

Chapter 3 → Management and Conservation of Resources

Conservation is an ethic of resource use, allocation, and protection. Its primary focus is upon maintaining the health of the natural world, its fisheries, habitats, and biological diversity. Secondary focus is on materials conservation and energy conservation, which are seen as important to protect the natural world. The consumer conservation ethic is sometimes expressed by the *four R's*: "Rethink, Reduce, Recycle, Repair".

IR is the single largest user of both energy and water in the country. IR consumed about 1.61 billion KWh⁴² of electricity during 2010-11 as against the national consumption of 568 billion KWh⁴³. Thus the policies adopted by it have a substantial impact on the conservation of both water and energy in the country. The tracks of IR traverse the length and breadth of the country. Thus its policies regarding conservation of forests and wildlife play an important catalytic role in conserving the natural habitat in the country and should act as a trend setter for the rest of the country.

3.1 Organisational Structure

In IR, multiple directorates are involved in management and conservation of resources like water, energy, flora and fauna. The Land and Amenities Directorate and Mechanical Directorate are responsible for creation of infrastructure for conservation of water through water recycling plant, rain water harvesting, automatic coach wash plants etc. Electrical Directorate is responsible for formulating policies and implementation of various energy conservation measures. Civil Engineering Directorate is primarily responsible for protection of ecology of flora and fauna alongside the railway tracks.

⁴² Figures extracted from Indian Railways Year Book 2010-11

⁴³ www.indexmundi.com

3.2 Conservation of Water

Water conservation can be defined as any beneficial reduction in water loss, use or waste as well as the preservation of water quality. It is a reduction in water use accomplished by implementation of water conservation or water efficiency measures. It refers to reducing the usage of water and recycling of waste water for different purposes such as cleaning, manufacturing, and agricultural irrigation.

There is a general shortage of water in India and in some parts, even drinking water is scarce. Rain water harvesting, waste water recycling, low-water-use flushing, usage of efficient equipment to minimize use of water, etc. are essential for conservation of water.

IR is a major user of water- both for drinking and for cleaning purposes. Water is used for cleaning of coaches and in toilets at stations and trains. Due to the presence of large number of passengers, attendants and vendors etc. the demand for water at stations and trains for sanitary purposes is substantial.

IR has adopted a number of best practices in the field of conservation of water and has issued a number of instructions for improving the efficiency of water use by installing of automatic coach washing plants and reducing the use of fresh water by way of recycling of water and rain water harvesting.

We examined the extent of implementation of the instructions of RB besides efficiency and effectiveness of initiatives of IR implemented in Zonal Railways. Besides at RB, examinations of the records at the zonal level were also examined to assess the quantum of conservation measures initiated or implemented in the zones. In all 212 major and minor stations test checked over 17 zones. The results of examination are discussed below:

3.2.1 Water Recycling Plant

Water recycling refers to reclaiming waste water from industrial, residential, municipal sources, by treating and purifying the wastewater for reuse. Based on the extent of the treatment, the recycled water can be reclaimed and used in the industrial processes, gardening, etc.

RB in July/August 2006 reiterated its instructions that the zones should provide water recycling plants especially at locations like stations and sheds where water is scarce and provision of the same is to be economically justified. Ministry also emphasized the need for use of fresh water optimally and for use of recycled water for non- domestic purposes at stations.

Test check of 212 stations over 17 zones revealed that 13 water recycling plants (WRP) were sanctioned in only five zones. While five WRPs were installed in four zones⁴⁴, the work for installation of eight WRPs was either not started or in progress as indicated below:

Station (Zone)	Year of sanction	Status
<i>Work not commenced</i>		
Hyderabad (SCR)	2008-09	Discharge of tender thrice for technical reasons and crunch of funds.
Bilaspur (SECR)	2009-10	Pending for want of approved design and drawing.
Lokmanya Tilak Terminus Pune	2009-10 2009-10	Contract is yet to be awarded.
Ballaharshah (CR)	2011-12	
<i>Work in progress</i>		
Katni	2008-09	Progress – 50 per cent.
Bhopal	2008-09	Progress – 85 per cent.
Satna (WCR)	2008-09	Progress – 60 per cent.

In 12 zones no provision of WRP has been made (March 2012). No WRP has yet been sanctioned in NWR. Railway Administration stated (March 2012) that the proposal for WRP would be included in phased manner based on availability of funds. Jurisdiction of NWR covers largely desert and semi-dry areas. We observed that despite there being perennial water shortage; no action has so far been taken (March 2012) for installation of WRP at major stations as directed by the RB.

Similarly, none of the major stations in SR, where shortage of water is acutely felt in summer months, were identified for provision of WRP. During Joint Inspection with Railway Officials, we observed that instead of recycled water from WRP, only fresh water drawn from bore wells /Municipal /Corporation sources was being used for all operations such as cleaning of platforms, cement concrete aprons and coaches.

⁴⁴ SCR, WCR, SWR and CR

In WCR, the actual availability of water was 80.24 lakh litres per day against the requirement of 110.15 lakh litres of water; only one out of four WRPs sanctioned has so far been installed.

While examining the efficiency of the functioning of WRPs installed in five zones (SCR, SECR, WCR, SWR and CR), we observed that:

- In SWR (Bangalore) and CR (Chatrapati Shivaji Terminus), WRPs were working at 60 and 50 per cent of their installed capacity respectively.
- The WRP installed at Secunderabad (SCR) at a cost of ₹ 0.96 crore was utilized upto only 22 per cent of its installed capacity. This resulted in procurement of water from Municipal Corporation leading to extra avoidable expenditure of ₹ 0.56 crore during the period May 2008 to March 2011.

Thus, we observed that the IR had not made significant progress in making provision of WRP at places where water is scarce. WRPs installed in three zones could not be utilized optimally. Besides lack of initiatives on the part of zonal railways, there was no further initiative at the RB level to expedite the provision of WRPs.

3.2.2 Automatic Coach Wash Plants

Cleanliness in trains has often been adversely commented upon by the Parliamentary Committees, other dignitaries and passengers. In September 2008, RB emphasized that the quality of cleanliness and hygiene in trains depends to a large extent on the method of cleanliness adopted in the depots during the maintenance of rakes and directed that Automatic Coach Wash Plants (ACWP) must be part of all green field coaching depots to improve the quality of coach exterior cleaning and to optimize utilization of resources viz. water consumption, saving of time and manpower etc. RB further instructed that ACWPs should be planned for all existing coaching depots in a time frame of the next three years. RB reiterated that the Zonal Railways should place their indents on COFMOW for ACWPs.

We examined the progress of setting up of ACWP in the zones and their performance. We observed that in eight zones (SCR, NCR, NER, SR, SWR, NR,



ECoR and ECR), no provision was made for setting up of ACWPs. The status of provision of ACWP in zones is tabulated below:

Sl. No.	Zone	No. of ACWP sanctioned	No. of ACWP installed	Remarks
1.	NWR	2	NIL	Installation of ACWP was delayed due to yard modeling works at Udaipur and modification of tender conditions in case of plants at Jodhpur.
2.	MR	1	NIL	Target for commissioning by December 2013.
3.	SECR	1	NIL	Not procured due to space constraints for installation at Coaching Depot/Bilaspur & Durg.
4.	WCR	1	NIL	Tender is yet to be finalized.
5.	SER	3	1	Not installed for want of suitable sites.
6.	NEFR	2	1	Remaining plant is out of order since February 2008.
7.	ER	3	2	Tender is yet to be finalized.
8.	CR	2	2	
9.	WR	2	2	
TOTAL		17	8	

From the table above, it was observed that out of total 17 ACWPs sanctioned by the RB, eight ACWPs had been commissioned in five zones and the works in respect of the balance 9 ACWPs in seven zones were either in progress or not taken up for delay in selection of site/ specification and selection of the plant, etc.

The impact of not commissioning of ACWPs on the water conservation efforts of IR was examined and the following were observed

- i. In SER, out of the three ACWPs sanctioned, only one was commissioned at Hatia. The works for installation of the remaining two plants at Tatanagar and Santragachi were held up due to failure in selection of sites. This resulted in non-achievement of savings of 10512 Kilo litre of water per annum, as assessed by the Railway Administration;

- ii. In CR, out of two ACWPs sanctioned; only one was commissioned at Lokamanya Tilak Coaching Depot. It was observed that the installation of ACWP led to a saving of 276 Kilo Liters consumption of water per day besides reduction in the cost of cleaning from ₹ 132 to ₹ 52 per coach;
- iii. In NEFR, an ACWP installed at New Guwahati in 2006 at a cost of ₹ 0.30 crore had remained unutilized since May 2008 due to a technical breakdown;
- iv. An ACWP with a capacity to wash 4 to 5 rakes per day was installed in October 2008 at Bandra Terminus Coaching Depot of WR. The saving in consumption of water was projected at 5400 liter per rake. The plant remained idle since April 2011 as the Railway Administration executed a mechanised cleaning contract which included external cleaning of coaches;
- v. In SR, an ACWP imported from UK at a cost of ₹ 2.25 Crore could not be commissioned at Basin Bridge Coaching Depot due to space constraint. It remained idle between March 2007 and July 2010 before being transferred to Central Railway. This aspect was highlighted in Para 4.1.3 of the Comptroller and Auditor General of India's Report No. CA 19 of 2008-09. The plant is yet to be installed and thereby defeating its objective of improvement of coach washing with minimum use of water.

Thus, we observed that the benefits of ACWPs are yet to be availed of in 12 zones. Delay in installation of nine ACWPs was indicative of a lack of urgency in water conservation. Further, in some zones, ACWPs installed were either not utilized or sub-optimally utilized thereby defeating the objective of constructing ACWPs.

3.2.3 Rain Water Harvesting

Rainwater harvesting (RWH) is the accumulation and storage of rainwater for reuse before it reaches the aquifer. The rain water so harvested is stored at surface or in sub-surface aquifers. RWH mitigates the effect of drought, improves ground water level and is environment friendly.

In May 2003, Ministry of Water Resources requested IR to make provision for rain water harvesting in all future Railway constructions. Accordingly, RB issued (February 2005) instructions to zones for implementation of RWH system.

Review of the status of implementation of RB's directives at 212 selected stations revealed that roof top water harvesting systems were installed at only seven

stations in five zones (SER, WCR, SR, SWR and WR). There was no system of monitoring implementation of the instruction of the RB.

The slow implementation of water conservation measures was indicative of the low level of urgency attached to water conservation, despite huge imbalance between demand and supply of water.

3.3 Conservation of Energy

Sustained economic growth of any economy is largely dependent upon availability of adequate energy and its efficient use. An Expert Committee⁴⁵ set up by the Planning Commission to formulate an integrated energy policy highlighted the importance of lowering the energy intensity of GDP growth through higher energy efficiency. The Report noted that a unit of energy saved by a user is greater than a unit produced, as it saves on production losses as well as transport, transmission and distribution losses. In the context of the IR, the Committee recommended promotion of the system of urban mass transport, energy efficient vehicles and freight movement by Railways through scheduled freight trains. The Committee also emphasized greater reliance on renewable sources of energy.

In IR, the expenditure on fuel constitutes a major portion of their Working expenditure. The total expenditure on fuel during 2010-11 was ₹ 10503 crore and constituted about 15 per cent of their total ordinary working expenses. Thus, fuel being a major cost element, needs greater focus for detection of areas of high energy wastage and adoption of energy saving techniques to realize a cost effective energy system with least environmental impact. In fact, the Energy Conservation Act, 2001 classifies IR as an energy intensive industry. IRs had issued various guidelines from time to time and fixed targets/norms for efficient use of fuels /electricity.

⁴⁵ Under the chairmanship of Dr. Kirit S. Parikh

3.3.1 Use of Energy Efficient Fittings

In May and July 2008, RB advised the Zonal Railways to fix action plan / targets for energy consumption (non-traction) by adopting various energy conservation measures through energy efficient devices. Some major energy efficient measures implemented in the zones were segregation of 70/30 lighting circuits⁴⁶ at platform, replacement of HPMV lamps with metal halides lamps, use of CFL fittings in place of 60/40 watt incandescent lamps, use of T-5 fluorescent tube etc. RB had also fixed target for implementation of the above measures.



Sensor for 70/30 segregation at Kurnal Station, SCR

We have examined the extent of implementation of energy efficient measures by the zones with reference to the target set by the Zonal Railway administration. IR assessed a saving of 860.25 lakh KWh of energy worth ₹70.20 Crore in 17 zones as a result of adoption of following energy efficient measure. Status of implementation of energy efficient measures is indicated below:

Sl. No.	Areas of activities	Target of the Railway Administration	Status (As of March 2011)
1.	Segregation of 70/30 lighting circuits at platform	100 per cent by December 2009	All zones except SER, ECR and NR achieved the targets set.
2.	Use of solar panels at stations	5 nos. of 10 kw solar panels per division in 2009-10	Only SWR achieved the target. While there was no progress in four zones (NCR, ECoR, SER and ECR), the status of progress in five zones (SECR, NEFR, NR, WR and CR) ranged between 20 and 50 per cent and the progress in SR was only 7 per cent. The records relating to progress in six zones (SCR, NWR, MR, WCR, NER and ER) were not available.

⁴⁶ Automatic illumination of station sensing the train arrival and an automatic switch of 70 per cent of lights after three minutes of the departure of train.

3.	Replacement of HPMV lamps with metal halides lamps	100 per cent by March 2011	Out of twelve zones, where the achievement could be assessed, in 10 zones+, achievement was more than 70 per cent and in one zone (SECR), there was no progress.
4.	Use of CFL fittings in place of 60/40 watt incandescent lamps	100 per cent by March 2011	Except Metro Railway (12 per cent) and WR (35.45 per cent), other zones almost achieved their target.
5.	Use of T-5 fluorescent tube	100 per cent by March 2012	While the achievement of six zones (SECR,SR,SWR,ECR,CR and NR) was in the range of 23 per cent to 46 per cent, the achievement in seven other zones (SER, NCR, MR, NEFR, NER, ECoR and WR) was 57 to 86 per cent. Achievement in respect of remaining four zones could not be ascertained.
6.	Timer switches in High Mast Towers	100 per cent by March 2012	Out of eleven zones where records relating to achievement were available, achievement in 4* zones was 6 to 42 per cent and in the remaining seven zones (SER, SWR, NEFR, ECoR, ECR, SECR and CR), achievement was between 60 and 97 per cent.

+SER,NCR,SR,NEFR, ECoR, ECR, CR ,SWR and NR *SECR,SR,NCR and NR

Thus, the achievement of IR in implementation of vital energy efficient measures was commendable excepting the areas like use of solar panels at stations and use of T-5 fluorescent tube. Further, non-availability/non-maintenance of records relating to the achievements and quantification of savings due to adoption of energy efficient measures was indicative of lack of priority in implementation and monitoring at RB level.

While admitting the audit contention regarding slow progress in adopting energy conservation measures in some areas, Ministry of Railways (MR) stated (October 2012) that works related to energy conservation were being planned regularly and progressively by the Railway Administration subject to availability of funds. MR also stated that the high cost, frequent theft, shortage of skilled labour and availability of funds were the primary reasons for under achievement in the use of solar panels. MR asserted that non traction energy consumption during the period 2008-12 remained almost constant despite 4-5 percent increase in connected load

per annum. The fact however, remains that it has not been possible to quantify the energy saved due to adoption of energy conservation measures.

3.3.2 Use of Renewable energy

A natural resource is a renewable resource, if it is replaced by natural processes at a rate comparable or faster than its rate of consumption by humans. IR is the single largest consumer of diesel and electricity in the country and thus its energy policy has a significant impact on the energy scenario of the nation. To handle its vast freight and passenger traffic, IR operates as many as 5,137 diesel powered and 4033 number of electric locomotives. These locomotives consume 2567.37 million liters of diesel & 16105.00 million units of electricity⁴⁷.

The Expert Committee set up by the Planning Commission emphasized the need of greater reliance on renewable sources of energy. Unlike fossil fuels, most renewable energy sources do not release carbon dioxide and other air pollutants as by-products into the atmosphere.

In the “IR Vision 2020 statement”, several measures for reducing carbon foot print were envisaged. One of the measures was to use at least 10 percent energy from renewable sources such as solar power, biomass, CNG and wind energy etc. The Minister for Railways, in her Budget Speech, declared 2011-12 as the “**Year of Green Energy**” and brought out some of the green measures viz. use of solar energy at level crossing gates, windmill etc. initiated by the IR. The energy conservation policy of IR envisaged use of non-conventional energy sources including the use of solar panels at stations, LC gates, use of wind energy for non traction purposes etc.



Different types of solar water heaters provided at Tiruchhchirappalli,SR

⁴⁷ Figures quoted from the Indian Railways Year Book 2010-11 and pertain to the year 2010-11.

3.3.2.1 Use of renewable energy at manned level crossing gates

RB issued instructions (March/May 2007) to provide solar based water heating systems for running rooms, rest houses, hospitals and base kitchens and also for provision of solar panels at level crossing (LC) gates. As per instructions (March 2007), the Zonal Railways were directed to install solar based lighting system at all manned Level Crossings.

RB also proposed (September 2008) that CR, NWR, ECoR, SR, SCR, SWR and WR should gain experience by providing a hybrid system⁴⁸ consisting of solar and wind energy at 3 locations each on trial basis for electrification of LC gate or wayside halt stations, etc.

We examined the extent of implementation of solar based/hybrid lighting system at all manned Level Crossings during the years 2007-11 as per RB's instructions and their performance. The status of achievement of electrification of solar based / hybrid lighting system at all manned Level Crossings are tabulated below:

Zone	Target for electrification of manned LC		Target Achieved		Whether Target achieved	Shortfall in achievements (in %)	
	Using Solar	Using Hybrid	LC electrified using Solar	LC electrified using Hybrid		LC electrified using Solar	LC electrified using Hybrid
SCR	No Target		190	1	NA		
NWR	33	0	57	0	Yes		
SER	25	0	48	0	Yes		
SR	5	3	40	1	Yes		66.67
NFR	175	0	251	0	Yes		
WR	76	0	143	1	Yes		
NER	319	0	328	0	Yes		
CR	91	1	91	1	Yes		
ER	91	3	91	3	Yes		
NCR	389	0	329	0	No	15.42	
SECR	103	0	58	0	No	43.69	
WCR	354	1	208	1	No	41.24	
SWR	70	5	22	1	No	68.57	80.00

⁴⁸ Hybrid system uses both solar and wind energy

ECOR	80	0	67	0	No	16.25	
ECR	1896	0	428	0	No	77.43	
NR	1984	0	594	0	No	70.06	
Totals	5691	13	2945	9		48.25	30.77

From the status of implementation, we observed the following:

- Out of a target of 5704 manned level crossings, 51 per cent (Solar-2945, Hybrid-9) were electrified using solar energy and hybrid system during 2007-11. The works in respect of 704 level crossings (Solar-602, Hybrid-102) are in progress.
- 7 out of 15 zones⁴⁹ could not achieve the target set for electrification of manned level crossings.
- In seven zones (SCR, WCR, SR, ER, CR, WR and SWR), 9 out of a target of 13 level crossings were electrified with hybrid system. There was shortfall in achievement in respect of SR and SWR, where out of eight manned level crossings; only two level crossings were electrified with hybrid system.
- Seven zones (NCR, SECR, WCR, SWR, ECoR, ECR and NR) could not achieve the target of electrification of level crossings using solar energy. In five zones (SECR, WCR, SWR, ECR and NR), the shortfall ranged between 41.24 to 77.43 per cent.



Solar Panel at manned level crossing between Darazpur - Mustafabad section, NR

Further scrutiny revealed that:

- In SCR, there was a decline in the pace of electrification of LC gates through solar power during the period of review. During 2007-08 and 2008-09, 94 and 72 LCs was electrified through solar power whereas in 2009-10 and 2010-11, only 18 and 6 LCs respectively were electrified. The reasons for declining trend could not be ascertained from the records of the Railway Administration.

⁴⁹ Achievement in respect of SCR could not be assessed due to absence of target

- 22 solar panels out of total 91 installed in electrification of level crossings in ER had been stolen.

Thus, the overall achievement of the IR in electrification of level crossings with solar panel was far below the target set for the period 2007 to 2011. There was no system in place to monitor or document performance of level crossings energized with solar panels or hybrid system. There was also no system of quantification of benefit accrued to Railways as a result of implementation of solar panels/hybrid system in electrification of level crossings.

Ministry of Railways stated (October 2012) that the level crossing gates only in non-electrified territory were being provided with solar panel/hybrid system on need basis subject to availability of funds. The reply of the MR was, however, silent about the reasons for failure to achieve the *target of electrification with solar panels/hybrid system*.

3.3.2.2 Wind Power Plants

Power generation through wind is one of the most rapidly adopted and cost effective renewable energy technologies. The wind potential is particularly high in coastal states of Tamil Nadu, Andhra Pradesh, and Karnataka, some parts of Maharashtra, Gujarat and in Rajasthan. It has added advantage of earning for the technology user, additional revenue in the form of carbon credit that could accrue from production of wind energy.

We examined the initiative of IR in tapping wind energy and the progress in setting up of wind power plants. Examination of the records of the Railway Administration revealed the following:

- Four wind power plants had been sanctioned during 2010-12 in three zones (NWR, SR and WR). While the works relating to two plants (WR and NWR) were in the early stages of progress, the progress in respect of the remaining two plants was in contractual stage.
- The proposals of two zones (SWR-3 and NEFR-1) for setting up of four wind power plants are still under process at the RB level.
- In SR, two small wind mill units of 2 KW capacities were installed at Aduthurai and Kallukuzhi Stations in Tiruchirappalli Division in April 2010. No record was being maintained regarding energy generated out of these two units.

- RB did not approve the proposal of SCR for setting up of one wind power plant.

Thus, IR failed to make a major progress in tapping wind energy. During the period of review (2007-12) only four wind power plants were sanctioned in 3 zones. This indicated a lack of urgency on the part of IR in exploiting cleaner and alternative renewable sources of energy.

3.4 Carbon Credit under Clean Development Mechanism

Clean Development Mechanism (CDM) defined in Article 12 of the Kyoto protocol⁵⁰ allows a country with an emission reduction under obligation to implement an emission-reduction project in developing countries. Such a project can earn tradable certified emission reduction (CER), each equivalent to one MT of CO₂. The purpose of this program was to reduce emissions of Green House Gases (GHGs) as well as to promote sustainable development in the host countries. Therefore, developing countries, such as India are expected to gain financial and environmental benefits by reducing the emission of GHGs.

IR has the potential to save energy by introducing locos with regenerative braking features, setting up of wind mills, installation of solar panels, etc. In order to claim CER, the project is required to be registered with National Clean Development Mechanism Authority (NCDMA) and obtain a host country approval.

In IR, only two projects have so far been registered under CDM. One project is replacement of incandescent lamps (ICLs) with compact Fluorescent lamps (CFLs) in Railway's residential quarters and the other project involves using EMUs with three-phase insulated gate bi-polar transistor (IGBT) technology and regenerative braking, for use along the Western and Central Railway corridors in suburban Mumbai. The regenerated electricity reduces the consumption of an equivalent amount of grid electrical energy, thereby conserving electrical energy and reducing net greenhouse gas emissions. The progress of induction of three phase electric locos with regenerative braking features is discussed below.

⁵⁰ The Kyoto protocol is a legally binding agreement that arose out of the United Nations Framework Convention on Climate Change (UNFCCC) to tackle climate change through a reduction of green house gas emissions.

3.4.1 Three Phase EMUs/Electric Locos with Regenerative braking

MR decided to replace the existing Electrical Multiple Units (EMUs) with the new ones fitted with regenerative brakes by adopting three phase technology with Insulated Gate Bi-polar Transistor (IGBT) based system initially in Mumbai suburban area of Western & Central Railways. This was later extended to other zones. During braking, the system is capable of regenerating 25 to 30 per cent of the energy used and these passenger trains have the ability to draw the same from the Over Head Equipment (OHE). The regenerated electrical energy reduces the consumption of equivalent grid electrical energy required by the powering train, thereby conserving electrical energy. This is expected to save the Railways ₹ 200 crore annually on energy.

The Designated National Authority (DNA) which is under Ministry of Environment & Forests has accorded host country approval (January 2009) for this project under Clean Development Mechanism (CDM). World Bank is working for registration of this project with United Nations Framework Convention on Climate Change (UNFCCC).

Review of consumption of energy by adopting three phase locomotives revealed that IRs had inducted 1566 three phase electric locomotives in nine zones (March 2011). The average savings in consumption of energy ranged between 12 to 26 per cent as against the envisaged level of 25 to 30 per cent.

However, savings in energy consumption due to regenerative braking features installed in three phase EMU rakes in suburban sections was much higher. In CR, energy savings ranged between 30 and 50 per cent during the review period and the range was between 31 to 36 per cent in WR.

The project of regenerated braking feature was submitted for validation in April 2010. Till March 2012, no carbon credit could be earned or realized.

3.5 Energy Audit

Energy audit encompasses verification, monitoring and analysis of use of energy, including submission of recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption. On the basis of guidelines issued by Bureau of Energy Efficiency (BEE), RB directed (July 2007/2008) all Zonal Railways to conduct energy audit of areas like major administrative buildings, hospitals, pumping installations, loco sheds, major railway stations and workshops as a onetime exercise and send the reports to

them. Subsequently, RB (July 2008) directed that energy audit of all Traction sub stations and workshops⁵¹ of IR was also to be taken up periodically. All these establishments had been notified by BEE as energy intensive consumers.

The progress of energy audit conducted in 17 zones and status of implementation of recommendations of energy auditors revealed the following:-

- No energy audit was conducted in three zones (SER, ECR and SECR).
- In the remaining 14 zones, 30 energy audits were conducted in workshops, traction sub-stations, pump houses, service buildings, etc. of the zones. Energy auditors made 149 recommendations for improving energy efficiency.
- While 48 out of 149 recommendations were not implemented in seven zones⁵², partial implementation was noticed in respect of 18 recommendations. The reasons for non-implementation of recommendations of energy auditors were attributed to constraint of funds, lack of feasibility to implement etc.
- Energy audit of 12 Traction Sub- Stations was conducted. In all cases, recommendations were either partially implemented or no targets were fixed for implementation of the recommendation of the energy auditors.

Thus, there was a lack of system at the RB level for monitoring the progress of energy audit and implementation of their recommendations. The slow progress of energy audit and implementation of their recommendations indicated a lack of urgency towards conservation of energy.

Ministry of Railways (MR) stated (October 2012), that the IR had adopted the technique of sample energy audit for one type of asset as the cost of energy audit per installation varied between two to four lakhs and the findings of one/two energy audits of a similar type of asset was sufficient to make an action plan for energy conservation. MR also stated that the scope of energy conservation in traction substation was limited. Regarding implementation of the recommendations of energy audit, MR asserted that some suggestions were not accepted due to operational requirement.

Contention of the MR was not acceptable as it was contradictory to its own instructions (July 2008). Further, no action plan for energy conservation measures

⁵¹ Traction sub-station and workshops are energy intensified units due to consumption of substantial electrical energy

⁵² NR,CR,SR,WCR,MR,NWR and SCR

had been drawn for implementing across zones on the basis of the recommendations of energy auditors.

3.6 Bio-diesel

Bio-diesel is a plant based renewable and cost effective fuel. It is biodegradable and non-toxic. Bio-diesel can help reduce emissions of many air pollutants such as particulate matter, carbon monoxide, hydrocarbons, sulphur oxides, nitrogen oxides, and air toxics. Bio-diesel can be made from renewable resources, including non-edible oils of *Jatropha*, *Curcas*, *Karanja* plants, *Sal*, *Mahua*, *Neem*, *Rubber*, *Linseed*, *Castor*, etc. Bio-diesel can also be manufactured from Lard and other waste animal fats, waste fish oil and vegetable fats.

The use of bio diesel blend of up to 20 percent does not require any engine modification. A blend of 20 percent biodiesel and 80 percent petro-diesel (B20) is generally used in IR. A B20 blend would be able to achieve an overall annual reduction in consumption of 489.84 million litres of petro-diesel⁵³.

For production of bio-diesel, two bio-diesel plants were established in June 2006 and November 2003 at Kharagpur (SER) and Loco Works, Perambur respectively.

We examined the performance of bio-diesel plants and observed the following:

- The Bio-diesel Esterification Plant of 2000 litre capacity commissioned in 2006 at Kharagpur at a cost of ₹ 0.29 crore produced 8803 litre of bio-diesel during 2006-10. No Bio-diesel was produced thereafter, due to non-availability of good quality seeds;
- In Loco Works, Perambur (SR), bio-diesel was being produced using Pungam seeds procured from the open market and used edible oil obtained free of cost from hotels. During the years 2008-11, the capacity utilization of the bio-diesel plant was only in the range of 12 to 16 percent. The under utilisation was due to short supply of raw material which was not envisaged at the time of setting up of the plant. Besides Southern Railway, various non governmental organizations resorted to large scale plantations with the aid of Tamil Nadu State Government. Government of India also identified Tamil Nadu for large scale plantations of bio-diesel plant. As a result of non-utilisation of the plants to its full capacity, the objective of development of an alternative fuel could not be effectively achieved.

⁵³ RDSO Report on Bio-diesel (2003)

- During 2006-07, RB sanctioned two projects for use of bio-diesel as an alternative fuel for traction purposes. One project was for the conversion of 100 Diesel Electric Multiple Units (DEMUs) to dual fuel mode using CNG and diesel and the other was for setting up of four bio-diesel esterification plants for the production of bio-diesel. To implement these projects, an organization viz., Indian Railways Organization on Alternate Fuels (IROAF) was set up in 2008 by RB. The aim of the organization was to harness the bio-diesel potential and extend the use of CNG and other alternate fuels /non conventional sources of energy.

We also observed that the contracts were executed in April 2011 and May 2011 for setting up of plants at Tondiarpet (SR) and Raipur (SECR) respectively. While the work of setting up of bio-diesel plant at Raipur was in progress, there was no progress in respect of plant at Tondiarpet as of March 2012 except identification of land.

Thus, the initiative of IR for production of bio-diesel remained largely unsuccessful as the existing bio-diesel plants could not yield desired results due to short supply of raw materials, a prime factor which should have been taken into consideration before setting up of plants.

3.6.1 Jatropha plantation

In January 2003, RB directed all the Zonal Railways to take up work of plantation of Jatropha Curcas on as much Railway land as possible for production of bio-diesel. RB's correspondence (November 2005) revealed that one jatropha plant can generate at least one litre of bio-diesel during a year and each tree starts bearing fruits in two years.

In February 2003, RB signed an Memorandum of Understanding (MOU) with Indian Oil Corporation (IOC) whereby Railway agreed to provide 500 hectare of land to IOC at a nominal lease charge of ` 1 per annum for a period of 15 years for Jatropha plantation and setting up of facilities for production of biodiesel. The IOC however had taken possession of only 188.49 hectares and planted trees only in 70 hectares across various zones. The effort of the Railways as well as of IOC towards production of bio-diesel were not found satisfactory as the plants on which an expenditure of ` 4.35 crore was incurred died prematurely. This was highlighted vide Para No. 3.5.2 of Comptroller & Auditor General of India's Report No. 6 of 2008 (Railways). Though the MR contended that the IR had not

incurred any expenditure and the Railway land got protected due to plantation, the very objective of exploring an alternative source of fuel was defeated.

We examined the records relating to Jathropa plantation over 16 zones and their survival rate and observed the following:

- Except NEFR, none of the zones could achieve the target set by the RB for plantation of Jathropa during the period 2006-11. Further, the survival rate was very low (up to 38 percent) in seven zones (NWR, WCR, SECR, NEFR, ER, ECR and WR). Low survival rate was attributed mainly to inadequate manpower for maintenance. Survival rate in five zones (SER, NCR, SR, ECoR and NR) ranged between 61 to 97 per cent. No records were being maintained in zones in respect of yield of seeds and their usage.
- In NEFR, 23.02 lakh Jathropa were planted during the period 2006-11 incurring an expenditure of ₹ 2.67 Crore. Only 23 per cent of them survived yielding only 6783 Kg. of seeds which were sold for ₹ 0.24 lakh.
- 61.22 per cent (95.93 lakh) of 136.61 lakh jathropa plantation done over 16 zones during 2006--09 could not survive. As a result, IR could not generate 9593.24 KL of bio-diesel which could have saved equivalent quantity of diesel oil worth ₹ 30.28 crore⁵⁴.

Thus, IR failed in achieving desired objective of developing alternative source of fuel through production of bio-diesel from Jathropa. Despite its insignificant use for production of bio-diesel, the need of continuance of Jathropa plantation was not reviewed and the wasteful expenditure on Jathropa plantation continued.

3.7 Conservation of Forests and Wildlife

Article 48 of the Constitution of India specifies that, "The state shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country" and Article 51-A states that "it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have compassion for living creatures".

Conservation of wildlife involves the protection of entire ecosystems. Trains can disrupt local ecosystems in irreparable ways. A diversity of flora and fauna live alongside the railway lines. The flora and fauna in some areas is sufficiently

⁵⁴ Calculated as per rate contract dated 11.08.2009 for procurement of HSD Oil @ ` 31561.49 per KL.

distinctive to be of scientific value. To maintain operational safety, line side vegetations have to be managed in a sympathetic manner.

3.7.1 Railways' approach to protection of wild animals

A Railway line passing through a rural/forest area can interrupt migration patterns, destroy habitat and even kill animals attempting to cross the track. In India, a large number of wild species are being killed annually due to accidents in Railway track and highways, but data maintained are very meager. Data are, however, available only for large animals like elephants.

Animal mortality due to train hits, apart from causing loss of animals can also cause severe loss to the Railways. In certain cases it could lead to derailment of the train, damage to the track, wagons and coaches; injury and death of passengers and/or detention of the train. Sixty-seven animals died during the review period, 2006-11, which included 62 elephants and one lion. The majority of elephant deaths occurred in NEFR where 43 elephants died followed by SR where 10 elephants died.

In March 2010, Ministry of Railways and Ministry of Environment & Forests jointly issued general advisories to prevent train accidents involving elephants. General advisories included measures like clearance of vegetation alongside the tracks sensitising programmes for train drivers/guards, keeping the track free from food wastes and engagement of elephant trackers.

We test checked the extent of implementation of above measures in three zones (SER, SR and NEFR) where the rate of animal mortality was high.

- The measures as mentioned in the general advisories were implemented in NEFR except the construction of forest underpasses/over passes across railway tracks⁵⁵ which were under progress.
- SR had taken a number of preventive measures like imposition of speed restriction, provision of warning boards, regular clearing of vegetation on sides of track for better visibility etc. The issue was also taken up by audit with Southern Railway Administration in June 2011 through a Study

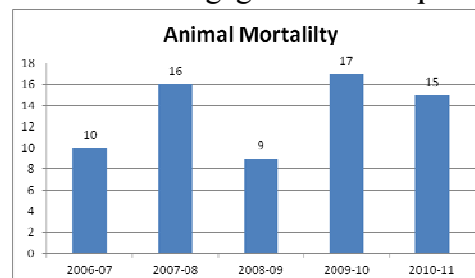


Guided Crossing of elephant by forest officials, Nilambur, Palghat Division, SR

⁵⁵ For safe passage of elephants in accident prone areas between Alipurduar and Siliguri section

Report. In response, Railway Administration stated (September 2011) that the long term measures were under scrutiny. They also stated that rail fencing had already been provided in forest areas between Ettimadai and Madukarai stations in Palakkad- Podanur section.

- In SER, it was however, observed that neither any sensitizing programme was being conducted nor any action was taken for engagement of elephant trackers. Besides, no specific clause was incorporated in the agreements with IRCTC for proper disposal of wastes in order to keep railway tracks free from food wastes.



Despite implementation of a number of preventive measures, the animal mortality due train hits had not declined.

3.8 Setting up of Eco park

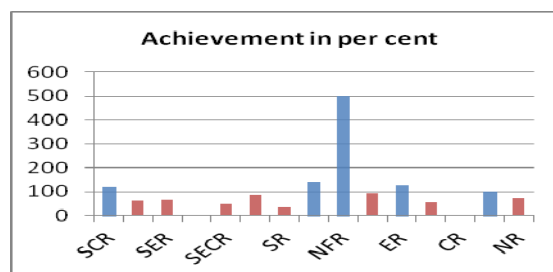
Railway Minister, in her Budget speech of 2010-11, announced the setting up of 10 Rail Eco-parks to conserve, protect and promote Railways’ wet lands and forest areas. The Parks were planned in different zones. Proposed Eco-Parks would provide facilities like herbal garden, nursery with rare plants, jogging track, gymnasium, health club, meditation centre, amphi-theatre etc. so as to develop natural environment with regional flora and fauna in the eco-parks, to provide a harmonious and natural environment.

We observed that no eco-park has so far been set up in IR.

3.9 Afforestation

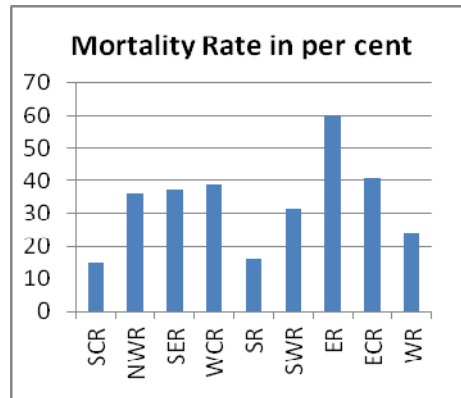
In terms of Para 702 of Indian Railway Works Manual (IRWM), each Division should prepare 'tree planting plan' for every subdivision and plantation work should be carried out accordingly. On all construction projects, provision should be made in the estimate for bulk afforestation in vacant land as an environmental improvement measure. Accordingly, afforestation measures were taken up in zones.

We examined the afforestation measures taken up by the zones and their achievement with reference to



the RB’s target besides assessment of mortality rate. We observed that:

- Out of 15 zones, target for plantation was achieved⁵⁶ in five zones (WR,ER,NEFR, SWR and SCR);
- In the remaining 10 zones⁵⁷, achievement was in the range of 59 to 96 per cent except in SECR and SR where the achievement was 49 per cent and 37 per cent respectively ;



- Average mortality rate of plantation was in the range of 15 to 41 per cent in eight zones (SCR, NWR, SER, WCR, SR, SWR, ECR and WR) except in ER where average mortality rate was 60 per cent.

3.10 Conclusion

IR has issued a large number of guidelines for the conservation of resources- both energy and water. However, their implementation is very low key and slow, indicating Railways lack of enthusiasm. Though guidelines have been issued for reducing the consumption of both water and energy and steps have been initiated for recycling water usage in the absence of proper emphasis and monitoring, its implementation leaves much to be desired. The actual performance on the ground is below par.

The installation of the Automatic Coach Wash Plant leads to a substantial reduction in water use. There has, however, been a substantial delay in both sanctioning and installation of ACWPs. Further, IR also initiated a number of measures like provision of Water Recycling Plants and Rain Water Harvesting systems etc. for conservation of water. However their pace of implementation was also slow.

A number of detailed instructions have been issued by IR for conservation of energy and greater use of renewable energy. However, IR was unable to achieve its targets for adopting energy efficient devices. Audit also observed that the focus here was on use of energy for non-traction purposes on which only a small proportion of expenditure is incurred. Further, the IR has still not been able to

⁵⁶ Indicated by Blue bar

⁵⁷ Except NCR and CR where relevant records were not available

earn any Carbon Credit under Clean Development Mechanism, despite two projects being registered with CDMA for that purpose.

The implementation of recommendations of Energy Auditors was patchy and slow which indicated the inconsistent attitude of IR towards the conservation of energy. We also observed that the production of bio-diesel was low and that the constructions of two more sanctioned plants were progressing very slowly.

Railway tracks traverse through dense forests and hence conservation of forests and wildlife assumes importance. Steps taken by the IR to protect the flora and fauna were not adequate, as animal mortality due to train hits remained high.

3.11 Recommendations

- To conserve water, measures like Water Recycling Plant, Automatic Coach Wash Plants and Rain Water harvesting system need to be implemented expeditiously by IR.
- IR needs to take urgent and effective steps to explore across the country scope for and to maximizing the use of alternative sources of energy besides taking initiatives in conservation of energy. The targets set for adopting energy efficiency measures need to be effectively implemented.
- Adequate effort needs to be put in to implement the long term measures for prevention of animal mortality. For this, the monitoring mechanism at the Railway Board's level should be strengthened.