Presentation on Energy Conservation on Indian Railways

4th May, 2016
Pranay Kumar, Director (Power supply)
Railway Board
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• Nature of Work/Role & Responsibility
• Energy Management on Indian Railways
• Achievements
• Issues & Challenges
Nature of Work/Role & Responsibility

Nodal Directorate for Formulation, Monitoring and Implementation of Policy on:

– Design, Operation, Maintenance, Safe & Efficient utilization of Electric Traction Distribution (TRD) assets of IR.

– Design, Maintenance, Safe & Efficient utilization of General Electric power supply Systems over stations, Work Shops, Offices, Colonies, other installations etc.


– Failure analysis and formulation of Action Plan/ Special Drives for improved reliability

– Finalisation of works program for demands 36 & 37

– Setting up captive Power Plants- Nabinagar (BRBCL), ADRA, etc.
• Co-ordination with Other Ministries of Power, Coal and statutory bodies under their control like CERC, CEA, Standing committees on technical, commercial, regulatory issues pertaining to Electricity Act 2003, & Energy conservation Act, 2002 etc.

• Co-ordination with MNRE and other agencies for:
  – Setting up of Solar Power units
  – Wind Power units and other non conventional generation systems
  – Analysis of various technological/financial models in developing non conventional sources
Monitoring and rationalizing cost of power procurement for traction and non Traction applications & Working to Reduce specific energy consumption

Appointment of Electrical Inspectors for Railways

Co-ordinating Procurement of power from diverse sources based on market arrangements.

Taking up/ guiding Railways on matters pertaining to Electricity act with regulatory authorities/ Min. of Power, CEA, CERC, etc to reduce cost of power for railways

Monitoring and guiding Railways to minimise PF, Harmonics, MD liabilities & **Passenger Amenity items** like lifts, escalators

Examination of Rationalise traction & non traction bill using [energy efficient technologies](#), energy audits
NEED FOR ENERGY MANAGEMENT

- ELECTRIC TRACTION - Key Statistics
  - About 26269 RKM (40%) electrified.
  - Hauling more than two third of Freight and half of Passenger traffic.
  - Electricity consumes 18.24 Billion units (1.9% of total consumption of the country)
  - Electricity bill: Rs. 11,218 crore (approx.)
Increase in Fuel Bill

- Fuel Bill- Diesel
- Fuel Bill- Electricity
Energy Consumption and Bill Paid

- 2009-2010
- 2010-2011
- 2011-2012
- 2012-2013
- 2013-2014
- 2014-2015 (Provisional)

- Power (Million kWh)
- Total energy bill paid in million Rs.
GTKMs Growth (5 Years)

- **Elect Goods**: 41%
- **Dsl Goods**: 21%
- **Dsll Pass**: 33%
- **Elec Pass**: 36%
Energy Conservation Potential in Indian Railway

- Energy used in railways has been categorised as by BEE: Electric traction, diesel traction and non traction use.
- The goals suggested by BEE that could be achieved:
  - i) Electric traction: 7.5%
  - ii) Diesel Traction : 4%
  - iii) Non traction : 10%

The achievement of these goals is possible with investment with a payback of 12 to 18 months.

In the longer term (7 to 10 year period depending on investment in capital stock and signalling technology) 15 to 18% increase in energy efficiency in electric traction, and a 10 to 12% increase in diesel traction is possible.
Achievements

• Total of Rs. 2656 crores (approx) saved in the last 5 years due to energy conservation measures

• Highest no. of Energy Conservation Awards bagged by Railways, with 23 “Awards” in 2015

• Developed a web based software ‘Rail Saver’

• Issued 98 Policy Guidelines/ Circulars on General Power Supply Systems like use of LED lights etc

• Directives issued to Zonal Railways for future use of only LED tube light fittings.
Achievements

• Under Domestic Efficient Lighting Programme (DELP) Scheme, about 7.0 lakh LED bulbs have been distributed to Railway staff.

• 448 locations audited till March, 2015. Another, 195 Energy Audits have also been carried out during 2015-16.

• MoUs have been signed with M/o Power, BEE for enhancing co-operation in these areas.

• Ministry of Power has notified 16- Zonal Railways & 6 Production units under Perform, Achieve & Trade (PAT) scheme cycle-II and energy consumption targets were also specified for above Designated Consumers (DC).

• These measures have almost maintained Energy consumption over last 3 yrs despite increase in load @ 5% per yr.
LED lights at Palanpur station

LED lights have been provided at stations

LED lights at Makarpura station
LED Lights in 5 Rakes of 12 Coaches EMU (Churchgate to Virar)
Actions on improving Energy Efficiency

Projects undertaken:

• Rail saver to monitor energy data
• Retro-fitment of LED lights in non AC coaches
• Optimal light control system at various locations
• SCADA system for power supply system
• Building management system
• Automation of pumping installations
Energy conservation Measures- Electrical loco

- Regular counseling of running staff for use of maximum regeneration braking.
- Provision of Coasting Board for assisting running staff.
- Shutting off of idle locomotives in shed / yards.
- While working on MU formation switch off trailing loco in case of light load.
- Switching of blowers of loco in case of waiting is more than 15 minutes.
- Simulator training to loco pilots for improving driving skills for negotiating and undulating terrain without frequent braking/notching up.
Initiatives taken under UNDP/GEF funded Project to Improve Energy Efficiency - Achievements

For “Improving Energy Efficiency in IR, pilot projects are being developed in collaboration with UNDP through Global Environmental Facility (GEF) funding of US$ 5.2 million.

Following projects have been finalized / in advance stage:

- A web portal Rail saver has been launched for monitoring energy data on all zonal railways and PUs, functional since 15.04.2014
- Retro-fitment of LED lights in non AC coaches
- Optimal light control system at various locations
- Implementation of SCADA system for better utilization of power supply system
- Building management system
- Automation of pumping installations
• 3 phase electric locomotives with regenerating braking feature from 2016-17 onwards.

• 116 energy efficient AC/DC rakes with 3 Phase IGBT type propulsion system have been introduced in Mumbai Suburban area with regenerative braking feature since 2007.

• 70 numbers of energy efficient rakes are under manufacturing at ICF with 3 phase IGBT based propulsion system and regenerative braking system to replace DC EMU rakes.

• Capacitor banks have been provided for improvement of power factor and to reduce feeder current in LHB EOG AC coaches and Power & Power Factor Correction ensures that PF is maintained over 0.95 in traction sub-stations.

• Regular energy audit of electrical installations and its implementation is done. Total 448 Energy audits were done till March 2015 and additional 66 energy audits were done in 2015-16 i.e., upto Nov 2015.

• Switching of trailing loco in case of multi units (MU).

• Microprocessor based Energy Meters have been provided in the all-Electric Locomotives of ELS/BIA to monitor the energy consumption.
Highlights (Non Traction)

• Replacement of tube lights with LED tube lights.
• Use of energy efficient water coolers and energy efficient pumps.
• Replacement of 60 W ceiling fans with 35 W super-efficient ceiling fans.
• Platform Lighting segregation of 70% / 30% circuits.
• Use of 3 stars and above labelled electrical products and equipment, Solar based LED lighting system for level crossing gates, use of solar water heater in place of electric geyser and usage of Occupancy sensors in offices lighting are also being done.
• Under the Clean Development Mechanism 14 Lakhs CFL were given free of cost by IR to its employees in the year 2009-10. This project was extremely successful and got registered with United Nations Framework Conventions on Climate Change (UNFCC) on 26 Nov 2010.
• Implementation of LED bulb scheme for Railway staff under Domestic Efficient Lighting Programme (DELP) Scheme. So far 6.7 lakh LED bulbs were distributed under the scheme across 17-zonal railways.
• MoU with BEE & ministry of Power signed
• International seminar on Energy efficiency Technologies in Railway held on 6th November 2015 at New Delhi
IR has been actively taking Policy initiatives by issuing various Guidelines/Circulars on General Power Supply Systems like use of LED lights, Star rated equipments etc. Listed below are some of the major Policy Guideline/Circulars and manual issued for Energy Conservation and energy management in Indian Railways in the recent past:

- Use of energy efficient LED lights in place of Compact Fluorescent Lamps (CFL) and incandescent lamps (GLS).
- Directions to carry out energy audit.
- Development and issue of Energy Audit Manual & Standard Template for Contract Procedure for Energy Audits Services for Indian Railways Installations by RDSO.
- Use of star labelled products on Railways
- Direction to take benefits of DELP scheme for LED bulbs for railway staff.
Future Initiatives

- Electric Non-Traction: In order to further improve upon energy efficiency, IR has taken up pilot projects for Energy efficiency improvement with an aim to multiply such successful projects in the coming days.
- Optimal light control system
- Smart sense & smart Grid sys
- Retro-fitment of LED lights in non AC coaches
- Automatic light & fan control for New Delhi Railway Station
- Automation of pumping arrangement
- Provision of Super energy efficient fans (DLI-200, UMB-200)
- Installation of VVVF, Variable voltage variable frequency drives for lifts
- Provision of Solar pumps
- Online Meter Data Acquisition (MDAS) for automatic and smart control of various loads.
## Summary of Indian Railway electricity consumption traction and non-traction IN LAST 5 YEARS

<table>
<thead>
<tr>
<th>SN.</th>
<th>YEAR</th>
<th>Total energy consumed in million kwh</th>
<th>Total energy bill paid in million Rs.</th>
<th>Average cost of energy in Rs./Kwh.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TRACTION</td>
<td>NON-TRACTION</td>
<td>TOTAL</td>
</tr>
<tr>
<td>1</td>
<td>2009-2010</td>
<td>13041.72</td>
<td>2506.17</td>
<td>15547.89</td>
</tr>
<tr>
<td>2</td>
<td>2010-2011</td>
<td>13571.53</td>
<td>2483.96</td>
<td>16055.49</td>
</tr>
<tr>
<td>3</td>
<td>2011-2012</td>
<td>14157.87</td>
<td>2458.34</td>
<td>16616.21</td>
</tr>
<tr>
<td>4</td>
<td>2012-2013</td>
<td>14582.57</td>
<td>2478.37</td>
<td>17060.94</td>
</tr>
<tr>
<td>5</td>
<td>2013-2014</td>
<td>15169.16</td>
<td>2492.08</td>
<td>17661.24</td>
</tr>
<tr>
<td>6</td>
<td>2014-2015</td>
<td>15742.89</td>
<td>2503.38</td>
<td>18246.27</td>
</tr>
<tr>
<td></td>
<td>(Provisional)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Issues & Challenges

- Absence of Procurement process based on life cycle cost
- Training and Capacity building of Staff and Officers being new area
- Legal, Regulatory and Policy issues
- Benchmarking, Standardisation and long term Institution building
- Following & Capturing Technological changes
- Adequate funds
- Administrative Issues
Energy Conservation - Non-traction

Measures initiated:

- Energy auditing of major load centers
- Segregating of 70:30 lighting circuits at platforms
- Use of energy efficient luminaries & fans.
- Policy to Procure star rated equipment
- Automation of pumps
- Power factor Improvement measures
- Timers for high mast lighting and sensors in offices

These measures have maintained Energy consumption over last 3 yrs despite increase in load @ 5% per yr.
Future Scenario - 2030

1. Present Power consumption is about 4000 MW.
2. By 2030 -
   • With almost 100% electrification of present rail network,
   • DFCCIL network of at least 7000 RKM,
   • Some new high speed (350 Kmph) corridors,
   • Few tracks upgraded to 160 to 200 Kmph and
   • With total loading of about 5-6 billion metric tonnes (as per projection of National Transport Development Policy Committee for 2032), the total power requirement on Indian Railways will be about 20000 MW.
Highlights ( Traction )

• 3 phase electric locomotives with regenerating braking feature from 2016-17 onwards.

• 116 energy efficient AC/DC rakes with 3 Phase IGBT type propulsion system have been introduced in Mumbai Suburban area with regenerative braking feature since 2007.

• 70 numbers of energy efficient rakes are under manufacturing at ICF with 3 phase IGBT based propulsion system and regenerative braking system to replace DC EMU rakes.

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• Regular energy audit of electrical installations and its implementation is done. Total 448 Energy audits were done till March 2015 and additional 66 energy audits were done in 2015-16 i.e., upto Nov 2015.

• Switching of trailing loco in case of multi units (MU).

• Microprocessor based Energy Meters have been provided in the all-Electric Locomotives of ELS/BIA to monitor the energy consumption.
Although a bulk consumer, Railways pays extremely high charges for traction power. It is proposed to procure power through the bidding process at economical tariff from generating companies, power exchanges, and bilateral arrangements. This initiative is likely to result in substantial savings of at least Rs.3000 crore in next few years.
## Installed Generation Capacity

<table>
<thead>
<tr>
<th>As on 31.01.2015</th>
<th>Thermal</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>RES</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coal</td>
<td>Gas</td>
<td>Diesel</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>46775</td>
<td>7428</td>
<td>0</td>
<td>54203</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5780</td>
<td>10691</td>
</tr>
<tr>
<td>State</td>
<td>55890</td>
<td>6974</td>
<td>602</td>
<td>63466</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>27482</td>
</tr>
<tr>
<td>Private</td>
<td>53525</td>
<td>8568</td>
<td>597</td>
<td>62690</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>2694</td>
</tr>
<tr>
<td>All India</td>
<td>156190</td>
<td>22970</td>
<td>1199</td>
<td>180359</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5780</td>
<td>40867</td>
</tr>
</tbody>
</table>

### Installed Capacity

- **Thermal**: 70%
- **Hydro**: 16%
- **Nuclear**: 12%
- **RES**: 2%

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5/4/2016

Source: CERC, CEA etc
Possible methods to Reduce the Cost of Power Procurement

1. Indian Railways to migrate from DISCOMs to GENCO

2. Improve efficiency of power utilization

3. Go for Renewable Energy
GETTING ELECTRICITY AT ECONOMIC TARIFF

Direct Procurement of power from Generators/Traders:

• As deemed Distribution licensee IR can now buy power directly from generators/Traders under Electricity Act 2003.
• For this Open Access has to be obtained. It can be for Short/Medium/Long terms (Section 38, 39 & 42 of Electricity Act 2003)
• Steps for this are:
• Selection of GENCOs/Trader through open bidding/Bilateral arrangements
• Signing of PPAs /Agreement with GENCOs /Traders
Direct Procurement of power from Generators/ Traders-

- Applying for NOC to SLDCs of generating and consuming states
- SLDC before giving NOC will ensure
  (i) ABT meters at STU and TSS ends
  (ii) Transmission capacity in the state network
  (iii) Valid PPA
- After obtaining NOC from SLDC apply to CTU/PGCIL
- Signing of Agreement with CTU.
Cost involved in procurement of power

• Cost of electricity at generator end
  (Rs 4.00/kWh)
• CTU charges including POC charges (injection & drawal- Rs. 0.49), losses( Rs.0.16)
• Wheeling charges of STU differ from state to state
  (Rs 0.35/kWh)
INITIATIVES TO REDUCE ELECTRIC TRACTION BILL

Power through bi-lateral arrangement:

1. 50 MW NTPC power in NCR replaced with DVC power
   - Saving achieved: 10.75 Cr per month
   - will result in a saving of about Rs. 100 Cr. per yr.

2. PPA for 100 MW power signed with GUVNL on 5.03.15
   - Open Access permission obtained from Gujarat
   - Application for open Access moved in Maharashtra

3. Power from DVC in SER and ER in advance stage

4. Procure electricity through Power Exchanges at lower tariff – Pilot project initiated in Haryana
MEASURE TO REDUCE ELECTRIC TRACTION BILL

- Tenders for 1060 MW power from market floated
- Take up Construction of Transmission lines-
- Work on Transmission corridors for Railways between CNB ALD MGS in progress for having connectivity with PGCIL
- Work for Transmission line from Sahibabad to Diwana is under progress
- This will facilitate in wheeling of power without involvement of state transmission network at a lower cost.
- Have Captive Power plants
- Take up matter with State Regulatory bodies
Power Exchange Mechanism

System Operators
NLDCs/SLDCs

power exchange

RTT
ATC

Submit Bids
(Trading)

Financial Settlement

Generators

PTC

Distribution Licensees/ OA users

PARTICIPANTS

functioning of Power Exchange

Invoice/Credit
Note

Debit/Credit

Bankers

Schedule

Power Exchange

Clearing House
Market Scenario

Weighted Average Market Clearing Prices in IEX & PXIL

![Graph showing weighted average market clearing prices from January 2014 to December 2014. The prices range from 2.67 to 4.33 Rs./KWh.]
Possible methods to Reduce the Cost of Power Procurement

Go for Renewable Energy-

Wind

Solar Power
Solar Photovoltaic based electricity generation in Indian Railways- **Aim:**

- To take benefit of reduced costs
- To fulfill renewal targets
- Use free railway rooftop and land spaces
- Explore new potential areas - Using Rly land parallel to Tracks
  - For 100 MW of solar power lifetime GHG emissions reduction of 5,201,000 tones of CO2
Global Solar PV Power projections

Residential sector continue to be the major part

Source: IEA
GOI’s Ambitious Solar Plans

- The **National Solar Mission** (NSM) was launched in 2010, with **target of 20 GW by 2022**.
- **NSM target is being revised to 100 GW by 2020**. Break up:

```
1,00,000 MW

40,000 MW
  20,000 MW
  10,000 MW
  5,000 MW

60,000 MW
  5,000 MW
  10,000 MW
  10,000 MW
```

- Rooftop Scheme
- Entrepreneur Scheme
- PSUs
- IPPs
- Large private sector
- State Policy
- Already Planned
Indian market potential for rooftop SPV is about 124 GW.
Roof top PV potential in INDIA

- According to 2011 Census India have 330 million houses.
- Average house can accommodate 1-3 kWp of solar PV system.
- The large commercial roofs can accommodate larger capacities.
- Conservative estimate - 25000 MW on buildings having > 2 rooms, considering only 20% roofs.
Growth of Solar Capacity (MW)

<table>
<thead>
<tr>
<th>State</th>
<th>MWp</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; N Island</td>
<td>5.1</td>
<td>0.17%</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>234.86</td>
<td>7.82%</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>0.025</td>
<td>0.00%</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>7.6</td>
<td>0.25%</td>
</tr>
<tr>
<td>Chandigarh</td>
<td>2</td>
<td>0.07%</td>
</tr>
<tr>
<td>Delhi</td>
<td>5.465</td>
<td>0.18%</td>
</tr>
<tr>
<td>Gujarat</td>
<td>929.05</td>
<td>30.94%</td>
</tr>
<tr>
<td>Haryana</td>
<td>12.8</td>
<td>0.43%</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>16</td>
<td>0.53%</td>
</tr>
<tr>
<td>Karnataka</td>
<td>67</td>
<td>2.23%</td>
</tr>
<tr>
<td>Kerala</td>
<td>0.025</td>
<td>0.00%</td>
</tr>
<tr>
<td>Lakshadweep</td>
<td>0.75</td>
<td>0.02%</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>353.58</td>
<td>11.78%</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>286.9</td>
<td>9.55%</td>
</tr>
<tr>
<td>Orissa</td>
<td>31.5</td>
<td>1.05%</td>
</tr>
<tr>
<td>Punjab</td>
<td>55.77</td>
<td>1.86%</td>
</tr>
<tr>
<td>Puducherry</td>
<td>0.025</td>
<td>0.00%</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>839.5</td>
<td>27.96%</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>104.2</td>
<td>3.47%</td>
</tr>
<tr>
<td>Telangana</td>
<td>8</td>
<td>0.27%</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>29.51</td>
<td>0.98%</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>5</td>
<td>0.17%</td>
</tr>
<tr>
<td>West Bengal</td>
<td>7.21</td>
<td>0.24%</td>
</tr>
<tr>
<td>Others</td>
<td>0.79</td>
<td>0.03%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3002.66</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

Source: MNRE
Advantages of solar rooftops

- Land is scarce, rooftop free
- Reduces dependency on grid power.
- Mitigates diesel generator dependency
- For Discoms, it reduces: Day Peak load Demand
  - T&D and conversion losses
- For commercial units: Max generation during day
  - It costs 50% of diesel power
  - A **100 kW** system requires **1000 sq. metre**
  - Payback in 3-4 years for diesel substitution,
Advantages of solar rooftops

- Savings in transmission and distribution losses
- Low gestation time
- Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity
- Reduction of power bill
- Battery elimination makes easy installation and reduced cost of system
Key elements and challenges

• Developing technically feasible model-
  Types of roof tops
  Land Patches- Sizes

• Address Grid connectivity issues
• Take benefit of net metering and banking
  State policies differ
• Address connectivity issues
• Address maintenance issues
How We Do it – What are the challenges

• Identify the Space - Land, Roof Top
• Get clearance from Engg wing
• Arrange Finance-
  - Railways Own funds
  - Go for Public-Private-Partnerships
• Develop PPA and performance based contracts
Renewable energy Solar – (Using Railway funds)

10.085 MWp solar plants installed:

- 5 MW through Solar panels at stations and Solar based lighting system at LC gates (4114 nos.)
- 2 MW plant at RCF Raibareily
- 1 MWp solar plant at Katra railway station and
- 30 KW solar plant at Railway Board

6.5 MW solar units is in final stage

Future Plans - 1000 MW Solar power:

- 50 MW of solar units on Roof Tops through VGF
- 200 MW through VGF under PSU scheme
- 100 MW through MNRE / World Bank Loan
• Balance 650 MW on vacant Railway land – Land has been indicated by Rlys.

3. A Pilot Project for solar plant along the land parallel to Tracks being worked out with UNDP

Harnessing renewable energy - Wind Power

• 10.5 MW wind mill plant installed in 2009 for ICF
• A tender for 10.5 MW wind mill plant under finalization
• 25 MW wind mill ordered (out of 157.5 MW) in JV model
• Another 150 MW in pipe line – already sanctioned
Benefit from Project

- Cheaper power to Railways
- Pressure on SEB to reduce electricity price.
- Railways can harness at least 10% of its energy from wind sources in Gujarat, Rajasthan, Karnataka, Andhra Pradesh, Maharashtra
- 600 MW
- 3600 crore investment
- Savings Rs. 560 crore per annum
- Fuel with no escalation.
Price of solar power has come down from Rs 17.91/kWh in 2010 to under Rs 6.5 /kWh now.

Solar power will achieve grid parity within the next 3 years
13 States have declared Solar Policy supporting grid connected rooftop systems: These are AP, Chhattisgarh, Gujarat, Haryana, Karnataka, Kerala, Manipur, Punjab, Rajasthan, UP, Tamil Nadu, Uttarakhand and West Bengal.

SERCs of 20 States/UTs have notified regulations for net metering/feed-in-tariff mechanism: These are AP, Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Tamil Nadu, Uttarakhand, West Bengal, Andaman & Nicobar, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Lakshadweep, Pondicherry, Goa, UP, Rajasthan and Odisha.
## Solar Project Financials

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>1 MW</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>Rs. 6.91 crore (approx.)</td>
</tr>
<tr>
<td>• Debt: 70%</td>
<td>Rs. 4.83 crore for 12 years tenure,</td>
</tr>
<tr>
<td>• Equity: 30%</td>
<td>Rs. 2.07 crore</td>
</tr>
<tr>
<td>O&amp;M cost</td>
<td>Rs. 12-13 Lakh per year</td>
</tr>
<tr>
<td>Tariff</td>
<td>Rs. 6.95 per kWh for 25 years</td>
</tr>
<tr>
<td>Project IRR</td>
<td>14-15 percent</td>
</tr>
<tr>
<td>Equity IRR</td>
<td>Greater than 16-18 percent</td>
</tr>
<tr>
<td>Tax benefit</td>
<td>Tax savings approx. Rs 1.8 Cr</td>
</tr>
</tbody>
</table>
Solar Project: Financials

- Equity return of at least 16-18% per year (compared to 8-9% in fixed/term deposits)
- Recovery of 98% of equity (Rs. 1.11 crore + 0.93 crore) within first two years as tax savings
- CDM benefits
  - in form of tradable CERs
- Increase in Brand value due to environment-friendly outlook
Largest rooftop plant in the Indian Railways

• 1.0 MW plant at Katra
• About 3500 PV panels
• Power fed through local grid to all railway installation
Harnessing renewable energy - New Areas-

Solar Panels on the roof top of a coach
Using railway land parallel to tracks
Challenges as Leaders:

- **Asset utilization**: Assets worth 7.0 lakh crores give an outturn of only 1.50 lakh crores, Backward/forward integration of activities,
- **System Efficiency**:
- **Assets Maintainability and Reliability**: Upgrading specifications and technology, Go to next level of technology, selection of better type of service agencies.
Message from Member Electrical

Indian Railway (IR) is one of the pioneering organisations focusing on energy conservation initiatives in yesteryears. The landmark decisions in adoption of three-phase energy efficient technologies in electric locomotives and electrical multiple units, policy intervention in implementation of the energy efficiency measures in traction and non-traction areas have scripted new dimensions in energy conservation efforts. These efforts have also been aptly recognised at National level as IR has been bagging maximum number of National Energy Conservation Awards.

Vision

To provide eco-friendly transport services in India in the most cost-effective manner by imbibing Energy Efficiency Measures.

Mission


ENERGY CONSERVATION
- Energy Conservation Initiatives
- National Energy Conservation Awards
- Energy Audit
- Energy Auditor List

ENERGY MANAGEMENT
- Energy Scenario
- Railway Energy Management Company (REMC)

RENEWABLE ENERGY
- Harnessing Green Energy

Public Grievances

Visitors Since September 01, 2014: **3310**
10.5 MW Wind Mill Project for ICF in the state of Tamil Nadu commissioned in March 2009

This Wind Mill has so far generated 115.85 million units of electricity from the date of its commissioning.
30 KWp solar plant at Rail Bhawan inaugurated by Hon’ble MR and MoSR
1 MWp solar power plant at Katra Railway station
Measures planned to Reduce Electricity Bill :-

8. Effective utilisation of Electric power :

- The percentage of goods traffic hauled on electric traction is 66.7% on all India basis. The corresponding figure for coaching traffic is 50.4%. However, to haul these levels of traffic, fuel expenses on electric traction (goods + coaching) are 34.07% of the total fuel cost on traction (diesel + electric).

<table>
<thead>
<tr>
<th></th>
<th>Coaching</th>
<th>Goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric</td>
<td>157.52</td>
<td>98.75</td>
</tr>
<tr>
<td>Diesel</td>
<td>275.22</td>
<td>176.47</td>
</tr>
</tbody>
</table>

- Line Haul Cost (Ref: Summary of End Results, 2011-12)
  (in Rs. /1000 GTKM)

Hence, electric traction is cheaper by 42.77% for coaching traffic and 44.04% for goods traffic when compared to diesel traction.
Actionable points Electrical loco

• Line haul cost of Electric traction is 44% less than diesel, hence optimize running of Electric locos in electrified territories.

<table>
<thead>
<tr>
<th>Year</th>
<th>Freight</th>
<th>Coaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>2008-09</td>
<td>2009-10</td>
</tr>
<tr>
<td>DSL</td>
<td>169.87</td>
<td>158.6</td>
</tr>
<tr>
<td>Elect.</td>
<td>89.99</td>
<td>90.55</td>
</tr>
<tr>
<td>% Cheaper</td>
<td>47.0</td>
<td>42.9</td>
</tr>
</tbody>
</table>

• More than 10% Freight trains and more than 500 coaching trains run on Diesel under wire. Trains for change of traction from Dsl to Electric can be identified based on kms under wire, availability of crew/loco changing facilities at Zonal Railways level by constituting a committee comprising of officers of Traffic, Electrical and Mechanical departments.
• 3-Phase locos re-generate on an average 15% of energy consumed.
• More three phase energy efficient electric locomotives having regenerative braking feature are being manufactured and inducted. Plan to complete switch over from 2015-16.

<table>
<thead>
<tr>
<th>Production up to 2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
<th>2012-13</th>
<th>2013-14 up to Feb 2014</th>
<th>Production in last 4 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>70</td>
<td>76</td>
<td>110</td>
<td>128</td>
<td>384</td>
</tr>
</tbody>
</table>
Procedure for Issuance of NOC from SLDC

Step 1: Agreement between Railway & Client PPA

Step 2: Submission of Application to SLDC for Approval.

Step 3: Issuance of Conditional Approval by SLDC.

Step 4: Procurement of ABT Meter.

Step 5: Inspection & Testing of ABT Meter by Authorized Agency.

Step 6: Submission of Application for NOC.

Step 7: Issuance of NOC By SLDC.

Step 8: Bidding Start at PX from Next Day.
<table>
<thead>
<tr>
<th>SN</th>
<th>Railways</th>
<th>TKM</th>
<th>TSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CR</td>
<td>5361</td>
<td>73</td>
</tr>
<tr>
<td>2</td>
<td>ER</td>
<td>4204</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>ECR</td>
<td>4567</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>ECoR</td>
<td>3723</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>NR</td>
<td>5543</td>
<td>29</td>
</tr>
<tr>
<td>6</td>
<td>NCR</td>
<td>4388</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>SR</td>
<td>5052</td>
<td>34</td>
</tr>
<tr>
<td>8</td>
<td>SCR</td>
<td>5926</td>
<td>39</td>
</tr>
<tr>
<td>9</td>
<td>SER</td>
<td>5786</td>
<td>33</td>
</tr>
<tr>
<td>10</td>
<td>SECR</td>
<td>3607</td>
<td>22</td>
</tr>
<tr>
<td>11</td>
<td>SWR</td>
<td>490</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>WR</td>
<td>4107</td>
<td>31</td>
</tr>
<tr>
<td>13</td>
<td>WCR</td>
<td>3752</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>Metro</td>
<td>72</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>56578</td>
<td>414</td>
</tr>
</tbody>
</table>
Achievements - Electrical Energy Management Directorate

• **To reduce cost of power procurement:**
  • Started Procuring power through Open Access, 50 MW power in NCR (from DVC), and saved Rs. 10.57 Cr. in March 15. Will save about Rs. 100 Cr. a year.
  • Govt. of India has allocated 500 MW power from RPPGL. This will cost about Rs 5.0 per unit
  • To have arrangements for longer periods through market mechanism, tenders floated to procure 50 MW in NCR, 440 MW for Western, 220 MW for Northern and 350 MW for Eastern regions. First tender of 50 MW will open on 8th June and rest by July 2016.
  • Policy directives issued to preferably have ISTS connectivity.
  • Pilot project to procure power through Exchange initiated.

2. As part of setting up captive power plant for Railways, the Boiler light up for first 250 MW unit at Nabinagar took place on 30.03.15. It is likely to be commissioned by Dec- 15.
3. **Renewal Power for Railways:**

**Solar Power: 10 MW Solar already installed:**
- 2MW at Raibarely
- 1MW on roof top at Katra
- **30 KWp solar plant at Rail Bhawan**
- 40 MW each on GM building at SCR, Tirupati station, Ajmer Stn,
- 5 MW at various other places.
- Order for 2 MW issued and for 4.5 MW in progress
- Railway have been asked to plan 50 MW on roof tops of Railway buildings
- A general coach with about 4 KW solar panels working in Northern Railway since December 2014
Wind Power: 10.5 MW already installed
• Tender of 10.5 MW in progress
• Contract for provision of 25 MW in Rajasthan awarded
• Plan to install another 130 MW

Energy efficiency improvement:
• Railways will conduct 150 Energy Audits
• As per the report of BEE Railways save 3.3% on traction and non-traction energy last year which amounts to a saving of about Rs.400 crores
• Directives have been issued to Zonal Railways on 27.03.2015 that for future use of LED tube light fittings for new office buildings and for replacement
• 18 National Energy Conservation Awards bagged by Railways.
• Developed a web based software ‘Rail Saver’.
5. Railways have taken up key technologies as pilot projects to improve energy efficiency on IR in consultation with UNDP – some projects:
   • SCADA control system for New Delhi Station
   • Building management system at Dadar
   • Pumping control system at GZB and Kishan Ganj
   • LED lights in Railway coaches
   • Optimal light control system
   • Smart sense and smart Grid system at Baroda House installed
   • Atomized light and fan control for New Delhi station will be installed

6. Passenger Amenities
   • Last year 36 escalators and 5 lifts installed.
   • This year planned to install 100 escalators and 100 lifts
## Measures taken to reduce electricity bills:

<table>
<thead>
<tr>
<th>Activities</th>
<th>Investment</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short term measures:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Coordination with State Electrical Regulatory Commissions</td>
<td>Nil</td>
<td>Rs.10-100 Cr</td>
</tr>
<tr>
<td>• Power through unscheduled interchange (UI) Mechanism</td>
<td>Nil</td>
<td>Rs. 600 Cr/ location</td>
</tr>
<tr>
<td><strong>Medium term measures:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Power trading activity</td>
<td>Nil</td>
<td>Rs. 8 Cr/ location</td>
</tr>
<tr>
<td>• Procurement of power through bilateral arrangements</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>• Harnessing of solar energy</td>
<td>Nil</td>
<td>Rs 1.5/Kwhr</td>
</tr>
<tr>
<td><strong>Long term measures:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Setting up of Captive Power Plants</td>
<td>Rs. 500-800 Cr</td>
<td>Rs.500-900 Cr/Year</td>
</tr>
<tr>
<td>• Construction of transmission lines by REMCL with PGCIL</td>
<td>Rs.30 lakh/Km</td>
<td>Rs 1.5/Kwhr</td>
</tr>
</tbody>
</table>
Methodology for Cost Reduction

• Migrating from DISCOMs to direct procurement.

• Migration methodology
   
   ➢ %age of existing traction loads - directly connected to STU (thru railway owned lines) - phased manner - 2015-16 and 2016-17.
   
   ➢ Future additional loads to be migrated in same ratio.
   
   ➢ Migration in States only where cost of power is high.
   
   ➢ The requirement of States (including future requirement) where migration has not been considered shall continue to be met from the existing arrangement.
Definition and Essence of Open Access

• Definition in The Electricity Act 2003
  – The non-discriminatory provision for the use of transmission lines or distribution system or a associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission

• Meaning
  – Non-discriminatory sale/purchase of electric power/energy between two parties utilizing the system of an in-between (third party), and not blocking it on unreasonable grounds

• Objective
  – To ensure consumers receive adequate supply from alternate competitive sources and enabling the captive generators to sell their surplus capacities while the distribution licensee improves performance
Short Term Market Vs Total Generation

### Total Generation in BU

- 2008-09*: 478.47
- 2009-10: 764.03
- 2010-11: 809.45
- 2011-12: 874.17
- 2012-13: 907.49
- 2013-14: 962.90
- 2014-15#: 1010.65

### Short Term Volume in BU

- 2008-09*: 7.37
- 2009-10: 8.63
- 2010-11: 10.08
- 2011-12: 10.81
- 2012-13: 10.90
- 2013-14: 10.87
- 2014-15#: 10.00

### Share of ST in total generation in %

- 2008-09*: 35.27
- 2009-10: 65.90
- 2010-11: 81.56
- 2011-12: 874.17
- 2012-13: 907.49
- 2013-14: 962.90
- 2014-15#: 1010.65

### YoY growth in Total Generation in %

- 2008-09*: 7.37
- 2009-10: 8.63
- 2010-11: 10.08
- 2011-12: 10.81
- 2012-13: 10.90
- 2013-14: 10.87
- 2014-15#: 10.00
PASSENGER AMENITIES

- **Escalator**
  - Total installed: 204 escalators at 79 stations
  - Under commissioning: 24 escalators
  - Planned: 400 nos. (179 stations) at A-1 & major Railway stations.
  - Target 2015-16: 117 nos.

- **Lifts**
  - Total installed: 101 lifts
  - Planned: 400 lifts (168 stations) at A-1 & major Railway stations.
  - Target 2015-16: 97 nos.
Solar mission of Indian Railways
Details suitable for harnessing solar energy

<table>
<thead>
<tr>
<th>Available roof top space (in sq. m)</th>
<th>Size of plot (in m x m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19,34,383</td>
<td>2,18,44299</td>
</tr>
</tbody>
</table>

*Note- considering 50% solar usable area*
USE OF LED LIGHTS

Use of LED light be progressed as per Board’s guideline issued recently. Provision of LED lighting by adopting CAPEX model should also be examined. Targets has been given by Zonal Railways for the year 2015-16.

<table>
<thead>
<tr>
<th>SN</th>
<th>Rly</th>
<th>LED lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CR</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>NR</td>
<td>10000</td>
</tr>
<tr>
<td>3</td>
<td>NCR</td>
<td>473</td>
</tr>
<tr>
<td>4</td>
<td>SR</td>
<td>10000</td>
</tr>
<tr>
<td>5</td>
<td>SER</td>
<td>6000</td>
</tr>
<tr>
<td>6</td>
<td>SCR</td>
<td>4000</td>
</tr>
<tr>
<td>7</td>
<td>SECR</td>
<td>3000</td>
</tr>
<tr>
<td>8</td>
<td>WCR</td>
<td>1650</td>
</tr>
<tr>
<td>9</td>
<td>WR</td>
<td>6538</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>44661</td>
</tr>
</tbody>
</table>
“Railsaver” Website Screenshot – www.railsaver.gov.in

RAILWAYS SYSTEM FOR ANALYSIS OF Vidyut Energy

Message from Member Electrical

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RENEWABLE ENERGY

- Harnessing Green Energy

Public Grievances

Visitors Since September 01, 2014: 3310

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This is the Website of Indian Railways Electrical Department. developed with an objective to enable a single window access to information and services being provided by the various Indian
IR-UNDP project “Improving Energy Efficiency for Indian Railways System - Achievements

Rail saver website


• In a move to further improve energy efficiency on Indian Railways, a web based Electrical Energy Management System, RAILSAVER, developed by CRIS. RAILSAVER will provide a IT based platform for energy consumption data, interpretation and analysis of data evolving future strategies for conceiving, implementation and further intensifying energy conservation efforts on IR
Various policy guidelines on General Power supply have been issued from time to time viz.:

- Use of LED light fittings.
- Conducting Energy Audit on Railway installations.
- Use of Renewable energy i.e. solar and wind on Railways.
- Use of 3 star labelled energy efficient electrical equipment on Railways.