



DETAILED PROJECT REPORT
SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 20
SUSTAINABLE TRANSPORT SYSTEM &
GREEN INITIATIVES



20 SUSTAINABLE TRANSPORT AND GREEN INITIATIVES

20.1 INTRODUCTION

Historically, sustainability has been a way of living. With the intent of progressing and developing the world, extensive use of resources took place and newer interventions were made to enhance the rate at which the advancement was happening. The effects of climate change became apparent soon thereafter in terms of rising temperatures and frequent incidences of natural calamities. As a result of all the environmental mayhem, the sustainable development goals (SDGs) were set and came into effect in January 2016.

To align with the global agenda and moving towards sustainability, several industries have been self-declaring to be sustainable by adopting greener practices. Sustainability was initially demonstrated as an environmental concept but over the years it has undergone a massive paradigm shift. It has been fully integrated into the way we think and plan our economic goals. In order to address the challenges faced by humanity, it is imperative to strike a balance between social development, sustained economic growth, sustainable management of natural resources and cultural variations. By focusing only on the economic growth and neglecting the other aspects would lead to short term growth but would eventually have irreversible consequences.

Keeping this in mind the integrated approach for sustainability becomes extremely important. The sustainability goals can thus be met by enhancing resource efficiencies and minimal waste generation without impacting the environment. Additionally, the intent is also to work symbiotically and ensure that the waste generated in one process becomes a resource for the other process thus creating a closed loop.

India had participated the following two important international United Nations (UN) conferences. India is also a signatory of these UN declaration for safeguarding the environment and sustainable development.

1. United Nations conference on the Human Environment (1972), Stockholm
2. United Nations Conference on Environment and Development (1992), Rio de Janeiro (also known as the World Earth Summit)

India was also a participant and signatory of the Kyoto Protocol, which prescribes emission standards and greenhouse gas emission reduction. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets.

In line with the national and international goals, K-Rail is committed to implement the concepts of environmental protection, sustainable development, sustainable transport, emission reduction and energy efficiency in this SilverLine.

20.2 SUSTAINABLE DEVELOPMENT

The concept of “Sustainability” is one of the most hot topics related to the technological development in the modern era. It aims to satisfy the present needs without compromising the needs of next generations.

Environmental Sustainability has been defined by the United Nations in 2005 as: “Meeting the needs of the present without compromising the ability of future generations to meet their needs. Encompasses, e.g. facilitating the renewal of renewable resources, conserving and establishing priorities for the use of non-renewable resources, keeping population densities below the carrying capacity of a region, and keeping environmental impact below the level required to allow affected systems to recover and continue to evolve”.

In order to guarantee a sustainable environmental development, a set of sustainable environment indicators has been considered, which can generally be understood as tools that analyse changes, while measuring and communicating progress towards the sustainable use and management of environmental resources.

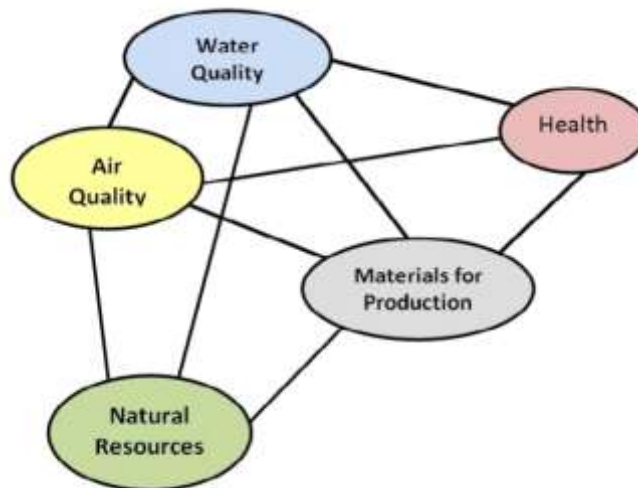


Figure 20-1: Indicators of Environmental Sustainability

An indicator complies must be compliant to the following

- Specificity (it must relate to the desired outcome, i.e. fit the purpose for measuring)
- Measurability (it should preferably be open to measurement in a quantitative manner);
- Sensitivity (it must readily change as circumstances change);
- Reliability (The information that an indicator is providing must be reliable. Data upon which the indicator is based must therefore be collected using a systematic method).

Now a days, it's proved that each of these indicators is also dramatically affected by the contribution of transportation. As per WHO study, transport sector accounted for about 23% of global carbon dioxide emissions in 2010 and 27% of end-use energy emissions

with urban transport accounting for about 40% of end-use energy consumption, on other hand only 2% of this amount is caused by rail transport as per study conducted by CPCB, Delhi.

Since train can be considered the major transport mode of the future, leading international organizations like UIC work for a continuous upgrading of sustainable rail transportation, in order to guarantee the best quality of life.

K- Rail proposes to build this SilverLine rail corridor as a Sustainable Transport. Hence this project is committed to develop an environmentally- and economically sustainable, long-term alternative to the current transportation systems in Kerala, which will increase transportation efficiency, use 100 percent renewable energy, and incorporate additional sustainability practices.

20.3 GUIDELINES FOR SUSTAINABLE TRANSPORT- AVOID, SHIFT, AND IMPROVE STRATEGY

There are three primary strategy responses to the challenge of reducing the environmental impact of transport (Dalkmann and Brannigan, 2007): Avoid, Shift, Improve. For sustainable development, first commutation should be avoided. If it cannot be avoided, then there should be a shift to sustainable public transport system. If there is no sustainable public transport system, then strategy must be there to improve public transport to make it sustainable. K- Rail is planning to attain the sustainable transport considering these pillar ideas.

20.3.1 Avoid

Limiting the transport demand can be obtained by enforcing quota systems, by creating transport alternatives or by reducing the transport needs. Digital revolutions play a significant role in communicating people without movement. When implementation of the semi high speed network boosts better land use through the relocation of housing, commercial and industrial real estate, the reorganisation of the local urban transports, or the promotion of new ways of life. The creation of co-working spaces in new stations illustrates this last aspect, while also providing access to a wide range of services and shop facilities.

20.3.2 Shift

The advantages of SilverLine in terms of energy consumption and Green House Gas (GHG) emissions, compared to its competitors, are one of the main drivers for reducing the carbon footprint of the transport sector. A UIC study on HSR in France and China concluded that the carbon footprint of HSR can be up to 14 times less carbon intensive than car travel and up to 15 times less than aviation travel, even when measured over the full life cycles of planning, construction and operation of the different transport modes. As a result, shifting passengers to high speed rail from air and road transport reduces CO₂ emissions. Expectations of a mode shift to rail regarding the corresponding CO₂ reductions have been proven by experience across a very large number of corridors.

20.3.3 Improve

Since 1964, HSR has constantly introduced improvements and innovations aimed at reducing high speed rail externalities: vibrations, noise, CO₂ emissions, etc. Much has also been done to recycle infrastructure and rolling stock components. Energy efficiency is at the heart of the problem. Numerous measures have been taken to :

- build lighter vehicles;
- streamline trains;
- increase on-board seat capacity;
- introduce energy regenerative systems;
- increase the share of renewable energies;
- improve all ancillary systems such as air conditioning or lighting; etc.

Paradoxically, the energy consumption per passenger of high speed trains is usually lower than that of conventional trains running between the same stations, according to several parameters such as a more homogeneous speed profile.

20.4 K- RAIL CORPORATE ENVIRONMENT POLICY

K- Rail and the SPV (Special Purpose Vehicle) to be constituted under K- Rail for execution and operation of this project may adopt a suitable Environment Policy for the commitment to integrate environmental protection and social development in its mandates, in a proactive manner, to contribute towards sustainable development. To achieve the fine balance among developmental imperatives and environmental wellbeing. K-Rail gives due importance to environmental considerations in adopting the projects to minimize adverse impacts and risks to the environment and people that may be affected.

K- Rail is very much concerned to environmental issues, commitment towards compliance, and responsiveness towards environmental requirements of its projects.

The Environment Policy proposed basically may cover the following.

- Sustainable development for inclusive growth as the key objective of the national economy to adopt an environment friendly mode of transport system
- To exhibit sensitivity towards environmental responsibilities and conduct our activities
- Efficient utilization of energy resources.
- Associate in direct activities towards environmental improvement through development of green belt and conservation of water resources.
- Make efforts for preservation of ecological balance & heritage.
- Mitigation measures for noise, vibration and waste pollution.
- Sensitize human resource of the corporation towards environmental needs.
- Sustain improvement of environmental performance of the organization.
- compliance of all regulations and guidelines relating to environment.

20.5 ENVIRONMENTAL FRAMEWORK

The Environmental Management Framework addresses following key issues

- to avoid and to minimize adverse environmental impacts/risks due to project,
- to ensure that adverse environmental impacts/risks are well mitigated/ minimized to achieve applicable environmental standards and objectives,
- to comply with applicable central and state government laws and regulations, and environmental safeguards requirements of development partners,
- to provide guidance to its own staff in conducting subsequent monitoring & reporting, and in undertaking corrective actions;
- To develop and exercise mechanisms for effective supervision by K-Rail during implementation.

Guidelines for the K-Rail in terms of for environmental regulations and its implementation for future projects.

For better understanding the Environmental Management Framework, EMF is divided into three parts:

- Environmental Management Regulatory Procedure (EMRP)
- Capacity Building Plan (CBP)
- Environmental Code of Conduct (ECoC)

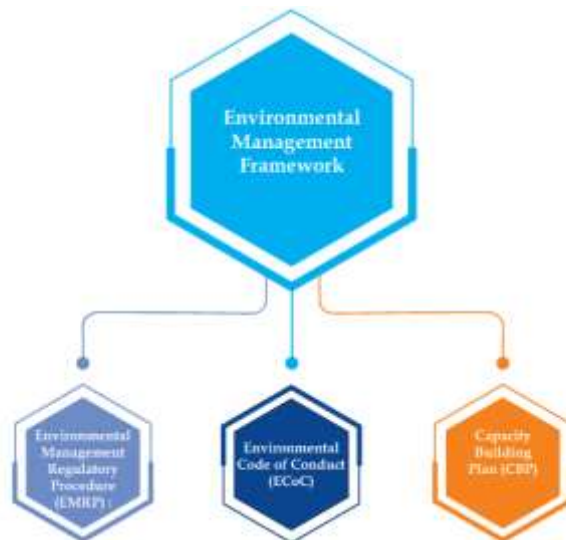


Figure 20-2: Environmental Management Framework

20.6 COLLABORATION WITH INDIAN INSTITUTE OF MANAGEMENT (IIM). AHMEDABAD

K- Rail is proposing to develop a sustainability policy in collaboration with Indian Institute of Management (IIM)- Ahmedabad, which is a world-renowned institute and other nodal agencies. A preliminary meeting was held with IIM - Ahmedabad and the basic modalities

are being worked out. More initiative to be launched and finalised to make the basic framework and policies to be adopted.

20.7 SUSTAINABLE TRANSPORTATION IN SILVERLINE

The objective of SilverLine for sustainable transport system includes :

- Allows the basic access and development needs of individuals
- Supports safety and human health
- Promotes equity within and between successive generations
- Is affordable, fair and efficient
- Offers choice of transport mode
- Supports a competitive economy and balanced regional development
- Limits emissions and waste within the planet's ability to absorb them
- Uses resources at rates which permit renewal or substitution
- Minimises impacts on the use of land and the generation of noise.

This project is committed to develop an environmentally and economically sustainable, long term alternative to the current transportation systems in Kerala, which will increase transportation efficiency, use 100 percentage of renewable energy and incorporate additional sustainability practices.

Although rail is one of the world's oldest transportation methods, it continues to be one of the most energy efficient ways to move large number of people. Experience both in India and abroad illustrate that rail travel provides an efficient alternative for the traveller, who wants to reach key, central destinations and important cities without the delay and hassle of air travel, and in a faster, less polluting, safer and more efficient method than driving.

As per traffic study conducted by K-Rail, in 2025, it is estimated that 79,934 passengers will use SilverLine corridor between Thiruvananthapuram and Kasaragod, which requires approximately 279 million units of energy. In 2052, approximately 497 million units of energy will be required to transport 1,58,946 passengers among the stations between Thiruvananthapuram and Kasaragod.. The energy required to move similar numbers of passengers by car would be thrice the energy required for SilverLine.

Energy - efficiency and maximizing recovery of electricity are just part of the plans. In 2025, it is proposed to adopt a policy goal to run operations with 100 percentage of renewable energy. Through proper planning and co-ordination with utility companies and regulatory agencies, it is proposed to achieve this goal to procure or producing enough renewable energy to feed into the grid to offset the amount the train uses.

This net zero approach means that renewable energy developers can find the most economical locations to develop and distribute energy to the grid. Simultaneously, through a formal call to industry process, it is proposed to ascertain the capacity, and the strong interest companies, to provide renewable energy to the system. In addition, it is

being explored to produce solar or other renewable energy generation on semi high speed rail canopies, roof and maintenance facilities as well as other structures.

In this fashion, the SilverLine will be ahead of the clean transportation curve and leading by example.

20.7.1 Rail as Energy Efficient Transport

Rail is a low carbon mode, a very safe transport mode, a very resource efficient mass transport system compared to other modes. It has an important social and economic role. It is key to a solution to traffic congestion, movement of freight etc.

A sustainable transport system combines the strengths of all transport modes in one integrated system. Rail can be the leader for such intermodal transport system. This corridor is designed as such towards sustainable transport.

The present SilverLine is proposed to meet the following :

- **A SUSTAINABLE MODE OF TRANSPORT**
 - Has a lower impact on climate and environment than all other compatible transport modes.
 - ✓ Energy consumption and GHG emissions
 - ✓ Air pollution
 - ✓ Noise and Vibration
 - ✓ Resource efficiency (material use)
 - ✓ Biodiversity
 - ✓ Visual insertion
 - ✓ Land use
 - The safest transport mode
 - Relieves roads and reduces congestion
- **AN ATTRACTIVE TRANSPORT MODE**
 - increases quality and productive time
 - provides reliable and comfort mobility
 - improves access to mobility
- **CONTRIBUTES TO SUSTAINABLE ECONOMIC DEVELOPMENT**
 - provides macro-economic advantages despite its high investment costs
 - has lower external costs than competitive modes
 - contributes to local development
 - provides green jobs
 - act responsibly and improve sustainability

20.7.2 Carbon Balance Of High-Speed Train

Semi High-speed Rail projects are usually appraised by means of two important criterion to balance namely, economic and environmental. The environmental balance spans the life cycle of the infrastructure from the very first design to final recycling of its components, through the construction and operation periods. This means that the footprint includes the carbon emissions when:

- designing the line, because the engineers and draftsmen will need buildings and devices to shelter them and provide comfort and heating or air conditioning, fuel for going in the field or to meetings, etc.;
- constructing the line, the stations and the rolling stock,
- including the emissions for extracting and shaping materials (e.g. steel or cement), and for their transport (e.g. moving the earth or transporting the rails);
- operating trains and stations;
- maintaining the infrastructure and the rolling stock;
- distributing tickets;
- recycling the components of the infrastructure and the rolling stock.

Calculation of the CO₂ emissions for a high speed project

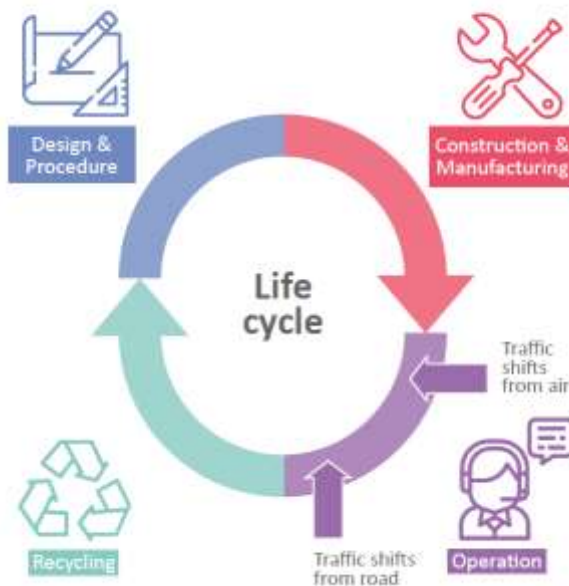


Figure 20-3: Calculation of CO₂ emissions for high speed project

It is clear that, all these emissions lead to a substantial footprint spread along the life of the project (from 50 to 100 years), but this is strongly concentrated at the beginning of the period due to the impact of construction. For example, in the case of a 300-km long HSR line, the CO₂ emissions amount to 1.5 million tonnes. However, these emissions are offset during the revenue period because of the CO₂ savings due to the traffic shift from road (50,000 tonnes per year) and air (80,000 tonnes per year) to rail. This means that the carbon balance, which is heavily negative at the end of the construction period, improves year on year of operation.

Therefore, a high-speed rail line project is only environmentally feasible if there is a strong certainty that the traffic diversion volumes will be significant. This is even more important where there are predictions of changes to the technology of all transport modes, such as cars, and even aero planes, powered by electricity.

UIC data on the comparison of CO₂ emission and energy consumption by different mode of transport is shown below.

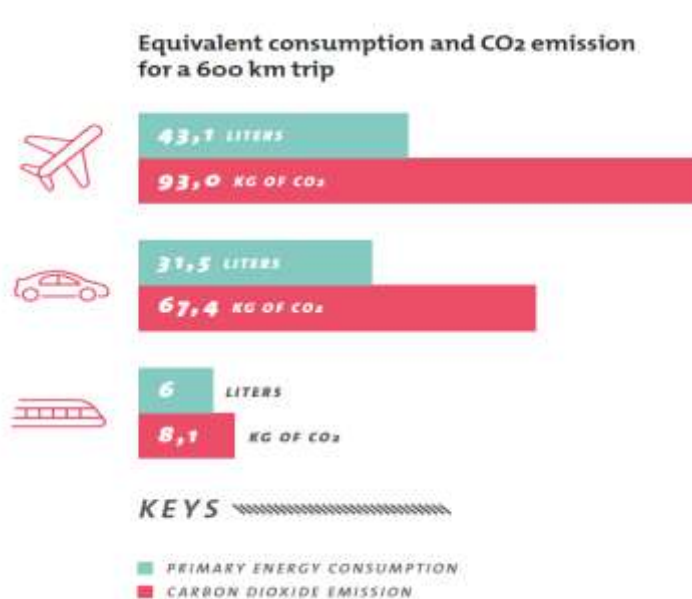


Figure 20-4: CO₂ emission in various transport system

20.7.3 Mode Shift Resulting in Energy Efficiency and Emission Reduction

So, what's the bottom line for high-speed rail as it relates to-energy future?

Starting in 2025, during the system's first year of operation, K- Rail anticipates a ramp-up in usage as travellers begin to make the switch from driving or flying to taking high-speed rail. Every subsequent year, as the system is projected to increase riders, it is expected continued reductions in GHG emissions as well as criteria air pollutants.

Cumulatively by 2029-30, the semi high-speed rail system will reduce 1.2 million tons of carbon dioxide equivalent (mmtCO₂e) and by 2050, the system will reduce minimum 10 million tons of CO₂e.

20.8 MEASURES FOR SUSTAINABLE TRANSPORT IN SILVERLINE

Multiple and proven solutions to achieve the sustainable transportation in SilverLine project is being proposed in this section.

20.9 ENVIRONMENT CONSIDERATION AND PRESERVATION

20.9.1 EIA Study

EIA study is being conducted, to evaluate the impact on the habitat of water bodies, wildlife, flora & fauna and for the probable impact of air, water and soil pollution. Strict mitigation measures are proposed to be taken based on the report.

20.9.2 Land and Water Body Preservation

Compared to other mode of transport, due its high passenger capacity, the land needed for semi high speed rail project for the large traffic volumes carried is much reduced. An average high-speed rail line uses 3.2 Ha/km and an average motor way uses 9.3 Ha/km.

Similarly, the semi high speed rail infrastructure requirements such as curves and gradients are optimized based on global practices to reduce the land requirement. The land proposed to be used in this corridor is approximate between 2.06-2.44 Ha/km, which is much less than the motor way.

20.9.2.1 Topsoil Preservation

“Top soil is the top layer of soil, in which all plants grow. Topsoil is so important because it contains all the nutrients that plants need to survive”.

While conducting construction operations at sites special care will be taken care to preserve precious top soil .Top soil being rich in organic nutrients that fit for plant growth and survival. Following practices are proposed to avoid wastage.

- Top soil is collected and preserved at designated place in situ with the help of Tarpaulin.
- The stockpiles being designed such that the slope does not exceed 1:2 (vertical to horizontal) and the height of the pile to be restricted to 2 m.
- After borrowing of earth material, preserved top soil is spread over the borrowed land to restore its productivity.
- The top soil being utilized for redevelopment of borrow areas, landscaping along slopes, incidental spaces etc.
- Incorporation of suitable and effective contractual clauses for rehabilitation and restoration of borrow areas and other temporary works and landscaping it with surrounding area immediately after its use.

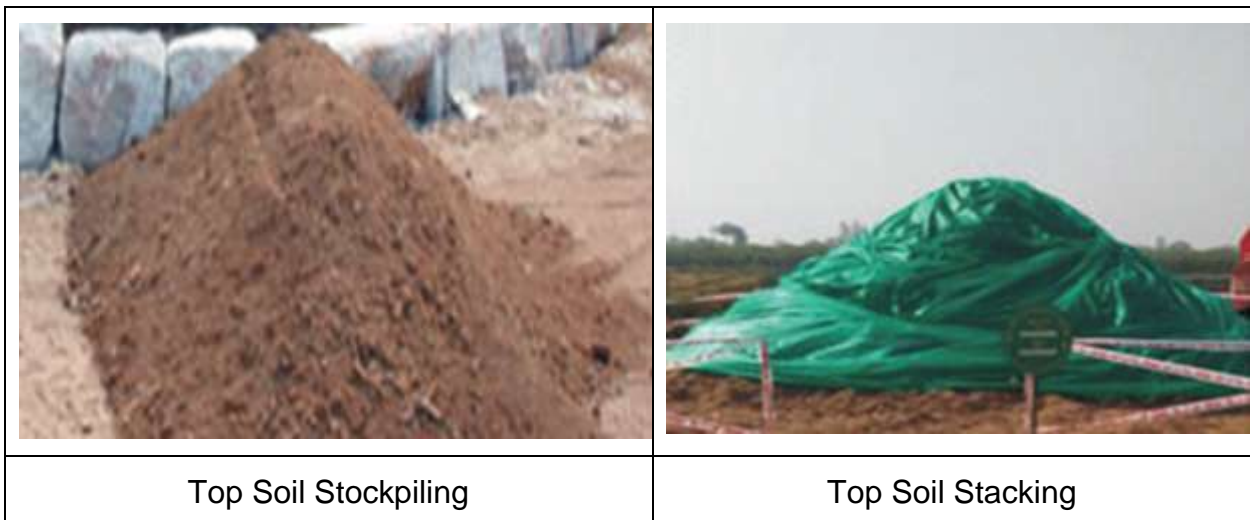


Figure 20-5: Topsoil Stacking



Figure 20-6: After Backfilling Topsoil Closed Borrow Area

20.9.2.2 Protection of Paddy Field and Agricultural Land

Paddy fields are considered to be the air coolers of Earth, reducing the Carbon-Dioxide in the atmosphere and store it in the form of Carbon. Paddy fields thus helps to preserve Earth from hazards of Carbon-Dioxide.

In view of the importance of paddy cultivation, Government of Kerala also have launched a program for Reviving of Paddy Farming duly allocating a separate fund and set up a separate executing organization. K- Rail has already associating and coordinating with this program. Necessary assistance of this agency and the special fund can also be taken to revive the damages to paddy fields and convert the follow land (due to the construction of this project) to green paddy fields.

Out of the total land requirement of 1343 Ha for this project, the paddy field land used is 253.45 Ha, which is only 18.9%. Out of 253.45 Ha of paddy land used, approximately 30 Ha will be redeveloped and reclaimed as paddy field and in addition approximately 10 Ha of follow land will be converted as paddy field.

The 15% of net paddy field agricultural land will come down after the follow land is converted into paddy field at the end of the project.

20.9.2.3 Protection of Agricultural Land while movement of construction vehicle on haul road

For suppressing the effect of generated dust on standing crop due to movement of construction vehicle on haul road, along with regular water sprinkling Green Net along agricultural farm is proposed to be provided. Extra precautions are being taken care of

as second layer of protection to safeguard the effect of dust generated on agricultural land from vehicle plying on road.

- (a) Haul Road Definition:** A Haul road is a term for roads designed for heavy or bulk transfer of construction materials by haul trucks in the vicinity of railway project. Such situation will be monitored.
- (b) Water Body Conservations:** Care has been taken while fixing the alignment to minimize the disturbance to water bodies and the free flow of water.
- (c) Bottom Sediments:** Silt fencing will be provided to avoid runoff into the river and to save water quality of water body. Care will be taken to avoid spreading of construction material and minimize impact on water quality.

20.10 ENVIRONMENTAL PROTECTION DURING CONSTRUCTION

Strategies proposed to be adopted during construction include items such as requirements for recycling all steel and concrete; diversion of construction waste from landfills through reuse and recycling; use of new, low emission construction equipment and replacement of inefficient truck engines and irrigation pumps.

20.11 FOREST AND ECOLOGY PRESERVATION

20.11.1 Avoiding Ecologically Sensitive Areas While Routing Lines

Kerala is one of the few States in India is provided with rich in Forest cover including virgin forests, Ecological sensitive areas, Flora and Fauna, Wildlife Sanctuaries, Biospheres. A highly sensitive very long coastal zone is also available. Though the geography is such that on one side it is the high mountain contains the sensitive forest ecology, the other side it is the fragile coastal region and, in the middle, thickly populated area,

Environmentally proactive approach has been taken in finalizing the alignments in such a way to avoid or minimize damage to the environment by avoiding of sensitive forest land and passing through wild life sanctuary and also the coastal zone. The alignment is not passing through any reserve forest, or near wildlife sanctuary.

Though Kerala has nearly 30 % age of total area as forest area, no forest land has been used for this project by careful planning, though the proposed rail corridor covers almost entire Kerala North to South.

20.11.2 Forestry Development

It is a necessary evil and unavoidable to cut or replant trees during any major construction like railway project. In this project, ten trees will be planted for every tree getting cut. In this way more trees will come up and hence the greenery.

20.12 NOISE

Noise disturbances as well as vibrations are important issues when examining sustainable transport. Millions of people are affected by noise, especially traffic noise.

Rail noise impacts tend to be limited to people living along rail network routes, and so affects far fewer people compared road noise.

20.12.1 Noise Limit

During construction and operation, the noise level will be within the limits prescribed by the standards and codes. Necessary noise limit clause will be incorporated in the specifications of the Equipment like Rolling Stock etc.

20.12.2 Installing Noise Barrier near Sensitive Receptor

School, Hospitals, Mandir, Masjid close to the track (within 20 m from ROW) are the primarily susceptible site for high noise level. It is proposed to safeguard sensitive receptor from high noise. Noise mitigation measures in the form of noise barrier at sensitive receptors will be provided during construction & operation phase of the semi HSR corridor . This will be included in the Contracts.

20.13 GREEN CONSTRUCTION

During construction the air, water and noise pollution is to be minimum and no waste or sewerage will be discharged in the water bodies. Noise level will be kept minimum and within limits by suitable measurement and preventing methods.

20.14 GREEN INITIATIVES

20.14.1 Green Building

There is a growing focus on reducing carbon emissions through sustainable buildings. The 2008 National Action Plan for Climate Change includes the National Commission on Enhanced Energy Efficiency which includes the promotion of energy efficiency in building. Whilst the sector is not underpinned by regulation, the government has announced several initiatives such as the Green Rating for Integrated Habitat Assessment (GRIHA) introduced by the Ministry of New and Renewable Energy.

Green buildings are designed to reduce the overall impact of the built environment on human health and natural environment by:

- Efficiently using energy, water and other resources.
- Protecting occupant's health and improving employee productivity.
- Reducing waste, pollution and environment degradation.

The pictorial representation is illustrated in figure 20-7.



Figure 20-7: Sustainable Green Building

Following can be considered for green buildings:

- Sustainable Architecture and Design
- Green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled content, or made from renewable resources).
- Create healthy indoor environments with minimal pollutants (e.g., reduced product emissions).
- Water Conservation and feature landscaping that reduce water usage (e.g., by using native plants that survive without extra watering).
- Energy Efficiency
- Indoor Environmental Quality
- A green building is a structure that is environmentally responsible and resource-efficient throughout its life-cycle. These objectives expand and complement the classical building design concerns of economy, utility, durability and comfort.

Green Features of a Green Building:

- Minimal disturbance to landscapes and site condition
- Use of non-toxic and recycled / recyclable material
- Efficient use of water and water recycling
- Use of energy efficient and eco-friendly equipment
- Use of renewable energy
- Quality of indoor air quality for human safety and comfort
- Effective controls and building management systems.

The features must comprise in Green Building is shown in Figure 20-8.

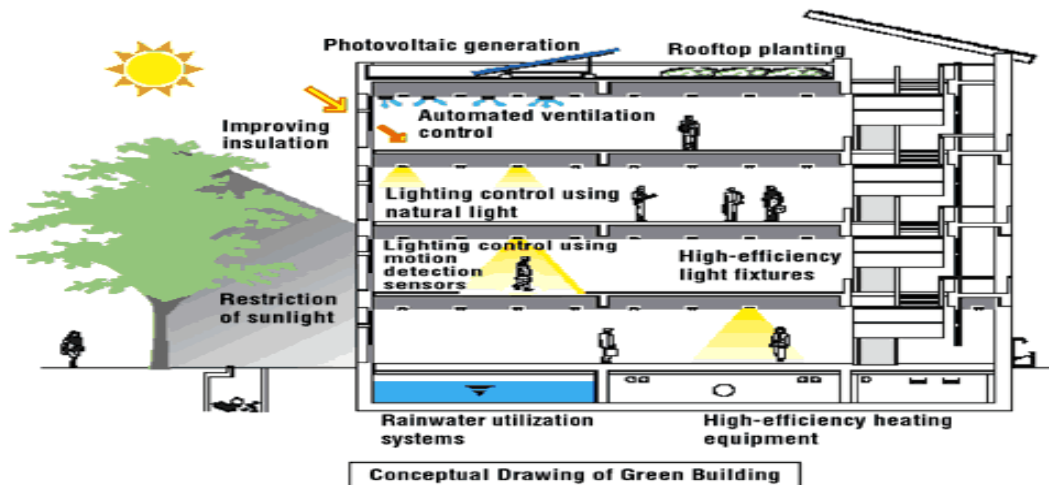


Figure 20-8: Green Building Features

Indian Green Building Council (IGBC) Green Railway Stations

CII-IGBC with the support of Environment Directorate of Indian Railway has developed the Green Railway Stations rating system. IGBC Green Railway Stations rating system is a voluntary and consensus-based program.

IGBC Green Railway Stations rating system is the first of its kind holistic rating in India to address environmental sustainability in Indian railway stations. The overarching objective of the rating is to facilitate adoption of green concepts, thereby reduce the adverse environmental impacts due to station operation & maintenance and enhance the overall commuter experience at station. The rating system will help the station management to understand their present position with respect to the 'green performance' of the station and the measures that need to be taken to enhance the performance on a continual basis.

Green Railway Stations Benefits

By applying the green concepts in the design & construction, the following benefits are envisaged over conventional railway station.

Indian Railways:

- Operational savings through reduction in electrical energy consumption towards non-traction upto 40%
- Water consumption reduction for station applications upto 30%
- Effective Waste management during operation of station
- Improved station facility management
- Opportunity to increase environmental awareness among all Indian Railways staff

Commuters:

- Improved accessibility to stations, thereby enabling easier first mile & last mile connectivity
- Effective ventilation & indoor environment quality
- Enhanced health, well-being & safety of commuters
- User-friendly design for differently abled & elderly people

Other Environmental Benefits:

- Reduction in energy consumption and hence the reduction in the associated environmental impacts.
- Increased use of renewable energy sources, thereby minimizing the fossil fuel energy use
- Improved waste management, thereby avoiding waste being sent to land-fills
- Use of eco-friendly construction materials thereby reducing the dependency on the use of virgin materials

Building construction and operation have an enormous direct and indirect impact on the environment. Buildings use vast amounts of energy and raw materials and produce waste and harmful emissions to the environment. Typical buildings in earlier decades were big users of chlorofluorocarbons (CFC) that degrade the ozone layer, and fossil fuels that emit greenhouse gases.

Smart architects think rationally about issues as sustainability, durability, longevity, using appropriate materials and the efficient use of space. This is not just locally or nationally, but there is an increasing recognition internationally in working with sustainable building or green building.

Sustainable buildings are structures that are built in an environmentally responsible manner by maximizing use of materials, minimizing use of resources and ensuring the health and well-being of occupants and the surrounding built environment both today and for generations to come. It is the practice of increasing the efficiency with which buildings and their sites efficiently use energy, water and material, and reducing building impacts on human health and the environment through better siting, design, construction, operation, maintenance and removal.

In this corridor, the Station buildings, depot, administrative building and other service buildings are designed based on the platinum rating standard of Indian Green Building Council (IGBC). Necessary certificate will be obtained at the time of construction and operation.

SilverLine Green Building Initiatives:

In view of above concept, following buildings models will be proposed for corridor as mentioned in indicative pictures,



Figure 20-9: Image of Station Buildings



Figure 20-10: Façade Image of the SilverLine Station



Figure 20-11: Image of a Windscreen



Figure 20-12: Image of Ticket Counters



Figure 20-13: Image of Commercial Zone in the Free Concourse Area



Figure 20-14: Image of Waiting Room for Second Class Passengers

20.14.2 Green Energy (100%)

This project is proposed to be 100% powered by renewable energy sources mainly solar power supplemented by the other form of renewable sources like wind to make it as a green energy and sustainable transport project.

20.14.3 Models adopted for Renewable Energy

There are different types of execution models available in India:

20.14.3.1 RESCO Model

A Renewable Energy Service Company (RESCO) is an Energy service company, which provides energy to the consumers from renewable energy sources, usually solar photovoltaics, wind power or micro hydro.

The main characteristics of a RESCO are:

- The household serviced does not own the generation equipment, which is owned by an external organization (RESCO)
- The user does not carry out maintenance, all maintenance and repair service will be done by RESCO;
- The user shall pay the energy charge per unit consumption

20.14.3.2 CAPEX Model

In this type of model all the capital and operational expenses shall be borne by the user.

20.14.4 Solar Energy

Solar energy is the best form of sustainable energy. Solar electricity or photo voltaic (PV) technology converts sunlight directly into electricity.

It is proposed to provide solar panel extensively in the premises of the entire corridor wherever unused terrain especially roof tops and other locations.

It is proposed to have the following provisions for the generation/ purchase of solar energy

- Provision of fixing Solar panels on the roof top of the buildings (roof top of all station building, depot building, Traction substation, Viaduct etc)
- Provision of Ground mounted solar system, where free land is available for a longer period and along the corridor.

Figure below shows the mounting arrangements of solar panels in roof top and Ground



Figure 20-15: Mounting arrangements of solar panels in roof top and Ground

The table below shows the tentative plant capacity of Stations, Depot, Traction substation, viaduct and free land available in Depot.

Table 20-1 Tentative plant capacity of Stations, Depot, Traction substation, viaduct and free land available in Depot.

Table 20-1: Tentative Plant Capacity

Sr No	Location	Tentative Plant Capacity (in MWp)
1	Station Building and other service building	15
2	Depot Building and other depot area	5
3	Viaduct, compound wall fencing and track side	80
	Total	100 MWp

It can be increased in future by suitably locating more locations.

In addition, solar and wind energy will be brought from inter-state and intra state models.

Consent of KSEBL: KSEBL, which supplies electricity over entire Kerala has already agreed to provide green energy to this project vide their letter KSEB/TRAC/CG/Miscellaneous/2019-20/292 Dated 14th August 2019. Hence the additional requirement over and above the K- Rail's in house generation and purchase, the green energy from KSEB will be availed.

20.14.5 Green Communication and Green Networking

Green Communication and Green Networking means energy efficient communication and energy saving by avoiding travel by using communication.

Green communications are the practice of selecting energy-efficient communications and networking technologies and products and minimizing resource use whenever possible in all branches of communications.

Green networking practices include:

- Implementing virtualization.
- Practicing server consolidation.
- Upgrading older equipment for newer, more energy-efficient products.
- Employing systems management to increase efficiency.
- Substituting telecommuting, remote administration and videoconferencing for travel.

Limited usage of Fossil fuel: The communication installations and tower will be normally powered from solar or Electricity board with back up UPS and Diesel Generators (DG). Only during all out-break downs, the diesel generators will be used.

20.15 RECYCLING

Recycling is a key tool for the sustainability transport. The methods for recycling is to be strictly adhered during construction, operation and maintenance.

20.15.1 Water Recycling and Conservation

Water recycling shall be implemented in all infrastructure as far as possible. Stations and Depots will be main area where water will be used much during construction as well as operation and maintenance. Water recycling facilities in Stations and Depots will improve the recycling of the water. The recycled water can be used for gardening and toilet purposes.

20.15.2 Waste Recycling

Waste management process and machinery is indeed a part of the SilverLine project. The maintenance of Rolling Stock and other equipment will create waste products which are to be treated and disposed properly. Treatment plants are proposed in all Depots for the treatment of the maintenance wastes. Similarly, human waste from the trains are to be removed, treated and disposed properly. Controlled emission plants are used in depot to collect the toilet wastes from the trains and associated treatment plants will treat the waste for proper disposal. In all stations also waste management process are to be implemented. The collected waste from stations are to be treated and disposed either in central facility or local facilities.

20.15.3 Rainwater Harvesting

Rainwater harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). One method of rainwater harvesting is rooftop harvesting. With rooftop harvesting, most any surface — tiles, metal sheets, plastics, but not grass or palm leaf — can be used to intercept the flow of rainwater and provide a household with high-quality drinking water and year-round storage. Other uses include water for gardens, livestock, and irrigation, etc. The rainwater harvesting will be provided on stations and depots and other offices.

20.15.4 Vermicomposting

Providing vermicomposting pit at satellite offices, to manage the quantum to biodegradable waste on surrounding. Vermicomposting facilities will be provided at all satellite offices to treat the kitchen waste as an initiative towards management of Biodegradable waste at site and generate compost for in-house landscaping.

20.16 BIO TOILETS IN TRAINS

Bio-toilets are provided in the trains as a measure of environment protection and cleanliness in the corridor, stations and yards.

20.17 ENERGY CONSERVATION MEASURES

20.17.1 Rolling Stock

The procurement specifications are to be drafted in such a way that it will implement the recycling of the materials used in Rolling Stock manufacturing and prevent the usage of hazardous material during manufacture as well as operation. Similarly, it is important to maintain the Rolling Stock with minimal impact to environment and climate. There are many measures proposed for making the Rolling stock for sustainable transport.

Light weight car body by using Aluminium based material will reduce the energy consumption considerably. Energy efficient VVVF Drives for Traction and Auxiliary converters are proposed. Extensive use of regenerative braking during the service braking is technically proven. It is used at speed as low as 5 KMPH. With modern controls, power factor is maintained almost to unity. Lights shall be of latest technology such as LED for energy efficient operation. The light level shall be controlled based on the ambient light level. Windows shall be provided to increase the use of natural lighting. Optimized control of the temperature inside the train shall be provided to reduce the energy consumption in the Air conditioning units. The air conditioning system shall monitor the passenger load and ambient conditions. Similarly, the car body and windows shall be designed to reduce the heat transmission. In the propulsion system high efficiency transformer and IGBT based inverters shall be used. The aerodynamic design shall ensure less resistance which can reduce the traction energy consumption. Energy efficient train running shall be implemented during the project execution with the advisory

system. All auxiliary machines are load controlled and VVVF driven to the extent possible. Optimized and modulated compressor operation is done using advanced software. Flange lubricators are to be used to reduce the wheel rail resistances.

20.17.2 Electrical & Mechanical Facilities

Energy charges of any High-Speed Rail system constitute a substantial portion of its operation and maintenance (O&M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The traction power consumption increases with an increase in train frequency /composition in order to cater more traffic. The proposed system of High-speed Rail includes the following energy-saving features.

- Using Star rated, energy efficient equipment: In case of electrical equipment motors, pumps, air conditioners and other rotating equipment, the operating cost constitute 95 to 98 percent and the capital cost is only two to five percent of the total life cycle cost of this equipment. Hence the energy efficient and star rated equipment only is recommended to be used even if the capital cost is marginally higher.
- Natural lighting and ventilation: Effective utilization of natural light and ventilation is proposed. In addition, the lighting system of the stations will be provided with different circuits (20%,50%&100%) and the relevant circuit can be switched on as per the requirements
- Energy efficient Lights and fans: Only energy efficient lights LED technology and energy efficient fans are proposed.
- Lifts: Machine room less type lifts with gearless drive has been proposed with 3 phase VVVF drive. These lifts are highly energy efficient. Recently regenerative types of lift are under trial and these types of lift may be used to recover energy.
- Escalators: The proposed heavy-duty public service escalator will be provided with 3 phase VVVF drive, which is energy efficient and improves the power factor. Further, the escalators will be provided with infrared sensors to automatically reduce the speed (to idling speed) when not being used by the passenger.
- Air conditioners: Use of VRF/VRV type air-condition system and Thermal energy storage system will be adopted for major centralized AC system like depot, OCC and administrative buildings
- The latest state of energy efficient electrical equipment (Transformer, motors, pumps, HVAC, light fittings etc) will be incorporated into the system design
- Energy Conservation Awareness: Energy saving, and conservation concepts will be inculcated among the staff, users, passengers and other stakeholders from the beginning and periodically.

20.18 OTHER GREEN INITIATIVES

20.18.1 Usage of Electrically Operated Feeder Services

All the stations will be provided with feeder services for connecting the passengers to city centre and main locations near to the stations. Battery operated buses and rickshaws are proposed to operate in the stations.

20.18.2 Promoting Manually Driven Cycles for Local Transport

Similar to metro stations, SilverLine stations will also provide free bicycles and electrically operated scooter services to promote the clean energy transport.

20.18.3 Urban Forestry

K- Rail will be also working with agencies to implement an urban forestry program to offset greenhouse gas (GHG) emissions associated with construction. This program will deliver additional benefits such as providing shade and recreation for communities within the train corridor.

20.18.4 Landscaping

Landscaping are provided in the open spaces in the offices, depot, parking areas and along the corridors to support the environment and reduce pollution.

20.19 PAPERLESS OFFICE (PAPER CONSERVATION)

E office is a concept in which no paper is used for communications and documentations thereby preventing the cutting of precious trees and reduce GHG emissions.

The greenest paper is no paper at all, said Vince Digneo, sustainability strategist at Adobe. So by using available technology e-office concept without using is introduced from the beginning. All the documents, correspondence, communications are kept in the digital form. K- Rail has already started using E-office.

The other measures include various options in its design and project implementation to improve energy performance and reduce the pollution.

- 1) Harnessing of solar energy being fruitfully implemented in staff quarters, station & substation buildings for street and site security lightening, water heating and pumping.
- 2) Low Sulphur High Speed Diesel to run DG sets

20.20 CONCLUSION

It is ensured that all the components of sustainable development and transport project are to be incorporated in the design, construction and operation of the project in addition to the proposed usage of 100% renewable energy. This corridor will become a par-excellent model for sustainable transport.

So, the bottom line for the semi-high-speed rail line (SilverLine) is to implement a **SUSTAINABLE TRANSPORT SYSTEM**. This can be visible starting in 2025, during the system's first year of operation, K- Rail anticipates a ramp - up in usage as travellers begin to make the switch from driving or flying to take high speed rail. Every subsequent year, as the system is projected to increase riders, it is expected continued reductions in GHG emissions as well as criteria air pollutants..

Cumulatively by 2028, the semi high-speed rail system will reduce 1.1 million tons of carbon dioxide equivalent (mmtCO₂e) and by 2050, the system will reduce minimum 10 million tons of CO₂e.

Hence, in addition to above, incorporated with other sustainability features like less land use, no forest land, no major ecological disturbance, less pollution during construction and operation phase, the proposed semi high speed rail is a game changing form of sustainable transportation, first of its kind in India and may also be few in the world.