



# Indian Railways at the Junction

## *Revitalised Freight Services, Careful Investment and a Role in Electricity Transmission Could Accelerate India's Economic Recovery and Energy Transition*

### Executive Summary

The COVID-19 pandemic has led to drastic short-term changes to the operations of Indian Railways, with the suspension of regular passenger services highlighting opportunities for a broader range of efficient and faster freight services. Responding to the new challenges and opportunities, Railways Minister Piyush Goyal has called for fresh ideas and “transformational changes in the national transporter”.<sup>1</sup>

This report considers opportunities for Indian Railways to effect a transformation that better supports India's changing post-pandemic economy and participates more fully in the country's energy transition.

India increasingly requires efficient logistics infrastructure to serve manufacturing, agriculture and emerging sectors dependent on rapid and reliable deliveries. When passenger services resume, even with an improved timetable, Indian Railways risks losing its hard-won cargo diversification, its doubling of freight speeds, and its potential to act as a catalyst of economic renewal, unless hard choices are made about the volumes and types of freight it carries.

A critical requirement is to avoid a return to the delays, low speeds and inefficiency that result from an over-congested rail network. Indian Railways should reconsider its plans to increase coal evacuation as a first step in reducing its over-dependence on coal freight. With forecasts for lower growth in electricity demand and stalling thermal coal requirements, some coal evacuation projects may no longer be either necessary or financially viable.

**This report considers opportunities for Indian Railways to effect a transformation that better supports India's changing post-pandemic economy and participates more fully in the country's energy transition.**

<sup>1</sup> Economic Times. [Piyush Goyal seeks crowdsourcing of ideas from railway employees to boost profitability](#). 16 July, 2020.

<sup>2</sup> Economic Times. [Few takers for solar power tender of railways, bid deadline extended](#). 15 November 2020.

Opportunities are outlined for Indian Railways to participate in the nation's energy transition beyond the extensive solar generation plans already underway, in particular by considering the feasibility of using selected railway corridors for High Voltage Direct Current (HVDC) transmission.

IEEFA sees strong merit in the electrification of Indian Railways and the concurrent development of renewable energy infrastructure (even if not as rapid as expected<sup>2</sup>) to leverage excess land (including railway station rooftops), thereby reducing costs and reliance on imported fossil fuels. We will explore this opportunity in a subsequent report.

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## Pandemic Highlights Railway Congestion Effects and Freight Diversification Opportunities

Indian Railways (IR) has been able to provide an extraordinarily extensive service to 23 million passengers each day at relatively low cost, while depending heavily on freight to provide the bulk of its income. In 2018-19, passenger and freight services yielded revenue of 51 billion and 122.6 billion rupees respectively.<sup>2</sup> Bulk freight, of which nearly half is coal, is often portrayed as the financial saviour of Indian Railways, through its cross-subsidisation of the passenger sector.

A landmark 2018 Brookings India report on the inter-dependence of coal and rail<sup>3</sup> reviewed this differential income, but also noted its fundamentally unsustainable nature. It outlined the danger of over-reliance on coal transport at a time when thermal coal is facing ever stiffer competition from renewables, and noted the higher prices paid by electricity generators for coal delivered by rail, especially over long distances. The report concluded that “the entire model of IR keeping afloat on the back of coal will need a revamp”. If this was true before India’s economic slowdown and the consequences of COVID-19, it is even more true today.

### *System Congestion Has Widespread Negative Consequences*

The pandemic has forced abrupt and radical changes to railway operations, and in turn, these have highlighted some critical choices and opportunities for Indian Railways.

High on the list is the question of what types of passenger and freight movements should be prioritised on a highly congested network, and one major question is the advisability of plans to further expand coal traffic, because, despite the attraction of increasing revenues, there are real logistical costs and financial risks of any expansion that outstrips demand.

Prior to the pandemic, severe congestion of India’s rail network was already seeing 40% of lines and all of the important freight routes operating above 100% of line capacity (see Figure 1). A 2015 White Paper<sup>4</sup> blamed congestion for passenger dissatisfaction with train delays, and for excessively slow freight speeds. With passenger services taking priority on a network that is largely shared, the average speed of freight trains in 2018-19 was just 23.2 km/h<sup>5</sup>, and parcel delivery operated with no published train schedule.

Not surprisingly, the White Paper called for infrastructure expansion:

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<sup>2</sup> Government of India, Ministry of Railways, Railway Board. [Indian Railways Statistical Summary, 2018-19](#).

<sup>3</sup> Kamboj, P & Tongia, R. [Indian Railways and Coal: An Unsustainable Interdependency](#). Brookings India, 2018.

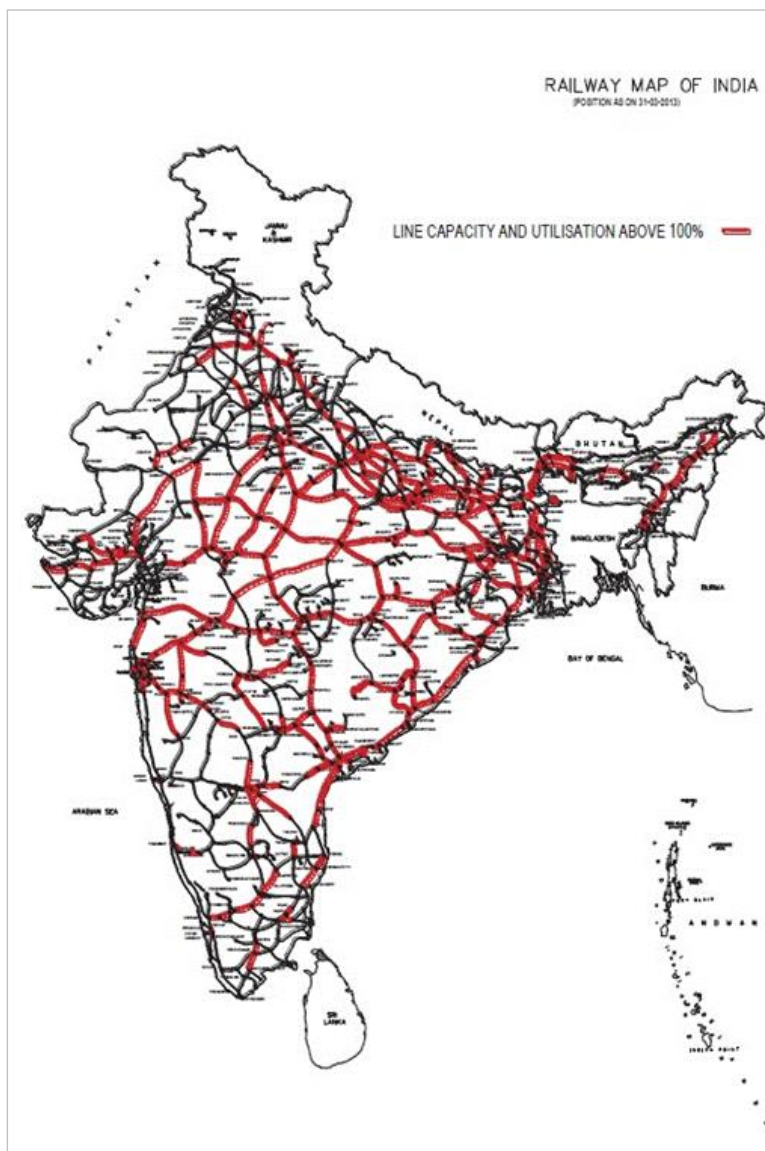
<sup>4</sup> Government of India, Ministry of Railways, Railway Board. [‘Lifeline of the Nation’ \(A White Paper\)](#), February 2015.

<sup>5</sup> Government of India, Ministry of Railways, Railway Board. [Indian Railways Yearbook, 2018-19](#).

*“Therefore, the need of the hour is to undertake a massive infrastructure expansion and decongestion program coupled with upgradation of technology and judicious electrification of tracks along with enhancement of terminal capacity. It is evident that the real issue today is the lack of physical capacity over IR on key routes due to severe congestion.”*

Although building more lines seems the obvious response and fixing avoidable bottlenecks is sensible, congestion is also a product of the volume and types of trains being run, and the mix of train speeds.

**Figure 1: Track Congestion Map**



Source: Govt of India, Ministry of Railways 'Lifeline of the Nation' (A White Paper), February 2015.

Slow freight not only becomes uncompetitive with road transport, especially for perishable or non-bulk items, it exacerbates delays further as faster trains catch slower ones, requiring more overtaking and diversions to passing loops. Increased braking and acceleration in turn consumes more energy and leads to more wear-and-tear on locomotives, rolling stock and track. Reducing differences in train speeds and allowing maintenance blocks feature as key strategies in studies of rail congestion internationally<sup>6</sup> as well as in India.<sup>7</sup> The latter study, from experts at IITB in Mumbai, appears to be the basis for a new post-pandemic “zero-based” passenger timetable set to be introduced by Indian Railways.<sup>8</sup>

This overhaul is reported to include a hub-and-spoke model, corridor blocks set aside for freight and maintenance, and the cancellation of as many as 10,000 halts where fewer than 50 passengers board or deboard. If these timetable reforms are sufficiently robust, India could experience benefits similar to those reported in the Netherlands, when that country started with a completely fresh timetable in 2006. Within a year Dutch Railways carried a record number of passengers with fewer rolling stock kilometres and record punctuality.<sup>9</sup>

Congestion has also been blamed for inadequate blocks of time for essential maintenance and modernisation of tracks, bridges and signals. By 2018, the competition for time between running trains and maintaining tracks and equipment was sufficiently pressing that Indian Railways had to time-table Sunday ‘mega-blocks’ to enable such work. With passenger trains suspended during the pandemic lockdown, the low traffic volume has enabled many long-standing maintenance projects to be completed, using this unique opportunity to repair bridges, remodel yards, renew scissors-crossovers and complete maintenance projects covering over 12,000kms of track.<sup>10</sup>

Another effect of slow freight speeds is that they increase costs and inefficiently use limited resources (locomotives, wagon rakes, and crews). Even though some customers may be indifferent to train speeds as long as their deliveries occur regularly and arrive in good condition, the railways must deploy more resources at greater cost. Where three or four slower trains deliver the same cargo volume per unit time as two or three faster ones, not only must additional trains (and crews) be in put into service, their presence on the tracks adds still further to congestion.

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<sup>6</sup> Warg, J. [Effects of increased traffic volume and speed heterogeneity on the capacity of a railway with dense mixed traffic](#). WIT Transactions on The Built Environment, 2012, Vol 127, 486-497.

<sup>7</sup> Rangaraj, N, Belur, M. [A concept note for railway timetabling to rationalize and improve capacity utilization](#), Niti Aayog, 2018.

<sup>8</sup> Financial Express. [Indian Railways prepares new zero-based timetable for trains! Over 6,000 ‘unremunerative’ stoppages to go](#). 24 July, 2020.

<sup>9</sup> Kroon, L. et al. [The New Dutch Timetable: The OR Revolution](#). Econometric Institute Report EI2008-19.

<sup>10</sup> Hindustan Times. [‘Once in a lifetime opportunity’: Railways carry out major track and bridge repairs pending for years, during lockdown](#). 2 May, 2020.

## *Revenue and Loading Statistics Under-Represent Bulk Freight's Contribution To Congestion*

Finally, despite the important revenue role of bulk freight, especially compared to passenger income, there is a fundamental difference between the two in that Indian passenger services are always at high capacity in both directions along routes (94% coach utilisation in 2018-19)<sup>11</sup> and non-bulk freight also tends to run in both directions along most routes. Bulk freight always runs empty in one direction, adding indirectly to congestion costs while not earning revenue.

**A significant proportion of line congestion results from slow bulk freight trains returning empty.**

The presentation of railway statistics downplays this by reporting loading, freight traffic and traffic density, respectively, in tonnes, net tonne-kilometres (NTKMs), and NTKMs per running track km, representing only the loaded portion of the round trip.

In 2018-19 freight overall had a traffic density of 8.09 NTKMs per km (compared to 12.62 passenger-kms per running track km), but when expressed in gross terms, this almost tripled to 23.11 gross tonne-kilometres (GTKMs) per km. A significant proportion of line congestion results from slow bulk freight trains returning empty, a cost that is not specifically paid for by the freight customers but which displaces and slows down other traffic.

## *Pandemic Opens the Door To New Freight Services*

Rail congestion has also severely constrained the range of freight services. Significant deficiencies have included the absence of timetabled parcel trains, patchy or non-existent cold chain services for perishable foodstuffs, and an overall loss of competitiveness with road transport. These problems prompted a call for Indian Railways “to have a serious look at its fare-to-freight ratio and provide more flexibility to its customers to improve freight competitiveness”.<sup>12</sup>

However, the recent suspension of most passenger services had decongested the rail network to the extent that, by August, Minister Goyal was able to announce that in the preceding 24 days not only was 5% more freight carried than a year earlier, the average speed had doubled to 46.7 kph.<sup>13</sup> Year-on-year loading had increased further in September, with a 26% increase. Speed increases, as shown in Figure 2,

<sup>11</sup> Government of India, Ministry of Railways, Railway Board. [Indian Railways Annual Statistical Statements, 2018-19](#).

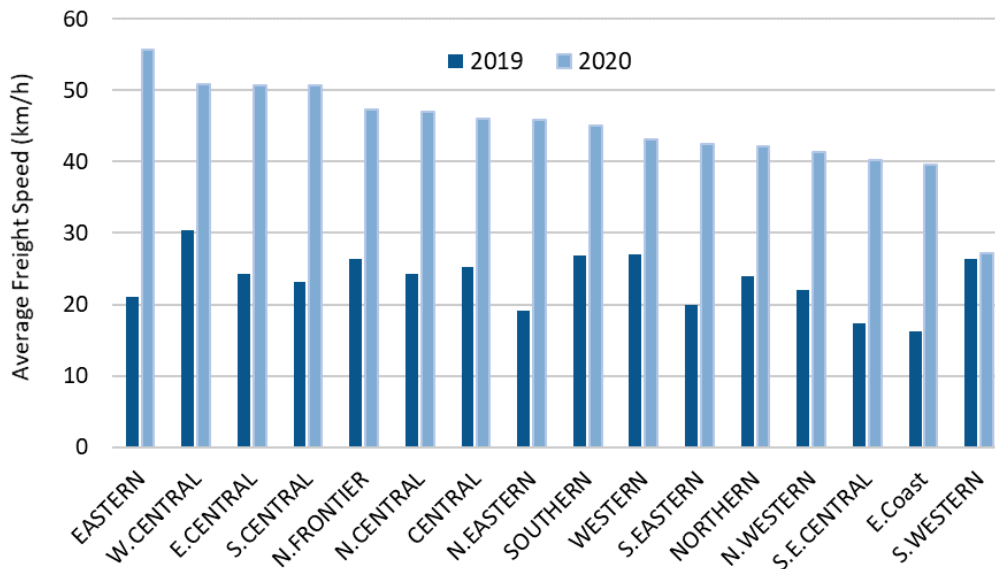
<sup>12</sup> National Council of Applied Economics Research. [Factors impacting rail freight traffic in India Report No. 2016-02-1](#), 2016.

<sup>13</sup> Economic Times. [India can become trusted partner in global supply chains: Piyush Goyal](#). 8 August, 2020.



were particularly striking in some of the coalfield areas in the east – including the Eastern zone where average speeds had nearly tripled by July, and three of the Central zones, as well as the East Coast, had average speeds above 50 kph.

**Figure 2: Freight Train Average Speeds for July 2019 and 2020**



Data source for figure: Govt of India, Ministry of Railways, Railway Board. *Monthly Evaluation Report, July 2020.*

Indian Railways also saw a change in the composition of freight. The rural sector has been a particularly important beneficiary. Special ‘Kisan’ (farmer) trains including refrigerated wagons, have transported perishable seasonal produce on multiple routes, with claims of reduced cost and wastage.<sup>14</sup> In the first 22 days of April, trains carried 4.58 megatonnes (Mt) of food grains – 2 ½ times the quantity transported in the corresponding period a year earlier.<sup>15</sup> Between April 1 and June 8, the Northern Railways zone alone transported 6.25Mt of rice and wheat from Punjab and Haryana – over twice the normal amount.

**During the pandemic freight trains have moved more freight and a greater diversity of cargoes, at twice the speed, bringing in new revenue.**

The Ministry of Railways has worked hard to diversify and enhance non-agricultural freight services as well, introducing timetabled parcel trains on 20 routes, new industrial salt movements in Gujarat, tractors to Bangladesh from Uttar Pradesh,

<sup>14</sup> Indian Express. [Mango Special to Banana Special: Kisan Rail gets on track.](#) 3 October, 2020.

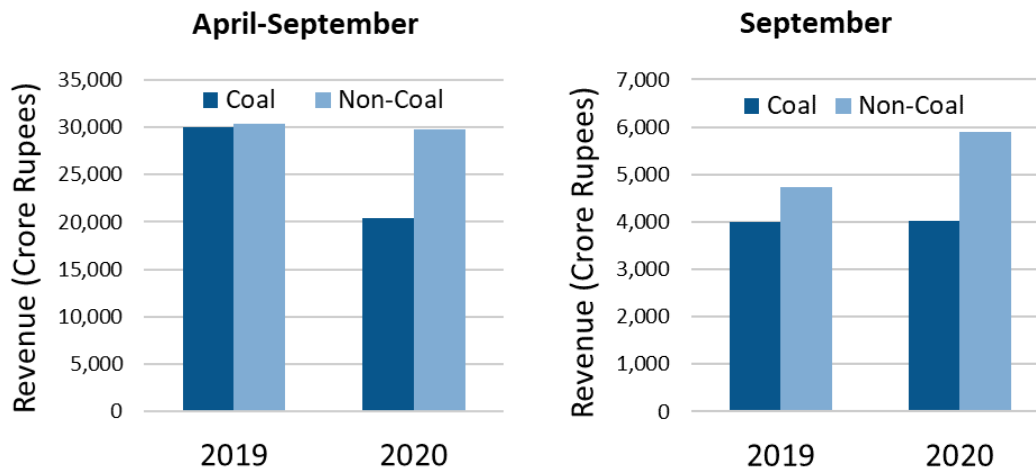
<sup>15</sup> Govt. of India Press Information Bureau Release ID: 1617462. 23 April, 2020.



wagon wheel-sets from Bengaluru to Kolkata, fly-ash from Telangana to Karnataka, and roll-on roll-off intermodal trucks from Karnataka to Maharashtra.

By September, coal freight had fallen by 2% to 17,863 NTKMs from the corresponding month the year before, while all other freight had increased 29% to 40,309 NTKMs. Consequently, there has been a corresponding change in freight revenue. Between April and September, revenues for coal had fallen by one-third, but non-coal freight had seen only a minor drop. With many of the new arrangements well in place by September and some economic recovery underway, coal revenues had recovered by that month, but non-coal freight was earning 24% more than the previous year (Figure 3).

**Figure 3: Freight Revenues for 2019 and 2020**



Data source for figure: Indian Government, Ministry of Railways, Revenue Freight Traffic Statistics, September 2020.

In summary, during the pandemic freight trains have moved more freight and a greater diversity of cargoes, at twice the speed, bringing in new revenue.

Some of this transformation in freight services can be attributed to urgent improvements to loading facilities, streamlined services such as zonal Business Development Units and a range of incentives, but it is also a manifestation of the latent freight demand that in normal times had simply been squeezed off the rails by too much traffic on the network.

### *Improved Logistics an Economic Imperative*

Strengthening and diversifying India's rail freight is not an objective that should be the chance outcome of the COVID-19 pandemic. There is ample evidence that economic development is held back by high costs and inefficiencies in transport and inventory.

A recent NITI-Aayog report noted that 25% of vaccines are wasted because of the absence of refrigerated transport, and that while only 4% of India's fruit and vegetables are transported through cold chains, the comparable figure in the U.S.A. is 85%. In consequence, agricultural products have a wastage rate as high as 40%.<sup>16</sup>

The same report noted that the final price of goods in India has a higher component attributable to transport than many countries, and a substantially greater component due to high inventory levels. Rail in India was specifically mentioned as being insufficiently reliable to allow the minimisation of buffer stocks held by suppliers and customers.

As India's economy moves towards flexible manufacturing and the rural sector develops more non-agricultural economic activity, just-in-time delivery and reliability will become even more necessary.

Extending rail freight diversification and maintaining fast and reliable schedules are critical if India is to develop a more robust, dynamic and sustainable post-pandemic economy.

## Hard Choices Confront Indian Railways When Passenger Services Resume

Without major changes to the prioritisation and scheduling of rail traffic, freight speeds will inevitably revert to their earlier levels on the resumption of passenger traffic, and many of these gains in new services risk being lost.

For this reason, a fundamental re-evaluation of traffic priorities is required. One principle that could be followed is to avoid adding traffic volume beyond the point where speed and reliability can be maintained.

The revised passenger timetable should relieve some of the congestion pressures, but seeking to diversify freight and make it attractive for high value cargo (not just in revenue terms but as a means of underpinning a more diverse and efficient economy, and reducing road congestion) should also be prioritised. As one commentator has noted: "Indian Railways must think of itself as part of a supply chain rather than a stand-alone competitor."<sup>17</sup>

A first step in making these hard choices is to re-think how much bulk freight is necessary and desirable. This was a clear recommendation of the latest 'Lok Sabha' Standing Committee on Railways report:

*"The situation has been further aggravated by the recent slump in the demand for coal and cement which used to be the mainstay of the Railway freight basket. In this context, the Committee would like the Railways to explore diversification of its freight business so that they do not remain fully dependent*

<sup>16</sup> Government of India, NITI Aayog. [Goods on the move. Efficiency and sustainability in Indian logistics](#). September 2018.

<sup>17</sup> Observer Research Foundation. [Three reforms to put railways on fast track](#). 28 July, 2016.

*on carrying traditionally bulk commodities like cement, coal and iron ore.”<sup>18</sup>*

While there are currently no good alternatives to rail transport of cement, or iron ore and coking coal for steel, this can no longer be said of thermal coal for power. Indeed, a glib but instructive view of transporting coal by rail to distant power plants is to consider it as solid electricity being inefficiently moved along an inflexible one-way path, each coal rake carrying about 6,000 MWh of energy.

### *A Rapidly Changing Coal Demand Outlook Calls Into Question Plans for ‘Urgent’ Expansion of Coal by Rail*

Dozens of projects to increase rates of coal evacuation are currently in progress or are planned, many initiated a decade ago at a time when power-plant coal shortages were a regular occurrence. The projects variously involve new lines and spurs, doubling or even quadrupling of lines, and other enhancements such as improved coal loading facilities.

With the time lags inherent in planning and building new infrastructure, a number of these projects are coming on-stream and ground is being broken on others just as thermal coal demand growth has faltered.

These plans reflect the ambitious one billion tonne production goal for Coal India Limited, first set in 2015 for the current financial year 2020-21, then postponed to 2025-26 when it became clear that the original time frame was far too ambitious, and recently brought back to 2024 by Coal Minister Pralhad Joshi who stated that:

*“Power demand is rising so fast and steeply that there is enough opportunity for both government and private sectors to produce coal without adversely impacting each other.”<sup>19</sup>*

Minister Joshi also cited the need to cut import bills by phasing out imported coal. However, neither import substitution nor power demand projections warrant such urgent expansion, particularly in light of the post-pandemic economic outlook.

Nevertheless, just as the pandemic was emerging in February 2020, the Coal Ministry held a ‘Chintan Shivir’ (planning retreat), at which the CEO of the Chhattisgarh East Railway Ltd laid out plans for the evacuation of an additional 370Mt of Coal India production in the next four years, mostly by rail, boosting daily

**Consider transporting coal by rail to distant power plants as solid electricity being inefficiently moved along an inflexible one-way path.**

<sup>18</sup> Standing Committee on Railways (2019-20), (Seventeenth Lok Sabha). [Third Report, Demands for Grants \(2020-21\)](#). March 2020.

<sup>19</sup> Economic Times. [Coal India advances target for one billion tonnes production by two years to 2024](#). November 2019.

coal rake loading by 63% from 276 to 450 rakes per day. A potential further addition of 250Mt from captive and commercial mining needing primarily rail evacuation was also flagged, requiring “a massive capacity enhancement in Railway system”.<sup>20</sup>

This rate of increase would imply an additional 159Mt supplied by rail to thermal power plants by 2024, given that they received 43% of the total amount of coal moved by rail in 2018-19.<sup>21</sup> Yet even before the 2019 economic slowdown and the 2020 pandemic, there were no plausible forecasts suggesting coal-fired power plants will require so much extra coal. The Kamboj and Tongia report,<sup>22</sup> for example, anticipated 60-104 million additional tonnes to be supplied to power stations by rail in 2030, equivalent to between 36 and 61Mt more by 2024.

The International Energy Agency’s (IEA’s) recently released World Energy Outlook (WEO) 2020<sup>23</sup> estimates the power generation by source for 2025 and beyond, factoring in the effects of COVID-19. Under its ‘Stated Policies Scenario’, it can be estimated that an extra 32Mt would be needed in India by 2025 compared to 2020, and 118Mt less under its ‘Sustainable Development Scenario’. These are shown in Figure 4 together with changes in thermal coal requirements based on The Energy and Resources Institute’s (TERI’s) independent electricity demand projections.<sup>24</sup> Converted to coal consumption, TERI’s baseline forecast for 2025 indicates a need for only 12Mt more thermal coal – even if renewables take no additional share of generation.

In fact, data from Central Electricity Authority reports show that thermal plants have lost an average 1.75% share of total generation each year for the last four years. On that trend, the TERI baseline forecast for 2026 sees 59Mt less coal burned for power in 2026 than 2020, despite overall power generation increasing.

The full range of additional coal requirements estimated from the WEO 2020, the three TERI post-COVID scenarios and one pre-COVID estimate, and the pre-COVID 2025-26 forecast from the 2017 Electrical Power Survey are shown in Figure 4, the last five with and without coal generation’s share continuing to fall at the trend rate.

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<sup>20</sup> Jha, JN [One Billion Tonne Strategy for Coal Evacuation](#) CERL. February 2020.

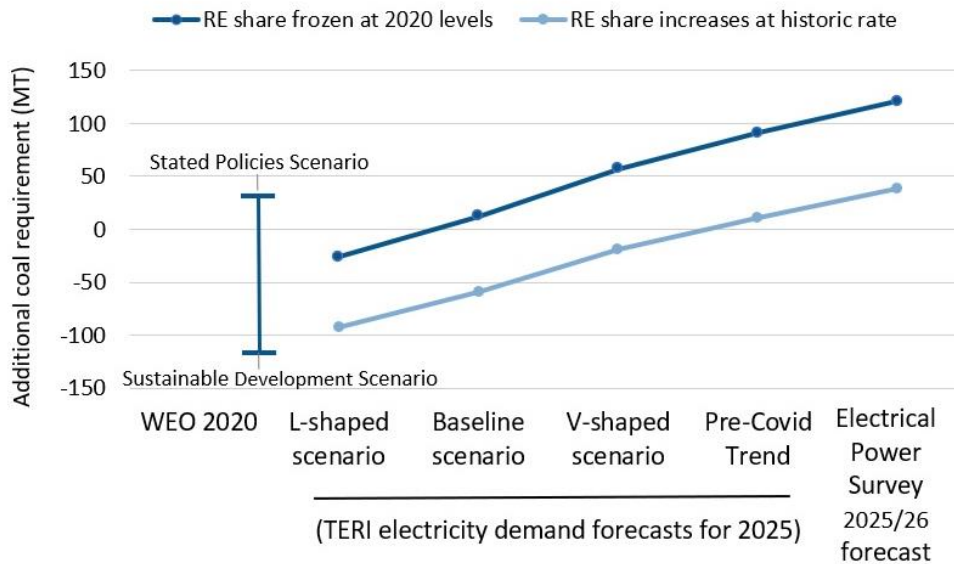
<sup>21</sup> Government of India, Ministry of Railways, Railway Board. [Indian Railways Annual Statistical Statements, 2018-19](#).

<sup>22</sup> Kamboj, P & Tongia, R. [Indian Railways and Coal: An Unsustainable Interdependency](#). Brookings India, 2018.

<sup>23</sup> International Energy Agency, [World Energy Outlook 2020](#).

<sup>24</sup> TERI. [Bending the curve: 2025 forecasts for electricity demand by sector and state in the light of the Covid-19 epidemic](#). 2020.

**Figure 4: Additional Coal Required for Power in 2025 Based on Pre- and Post-Pandemic Electricity Demand Forecasts**



Data sources for figure: IEA *WEO 2020* and TERI, *Bending the curve: 2025 forecasts for electricity demand by sector and state in the light of the covid-19 epidemic, 2020*.

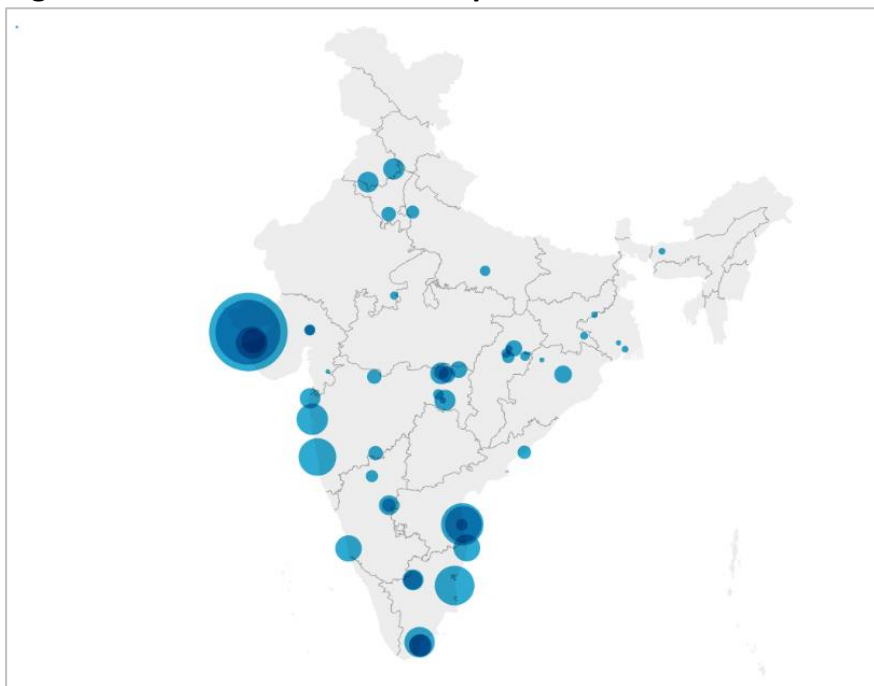
Although the range of forecasts is wide, the quantum of net new coal evacuation capacity and urgency of its construction presented at the Chintan Shivir seem significantly overstated. This has produced a situation quite unlike that in China a decade ago, where new rail infrastructure increased coal movement because it preceded a sustained period of rapidly increasing coal demand.<sup>25</sup>

### *Substitution of Imported Coal Possible With More Focused Infrastructure Development*

Although the substitution of imported thermal coal with domestic production is unlikely to be achieved rapidly or completely, the goal of reducing India’s coal import bill and harvesting precious foreign currency reserves is strategically and financially sensible.

Analysis of recent thermal power plant imports show that import substitution would not impose a major burden on Indian Railways. CEA data for the 2019-20 financial year shows that all but 12Mt of coal imported for power stations was shipped directly to coastal power plants (Figure 5).

<sup>25</sup> Rioux B, et al. *Economic impacts of debottlenecking congestion in the Chinese coal supply chain*. Energy Economics, 60, p.387-399 November 2016.

**Figure 5: Destinations of Coal Imported for Power Plants, 2019-20**

Source: IEEFA analysis of CEA monthly coal statements. Map data © OSM. Created with Datavrapper.

Note: Circle sizes are proportional to annual consumption of imported coal.

Coastal plants took 57Mt of the total 69Mt, with the Mundra plants in Gujarat being the largest customers. Inland customers are widely scattered and many used relatively small quantities of imports. Replacing those quantities with domestic coal should not be unduly difficult, in part because the imports to be replaced were themselves largely supplied by rail. Any additional rationalisation of coal linkages, and the potential closure of some older plants<sup>26</sup> may further ease the transition.

A factor that does increase the logistical cost of import substitution is the recent dropping of requirements for thermal plants to use washed coal.<sup>27</sup> This would mean that much more high-ash coal (per unit of electricity generation) would require transport to those plants currently using lower-ash imported product.

The larger question concerns changing the supply for coastal plants. Plans to move coal from the Eastern coalfields to the Odisha port of Paradip (and others in that state as well as Andhra Pradesh), for the supply of southern coastal plants by rail and ship, are under implementation. A doubling in supply of coastal power plants with coal from the Mahanadi coalfields to over 60Mtpa by 2024 has been

<sup>26</sup> [India to replace coal fired power plants with renewables – minister](#). Reuters, 7 Oct 2020.

<sup>27</sup> [Thermal power plants allowed to use coal with high ash content](#). Economic Times, 26 May 2020.

forecast.<sup>28,29</sup> The addition of new lines feeding these ports may represent a more sound approach than rail projects serving unspecified new demand in northern and western India that may never fully eventuate.

It remains unclear whether the economics of domestic coal by rail-and-ship would allow an extension of these plans to supply the west coast plants, which would involve longer shipping routes. The longest of all such shipping routes would be to the large Mundra plants, replacing the 27Mt of imported coal they used in 2019-20.

This would have to be competitive not only with the current importing arrangements, but with coal sent westward by rail, potentially even using some sections of the forthcoming Dedicated Freight Corridors (although connectivity and capacity through Rajasthan and Gujarat may be an issue), and consequently they are likely to remain dependent on imported coal for some time.

### *Dedicated Freight Corridors*

Although they are the flagships of India's rail freight modernisation plans, neither of the first two Dedicated Freight Corridors, announced in 2005 and due for completion in 2021, carry the same risks as the coal region projects.

The 1,483 km Western Freight Corridor from Mumbai to Dadri in UP was always envisaged as primarily an intermodal container traffic line, with coal making up only a modest proportion of its cargo (Table 1).

By contrast, the 1,839km Eastern Freight Corridor linking Dankuni in West Bengal with Ludhiana in Punjab, was planned with coal as the dominant form of freight. It has the potential to relieve other lines of almost the entire thermal coal requirements for Punjab, Delhi, Haryana, Rajasthan and Uttar Pradesh, which amounted to 119Mt in 2018-19.

This should create significant scope for improved passenger services across the Ganges Basin, whose states are home to 560 million people and where some of the greatest rail congestion occurs currently. But if it is used to shift coal efficiently and at lower cost, it may also further weaken the business case for some of the new coal evacuation projects targeting the north but using other lines.

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<sup>28</sup> Coastal shipping of coal to double in 6 years: Crisil Research. Economic Times. 18 January, 2018.

<sup>29</sup> Indian Port Rail & Ropeway Corporation Ltd. (IPRCL). Progress of IPRCL Projects.



**Table 1: Expected Coal and Non-Coal Traffic on Dedicated Freight Corridors**

		2020	2021	2022	2023	2024
EFC	Coal (MT)	110.49	114.9	119.5	124.28	128.26
	Other (MT)	201.26	210.19	219.57	230.59	240.42
	% Coal	54.9	54.7	54.4	53.9	53.3
WFC	Coal (MT)	23.3	24.2	25.2	26.2	27
	Other (MT)	143.8	154.8	167.1	181.3	191.5
	% Coal	16.2	15.6	15.1	14.5	14.1

Data source for table: DFCCIL Corporate Plan, 2020-2024.

### Financial Risks of Coal Evacuation Projects

If thermal coal demand stays flat or growth remains depressed, as IEEFA projects, there is a possibility that over-building rail evacuation infrastructure may lead to stranded assets and some unviable projects.

This possibility was recognised even when a far rosier view of demand growth was being taken. One example concerns the Gevra Road-Pendra Road line, a Rs.49.7 billion joint venture project which is intended to bypass the crowded Bilaspur line with a new 135km double track carrying about 65Mt annually. To start with, this project required the ministerial approval of inflated charges in order to be viable:

*“MoR has sanctioned 60% inflated Mileage to ensure Project IRR of 14%”<sup>30</sup>*

Further, a presentation on the project six years ago acknowledged its susceptibility to lower than expected demand:

*“Based on the traffic projection (initial traffic and growth), the project is considered bankable. There will be negative cash flow for the first 15 years (up to the level of 40Mtpa). There may be cause for concern in case traffic projections are not met.”<sup>31</sup>*

In several of the demand outlook scenarios, this single project would account for more new coal movement than may be required by all India’s power plants in the next few years, but it is only one of many such projects for enhanced rail evacuation in Chhattisgarh, Jharkhand, Odisha, Madhya Pradesh and elsewhere.

Moreover, despite the details of the financing arrangements being unclear, the burden of any financial risk may fall unevenly on participants and could even hurt the railways in the long run.

The Gevra Road-Pendra Road project, for example, is a joint venture with South East Coalfields Limited having a 64% stake, India Railways’ construction arm IRCON

<sup>30</sup> Jha JN, *One billion tonnes strategy for evacuation, Chintan Shivir meeting*. February 2020.

<sup>31</sup> IRCON International Limited. *Chhattisgarh Rail Corridors*. 2014.

26%, and the State of Chhattisgarh 10%.<sup>32</sup> Rs.39.76 billion have been borrowed from a consortium of banks led by the State Bank of India (all six of which were recently rated lower than private banks in provisioning for non-performing assets<sup>33</sup>).

It is likely that one branch of Indian Railways (IRCON) will recoup its investment first, once it is paid for constructing the line. But if demand expectations are not met, India Railways as a whole risk generating less revenue than required to repay the incurred debt. South Eastern Coalfields Limited may well have the technical capacity to extract all the projected new coal, but this would have value to them only to the degree it has customers. While this and other projects may eventually turn out to be profitable, their viability rests on the high degree of supply-side optimism from the proponents proving to be correct over the next 25 years.

The use of this one CERL project is intended to illustrate the challenges, rather than to suggest it is especially vulnerable. Indeed, unlike some other projects, it has the merit of providing new passenger trains to an un-serviced region, and there are competing projects, such as the Jharsuguda-Sardega line doubling in the Ib Valley, with reportedly higher cost (Rs.25 billion in total) and smaller evacuation targets (though at 40Mt still substantial).<sup>34</sup> Nor are all projects efficiently used once the rail infrastructure is in place. At the end of last year, the Jharsuguda-Sardega line was reported to be well short of capacity “as of December 2019, the line was underutilised with barely six rakes (approximately 8.5Mt [per year]) moving daily” because of mine works being incomplete.<sup>35</sup>

Similarly, the much-heralded and long-delayed Tori-Shivpur line was long argued to be a critically important coal project. Former chairman and managing director of Central Coalfields Ranjan Kumar Saha was quoted as saying in 2014 that “The problem is the government has not understood the urgency of the projects. Building the tracks is not a choice. It’s a must.”<sup>36</sup> Yet when completed four years later, it was reported that rather than seeing the evacuation of the projected 100Mt annual production, “barely half-a-dozen or fewer rakes, capable of moving 6-7Mt annually, are despatched every day via this line. This is because state-owned CIL’s subsidiary Central Coalfields Ltd (CCL) failed to ensure the construction of the necessary rapid loading system, which includes a U-shaped loop line connecting the mine head and two mechanised loaders.”<sup>37</sup>

The potential for these kinds of capital projects to be unremunerative was noted in the Comptroller and Auditor-General’s most recent report on Indian Railways. A

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<sup>32</sup> Energyworld. [CEWRL signs pact with SBI-led consortium for funding rail line project to evacuate coal](#). 5 May, 2020.

<sup>33</sup> Quartz India. [India’s banks are preparing for the worst—but the crisis could actually be worse](#). 10 September, 2020.

<sup>34</sup> Business Today. [Mahanadi Coal Fields to invest Rs 60,000 crore in Odisha](#). 21 June, 2020.

<sup>35</sup> Business Line. [Key Jharkhand rail link lies almost idle as CIL fails to implement peripheral projects](#). 22 January, 2020.

<sup>36</sup> Economic Times. [Sunday ET: Non-populist railway project: Coal rail lines in Jharkhand, Odisha and Chhattisgarh languish due to lack of funding](#). 26 January, 2014.

<sup>37</sup> Business Line. [Key Jharkhand rail link lies almost idle as CIL fails to implement peripheral projects](#). 22 January, 2020.

total of 79 projects were found to have a rate of return less than the desired threshold, or even negative. All of the 18 negative rate of return projects were new lines or line doublings.<sup>38</sup>

## New Opportunities to Enhance India's Energy Transformation

If Indian Railways takes a more measured approach to the movement of thermal coal and continues to focus on broader, more reliable and faster freight services, this does not mean that it has to forgo its role in supporting India's energy needs.

Even by 2018 Kamboj and Tongia had recognised that moving latent electricity in the form of coal was becoming increasingly uncompetitive compared to moving actual electricity on transmission lines:

*"Assuming a notional power plant with a specific coal consumption of 0.63 kg/kWh (average value for mid 2016) located at varying distances between 100km and 2,000km from coal mines, the transportation cost of coal by railways per unit of electricity generated is as low as Rs.0.13/kWh for 100km and as high as Rs.1.85/kWh for 2,000km."*

Furthermore, they noted that while new wagons can be added more quickly than transmission lines can be erected, building new rail lines is even slower.

Developments in High Voltage Direct Current (HVDC) technology and burgeoning renewable electricity generation has made a flexible and efficient grid both more possible and more necessary. India's existing HVDC lines are strung across conventional towers. But while these are relatively inexpensive, they carry other significant drawbacks. These include sometimes lengthy delays negotiating land rights and organising the necessary compensation to farmers and other land-holders, and in the case of forests, wetlands or other environmentally sensitive regions, overhead transmission lines inevitably cause some unavoidable loss of vegetation and habitat, and protracted approval processes for obtaining forest clearances may delay their construction.

One commentator has suggested that transmission rather than renewable generation is the rate-limiting step of India's clean energy transition:

*"With the transmission system failing to keep pace with the increase in solar power generation, the glaring mismatch is bound to put immense pressure on the present transmission infrastructure."<sup>39</sup>*

For these reasons there is an opportunity for Indian Railways to urgently evaluate the potential for locating underground HVDC lines on suitable sections of their right

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<sup>38</sup> Comptroller and Auditor General of India, Report No.8 of 2020 - Union Government (Railways), Railways Finances.

<sup>39</sup> Economic Times, Hartek Singh. [Why renewable energy evacuation demands a decisive push](#). 26 December, 2017.

of way. Whether publicly owned or operated by Power Grid Corporation of India Limited (PGCIL) or leased to private transmission companies, electricity transmission could become a valuable new revenue stream for Indian Railways. Organisationally there is already a precedent in the government-owned RailTel, with its 55,000km of optical fibre alongside tracks, that reports to the Ministry of Railways.

The feasibility of such HVDC lines depends on several technical as well as economic factors. A chapter on technical and environmental challenges for underground HVDC in the USA Supergrid report<sup>40</sup> has recommended burying HVDC cables at least 1.2m to prevent accidental damage, manage electromagnetic radiation, interference with fiber-optic cables, and heat dissipation. Some soil types were reported as being more suitable than others, as their properties would allow back-filling of trenches with the excavated material, rather than with engineered soils. These include soil types common in India, including entisols, common in alluvial regions such as the Ganges Basin, and inceptisols and aridisols, found in desert regions, where a high proportion of renewable generation is located. Soil depth is also important, as excavating shallow bedrock is more difficult and costly. The same report noted that it may even be possible to lay HVDC cables in the sub-soils directly beneath, rather than adjacent to tracks.

A recent report by the U.S. Federal Energy Regulatory Commission, which noted HVDC's potential to "improve the reliability and resilience of the transmission system by allowing utilities to share generating resources, enhance the stability of the existing transmission system, aid with restoration and recovery after an event, and improve frequency response and ancillary services throughout the existing system", also specifically reviewed the use of transportation corridors and some of the technical challenges and limitations of siting HVDC along railway lines.<sup>41</sup>

Underground cables are generally much more costly to build than overhead cables, but the use of rail right-of-way in India at scale could bring down these additional costs. Apart from the efficiencies gained by avoiding clearances and compensation payments, railways make access for the construction crews and supplies relatively straightforward, and a degree of mechanisation could be developed to further reduce costs. In the short term, schemes of this kind could also provide much-needed non-agricultural rural employment.

HVDC on railway right-of-way is already underway in the U.S., where the SOO Green Link HVDC line is planned to evacuate renewable energy from north-central Iowa to just west of Chicago, using a pair of cross-linked, insulated polyethylene cables carried in conduits. For much of the route, simple open trenching and back-filling is

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<sup>40</sup> Climate Institute, [North American Supergrid: Transforming Electricity Transmission](#). 2019 revision.

<sup>41</sup> U.S. Government, Federal Energy Regulatory Commission, [Report on Barriers and Opportunities for High Voltage Transmission](#). A Report to the Committees on Appropriations of both Houses Of Congress pursuant to the 2020 Further Consolidated Appropriations Act, 2020.

to be used to bury the cables about 1.5 metres below the surface, with some drilling and other methods required depending on geological conditions.<sup>42</sup>

A second U.S. project, the 1,000 megawatt (MW) Champlain Hudson Power Express, will bring energy from the Canadian border 540km to New York City and also makes use of HVDC buried beside railway lines, as well as roads, and finally tunnelling beneath the Hudson River.<sup>43</sup>

The combination of these detailed scoping reports and actual projects, together with a recognition of the need to overhaul America's electricity transmission system if energy and environmental goals are to be met, has led incoming U.S. President Joe Biden to explicitly advocate the use of road and rail corridors for transmission infrastructure, in part to alleviate the delays caused by obtaining the permissions required from private land-holders and public authorities, a problem in both the U.S.A and India.<sup>44</sup>

As an example of the potential for such projects in India, the 400 kilovolt (kV) Green Corridor HVDC line connecting Pugalur in the south with Raigarh is relevant. This project uses over 4,000 conventional towers and spans a total length of 1,765.5km. The first leg of what will ultimately be a 6,000MW capacity transmission line was commissioned in September. It has taken years to complete, and experienced delays in Tamil Nadu due to "severe RoW (right-of-way) issues", and "huge forest involvement (432 Ha.) in WR portion."<sup>45</sup>

Without commenting on the geological conditions or logistical suitability of the rail routes that could have served as alternatives, it is nevertheless worth noting that a marginally shorter 1,754km route length was available via east coast railway lines between Raigarh and Pugalur, or a somewhat longer 2,185km more westerly inland option via Nagpur. Of course, hybrid projects could circumvent geologically unsuitable sections with overhead transmission.

An almost unique strength of Indian Railways is the extent of its network, with route lengths totalling 67,000km reaching almost every part of the country. There are rail routes in the vicinity of almost all renewable generation regions and virtually every significant load centre.

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<sup>42</sup> SOO Green Link [Project Overview](#).

<sup>43</sup> Champlain Hudson Power Express [Project Overview](#).

<sup>44</sup> GreenTech Media. [Biden Pledges \\$2T in Clean Energy and Infrastructure Spending](#), July 2020.

<sup>45</sup> Government of India, Ministry of Power, Central Electricity Authority. [Monthly Progress report of Cross border/ Inter-Regional/ Inter-State Transmission Schemes](#) (As on 31.05.2019).

Along with the number of renewable energy projects already completed in India's south and west, and the expectation that far more capacity is to be added in coming years, the ubiquity of potential routes should make cooperation between PGCIL and Indian Railways on one or more demonstration projects a high priority.

Indian Railways has served the nation proudly since its inception and has undergone many types of transformation. Minister Goyal's calls for renewal, a recently restructured Railways Board<sup>46</sup> in the throes of adopting a National Rail Plan,<sup>47</sup> and new economic conditions create both the need and the opportunity for a further period of innovation – one that bolsters a more flexible, reliable and rapid set of freight services that decongests India's roads, and steps back from its excessive and increasingly risky reliance on coal freight. Further, Indian Railways can add to its developing role as a major generator of renewable energy by giving priority to the evaluation of new and potentially lucrative transmission routes, thus supporting a stronger and more flexible grid and further facilitating India's remarkable clean energy transition.

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<sup>46</sup> Financial Express. [Railway Board structure revised! Here's the work distribution of Indian Railways' board members](#). 10 September 2020.

<sup>47</sup> International Railway Journal, [Indian Railways to adopt National Rail Plan](#). 2 November 2020.

## About IEEFA

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*The author thanks Thomas Spencer, Fellow at TERI, for comments on an earlier version of this report.*

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