Making the most of green energy

The Indian government sees rail investment and modal shift as a major contributor to reducing greenhouse gas emissions, and a key element in this is the construction of the Dedicated Freight Corridors. Along with the award of three main electrification contracts, a study into energy optimisation and energy-efficient driving is underway.

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At the beginning of this year, Dedicated Freight Corridor Corp of India awarded a 42-month design and build contract worth Rs12·1bn to a consortium of L&T Construction and Japan's Sojitz Corp, covering the electrification of the 422 km Vadodara – Jawaharlal Nehru Port section of the 1490 km Western DFC between Delhi and Mumbai. This follows a similar contract covering the 915 km Rewari – Vadodara section which was awarded to the same consortium in 2014.

Between Rewari and JNPT, the consortium will supply and install 1337 route-km of 2 x 25 kV 50 Hz overhead electrification suitable for double-stack container trains, with 23 traction substations and 131 switching stations, managed by SCADA from an operational control centre at Ahmedabad.

The Western DFC is being developed under a Japanese Official Development Assistance loan funded through the Japan International Co-operation Agency. Under the Special Terms for Economic Partnership conditions, consortium leader Sojitz will supply the traction power transformers, autotransformers and copper conductors from Japan, amounting to around 40% of the project value. L&T will supply other components as well as taking responsibility for project management and installation on the ground.

Work has reached a similar stage on the 1840 km Eastern Dedicated Freight Corridor. In July 2015, the AIL-ATSA joint venture of Alstom companies was awarded a Rs14·97bn design and build lump-sum contract covering the supply and installation of all systems on the 343 km Bhaupur (Kanpur) – Khurja section of this route. Funded by the World Bank, the package includes 2 x 25 kV 50 Hz electrification, as well as signalling, axle-counters and GSM-R communications. With tracklaying and electrification now progressing at a fast pace, the Ministry of Railways expects both lines to open in the next three years.

Tracklaying and electrification work is well advanced on key sections of India's first two Dedicated Freight Corridors.

Modal shift objectives

The construction and electrification of the two DFCs is a fundamental part of Indian Railways' efforts to help combat climate change. The construction of around 3300 route-km of new electrified railway is expected to be a major contributor to meeting the Indian government's CO_2 emission reduction targets.

Speaking at the COP21 summit in Paris last December, Prime Minister Narendra Modi committed India 'to take forward development and protect the environment', emphasising the 'urgent need to craft a comprehensive, equitable and durable agreement to limit global warming'. Suggesting that innovation 'should be driven by public purpose, not just market incentives', he said it was important to 'come together in a partnership to bring clean energy within the reach of all'.

A key focus in Paris was the impact of the transport sector, both as a major consumer of fossil fuel and as a source of increasing greenhouse gas emissions (RG 1.16 p3). Recognising the importance of modal shift to more environmentally-sustainable modes, India has set some ambitious targets for increasing rail's share of both the freight and passenger markets, while at the same time increasing the proportion of traffic which is electrically hauled.

Thanks to the country's economic upsurge, Indian Railways has witnessed a significant increase in freight volumes over recent years. With only marginal investment in additional infrastructure, the steady increase in traffic has absorbed available capacity on the existing network. Many of the major trunk routes are now saturated, and there is little

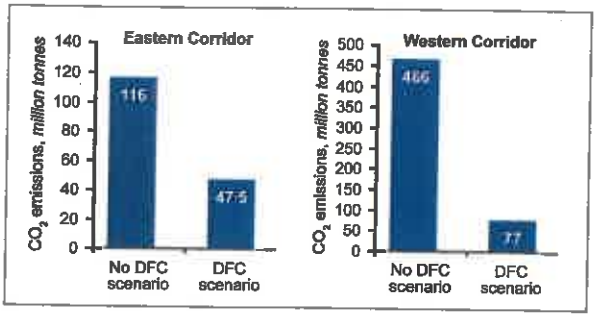

Fig 1. According to the EY study, construction of the DFCs is expected to produce a significant cumulative reduction in greenhouse gas emissions over the 30 years to 2041-42.

scope for further capacity enhancement.

With the National Transport Development Policy Committee projecting a five-fold increase in rail freight tonne-km over the next 15 years (RG 10.15 p68), the country is pressing ahead with construction of the DFCs, both to decongest the most saturated routes and to get containers out of the port as quickly as possible. They will also provide the increased capacity needed to attract more freight from the roads.

It is widely accepted that railways produce the lowest GHG emissions per unit of transport. The DFCs should be even more efficient, as they are being designed and equipped for the operation of frequent heavy haul trains at faster speeds, typically 100 km/h.

A key feature of transport is that energy is consumed on the move and consumption varies according to the route. Hence the long-standing dominance of fossil fuels that are easily transportable. However, the rising cost of imported oil, combined with the environmentally-damaging effects, has encouraged India to put a greater emphasis on railway electrification. This allows the energy to be generated in more efficient fixed plant and transferred to the point of consumption through a high-performance transmission network. To minimise power losses, both the Eastern and Western DFCs will use 2 x 25 kV 50 Hz electrification and auto-transformers (RG 11.14 p49).

Emissions reduction measures

To try and quantify the benefits of the DFC traction strategy, DFCCIL and the World Bank engaged Ernst & Young to undertake a study of the potential CO_2 savings over a 30-year period to 2041-42. This found that not building the DFCs would result in 2·5 times as many carbon emissions in the Eastern Corridor and five times more in the Western Corridor.

Emissions due to the construction of the two corridors and their supporting infrastructure were found to be very low compared to operations-related emissions. Much of the benefits come from the additional capacity and reduced congestion, facilitating modal shift from road. The dominant traffic flows are coal in the eastern corridor and containers in the western corridors, both of which currently contribute substantial GHG emissions.

In 2007-08, 40% of India's freight tonne-km moved by rail, generating 3 million tonnes of CO_2 equivalent. The other 60% moved by road, emitting 66 million tonnes. Under various economic growth and policy implementation scenarios, the study estimated that rail's improved attractiveness and capacity would create sufficient modal shift by 2020 to save between 14 and 25 million tonnes of CO_2 per year.

However, the study emphasised that the emissions performance of rail depends on the generation mix. This underlined the benefits of moving to renewable energy supplies. Speaking in Paris, Modi confirmed the Indian government's ambitious target of developing 175 GW of renewable energy generation, with a particular focus on solar.

Energy optimisation study

One of the major factors affecting train operations is energy-efficient driving. Energy consumption is influenced by the way in which a train is driven, in relation to curves, gradients, permanent and temporary restrictions and signal locations. On the DFCs, the frequency of freight train movements will be quite high, with an average power draw of around 1 MVA per route-km. With such a high traction power requirement, the efficiencies that can be achieved through the use of an in-cab driver advisory system are likely to be substantial.

With this in mind, DFCCIL and the World Bank engaged Australian DAS specialist TTG to undertake a study into the options for energy optimisation across the DFC network. This is expected to be completed by the end of July. An initial report has been prepared, and the final specifications for the software and hardware are being drawn up.

The intention is to provide information about optimum speed, coasting and braking to the driver via a user-friendly DMI. This is expected to save between 8% and 10% of traction energy consumption, helping to reduce the railway's carbon footprint substantially.

The equipment would be installed on all locomotives operating on the DFC network. One early decision is that there should be no changes to the traction and braking controls. The information would only be provided via an additional screen, leaving the control of the train in the hands of the driver.

As well as optimising the running

The DFCs taking shape alongside IR's existing trunk lines will help to alleviate congestion on the most saturated corridors, providing capacity to handle additional traffic.

speed, energy saving should also be achievable through reducing the power draw of auxiliary equipment during long halts and lowering the pantograph after a predetermined period of time, if required.

The scope of the energy optimisation study includes the identification of both fixed and dynamic inputs for the DAS equipment, the location of control points along each route and the communications system to be used for capturing the dynamic data.

Work is currently underway to develop the 'look and feel' of the DMI, and to prepare an instruction manual for the drivers. A software model is being developed to support simulations to assess the performance of the different locomotive types in relation to the route characteristics. Analysing the results of these simulations will inform the planned train running timings and future energy optimisation strategies.

A range of speed profiles for actual and optimised train movements has been developed, and the intention is to create a proper freight train timetable for the first time in India. Careful scheduling will be particularly important when 1 500 m long heavy haul trains are passing through neutral sections.

The next step will be to develop a detailed plan for a pilot implementation of the equipment, and for its subsequent roll-out across the entire DFC network. The World Bank is planning to award a further study to look at commissioning the DAS hardware on the various different locomotive types. Part of this includes modelling the financial impact of the projected energy savings to justify the investment, as well as demonstrating the reduction in carbon footprint.

Non-traction savings

As part of our green initiative, the DFCs will be making greater use of solar power. As well as the traction supply, small-scale solar installations to power offices and ancillary services at many locations will help to reduce overall CO_2 emissions. Total planned solar capacity across the network will have a peak performance of 645·2 kWp.

Following an exhaustive energy awareness drive, the corporation's offices at Pragati Maidan in New Delhi have just achieved the Bureau of Energy Efficiency's 5-star rating, with an Energy Performance Index of 85 — down from 94 in 2012 (Fig 2). The offices were rated at 4-star in November 2012. Since then, everyone has been made aware of the need for energy conservation. Energy-efficient LED lights and occupancy sensors have been installed, together with a more efficient monitoring and control mechanism for the air-conditioning system.

Further green energy improvements can be anticipated during the construction of the new DFCCIL corporate office building, in Noida, which will shortly get underway. The design of the building follows all of the national GRIHA green building recommendations and the New Energy Conservation Building Code 2016 which the government is expected to publish shortly. ■

Above: To cope with higher power requirements and reduce transmission lossess, the DFCs are being equipped with 2 x 25 kV electrification and autotransformers.

Below left: Feeder substations such as this one at Kudra will be managed using SCADA from a central control room.

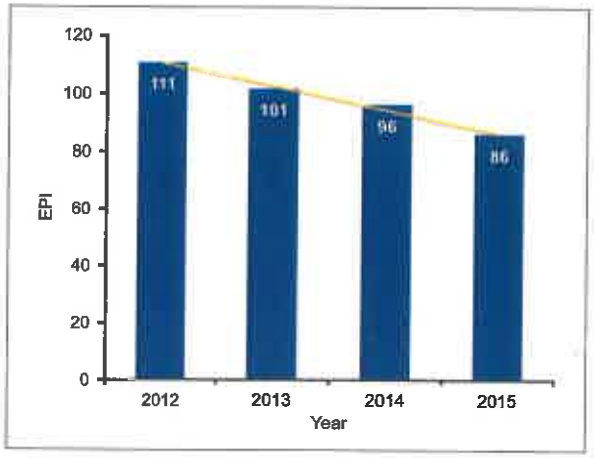

Fig 2. The energy performance index of DFCCIL's offices has been improving steadily over the past four years.