Centre of Excellence (COE) within IR which will be responsible for (i) promoting and coordinating EE activities within IR; (ii) providing technical support and advice on EE technologies and measures, including trainings; and (iii) collecting and disseminating information on EE technologies and measures (Output 1.2).
· Lack of adequate capacity within training and testing facilities	The project will support existing training institutes in upgrading/strengthening their capacity for delivering trainings and conducting tests on EE (Output 1.3).
· Lack of consideration for EE measures and energy conservation practices in standard specifications for the purchase of material and equipment	The project will support the creation of a Centre of Excellence (COE) which will be responsible, among other tasks, to collect and disseminate information on EE technologies. One of the tasks of the COE will be the review and development of improved EE specifications for technologies, installation, testing, and operation and maintenance procedures, and of audit manuals/guidelines on EE for specific railway operations (Output 1.2). Within the COE, a Technology Information Resource and Facilitation Desk (TIRFAD) will be established to disseminate information on EE technologies and measures to equipment vendors (Output 1.2).
(2) Information and capacity barriers	
· Insufficient information/awareness among IR officials and staff about existing EE measures	The project will support the creation of a Centre of Excellence (COE) which will be responsible, among other tasks, to collect and disseminate information on EE technologies and measures (Output 1.2). One of the tasks of COE will be to assess the existing EE technologies adopted by different units of the IR, and come-up with a list of priority technologies to be implemented in IR (Output 2.1). The COE will also develop and implement energy audit procedures for each railway operation to identify energy intensive departments and benchmarks for EE, and produce audit manuals for IR staff to monitor the key parameters of EE (Output 2.2). Finally, some of the activities that the project will support are the creation of a web-based portal for the dissemination of information of EE technologies and measures, benchmarks, training material and best practices to IR staff (Output 1.2), and the production of publications, leaflets, reports, and newsletters to disseminate the information and lessons learnt through the implementation of the project (Output 4.1).

[13] Even if the number of the people that are proposed to be trained may appear significant, in fact it represents only a small percentage of the entire 1.4 million staff of Indian Railways. A detailed list of the proposed participants is reported in Annex F.

· Lack of proper technical skills and capacity among IR staff to assess, test and implement EE technologies and measures	The project will support existing training institutes in developing and delivering trainings on EE technologies and best practices (Output 1.3). The project will in addition support the implementation of already proven EE technologies and measures to build confidence and capacity among IR staff to adopt and implement EE technologies (Output 2.3).
(3) Incentive barriers	
· Lack of incentives to staff to implement EE measures	The project will support (i) the review of existing incentive and award schemes, both within and outside India, (ii) the development of suitable incentive schemes to encourage the adoption and implementation of EE measures, and (iii) the institutionalization of the incentive schemes, if successful (Output 2.4).
· Lack of incentives to vendors and manufacturers to develop/retail EE products	The project will indirectly provide incentives to vendors and manufactures to develop/retail EE products by (a) providing technical assistance to manufactures, vendors, importers, and new entrepreneurs to design and produce EE equipments (Output 2.3), and (b) supporting the implementation of already proven EE technologies and measures (Output 2.3).
(4) Technology barriers	
· Limited adoption of proven EE technologies abroad	The project will support (a) the interaction of IR staff with 'units of excellence' of railways systems of other countries to identify/familiarize with other countries' EE best practices (Output 1.1); (b) the development and implementation of training plans on EE best practices (Output 1.3); and (c) the piloting and testing of selected energy efficiency technologies and measures that have proven to be successful abroad, but have not yet been tested in India, to check their applicability in India (Output 3.1).
· Lack of specific R&D focused on EE	The project will not directly support activities aiming at addressing this specific barrier.

27. The trained staff will become trainers or resource persons on energy efficiency for Indian Railways in their respective Units or Departments. The main idea behind this approach is that these trained staff would contribute to progressively train and awareness raising among the whole Indian Railways staff. It is estimated that about 5,000 local level staff will benefit from training and awareness raising activities on energy efficiency within the three years of the project (see Annex F for details).

28. Part of the capacity building activities (i.e. field technical visits) will be conducted abroad as some of the energy efficiency technologies and measures that are proposed to be implemented in India are currently available only abroad. Therefore it is important that staff have a 'first-hand' experience to assess their efficiency and feasibility, and build their confidence.

29. To address the issue of lack of information and awareness on energy efficiency technologies and measures among IR staff and third-parties (e.g. vendors, equipment suppliers, etc.), a critical role will be played by the Technology Information Resource and Facilitation Desk (TIRFAD). TIRFAD will be established through the project to disseminate information on EE technologies and measures to all key stakeholders, both from the public (i.e. Indian Railways) and private sector (i.e. small and medium enterprises, vendors, etc.). TIRFAD will make available and easily accessible a wide range of knowledge

products on EE practices, which include information on their technical, environmental and economic parameters.

Table 6: Selection of technologies and measures for the project

	EE technologies and measures already proven in India	**EE technologies and measures that have proven to be successful abroad, but have not yet been tested in India**
Traction and Rolling Stock	• Installation of Automatic Switched Capacitor Bank (ASCB) to reduce electrical losses in Traction Sub Stations (TSS) • Installation of LED (light-emitting diode) lights in coaches	• Installation of GPS-based 'driver advice system' (GPSDAS) and Energy Management System (EMS) to ensure safe and energy efficient driving • Installation of microprocessor controlled air-conditioning systems for AC couches • Introduction of roof solar panels in coaches to generate electricity • Conduct energy audits of rolling stock (locomotives) and coaches*
Non-traction	• Replacement of fluorescent tube lights with low energy consumption lights (T5 fluorescent tubes in place of T12 tubes for lighting stations, workshops and railway offices) • Replacement of incandescent bulbs with CFLs bulbs for service buildings and railway quarters • Introduction of VVVF (Variable Voltage Variable Frequency) drives for machine	• Installation of Energy Management System (EMS) for pumping installations • Installation of Building Management Systems (BMS) for stations, workshops and railway offices • Energy audits of stations, workshops and railway offices, etc.* • Support to energy testing laboratories*

(*) Even if these activities cannot be properly considered technologies, they have been included as key critical activities to assess energy consumptions and promote energy efficiency measures.

4.3 Strategic considerations: rationale and criteria for selection of energy efficiency technologies and measures to be implemented or tested through the project

30. After stakeholder consultations, a limited number of energy efficiency technologies and measures have been selected to be implemented or tested through the project (see Table 6). The criteria used for selecting these technologies are the following (see Table 7):

(a) For energy efficiency technologies and measures already technically proven in India (although not widespread due to before-mentioned barriers): priority was given to technologies and measures that:

- Have high rate of return
- Are easy to implement
- Require a single department intervention (vs. multi-department intervention)
- Are complementary to existing knowledge within IR
- Have already proven to be successful in India
- Have high potential for absorption/replicability

(b) For pilot demonstration of energy efficiency technologies and measures (i.e. technologies and measures that have proven to be successful abroad, but that have not yet been tested in India): priority was given to technologies and measures that:

- Have high rate of return

- Are easy to implement
- Require a single department intervention (vs. multi-department intervention)
- Are complementary to existing knowledge within IR
- Have already proven to be successful abroad/ are recommended by international bodies
- Have high potential for absorption/replicability

31. All the other energy efficiency technologies identified during project preparation (ref. par. 3.2) (including those that have high potential, but do not fulfil the other criteria, e.g. have high initial capital cost and/or low-medium rate of return, require long time for implementation, etc.) will not be tested or implemented during the course of the project.

Table 7: Criteria for technology selection

	Technology	Rate of return	Implementability	N. of Departments	Intervention type	Provenness	Potential for Absorption/ Replicability
Traction	• Installation of ASCB to reduce electrical losses in Traction Sub Stations (TSS)	H	E	S	C	PI	H
	• Installation of LED (light-emitting diode) lights in coaches	H	E	S	C	PI	H
	• Installation of GPSDAS and EMS to ensure safe and energy efficient driving	H	E	S	C	PA	H
	• Installation of microprocessor controlled air-conditioning systems for AC couches	H	E	S	C	PA	H
	• Installation of roof solar panels in coaches to generate electricity	H	E	S	C	PA	H
	• Conduction of energy audits of rolling stock (locomotives) and coaches*	H	E	S	C	PA	H
Non-traction	• Replacement of fluorescent tube lights with low energy consumption lights	H	E	S	C	PI	H
	• Replacement of incandescent bulbs with CFLs bulbs for service buildings, etc.	H	E	S	C	PI	H
	• Installation of VVVF (Variable Voltage Variable Frequency) drives for machine	H	E	S	C	PI	H
	• Installation of Energy Management System (EMS) for pumping installations	H	E	S	C	PA	H
	• Installation of BMS for stations, workshops and railway offices	H	E	S	C	PA	H
	• Energy audits of stations, workshops and railway offices, etc.*	H	E	S	C	PA	H
	• Support to energy testing laboratories*	H	E	S	C	PA	H

(*) Even if these activities cannot be properly considered technologies, they have been included as key critical activities to assess energy consumptions and promote energy efficiency measures. See also Annex D for more details

Legend:

- Rate of return: High (H), Medium (M), Low (L)
- Implementability: Easy (E), Medium (M), Difficult (D)
- Number of Departments necessary for implementation: Single (S), Multi-Department (MD)
- Complementary to existing knowledge within IR (C)

- Provenness: Proven in India (PI), Proven in abroad/Recommended by international bodies (PA), Not-Proven (NP)
- Potential for Absorption/ Replicability: High (H), Medium (M), Low (L)

4.4 Strategic considerations: consistency with GEF strategies and strategic programs

32. The proposed project is in line with the GEF objective of the Operational Program 5, i.e. "to promote energy-efficient technologies and practices in industrial production and manufacturing processes" and the related Strategic Program 2 (SP-2), i.e. "promoting energy efficiency in the industrial sector".

4.5 Strategic considerations: consistency with UNDAF and UNDP Country Programme

33. The proposed project is consistent with the objectives of the UNDAF (2008-2012), the planning framework for UN support to the Government of India, and particularly to the objectives set in Outcome 4, i.e. "the most vulnerable people […] have the abilities to prepare, adapt/recover from […] environmental changes".

34. The proposed project is in addition consistent with the objectives set in the UNDP Country Programme Action Plan (CPAP) 2008-2012, the planning framework for the specific UNDP support to the Government of India. The CPAP 2008-2012 states that a special focus will be placed on energy efficiency in order to contribute to reduction of greenhouse gas emissions in energy intensive industries, transport and commercial sectors, and that under this Program actions aiming at identifying and facilitating access to clean energy and piloting energy efficiency technologies to reduce greenhouse gas emissions will be supported. Specifically, the proposed project is consistent with the CPAP Outcome 4.3, i.e. "Progress towards meeting national commitments under multilateral environmental agreements", and Output 4.3.3, partnerships and capacities developed to meet national commitments under multilateral environmental agreements".

4.6 Strategic considerations: consistency with other national initiatives

35. The proposed project is one of the five projects under the "Programmatic Framework Project for Energy Efficiency in India" (GEF project 3538). The other four energy efficiency projects under this programme include: (i) the "Energy Efficiency Improvements in Commercial Buildings" project (UNDP); (ii) the "Chillers Energy Efficiency" project (World Bank); (iii) the "Financing Energy Efficiency in Small and Medium Enterprises" project (World Bank); and (iv) the "Promoting Energy Efficiency and Renewable Energy in selected SME clusters in India" project (UNIDO). The proposed project will establish the necessary communication and coordination mechanisms through its project board and management to ensure a proper coordination with this programme on energy efficiency. UNDP India will also take the lead ensuring adequate coordination and exchange of experiences.

5. COUNTRY ELIGIBILITY, POLICY CONFORMITY AND COUNTRY OWNERSHIP

5.1 Country eligibility

36. India ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 1 November 1993. India has completed and submitted its First National Communication and is currently preparing its Second National Communication.

5.2 Policy conformity and country ownership

37. The proposed project supports the objectives and targets on energy efficiency set in the Eleventh Five-Year Plan (2007-12), i.e. reducing energy intensity per unit of GDP by 20% over the 11th FYP period; savings of 5% energy consumption levels through the implementation of a set of energy efficiency interventions, including the establishment of an appropriate set of incentives; the creation of an enabling institutional framework; the promotion of energy service companies (ESCOs); and the promotion of energy efficient technologies.

38. The proposed project is in addition consistent with the actions envisaged in the Integrated Energy Policy (2006), i.e. improving energy efficiency and energy conservation in use and demand side management, shifting freight traffic to railways, and expanding electrification of railways to reduce diesel needs.

39. Finally, the proposed project is consistent with the National Action Plan on Climate Change (2008), and particularly with the National Mission for Energy Efficiency, which calls for strengthening the legal mandate of Energy Conservation Act of 2001; promoting market based mechanisms to enhance cost effective investments in energy efficiency in energy-intensive large industries and facilities; accelerating the shift to energy efficient equipments; creating mechanisms to finance demand side management energy saving programmes; and developing fiscal instruments to promote energy efficiency.

6. PROJECT OBJECTIVES, OUTCOMES AND OUTPUTS

6.1 Project goal, objective and expected results

40. The project goal is the reduction of GHG emissions from the Indian Railway system. The proposed project aims at improving energy efficiency in the Indian Railways system (and thereby reducing greenhouse gas emissions) by removing some of the key barriers that prevent the wide adoption of energy efficiency technologies and measures in the Indian Railways system. Emission reduction estimates are quantified in Section 8.

6.2 Project components, outcomes, outputs and activities

41. The project is organized along four components:

(1) Institutional capacity development and technical training

(2) Implementation of proven energy efficiency technologies and measures

(3) Pilot demonstration of energy efficiency technologies and measures

(4) Information and knowledge sharing

Component 1 **Institutional capacity development and technical training**

Expected Outcome: **(1.1) Strengthened IR institutional capacity; (1.2) Improved EE management and technical capacity of IR staff**

Output	Activities
1.1 Documented energy efficiency (EE) best practices (measures and technologies) and defined EE benchmarks for railway systems	1.1.1 Review of available information and collection of technical data on energy efficiency technologies in railway operation in India. 1.1.2 Gap analysis to define focus areas for the implementation of EE technologies and measures. 1.1.3 Interaction with industrialized countries (such as Japan, Germany, France, UK), including visits to their 'units of excellence', to assess the efficacy of their EE technologies and measures and define benchmarks. 1.1.4 Based on activities 1.1.1 and 1.1.2, identification and documentation of 'best practices', and efficiency benchmarks and assessment of their applicability in the context of Indian Railways. 1.1.5 Definition and establishment of specific EE benchmarks for the Indian Railways System (IRS)

42. The activities to be carried out to deliver Output 1.1 are aimed at identifying a set of energy efficiency technologies and measures with application potential in the Indian Railways, and at defining specific energy efficiency benchmarks for the Indian Railways.

43. The activities include a comparative analysis between the existing energy efficiency technologies and measures in India and the pilot demonstration of technologies proved to be successfully demonstrated in developed countries. Best practices and energy efficiency benchmarks in industrialised countries will be analysed and assessed on applicability in the Indian context. A key activity for the achievement of this output will be the interaction with the units of excellence that have expertise in EE technology applications in railway systems in industrialized countries, including limited technical field visits to them to familiarize and directly assess the efficacy and the compatibility of energy efficiency technologies applied abroad to the Indian context.

44. The information on energy efficiency technologies, measures, and benchmarks will be documented and disseminated to the Indian Railway divisions and production units, suppliers and the various associations in the operating zones and divisions of the company through the web portal and the Technology Information Resource Facilitation Desk (TIRFAD) which will be established during the project (ref. Activities 1.2.3, 1.2.4, and 4.1.2).

Output	Activities
1.2 Established and supported Centre of Excellence (COE)	1.2.1 Development of a business plan for the COE 1.2.2 Establishment of the COE 1.2.3 Development of a web- portal for the dissemination of information on EE technologies and measures 1.2.4 Establishment of a Technology Information Resource and Facilitation Desk (TIRFAD) to disseminate information to equipment vendors for product development

45. The activities that will be implemented to deliver Output 1.2 aim at establishing and supporting a Centre of Excellence (COE) for energy efficiency within Indian Railways.

Box 3 The Centre of Excellence (COE)

To strengthen the institutional capacity of Indian Railways, the establishment of a Centre of Excellence (COE) is planned. The COE will be as an autonomous body within Indian Railways, reporting directly to the Railways Board (ref. Annex E). The COE will act as resource centre for technical support and advice on energy efficiency technologies and measures, dissemination of the information to the staff and to stakeholders. The COE will support the implementation of EE measures and technologies in the various zonal institutions and zonal units by promoting, coordinating, and providing technical back-up on EE activities. It will also be charged with the responsibility to monitor and evaluate the uptake of various EE technologies in terms of the number of projects employing these technologies but also the performance of the technology applications.

The COE will be responsible for:

- Data collection, review and assessment of existing energy efficiency technologies and measures (in the country and abroad);
- Gap analysis, i.e. identification of gaps between existing energy efficiency technologies and energy efficiency technologies adopted by IR;
- Cost-benefit analysis and prioritization of existing energy efficiency technologies and measures;
- Development of procurement and material & workmanship (M&W) specifications[14];
- Development of audit manuals and guidelines on energy efficiency for railways operations;
- Development of testing procedures for energy efficiency technologies and measures and provision of guidance to testing houses on measurement, testing and calibration of energy efficiency equipment;
- Development of training modules on energy efficiency technologies and measures;
- Provision of technical support for the implementation of energy efficiency technologies and measures;
- Promotion and coordination of energy efficiency activities;
- Dissemination of information and knowledge sharing on energy efficiency technologies and measures, benchmarks, and specifications,
- Coordination with the Knowledge Management and Sharing (KMS) system established at BEE to manage information sharing among the projects under the "Programmatic Framework Project for Energy Efficiency in India" (e.g. common knowledge information portal).

The functions and functioning of the COE are summarized in the figure below.

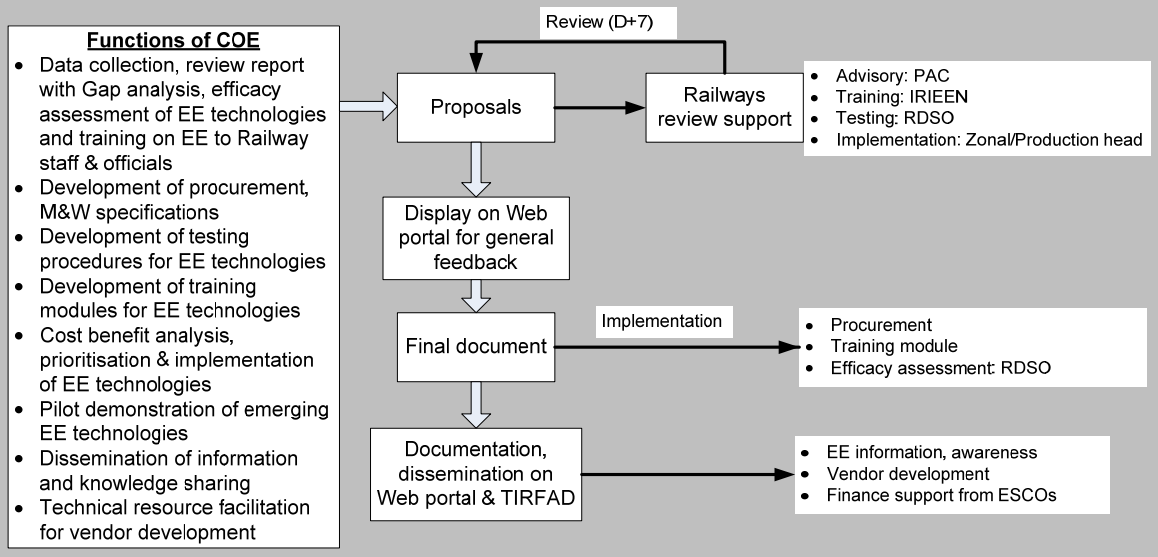

Figure 2: Functions and functioning of COE

[14] Whenever labeled products exist, public procurement of energy efficient goods (appliances/equipments) would include star labeled products.

The COE is not meant to duplicate the functions of existing units/divisions within IR. On the contrary, it will strengthen the capacity and rely on the functions already in place in the railways system. For example, while draft proposals will be developed by the experts of COE, they will be reviewed by the existing testing units (e.g. RDSO and other training institutes of IR). (See Annex E for more details).

The functions of the COE will be initially carried out by the Project Management Unit (PMU) for the duration of the project. As an exit strategy, it is foreseen that staff of the PMU may be absorbed in the COE at the completion of the project, so as to retain the capacity and expertise developed during project implementation.

46. To deliver this output, the activities that will be conducted include the development of a business plan for the COE, which describes organizational set-up, functions, and activities of the Centre; the establishment of the COE, including physical infrastructures and equipment; the development of a web-portal for the collection and dissemination of relevant information on energy efficiency technologies and measures, including benchmarks, training material, etc.; and the establishment of a Technology Information Resource Facilitation Desk (TIRFAD) within COE for the dissemination of information to all key stakeholders, both from the public (i.e. Indian Railways) and private sector (i.e. small and medium enterprises, vendors, etc.). TIRFAD will make available and easily accessible a wide range of knowledge products on EE practices, which include information on their technical, environmental and economic parameters. TIRFAD will function as an interface between the COE and the industry, manufacturers, entrepreneurs and vendors. It will help promoting EE measures among these stakeholders, thus facilitating the development of specific EE equipment in India.

Output	Activities
1.3 Trained and qualified staff members of the relevant IR departments capable of implementing EE technologies, measures, and best practices	1.3.1 Detailed capacity need assessment of IR (IR staff skills and expertise in EE, and capacity of training and testing institutes to conduct EE tests and trainings) 1.3.2 Development of a training plan, program and training modules 1.3.3 Conduct of training of trainers and awareness raising workshops 1.3.4 Conducting training courses at divisional level 1.3.5 Capacity building for training and testing units to ensure effective implementation and monitoring of EE technologies and measures, and maintenance of EE assets

47. The activities that will be carried out to deliver Output 1.3 aim at strengthening the capacity of Indian Railways (i.e. competences and expertise of IR staff, and facilities and equipment of IR training and testing institutions) to adopt and replicate energy efficiency technologies, measures and best practices.

48. Such activities include: a review and assessment of the expertise/technical skills available within IR staff (at both managerial and technical level) in relevant fields (i.e. rolling stock, traction and distribution, etc.) and the capacity of testing and training institutes and units to conduct energy efficiency tests and trainings; identification of the training needs and support to training institutes and units in developing a training plan and training modules; conduct training of trainers and awareness raising workshops among IR staff (ref. section 4.2 and Annex F for more details on the training and awareness raising activities) and training courses at divisional level; and capacity building for training and testing institutes/units, including accredited test-houses, by providing testing, measurement and calibration facilities, and training facilities to ensure effective implementation and monitoring of energy efficiency technologies and measures, and maintenance of energy efficiency assets.

Component 2 Implementation of proven[15] energy efficiency technologies and measures

Expected Outcome: Proven EE technologies and measures in traction and non-traction operations are implemented and energy savings realized

Output	Activities
2.1 Documented detailed information on available EE technologies and measures	2.1.1 Review and assessment of existing energy efficiency technologies and measures that have proven to be successful in India (either in IR or in other sectors) and definition of EE benchmarks 2.1.2 Cost-benefit analysis of identified EE technologies 2.1.3 Prioritization of energy efficiency technologies and measures to be implemented 2.1.4 Documentation of EE technologies (e.g. standards, code of practices, M&W specifications, test procedures, installations & testing check lists, etc.)

49. The activities that will be implemented to deliver Output 2.1 aim at assessing and compiling detailed information on existing energy efficiency technologies and measures in both the electric traction (TR) and non-traction (NT) fields.

50. These activities include: assessment of the proven energy efficiency technologies and measures (i.e. technologies and measures that have proven to be successful in India, either in the IR or in other sectors), a cost-benefit analysis of the identified technologies; the prioritization of energy efficiency technologies and measures to be implemented based on their cost-benefit, readiness and timeframe for implementation, risks, etc.); and a definition of energy benchmarks (based also on the analysis of Activity 1.1.3). Information on technologies (e.g. standards, code of practices, M&W specifications, test procedures, installations & testing check lists, etc.) and benchmarks will be collected and documented.

51. The collected information will be disseminated to the Indian Railway divisions and production units, suppliers and the various associations within the operating zones and divisions of the company through the web portal and the Technology Information Resource Facilitation Desk (TIRFAD), which will be established during the course of project implementation.

Output	Activities
2.2 Developed and implemented energy audit procedures	2.2.1 Identification of energy intensive departments, segments, and units 2.2.2 Development of energy audit guidelines, manuals, and procedures for each railway operation (e.g. production units, traction substations, workshops, production units, maintenance depots and buildings etc.) 2.2.3 Conduct of energy audits and definition of benchmarks 2.2.4 Development of contract procedures for energy audits, procurement and implementation[16]

52. The activities that will be carried out to produce Output 2.2 aim at developing and implementing energy audit procedures for railways operation.

[15] That is, energy efficiency technologies and measures that have already proven to be successful in India (either in IR or in other sectors). The project demonstrates how successfully these technologies and measures can be applied and implemented cost-effectively as these have not yet been widely adopted.

[16] Whenever labeled products exist, public procurement of energy efficient goods (appliances/equipments) would include star labeled products.

53. The activities include: identification of energy intensive departments, segments and units (e.g. sub-stations, work centres, traction sub-stations, etc.); development of audit guidelines, procedures and manuals for each railway operation (e.g. production units, traction substations, workshops, production units, maintenance depots and buildings etc.); conduct of demonstrative energy audits (in about 20 different utilities) to promote energy audit procedures and demonstrate the benefits of energy audits to improve energy efficiency, and the definition of energy efficiency benchmarks[17].

54. The PMU will provide support in developing the contract and procurement procedures for energy audits.

Output	Activities
2.3 Completed implementation of ready and proven technologies and measures	2.3.1 Preparation of standards (both technical and financial) for EE services while inviting tenders. 2.3.2 Implementation of ready and proven energy efficiency technologies and good housekeeping measures as identified during project preparation and under the audits to build confidence and promote EE 2.3.3 Development of the guidelines and standards that needs to be met by the manufacturers, vendors, importers, new entrepreneurs, indigenous entrepreneurs to replicate and produce EE technologies locally and reduce the costs of production. 2.3.4 Capacity building for manufacturers of energy efficient equipment on the design, production and testing of energy efficient equipment.

55. The activities that will be carried out to produce Output 2.3 aim at supporting the implementation of energy efficiency technologies and measures that have already proven to be successful in India (either in IR or in other sectors) but have not been yet widely adopted. In favouring the implementation of these technologies and measures, the project expects to build capacity and confidence among IR staff on energy efficiency measures, thus favouring the replication of these technologies and measures on a larger scale.

56. Box 4 below summarizes the proven technologies and measures that have been identified during project preparation phase that will be implemented during project implementation, including their investment cost, estimated energy saving, and estimated annual CO_2 reduction. A detailed description of the technologies/measures, electricity consumption with the present method, estimated electricity consumption with the intervention, estimated electricity saved, estimated amount saved, payback period and estimated annual emission reduction are reported in Annex D and Table 18.

57. The EE measures identified above will be implemented in each Zonal Railways and field unit to showcase their effectiveness and benefits thereby building and/or enhancing the confidence of zonal railway managers in investing resources in EE.

58. The GEF contribution to the implementation of the above EE technologies and measures will amount at about 10-15% of the total costs. GEF resources will be primarily used for capacity development, training, awareness creation and information dissemination, which practically are the incremental activities that are needed to ensure the effective demonstration of the selected EE technologies, techniques and measures. IR will contribute with investments in equipment and infrastructure.

59. In delivering this output, technical support will be provided to manufacturers, vendors, importers, new entrepreneurs, etc. to upgrade the design, testing and technical characteristics of EE equipment and products, to indigenous entrepreneurs to replicate and produce EE technologies locally and reduce the

[17] The best energy efficiency achieved at any of the field units will be considered as EE benchmarks.

costs of production. Manufacturers of equipment will receive further guidance regarding the design, production and testing of energy efficient equipment.

Output	Activities
2.4 Developed and implemented incentive schemes	2.4.1 Review of existing incentive and award schemes, both within and outside India 2.4.2 Development of suitable incentive schemes to encourage the adoption and implementation of EE measures 2.4.3 Institutionalization of the proven successful incentive schemes 2.4.4 Mobilization of financial support for the implementation of the incentive schemes

60. Output 2.4 will be delivered through the implementation of activities aimed at developing and implementing an incentive scheme to provide incentives to IR staff to adopt and implement energy efficiency technologies and measures.

61. Such activities include: review of existing incentive and award schemes, both within and outside India, development of suitable incentive schemes to encourage the adoption and implementation of EE measures, and the institutionalization of the proven successful incentive schemes. In order to support the effective implementation of incentive scheme, funds need to be mobilized for an effective implementation of incentive scheme from the respective authority.

Box 4 Proven interventions and impact estimate (Outcome 2)[18]

(A) Traction

1. Automatic Switched Capacitor Bank to reduce electrical losses in Traction Sub Stations (ASCB for TSS)
2. LED (Light Emitting Diode) lights in coaches

(B) Non Traction

3. T5 tubes in place of T12 tubes for lighting for stations, workshops and railway offices
4. CFLs replacing incandescent bulbs for service buildings and railway quarters
5. VVVF (Variable Voltage Variable Frequency) drives for machines

#	Technology/Device/Measure description	Investment cost (USD)	Estimated annual energy savings (million kWh per year)	Estimated annual CO_2 reduction (tonnes/year)
	(A) Traction			
1	Installation and operation of Automatic Switched Capacitor Bank to reduce electrical losses in Traction Sub Stations (ASCB for TSS)	425,532	0.38	308
2	Installation and use of LED (Light Emitting Diode) lights in coaches	1,276,596	1.21	992
	(B) Non-traction			

[18] See Annex D for more details.

3	Installation and use of T5 fluorescent tubes in place of T12 tubes for lighting for stations, workshops and railway offices	8,510,638	27.6	22,632
4	CFLs replacing incandescent bulbs for service buildings and railway quarters	1,382,979	79.56	65,239
5	Installation and operation of VVVF (Variable Voltage Variable Frequency) drives for machines	1,063,830	3.24	2,657
	Total (proven technologies/devices/measures)	**12,659,574**	**112**	**91,827**

Component 3: Pilot demonstration of energy efficiency technologies and measures

Expected Outcome: Increased confidence in the application of EE technologies and practices piloted in the IRS

Output	Activities
3.1 Completed demonstration of EE technologies and measures	3.1.1 Design of EE demonstration projects in relevant fields of Railways like rolling stock (RS), traction distribution (TRD) and building sector (BS), including testing facilities, workshops and production facilities 3.1.2 Implementation of pilot demonstration projects in relevant fields of Railways i.e. EE rolling stock, TRD, BS and E&M for testing house, static installation, work shop and production facilities 3.1.3 Technical evaluation and auditing of the pilot projects and documentation of lessons learned (linked with activity 4.1.3)

62. Within this component, the project will support the pilot demonstration of advanced energy efficiency technologies, devices and measures that have proven to be successful abroad. Those technologies and measures will be taken up for further replication, if their suitability to the Indian context is demonstrated. Pilot projects would involve demonstrations in both traction and non-traction segments (including testing houses, rolling stock, static installation, and workshop and production facilities).

63. The box below summarizes the technologies and measures that have been identified during project preparation to be piloted during project implementation, including their investment cost, estimated energy saving, and estimated annual CO_2 reduction. A detailed description of the technologies/measures, electricity consumption with the present method, estimated electricity consumption with the intervention, estimated electricity saved, estimated amount saved, payback period and estimated annual emission reduction are reported in Annex F.

Box 5 Pilot interventions and impact estimate (Outcome 3)[19]

(A) Traction

1. Energy audit of rolling stock
2. GPS based train Driver Advice System (GPSDAS) and Traction Energy Management System (TEMS)
3. Microprocessor controlled air-conditioning systems for AC coaches
4. Roof mounted SPV for electricity generation for passenger trains

(B) Non Traction

5. Energy audit of stations, workshops and railway offices
6. Building Management Systems for stations, workshops and railway offices

[19] See Annex D for more details.

7. Energy Management System (EMS) for pumping installations
8. Energy Testing and Resource Centres

#	Technology description (pilot demonstration)	Investment cost (USD)	Estimated annual energy savings (million kWh per year)	Estimated annual CO_2 reduction (tonnes/year)
(A) Traction				
1a/1b	Energy audit of rolling stock (locomotives) Energy audit of coaches Implementation of selected energy conservation opportunities (ECOs) and EE improvements (EEIs) identified and recommended by the energy audits.	212,766	1.02	835
2	GPS based Driver Advice System (GPSDAS) and Energy Management System	244,681	2.11	1,733
3	Microprocessor controlled air-conditioning systems for AC couches	255,319	1.04	850
4	Roof mounted SPV for electricity generation for passenger trains	223,404	0.05	37
(B) Non Traction				
5	Energy audit of stations, workshops and railway offices Implementation of selected energy conservation opportunities (ECOs) and EE improvements (EEIs) identified and recommended by the energy audits.	531,915	12.0	9,840
6	Building Management Systems (BMS) for stations, workshops and railway offices	1,063,830	12.0	9,840
7	Energy Management System (EMS) for pumping installations	638,298	2.19	1,796
8	Energy Testing and Resource Centres	2,127,660		
	Total (pilot technologies/devices/measures)	**5,297,872**	**30**	**24,931**

64. The PMU/COE will identify the pilot projects after the efficacy assessment under activity 1.1.2, in consultation with other the IR units. Zonal railways and other field units will design the demonstration projects, procure, install and commission the necessary hardware with suitable external engineering support. Where and when necessary, the PMU/COE will provide support in reviewing the design and monitor the procurement and installation process as well as providing advice during procurement (e.g., identification of suppliers, preparation of bids). The results of the pilot projects will be evaluated, and the lesson learnt and knowledge gained will be shared to support decision making processes.

Component 4: Information and knowledge sharing

Expected Outcome: Information and knowledge on EE technologies and measures are widely available and accessible for IRS divisions and their affiliates

Output		Activities	
4.1	Collected lessons learned and developed knowledge sharing products	4.1.1	Collection and documentation of information on EE technologies, measures, best practices, and lessons learnt
		4.1.2	Dissemination of collected information through the web portal and TIRFAD
		4.1.3	Production of documentation, publications; leaflets; reports, and of a regular (project) newsletter
		4.1.4	Conduct of awareness campaigns at divisional level
4.2	Developed post-project action plan for COE	4.2.1	Synthesis of project results and development of an action plan for the post-project functioning of the COE
		4.2.2	Conduct of closing workshop

65. The activities that will be carried out under this component are aimed at supporting the sharing of information and knowledge regarding energy efficiency technologies, measures and best practices through the activities of the project.

66. Such activities include: collection and documentation of information on EE technologies, measures, best practices, and lessons learnt; activities to favour information dissemination and knowledge sharing such as dissemination of collected information through the web portal and Technology Information Resource and Facilitation Desk (TIRFAD); production of documentation, publications; leaflets; reports, and of a regular (project) newsletter; and, the conduct of awareness campaigns at the divisional level within the IRS.

67. Under this component, a post-project action plan for the COE will be developed. A synthesis of all project results will be done, and used as basis for the post-project action plan. Such plan will be presented in a workshop, along with the synthesis of the project results.

68. A key role for the dissemination of information and knowledge will be played by the TIRFAD, established under output 1.2. TIRFAD will disseminate information on EE technologies and measures to all key stakeholders, both from the public (i.e. Indian Railways) and private sector (i.e. small and medium enterprises, vendors, etc.). TIRFAD will make available and easily accessible a wide range of knowledge products on EE practices, which include information on their technical, environmental and economic parameters.

69. This component will, in addition, favour and support knowledge sharing from the other projects under the "Programmatic Framework Project for Energy Efficiency in India" (GEF project 3538), coordinated by BEE.

7. KEY INDICATORS AND ASSUMPTIONS

7.1 Indicators

70. Progress towards and attainment of the project goal and objective will be measured through the following outcome indicators:

Project objective	Outcome indicators
Improvement of the energy utilization efficiency in the Indian Railways system (and thereby reducing greenhouse gas emissions) through the removal of some of the key barriers that prevents the wide adoption of energy efficiency technologies and measures in the Indian Railways system.	(1) Total direct energy savings by EOP (2) Total direct CO_2 emission reductions achieved in the IRS by EOP

71. Progress and achievements within the single components are measured through the following intermediate-outcome and output indicators (details are presented in Section 10):

Table 8: Project outcome and output indicators

Project component/ outcome	Component output	Intermediate-outcome/ output indicators
(1) Institutional capacity development and technical training *Expected outcomes:* (1.1) strengthened IR institutional capacity (1.2) improved EE management and technical capacity of IR staff	1.1. Documented energy efficiency (EE) best practices (measures and technologies) and defined EE benchmarks for railways systems	• Status report of targeted EE technologies / measures, its availability in India/abroad and gap analysis for its implementation
	1.2. Established and supported Centre of Excellence (COE)	• Established and functioning of EE Centre of Excellence (COE) in IRS by EOP • TIRFAD established and functioning by EOP • COE website established and operational by EOP
	1.3. Trained and qualified staff members of the relevant IR departments capable of implementing EE technologies, measures, and best practices	• Number of training courses conducted by the training institutes each year starting from year 3 • Number of managers and staff members trained on EE best practices and technologies by EOP • Number of training and testing institutes with capacity to provide trainings and test EE measures/equipment by year 3 • Number of successful EE projects implemented by the trained managers and staff members by EOP

Project component/ outcome	Component output	Intermediate-outcome/ output indicators
(2) Implementation of proven energy efficiency technologies and measures *Expected outcome:* Proven EE technologies and measures in traction and non-traction operations are implemented and energy savings realized	2.1 Documented detailed information on available EE technologies and measures	• Number of project proposals (technical and financial) prepared by EOP for EE technology / measure application projects
	2.2 Developed and implemented energy audit procedures	• Potential energy savings from the implementation of EE technologies and/or measures by year 3
	2.3 Completed implementation of ready and proven technologies and measures	
	2.4 Developed and implemented incentive schemes	• Percentage of savings derived from EE measures implemented allocated as incentives to EE implementers by EOP
(3) Pilot demonstration of energy efficiency technologies and measures *Expected outcome:* Increased confidence in the application of piloted EE technologies and practices in the IRS	3.1 Completed pilot demonstration of EE technologies and measures	• Number of energy audits conducted in IRS units above 0.5 MW load by year 3 • Number of pilot demonstrations designed and implemented by year 3 • Total energy savings achieved from pilot projects by EOP, million kWh • Percentage of successful pilot demonstrations adopted by IRS for replication by EOP • Based on energy audits, number of EE technologies and measures identified as feasible for implementation (planned and budgeted) by year 3
(4) Information and knowledge sharing *Expected outcome:* Information and knowledge on EE technologies and measures are widely available and accessible for IRS divisions and their affiliates	4.1 Collected lessons learned and developed knowledge sharing products	• Average number of visitors visiting the web portal each year starting year 2 • Number of sets of knowledge sharing products (KSPs) developed and disseminated by EOP • Number of awareness campaigns conducted per division per year starting year 3 • Number of IRS divisions that are actively participating in IRS EE programs by EOP • Number of vendors registering with TIRFAD each year starting year 3(i.e. from 2013) • Cumulative number of vendors attending TIRFAD campaigns by the EOP

7.2 Assumptions

72. General assumptions are (see Section 10 for more details):

- The commitment on energy efficiency by the Indian Railways' decision-makers;
- Existing organizations within IR, such as RDSO and IRIEEN, do not feel threatened by the new COE, but see it as support centre for mobilising internal institutional support for promotion of EE technologies and measures and coordination;

- The support by RDSO and training institutions to review the technical documentation on EE technologies and measures, testing and training modules and to assist in implementation;
- Required contributions from UNDP and Railways are available;
- The field units facilitate the implementation and pilot demonstrations;
- The COE will be institutionalised to function independently under the IR Board.

7.3 Risks

73. The main risks to the effective implementation of the proposed GEF project are related to the following:

- Failure to secure continuous support to the Energy Efficiency and Conservation Programme (EECP) from planners in Indian Railways zonal production and other units;
- Lack of manufacturers' interest in investing for EE products, thus leading to initiatives failure;
- Failure to trigger a positive response from technical staff on initiatives supporting EECP;
- Lack of effective coordination between IR units on initiatives supporting the EECP;
- Willingness of IR managers to give proper priority to EE in investment decisions;
- Competition from inefficient and cheap technologies and high cost of advanced (monopolistic) technologies;
- Fast changing technologies in particular in the electronics segment.

74. Details on measures that will be undertaken to mitigate the risks are reported in Annex A.

8. GEF INCREMENTAL REASONING AND COST-EFFECTIVENESS

8.1 Baseline scenario

75. Indian Railways has in the past carried out some initiatives on energy efficiency in accordance with the Energy Conservation Act, and policy directives are periodically issued to promote the adoption of energy efficiency measures. However, the implementation of such initiatives and measures has been rather ad-hoc (i.e. based on the good will of sensitive officers) and uncoordinated. In general, the uptake of energy efficiency technologies and measures has been rather slow.

76. To promote the adoption of energy efficiency technologies and measures in a more comprehensive and effective way, Indian Railways is developing a long-term Energy Efficiency and Conservation Program (EECP) (2010/11-2031/32) with the objective of saving 10% of the total electricity consumption in absolute terms by 2032.

77. However, considering the pace with which energy efficiency measures have been implemented in the past, there is an inherent risk that the implementation of the Energy Efficiency and Conservation Program (EECP) would also be slow. During project preparation a number of barriers have been identified as being responsible for low absorption rate of energy efficiency technologies and measures (ref. Section 3.3 for more details). Unless these barriers are addressed, it is likely that the implementation of the EECP would also be slow.

78. Without GEF intervention (i.e. baseline scenario), Indian Railways is expected to move from the current (2009-10) estimate of 15.7 billion kWh of electricity consumption in the railways sector to 100.5 billion kWh in 2031-32 (about 1,030 billion kWh cumulatively for the period 2010/11-2031/32). These figures are equivalent to the emission of about 12.8 and 82.4 million tonnes of CO_2 respectively. Details on the baseline scenario are provided in Annex D.

8.2 GEF alternative scenario

79. With GEF intervention (i.e. GEF alternative), it is assumed that, thanks to improved institutional set-up, improved capacity, confidence and awareness, improved incentive system, etc., energy efficiency technologies and measures will be adopted and implemented at a faster pace and on a wider scale.

80. As a result of the GEF intervention, the adoption of energy efficiency technologies and measures will be faster in the Indian Railways' Energy Efficiency and Conservation Program (EECP) thereby reduction in energy consumption and related CO_2 emissions when compared to baseline scenario. It is estimated that due to GEF intervention, total CO_2 emissions during the period 2031-32 will be about 75.4 million tCO_2, which is less than the estimated emissions under the baseline scenario for the same period. Table 19 in Annex D compares total energy consumption (per year and cumulative), energy savings (per year and cumulative), and CO_2 emissions (per year and cumulative) under the baseline and GEF scenarios for the years 2010-11 (beginning of the project) up to 2031-32, however considering up to the year 2020-21 is advised on a conservative basis.

81. **Annual direct CO_2 emission savings** are estimated at 0.117 million tCO_2 (ref. Box 4 and 5). **Cumulative direct CO_2 emission reductions** over 10-year investment lifetime (average) are estimated at 1.17 million tonnes of CO_2 (tCO_2). Considering the total avoided GHG emission reductions that are attributable to the project, which amounts to 1.17 million tCO_2, the corresponding unit abatement cost (UAC[20]) (i.e. GEF$ per tCO_2) is USD 4.45/tCO_2.

82. After the project's completion, investments will be affected by the long-term outcomes of the barrier-removal activities, e.g. capacity building and institutional strengthening. The corresponding CO_2 emissions reduction is referred to as *indirect emission reduction.* A replication factor of "3" has been chosen as a conservative estimate for Indian Railways based on the market transformation and demonstration approach of the project. Thus, **indirect emission reductions (bottom-up**) over 10-year investment lifetime are estimated at 1.17 million tCO_2 * 3 = **3.50 million tCO_2**.

83. In the alternative scenario the cumulative amount of 4.16 $MtCO_2$ would be reduced over the period 2011/12-2020/21 (that is, a total duration of 10 years during and after the project's lifetime). Of course, this potential cannot be fully attributed to the GEF intervention alone as other projects may have an influence over the entire IR system. Uptake of EE technologies would also take place to some extent due to ongoing (and future) national efforts and future donor-funded initiatives. We propose to apply conservatively a 'causality factor' 4 of 80%. This gives **indirect emission reduction (top-down)** 4.16 $MtCO_2$ * 80% = **3.32 $MtCO_2$.**

Box 6 Summary of the emission reduction impacts of the project

(a) Direct savings

			2010-13
Alternative scenario (i.e. implementation of EECP with GEF support)	**Energy Savings**	Electricity consumption (billion kWh)	**0.142**
	CO_2 emission savings	CO_2 emission savings (million tonnes)	**0.117** **1.168 (cumulatively for 10 years)**

Savings directly due to the specific energy saving technologies and measures implemented during the project (i.e. implementation of proven technologies and measures and pilot demonstrations - ref. Box 4 and 5). Cumulative emissions over 10-years are 1.168 million tCO_2, assuming a 10 year lifetime of equipment on average.

[20] Only direct emission reductions are considered for 10 years of economic lifetime as per GEF guidelines. There are no direct post-project emissions pertain to the project. Therefore, GEF finance of USD 5,200,000/1,167,581 tCO_2.

(b) Indirect savings (bottom-up)

		During 10 years of lifetime
Alternative scenario (i.e. implementation of EECP with GEF support)	**CO_2 emission savings** (million tonnes)	**3.503**

Based on direct emissions reduction, applying replication factor of 3.

(c) Indirect savings (top-down)

		2009-10	2012-13	Cumulative 2010/11-12/13	2020-21	Cumulative 2011/12-20/21
Baseline scenario (i.e. implementation of EECP without GEF support)	Electricity consumption (billion kWh)	15.65	19.90	55.21	38.60	273.00
	CO_2 Production (million tonnes)	12.83	16.32	45.27	31.66	223.86
Alternative scenario (i.e. implementation of EECP with GEF support)	Electricity consumption (billion kWh)	15.65	19.82	55.07	37.21	267.93
	CO_2 Production (million tonnes)	12.83	16.25	45.16	30.52	219.71
Energy Savings	Electricity consumption (billion kWh)			**0.14**		**5.07**
CO_2 Savings	CO_2 Production (million tonnes)			**0.11**		**4.16**

Savings due to the progressive uptake of energy efficiency technologies and measures indirectly induced by the activities of the project (e.g. awareness raising, capacity building, etc.).

Applying a causality factor of 80%, indirect (top-down) emission reduction is estimated at 3.32 million tCO_2

9. SUSTAINABILITY AND REPLICABILITY

9.1 Sustainability

84. After completion of the proposed GEF project, the Energy Efficiency and Conservation Program (EECP) will continue. The improved institutional environment and implementation and evaluation structures, to be developed with support from the proposed GEF project, are expected to be maintained by the Indian Railways (IR) Board upon completion of the project. Since the proposed GEF project has a strong capacity-building element, its outputs will foster institutional capacities to effectively maintain and expand the EE programme through its EE Centre of Excellence (COE) as a resource centre that provides advisory and technical support to other IR units in the implementation of EE technology and measures. The project places high priority on active participation by all Indian Railways stakeholders, i.e. staff of the various zonal units, testing houses, RDSO, training institutes, workshops, etc., ensuring ownership and sustainability of the EE programme.

85. The proposed project will establish an enabling framework and promote and strategic partnerships between Indian Railways, equipment manufacturers and importers and international EE agencies like UIC, SNCF etc. Such capacities and partnerships are expected to remain in place and facilitate the continuation of the EECP. Since the proposed GEF project has a strong capacity-building element, its outputs will foster institutional capacities to effectively maintain and revise the EE programme through Centre of Excellence.

9.2 Replicability

86. It is expected that the proposed project will demonstrate an effective model for the implementation of EE applicable to a wide-range of equipments and departments within Indian Railways. The outcomes of the project will support the accelerated transformation of Railways towards energy efficient Organisation. The enabling environment and the enhanced institutional capacities will facilitate the effective implementation of EE and the awareness campaign on EE under the proposed GEF project will motivate the Indian Railway implementing agencies, test houses and other users. The successful implementation of demonstration pilot projects along with effective dissemination and capacity building measures are expected to enhance replication potential. This process will be accelerated through adoption of 4-step replication strategy as follows:

- Step 1: A Project Management Unit will be set up and institutional capacity within IR will be strengthened by creating a Centre of Excellence (COE) to monitor and implement the EE initiatives. Experts and consultancy agencies as engaged under PMU will undertake detailed studies, efficacy assessment of various technologies, gap assessments and identify areas for improvement in technology and skills including the training modules as required.
- Step 2: Indian Railways will initiate implementation of EE measures and pilot demonstration projects in its various zonal and other units, assisted and monitored by COE.
- Step 3: Systems will be developed by COE for sharing information within each zone on technical skills, availability of technical support services, cost effectiveness and characteristics of EE technologies and measures (as well as internal and external sources of finance). The documentation and dissemination of 'best practices' through a web portal, monitoring of energy consumption patterns and profile as well as the development of progress indicators for assimilation and absorption of technologies together with training and deployment of energy mangers in each zone would lead to a large-scale development of energy efficiency projects in the Railways.
- Step 4: Case studies of financial returns on investment and demonstration of cost recovery of EE projects would lead to development of a culture of 'willingness to finance' amongst financial institutes and ESCOs (currently non-existent in India). The capacity building activity for all stakeholders at Zone and Headquarters level and other technical support through the TIRFAD will facilitate fast replication of pilot technologies. This would be further strengthened in cooperation with the potential equipment vendors, i.e. a group of entrepreneurs will be developed for cooperative procurement of services for hedging the transaction costs, post-installation assistance and after-sales services.

10. PROJECT RESULTS FRAMEWORK

This project will contribute to achieving the following Country Programme Outcomes (as defined in CPD): *Outcome:* Progress towards meeting national commitments under multilateral environmental agreements (CP, Outcome 4.3) *Output:* Strengthened capacity for low carbon development and sustainable management of natural resources (CP, Output 4.3) *Output indicators:* Number of clean technologies / mechanisms piloted
CPAP Outcomes and Indicators *Outcome:* Progress towards meeting national commitments under multilateral environmental agreements (CPAP, Outcome 4.3) *Output:* Partnerships and capacities developed to meet national commitments under multilateral environmental agreements *Output indicators:* (a) Million USD received as funding from GEF and Montreal Protocol through UNDP; (b) number of additional UNDP initiatives for achieving global and national targets under multilateral environmental agreements
Primary applicable Key Environment and Sustainable Development Key Result Area: Mainstreaming environment and energy
Applicable GEF Strategic Objective and Program: Strategic Programme 2 (SP-2): Promoting Energy Efficiency in the Industrial sector
Applicable GEF Expected Outcomes: Increased deployment of energy efficient technologies and practices
Applicable GEF Outcome Indicators: (a) **amount of energy saved (b)** tonnes of CO_2 avoided, (c) number of energy efficient technologies and measures promoted

Table 9: Project Planning Matrix (PPM)

Strategy	Objectively Verifiable Indicators			Means of Gauging Success	Assumptions
	Indicator	Baseline	Targets		
Project Goal: Reduction of GHG emissions in the Indian Railways System (IRS)	Cumulative emission reductions[21] achieved in the IRS by EOP[22] (million t CO_2)	• 0	• 0.117	• M&E reports of the pilot/model projects and documents available with IRS.	• Timely execution of planned activities planned with adequate resource mobilization • Efficient and quality measurement & recording systems are available • Field units of IR extend the support in desired manner and effectively implement the identified EE measures

[21] Total direct emission reductions (from year 3 of the project i.e. final year)
[22] The use of words "End of Project (EOP)" and "Year 3" are interchangeably used, which means the same

Strategy	Objectively Verifiable Indicators			Means of Gauging Success	Assumptions
	Indicator	Baseline	Targets		
Project Objective Removal of key barriers that prevent the wide adoption of energy efficiency technologies and measures in the IRS	Total direct energy savings[23] by EOP (billion kWh)	• 0	• 0.142	• See Annex D • Energy bills verified by IR and technical reports	• Timely implementation of all identified measures • IR zonal, division and other unit managers give EE importance in their investment decisions

[23] Total direct energy savings (from year 3 of the project i.e. final year)

Strategy	Objectively Verifiable Indicators			Means of Gauging Success/Source of verification	Assumptions
	Indicator	**Baseline**	**Targets**		
Component 1: Institutional capacity development and technical training[24]					
Outcome 1.1: Strengthened IR institutional capacity	Status report of targeted EE technologies / measures, its availability in India/abroad and gap analysis for its implementation	• 0	1	• Status report • Letter of appointment of head and staff • Office space allocated • APR/PIR and other progress reports produced	• Managers and technical staff are willing to benefit from training and supporting materials • Subjected to the availability of the funds • Identified training and testing institutes are competent and capable staff are retained on long-term • Competent website administrator appointed
	Established and functioning of EE Centre of Excellence (COE) in IRS by EOP	• 0	• 1[25]		
	TIRFAD established and functioning by EOP	• 0	• 1		
	COE website established and operational by EOP	• 0	• 1	• URL domain	
	Number of training and testing institutes with capacity to provide trainings and test EE measures/equipment respectively by year 3	• 0	• At least 8[26] • At least 2[27]	• List of training modules of training institutes • Inventory list of testing institutes	
	Number of training courses conducted by the training institutes each year starting from year 3	• 0	• 64[28]		
Outcome 1.2: Improved EE management & technical capacity of IR staff	Number of managers and staff members trained on EE best practices and technologies by EOP	• 0	• At least 325 managers and 675 staff	• Training attendance sheets	
	Number of successful EE projects implemented by the trained managers and staff members by EOP	• 0	• 45[29]	• APR/PIR and other progress reports produced	

[24] The objective and all outcomes monitored annually in the APR/PIR, according to the suggested list of indicators.
[25] Centre of Excellence established with full staff completed by year 3
[26] Training institutes with the capacity (i.e. equipment and trained staff) to provide trainings on EE
[27] Testing institutes with the capacity (i.e. test benches, calibration) to test EE measures
[28] At least one training program conducted quarterly in each of the 16 divisions starting from the third year of the project.
[29] A Project is defined as the implementation of defined technology in a specific location. The target is given assuming that all the 5 identified technologies (ref. Box 4) are implemented across the 9 Railway zones

Strategy	Objectively Verifiable Indicators			Means of Gauging Success/Source of verification	Assumptions
	Indicator	**Baseline**	**Targets**		
Component 2: Implementation of proven energy efficiency technologies and measures					
Outcome 2 Proven EE technologies and measures in traction and non-traction operations are implemented and energy savings realized.	Potential energy savings from the implementation of EE technologies and/or measures by Year 3, million kWh/yr	• 0	• 1.58 (for traction) • 110.40 (for non-traction)	• Project progress reports • Energy audit reports • Project reports on implemented EE measures • Energy bills	• Relevant details are shared by the respective field units. • Standard tools/ methods/ procedures of evaluations are used • Criterion & significant factors considered for prioritization. • Prioritization is identified by a competent team/ energy managers/ auditors
	Percentage of savings derived from EE measures implemented allocated as incentives to EE implementers by EOP	• NA	• At least 10%	• Cash outflow report • IRS Project progress reports	
	Number of project proposals (technical and financial) prepared by EOP for EE technology / measure application projects	• 0	• 45[30]	• Prepared detailed project proposals (technical and financial)	
Component 3: Pilot demonstration of energy efficiency technologies and measures					
Outcome 3 Increased confidence in the application of piloted EE technologies and practices in the IRS	Number of energy audits conducted in IRS units above 0.5 MW load by year 3	• NA	50	• Energy audit reports • Project progress reports • Project reports on implemented EE measures • Energy bills • Documentation on demonstration project design and financial closure and/or budget allocation • Project progress reports	• The developed countries agree to share the information on technology • Transfer of technology is negotiated. • Prioritization is identified by a competent team / energy managers / auditors • An interaction is established with developed countries to absorb the technologies on IR • Resources are mobilized in time
	Number of pilot demonstrations designed and implemented by year 3	• NA	• At least 8[31]		
	Total energy savings achieved from pilot projects by EOP, million kWh	• 0	• 30.40		

[30] A Project is defined as the implementation of defined technology in a specific location. The target is given assuming that all the 5 identified technologies (ref. Box 4) are implemented across the 9 Railway zones

[31] Pilot/demo activities implemented and audited per selected technology (as in indicated in Box 5 and Annex D)

Strategy	Objectively Verifiable Indicators			Means of Gauging Success/Source of verification	Assumptions
	Indicator	**Baseline**	**Targets**		
	Percentage of successful pilot demonstrations adopted by IRS for replication by EOP, %	• NA	• At least 25%[32]	• Budget report to verify funds allocated for implementation of successful projects	• Efficient and quality measurement & recording systems are available for measurement
	Based on energy audits, number of EE technologies and measures identified as feasible for implementation (planned and budgeted) by year 3	• NA	• At least 5[33]	• Documentation on demonstration project design and financial closure and/or budget allocation • Project implementation progress reports	

[32] For replication by the end of the project and initiated
[33] Pilots design for implementation as per selected technology and/or measure (as in indicated in Box 4 and Annex D)

Component 4: Information and knowledge sharing					
Outcome 4 Information and knowledge on EE technologies and measures are widely available and accessible for IRS divisions and their affiliates	Average number of visitors visiting the web portal each year starting year 2	• NA	• 24,000	• Web portal counter	• Captured all the information, updated knowledge and documented the results • The web portal is created and operational • TIRFAD is created and operational
	Number of sets of knowledge sharing products (KSPs) developed and disseminated by EOP	• NA	• 13[34]	• Annual report	
	Number of awareness campaigns conducted per division per year starting year 3	• 0	• 552[35]	• Annual report	
	Number of IRS divisions that are actively participating in IRS EE programs by EOP	• 0	• 68	• Annual report at the divisional level	
	Number of vendors registering with TIRFAD each year starting year 3 (i.e. from 2013)	• NA	• About 3[36]	• TIRFAD registration log	
	Cumulative number of vendors attending TIRFAD campaigns by the EOP	• 0	• At least 39[37]		

[34] At least one leaflet/booklet for each technology or a measure that will be demonstrated will be produced. This information is included in a regular (project) newsletter and also uploaded onto the web.
[35] At least 2 campaigns per division per year conducted by the end of the project (i.e. 68 divisions + 16 zonal headquarters + 1 railways + IRIEEN + IDSO + 5 production units x 3 years) over 16 zonal headquarters
[36] Per successful pilot technology register with TIRFAD
[37] At least three vendors per technology (13 numbers)

11. TOTAL BUDGET AND WORK PLAN

Annual Budget and Work Plan (ABWP)

Table 10: Project Annual Budget and Work Plan (ABWP)

Award ID:	00060440
Project ID:	00076108
Award Title:	PIMS 4044 CC FSP Improving Energy Efficiency in the Indian Railway System
Business Unit:	IND10
Project Title:	PIMS 4044 CC FSP Improving Energy Efficiency in the Indian Railway System
Implementing Partner (Executing Agency):	Indian Railways (IR); Ministry of Railways

GEF Outcome / Atlas Activity	Responsible Party (Implementing Agency)	Source	Budget Code	ERP/ATLAS Budget Description/Input	Annual Expenses (USD)			Total (USD)	#
					Year 1	Year 2	Year 3		
Outcome 1	UNDP	GEF 62000	71200	International Consultants	80,000	50,000	36,500	166,500	1
			71300	Local Consultants	110,000	90,000	40,600	240,600	2
			71600	Travel	75,000	50,000	39,010	164,010	3
			72100	Subcontracts	100,000	100,000	158,250	358,250	4
			72200	Equipment and furniture	10,000	5,000	75,000	90,000	5
			72500	Supplies	7,000	2,000	2,000	11,000	5
			72800	Info Tech Equipment	2,000	2,500	20,000	24,500	6
			73100	Rental and Main Premises	2,000	1,500	1,500	5,000	5
			73400	Rental and Main Equip	2,000	2,000	1,000	5,000	5
			74200	Audio visual & Printing Prod. costs	10,900	7,000	3,000	20,900	11
			74500	Miscellaneous	3,230	3,230	2,780	9,240	12
			sub-total		**402,130**	**313,230**	**379,640**	**1,095,000**	

GEF Outcome / Atlas Activity	Responsible Party (Implementing Agency)	Source	Budget Code	ERP/ATLAS Budget Description/Input	Annual Expenses (USD)			Total (USD)	#
					Year 1	Year 2	Year 3		
Outcome 2	UNDP	GEF 62000	71200	International Consultants	75,000	200,000	88,000	363,000	7
			71300	Local Consultants	90,000	275,000	103,500	468,500	8
			71600	Travel	35,000	90,000	30,750	155,750	3
			72100	Subcontracts	35,000	75,000	171,250	281,250	9
			72200	Equipment and furniture	100,000	100,000	83,000	283,000	10
			72500	Supplies	2,000	1,750	7,000	10,750	5
			72800	Info Tech Equipment	1,000	750	250	2,000	6
			73100	Rental and Main Premises	250	500	250	1,000	5
			73400	Rental and Main Equip	400	400	450	1,250	5
			74200	Audio visual & Printing Prod. costs	1,000	2,000	1,100	4,100	11
			74500	Miscellaneous	1,000	1,000	900	2,900	12
			sub-total		**340,650**	**746,400**	**486,450**	**1,573,500**	
Outcome 3:	UNDP	GEF 62000	71200	International Consultants	20,000	100,000	67,500	187,500	13
			71300	Local Consultants	30,000	140,000	147,025	317,025	14
			71600	Travel	10,000	50,000	27,952	87,952	3
			72100	Subcontracts		250,000	374,250	624,250	15
			72200	Equipment and furniture	10,000	20,000	20,000	50,000	16
			72500	Supplies	5,000	3,000	4,000	12,000	5
			73100	Rental and Main Premises	1,000	1,000	1,000	3,000	5
			74200	Audio visual & Printing Prod. costs	500	1,500	2,100	4,100	5
			74500	Miscellaneous	2,000	1,500	673	4,173	12
			sub-total		**78,500**	**567,000**	**644,500**	**1,290,000**	
Outcome 4:	UNDP	GEF 62000	71200	International Consultants	90,000	45,000	64,500	199,500	17
			71300	Local Consultants	100,000	64,525	100,000	264,525	18

GEF Outcome / Atlas Activity	Responsible Party (Implementing Agency)	Source	Budget Code	ERP/ATLAS Budget Description/Input	Annual Expenses (USD)			Total (USD)	#
					Year 1	Year 2	Year 3		
			71600	Travel	38,853	25,000	47,449	111,302	3
			72100	Subcontracts	85,000	100,000	143,500	328,500	19
			72200	Equipment and furniture	5,000	2,500	2,500	10,000	5
			72500	Supplies	500	250	250	1,000	5
			73100	Rental and Main Premises	1,000	500	500	2,000	5
			73400	Rental and Main Equip	2,000	1,000	2,000	5,000	5
			74100	Professional Services	4,000	4,000	4,000	12,000	20
			74200	Audio visual & Printing Prod. costs	3,500	2,000	3,700	9,200	11
			74500	Miscellaneous	4,000	2,000	973	6,973	12
			sub-total		**333,853**	**246,775**	**369,372**	**950,000**	
Project Management Unit	UNDP	GEF 62000	71400	Contractual Services-Individuals	81,083	81,083	81,084	243,250	21
			71600	Travel	10,000	7,500	4,372	21,872	
			72200	Equipment and furniture	5,000	5,000	3,000	13,000	
			72500	Supplies	2,000	2,000	2,000	6,000	
			74200	Printing and audiovisuals	3,285	2,500	1,593	7,378	
			74500	Miscellaneous	-	-	-	-	
			Sub-total		**101,368**	**98,083**	**92,049**	**291,500**	
TOTAL					**1,256,501**	**1,971,488**	**1,972,011**	**5,200,000**	

General notes to the budget:

- International consultants (IC) are budgeted at USD 3,000 per week, senior national consultants (NC) are budgeted at USD 550 per week and junior consultants at USD 375 per week
- The cost of workshops has been divided of various budget lines as per UNDP ATLAS budget which does not have a separate budget line for training/ workshops. For example, budget line 'international consultant' will have a % allocation for international experts to support workshops. The number of workshops for each output is given in the 'results framework'. A workshop will cost about USD 2,500 per day.

Specific notes (the numbers correspond to the last column of Table 10):

1. 56 person/weeks of international expertise for capacity assessment analysis, development of training and imparting training and other events (workshops, seminars)
2. 483 person/weeks of local short-term consultancy on traction, non-traction and energy efficiency for institutional capacity development and training
3. Travel cost (DSA and ticket) is budgeted at 30% of international consultant's fee and 10% of national consultant's fee as a general rule-of thumb
4. Subcontracts with companies for organization of workshops training events and study tours as well as website design
5. Equipment, rental premises, rental equipment for workshop and event organization;
6. Info tech equipment, includes software acquisition for training purposes
7. 121 person/weeks of international expertise) for assessment of technology status and implementation of EE technology in measures in traction and non-traction
8. 864 person/weeks of local short-term consultancy for assessment of technology status and implementation of EE technology in measures in traction and non-traction as well as related on-the-job training
9. Subcontracts with companies for energy audits, and technical assistance during assessment and implementation of EE measures in traction and on-traction (see Box 4)
10. Equipment, rental premises, rental equipment for workshop and event organization; and instrumentation for EE measures assessment
11. Printing and reproduction cost of workshop papers and proceedings and training materials as well as printing of project technical reports (assessments, feasibility analysis, investment proposals, technical studies, etc.)
12. Miscellaneous is for unforeseen expenses that are difficult to anticipate
13. 63 person/weeks of international expertise) for assessment and implementation of pilot demonstration activities
14. 617 person/weeks of local short-term consultancy to assist in the implementation of EE pilot projects
15. Subcontracts for technical assistance in the implementation of pilot projects as detailed in Box 5
16. Equipment, rental premises, rental equipment for workshop and event organization; and instrumentation for EE measures assessment
17. 67 person/weeks of international expertise) to support baseline, end-of-project impact and evaluation studies
18. 551 person/weeks of to support baseline, end-of-project impact and evaluation studies as well as supporting TIRFAD in info dissemination
19. Subcontracts to conduct baseline and end-of-project impact study
20. Professional services for annual financial auditing
21. Project management, as detailed in Table 14

Table 11: Summary of Funds (GEF and co-financing)

Donor	Year 1	Year 2	Year 3	Total
GEF	1,256,501	1,971,488	1,972,011	5,200,000
Indian Railways	7,000,000	7,000,000	7,000,000	21,000,000
Total	**8,256,501**	**8,971,488**	**8,972,011**	**26,200,000**

Table 12: Budget per Project Component and Major Budget Items

Category	USD	Components				
		1	2	3	4	5
International experts	916,500	166,500	363,000	187,500	199,500	-
National consultants	1,533,900	240,600	468,500	317,025	264,525	243,250
Travel	540,886	164,010	155,750	87,952	111,302	21,872
Subcontracts	1,592,250	358,250	281,250	624,250	328,500	-
Equipment	446,000	90,000	283,000	50,000	10,000	13,000
Supplies and rental premises and equipment	89,500	45,500	15,000	15,000	8,000	6,000
Printing and audiovisuals	45,678	20,900	4,100	4,100	9,200	7,378
Professional services	12,000	-	-	-	12,000	-
Miscellaneous	23,286	9,240	2,900	4,173	6,973	-
Total	**5,200,000**	**1,095,000**	**1,573,000**	**1,290,000**	**950,000**	**291,500**

Table 13A: Co-financing Details

Outcome		GEF (USD)	Co-fin (USD)	Cash (USD)	In-kind (USED)	Total (USD)
1	Institutional capacity development and technical training	1,095,000	600,000	500,000	100,000	1,695,000
2	Implementation of proven EE technologies and measures	1,573,500	12,835,750	12,700,000	135,750	14,409,250
3	Pilot demonstration of EE technologies and measure[38]	1,290,000	6,035,750	5,800,000	235,750	7,325,750
4	Knowledge sharing and learning	950,000	350,000	250,000	100,000	1,300,000
5	Project management	291,500	1,178,500	750,000	428,500	1,470,000
Total		**5,200,000**	**21,000,000**	**20,000,000**	**1,000,000**	**26,200,000**

Note: Co-financing of Outcome 2 includes investment in 'proven' EE technologies and measures of USD 12,659,574. Co-financing of Outcome 3 includes investment in pilot and demonstrations of USD 5,297,872

[38] This includes conducting energy audit and implementing energy audit recommendations. The recommendations (ECO/EEI) will be coming from the energy audits which are not known yet. Therefore the budget allocated tentatively is US$ 212,766.

Table 13.B shows the breakdown of the project management costs for this project.

Table 13.B: Project Management Costs

Budget Items	Person weeks	GEF Amount ($)	Co-financing ($)	Project Total ($)
Local consultants and staff	275	243,250	861,650	1,104,900
Office facilities, equipment		26,378	131,197	157,575
Travel		21,872	185,653	207,525
Total		**291,500**	**1,178,500**	**1,470,000**

12. MANAGEMENT ARRANGEMENTS

12.1 Project organization structure

87. The project will be implemented by the Indian Railways under the Ministry of Railways. IR will assume the overall responsibility for the achievement of the project results as the *Implementing Partner*. The project is co-financed with funding from the GEF fund and UNDP acts as the *GEF Executing Agency*. UNDP provides overall management and guidance from its New Delhi Country Office and the Asia Pacific Regional Centre (APRC) in Bangkok, and is responsible for monitoring and evaluation of the project as per normal GEF and UNDP requirements. Indian Railways (IR) will designate a senior official as the *National Project Director (NPD)* for the project (usually an official with the rank of 'Joint Secretary' level or above). The NPD will be responsible for overall guidance to project management, including adherence to the work plan and achievement of planned results, and for the use of UNDP funds through effective management and well established project review and oversight mechanisms. The NPD also will ensure coordination with various government ministries and agencies provide guidance to the project team, to coordinate with UNDP, to review reports and to look after administrative arrangements required under the Government of India and UNDP.

88. A *Project Management unit (PMU)* shall be established to implement the project. Under the overall responsibility of the NPD, the PMU shall be responsible for implementing day-to-day activities headed by the *National Project Coordinator (NPC*). Efforts shall be made to mobilise the project team for the full project tenure to ensure the availability of experts and consultants until the end of project. The project manager (PM) will be supported by administration and finance staff, and Project Managers for Traction (TR), Non-Traction (NT) and Energy Efficiency (EE). As needed, adequate numbers of technical experts in different disciplines and project management consultants with expertise in project, finance, legal matters, etc. will be associated on both longer-term and short-term time basis depending upon the work load. The job description and ToRs for the PMU positions and assignments are enclosed in Annex C. Rites Ltd has entered in agreement with IR to provide support for the preparation of the project during the PPG stage with provisions to extend the support for project management and provision of consultancy services during the FSP stage, but only if ratified by the PSC.

89. The *Project Steering Committee (PSC)* is responsible for making management decisions for a project in particular when guidance is required by the NPC. The PSC plays a critical role in project monitoring and evaluations by quality assuring these processes and products, and using evaluations for performance improvement, accountability and learning. It ensures that required resources are committed and arbitrates on any conflicts within the project or negotiates a solution to any problems with external bodies. Indian Railways will sign the budgeted Annual Work Plan (AWP) with UNDP on an annual basis, as per UNDP rules and regulations. Based on the approved AWP, the PSC will consider and approve the quarterly plans and also approve any essential deviations from the original plans.

90. PSC will be composed of the Indian Railways[39], Ministry of Environment and Forests (MOEF), Bureau of Energy Efficiency (BEE)[40], Ministry of Environment and Forests (GEF OFP office), Department of Economic Affairs (DEA), as well as UNDP[41]. Other members (e.g. manufacturers' and suppliers' associations, research institutes)[42] can be invited by the decision of the PSC on as-needed basis, however, by taking care that the PSC remains operational by its size.

91. Where needed, PMU will work with various (ad-hoc) *Advisory Committees* of experts and stakeholders including representatives from industry, manufacturer / supplier organisations, industrial associations, and the user Railway units etc. to discuss thematic issues and also to seek inputs from other organisations (besides the institutions involved in the project) on how the programme should be implemented on a product-by-product basis.

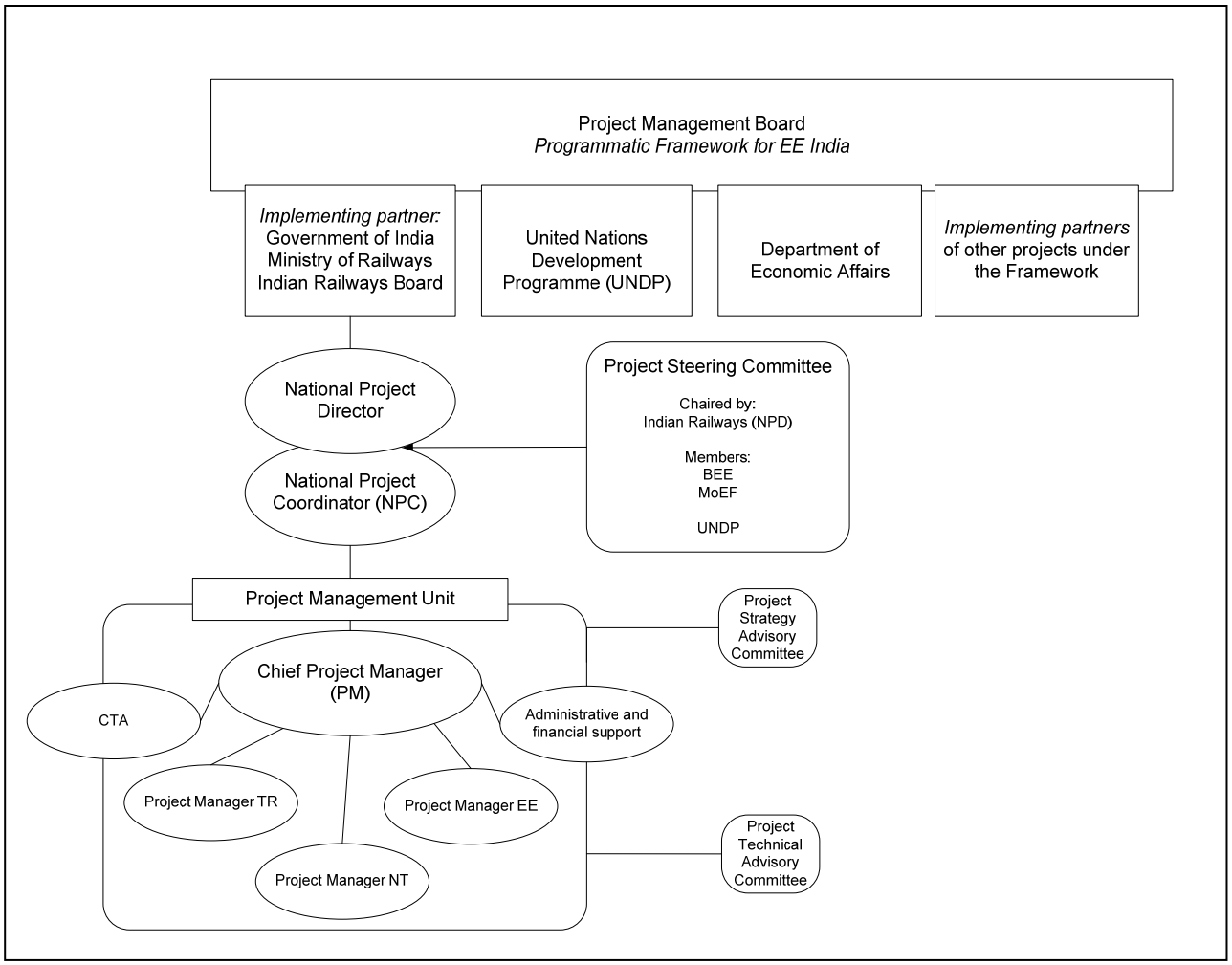

Figure 3: Project management structure

39 Executive: in this case the NPD, representing the project ownership by Indian Railways and chair.

40 Supplier: parties concerned which provide funding for specific cost sharing projects and/or technical expertise to the project.

41 Assurance: supports the PSC and PMU by carrying out objective and independent project oversight and monitoring (in this case done by UNDP India).

42 Beneficiary: individual or group of individuals representing the interests of those who will ultimately benefit from the project

12.2 UNDP support service

92. Railways may enter into an agreement with UNDP for support services in the form of procurement of goods and services during the project implementation process[43]. In such a case, appropriate cost recovery will be charged as per UNDP rules and regulations. The support services will be outlined in the form of Letter of Agreement signed between IR and UNDP. A small budgetary allocation will be allocated for communication, advocacy and accountability purposes undertaken by UNDP. UNDP India may assume the role of project assurance, providing independent project oversight, carrying out monitoring functions and ensuring project implementation. It will support project implementation by disbursing project funds on a regular basis. It will also monitor project implementation through Project Implementation Reports (PIRs) and mid-term and final evaluations.

12.3 Collaborative arrangements with related projects

93. The proposed project is closely related to the framework programme of "Supporting National Development Objectives with Co-Benefits of Mitigation Climate Change" with the following specific outputs:

- Energy efficiency improvements in selected energy-intensive sectors
- Framework developed for inclusive planning and delivery of clean energy services
- Strategic partnerships to leverage environmental financing
- Knowledge sharing and inputs provided for environmental and climate policy regimes

94. The indicative GEF budget is USD 5.2 million for the period 2010-2013 (three-year period) with expected co-financing of USD 21 million. Regarding the energy efficiency output, co-financing is sought from the GEF, and for this purpose and overall "Programmatic Framework Project for Energy Efficiency in India" (GEF project 3538). Five projects on energy efficiency are proposed under this programme: (i) Energy Efficiency Improvements in commercial Buildings (UNDP); (ii) Chillers Energy Efficiency Project (World Bank); (iii) Financing Energy Efficiency in Small and Medium Enterprises (World Bank); (iv) Promoting Energy Efficiency and Renewable Energy in Selected SME Clusters in India (UNIDO); and, (v) Improving Energy Efficiency in the Indian Railways System (UNDP).

95. The proposed project will establish the necessary communication and coordination mechanisms through its PMU and PSC with the Project Management Board of the "before-mentioned framework programmes to ensure proper coordination between the various projects under the GEF "Programmatic Framework for EE" umbrella programme on energy efficiency. UNDP India will also take the lead ensuring adequate coordination and exchange of experiences. In addition, the project will seek to coordinate its actions with other UNDP energy and climate change activities in India. Similarities in the strategy of the proposed project may extend an opportunity to share lessons and exploit synergies, in particular in the areas of harmonization and mutual recognition.

12.4 Prior obligations and prerequisites

96. There are no prior obligations or prerequisites that been identified

12.5 Brief description of inputs to be provided

97. The tentative GEF-supported budget of the Project Management Unit (PMU) is given below:

[43] Whenever labeled products exist, public procurement of energy efficient goods (appliances/equipments) would include star labeled products.

Table 14: GEF-supported budget of the Project Management Unit (PMU)

PM Budget Item	GEF Budget (USD)	Remarks
National Project Coordinator (NPC) with a total of 93 person weeks (pw) @ USD 950/pw	88,350	• Assist NPD in the preparation of the project execution scheme/work plan; • Support the NPD, in the provision of guidance in the organization and implementation of all activities specified in the project document and ensuring timely completion; • Responsible for day-to-day planning, operation and monitoring project activities; • Provision of substantive inputs on project implementation results and issues to the NPD, consultants and stakeholders; • Organization and coordination of project meetings (across Division and Zones), workshops and other expected deliverables from the Project; • Responsibility for the monitoring of overall project implementation, project review and facilitate independent project mid-term and terminal review; • Coordination of financial auditing of the project according to the standards and rules established by UNDP and prepare work plans, reports, budgets, and terms of reference for sub-contractors and consultants; • Liaison with Indian Railways units, equipment and technology providers, national R&D institutions, test laboratories and technology institutes of the project and promote exchanges of information among project participants; • Review of drafts of any working documents to be submitted to meetings or emanating from project activities, and communicate comments to consultants; • Represent the project at forums and meetings.
Project Manager, TR with a total of 37 person weeks (pw) @ USD 950/pw	35,150	• Support the planning and monitoring of "rolling stock" and "Traction distribution" related railway operation activities; • Review and provide comments on outputs pertain to traction; • Assistance in the formulation of TORs and activity descriptions where needed; • Provision of substantive inputs on project activity implementation to the expert consultants and stakeholders.
Project Manager, NT with a total of 37 person weeks (pw) @ USD 950/pw	35,150	• Support the planning and monitoring of non-traction related activities & services; • Review and provide comments on outputs pertain to non-traction; • Assistance in the formulation of TORs and activity descriptions where needed; • Provision of substantive inputs on project activity implementation to the expert consultants and stakeholders.
Project Manager, EE with a total of 63 person weeks (pw) @ USD 950/pw	59,850	• Support for the planning, implementation, monitoring and reporting of energy efficiency related activities such as energy audits, awareness creation, training and capacity building; • Assistance in the formulation of TORs and activity descriptions where needed
Office manager (F&A) with a total of 45 person weeks (pw) @ USD 550/pw	24,750	• Responsible for administrative and secretarial matters; • Perform project-related communication and liaison work: arrangement of logistics, including travel and organization of meetings/workshops; • Make annual budget and review its implementation, making adjustment correspondingly; • Carry out and manage the project contract payments; • Conduct annual financial audit of the project in line with the UNDP, produce the required statements as needed, keep checks and balances in place to ensure proper use of finances under various heads and report the financial progress; • Assist processing and reporting project incomes and expenditures.
Travel (in-country)	21,872	• Travel expenses of the Project Coordinator and the project managers for their project monitoring work in the different project sites under the various Zones and Divisions of IR.
Office facilities, equipment	26,378	• Cost of office space rental for the PMO. • Equipment such as computers and their peripherals, document reproduction equipment as well as office supplies (e.g., stationeries) • Purchase and use of telecommunication equipment and the monthly payment for the communication costs (e.g., phone bills, internet service fees, etc.).
Total	**291,500**	

98. Indian Railway (IR) is the single largest organization with the highest electricity consumption in India. With the aim of realizing the project objective, the project specifically targets traction and non-traction activities of IR. To realize the project objective, the PMU will have an enormous task of properly managing and coordinating the project activities. The PMU shall coordinate with IR's six production units that are engaged in the manufacturing of rolling stock, wheels and axles and other ancillary components to properly direct and manage the project activities. In this regard, the PMU must have specific skill set of project managers and office staff that will oversee the implementation of these specific project activities in 16 Zones of Indian Railways and are further subdivided into 68 Divisions. These Zones and Divisions are spread across India and needs extensive travelling of PMU staff in order to coordinate and manage the project activities. Considering the required additional project management personnel and PMU officers/staff members, and based on the estimated person-weeks for each type of PMU staff, the estimated cost for such local consultants and staff is US$ 243,250. IR will provide the other staff members that will be assigned to carry out project management tasks in the various Zones and Divisions of Indian Railways. The cost for such personnel amounts to US$ 861,650.

99. As part of the PM work, office facilities such as computers and their peripherals, document reproduction equipment as well as office supplies (e.g., stationeries) are required. The proposed budget for office facilities and equipment also includes the purchase and use of telecommunication equipment and the monthly payment for the communication costs (e.g., phone bills, internet service fees, etc.). The cost of office space rental for the PMO is also part of this PM budget line item. The co-financing for this budget line item, which is about the same as the GEF contribution, includes the in-kind contribution for office space and office equipment, as well as testing facilities, for project activities that will be hosted by the various Zones and Divisions of Indian Railways.

100. The travel budget to be paid for by GEF funds, which is about 11% of the total travel budget for project management, is for the travel expenses of the Project Coordinator and the project managers for their project monitoring work in the different project sites under the various Zones and Divisions of Indian Railways. The counterpart financing for the travel budget, includes the travel costs of various IR staff members who will be involved in the project implementation, including in-kind contribution for the utilization of Indian Railways transport services during monitoring missions.

101. The management of the proposed project will entail the deployment of personnel and office facilities, equipment and supplies described above, as well as travel for the project management staff. With the abovementioned project management requirements, a total of about US$ 291,500 is needed and is being requested from the GEF. This is 6% of the total GEF contribution to the proposed project. The total co-financing for the PM activities amounts to US$ 1,178,500, which is about 80% of the estimated total PM cost of US$ 1.47 million.

12.6 Audit arrangements

102. The Government will provide the Resident Representative with certified periodic financial statements, and with an annual audit of the financial statements relating to the status of UNDP (including GEF) funds according to the established procedures set out in the programming and finance manuals. The audit will be conducted by the legally recognized auditor of the Government, or by a commercial auditor engaged by the Government.

12.7 Agreement on the intellectual property rights and use of logo on the project's deliverables

103. In order to accord proper acknowledgement to GEF for providing funding, a GEF logo should appear on all relevant GEF-supported project publications, including among others, project hardware, if any, purchased with GEF funds. Any citation on publications regarding projects funded by GEF should also accord proper acknowledgement to GEF. Alongside GEF and UNDP logo, Government of India or the Ministry of Railways logo may also feature as the Implementing Partner of the proposed project.

13. MONITORING FRAMEWORK AND EVALUATION

13.1 Project start

104. A *Project Inception Workshop* will be held within the first two months of project start with those with assigned roles in the project organization structure, UNDP country office (CO) and where appropriate/feasible regional technical policy and programme advisors as well as other stakeholders. The Inception Workshop is crucial to building ownership for the project results and to plan the first year annual work plan. The Inception Workshop should address a number of key issues including:

- Understand objectives & other outputs and activities
- Assist all partners to fully understand and take ownership of the project. Detail the roles, support services and complementary responsibilities of UNDP CO and Asia Pacific Regional Centre (APRC) staff vis-à-vis the project team. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.
- Based on the project results framework and the relevant GEF tracking tools, if appropriate, finalize the first Annual Work Plan (AWP). Review and agree on the indicators, targets and their means of verification, and recheck assumptions and risks.
- Provide a detailed overview of reporting, monitoring and evaluation (M&E) requirements. The Monitoring and Evaluation work plan and budget should be agreed and scheduled.
- Discuss financial reporting procedures and obligations, and arrangements for annual audit.
- Plan and schedule meetings of the Project Steering Committee (PSC). Roles and responsibilities of all project organization structures should be clarified and meetings planned. The first Project Board meeting should be held within the first 12 months following the inception workshop.

105. An *Inception Workshop report* is a key reference document and must be prepared and shared with participants to formalize various agreements and plans decided during the meeting.

13.2 Quarterly review

106. Will consist of:

- Progress made shall be monitored in the UNDP Enhanced Results Based Management Platform.
- Based on the initial risk analysis submitted, the risk log shall be regularly updated in ATLAS. Risks become critical when the impact and probability are high. Based on the information recorded in Atlas, a Project Progress Reports (PPR) can be generated in the Executive Snapshot.
- Other ATLAS logs can be used to monitor issues, lessons learned, etc. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard.

13.3 Annual review

107. *Annual Project Review/Project Implementation Reports* (APR/PIR): These key reports are prepared to monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements. The APR/PIR includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of-project targets (cumulative);
- Project outputs delivered per project outcome (annual);
- Lesson learned/good practice;
- AWP and other expenditure reports;
- Risk and adaptive management;
- ATLAS quarterly progress reports (QPR);
- Portfolio level indicators (i.e. GEF focal area tracking tools) are used by most focal areas on an annual basis as well.

108. UNDP CO and the UNDP APRC will conduct visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the PSC may also join these visits. A Field Visit Report will be prepared by the CO and UNDP APRC and will be circulated no less than one month after the visit to the project team and Project Board members.

Table 15: Elements and cost of monitoring and evaluation (M&E)

Type of M&E activity	Responsible Parties	Budget USD Excluding project team staff time	Time frame
Inception Workshop and Report	▪ Implementing Partner (National Project Director and National Project Coordinator) ▪ UNDP CO	Indicative cost: $10,000	Within first two months of project start up
Measurement of Means of Verification of project results (baseline and end-of-project impact studies)	▪ UNDP GEF RTA/ NPC will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members.	Indicative cost: $120,000	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on *output and implementation*	▪ Oversight by National Project Coordinator ▪ Project team	Indicative cost: $8,000 (To be determined more precisely) as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
APR/PIR	▪ NPD, NPC and Project team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	Already included in the PMU cost	Annually
Periodic status/ progress reports	▪ NPD, NPC and Project team	Already included in the PMU cost	Quarterly
Mid-term Evaluation	▪ NPD, NPC ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: $25,000	At the mid-point of project implementation.
Final Evaluation	▪ NPD, NPC	Indicative cost :	At least three months

Type of M&E activity	Responsible Parties	Budget USD Excluding project team staff time	Time frame
	▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	$25,000	before the end of project implementation
Project Terminal Report	▪ NPD, NPC ▪ UNDP CO ▪ Consultant	None	At least three months before the end of the project
Audit	▪ UNDP CO ▪ NPD, NPC and Project team	Indicative cost per year: $4,000	Yearly
Visits to field sites	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	from IA fees and operational budget	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US$ 200,000 (3.8% of total GEF budget)	

13.4 Mid-term of project cycle:

109. The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation. The Mid-Term Evaluation will determine progress being made toward the achievement of outcomes and will identify course correction, if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO based on guidance from the APRC and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Centre (ERC).

13.5 End of project:

110. An independent Final Evaluation will take place three months prior to the final Project Board meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the APRC and UNDP-GEF.

111. The Terminal Evaluation should also provide recommendations for follow-up activities and requires a management response which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Centre (ERC).

112. During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

13.6 Learning and knowledge sharing

113. Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks, forums and Information web portals including the TIRFAD.

114. The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects.

115. Finally, there will be a two-way flow of information between this project and other projects of a similar focus.

14. LEGAL CONTEXT AND OTHER AGREEMENTS

116. This document together with the CPAP signed by the Government and UNDP, which is incorporated by reference, constitute together the instrument envisaged in the Supplemental Provisions to the Project Document. Consistent with the above Supplemental Provisions, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner.

117. The implementing partner shall:

- Put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;
- Assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

118. UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

119. The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document. The list can be accessed via:

http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm.

Part C. **ANNEXES**

ANNEX A: RISK ANALYSIS

ANNEX B: AGREEMENTS

ANNEX C: TERMS OF REFERENCE

ANNEX D: EMISSION REDUCTION CALCULATION

ANNEX E: ORGANISATIONAL SETUP OF RAILWAYS AND WEBSITES

ANNEX F: TRAINING AND CAPACITY BUILDING ACTIVITIES

ANNEX G: PROJECT ANNUAL TARGETS

ANNEX A. RISK ANALYSIS

Table 16: Summary of Risk Log and counter measures

Project Title: Improving Energy Efficiency in the Indian Railways System	**Award ID:00057084**	**Date: April 2010**

#	Description	Date identified	Type	Impact & Probability - on a scale of 1 (low) to 5 (high)	Countermeasures / Management response	Owner	Submitted, updated by
1	Failure to secure continuous support from planners in Indian Railways zonal, production and other units to the EE programme	30 April 2010	Operational	Probability = 1 Impact = 5	• Zonal Railway and production units are governed by Indian Railways under the Ministry of Railways. The PMU is housed in IR and the PSC is headed by senior official in IR. Hence any non lack in commitment will be addressed through PSC and other channels. • Commitment of stake holders IR, zonal / production Field units will be established during inception workshop and project implementation.	UNDP	UNDP CO
2	Lack of manufacturers' interest in investing for EE products	30 April 2010	Strategic	Probability = 1 Impact = 5	• Project offers significant number of devices to create an interest in manufacturers. • IR showcase the intent for larger scale replications of devices trailed through the project. • BEE will play a key role in stimulating manufacturers' interest in investing in EE products.	UNDP	UNDP CO
3	Failure to trigger a positive response from technical staff on initiatives supporting EE programme	30 April 2010	Operational	Probability = 3 Impact = 4	• The incentive programmes designed helps create adequate interest. • IR being the Implementing Agency of the project will also make it obligatory to support the project activities	UNDP	UNDP CO
4	Lack of effective coordination between IR units on initiatives supporting the EE programme	30 April 2010	Operational	Probability = 2 Impact = 4	• PSC is chaired by senior official from IR and the PSC meetings are held at regular intervals. This helps in getting adequate support from different divisions.	UNDP	UNDP CO
5	Willingness of IR managers to give priority to EE in investment decisions	30 April 2010	Strategic	Probability = 2 Impact = 5	• A directive will be prepared and approved by the IR Board to support the project activities.	UNDP	UNDP CO

#	Description	Date identified	Type	Impact & Probability - on a scale of 1 (low) to 5 (high)	Countermeasures / Management response	Owner	Submitted, updated by
6	Competition from inefficient & cheap EE devices	30 April 2010	Financial	Probability = 1 Impact = 2	• IR has committed co-financing for hardware interventions. Hence the project implementation is not likely to get affected. • Minimum energy performance standards (MEPS) and energy benchmarking would be made basis for selecting the devices. This would be propagated through IR channels to the divisions.	UNDP	UNDP CO
7	Devices chosen may become obsolete (particularly electronics segment devices)	30 April 2010	Strategic	Probability = 2 Impact =4	• Firstly, Annual Maintenance Contract and other spare part supply guarantees will be carefully considered by the PMU with manufacturer so that the devices installed can run for a reasonable time. • Secondly, PSC will take stock of the situation and recommend mid course correction (in choosing an alternate device to what has been proposed in the project) without changing the overall framework of project.	UNDP	UNDP CO
8	Delays in implementing the measures	30 April 2010	Operational	Probability = 4 Impact = 3	• IR has well structured top down system to carry out its operations. PMU is hosted in IR and the PSC is chaired by a senior official from IR. These systems are expected to ensure timely implementation of measures.	UNDP	UNDP CO
9	Failure to get Centre of Excellence (COE) institutionalised with proper mandate	30 April 2010	Strategic	Probability = 4 Impact = 4	• The institutionalisation of COE will start from year 2 itself to learn its adaptability in IR system. In Year 3, the same will be reviewed by PSC and steps to institutionalise it are strengthened.	UNDP	UNDP CO
10	Lack of effective coordination between IR units and training institutes	30 April 2010	Operational	Probability = 2 Impact =4	• Different training institutes and IR units are governed through IR, Ministry of Railways. The project PMU is hosted at IR which has organic linkages. Regular PSC will help coordinating the IR units and training to effectively carry out the project activities.	UNDP	UNDP CO
11	Test laboratories do not find EE testing and certification sufficiently attractive	30 April 2010	Operational	Probability = 1 Impact = 4	• Analyses made on most (except few) of the technologies/devices/measures indicate fast payback. Hence PMU will impress upon IR to get these testing and certification first as voluntary and	UNDP	UNDP CO

#	Description	Date identified	Type	Impact & Probability - on a scale of 1 (low) to 5 (high)	Countermeasures / Management response	Owner	Submitted, updated by
					then as mandatory based on project results.		

ANNEX B. AGREEMENTS

GEF PIF and GEF OFP Endorsement Letter

Will be attached in a separate electronic file

Co-financing letter (Indian Railways)

सत्यमेव जयते

भारत सरकार
रेल मंत्रालय, (रेलवे बोर्ड)
नई दिल्ली-११० ००१
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)
NEW DELHI-110001

No. 2007/Elect(G)/182/2

Date: 28.01.2010

Ms. Preeti Soni
Head Energy & Environment
UNDP, India,
55, Lodhi Estate, New Delhi-110003
Ph.91-11-46532333 extn:216

Sub: Letter of co-financing
Ref: GEF SEC project ID 3554/ GEF AGENCY Project ID: 4044
Project "Improving Energy Efficiency in the Indian Railways

Dear Madam,

In reference to above subject matter, I would like to inform you that Indian Railways, Ministry of Railways, Government of India is committed to provide all the co-financing support in cash and kind as specified in the Project Document and planned to allocate the required fund of US$ 21000,000 for implementation of above project on "**improving Energy efficiency in the Indian Railway System**" over the period of FY 2010-13 for identified activities. Indian Railways is willing to cooperate with UNDP and other partners for implementation of the project.

The Support of Ministry of Railways, as implementing partner is described in the project document and the associated Budget ATLAS. We assume that all the direct cost associated with producing the output described in the Project Document qualify as project's co financing.

We look forward to cooperating with you in this important understanding and initiatives.

Sincerely Yours

(R.K.Jain)
Director Electrical Engg.(Power Supply)
Railways Board
&
National Project Director,

ANNEX C. TERMS OF REFERENCE

Draft Terms of Reference (TORs) for the key project personnel

A. National Project Director (NPD)

The National Project Director (NPD) will be appointed by Indian Railways in consultation with UNDP for overall supervision of the project. NPD will act as Member Secretary to the Project Steering Committee (PSC) and shall be responsible for overall implementation of the project.

Scope of work:

1. To organize/convene Project Steering Committee meetings as per UNDP procedures
2. To facilitate interaction and communication with other Ministries and Governmental departments
3. To establish the Energy Efficiency Centre of Excellence (COE) within Indian Railways
4. To provide guidance to the National Project Coordinator and the Project Management Unit (PMU)
5. Approve Terms of Reference for PMU staff
6. Review monitoring, evaluation and audit reports to Executing Agency (EA) and UNDP/GEF and facilitate their timely submission.
7. General administration of Centre of Excellence.

B. National Project Coordinator (NPC)

Scope of work:

1. Assist NPD in management and implementation of the project and achievement of the objective of GHG reduction
2. To prepare reports and recommendation to the Project Steering Committee
3. Coordination with zonal and other units within Indian Railways as well as other government agencies
4. Establishment of Centre of Excellence
5. Day-to-day planning, implementation and monitoring of project activities
6. Carry out managerial and organization tasks for the timely achievement of project outcomes and outputs
7. Liaison with Indian Railways units, equipment and technology providers, national R&D institutions, test laboratories and technology institutes
8. Preparation of Annual Work Plan (AWP) and project budget revisions
9. Delegate responsibilities to the Project Managers TR, NT, EE and Office Manager (A&F)
10. Formulate quarterly and annual progress reports to IR and GEF-UNDP and their timely submission
11. Coordination with international and national consultants Prepare and approve Terms of Reference for consultants and subcontracts and for equipment procurement
12. Disbursement of funds, maintenance of accounts as per requirements of UNDP and internal audits
13. Review consultants' reports, project budget revisions, annual progress reports, annual work plan, and other administrative arrangements as required by IR and UNDP.

C. Project Manager, Traction (TR)

Scope of Work:

1. Overall responsibility of implementing interventions identified for traction

2. Participate in preparation of AWP and prepare quarterly plan
3. Provide inputs to prepare quarterly and annual reports
4. Plan, implement, monitor and report project activities related to 'rolling stock' and 'Traction distribution' identified in the project
5. Benchmark performance parameters, monitor energy savings and report on quarterly basis
6. Carryout cost-benefit analysis, economic, and environmental (benefits due to carbon dioxide reduction) as outlined in indicators
7. Report to NPC and extend support to other managers as and when required.

D. Project Manager, Non-Traction Services (NT)

Scope of work:

1. Overall responsibility of implementing interventions in non traction
2. Participate in preparation of AWP and quarterly work plans
3. Provide inputs to prepare quarterly and annual reports
4. Plan, implement, monitor and report project activities related to non traction related interventions
    a. Benchmark performance parameters, monitor energy savings and report it quarterly basis
    b. Carryout cost benefit analysis, economic and environmental (benefits due to carbon dioxide reduction) as outlined in indicators
5. Report to NPC and extend support to other managers as and when required in consultation with NPC.

E. Project Manager, Energy Efficiency and Training

Scope of work:

1. Overall responsibility of implementing energy efficiency related activities such as energy audits, awareness creation, training and capacity building
2. Participate in preparation of AWP and quarterly work plans
3. Provide inputs to prepare quarterly and annual progress reports
4. Plan, implement, monitor and report project activities as outlined in point 1.
5. Synergise the implementation of EE in Indian Railways in BAU with the project activities
6. Liaise the awareness, training and capacity building activities for different target groups of IR
7. Identify the technologies to be learnt from abroad and implemented in IR
8. Benchmark the energy performance
9. Report overall benefits of energy savings and CO_2 emission.

F. Office Manager, Administration & Finance

Scope of work:

1. Maintenance of accounts, inventory, assets register, and other requirements of GEF-UNDP and IR
2. Timely preparation and submission of quarterly FACE (Funding Authorisation and Certificate of Expenditure) to account for expenditure GEF-UNDP and as required by IR,
3. Facilitate annual financial audit of the project, prepare management responses to audit observations and carry out follow up action for GEF-UNDP and IR
4. Exercise financial due diligence in expenditure
5. Arrange logistics for travel (national and international), meetings, workshops

A detailed list of International and National Consultants for Technical Assistance activities is annexed to the GEF CEO Endorsement Request sheet.

ANNEX D. EMISSION REDUCTION CALCULATION

120. This Annex presents the assessment of the CO_2 emissions that are avoided as a consequence of the project's interventions. The assessment has been done in accordance with the GEF Manual for calculating CO_2 emission reduction[44]. It describes the calculation of **direct** and **indirect** emission reduction.

D.1 Direct emission reduction

121. As indicated in the Boxes 4 and 5 (in Section 6.2), IR will make investments during the project's supervised implementation period (3 years) as part of the Outcomes 2 and 3.

122. Several energy efficiency technologies and measures that could potentially be introduced through the Energy Efficiency and Conservation Program, or whose adoption can be widened, have been identified during project preparation. These technologies and measures have been divided into four (traction and non-traction wise) categories:

(1) Technologies and measures that have already been tested in India (in the railways sector or in other sectors) but need a more widespread dissemination (traction and non-traction);

(2) Technologies and measures that have proven to be successful abroad, but have not yet been tested in India (traction and non-traction).

123. In order to select the energy efficiency technologies and measures to be implemented or tested through the project, each identified technology has been assessed against the following criteria (see Table 7 in Section 4.3)

- Rate of return
- Easiness to implement
- Number of departments involved for the implementation
- Complementarity to existing knowledge within IR
- Provenness in India or abroad/recommended by international bodies
- Potential for absorption/replicability

The direct emission reduction is calculated based on the following formula and assumptions:

CO_2 direct = E * L * C; where

- C – CO_2 emission factor: grid emission factors of 0.82 tCO_2/MWh for grid
- L – average useful lifetime of equipment: considering the fact that a range of technologies will be demonstrated, which may have varying lifetimes, an average of 10 years has been assumed for the calculation; and
- E – annual energy saved, 142 million kWh in electrical energy is estimated to be saved annually through the implementation of measures (Outcome 2) and project demonstrations (Outcome 3), as detailed in the Tables 17 and 18 (and summarized in the Boxes 4 and 5)

Thus, applying the above formula separately to electricity and thermal energy savings, **cumulative direct CO_2 emission reductions** over 10-year investment lifetime are estimate at:

[44] Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects, GEF/C.33/Inf.18

142 million kWh * 0.82 kgCO_2/kWh * 10 years = **1.17 million tCO_2**

Cost effectiveness

If we divide the GEF contribution (USD 5.2 million) by the combined direct and direct post-project emission reductions gives the corresponding unit abatement cost (UAC[45]) (i.e. GEF$ per tCO_2) of USD 4.45/tCO_2.

Table 17: Estimates of energy savings and direct emission reduction

(a) Traction and Rolling Stock

Technology/Device/Measure description	Investment cost USD	Est. annual energy savings (million kWh per year)	Est. annual CO_2 reduction (tonnes/ year)
Already proven in India			
Installation and operation of Automatic Switched Capacitor Bank to reduce electrical losses in Traction Sub Stations (ASCB for TSS) Provision for Automatic switched Capacitors help correcting the power factor[1] of electrical loads at Traction Sub Stations (TSS). All TSS at present have fixed capacitor banks to compensate Power Factor (PF) to save electricity losses in line. Due to fluctuating nature of traction demand, they are unable to optimally compensate the losses. Modern Automatic switched Capacitor Banks can compensate PF to 0.98 compared to PF of 0.85 achieved at TSS with older capacitor banks. (PF of 1 has minimum losses.) (The power factor of an AC (alternating current) has relation to drawing of current and thereby electrical losses. Electrical load with low power factor draws more current than a load with high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require higher size conductors, cables and other equipment. An Automatic switched capacitor corrects the Power Factor optimally based on the sensed power transfer and adjusts the power factor on real time to the required quantum, thereby reducing the electrical losses.) It is assumed that the line losses presently at 5% of traction energy will reduce by 25% (of the line losses) on introduction of Intelligent Capacitor Banks and the device is expected to have a life of 20 years. There are 400 TSS in Indian Railways. These TSS supply traction power estimated to total about 12 BU of electricity annually. Intelligent Capacitor Bank will be implemented in one TSS initially. The measure is estimated to cost USD 425,532 and the payback on investment is rather low i.e. 10.7 years (@ electricity cost 0.106 USD/kWh). State electricity agencies also provide incentives to end user having higher power factor. This co-benefit also helps reducing the payback period further.	425,532	0.38	308
Installation and use of LED (Light Emitting Diode) lights in coaches Light emitting diodes, commonly called LEDs, basically, are just tiny light bulbs	1,276,596	1.21	992

[45] Only direct emission reductions are considered for 10 years of economic lifetime as per GEF guidelines. There are no direct post-project emissions pertain to the project. Therefore, GEF finance of USD 5,200,000/1,167,581 tCO_2.

that fit easily into an electrical circuit. They are illuminated solely by the movement of electrons in a semiconductor material, and they last just as long as a standard transistor. Their efficiency of conversion of electricity to light is about 4 times more that of incandescent lamps (lumens per watt). At present train coaches have 20 Watt lamps each of which consume 28 Watts including 8 Watts for choke. It is envisaged that LED replacement lights will require only 12 Watts that gives better light and save approximately 60% of electricity. While this is a direct saving, there are indirect savings in lesser electricity generation by axle powered coach low efficiency generating units and reducing the frictional burden of coaches[46]. The present lamps last for about 5,000 hours while the LED light is expected to last for 50,000 hours. Indian Railways has about 36,100 coaches (5,800 AC coaches and 30,300 Non AC normal coaches). It is envisaged to replace the lamps in 200 AC coaches with LED lights. One coach requires 70 lights nos. The present cost of lights in a coach is about USD 1,489 while the replacement of LED lights would cost about USD 6,383. However, the electricity consumption reduces by about 6048 kWh per coach annually. The payback on investment is 2.5 years (@ electricity cost 0.426 USD per kWh – on locomotive it costs higher).			
Proven abroad			
Energy audit of rolling stock and implementation of recommendations Energy audit of locomotive and AC coaches to measure the energy used by each system and subsystem. It will analyse the present duty cycles and consumption levels and provide the means to assess the scope for improvements in the system to reduce the energy consumption. There are about 3600 electric locomotives and about 5,800 AC Coaches in IR. Energy audit will be carried out in two locomotives and 8 AC coaches of different classes namely, First class AC, AC Two tier, AC Three tier, Chair Car. In addition there are 30,300 non AC coaches which consume much less electricity and will be tackled separately. A locomotive is estimated to consume about 4.23 MU of electricity annually. And uses about 10% in Auxiliaries Most energy audits give at least scope for 10% savings. Assuming this reduction if recommendations are incorporated, the new electricity consumption would be reduced by 1% of annual traction energy consumed by the locomotive, about 42,300 kWh per locomotive. The cost of audit is USD 85106 per locomotive and the payback is expected to be 0.5 year (@ 0.426 USD/kWh) if the recommendations are implemented. It is proposed to carry out energy audits in two locomotives. Low cost and high return measures recommended will be implemented. In AC coaches a saving potential of 10% is also (21,600kWh) is also expected per coach. The cost of audit is USD 5,319; the payback is expected to be 0.6 years (@ 0.426 USD/kWh).	212,766	1.02	835
Installation and operation of GPS based Driver Advice System (GPSDAS) and Energy Management System GPS based 'Driver Advice System' guides the driver on route conditions, traffic ahead on the line, speed optimisation, coasting[47] guidance ensuring safe and energy-efficient driving. The system would include integration with onboard	244,681	2.11	1,733

[46] Self generation, frictional burden, low capacity wiring network:

[47] Coasting: It is defined as a free-running operational timing mode in which continuous or periodic movement is not made

energy management system, digital energy meters to monitor energy used, regenerated energy and specific energy consumption (SEC) achieved for the trip against the best norm possible. GPSDAS will assist the driver through a console showing, location of the train and the route, will furnish on line information and advise the driver of optimum speed to be maintained and monitor his performance. This will be interfaced for EE management at the Central Control office, which will have real time train running information. The GPSDAS system will be a complement to the existing to the Railways Traction Supervisory control & Data acquisition system (SCADA) providing a tool for an intelligent Energy Management system (EMS) with Demand Controllers to monitor real time trends of traction energy These systems would minimize energy demand from the Power Utility network and also help verify energy consumption profile of driver, type of train (passenger or goods), traction substation loads and ascertain losses under various components. It is expected that the life of the system would be 15 years. On board GPSDAS system along with EMS support will cost about USD 48,936 (INR 2,300,000). Centralised Control centre support systems include work stations, communication support etc. A locomotive approximately consumes 4.23 MU per year without GPSDAS. With the introduction of GPSDAS it is expected to derive 10% reduction (0.42 MU per year) in energy consumption.			
Installation and operation of Microprocessor controlled air-conditioning systems for AC couches Microprocessor Controlled Air-conditioning system (MCAS) involves adding sensors in different parts of the coach to optimally provide the air-conditioning and ventilation through intelligent control of output to the actual need depending upon number of persons and the weather conditions. At present only a thermostat at one location governs the temperature control. It is expected that this measure can save 20% of electricity over conventional controllers. Electricity consumption in an AC coach consumes 0.065 MU per annum that would get reduced to 0.052 MU per annum with MCAC. This measure is estimated to cost USD 3,191 (INR 150,000) per coach. It is expected that the life of MCAS would be about 15 years. IR has about 5,800 AC coaches. It is planned to pilot this measure in 80 coaches.	255,319	1.04	850
Installation and operation of Roof mounted SPV for electricity generation for passenger trains Generally coaches are illuminated by electricity of self-generating coaches which have axle hung generators. These are very inefficient and the cost of electricity is about USD 0.426 per kWh (INR 20). Part of electricity can be provided by solar cells located on the roof of the coaches. It is proposed to install 2 kW modules in 15 coaches. Each coach would be able to generate about 3,000 kWh electricity annually. This is assuming generation of electricity will occur in 5 day light hours and the system runs for 300 days per year. The life of the SPV system is about 25 years. The estimated cost for SPV system per coach is USD 14,894 (INR 700,000).	223,404	0.05	37

(b) Non-Traction

Technology/Device/Measure description	Investment cost USD	Estimated annual energy savings (million	Est. annual CO_2 reduction (tonnes/

		kWh per year)	year)
Proven in India, but not widespread applied			
Installation and use of T5 Fluorescent tubes in place of T12 tubes for lighting for stations, workshops and railway offices T5 lights provide better light, than the T12. T5 provide 104 lumen/ Watt whereas T 12 provides 60. T12 consumes about 55 Watts, (40-Watt per tube and 15 Watt for choke). This is proposed to be replaced by T5 tubes. T5 tube light has electronic ballast, power factor corrected, instant soft start, tri-phosphor coatings having better performance and consumes 32 Watts (28 W tube per tube light and 4 Watt for choke). Approximately, 42% reduction in electricity consumption is expected with this replacement. T5's life is approximately 20,000 hours as compared with the T-12's 5,000 hours. IR has about 500,000 houses and 500,000 service buildings. It is proposed to replace 500,000 T12 with T5. The cost increase per light unit is from 12.8 USD for T12 to 17 USD for T5. However, the annual electricity consumption reduces from 66 MU for 500,000 T12 to 38.4 MU for T5. The payback on investment is 2.9 years (electricity cost @ 0.106 USD per kWh).	8,510,636	27.6	22,632
CFLs replacing incandescent bulbs for service buildings and railway quarters Recently introduced Compact Fluorescent Lamp (CFL) can fit into existing incandescent light fixtures. They consume much less power for the same light output. It is proposed to replace 60 Watt incandescent bulbs with 9 Watt CFL. The estimated electricity savings due to this replacement is 80%. An incandescent bulb has an average life of just 1000 hours whereas a CFL can last for 8,000 hours. CFL lamps, however, cost more. The cost of CFL is 2.13 USD while an incandescent bulb is 0.21 USD per piece. IR has about 650,000 houses for employees which are mostly fitted with incandescent bulb for lighting. It is estimated that each household has about 6 bulbs totalling to about 3.9 million bulbs which will be replaced. Initially It is envisaged that 650,000 incandescent bulbs used in these houses will first be replaced by CFLs. Electricity consumption per lamp reduces from 144 kWh in incandescent bulb to 21.6 kWh per annum in CFL. The payback on investment is just 0.2 years (electricity cost @ 0.106 per kWh).	1,382,979	79.56	65,239
Installation and operation of VVVF (Variable Voltage Variable Frequency) drives for machines VVVF drives for electric motors are more versatile and draw minimum energy from source for the duty-cycle and have minimum losses in starting. These drives will be installed on machines with frequent starts and stop, and variable load duties, like lifts, compressors, lathes, pumps etc. It is proposed to install VVVF drives on 1,000 machines in IR. It is expected to save about 30% in energy demand due to this. .For an average motor Electricity consumption without VVVF drive is about 10,800 kWh per drive per annum while machine with VVVF drive would consume be 7,560 kWh per annum (a reduction of 30% electricity). The cost of a VVVF drive is about 1,064 USD per device. It is expected that the life of such drive is about 20 years. The payback on	1,063,830	3.24	2,657

investment is 3.1 years (electricity cost @ 0.106 USD per kWh)			
Proven in abroad			
Energy audit of stations, workshops and railway offices IR has about 8,200 building facilities namely; 8,000 stations, 100 workshops and 100 railway offices. Average connected load of these facilities is 500 MW. It is proposed to carry out Energy Audits of 50 stations, workshops and railway offices (40 stations, 5 workshops and 5 railway offices). It is expected that the recommendations can lead to energy saving of at least 20%. Energy Audit helps in putting a plan for implementation of measures that can reduce the energy consumption in these facilities. Building Management System may be one of the follow up action of Energy audit in these facilities. It is estimated that Energy audit of each facility will cost about USD 10,638 (INR 0.5 million).	531,915	12.0	9,840
Installation and operation of Building Management Systems (BMS) for stations, workshops and railway offices ECBC (Energy Conservation Building Codes) to bring Energy Efficiency in buildings is currently voluntary. It is likely to become mandatory in a few years, especially for buildings with connected load of 500 kW. As already explained in the previous section, railways have about 8,200 facilities that have an average load of 500 kW. The BMS helps establish benchmarks. It helps energy monitoring, control and efficient management. The system helps identifying predictive maintenance through monitoring power consumption profile of machinery & equipment. It is estimated that each facility consumes about 1.2 MU of electricity annually. This is estimated to get reduced to 0.96 MU annually (saving of 20%). The expected life of the system is about 15 years. It is envisaged that 50 facilities will be brought under BMS. It is expected to cost about USD 21,277 per facility (INR 1.0 million).	1,063,830	12.0	9,840
Installation and operation of Energy Management System (EMS) for pumping installations Pumping installations: Provision of Discharge meters at pumping installations can control waste. The discharge meters at pump delivery sides monitor the pumping performance, water discharge and collection to regulate the use of water through SCADA based monitoring & control system. Following parameters will be looked into to bring EMS at pumping installations; (i) Redesign the system with most efficient piping and pump and motor size providing optimum pumping with minimum energy consumption, whenever due for replacement, (ii) controlling the flow rate by speed variation, (iii) eliminating flow control valve; (iv) eliminating by-pass control; and (v) start/stop control of pump. IR has about 6800 installations across 68 divisions, approximately 100 installations per division. The project aims to put up EMS in about 100 pumping installations. On an average the pump rating per installation is 25 kW. The present electricity consumption is about 0.073 MU per installation. The EMS is expected to save 30% (0.0219 MU/year) of the electricity consumption. Thus the electricity consumption is expected to be 0.0511 MU/year. The cost of EMS per installation is about USD 6,383 (INR 0.3 million).	638,298	2.19	1,796
Energy Testing and Resource Centres RDSO (Lucknow, UP) will develop facilities to test energy efficiency parameters of Energy Efficiency measures. Energy Resource Centre at Indian Institution of	2,127,660		

Electrical Engineers at Nasik (Maharashtra) will be developed to demonstrate and teach the means of Energy Efficiency measures.			

Table 18: Direct emission reduction: annual electricity consumption, saving and cost benefits (payback) and annual emission reduction of different technologies and measures proposed in Outcomes 2 and 3

#	Technology/Device/ Measure	Proposed number of devices under the project (#)	Present cost of device/ measure (USD per unit)	Present total cost of device/ measure (USD)	Cost of EE device/ measure per unit (USD)	Total cost of devices/ measures (USD)	Present electricity consumed (million kWh/year)	Estimated annual electricity saved due to the measure/device (million kWh/year)	Estimated annual electricity consumed with the new device/ measure (million kWh/year)	Saving %	Cost of electricity (USD/kWh)	Annual amount saved (USD/year)	Payback period (years)	Annual CO_2 emission reduction (tonnes)
A	**Technologies/measures for implementation (Outcome 2)**													
	Traction													
1	Installation and operation of Intelligent Capacitor Bank for TSS	1			425,532	425,532	30	0.38	29.63	1.3%	0.106	39,894	10.7	308
2	Installation and use of LED in coaches	200	1,489	297,872	6,383	1,276,596	2.12	1.21	0.907	57.1%	0.426	514,723	2.5	992
	Non Traction													
3	Installation and use of T5 tubes for stations, workshops & railway offices	500,000	12.77	6,382,979	17.02	8,510,638	66	27.60	38.4	41.8%	0.106	2,936,170	2.9	22,632
4	CFL replacing Incandescent bulbs for railway houses, service buildings	650,000	0.21	138,298	2.13	1,382,979	93.6	79.56	14.04	85.0%	0.106	8,463,830	0.2	65,239
5	Installation and operation of VVVF controls for machines	1,000			1,064	1,063,830	10.8	3.24	7.56	30.0%	0.106	344,681	3.1	2,657
	Total					**12,659,574**	**203**	**112**	**91**			**12,299,298**	**1.03**	**91,827**
B	**Pilot technologies/ devices/ measures (Outcome 3)**													
	Traction													
1(a)	Energy audit on Rolling stock (Locomotives)	2			85,106	170,213	8.45	0.85	7.61	10.0%	0.426	359,719	0.5	693
1(b)	Energy audit on Rolling stock (Coaches)	8			5,319	42,553	1.73	0.17	1.56	10.0%	0.426	73,532	0.6	142
2	Installation and operation of GPS based Driver Advice System (GPSDAS) and Energy Management System	5			48,936	244,681	21.13	2.11	19.02	10.0%	0.426	899,298	0.3	1,733
3	Installation and operation of Microprocessor controlled Air-conditioning system for AC coaches	80			3,191	255,319	5.18	1.04	4.15	20.0%	0.426	441,191	0.6	850
4	Installation and operation of Roof mounted SPV for electricity generation in coaches	15			14,894	223,404		0.05			0.426	19,149	11.7	37
	Non Traction													
5	Energy audit of Stations, Workshops and Railway Offices	50			10,638	531,915	60	12.00	48	20.0%	0.106	1,276,596	0.4	9,840
6	Installation and operation of Building Management System (BMS) for Stations, Workshops and Railway Offices	50			21,277	1,063,830	60	12.00	48	20.0%	0.106	1,276,596	0.8	9,840
7	Installation and operation of Energy Management System (EMS) for pumping systems	100			6,383	638,298	7.30	2.19	5.11	30.0%	0.106	232,979	2.7	1,796
8	Energy testing Laboratory	1			2,127,660	2,127,660								
	Total-pilot technology/measures					**5,297,872**	**164**	**30**	**133**			**4579060**	**1.16**	**24931**
	Total A and B					***17,957,447***	***366***	***142***	***224***			***16878357***	***1.06***	***116758***

Assumptions:

USD 1 = INR 47; Grid emission factor = 0.82 $kgCO_2$ per kWh

D.2 Indirect emission reduction

124. After the project's completion, investments will be affected by the long-term outcomes of the barrier-removal activities, e.g. capacity building and institutional strengthening. The corresponding CO_2 emissions reduction is referred to as *indirect emission reduction.* Following the GEF Manual for calculating CO_2 emission reduction[48], these are estimated as described below.

Bottom-up approach

125. The GEF bottom-up approach implies the replication of the project demonstration investments to other Zonal Railways with Indian Railways over the GEF project influence period of 10 years and the CO_2 emission reductions are calculated using the following formula:

Indirect CO_2 emission reductions (billion kWh) = CO_2 direct * RF, where
CO_2 direct = estimate for total direct emission reductions
RF = replication factor

For RF, the value of "3" has been chosen as a conservative estimate for Indian Railways based on the market transformation and demonstration approach of the project. Thus, applying the above formula, indirect emission reductions (bottom-up) are estimated as 1.17 million tCO_2 * 3 = **3.50 million tCO_2.**

Top-down approach

126. The 'top-down' approach provides an 'upper limit' by looking at the potential leverage of the project of the market for the EE technology for Indian Railways as a whole. In this approach the market potential for technology within 10 years during and after the project's lifetime is looked at (2011/12-2020/21). Table 19 provides a baseline scenario and an alternative scenario, based on energy growth figures provided by Indian Railways, taking fiscal year 2009/10 as the base year for electricity consumption estimate.

127. In the *baseline scenario* it is estimated that the total demand of electricity in the railways sector will grow at a rate of more than 9% annually (see also Section 1.3 for a description). The electricity consumption is projected to be about 100.5 billion kWh by 2031-32. The rapid growth is due to ambitious electrification plans, in which 80% of rail freight and 60% of passenger traffic will run on electric energy by 2031-32.

128. Indian Railways (IR) is developing a long-term Energy Efficiency and Conservation Program (EECP) (2010-2032). The Program aims at progressively introducing a number of energy efficiency technologies and measures in the railways system). The objective of this Program is to save 10% of the electricity consumption in absolute terms by 2032, in line with the targets of national initiatives on energy conservation and climate change.

[48] Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects, GEF/C.33/Inf.18

Table 19: Indirect emission reductions analysis

Year	Baseline scenario (BAU)		Penetration	Alternate scenario			Cumulative Energy Saving	Cumulative CO2 Saving
	Impl. EECP of IR without GEF Support			Implement EECP of IR with GEF Support (final 85%penetration of 10% saving in 20 years)				
	Elect consumption (million kWh)	CO2 Production tonnes (1000)		Elect consumption (million kWh)	CO2 Production tonnes (1000)	Elect consumption Saved (million kWh)	Elect consumption (million kWh)	CO2 Prod. Saved tonnes (1000)
2007-08	14,096	11,558						
2008-09	14,731	12,079						
2009-10	15,651	12,834	0	15,651	12,834	-		
2010-11	16,947	13,897	0	16,947	13,897	-	-	-
2011-12	18,360	15,056	3	18,305	15,010	55	55	45
2012-13	19,902	16,319	4	19,822	16,254	80	135	110
2013-14	21,583	17,698	6	21,454	17,592	129	264	217
2014-15	23,419	19,203	8	23,231	19,050	187	452	370
2015-16	25,423	20,847	12	25,118	20,596	305	757	620
2016-17	27,612	22,642	16	27,170	22,279	442	1,198	983
2017-18	30,004	24,603	20	29,404	24,111	600	1,798	1,475
2018-19	32,618	26,747	25	31,803	26,078	815	2,614	2,143
2019-20	35,477	29,091	30	34,413	28,219	1,064	3,678	3,016
2020-21	38,604	31,656	36	37,215	30,516	1,390	5,068	4,156
2021-22	42,026	34,461	42	40,261	33,014	1,765	6,833	5,603
2022-23	45,771	37,532	47	43,620	35,768	2,151	8,984	7,367
2023-24	49,871	40,894	53	47,228	38,727	2,643	11,627	9,535
2024-25	54,362	44,577	59	51,154	41,946	3,207	14,835	12,165
2025-26	59,281	48,610	65	55,428	45,451	3,853	18,688	15,324
2026-27	64,672	53,031	70	60,145	49,318	4,527	23,215	19,036
2027-28	70,580	57,876	75	65,287	53,535	5,294	28,509	23,377
2028-29	77,059	63,188	80	70,894	58,133	6,165	34,673	28,432
2029-30	84,164	69,014	80	77,431	63,493	6,733	41,406	33,953
2030-31	91,958	75,406	80	84,602	69,373	7,357	48,763	39,986
2031-32	100,511	82,419	85	91,967	75,413	8,543	**57,307**	**46,991**
Total 2010-32	1,030,203	844,767		972,897	797,775	57,307		

129. The *alternative scenario* (with full EECP implementation) India is expected to reduce the expected electricity consumption in the railways sector from 100.5 billion kWh in 2031-32 (up from the current[49] 15.7 billion kWh, based on 9% growth per year) to 92.0 billion kWh by 2031-32. Correspondingly, the CO_2 emission reduction figures would be reduced by the year 2031-32 in the EECP scenario to 75.4 million tCO_2 from 82.4 million tCO_2 (up from 12.8 million tCO_2 in 2009-10).

130. In the alternative scenario the cumulative amount of 4.16 million tCO_2 would be reduced over the period 2011/12-2020/21 (that is, over the 10 years of project's lifetime).

131. Of course, this potential cannot be fully attributed to the GEF intervention. Uptake of EE technologies would take place to some extent due to ongoing (and future) national efforts and future donor-funded initiatives. We propose to apply conservatively a "causality factor" 4 of 80%, which implies that the impact of the GEF intervention is dominant (justifiable, as this would be one of first IR-wide projects to be implemented by Indian Railways, including institutionalization of energy efficiency in the Centre of Excellence). Some indirect emission reductions can be attributed to changes in the baseline over time as some EE measures would be implemented anyhow.

132. Thus, an upper limit to indirect emission reduction impacts can be calculated as:

CO_2 indirect TD = CO_{2TM} * CF, where

[49] 2009-10, estimated.

CO_{2TM} = total market potential for CO_2 emission reductions
CF = causality factor

4.16 $MtCO_2$ * 80% = **3.32 million tCO_2**

ANNEX E. ORGANISATIONAL SETUP OF INDIAN RAILWAYS

Table 20: Organisational setup of Indian Railways

ZONAL RAILWAYS	PRODUCTION UNITS	OTHERS	OTHERS
Central Railway	Chittaranjan Loco Works	Central Organization for Railway Electrification	IT Projects under CAO/FOIS
East Central Railway	Diesel-Loco Modernization Works	Dargeeling Himalayan Railways	**ORGANISATION**
East Coast Railway	Diesel Locomotive Works	Delhi Metro Rail Corporation	Metro Railway Kolkata
Eastern Railway	Integral Coach Factory	Dedicated Freight Corridor Corporation of India Limited (DFCC)	National Rail Museum sites
North Central Railway	Rail Coach Factory, Kapurthala	Federation of Railway Officers Associations	Palace on Wheels
North Eastern Railway	Rail Coach Factory, Raebareli	General Rules Review Committee	Railway Claims Tribunal
North Western Railway	Rail Wheel Factory	Indian Railway Accounting	Rail Land Development Authority
Northeast Frontier Railway	**CORPORATION SITES**	Indian Railway Accounts Service Association	Railway Recruitment Boards
Northern Railway	Central Organization For Modernization of Workshops	Indian Railway Central Organization for Telecom	Railway Staff College, Baroda
South Central Railway	Centre for Railway Information System	Indian Railways Institute of Electrical Engineering	Rail Vikas Nigam Ltd.
South East Central Railway	Container Corporation of India Ltd.	Indian Railways Institute of Mechanical and Electrical Engineering	Research Design and Standards Organization
South Eastern Railway	Indian Railway Catering and Tourism Corporation Ltd.	Indian Railways Institute of Signal Engineering and Telecommunications	Secret Ballot Committee
South Western Railway	Indian Railway Finance Corporation	Indian Railways Service of Mechanical Engineers	
Southern Railway	IRCON International Ltd.	Indian Railway Traffic Service Association	
West Central Railway	Konkan Railway Corporation's	Institute of Rail transport	
Western Railway	Pipavav Railway Corporation Limited	Indian Railways Institute of Transport Management	
	Mumbai Railway Vikas Corporation		
	RAILTEL Corporation of India Ltd.		
	RITES Ltd.		

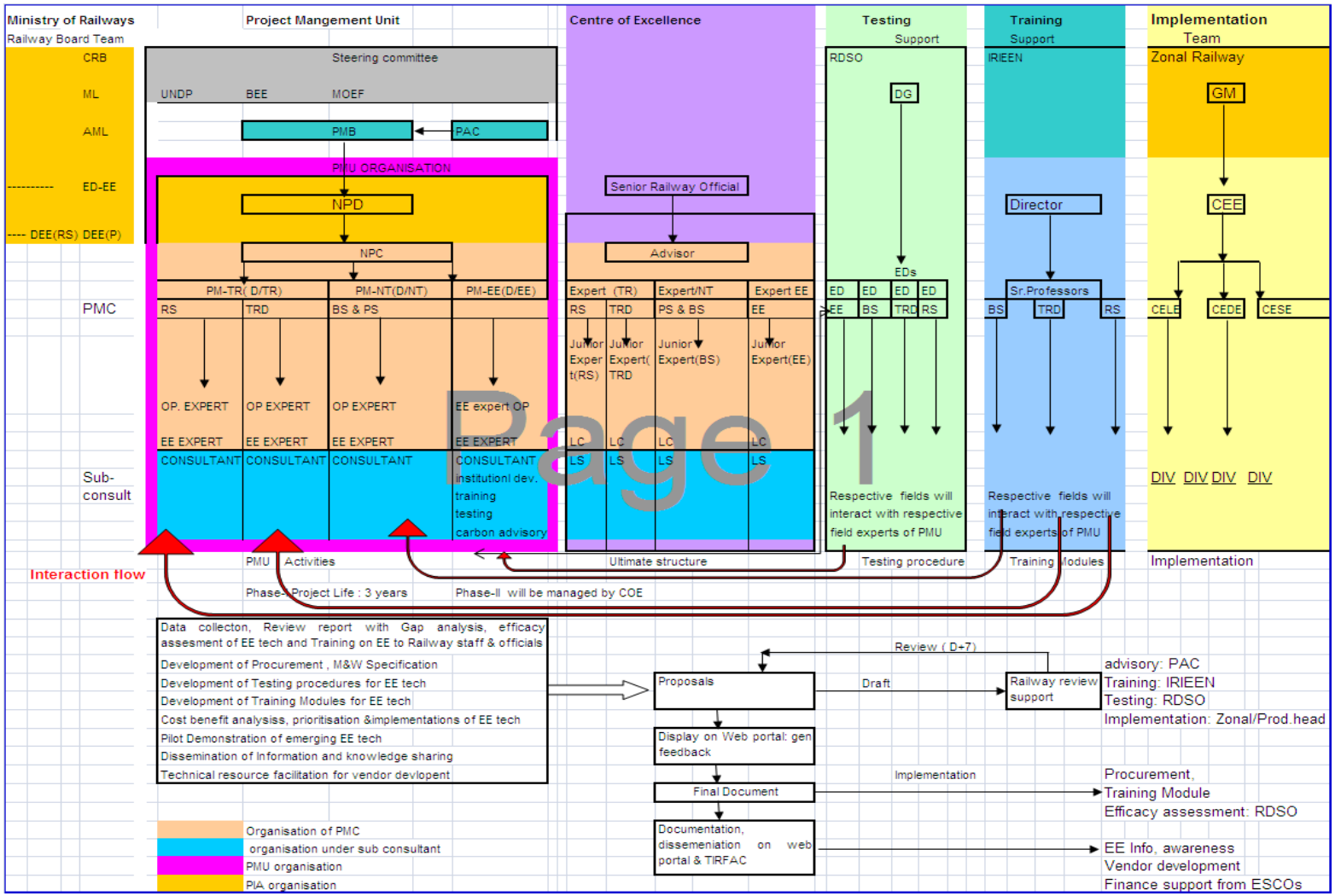

Figure 4: Organisational Structure and Roles & Functions for EE:

Please note that within the pink-coloured frame, only NPC and will be funded with GEF resources

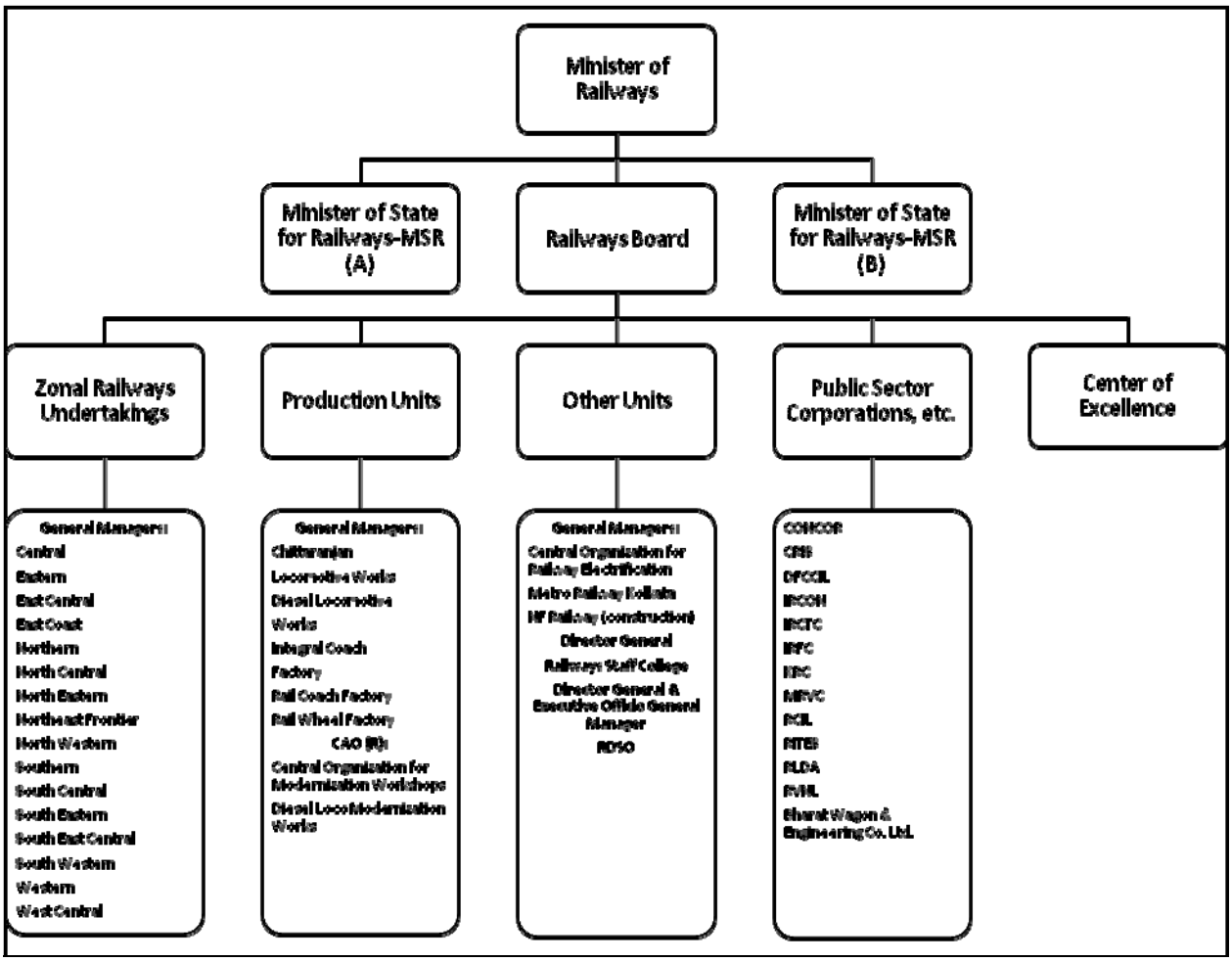

Figure 5: Indian Railways' Organisational Chart (including COE)

The above chart is adapted from Annual Report & Accounts 2007-08. It indicates the position of the proposed CEO within the IR hierarchy

ANNEX F. TRAINING & CAPACITY BUILDING ACTIVITIES

F.1 Proposed participants to capacity building activities

Table 21: Top managers

	PMU/COE	Railways Board	Zonal Railways (32)	Zonal Divisional Units (68)	Production Units (5)	RDSO	IRIEEN	Staff Training Institute (16)	Others (e.g. technical staff) (16)
Planners and policy makers	2	2				2	2		
Rolling stock	2	2				2	2		
Traction distribution	2	2				2	2		
Building services	2	2				2	2		
Energy Managers	2	2			5	2	2		
Total	**10**	**10**	**64**	**122**	**10**	**10**	**10**	**32**	**32**

Total: 300

Table 22: Middle-managers

	PMU/COE	Railways Board	Zonal Railways (16)	Zonal Divisional Units (68)	Production Units (5)	RDSO	Training Institutes	Staff Training Institute (16)	Others (e.g. technical staff) (16)
Planners and policy makers		3				2		1	2
Rolling stock	2	2				2			
Traction distribution	2	2				2			
Building services	2	2				2			
Energy Managers	2	4				2		1	
Total	**8**	**13**	**32**	**122**	**10**	**10**	**2**	**32**	**32**

Total: 261

Table 23: Supervisors and technical staff

	PMU/COE	Railways Board	Zonal Railways (16)	Zonal Divisional Units (68)	Production Units (5)	RDSO	Training Institutes	Staff Training Institute (16)	Others (e.g. technical staff) (16)
Planners and policy makers						2			
Rolling stock	2	2		2		2	2	1	
Traction distribution	2	2		2		2	2	1	
Building services	2	2		2		2	2	1	
Energy Managers	2	1		2	2	2	2	1	2
Total	**8**	**8**	**264**	**696**	**10**	**20**	**16**	**102**	**48**

Total: 1,172

F.2 Examples of training modules and activities

Table 24: Training program for pilot demonstrations

	Day 1	Day 2	Day 3	Day 4	Day 5
Session 1	Presentation on the setup and Brief on best practices pursued Structure, functions & focus areas of COE	Energy Efficiency bench marks of pilot demonstration technologies/measures & comparison	Designs capabilities & simulations	Efficacy assessment, verification of performance, & records	Energy audit procedures
Session 2	Evolution of best practices on EE	Testing facilities & conducting tests	Training facilities & training modules	Reliability, Availability, Maintainability, Safety assessment of the best practices	Implementation strategies, Transfer of technology
Session 3	Contemporary technologies	Site visit/working technology & model demonstration	Site visit/working technology & model demonstration	Site visit/working technology & model demonstration	Customization potential
Session 4	Site visit/ working technology & model demonstration of pilot demonstration technologies/measures	Interaction with the users and sharing knowledge with experts	Interaction with the users and sharing knowledge with experts	Interaction with the users and sharing knowledge with experts	Development of strategy for replication in India

Table 25: Training program on Proven Technologies (i.e. technologies that have already been tested in India and proven to be technically successful, but not widespread disseminated yet)

	Day 1	Day 2	Day 3	Day 4	Day 5
Session 1	Presentation on the setup and Brief on best practices pursued Structure, functions & focus areas of COE	Energy Efficiency bench marks of pilot demonstration technologies/measures & comparison	Designs capabilities & simulations	Efficacy assessment, verification of performance, & records	Energy audit procedures
Session 2	Evolution of best practices on EE	Testing facilities & conducting tests	Training facilities & training modules	Reliability, Availability, Maintainability, Safety assessment of the best practices	Implementation strategies, Transfer of technology
Session 3	Contemporary technologies	Site visit/working technology & model demonstration	Site visit/working technology & model demonstration	Site visit/working technology & model demonstration	Customization potential
Session 4	Site visit/ working technology & model demonstration of proven technologies	Interaction with the users and sharing knowledge with experts	Interaction with the users and sharing knowledge with experts	Interaction with the users and sharing knowledge with experts	Development of strategy for replication in India

(a) Training activities for local level staff

The managers, supervisors and technical staff that will initially benefit from the above described training programs on energy efficiency will become trainers or resource persons for the IR system and will contribute to train or raise awareness among the whole IR staff.

Trainings for local level staff will be regularly organized in the appropriate training institutes benefiting from the competences of the trained staff.

At least 100 local staff in each of the 16 zone will annually be trained on energy efficiency in their respective service of competence (i.e. rolling stock, traction power distribution, and building services). A total of 4,800 (100x16x3) staff is therefore expected to be trained annually.

In addition, at least four courses of 25 officials each will be conducted separately.

Finally, one module on energy efficiency will be added in each refresh course on rolling stock, traction power distribution, and building services (to which about 2,000 staff participate annually).

Training modules will be developed by the PMU/COE.

ANNEX G. PROJECT ANNUAL TARGETS

Table 26: "Improving Energy Efficiency in the Indian Railways System" Project Annual Targets

	Indicator	Target	Year 1	Year 2	Year 3
Project Goal: Reduction of GHG emissions in the Indian Railways System (IRS)	Cumulative emission reductions achieved in the IRS by EOP (million t CO_2)	0.117	0	0	0.117
Project Objective Removal of key barriers that prevent the wide adoption of energy efficiency technologies and measures in the IRS	Total direct energy savings by EOP (billion kWh)	0.142	0	0	0.142
Component 1: Institutional capacity development and technical training					
Outcome 1.1: Strengthened IR institutional capacity	Status report of targeted EE technologies / measures, its availability in India/abroad and gap analysis for its implementation	1	1	0	0
	Established and functioning of EE Centre of Excellence (COE) in IRS by EOP	1	0	0	1
	TIRFAD established and functioning by EOP	1	0	0	1
	COE website established and operational by EOP	1	0	1	0
	Number of training and testing institutes with capacity to provide trainings and test EE measures/equipment respectively by year 3	At least 8 At least 2	0 0	2 0	6 2
	Number of training courses conducted by the training institutes each year starting from year 3	64	0	0	64
Outcome 1.2 Improved EE management & technical capacity of IR staff	Number of managers and staff members trained on EE best practices and technologies by EOP	At least 325 managers and 675 staff	200/75	75/200	50/400
	Number of successful EE projects implemented by the trained managers and staff members by EOP	45	0	20	25

	Indicator	Target	Year 1	Year 2	Year 3
Component 2: Implementation of proven energy efficiency technologies and measures					
Outcome 2 Proven EE technologies and measures in traction and non-traction operations are implemented and energy savings realized.	Potential energy savings from the implementation of EE technologies and/or measures by year 3	• 1.58 million kWh/y (for traction) • 110.40 million kWh/y (for non-traction) from 3rd year onwards	0/0	0/0	1.58/110.40
	Percentage of savings derived from EE measures implemented allocated as incentives to EE implementers by EOP	At least 10%	10%	10%	10%
	Number of project proposals (technical and financial) prepared by EOP for EE technology / measure application projects	45	0	20	25
Component 3: Pilot demonstration of energy efficiency technologies and measures					
Outcome 3 Increased confidence in the application of EE technologies and practices in the IRS	Number of energy audits conducted in IRS units above 0.5 MW load by year 3	50	0	20	30
	Number of pilot demonstrations designed and implemented by year 3	At least 8	0	0	8
	Total energy savings achieved from pilot projects by EOP, million kWh	30.40	0	0	30.40
	Percentage of successful pilot demonstrations adopted by IRS for replication by EOP	At least 25% of successful pilot projects are adopted by IR for replication by the EOP and initiated	0	0	25%
	Based on energy audits, number of EE technologies and measures identified as feasible for implementation (planned and budgeted) by year 3	At least 5	0	0	5
Component 4: Information and knowledge sharing					
Outcome 4 Information and knowledge on	Number of visitors visiting the web portal each year starting year 2	24,000	0	12,000	12,000

	Indicator	Target	Year 1	Year 2	Year 3
EE technologies and measures are widely available and accessible for IRS divisions and their affiliates	Number of sets of knowledge sharing products (KSPs) developed and disseminated by EOP	13	0	0	13
	Number of awareness campaigns conducted per year starting year 3	552	184	184	184
	Number of IRS divisions that are actively participating in IRS EE programs by EOP	68	0	0	68
	Number of vendors registering with TIRFAD each year starting year 3 (i.e. from 2013)	About 3 vendors per successful pilot technology register with TIRFAD	0	0	3
	Cumulative number of vendors attending TIRFAD campaigns by the EOP	At least 39	0	0	39