



सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF  
**COAL**

A large yellow mining truck is shown in a coal mine, driving on a dirt road. The truck has the number '1382' on its side. The background shows a large, dark, rocky hillside, likely a coal seam, under a cloudy sky.

# Technology Roadmap for Coal Sector

# *Volume- I*

## *Part-A*

# Table of Contents

Disclaimer .....	3
1. Introduction .....	4
2. Underground Coal Mining Technologies .....	6
3. Opencast Coal Mining Technologies .....	10
4. Transportation.....	17
5. Communication.....	23
6. Safety in Underground & Opencast Mines .....	31
7. Information Technology/Artificial Intelligence/ IoT .....	37
8. Survey/Mapping .....	50
9. Exploration .....	53
10. Mine Planning & Scheduling .....	57
11. New Initiatives .....	59
12. Research & Development .....	63
13. Environment & Sustainability .....	69
14. Worldwide New Technologies.....	76
15. Business Models .....	84
Annexure-1: Minutes of meeting on the direction of Hon'ble Prime Minister, chaired by Secretary Coal on 27 <sup>th</sup> September 2021 .....	86
Annexure-2: Coal India as compare to leading global coal miners in terms of digital initiatives: .....	92

## **Disclaimer**

*Technology Roadmap for Coal Sector is a document prepared based on the information available on public domain and inputs provided by various stakeholders.*

*It is a document for coal companies for information purpose to adopt new technologies in time bound manner. In addition to Technology Roadmap, the quantification of benefits of Technology Roadmap has been done for the purpose of getting actual no. of applications feasible in today's scenario.*

*The content in this report do not comprises any technical, legal & professional advice. Coal companies should consult technical & financial advice before implementing any of the Technology proposed and should do cost benefits analysis.*

*Ministry of Coal does not own responsibility for any loss. Further Ministry is not liable to any claims. Users are strongly advised to take firm decisions based on their own analysis.*

*Feedback for further improvement and updating in content as well as design in publication is solicited and would be appreciated. It is requested to send your valuable suggestions to [socrc.moc@nic.in](mailto:socrc.moc@nic.in).*

## 1. Introduction

Coal is the most important and abundant fossil fuel in India. Coal-fired power plants meet 72% of India's electricity demand. Presently India is the second largest producer of coal in the world after China. India had a total coal resource of 344.02 Bt the total lignite reserve stands on 46.02 billion tons. Commercial primary energy consumption in India has seen a rise of 700% over the last four decades. The major factors for the increase in demand of energy sector are expanding economy, rising population, moreover the improvement of quality of life. The limited potentiality of other energy sources will lead to the continuation of coal as the primary resource in India's energy scenario for the next few decades. However, due to the high demand and poor average quality, India has to import coal of higher quality mainly to meet the requirements of its steel plants, cement plants, sponge iron plants etc.

Coal India has a target of achieving 1 billion tonnes by 2023-24. To reduce the dependency on imports, it is critical for CIL to reach the 1 Bt target, thereby embarking on a technological transformation journey. New technologies can have a number of impacts on mining operations, including safety and productivity, environmental protection and opportunities for women. Safer working conditions through improved underground communication, automation, more sophisticated mineral and metal transportation, and emergency response measures are achieved by integrating technology into mining projects. Technological advancements in mining are also making operations more productive.

The objective is to implement new technologies and build digital infrastructure to support current and future ramp-up for the mines. This involves a strong, multi-speed backbone information technology and infrastructure system that allows rapid deployment of new technologies. Creation of such system would require access to new-age ecosystems (e.g., start-ups, established vendors, research institutes, etc). The technological transformation will also entail creation of a new culture in the organisation.

A new way of thinking will be inculcated in the entire organisation. A technology transformation team to be set in place to drive impact and sustain the program with established Centre of excellence. A robust tracking and change management mechanism to be deployed to ensure timely resolution and delivery.

The scope of this roadmap is as follows:

- Technology enablement in coal mines for transformation across business value chain.
- Leveraging 'Digital Technology' as an accelerator for demonstrating performance enhancement from in the coal mines.
- Defining Coal sector's technology transformation ambition and prepare workforce in Coal Sector for Industry 4.0 Digital Technology.

- Increasing productivity, safety & sustainability while mean time reducing environmental impact by upgrading conventional technologies to new technologies.

## 2. Underground Coal Mining Technologies

### 2.1. Present Technologies

#### 2.1.1 Semi Mechanized Methods:

Currently, most of CIL mines using Bord & Pillar remove coal from the face by blasting & deploy SDL or LHD for loading and transportation of coal in the active mining areas. Coal transportation to surface is either by a series of belt conveyors or rope haulage drawn coal tubs.



Side Discharge



Load Haul Dump

#### 2.1.2. Continuous mining

In many of CIL new underground mines, bord & pillar mining is carried out using Continuous Miner method where geo-mining conditions permit.



Continuous Miner



Shuttle Car

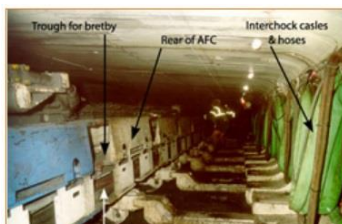


Quad Bolter

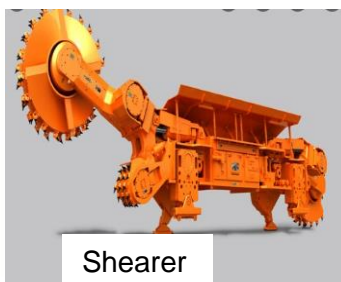
At present 17 Continuous Miners with a capacity of 7.46 Mt has been deployed in mines and another 41 mine CMs of 17.85 Mt capacity are under pipeline for future commissioning

#### 2.1.3. Longwall

Fully mechanized underground mining method where the roof at the coal face is supported by self-advancing powered supports & the coal is mined by a shearer.



Armed face Conveyor



Shearer



Powered Support

## 2.2. Way Ahead for New Technologies

S. No	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
2.2.1.	Discontinuation of Drilling and blasting	<ul style="list-style-type: none"> <li>✓ Drilling Blasting process for coal preparation shall be discontinued.</li> </ul>	All profitable underground mines wherever geo mining conditions feasible				
2.2.2.	Longwall Mining	<ul style="list-style-type: none"> <li>✓ Longwall mining has advantage of high recovery, lower operating cost, easier to supervise, works under weak roofs.</li> <li>✓ Longwall is applicable in preferably flat and uniform (dip less than 12 degree) &amp; Deposit size- large areal extent &amp; uniform thickness</li> </ul>	All new mines wherever suitable				
2.2.3.	Phasing out of SDL/LHD	<ul style="list-style-type: none"> <li>✓ SDL/LHD to be phased out from all underground mines.</li> <li>✓ Task force to oversee this in existing mines.</li> <li>✓ PR revision if conditions favorable</li> </ul>	All underground mines wherever geo mining conditions suitable				



S. No	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
2.2.4.	Continuous Miner	✓ Continuous miner/ Bolter miner /RH/LW/SW/HM shall be introduced in underground mine for cutting coal wherever applicable.	All new mines wherever suitable geominig conditions				
2.2.5.	Amalgamation	✓ Small mines to be amalgamated to larger mines to make the mine profitable with high mechanization.	Implementation				
2.2.6.	R&D initiatives	✓ For liquidation of coal from deep UG mine R&D Initiatives (Coking coal) shall be taken up.	Implementation				
		✓ For new Backfilling Technologies in underground mines such paste fill, aqua fill etc	Paste Fill technology (using Fly ash rejects of power plants) in 4 mines of ECL is under consideration through R&D/pilot route.				

S. No	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
2.2.7.	New alternative combinations	<ul style="list-style-type: none"> <li>✓ Use of Road Header for production of Coal.</li> <li>✓ Road Header in combination with LHD, Roof Bolter &amp; belt conveyor.</li> <li>✓ Currently in use at Sial Ghogri Mine, Chindvara MP.</li> </ul>	Trial & Implementation				
2.2.8.	Technology Transformation cell	<ul style="list-style-type: none"> <li>✓ A dedicated team of persons having acceptability towards u/g mechanization culture positively need to be made from existing employees who are to carry the technology transformation at our u/g mines with sufficient coal reserve potentiality at the mine leasehold.</li> </ul>	All Mines				
2.2.9.	Centralised control room	<ul style="list-style-type: none"> <li>✓ Each mine shall be established for maintenance, monitoring, and supervision.</li> </ul>	All Mines				

## 3. Opencast Coal Mining Technologies

### Present Technologies

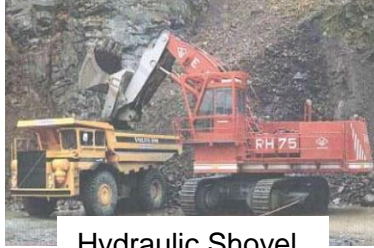
#### 3.1 Cyclic Mining

##### 3.1.1 Shovel Dumper:

- ✓ It is the most sought-after technology in opencast mining due to its inherent flexibility of operation. It also offers flexibility for easy transition to any other technology or equipment configuration.



Rope Shovel



Hydraulic Shovel

- ✓ CIL has fast tracking the process of procuring 360 high-capacity mining equipment valued at over Rs 7000 crore to bolster production after reviving the one billion tonne production target.
- ✓ 201 nos. new High Capacity HEMMs have been commissioned during 2020-21 (10 cum & higher bucket capacity Shovels – 14 nos., 150 T & 190 T Rear Dumpers – 144 nos. and 460 HP & 850 HP Dozers – 43 nos.).

##### 3.1.2. Dragline:

- ✓ Dragline mining is the most cost-effective technology for the bedded deposits and is the first-choice technology for large opencast mining. Total of 32 draglines are in use in Coal India Ltd. of which maximum no. of 23 are in NCL.



Dragline

- ✓ Purchase Orders for 5 nos. 24/96 Dragline amounting to Rs 2400 Crores and 96 nos. 240T dumpers amounting to Rs 3200 Crores have been placed.

#### 3.2. Continuous Mining

##### 3.2.1. Surface Miner:

- ✓ They mine commodities selectively, ensuring a high quality and optimum exploitation of the deposit. Does not need drilling blasting.

Total surface miners in CIL are 41, of which 8 are in NCL, 23 are in MCL and 10 are in SECL.

✓



Surface Miner



Bucket Wheel Excavator

✓

### 3.2.2. Bucket wheel excavator (BWE):

- ✓ BWE's are continuous cutting machines for soft to semi hard materials like clay, sand, gravel, as well as lignite and hard coal. The BWE is a Continuous Mining Technology and works in conjunction with Conveyor belts & Spreaders.

3.3. In the Financial year 2021-22, it has been planned to procure High-Capacity Equipment of more than Rs 9000 Crores viz, 1 no. Dragline, 35 nos. Shovels, 112 nos. Dumpers and 43 nos. of Dozers for achieving the enhanced coal production target in the coming years.

Taking initiative for efficient and environmentally friendly evacuation of coal through rail, initiative has been taken for building rail infrastructure both on 'Deposit Basis' as well as by forming SPVs with Rail PSUs and the concerned State Govt. CIL plans to increase mechanized evacuation from 150 million tons to 665 million tons by FY24.

- ✓ 7 railway lines – estimated investment of INR 20,000 crore
- ✓ 21 railway sidings – estimated investment of INR 3,750 crore.
- ✓ 24 FMC Rail Connectivity Projects at an estimated INR 3,400 crore
- ✓ 33 coal trunk roads planned to be built by FY24

### 3.4. Way Ahead for New Technologies:

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
3.4.1	In-pit crushing & conveying	<ul style="list-style-type: none"> <li>✓ Should be introduced in phased manner in all big opencast mines with flatter gradients.</li> <li>✓ In pit crushing of coal is generally found to be economical in high-capacity opencast mines where reasonable lead distance and lifts are involved.</li> <li>✓ Depending on individual parameters, it can achieve full or partial replacement of trucks for material transport within and out of a mine.</li> </ul>	All big opencast mines with favorable gradients wherever geomining conditions & economics permit. This would be increasing the efficiency as well as safety and help in fuel conservation.				
3.4.2.	Shovels & Dumpers	<p><u>Size upgradation</u></p> <ul style="list-style-type: none"> <li>✓ Further Upgradation of Dumper &amp; Shovel sizes. The largest dumpers deployed internationally are 400T at present.</li> <li>✓ 42 cum bucket capacity rope shovel at Gevra, Dipka &amp; Kusmunda OCPs (SECL) are the biggest rope shovels deployed in CIL &amp; India. Internationally the largest Rope Shovel deployed is of 63cum bucket capacity.</li> <li>✓ High Capacity HEMM has Less specific fuel and</li> </ul>	High capacity HEMM to be introduced in large mines with production more than 10 Mt or volumetric handling of more than 40 Mm <sup>3</sup> . Further large operating space, turning radius & pit size available.				

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		other resources consumption. less pollution, dusts etc. dispersion because of bulk handling and less number of exposed people.					
3.4.3	Highwall Mining	<ul style="list-style-type: none"> <li>✓ Highwall mining to be introduced in mines where coal is blocked in batter existing opencast mines and which have reached their final limit due to uneconomic stripping ratio or due to local constraints (which limit further mining by normal surface/ opencast technology), by deploying remote operated equipment.</li> <li>✓ This method relies upon the self-supporting capacity of the strata above the series of parallel entries driven mechanically to a considerable depth without artificial roof support and ventilation in the seam horizon.</li> </ul>	To be considered where geo mining conditions permit.				
3.4.4.	Dozer-Ripper	<ul style="list-style-type: none"> <li>✓ Dozer ripper for blast free removal. Technology also helps in minimizing in air pollution. Started in MCL and further feasibility should be explored</li> </ul>	Wherever applicable possibilities to be explored				

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		to other mines of CIL.					
3.4.5.	Rippers	<ul style="list-style-type: none"> <li>✓ New technologies to cut overburden and coal by Impact energy accumulation.</li> <li>✓ Few mines of CIL have started issuing contract with this technology.</li> <li>✓ Full potential of this technology should be explored.</li> </ul>	Implementation				

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
3.4.6.	Alternative Fuel Technology	<p><u>Use of LNG in HEMM</u></p> <ul style="list-style-type: none"> <li>✓ LNG offers better fuel consumption efficiency, lower operating cost, Lower carbon emission (~ 22% less), higher energy density and no theft and adulteration.</li> <li>✓ LNG hybrid operation in high-capacity mining dump trucks has been implemented in US, Canada, Mexico, Russia and Ghana. In India, 5 nos. 240T dumpers (Bucyrus make) converted to Diesel-LNG dual fuel system by Sasan coal mine.</li> <li>✓ LNG engines emit almost 17% lower CO2 than Diesel engine.</li> <li>✓ CIL has also taken initiatives to go for pilot project in collaboration with GAIL in one mine site of CIL before starting bulk use of LNG. A pilot project for use of LNG in HEMMs has been started in Lakhanpur OCP of MCL on 100 T BEML make dumpers.</li> <li>✓ After completion of pilot project if found feasible this technology to be extended to other OC mines.</li> </ul>	<p>Pilot project likely to complete by December 2021. Further Implementation if Trial successful</p>				



S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		<u>Use of Hydrogen</u> ✓ Some of the companies of world have started operating truck operating on hydrogen. The performance of the trucks is the same or better than the original diesel trucks, with the additional benefits of cleaner air, less noise and lower maintenance costs. ✓ Further linking this technology with recent coal to hydrogen initiative of MoC.	R & D towards this technology is needed for future prospects.			Implementation, if found feasible	

## 4. Transportation

### 4.1. Present Technologies

#### 4.1.1. Opencast Mines

Presently in most of the mines of coal India Dumpers are used for transportation of coal. Conventional conveyors are in use in many mega mines. Conveyors that can handle coal up to 4500tph/hr has been planned in Coal India. Conventional conveyors are limited to inclined angles around 16 to 18 degrees.

#### 4.1.2. Underground Mines

##### Coal/ Material

In Underground mines rope haulages and conveyor system is used for material transport. Further transportation of coal by shafts are prevalent in some of the mines of coal India.

**Direct Rope Haulage:** Consist of one pulling rope and one haulage drum for hauling minerals in tubs or mine cars up a gradient which is generally steeper than 1 in 10.

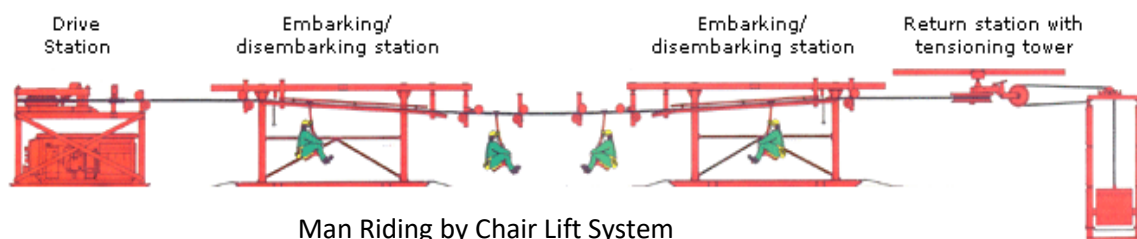
**Endless Rope Haulage:** In this system there are two parallel tracks side by side. One for loaded tubs and another for empty tubs and the endless rope passing from the driving drum located at out bye end of the haulage road to the in-bye end and back again via a tension bogey.

**Conveyors:** In coal mines and other mines of stratified deposits, where the underground mineral if won by longwall method, the transport media often consists of conveyor.

**Shuttle cars:** A shuttle car is a pneumatic tire mounted, electrically driven and low-height transport vehicle of 5-7 te capacity with an open topped and open-ended body, used for transport of mineral from face to a central loading point.

##### Man Transportation

In most of the mines transportation of men via incline or either via shaft. Some of mines using man riding system for man transport.




## 4.2. Way ahead for new technologies.

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
<b>4.2.1. Transportation of Men in Underground Mines</b>							
1	Chair lift Man Riding System	<ul style="list-style-type: none"> <li>✓ Man riding systems are the rapid, safe and comfortable solution when it comes to transporting persons fast, over long distances, including horizontal and vertical curves in underground mines.</li> <li>✓ Objective of reducing unproductive travelling time of mine workers.</li> </ul>	Should be introduced in all UG Mines where mechanization permits				
2.	Winder shaft	<ul style="list-style-type: none"> <li>✓ All steam winder shaft shall be replaced with electric winders.</li> </ul>	All Mines				
3.	FSV	<ul style="list-style-type: none"> <li>✓ Battery operated Free steered vehicle can be used for man transport in Underground mine.</li> </ul>	All new mines where mechanization proposed				
<b>4.2.2. Transportation of Coal from Underground Mines</b>							
1.	Conveyors	<ul style="list-style-type: none"> <li>✓ Coal transport by Haulage based system shall</li> </ul>	All new mines and present mines where				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		<p>be discontinued and conveyor belt system of coal transport from face to surface shall be introduced.</p> <p>✓ Considering the economic and environmental benefits of conveyor, it's use needs to be promoted wherever it is economical to use in CIL mines.</p>	mechanization & gradient permits				
2.	MUV	<p>✓ Battery operated Multi Utility Vehicle can be used for material transport.</p>	All new mines where mechanization proposed				
<b>4.2.3. Transportation of Men in Opencast Mines</b>							
1.	Electric Infrastructure	<p>✓ Electric Infrastructure to be developed in open cast mine.</p> <p>✓ Battery operated portable man transport vehicles to introduce in OC mines.</p>	Charging station for group of mines.				
<b>4.2.4. Transportation of Coal from Opencast Mines</b>							

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
1	High angle Conveyors	<ul style="list-style-type: none"> <li>✓ A high angle conveyor can be defined as any conveyor that transports material along a slope exceeding the dynamic stability angle of the transported material.</li> <li>✓ Implementation of High angle conveyors technology in opencast mines to be explored as early as possible. Though In some Project Reports prepared by CMPDIL, provisioning has been made for high angle conveyors.</li> </ul>	Proposed to be introduced at all new mines where geomining condition permits. Reassessment to be done for ongoing mines				
2.	Pipe conveyors	<ul style="list-style-type: none"> <li>✓ Used where spillage of materials, environmental issues and limitations in routing prevents the use of unconventional conveying systems.</li> <li>✓ For transportation of coal can be considered where long distance is involved. In some of the Project reports of CMPDIL provisioning has been made for Pipe conveyors.</li> </ul>	Proposed to be introduced at all new mines where geomining condition permits. Reassessment to be done for ongoing mines				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
3.	Rope conveyor	<ul style="list-style-type: none"> <li>✓ Rope conveying system for difficult terrain such as rivers, buildings, deep valleys or roads without any problem.</li> </ul>	Implementation wherever techno economic feasibility permits				
4.	First Mile connectivity	<ul style="list-style-type: none"> <li>✓ Elimination of road transportation of coal in mines having capacity of 4 Mty and above.</li> <li>✓ Creation of Mechanized conveyor system and computerized loading system (SILOs). in such a way that, wharf wall loading by pay loaders is eliminated by year 2023-24.</li> <li>✓ Automation of Coal Evacuation and further adding a layer of IoT through Digitization would increase the efficiency and safety factor.</li> <li>✓ 53 FMC Projects identified: 39 to be completed by FY 2024 (Ph-I)</li> </ul>	Wharf wall loading by pay loaders is to be eliminated		Phase-1 (39 FMC projects )		

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		 <p>Mechanised Evacuation of coal from the pithead to despatch point under FMC initiative</p>					
5.	Autonomous Trucks	<ul style="list-style-type: none"> <li>✓ This technology is already in use in some of mining companies.</li> <li>✓ In coming years, with rising wage cost and demand for higher operational efficiencies, deployment of autonomous equipment will become a necessity.</li> </ul>	Coal industry in India may plan a shift to autonomous Trucks in a phased manner				

## **5. Communication**

### **5.1 Present technologies**

For communication in opencast mines supplied with walkie-talkie instruments from the central control room for interpersonal communication during the operations between different units/places of working.

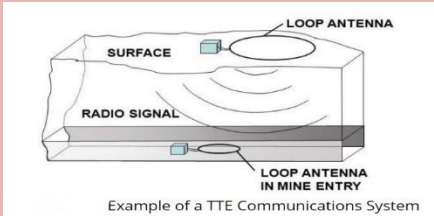
Further underground coal mines use wired telephonic communication as the primary means of communications between the surface and the underground miners. Conventional systems or the wired system is comprised of magneto phones, voice powered phones etc. This system is known as CDS system.

For communication related to transport of coal and material to underground and surface signaling system used for haulage, shafts is used. Audible and/or visual signaling systems are still widely used to communicate safety messages.

The use of longwall led to the development of voice communications using speaker sets spaced across the face area.



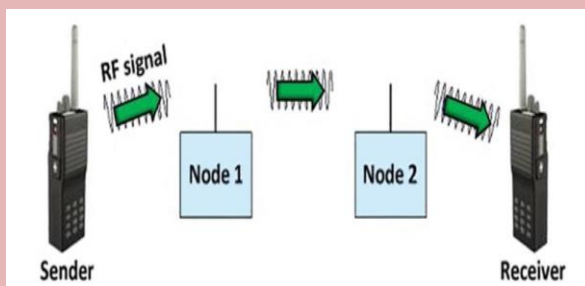
## 5.2. Way ahead for new Technologies

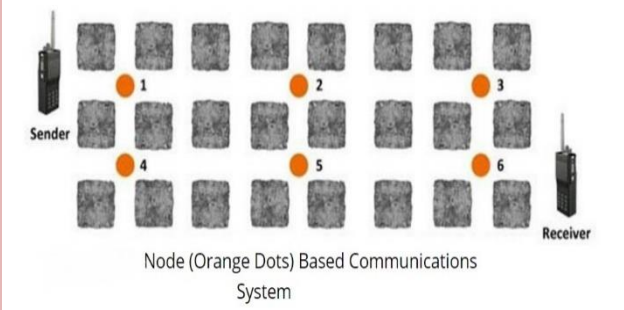
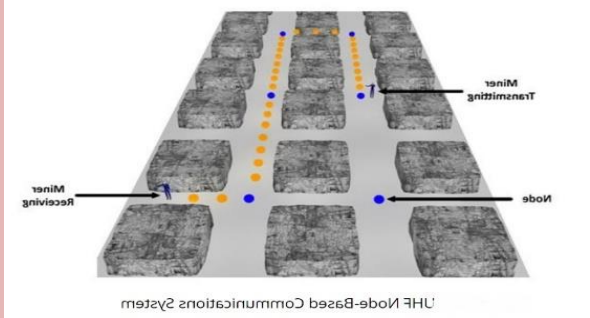
S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
5.2.1.	Through-the-earth mine communications	<ul style="list-style-type: none"> <li>✓ Through-the-earth (TTE) and wireless radio systems are less common.</li> <li>✓ Through-the-Earth (TTE) signaling is a type of radio signaling used in mines that uses low-frequency waves to penetrate dirt and rock, which are opaque to higher-frequency conventional radio signals.</li> </ul>  <p style="text-align: center;">Example of a TTE Communications System</p> <ul style="list-style-type: none"> <li>✓ In mining, these lower-frequency signals can be relayed underground through various antennas, repeater or mesh configurations, but communication is restricted to line of sight to these antenna and repeaters systems.</li> <li>✓ Except for TTE systems, most wireless systems require some wire-bound components, which are susceptible to failure during disasters as cable breakage interrupts communications.</li> </ul>	Phase -1 Trial Period		Phase -2 Implementation	

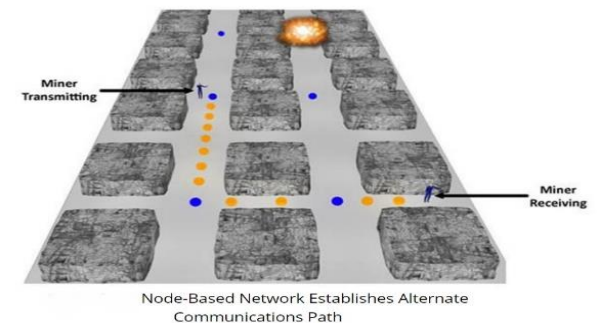
S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
5.2.2.	Leaky Feeder Systems	<ul style="list-style-type: none"> <li>✓ A leaky feeder system used in an underground coal mine typically involves a single large transceiver on the surface that can communicate with all miners' radios along the length of the system.</li> <li>✓ The transceiver on the surface, called a base station, connects to a DAS system.</li> <li>✓ Leaky feeder systems operate at a frequency that is conventionally used by two-way voice radio communications, with the electromagnetic energy transmitted and received through radio frequencies (RF).</li> <li>✓ This leaky feeder cable "leaks" the radio signal in or out along its length, thus creating a continuous coverage area along the tunnels in which the cable is strung.</li> <li>✓ The coaxial cable has regular openings in the outer shield which permit RF energy to enter or leave the cable. It can receive and transmit signals down its entire length. Wherever a mine desires communications, it installs leaky feeder cable down the entries to the mine.</li> </ul>	Phase -1 Trial Period		Phase -2 Implementation	

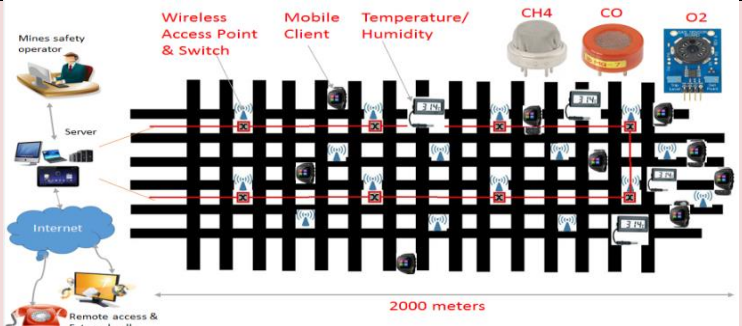
S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
5.2.3.	Node-Based System	<ul style="list-style-type: none"> <li>✓ Node-based systems refer to systems that use discrete antennas connected to small transceivers called “nodes.”</li> <li>✓ The nodes also contain small computers (microprocessors) that perform a variety of functions.</li> <li>✓ In all node-based systems, the node can detect when a miner’s radio is in range and provides an automatic connection to the network.</li> <li>✓ Node-based communications systems for coal mines can be assembled from a number of different technologies.</li> <li>✓ Wireless Fidelity (Wi-Fi), also referred to as wireless local area network (WLAN), is the foundation of one node-based system used for underground coal mines.</li> <li>✓ Using UHF radios is another approach to node-based communications. In the underground coal mine environment, UHF radios can communicate directly with each other over</li> </ul>	Phase -1 Trial Period		Phase -2 Implementation	

S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
		<p>significant distances, perhaps 1,000 feet.</p> <ul style="list-style-type: none"> <li>✓ To extend the communications range, it is necessary to use repeaters (also called nodes) as intermediate components in the communications route.</li> <li>✓ The communications connection between the sender and the receiver is generally from the transmitter to air, air to node, node to node to node (i.e. may possibly involve multiple nodes), and, finally, node to air to receiver.</li> <li>✓ Note that the node-to-node link is also through the air.</li> <li>✓ The manner in which a UHF radio wave travels through the air in a coal mine is different from through the air on the surface.</li> <li>✓ In an underground mine, the UHF waves, which bounce off the walls, floor, and roof.</li> </ul>				



S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
		 <p>Node (Orange Dots) Based Communications System</p> <p>✓ For a UHF network, fiber-optic cables or metallic conductors can connect the nodes in the entries to the mine. However, because the UHF nodes both receive and transmit UHF signals, a wireless connection is possible, with no cabling needed.</p>  <p>UHF Node-Based Communications System</p>				

S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
		 <p>Node-Based Network Establishes Alternate Communications Path</p> <ul style="list-style-type: none"> <li>✓ Orange dots indicate the RF signal route between the two miners. Should an incident occur that disables one of the nodes, it is possible for the node computers to recognize the loss and to determine a new route for reestablishing the communications link.</li> </ul>				
5.2.4.	Wireless communication system approved by DGMS for Underground	<ul style="list-style-type: none"> <li>✓ DGMS Permitted Underground Mines Wireless Network Communication System Is Successful at Moonidih Colliery, BCCL, Dhanbad, Jharkhand, India.</li> <li>✓ Mobile client a wearable on wrist and it is connected to Wi-Fi mesh network infrastructure of underground mines.</li> <li>✓ Automatically send signals to surface control room on location, man fall down, dangerous tunnel traversal by miners so that safety and rescue team can call back.</li> </ul>	Phase-1 Trial for further extension to other UG mines		Phase -2 Implementation	

S.No	Technology	Description	Timeline			
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
		 <p>✓ Introduction of this system may be considered in all underground mines and phasing put of ols communications system.</p>				

## 6. Safety in Underground & Opencast Mines

### 6.1. Present Technology

#### 6.1.1. Personal Protective Equipment (PPE) :

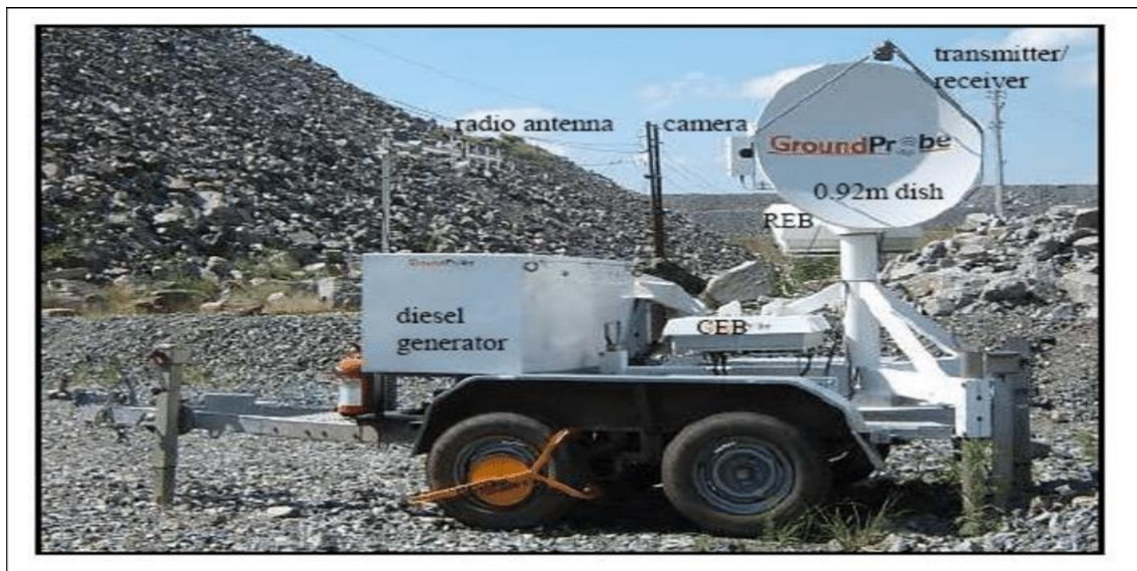
Work Gloves, Footwear, Hearing Protection, helmet, Reflective clothing is in use for safety of individual in mines.

#### 6.1.2. Support system in underground mines

Supports such as chock support, cog support, roof bolting, powered support in longwall mining etc.

#### 6.1.3. Slope stability radar:

The “slope stability radar” has been developed to remotely scan a rock slope to continuously monitor the spatial deformation of the face. Currently in use in some of coal mines for safety related to dump failure.



#### 6.1.4. Audio visual alarms:

In order to avoid accident, during reversing, Audio and Visual Alarm is required. To reduce such accidents DGMS made it compulsory to install Audio Visual Alarm (AVA) in every HEMM. & Surface Transportation Machineries used in Mines.

#### 6.1.5. Flame safety lamps & Multigas detectors:

The flame is generally surrounded by a cylindrical covering of wire gauze. An explosive or flammable mixture of gas entering the lamp will be ignited by the flame. Further Multi Gas Detectors and monitors are used for the detection of flammable gases, oxygen depletion and an extensive range of toxic gases.

#### 6.1.6. Safety Monitoring:

A Centralized Safety Information System portal is available to all concerned officers of CIL & Subsidiaries upto Mine Safety Officer who enter relevant data on a daily basis. All important aspects of safety functions have been covered in this portal through which informed decision can be taken by the management.




## 6.2. Way Ahead for new technologies:

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
6.2.1.	Personal Protective Equipment (PPE)	<ul style="list-style-type: none"> <li>✓ Sensor based PPE (applicable for both OC &amp; UG mines).</li> <li>✓ By the use SMART PPE, it is quite easy to track vibrations to anticipate when motorized equipment might fail or need a check.</li> <li>✓ SmartCap, a sensor-rigged PPE helmet, continually monitors common signs of fatigue and measures alertness to cut down on distraction-related incidents.</li> </ul>	All mines both OC & UG				
6.2.2	Dust suppression	<ul style="list-style-type: none"> <li>✓ Deployment of Mist spray canon for dust suppression in TOP 75 opencast mines.</li> <li>✓ Fog canons are to be introduced in different mines which are deployed at coal stock yards and Railway siding which effectively suppress air borne dust.</li> <li>✓ Truck mounted fog canons should be introduced in all mines of coal India for</li> </ul>	On-going technology and to be extended to all mines in phased manner				

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		dust suppression in haul road. ✓ Wheel washing of trucks entering & Leaving mines. ✓ Deployment of mechanical road sweepers. ✓ Black topping of road transport roads & Plantation along road transport roads to minimize air pollution.					
6.2.3.	Tele-monitoring System (ETMS)	✓ Deployment of Tele-monitoring System (ETMS) to be installed in all UG mines.	To be extended to all UG mines				
6.2.4.	Digital Mine Collision Awareness System	✓ Introduction of Digital Mine Collision Awareness System ✓ Using a VLF magnetic system, the Collision Awareness System (CAS) enables detection around corners and through strata to provide alerts for potential collisions between people and heavy equipment before they happen. ✓ VLF (very low frequency) is used to generate a magnetic field – based on	Trial Phase	All mines In phased manner			

S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		low frequency technology – around a vehicle, essentially an electric ‘fence’					
6.2.5.	Digital Mine’s Safety	<ul style="list-style-type: none"> <li>✓ Digital Mine’s Safety Solution in all mines for consistent, real-time detection.</li> <li>✓ Digital Workplace Safety software processes multiple CCTV feeds simultaneously.</li> <li>✓ Its ever-evolving machine learning filters (artificial intelligence) is trained to recognize – and get continuously better at recognizing: <ul style="list-style-type: none"> <li>• Safety-zone violations</li> <li>• Hard hat violations</li> <li>• Safety vest violations</li> <li>• Protective eye wear violations</li> <li>• Crowding &amp; abnormal behaviour</li> </ul> </li> </ul>	All Mines				

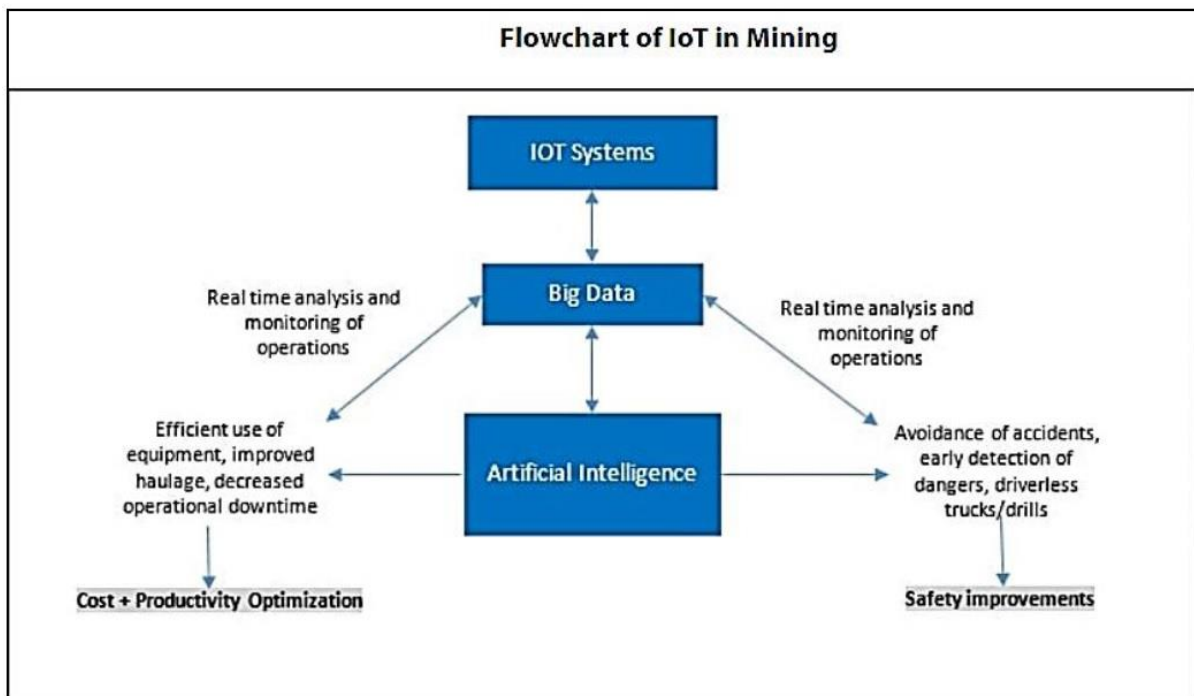
S. No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
6.2.6.	SAGES (self-advanced goaf edge support):	<ul style="list-style-type: none"> <li>✓ Medium duty 200t capacity remote controlled roof support system in underground coal mines.</li> <li>✓ Implemented in RK-7 min of SCCL.</li> </ul> 	Feasibility of Commercial usage & Further R&D for higher capacity				
6.2.7.	Strata monitoring	<ul style="list-style-type: none"> <li>✓ Use of Underground mines strata monitoring by devices like convergence rods, tape extensometers, vibrating wire load cells in all underground mines for safety of persons working.</li> </ul>	Implementation				

S. No.	Technology	Description	Timeline					
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30	
6.2.8.	Slope stability radar	✓ This technology should be extended to Top 35 mines for monitoring slope in OC mines.	Top 35 mines of CIL					
6.2.9.	CAAQMS	✓ CAAQMS facilitates in measuring a real time monitoring of Air Pollution, including particulate matter, all round the year.	For Group of 5 Mines					

## 7. Information Technology/Artificial Intelligence/ IoT

Considering the numerous incentives, it brings in Mining Sector, many large mining companies are planning and evaluating ways to start their digital journey and digitalization in mining industry to manage day-to-day mining operations.

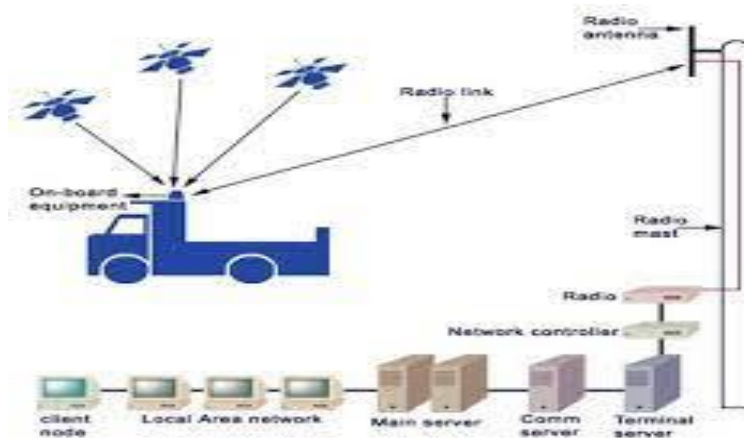
How IoT will work in mining industry?



### 7.1. Present Technologies

#### 7.1.1. Online Truck Dispatch System (OITDS)-

A GPS - based, operator-independent truck dispatch system (OITDS) suitable for open cast mines has been installed and in operation at Mega mines of Coal India. This technology needs further upgradation compatible with the present and future requirements.



#### 7.1.2. 3D Laser Scanner:

Currently 3D laser scanning is in use in surveying and volumetric measurements. A laser-scanning instrument works on the principle of LIDAR (light Detection & Ranging). The scanner emits laser rays, which hit the object to be captured and come back to the scanner. Within a very short period, the scanner collects billions of points (clouds), this point cloud data can be used to create 3D models for a wide variety of spatial volumetric tasks.

#### 7.1.3. Geographic Information System:

Nowadays maps are stored in layers of spatial information in a geographic information system (GIS) allowing manipulation, analysis, and display of spatial data.

#### 7.1.4. Photogrammetry and Remote sensing:

Currently most of the jobs are being done based on satellite remote sensing such as land reclamation monitoring of all major opencast mines of CIL. Vegetation cover map of all major coalfields is also being done based on satellite data.

#### 7.1.5. Drones:

UAV equipped with a downward-facing RGB camera takes images of an open-pit mine or quarry from different points. Photogrammetry software uses these images to create geo-referenced 3D maps, contour lines, digital terrain models, or digital surface models of the site.

#### 7.1.6. Enterprise Resource Planning

The primary objective of the project is to deploy a state-of-the-art ERP system across all aspects of the operation of CIL and its subsidiaries for the purpose of positioning the organization as an efficient and dynamic organization.

## 7.2. Way Ahead for new technologies:

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.1	OITDS	<ul style="list-style-type: none"> <li>✓ Full OITDS technology utilization such as automatic allocation of dumpers to shovels to reduce cycle time and cost instead of presently just tracking of vehicles in most of the mines.</li> <li>✓ It should be implemented in Top 75 mines in phased manner.</li> <li>✓ Integration OITDS with HEMM health monitoring sensors.</li> </ul>	Top 35 mines of CIL		Other mines		
7.2.2	Dumper Truck Volume Analyzer	<ul style="list-style-type: none"> <li>✓ Latest industrial high-resolution and wide dynamic range camera and laser technology for superior accuracy and robustness.</li> <li>✓ Detection of overloading and uneven loading to avoid fleet damage and increased maintenance cycles</li> <li>✓ Detection of under loading to avoid suboptimal fleet utilization and enable operator behavior improvement</li> </ul>	All OC mines				



S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.3.	Enterprise Resource Planning	<p>Linking of ERP with all core functions such as should be done as early as possible</p> <ul style="list-style-type: none"> <li>✓ Project Management</li> <li>✓ Purchasing/ Procurement, Contracts and Materials Management</li> <li>✓ Asset and Plant Maintenance Management</li> <li>✓ Finance &amp; Management Accounting.</li> <li>✓ Production and Planning</li> <li>✓ Marketing and Sales</li> </ul> <p>Activities regarding real time monitoring outside the coverage of ERP to be integrated</p> <ul style="list-style-type: none"> <li>✓ e-procurement and GeM based Procurement System</li> <li>✓ e-auction</li> <li>✓ Explosive Delivery Performance Monitoring System</li> <li>✓ Centralized Safety Information System</li> <li>✓ Coal Quality Monitoring System</li> <li>✓ Weigh bridges /Road Dispatch</li> <li>✓ Performance review and appraisal of Executives of CIL</li> </ul>	Phase -1		Phase -2		

S.No.	Technology	Description	Timeline					
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30	
7.2.4.	RFID	<ul style="list-style-type: none"> <li>✓ RFID provides automated solutions that monitor trips made by vehicles</li> <li>✓ Real-time location tracking and monitoring, especially of moveable assets</li> <li>✓ RFID-enabled weighbridges automate calculation of vehicle tare weight and laden weight, update databases at remote servers and transmit this data to the destination weighbridge for verification of trip made and delivered coal quantity.</li> <li>✓ RFID based Automatic boom barriers are installed at all the entry and exit points of Mines and Railway Sidings so that only authorized vehicles/tippers can enter/exit into the mine premises which eliminate the possibility of any coal pilferage and helps to regulate vehicle traffic.</li> <li>✓ RFID based sensor to be introduced in all mines of CIL in HEMMs, sidings, loading points etc.</li> </ul>	All Mines					

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.5.	Load Cells for Weighment	<ul style="list-style-type: none"> <li>✓ Load cell can be installed below static weighbridges for accurate weight measurements</li> <li>✓ In motion load cell to be installed in rail tracks.</li> </ul>	All Mines				
7.2.6.	Mine Monitoring system	<ul style="list-style-type: none"> <li>✓ Live feed CCTV system established at the weighbridges and coal heaps in some of coal mines of CIL to be extended to all areas and mines of coal India.</li> </ul>	All Mines				
7.2.7.	Geo-fencing	<ul style="list-style-type: none"> <li>✓ All mine boundaries, coal patches, unloading points like sidings, stocks, feeder breakers, crusher and bunker, internal coal transportation routes should be geo-fenced.</li> <li>✓ Mine surveillance: Geo-referenced mining leases are superimposed on the latest satellite remote sensing scenes. System checks a defined region around the existing mining lease boundary to search for any unusual activity which is likely to be illegal mining.</li> <li>✓ Periphery surveillance using virtual fencing for</li> </ul>	All Mines				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		detecting intrusion of vehicles with the intention of illegal transportation of mineral through unauthorized routes as well as identifying human intrusion into an industrial area.					
7.2.8.	High Speed cameras	<ul style="list-style-type: none"> <li>✓ Blast optimization study with the help of high-speed cameras.</li> <li>✓ Stemming retention studies--effects of changing stemming type and height and the performance of stemming plugs.</li> <li>✓ Face movement studies including front row burden, blowouts, hard toe problems, material trajectory, velocity, and casting range</li> <li>✓ Timing studies, including detonator delay time quality, actual blast hole sequence, and blast delay times achieved, effects of timing changes, cutoffs, and misfires</li> <li>✓ Environmental studies including fly-rock, air-blast noise from blowouts, vibration from choked blast, back-break, and noxious fumes</li> </ul>	All Mines				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.9.	Global Positioning System	<ul style="list-style-type: none"> <li>✓ GPS to extended to all HEMMs</li> <li>✓ Integration of drilling and blasting operations is GPS applied to drill positioning on individual blastholes.</li> <li>✓ These systems allow the blast plan with hole locations to be downloaded to the drill. Through display the drill is guided onto the designed hole location.</li> </ul>	All Mines				
7.2.10.	Conveyor Belt health check	<ul style="list-style-type: none"> <li>✓ The Belt Condition Monitoring Solution will identify surface features on your conveyor belts, such as splices, tears and edge deformations.</li> <li>✓ Real time belt integrity/rip monitoring and belt alignment detection.</li> <li>✓ Fiber Optic Sensing measuring temperature and vibration of idlers along the length of the belt.</li> <li>✓ System to introduced in all mines where conveyors are in use.</li> </ul>	All Mines				
7.2.11.	Simulator based		One training centre For each subsidiary				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
	training platform	<ul style="list-style-type: none"> <li>✓ Simulators provide operators a safe environment to learn and practice their skills; Immersive Technologies' simulators allow the operator to practice for a range of possible emergency situations. Many of these situations are too dangerous, too difficult or too expensive to test in an actual mine.</li> <li>✓ Within the often-hazardous mining industry, simulation training has quickly gained recognition as a significant method of increasing site safety and profitability through improved operator skill and knowledge.</li> <li>✓ Simulator based training for operation of high capacity equipment has already been installed at NCL and training is being imparted to operators of NCL &amp; other subsidiaries.</li> </ul>	company of CIL				
7.2.12	Fleet Management System	<ul style="list-style-type: none"> <li>✓ Improve Driver Behavior: Enforce safety behavior and prevent over speeding. Instant alert devices allow employees in the field to call for help through GPS system. Operators kept on task with onscreen work details</li> <li>✓ Improves Vehicle Life: Maintenance reminders</li> </ul>	Introduction of Fleet Management System for mines producing more than 10 MTPA.				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		<p>based on engine hours. Observe machine performance with data direct from OEM systems</p> <ul style="list-style-type: none"> <li>✓ Reduced fuel budget: Monitor excessive idling and unauthorized vehicle use, route optimization. Status of all shovels, trucks, drills, dozers and other equipment monitored</li> <li>✓ Streamline Operation: Two-way communication helps to update the workers in the field with new assignments. Real-time views of location and activity for all equipment at the mine.</li> <li>✓ FMS is deployed in Noamundi Iron ore mines of Tata Steel.</li> </ul>					
7.2.13.	Behavior of Goaf	<ul style="list-style-type: none"> <li>✓ Using the data analytics to predict the roof fall in underground mines.</li> <li>✓ Periodic vetting of different type of data such as RMR ratings (Rating of rocks according to there quality), size of pillars, movement of strata (vertically and horizontally), magnitude and interval of different roof falls can be used to make system of prediction.</li> </ul>	Further Research project in this is to be encouraged.				

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.14.	HEMM predictive maintenance monitoring.	<ul style="list-style-type: none"> <li>✓ Maintaining &amp; monitoring of HEMM such as Dumpers, Shovels, Surface Miners etc. before breakdown occurs.</li> <li>✓ Predictive Maintenance focuses on failure events; therefore, it makes sense to start by collecting historical data about the machines' performance and maintenance records to form predictions about future failures.</li> <li>✓ Usage history data is an important indicator of equipment condition.</li> <li>✓ Software modules for Prescriptive maintenance are also available where optimum solution is recommended by the software itself, in addition to prediction of failure of components etc.</li> </ul>	CIL is procuring dump trucks with real-time monitoring interface facility compatible for GPS				
7.2.15.	Prediction of Fly rocks in OC mines	<ul style="list-style-type: none"> <li>✓ By studying behavior of rocks in different type of blasting explosives, pattern of blasting, different rock qualities, delays detonators (detonator used to introduce a time lapse between the application of a firing signal and detonation) etc.</li> </ul>	Further Research project in this is to be encouraged.				



S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
		we can develop a system of prediction to minimize fly rocks in opencast mines.					
7.2.16.	Rescue of Trapped workers in mine.	<ul style="list-style-type: none"> <li>✓ Use of robotics for rescuing trapped miners in underground and hazardous places where rescue teams cannot reach.</li> <li>✓ In situation when accidents take place in underground mine when it is impossible or dangerous to rescue persons to reach to rescue trapped miners then use of robotics can help.</li> <li>✓ Research projects to be encourage in this field.</li> </ul>				Further Research project in this is to be encouraged.	
7.2.17.	Online Coal Ash, Moisture, GCV & VM Analyzer for Coal Mines, Washeries & Power Plants.	<ul style="list-style-type: none"> <li>✓ Online laser-based coal analyzer for real time data about quality of coal.</li> </ul>				Trial & Implementation	

S.No.	Technology	Description	Timeline				
			FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	FY 2029-30
7.2.18.	Big Data Management and Intelligent Analytics software.	<ul style="list-style-type: none"> <li>✓ CMPDIL is in the process of software procurement of Big Data Management and Intelligent Analytics software.</li> <li>✓ The tender has been floated in GeM Portal and final stage of Reverse Auction is completed.</li> </ul>	2 pilot projects by March 2022.				
7.2.19.	Real Time Rake Tracking	<ul style="list-style-type: none"> <li>✓ The turnaround time for rakes in India is a critical area on which the dispatch of raw coal and other mined materials depend.</li> <li>✓ Tata Steel Ltd. deployed real-time tracking of rakes to ensure minimum delays due to rake unavailability and lower inventory lying with the mine and siding.</li> </ul>	Implementation				

## 8. Survey/Mapping

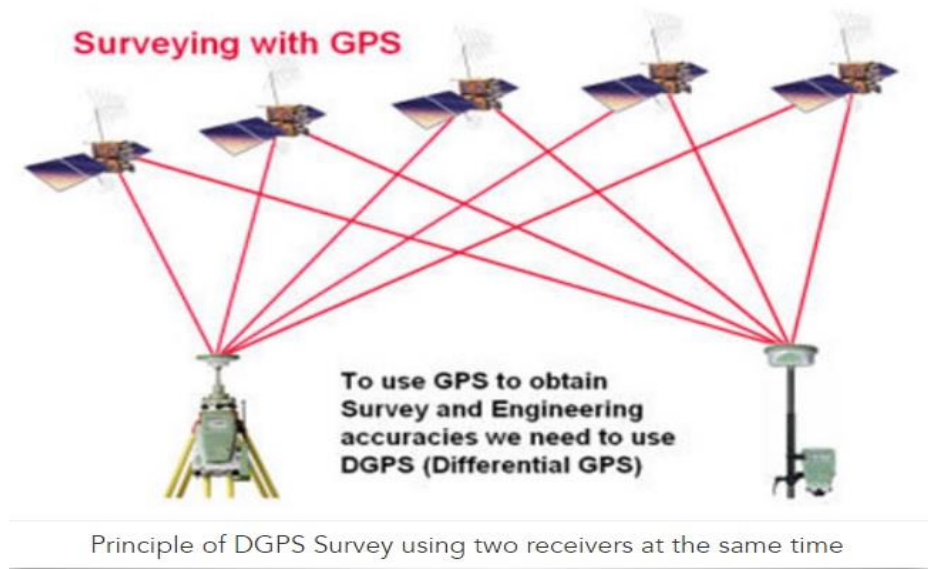
### 8.1. Present Technologies

#### 8.1.1. Volumetric Measurement

The major job of survey is volumetric measurement and boundary demarcation. In volumetric measurement, LiDAR technology is in use since 2008. It is the latest technology for terrestrial volumetric measurement wherein 3D Terrestrial Laser Scanner is used for creating a point cloud based DTM through which volume is computed.

#### 8.1.2. Boundary demarcation

For boundary demarcation, high-end DGPS instruments are in use. A Differential Global Positioning System (DGPS) is an enhancement to the Global Positioning System (GPS) which provides improved location accuracy, in the range of operations of each system, from the 15-meter nominal GPS accuracy to about 1-3 cm in case of the best implementations.



#### 8.1.3. Remote Sensing

Currently many jobs are being done based on satellite data using remote sensing technique. Major jobs in this area are as follows:

- Land Reclamation Monitoring of all major opencast mines of CIL.
- Vegetation cover map of all major coalfields based on satellite data
- Core and Buffer Zone mapping for incorporation into EIA/EMPs
- Settlement Mapping based on High resolution Satellite Data
- Coal Mine Fire monitoring based on Thermal Infrared Satellite Data

## 8.2. Way Ahead for New Technologies

S.No.	Technology	Description	Timeline		
			FY 2022-23	FY 2023-24	FY 2024-25
8.2.1.	Drones	<ul style="list-style-type: none"> <li>✓ In future drones will be used for generating DTM.</li> <li>✓ CMPDI has procured two drones which are currently in use and benchmarking is being done to establish the variance between volumetric measurement by 3D TLS and drone-based photogrammetry survey.</li> <li>✓ Once successfully established, gradual technological shift.</li> <li>✓ Volumetric measurement of Overburden Removal</li> <li>✓ Monitoring of plantations/afforestation for assessment of their survival and growth.</li> <li>✓ Mine closure monitoring</li> <li>✓ Thermal mapping of mine fire zones.</li> <li>✓ Haul road monitoring by drones helps accounting of haul fleet and safe conditions will ensure savings in fuel costs and higher productivity of workers.</li> <li>✓ Generation of digital terrain models for mine operational planning</li> <li>✓ Security of mine and coal stockyard.</li> <li>✓ Almost 2X reduction in total survey time.</li> </ul>	Implementation already started		

S.No.	Technology	Description	Timeline		
			FY 2022-23	FY 2023-24	FY 2024-25
8.2.2.	Remote Sensing	✓ Use of Satellite and Drone remote sensing for generation of high-resolution imagery for jobs like settlement mapping, monitoring of plantation and mine closure monitoring.	Already in Operation		

## 9. Exploration

### 9.1. Present Scenario and Technologies:

The present standard procedure for exploration is as follows:

- ✓ In the initial stage, reconnaissance survey is mainly done by GSI (scientific agency under the Government of India).
- ✓ Then regional/promotional and detailed exploration are done by public sector agencies like CMPDI, MECL to further increase the confidence level to prove the resources mainly through drilling coupled with geophysical logging and 2D & 3D seismic survey to enhance the productivity with simultaneous reduction in cost and time.

#### 9.1.1. Drilling:

- ✓ Mostly mechanical rigs are used for drilling, but nowadays more hydrostatic rigs are getting deployed which are more competent and faster.
- ✓ Introduction of more hydrostatic rigs for it's easy and fast hydrostatic operational system with higher depth capacity to enhance the pace of exploration.

#### 9.1.2. Geo-physical Survey:

- ✓ The conventional methods for geophysical logging are used currently. The newly introduced method of 2D/3D seismic survey for both Promotional and detailed exploration will increase the productivity with simultaneous reduction in cost and time.
- ✓ Geophysical logging, Gravity, Magnetic, Resistivity Imaging and GPR (Ground Penetrating Radar) being used..

#### 9.1.3. Software used for Geological Report preparation:

- ✓ The software used for the preparation of Geological reports are ArcGIS, AutoCAD, MINEX etc. The introduction of modern software like these has contributed for the faster processing and storage of geological data.
- ✓ Paradigm software is currently used for the processing of 2D/3D Seismic geophysical data for exploration.
- ✓ INTREPID and Geo Modellar Software are being used for Gravity and Magnetic data processing. Electre-Pro, ProSys, Res1D/2D/3D and Slicer Dicer Software being used for Resistivity data processing and Modelling.

- ✓ RADAN 7 being used for GPR (Ground Penetrating Radar) data processing and interpretation.
- ✓ CMPDI is accredited as GWCO by QCI-NABET and Groundwater Professionals by CGWA (Ministry of Jal Shakti, Govt. of India) with an objective to provide Hydrogeological services in Mining area for both Coal and Non-Coal Sector as an accredited consultant. Groundwater Modelling using Visual MODFLOW software is under process which has potential scope for future Hydrogeological Services.
- ✓ CMPDI has developed WEB portal OCBIS (Online Coal Block Information System) to provide block related information across all the major coalfields of the country.

#### 9.1.4. Online System for Geo-data base:

- ✓ SCCL has indigenously developed a web enabled program named as SIDEX (Singareni Integrated Data on Exploration) which aims to help the Exploration division and management to query about various aspects of exploration data with a provision to automatically update / upload with the data of Drilling, Chemical, Geophysical, Hydrogeological, Geotechnical & in obtaining required graphic output etc.

## 9.2. Way Ahead for New Technologies

S. No	Technology	Description	Timeline				
			FY 2023-24	FY 2024-25	FY 2025-26	FY 2026-27	FY 2029-30
9.2.1.	Drilling	<ul style="list-style-type: none"> <li>✓ Introduction of more hydrostatic rigs for it's easy and fast hydrostatic operational system with higher depth capacity to enhance the pace of exploration.</li> <li>✓ Do away with all the Conventional Mechanical Rigs</li> </ul>				All of the mechanical rigs can be replaced by hydrostatic drills by the year 2026-27	
9.2.2.	Geo-physical Survey	<ul style="list-style-type: none"> <li>✓ Vast use of 2D/3D seismic survey for both Promotional and Detailed exploration.</li> </ul>	Implementation has already been started				
9.2.3.	Software	<ul style="list-style-type: none"> <li>✓ Integration of Minex and Paradigm Software for Resource evaluation and Mine Planning; Synergising the capability of Geology, Geo-Physics and Mining.</li> </ul>	In operation				
9.2.4.	Geo-physical technology	<ul style="list-style-type: none"> <li>✓ Extensive use of Geophysical logging of boreholes to partly replace the Coal characteristic study including Physico-</li> </ul>	Phase 1: Pilot project			Phase 2: Implementation	



S. No	Technology	Description	Timeline				
			FY 2023-24	FY 2024-25	FY 2025-26	FY 2026-27	FY 2029-30
		mechanical study. (Pilot project in <b>SCCL</b> ) Ex: Sonic Probe can be used to obtain the data for the Physico-mechanical study of a rock strata.					
9.2.5.	Online System for Exploration work of CMSP and MMDR blocks	✓ Presently grant of PL and GR formulation and approval process is in manual mode. A module is being developed under SWCS under which all the process related to exploration of CMSP and MMDR blocks will be brought on digital platform. For which, presently, System Requirement Gathering is under process.	Imple- mentation				

## 10. Mine Planning & Scheduling

### 10.1. Present Technologies:

Today the mining industry use the software for exploration, geological resource modelling, mine optimization, mine design, reserve calculations, mine scheduling, operational efficiencies, equipment analysis, project management and financial modelling. The various types of software packages available in the market are MAPTEK VULCAN, GEOVIA SURPAC, DATAMINE, GEOVIA MINEX, CARLSON, SLOPE STABILITY SOFTWARES, SIMULATION SOFTWARES etc.

### 10.2. Way Ahead:

S.No.	Technology	Description	Timeline	
			FY 2022-23	FY 2023-24
10.2.2	CAD design software	<ul style="list-style-type: none"> <li>✓ Use of CAD design software in all coal mines.</li> <li>✓ Do away of physical preparation of plans.</li> </ul>	Implementation	
10.2.3.	MIS/ Dashboard	<ul style="list-style-type: none"> <li>✓ Dashboard of each subsidiary for regular updation of plans related to each mine.</li> </ul>	Implementation	
10.2.4.	Mine Scheduling	<ul style="list-style-type: none"> <li>✓ Short term and long term mine scheduling to be done using Mine Planning software.</li> </ul>	Implementation	
10.2.5.	Optimization	<ul style="list-style-type: none"> <li>✓ Simulating the mine operations to optimize the production and fleet of HEMM etc.</li> <li>✓ In coal India the use of software is limited to preparation of Project report. Use should be further percolated up to individual coal mines.</li> </ul>	Implementation	

S.No.	Technology	Description	Timeline	
			FY 2022-23	FY 2023-24
10.2.6.	Blasting	<ul style="list-style-type: none"> <li>✓ Software such as Wipfrag, fragblast etc. are used in blasting fragmentation analysis to extended to all mines. Other software such as Blast Design Software JK Simblast etc.</li> </ul>	Implementation	

## 11. New Initiatives

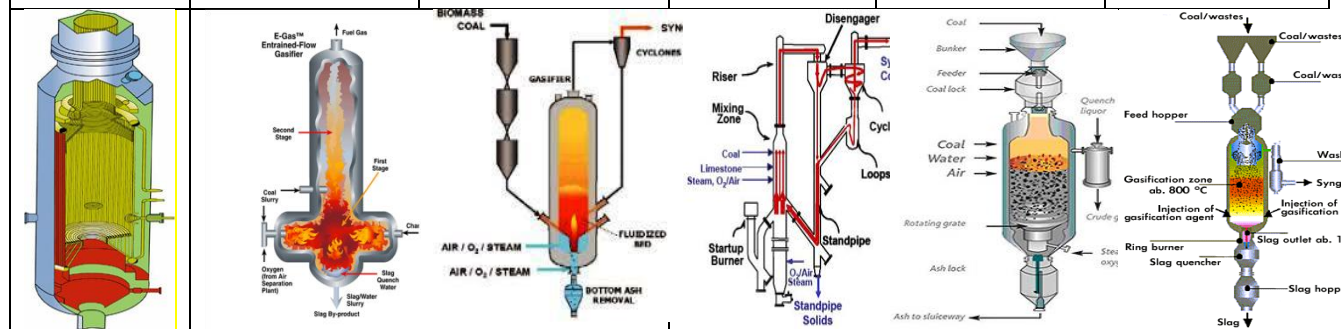
### 11.1. Surface Coal gasification:

S.No.	Technology	Description	Timeline
1.	<p>There are mainly three gasification technologies:</p> <ul style="list-style-type: none"> <li>• Moving bed technology</li> <li>• Fluidisation Bed technology</li> <li>• Entrain flow technology</li> </ul> <p>Worldwide Coal Gasification Technologies are given in Table no.11.1</p>	<ul style="list-style-type: none"> <li>✓ Alternate use of coal &amp; lesser carbon footprint than direct burning.</li> <li>✓ Setting up of Coal to Methanol plant at Dankuni Coal Complex (DCC) is another maiden initiative, CIL is exploring the possibilities to venture into Coal-to Chemical's sector on stand-alone basis by setting up a Coal to-Methanol plant at Dankuni Coal Complex (DCC).</li> <li>✓ Four Coal gasification projects in CIL are being undertaken; out of which 3 projects are being implemented under BOO mode with a freedom to choose any gasification technology and all three projects are at different stages of implementation while one project is under conceptual stage.</li> <li>✓ BHEL is carrying out the Pre-Feasibility studies for production of Ammonium Nitrate from high ash coal using their indigenously developed technology. If the Pre-Feasibility studies are encouraging, CIL and BHEL may establishing a collaboration for Coal gasification project</li> </ul>	<p>India to gassify 100 million tonnes (MT) coal by 2030.</p>

S.No.	Technology	Description	Timeline
		✓ JSPL is operating a plant in Angul district of odisha for steel making through gas based DRI by domestic coal.	

**Table No. 11.1 Worldwide Coal Gasification Technologies**

Entrained Flow		Fluidised Bed		Fixed Bed	
Dry Feed	Slurry Feed	Bubbling	Circulating	Dry Ash	Slagging
Air Products (Shell)	CB&I (Conoco Phillips/E-GAS)	ThyssenKrupp Uhde (HTW)	KBR Transport Gasifier	Air Liquid (LURGI)	BGL
Siemens (BBP Babcock Borsig Power /Noell)	GE (Texaco)	SES (U-GAS)		BHEL Moving Bed Gasifier	
Uhde (Prenflo/Krupp Coppers)	ECUST	KRW Kellogg Rust Westinghouse			
Eagle		BHEL FBG			



### 11.2. Coal Bed Methane:

S.No.	Technology	Description	Timeline
1.	<ul style="list-style-type: none"> <li>✓ Reservoir Simulation is carried out to assess the producibility of the CBM Reservoir.</li> <li>✓ Simulation Software widely used for the purpose include: Comet-3, Eclipse, JAM etc.</li> <li>✓ CBM Extraction Technologies as internationally practised in CBM Industry which involves drilling, completion and production.</li> </ul>	<ul style="list-style-type: none"> <li>✓ 04 CBM Blocks has been delineated in CIL leasehold areas:               <ol style="list-style-type: none"> <li>1. Jharia CBM Block-I (Jharia Coalfield)</li> <li>2. Raniganj CBM Block (Raniganj Coalfield)</li> <li>3. Sohagpur CBM Block-I (Sohagpur Coalfield)</li> <li>4. East Bokaro CBM Block (East Bokaro Coalfield)</li> </ol> </li> <li>✓ Jharia CBM Block-I has been awarded to M/s Prabha Energy Pvt. Ltd. (PEPL) through Global Bidding on Revenue Sharing Basis for CBM Extraction and the Coal Bed Methane Developer (CBMD) will have freedom to choose the best technology</li> </ul>	Jharia CBM block-I is under Exploration Phase

### 11.3. System improvement in project monitoring:

S.No.	Technology	Description	Timeline
1.	WEB Based Online Monitoring System	<ul style="list-style-type: none"> <li>✓ CIL had developed WEB Based Online Monitoring System for monitoring implementation of coal projects.</li> <li>✓ The portal has all important information related to salient features, Land, R&amp;R, EC, Production, financial information, Milestones etc. which is updated regularly.</li> </ul>	Ongoing

S.No.	Technology	Description	Timeline
		<ul style="list-style-type: none"> <li>✓ Apart from this portal, the progress of implementation of all the ongoing projects costing more than 20 Crores. are being monitored through Master Control Networks (MCNs), developed in MS project software and uploaded in project server.</li> </ul>	

#### 11.4. Improve Mine Operations

S.No.	Technology	Description	Timeline
1.	Digital Transformation at Mine Level	<ul style="list-style-type: none"> <li>✓ Coal India Ltd (CIL) has identified seven opencast mines for digitalization of mine process to accelerate performance and enhance output. The initiative shall witness the implementation of digitalization and process excellence with a goal of an increased coal output of 100 million tonnes from the identified mines.</li> <li>✓ The seven identified mines are Kusmunda, Gevra &amp; Dipka projects of the South Eastern Coalfields Ltd (SECL) and Nigahi, Jayant, Dudhichua &amp; Khadia projects of the Northern Coalfields Ltd (NCL).</li> <li>✓ The roadmap adopted by CIL aims to use available data from the sites to analyse mine productivity and efficiency through planning, project and dynamic monitoring. As part of data flow into the interconnected system, the project envisages to deploy digital sensors in the HEMMs to monitor the asset health, fuel consumption and other key factors responsible for the optimal utilization of assets at site.</li> </ul>	Ongoing

## 12. Research & Development

### 12.1 Ongoing Projects

SI No.	Projects	Brief Details
1.	On-line coal dust suppression system for opencast mines.	<p>Implementing agencies are Centre for Development of Advanced Computing (CDAC), Thiruvananthapuram &amp; CMPDI, Ranchi.</p> <p>The objectives of the project is to identify air pollutants present in opencast coal mines and provide centralised online monitoring of inventory of the pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub> and CO) based on National Ambient Air Quality Standard (NAAQS) and to develop an automatic dust suppression system for the dust generated during transportation activities in opencast coal mines for regulating the amount of particulate matter PM<sub>10</sub> and PM<sub>2.5</sub> present in the air based on NAAQS standard by sprinkling of adequate quantity of water.</p>
2.	Indigenous development of early warning radar system for predicting failures/slope instabilities in open cast mines.	<p>Implementing agencies are Society for Applied Microwave Electronics Engineering &amp; Research (SAMEER), Mumbai, Armament Research &amp; Development Establishment (ARDE), Pune, Centre of Studies in Resources Engineering (CSRE), Indian Institute of Technology (IIT), Mumbai and Central Mine Planning &amp; Design Limited (CMPDI), Ranchi.</p> <p>The objectives are development of a prototype instrument of SSR system based on GB-SAR principle and an Interferometric Information Generation System (IIGS). It will also help to develop a Control Logic, Archiving and Prediction System (CLAPS) and the Displacement Map Generation System (DMGS) of the SAR processed time series data.</p>
3.	Development and Field Trial of 500 T Capacity	Implementing agencies are IIT-ISM, Dhanbad, SECL, Bilaspur, M/s Andhra Pradesh Heavy



SI No.	Projects	Brief Details
	SAGES-III for Use with Continuous Miners (Phase-III)	Machinery & Engineering Limited (APHMEL), Vijayawada and M/s Jaya Bharat Equipment Pvt. Ltd. (JBEPL), Hyderabad. The objectives are to design, develop and manufacture of 4 nos. of 500 t capacity Self Advancing Goaf Edge Supports (SAGES) compatible with continuous miners in extraction of coal pillars and field trial of developed SAGES in depillaring operation with continuous miner at one of the underground mines of SECL and to study the techno-economic of deployed SAGES (500 T) with Continuous miner.
4.	Indigenous Development of IoT Enabled Technology for Monitoring, Analysis and Interpretation of Longwall Shield Pressures for Improving Safety and Productivity	Implementing agencies are CMPDI, Ranchi, IIT Kharagpur & Eastern Coalfields Limited (ECL), Sanctoria. The objective of the project is the indigenous development of IoT Enabled Technology for Monitoring, Analysis and Interpretation of Longwall Shield Pressures for Improving Safety and Productivity.
5.	Design & Development of Drone Mounted Optical Sensor for continuous monitoring of PM <sub>2.5</sub> & PM <sub>10</sub> in railway siding before, during & after loading operation	Implementing agencies are IIT-BHU, Varanasi and NCL, Singrauli. Objectives are to design and develop a device for real-time monitoring of PM <sub>2.5</sub> & PM <sub>10</sub> concentration at railway siding before, during, and after loading of coal on rail wagons and to predict Air quality & measure the heat, humidity and pressure in a non-contact manner.
6.	Development of Coal Quality Exploration Technique based on Convolutional Neural Network and Hyperspectral Images	Implementing agencies are CIMFR, Nagpur and Department of Computer Science & Engineering, Shri Ramdeo baba College of Engineering & Management, Nagpur. The objective is to develop a new coal quality identification and classification equipment and a technique to predict coal quality data by using Hyper-spectral imaging.

SI No.	Projects	Brief Details
7.	Development of Virtual Reality Mine Simulator (VRMS) for improving safety and productivity in coal mines	For improving safety and productivity in coal mines” has been taken up by IIT-ISM, Dhanbad. After the completion of project, necessary training programmes will be run by IIT-ISM, Dhanbad for CIL to build the capacity in mining technologies and mines safety with active participation from subsidiaries of CIL on mutually agreed cost basis. Schedule date of completion of the above project is 31 <sup>st</sup> May 2022.

## 12.2. Projects completed in last 5 years:

SI No.	Projects	Brief Details
1.	Enhancing life of de-watering pipes in coal/lignite mines by prevention of erosion-corrosion with nano-crystalline surface engineering treatments	Implementing agencies are NLCIL and NIT, Tiruchirappalli. Under this project poly-urea coatings are indigenously developed to increase the life of the pipes with great cost savings. Developed coatings are under implementation at Mine No. I, IA & II of NLCIL.
2.	Design and development of truck mounted mobile coal sampler for instant coal ash & moisture analyser at site from railway wagon/truck	Implementing agencies are CSIR-CIMFR, Dhanbad and M/s Pranay Enterprises Pvt. Ltd., Hyderabad. Nuclear technique was established with dual gamma-ray transmission for analysis of coal ash and moisture contents. This project is implemented at SCCL.
3.	Blast design and fragmentation control-key to productivity	Implementing agency is CSIR-CIMFR Dhanbad. This helps in achieving optimal explosive energy utilisation in rock fragmentation and improvement in productivity. This is implemented at Kustumda OCP, SECL, Sonapur Bazari OCP, ECL, Nigahi OCP, NCL and Samleswari OCP, MCL.

SI No.	Projects	Brief Details
4.	Optimization of various parameters of lab scale Coal Winnowing System (Phase-II)	Implementing agencies are CIMFR Nagpur unit and CMPDI, Ranchi. Under this project various parameters of lab scale 'Coal winnowing system' were optimized for consistency in product yield and ash of various coal samples. This is a developed lab scale technology and is required to be tried in a pilot scale.
5.	Development of an on-line coal wash ability analyser	Implementing agencies are CSIR-CIMFR, Dhanbad and M/s Ardee Hitech Pvt. Ltd., Vishakhapatnam. In this an x-ray based instant online coal washability analyser is developed which can save time as compared to traditional float-sink tests. It has already been installed at CSIR-CIMFR, Digwadih campus, Dhanbad.
6.	Techno-economic evaluation and performance behaviour of self-advancing (mobile) Goaf Edge Supports (SAGES) (Phase-II)	Implementing agencies are IIT-ISM Dhanbad and M/s Jaya Bharat Equipment Pvt. Ltd. (JBEPL), Hyderabad. SAGES developed for safe, economic and efficient extraction of locked coal in pillars in UG coal mines. It is implemented at RK-7 mines of SRP area, SCCL and the provisioning of SAGES is recommended by CMPDI in the project report for depillaring at Parej East UG mine, CCL.
7.	Assessment of horizontal stress fields in deeper horizons and development of roof hazard maps of coal resources in SCCL	Implementing agencies are NIRM, Bengaluru & SCCL, Kothagudem. Under this project horizontal stress fields are assessed in deeper horizon in the mines of Godavari coalfield and suitable support systems are devised for coal mining blocks of SCCL. This is implemented at Mandamari Shaft block and RKNT dip side block, SCCL.

SI No.	Projects	Brief Details
8.	Design of water network to optimize water consumption in coal washeries for removal of impurities from coal	Implementing agencies are IIT, Roorkee, CMPDI, Ranchi and CCL Ranchi. An optimum water network is suggested for washeries, which is required to be modified for closed water circuit operation with zero discharge of effluent to the surrounding. The implementation of outcome of the project is under consideration at Kedla & Piparwar Washery, CCL.
9.	Shale gas potentiality evaluation of Damodar basin of India	Implementing agencies are NGRI, Hyderabad, CIMFR, Dhanbad & CMPDI, Ranchi. 3D seismic survey was conducted for different blocks and estimation for shale gas resources were done.
10.	Electronification of Ground Water Control and Conveyor System in Mines	Implementing agencies are NLCIL, Neyveli & NITT, Tamil Nadu. A real time automation of Ground Water Control (GWC) system has been developed and continuous monitoring of parameters like vibration, temperature, energy of the conveyor drives in the mines through Internet of Things. It is already under operation in the Mine No.-II of NLCIL and work order is placed for replication of the developed system in other mines of NLCIL.
12.	Seismic data processing, interpretation and identification of thin coal seams using Inverse Continuous Wavelet Transform Deconvolution (ICWT-Decon) for resource estimation	Implementing agencies are Gujarat Energy Research and Management Institute (GERMI), Gandhi Nagar & CMPDI, Ranchi. Under this project a software is developed for Spectral Enhancement (SPE) that will help in identifying thin coal seams under the earth crust and improving the assessment of resources of fossil fuel using seismic survey during exploration process. The developed SPE software is being used in CMPDI for resource estimation.

SI No.	Projects	Brief Details
13.	Integrated geo-physical approach for tectonic study in Main coal basin of Singrauli coalfield using 3D inverse modelling of Gravity, Magnetic and AMT data.	Implementing agencies are IIT-ISM, Dhanbad & CMPDI, Ranchi. An integrated geophysical approach is adopted for demarcation of coal seams, tectonic features (faults, fractures etc.) in main coal basin of Singrauli coalfield without exploration in that area.
14.	Development of the robotics and remote operation technology for underground coal mines	Project has been completed in March 2021. The developed robot is capable of monitoring environmental parameters in UG viz % of Co <sub>2</sub> , CH <sub>4</sub> , O <sub>2</sub> , and also humidity & temperature.

## 13. Environment & Sustainability

### 13.1. Mine Water Utilization in sync with National Water Mission

In the process of coal mining, huge volume of mine water gets collected in mine sumps and subsequently pumped out to surface. By application of appropriate treatment methods, the available mine water may be used for drinking/irrigation purposes. Coal companies are doing commendable job in gainful utilization of mine water – both from active and abandoned mines. This endeavour is in line with the Jal Shakti Abhiyan for water conservation campaign initiated by Government of India.

Mine Water is used for own consumption (industrial and domestic) and surplus water supplied for community use for domestic and irrigation purposes and also for ground water recharge. During the year 2021-22, coal/lignite PSUs had utilized 2984.37 LKL for own use and supplied 3462.65 LKL to nearby community, for irrigation (2471.37 LKL) and domestic use (991.28 LKL) benefitting 15.87 lakh people and creating substantial irrigation potential. Balance water helps ground water recharge and part of that will be covered in future mine water utilization schemes. The envisaged community mine water supply target for next 4 years is:

PSUs		2022-23	2023-24	2024-25	2025-26
<b>Community Use (in Lakh Cu. Meter)</b>					
<b>CIL</b>	Domestic	900	950	1000	1050
	Irrigation	2100	2300	2350	2400
	<b>Total</b>	<b>3000</b>	<b>3250</b>	<b>3350</b>	<b>3450</b>
<b>SCCL</b>	Domestic	35	50	50	50
	Irrigation	615	630	650	700
	<b>Total</b>	<b>650</b>	<b>680</b>	<b>700</b>	<b>750</b>
<b>NLCIL</b>	Domestic	100	100	100	100
	Irrigation	250	270	300	300
	<b>Total</b>	<b>350</b>	<b>370</b>	<b>400</b>	<b>400</b>
<b>Total</b>	Domestic	1035	1100	1150	1200
	Irrigation	2965	3200	3300	3400
	<b>Total</b>	<b>4000</b>	<b>4300</b>	<b>4450</b>	<b>4600</b>

## Expenditure and Impact

	CIL	SCCL	NLCIL	Total
<b>Estimated Expenditure during 5 Years (Rs. Crore)</b>	66	10	40	116
<b>Villages to be covered in 5 years (Nos.)</b>	700	120	40	860

### **13.2 Gainful Utilization of OB to extract sand for supporting PM Awas Yojna**

Up till now, the linear 'take-make-waste' model of growth has created the climate crisis, driven biodiversity loss and left behind mountains of waste in the environment. Time has come to adopt the circular economy with reduced consumption, reuse of resources and minimum waste generation. Coal companies are also promoting principles of circular economy by ensuring optimal use of various natural resources that are handled in course of mining.

Extraction of sand from Over Burden (OB) for use as construction & stowing material is another unique initiative promoting sustainable development. This not only helps in availability of cheaper sand for construction and other usage but also minimizes the land required for OB dump. More so, this initiative also lowers the adverse footprint of river bed mining of sand. Besides extraction of sand, OB may also be utilized in road construction or in laying of Railway track.

As on 31.03.2022, three (3) OB processing plants for providing sand for construction purpose and 3 for providing UG stowing material is already in operation. These plants have handled more than 41 lakh Cu.m of OB during last 5 years. Further CMPDI has prepared a document to facilitate OB to Sand tenders by subsidiary companies. Coal companies have planned to take up more such projects in coming 4 years:

<b>Extraction of Sand from OB</b>					
PSUs	Years	Nos. of Operating Plants	Total Volume of OB to be handled (Cu.m)	Total Sand generation (Cu.m)	Avenues of sand Utilization
<b>CIL</b>	<b>2022-23</b>	11 (9+2)	3495000	1592000	UG Stowing Construction (Own and Commercial use)
	<b>2023-24</b>	12 (11+1)	3860000	1775000	
	<b>2024-25</b>	14 (12+2)	4075000	1859000	
	<b>2025-26</b>	15 (14+1)	4780000	2142000	
<b>SCCL</b>	<b>2022-23</b>	4 (3+1)	844172	506503	3 Plants already in operation for UG sand stowing,
	<b>2023-24</b>	4	865968	519581	

	2024-25	4	784982	470989	1 plant will be added for Construction Sand
	2025-26	4	742317	445390	
(Neyvelli Mines) NLCIL	2022-23	2	796000	524000	Construction
	2023-24	3 (2+1)	1195000	786000	
	2024-25	3	1195000	786000	
	2025-26	3	1195000	786000	

### Expenditure and Impact

	CIL	SCCL	NLCIL
Estimated number of local people likely to be engaged (In Nos.)	160	200	30
Estimated Capital (In Rs. Crore)	HoE basis		1.8

### **13.3. Promoting Renewable in Sync with National Solar Mission**

In order to minimize the carbon footprints of mining, coal/lignite companies are keen on promoting renewables. Coal companies are going for both roof top solar and ground mounted solar projects. It has also been envisaged to develop solar parks in some of the reclaimed mining areas.

As on 31.03.2022, Coal/lignite PSUs have installed solar capacity of about 1598 MW and wind mills of 51 MW thereby creating carbon offset potential of about 1.4 Million Ton Per annum. Coal India has planned to install 3 GW of solar Power in next 4 years.

Comp.	Target for renewables (MW)				
	2022-23	2023-24	2024-25	2025-26	Total
<b>CIL</b>	1315	1215	*	*	2530
<b>SCCL</b>	100	100	100	100	400
<b>NLCIL JV</b>		1200			1200
<b>NLCIL</b>	250	510			760

\*\* CIL will be participating in tenders of SECI. Will firm up the targets after award of tender

The estimated carbon offset potential by the targeted projects would be around 7 Million Ton of CO<sub>2</sub> e per Year.



### 13.4. Electric Vehicle Charging Stations

S.No	Technology	Description	Timeline		
			FY 2023-24	FY 2024-25	FY 2025-26
1.	Electric Vehicle Charging Stations	<ul style="list-style-type: none"> <li>✓ Electric vehicles that use exclusively chemical energy stored in rechargeable battery packs, with no secondary source of propulsion.</li> <li>✓ To cut overall CO2 emissions and mitigate the risks of diesel-powered vehicles on the health and wellbeing of their employees, the market for EVs within the mining sector has proliferated.</li> </ul>	Charging Station for Group of Mines		

### 13.5. Use of Geo-Textiles for Dump Management

S.No	Technology	Description	Timeline		
			FY 2023-24	FY 2024-25	FY 2025-26
1.	Geotextiles	<p>A new approach Geotextile – for controlling erosion of the dump surface has been explored few years back. Geotextile are thin, bio-degradable, permeable material made up of coir, cotton, jute, interwoven with nylon filaments. Geotextiles are laid on dump slope before onset of monsoon, which reduces impacts of rain on dump surface thus preventing erosion and also conserving moisture by acting as mulch for the better growth of the plant. Geotextiles decomposes within three years by the time dump</p>	Implementation if trial Successful		

S.No	Technology	Description	Timeline		
			FY 2023-24	FY 2024-25	FY 2025-26
		is stabilized with vegetation.			

### 13.6. Use of Dumps for installing solar panels.

S.No.	Technology	Description	Timeline
			FY 2023-24
1.	Solar Panel on Dumps	While most post-mining plans, especially for surface mines, calls for pits to be redeveloped into lakes or farm land, an increasing body of research and evidence shows that these ripped-up landscapes can be successfully transformed into clean energy. Reservation of at least 30 percent can be considered in OB dump for installation of solar panels.	Feasibility Check

### 13.7. Using water bodies of abandoned OC mines as reservoirs

S.No.	Technology	Description	Timeline
			FY 2023-24
1.	Water bodies of abandoned OC mines as reservoirs	<ul style="list-style-type: none"> <li>Mines that are adjacent to rivers and seasonal nalas.</li> <li>Throughput &amp; through inlet to river/nala.</li> <li>Flow of water in reservoir in case of increase in water in river during peak monsoon season &amp; vice versa.</li> <li>Development of pisciculture.</li> <li>Development of Species that survived in high water depth.</li> <li>Development of tourism &amp; livelihood activities.</li> </ul>	Feasibility Check

### 13.8. Energy Efficiency measures in sync with National Mission on Enhance Energy Efficiency

Efficient use of energy resources and their conservation assume tremendous significance as one unit of energy saved at the consumption level reduces the need for fresh capacity creation by 2 times to 2.5 times. Further, such saving through efficient use of energy can be achieved at less than one-fifth the cost of fresh capacity creation. Most importantly, energy conservation also translates into reduction of carbon footprint. Coal companies also have several areas for implementing energy efficiency measures:

- Colonies, buildings, offices, industrial establishments, rest houses etc.
- Various mining activities – HEMM, Transport, Ventilation, Pumping etc.
- Efficient Power Supply Management and many other avenues

Coal companies have been taking various energy conservation and efficiency measures over the years. The details of various efficiency measures taken during last year are:

Status of Energy efficiency measures as on 31.03.2022								
Target (FY : 2021-22)								
PSU	Energy efficiency measures - Target							
	Use of LED Lights	Energy Efficient AC	Super Fan	E-Vehicle	Efficient Water Heaters	Energy Efficient Motors for Pumps	Auto-timer in street lights	Capacitor Bank
	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.
<b>CIL</b>	92806	1668	36736	183	482	545	1745	65
<b>SCCL</b>	19800	893	11800	-	-	-	-	13
<b>NLCIL</b>	4200	20	500	-	-	2	10	20
<b>Grand Total</b>	<b>116806</b>	<b>2581</b>	<b>49036</b>	<b>183</b>	<b>482</b>	<b>547</b>	<b>1755</b>	<b>98</b>
Achievement (as on 31.03.2022)								
PSU	Energy efficiency measures – Achievement							
	Use of LED Lights	Energy Efficient AC	Super Fan	E-Vehicle	Efficient Water Heaters	Energy Efficient Motors for Pumps	Auto-timer in street lights	Capacitor Bank
	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.
<b>CIL</b>	98364	803	11869	5	254	36	980	22725 kVAR
<b>SCCL</b>	34094	840	1683	-	11	*	**	22
<b>NLCIL</b>	4500	17	200	-	-	0	16	26

<b>Grand Total</b>	<b>136958</b>	<b>1660</b>	<b>13752</b>	<b>5</b>	<b>265</b>	<b>36</b>	<b>996</b>	<b>-</b>
--------------------	---------------	-------------	--------------	----------	------------	-----------	------------	----------

\* Energy Efficient Motors for Pumps: During the last 5 years Energy Efficient Squirrel Cage Induction Motors of various capacities - 977 nos. and Slip ring Induction Motors of various capacities- 453 nos. were procured and replaced in SCCL.

\*\* Auto-timer in street lights: Auto Timers are provided in Street Lighting circuits of all colonies, OCPs, UG Mines and Offices of SCCL.

CIL has signed MOU with EESL to implement Energy Efficiency Programs at CIL and Subsidiaries. This shall cover Building Energy Efficiency Projects (BEEP), Replacement of old fans, ACs and conventional light fittings, motors, adoption of e-vehicle, installation of distributed and rooftop solar projects.

## 14. Worldwide New Technologies

### 14.1 Digital Mine Collision Awareness System

Using a VLF magnetic system, the Collision Awareness System (CAS) enables detection around corners and through strata to provide alerts for potential collisions between people and heavy equipment before they happen. The high-integrity CAS-Surface can be deployed with a variety of proximity detection methods including GPS, radio frequency (RF), VLF magnetic, and cameras. With the CAS reporting and analytics tools, you can monitor and manage operator behaviour, as well as help improve safety culture and compliance at your mine site. VLF (very low frequency) is used to generate a magnetic field – based on low frequency technology – around a vehicle, essentially an electric ‘fence’ which is independent of the material present in the immediate environment. “In other words, VLF technology allows this magnetic field to travel through obstacles like rock and water, maintaining the ‘fence’ at a constant distance from the vehicle. This means that the shape of the fence around the vehicle remains exactly the same, whether the vehicle is underground or on surface.

- CAS-CAM – Camera system for blind spot vision

Proximity Detection:

- CAS-RF – Radio Frequency (RF)-based proximity solution for heavy and light vehicles
- CAS-GPS – GPS-based proximity solution for heavy and light vehicles
- CAS-WEB – Web-based reporting system
- Personnel Tag – Personnel solution
- Self-Test – Real-time system health monitoring.
- CAS Extensions

Advisory Controls (level 8) and intervention Controls (level 9) – global EMESRT / ICMC initiative using industry standard PDS-OEM interface (ISO 21815)

Driver Fatigue Monitoring – integration with third party systems

Fleet Management System and Dispatch – integration with third party system

Most important of these is the creation of detection ‘zones’ within the magnetic field which trigger specific greater operator warnings and subsequent actions. This technology allows us to define the accuracy of these zones to within very low deviation tolerances. For instance, our first zone of safety may be 20 m from the moving vehicle – and this is accurate to within 10 cm.”

ZONE 1: When a miner – equipped with a VLF receiver and buzzer unit – enters this zone, the system sends a warning through a flashing light and buzzing sound, to alert them to the fact that they are entering a dangerous area. Importantly, the

behaviour of the VLF waves will allow the miner to be alerted even if they are behind a corner or otherwise out of sight of the vehicle operator, when within the detection range.

ZONE 2: A second zone, closer to the vehicle, is also set up in the PDS to warn the vehicle operator that there is a pedestrian in the proximity. If the pedestrian does not respond to the warnings and gets even closer, they will enter a third zone which could now trigger the mechanical intervention: switching the vehicle automatically to 'creep' mode.

ZONE 3: Should the pedestrian enter the last zone defined by the PDS – even closer to the vehicle – then a second intervention comes into play, stopping the machine in its tracks to avoid any possible collision or injury.

#### **14.2. Autonomous Drilling in mines**

Potential benefits:

- ✓ Integrating the technology into the current systems with real time data
- ✓ Increased productivity of the mines
- ✓ Higher safety

While global practices show that in Rio Tinto it has piloted two autonomous electric drills at Iron Ore Company of Canada (IOC) in Newfoundland & Labrador and a single operator to monitor multiple drills from IOC's Integrated Operations Centre in Labrador City.

#### **14.3. Real time data visualisation**

In Fushun West Open Pit Mine the roads of Open Pit roads are divided into two types: Fixed and Temporary link Roads. Using Machine learning prediction accuracy of 15.79% is obtained for link road.

Glencore's Matagami Zinc mine – Canada: understanding of operations with essential data from interconnected assets and equipment has helped better understand how their equipment works in order to improve productivity. The company has reported that average tonnage of ore hauled in each trip has risen from 55 to 60 tonnes.

#### **14.4. Use of AI in Preventive Maintenance**

Benefits:

- ✓ Improvement in machine health (involves wear and tears detection of vital parts of equipment when maintenance or repairs are needed)
- ✓ Improves overall equipment efficiency
- ✓ Reduces cost of operations
- ✓ improves work environment with higher safety standards

Hecla Mining Company -Casa Berardi mine – Canada: With real-time equipment diagnostics, Hecla has been able to use data to determine optimal ways to utilize

machines and make immediate diagnoses of equipment issues in order to decrease downtime. Since its implementation, the mine has quantified an increase of an hour per day of operations.

#### **14.5. Automatically adjust underground ventilation**

Goldcorp - Porcupine Gold Mine's Borden site – Canada: With a Ventilation on Demand system, Goldcorp can automatically adjust underground ventilation by controlling fans remotely through a centralized digital interface on the surface. This allows for a more efficient use of energy and can better control for potential operational stoppages due to a lack of ventilation. This project has cut the operation's electrical consumption in half and significantly reduced cost.

#### **14.6. Digital Mine's Safety Solution**

Wabtec's Digital Mine's Safety Solution combined with Stone Three Solutions provides for safety monitoring system that allow for consistent, real-time detection. Digital Workplace Safety software processes multiple CCTV feeds simultaneously. Its ever-evolving machine learning filters (artificial intelligence) is trained to recognize – and get continuously better at recognizing:

- ✓ Safety-zone violations
- ✓ Hard hat violations
- ✓ Safety vest violations
- ✓ Protective eye wear violations
- ✓ Crowding & abnormal behaviour

#### **14.7. Volume Analyser**

Analyzer system is a reliable and robust machine vision-based solution. Used to measure the volume and tonnage of bulk material such as mineral ore on haul trucks. This system makes use of the latest industrial high-resolution and wide dynamic range camera and laser technology for superior accuracy and robustness. The Digital solution now utilizes the latest deep learning detection technology. This allows for automatic identification of different truck types, e.g. Cat 777 vs Komatsu 785 and accurate detection of the truck bucket. The deep learning models are robust against the presence of sunlight, shadows and dust on the imaging area. Machine vision technology is used for detailed truck motion tracking to compensate for non-linear motion, e.g. curved parking at crusher.

##### Key Benefits

The system automatically identifies and scans each truck to provide high accuracy data on the ore received and has the following benefits:

- ✓ It is automated, real-time and statistically representative
- ✓ High accuracy volumetric measurement. Inferred tonnage using bulk density factor

- ✓ Detection of overloading and uneven loading to avoid fleet damage and increased maintenance cycles • Detection of under loading to avoid suboptimal fleet utilization and enable operator behaviour improvement
- ✓ Ideal for totalizing material received during a period (shift, day, week, month) and comparing with mining plan or fleet contractor obligation
- ✓ More cost effective than truck load cells, simplified calibration.
- ✓ Can be deployed within 2 months after hardware installation.
- ✓ The machine vision-based measurement is non-contact and therefore robust and low maintenance.
- ✓ Can also incorporate a Particle Size Analysis Solution to provide detailed data on the ore received.

#### **14.8. Advanced GPS System in Mining**

The GNSS guidance systems are applied to many aspects of mining operation including:

Blasthole Drilling: GNSS based blasthole drill systems provide drill monitoring, control and guidance. The prime objective of GNSS positioning for drilling is to navigate the drill rig over the designed collar position, eliminating the need for manual survey.

Shovels, Loaders, Dozers and Graders: The planned design of the mines, ore blocks, pits and roads, is overlapped with the vehicle's current positions providing the operator with the assistance required to mine the pit and ore block to the intended mine design. The on-board display provides required assistance by providing visual cues to where are located the ore blocks and whether the current floor grade is below or above the design floor grade.

Vehicle Tracking and Dispatch: The dump trucks positions obtained are sent to the central control station, where is carried the dumping scheduling management. This application determines which material is loaded and sends information and instructions to be followed by the truck drivers, in order to guarantee that the assignments are followed and the materials are correctly collected from the correct ore block and dumped in the correct dumping location.

GNSS Surveying: The advantage of using GNSS for surveying in open pit mining is that only a single surveyor is required, in opposition to the conventional methods.

Monitor Drivers and Vehicles: The sensors in the vehicle provide monitoring information of equipment's, like for instance air pressures. These systems also provide sensors to analyse the operator's well-being, by measuring key body parameters such as heart rate and skin temperature. This information is combined with GNSS information and is sent to a central control station. This information will allow for rapid intervention in case of problems

#### **14.9. Barracuda - compact bucket wheel excavator to enhance operational efficiency**



The barracuda compact bucket wheel excavator vastly extends the application range of bucket wheel excavators as it can dig or cut materials with average uniaxial compressive strengths of up to 50 MPa. In other words, the barracuda® is a genuine alternative to the conventional drilling and blasting methods used in mining coal, phosphate, ore and potash or the corresponding overburden and waste removal. But the barracuda® is not just a smart interesting alternative to drill and blast or surface miner; it has more to offer.

The combined extracting and loading process within a single machine eliminates hazardous and ecologically harmful blasting as well as additional loading activities. That is why health and safety standards at the highest level can be ensured. Since the new bucket wheel excavators are able to produce throughputs of over 3,000 t/h, and less vehicles and manpower are required, so operational expenditures can be reduced significantly.

#### **14.10. GPS for Underground**

The inability to access satellite-based global positioning data in underground environments has created many challenges for the mining sector, particularly in terms of miners' safety, materials tracking, fleet management, autonomous-truck deployment and drill automation.

The LiDAR- and UGPS-based underground tunnel positioning (LUTP) system performs mine scanning, mapping and positioning. The portable mobile mapping unit pinpoints the exact location of miners, drillers, surveyors, and autonomous truck or robotic drills, and allows users to plan their routes precisely according to tunnel maps.

#### **14.11. Hydrogen powered Dumpers**

Anglo American's innovation-led approach to sustainable mining, Future Smart Mining, which applies innovative thinking and technological advances to address mining's major sustainability challenges. This collaboration with ENGIE, in which ENGIE is providing the hydrogen generation solutions and Anglo American is developing the truck, marks the first time a truck of this size and load capacity has been converted to run on hydrogen. Operational performance of the converted trucks is the same or better than the original diesel trucks, with the additional benefits of cleaner air, less noise and lower maintenance costs. A lithium-ion battery will replace the diesel engine, allowing the FCEV haul truck to be powered by both a battery and hydrogen fuel cell technology. The truck will also have regenerative braking, allowing the vehicle to conserve and recuperate energy while going downhill.

#### **14.12. Process Health: Sensors (A Digital Mine Solution from Stone Three and Wabtec's Digital Mine)**

Crushing: A healthy mineral extraction process relies on optimal crusher performance – and complications like improper gap settings, irregular feed size and

unpredictable liner wear can compromise this. Leveraging machine vision Crusher Diagnostics and Analytics Solutions, one will be able to continuously monitor the feed and product size distribution in real time, while improving your maintenance planning, increasing your crusher uptime, and optimizing your crusher control at the same time.

#### Truck Particle Size Measurement Solutions:

A working primary crusher is of key importance in the mining industry serving as a vital link between the mine and plant for managing ore size. If rocks or other materials are oversized when entering the crusher, they can cause significant damage, which can be costly to repair. The Truck Particle Size Measurement Solution uses machine vision laser-based sensors to measure and monitor the particle size distribution of ore as it goes into the crusher, improving uptime, increasing efficiency and providing actionable feedback.

#### **14.13. High Fidelity Fiber Sensing & Asset Performance Management in Conveyor Belt**

Managing the key assets is always vital to keeping costs down on site, particularly when it comes to conveyor belts. Belt failures can be dangerous, disruptive and costly – but can be prevented. The Belt Condition Monitoring Solution will identify surface features on your conveyor belts, such as splices, tears and edge deformations, while detecting belt drift at the same time. Wabtec corporation's enhanced early detection helps to simplify the belt inspection process, resulting in improved maintenance scheduling and helping to keep costs and downtime at a minimum.

#### Belt Integrity and Operation

Real time belt integrity/rip monitoring and belt alignment detection. PSA and volumetric measurement.

- ✓ Reduce damage on belt
- ✓ Reduction in safety risks
- ✓ Proactively detect potential belt failures

#### Idler temperature and vibration profile monitoring:

Fiber Optic Sensing measuring temperature and vibration of idlers along the length of the belt

- ✓ Real time visibility on idler health
- ✓ Alarm location along length of belt
- ✓ Reduce engineering cost in troubleshooting
- ✓ Prevent unplanned downtime.

#### Predictive Analytics

Pre-emptive detection of eminent failures on the drive and gearbox using digital twins.

- ✓ Reduce unplanned downtime
- ✓ Remote monitoring augmenting engineering team

#### Asset Centric Application

Unified analytics and visibility of operational performance and how the conveyor system relates to the up- & downstream operation with Value Stream Mapping, KPI Driver Trees and Bottleneck Identification

- ✓ Continuous improvement on production capability
- ✓ Operational performance improvement

#### **14.14. Drone-based Subsidence Monitoring**

Measure Australia's drones can take precise measurements of an area of land, on average, five times faster than traditional methods of land surveying. Rather than needing a whole team of surveyors, in most cases, there is just one person piloting the drone. Not only is drone-based subsidence monitoring faster, but it's also extremely accurate and much more affordable compared to traditional methods. The data is captured once, completely, and accurately eliminating the need to revisit the site to double-check measurements.

#### **14.15. Autonomous Trucks:**

**Rio Tinto** had already been using autonomous haul trucks that can carry 350 tonnes and operate totally independently since 2008. These trucks have impacted the company's bottom line by reducing fuel use by 13 percent and are safer to operator.

Some companies have begun to use smart sorting machines that can sort the mined material based on whatever criteria a company wants. This work can lead to savings in fuel and energy during processing and reduce grade dilutions.

#### **14.16. Data Twinning**

**Rio Tinto's** other initiative called data twinning. By creating a virtual model that is fed real-time data from the field, scenarios can be quickly tested, and operations and production can be optimised. This ability to test out decisions before they are implemented in a replica system leads to better outcomes and savings.

#### **14.17. Rope Conveying**

An innovative conveying system for difficult terrain.

- ✓ Rope conveying technology and was specially developed for handling materials of all kinds. This system has shown itself to be unbeatable – even in impassable terrain.

- ✓ It can cross obstacles such as rivers, buildings, deep valleys or roads without any problem.
- ✓ Rope provides handling capacities of up to 25,000 t/h while occupying a minimum structural footprint. Simple maintenance of the conveying line and low space requirements are the key features of this product.
- ✓ Rope transports material on a flat belt with corrugated side walls. The belt performs the haulage function and is driven and deflected by a drum in the head or tail station.
- ✓ The belt is fixed to axles arranged at regular intervals to support the belt. Running wheels are fitted to either end of the axles. These run-on track ropes with fixed anchoring and guide the belt. The track ropes are elevated off the ground on tower structures.



#### Rope Conveying at a glance

- ✓ Continuous conveyor system for bulk materials and unit loads of all kinds
- ✓ Proven conveyor technology combined with decades of ropeway experience
- ✓ Conveying capacities of up to 25,000 t/h
- ✓ Rope span length of approx. 1 km possible.

## **15. Business Models**

### **15.1. Mine Development Operator Model**

The MDO, appointed under a Coal Mining Agreement (**CMA**) signed between the private entity and PSU, broadly undertakes pre commencement activities including land acquisition, rehabilitation and resettlement, procurement of applicable permits, construction activities, setting-up of the mining plant infrastructure, setting-up of storage facilities, development of transportation and handling facilities, etc. for the coal mine. During the operation period of the project the MDO undertakes coal excavation operations and transportation to delivery points, for a mining charge on achieving a certain level of production of coal as specified in the agreement. Usually, the contract period of such CMAs is envisaged to last up to the life of the mine.

### **15.2. Revenue sharing Model**

Revenue sharing is a somewhat flexible concept that involves sharing operating profits or losses among associated financial actors. Revenue sharing can exist as a profit-sharing system that ensures each entity is compensated for its efforts. In coal mining revenue sharing model, the bidders being obliged to bid for a percentage share of revenue from selling coal mined. Eg. Coal Block Auction.

### **15.3. Lease/Hiring of equipment**

As a mode of aiding business operations, Equipment leasing/hiring provides flexibility for coal companies to make decision based on current market conditions by avoiding the need to invest capital in equipment and allowing periodic affordable payment plan with low interest rates. Coal mining sector find leasing flexible and more convenient because of its apparent low cost. The coal companies here is called just to pay a rental fee payment monthly, quarterly or yearly based, brief periodically in order to continue using the equipment.

### **15.4. Build-Operate-Transfer (BOT)**

It is conventional PPP model in which private partner is responsible to design, build, operate (during the contracted period) and transfer back the facility to the public sector. Private sector partner has to bring the finance for the project and take the responsibility to construct and maintain it. Public sector will allow private sector partner to collect revenue from the users.

### **15.5. Build Operate Own (BOO)**

In this model ownership of the newly built facility will rest with the private party. On mutually agreed terms and conditions public sector partner agrees to 'purchase' the goods and services produced by the project.

### **15.5. Build Operate Own Transfer (BOOT)**

In this variant of BOT, after the negotiated period of time, project is transferred to the government or to the private operator. BOOT model is used for the development of highways and ports.

### **15.6. Lump Sum Turnkey (LSTK)**

A Lump Sum Turnkey (LSTK) is a combination of Lump Sum (LS) contract and Turnkey (TK). A Lump Sum Contract is a type of the contracts under which an owner agrees to pay a specified contracted amount for completing work to a contractor, and the contractor is responsible for completing the project under the contractor's financial risk. Turnkey (TK) specifies that the scope of work includes start-up of a facility and achievement of the normal operation status under the contractor's responsibility.

### **15.7. Engineering, Procurement and Construction (EPC)**

Under this model, the cost is completely borne by the government. Government invites bids for engineering knowledge from the private players. Procurement of raw material and construction costs are met by the government. The private sector's participation is minimum and is limited to the provision of engineering expertise. EPC Contractor (private entity) is made responsible for all the activities from design, procurement, construction, to commissioning and handover of the project to the Government.

### **15.8. Engineering, Procurement, Construction & Management (EPCM)**

EPCM stands for Engineering, Procurement and Construction Management. Simply put, EPCM is a way of working on an engineering project which lets the project owner (say Government) stay in complete control of their project while engineering consultants (Private entities) manage the process from start to finish. This means the private entities take care of all the stages of engineering: including planning, complex engineering requirements, co-ordinating all contractors and vendors etc. on the client's behalf and providing a single point of contact.

### **15.9. LOT (Lease, Operate and Transfer)**

Under this type of PPPs, a facility which already exists and is under operation, is entrusted to the private sector partner for efficient operation, subject to the terms and conditions decided by mutual agreement. The contract will be for a given but sufficiently long period and the asset will be transferred back to the government at the end of the contract. Leasing a mine to the private sector along with the employees and all facilities by entrusting the management and control, subject to pre-determined conditions could come under this category.

**Annexure-1: Minutes of meeting on the direction of Hon'ble Prime Minister, chaired by Secretary Coal on 27<sup>th</sup> September 2021**

Cord-F0204/1/2017-CO-ORDINATION  
Government of India  
Ministry of Coal  
\*\*\*\*\*

Shastri Bhawan, New Delhi,  
Dated 1<sup>st</sup> October, 2021


**OFFICE MEMORANDUM**

**Subject: Minutes of the meeting on the directions of Hon'ble Prime Minister, chaired by Secretary Coal on 27th September 2021-reg.**

The undersigned is directed to enclose Minutes of the Meeting taken by Secretary (Coal) on the directions of Hon'ble Prime Minister on 27.09.2021 at 4:00 PM for necessary action.

2. The action taken report may be sent to Coordination Section on [coord.moc@nic.in](mailto:coord.moc@nic.in) positively by 08.10.2021.

Encl: As above.

  
(Rishan Rynthathiang)  
Under Secretary (Coord.)  
Tel: 23073936  
Mail : [rishan.r75@nic.in](mailto:rishan.r75@nic.in)

To,

1. AS(C)/AS (MN)/JS (SBN)/JS (VT)/JS (BPP)/JS&FA/EA/DDG/ Advisor (P)
2. All Directors/DSSs

Copy for information to:

PSO to Secretary (Coal)

**Minutes of the Meeting on the directions of the Hon'ble Prime Minister, chaired by Secretary Coal on 27.09.2021 at 4:00 PM in Conference Hall**

1. List of participants at Annexure.

2. Secretary (Coal ) shared his experience of interaction with Hon'ble Prime Minister with Secretaries to the Govt of India on 18th September, 2021. He mentioned that we should share maximum possible data in public domain so that the faith & confidence of public in the coal sector increases which in turn will have a positive impact on market . ESG (Environment Social Governance) should have more focus.

3. All the key points of the aforesaid interaction meeting with PM as summarized by Cabinet Secretariat in its DO letter No.-1/28/3/2021-CAB dated 20.09.2021 were discussed in details as below:-

**a. Every effort needs to be made to fully leverage the power of technology. All schemes/ programmes of Government of India should therefore have an inbuilt digital component.**

The technology review that is being taken up in MCL was discussed at length. It was informed that Accenture has been appointed to prepare medium and long term technology roadmap and strategy for MCL. Greater automation in machinery should be encouraged in the coal companies.

Advisor (P) was asked to drive the technology agenda and to prepare a Note on "Technology roadmap of Coal companies" within 3 weeks on the technology present in coal companies under various categories like safety, efficiency, precision etc. Possibilities of engagement with private sector to understand the implementation of technology in their coal mines may also be explored.

[Action- Advisor(P)]

**b. In today's digital age, data is a very valuable resource. A single data source can be useful for multiple benefits. Data governance is a key to our efforts to transform the lives of our countrymen. We must embrace the concept of 'Data as wealth' and utilize this potential of data.**

Secretary (C) emphasized that data being a powerful tool of information should be developed in a certain shape in the coal sector. Metadata available with us could be analysed for patterns of production/supplies/despaches/seasonal vagaries. Information on of rakes moved, despatch of coal from coal mines to various sectors plus other data should form part of the



database. ERP rollout in CIL was discussed which is presently implemented only in HR, Hospital management and in Accounts.

DDG was asked to prepare a report on various types of datasets available with CIL, like the data of consumers, rakes, despatches of coal to different sectors etc.

[Action-DDG]

**c. Implementation of budget announcements needs to be taken forward in right earnest. Capital expenditure needs to be speeded up to meet the target for the current financial year. The progress in many Ministries at the end of the first quarter of financial year is not satisfactory.**

There were no issues related to Ministry of Coal in the Budget Announcements for 2021-2022.

**d. Actionable points from PM's Independence Day speech, 2021 may be identified by all Ministries/ Departments and time bound implementation ensured. In particular, a road map may be prepared for achieving 100 % saturation under all Central Government schemes. In this regard, it may also be mentioned that this Secretariat has uploaded major initiatives announced in PM's Independence Day Speech on the e-Samiksha portal. All Ministries/ Departments are requested to report progress of implementation regularly on the said portal.**

While noting that single use plastics had been done away, hospitals had been enabled with oxygen beds, a draft list of 24 take aways gleaned from the Hon'ble PM's speech 2021 were broadly discussed -these were asked to be circulated to all divisions for inputs. It was directed that action on all the take away points should be updated on eSamikSha portal with details of the activities undertaken.

[Action-JS(Coord.)]

**e. The Government has established Capacity Building Commission (CBC) to reorient training of Civil Servants in line with evolving requirements. Ministries/Departments should reach out to the CBC and apprise them about their current training architecture/institutes and discuss in details their training needs, as also the need for continuation/reorientation of the extant training institutions. A nodal officer may be designated by each Ministry/Department for interaction with CBC.**

Training needs in the Coal Sector were discussed which need to be aligned with the emerging challenges in the coal sector. Trainings on Diversification, Sustainability and Financial management, ESG etc. to be taken up

It was decided that “Paper Presenting Sessions” that we were having earlier by the senior officers of MOC on various topics should be now held regularly.

[Action-JS (EST.)]

**f. GeM Portal has enormous potential as an e-market. All Ministries/Departments and the organizations under them need to use this portal for all their procurement.**

JS&FA informed that all procurement in the Ministry is being done through GeM portal.

JS&FA was asked to give a presentation on the Ministry's activities in GeM Portal relating to procurement, availability of products and issues encountered.

[Action-JS&FA]

**g. Secretaries may organize interaction sessions with their staff and seek their inputs/suggestions relating to the work of their Ministry/Department.**

Secy(C) suggested to organize suitably paced interactions with various levels of officers of the Ministry.

[Action- JS (Admin.)]

#### **4. Other Decisions**

- i. A review meeting on the achievements of first half in Agenda Setting 2021-22 should be organized soon after getting the progress reports from the officers.

[Action-JS(Coord.)]

- ii. All the senior officers of MOC should be on the Board of the Coal Companies

[Action-JS (Estt.)]

iii. A Presentation on CCO should be organized soon

[Action-DDG]

iv. Officers of MOC may visit the mines of the Coal Companies for appraising ground situation after 15<sup>th</sup> Oct 2021.

[Action- JS (Estt.)]

v. NIC should give a presentation on their dashboard and booking of internal meetings should be through the portal.

[Action-STD, NIC]

vi. The action points/responsibilities decided in the meetings chaired by Secretary (C) should also be uploaded on Coal Taskmaster Portal. What's new should be displayed on our website and also PIB who should be engaged proactively for reporting our reform stories.

[Action- AS (C)]

vii. Seminar on Capacity Assessment should be organized by CIL inviting all coal companies, CMPDI, private sector for stakeholder consultations.

[Action- JS(CA)]

vii. A Live dashboard should be prepared on Coal Production/dispatches

[Action-JS(CPD)]

viii- On Agenda 2047- Energy Independence " A presentation to be organized with focus on eliminating imports

[Action - EA]

**An ATR to be provided by all concerned divisions as above which will be sent as a Note to the Cabinet Sectt**

Minutes concluded.

Meeting on the directions of Hon'ble Prime Minister taken by Secretary (Coal) on 27.09.2021 at 4.00 PM. in Conference Room no. 321-A Wing with all JS/equivalent & above officers

List of Participants:

S. No.	Name	Designation
1.	Dr. Anil Kumar Jain	Secretary (Coal)
2.	Shri Vinod Kumar Tiwari	AS (Coal)
3.	Shri M.Nagaraju	AS (MN)
4.	Shri S.B.Negi	JS (Estt.)
5.	Smt. Nirupama Kotru	JS & FA
6.	Shri Bhabani Prasad Pati	JS (P&S)
7.	Shri Animesh Bharti	EA
8.	Ms. Santosh	DDG
9.	Shri Anandji Prasad	Advisor Projects
10.	Shri Mukesh Choudhary	Dir (CPD &IC)
11.	Shri Rajnish Kwatra	DS(Coord. & Parl.)

## Annexure-2: Coal India as compare to leading global coal miners in terms of digital initiatives:

Area	Digital enablers		 AngloAmerican		 exxaro	 bhpbilliton	 RioTinto	 ArchCoal
<b>Business</b>	Coal production	602 MTPA	49 MTPA	30 MTPA	47 MTPA	70 MTPA	Exited from coal business	100 MTPA
	Typical SR (cum/t)	~2.0-2.2	3.5*	2.3 – 3.2*	0.5 – 3.5*	2.4 – 9.7*	NA	
	Digital Maturity	<b>Low</b>	<b>High</b>	<b>High</b>	<b>High</b>	<b>Advance</b>	<b>Advance</b>	<b>Low</b>
<b>Data Management</b>	Physical Server	✓	✓	✓	✓	✓	✓	✓
	Cloud storage	✗	✓ Single cloud platform	✗ Developing	✓ Migrating SAP to Microsoft Azure	✗ Planning	✓ Azure Stack to be deployed	✓ Workforce – employee cloud solution
	2D/3D/4D data modelling	✓ SURPAC use in NCL	✓ GOCAD Mining Suite, PaleoGIS	✓ 3D Modelling & RCubed	✓ Xpac, acQuire, EQuIS	✓ 3D Interpretation software	✓ 3D Interpretation software	✓ 3D Interpretation software (Minex)
<b>Mine operations</b>	Robotics and equipment automation	✗ Developing tele robotics	✓ DR412I blasthole rig	✓ BIKE Platform from GE	✗ Introducing gamification & robotics (Digital Twin)	✓ Autonomous truck - BHP's Jimblebar mine	✓ Autonomous mining trucks	✗
	Advance analytics	✗	✓ Machine learning analytics	✓ Big Data Analytics	✓ LightApp - energy analytics	✓ Machine learning applications	✓ Digital Twin	✗
	IoT devices	✗	✓ Digital Twin	✓ Optical Laser Scanner	✓ Underground wifi	✓ L&T Infotech developed IIoT	✓ IoT application on automation	✗
	Drone technology	✓ CMPDIL to develop	✓	✓ LiDAR and Drone technology use	✓ Rocketmine drones	✓ UAV in Goonvellya	✓ Drones & Remotely Operated Vehicles (ROVs)	✓ DroneMapper Technology
<b>Mine health &amp; safety</b>	Remote Operations Centre	✓ Wireless communication	✓ Electronic tablet in UG	✓ Safe-halo app	✓ Belfast Coal – remote monitoring & tracking	✓ Integrated Remote Operations Centre	✓ Operation Centre – entire operation in action – in real-time	✓ Wireless communication (IWT Wireless System)
<b>Supply-chain</b>	Automation and robotics	✗	✗	✗	✗	✓ Blockchain	✓ AutoHaul™	✗
	Artificial Intelligence/ Real-time advance analytics	✗	✗	✗	✗	✓ FactoryTalk Historian Site Edition (SE) software	✓ AutoHaul™	✗
<b>Business Process</b>	Integrated Enterprise, Platforms	✓ ERP by Tech Mahindra	✓	✓ ERP by Tech Mahindra	✓ SAP Enabled	✓	✓ SAP estate into the Microsoft Azure	✓

\* - Selected opencast mines

✓ - Implemented or likely to be implemented | ✗ - Not implemented