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भारत में खदान बंद करने की रणनीतियाँ- एक समीक्षा

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सारांश

यह समीक्षा लेख-पत्र माइन प्लान गाइडलाइन वर्ष 2020 एवं वर्ष 2024 पर आधारित है। खनन और खदान बंद करने और पुनर्वास की योजना और उसके परिचालन प्रथाओं की मौलिक अवधारणा को उजागर करने का प्रयास किया गया है। यह समीक्षा पत्र वैश्विक समानता को उजागर करते हुए भारत में खनन बंद करने के लिए अपनाई जाने वाली विभिन्न प्रथाओं का अवलोकन प्रदान करने का प्रयास करता है। यह समीक्षात्मक लेख अंतरराष्ट्रीय और भारतीय प्रथाओं और पर्यावरण की दृष्टि से टिकाऊ और विवेकपूर्णता से खनन बंद करने की रणनीतियों और अंतराल की पहचान के प्रयासों के बारे में प्रकाश डालता है। नई गाइडलाइन कैसे अपने पूर्ववर्ती गाइडलाइन से भिन्न है। आवश्यक विशेषताओं से सुसज्जित इस नई गाइडलाइन की गहन अध्ययन कर विस्तृत विश्लेषण से पता चलता है कि 2024 का गाइडलाइन दूरगामी प्रभाव डालेगा। इसके कारण कुल 20 खंडों/उपखंडों पर प्रभाव पड़ा है। कुल 5 अध्याय, 11 परिभाषा एवं 9 परिशिष्ट जोड़ कर इसे तर्क संगत किया गया है। कुछ खंडों को विलोपित कर कुछ नए उपबंध भी जोड़े गए हैं। ''जस्ट ट्रांसफॉर्मेशन,'' ''रेस्टोरेशन व रिपरपसिंग'' एवं ''लोग व समुदाय,'' खदान बंद करने के लिए समय निर्धारण कि एक नई व्यवस्था की गई है- खनन बंद होने के बाद की अवधि 3 (तीन) वर्ष मानी जाएगी और बंद होने के बाद की निगरानी अवधि उसके बाद 2 (दो) वर्ष के लिए होगी। यह लेख कोयला खदान प्रबंधकों को माइन क्लोजर के सभी आयामों को बेहतर ढंग से समझने में मदद करेगा।

कुंजी: ''जस्ट ट्रांसफॉर्मेशन'', ''रेस्टोरेशन व रिपरपसिंग'' एवं ''लोग व समुदाय'',

[1]वरीय प्रबंधक, पर्यावरण प्रभाग सीएमपीडीआई मुख्यालय राँची।

[2]महाप्रबंधक, पर्यावरण प्रभाग सीएमपीडीआई मुख्यालय राँची।

Abstract

This review article is based on the Mine Plan Guidelines for the year 2020 and 2024. An attempt has been made to highlight the fundamental concepts of mining and mine closure and rehabilitation planning and its operational practices. This review paper attempts to provide an overview of the various practices adopted for decommissioning in India while highlighting global similarities. This review article highlights international and Indian practices and efforts to identify strategies and gaps in mining closures in an environmentally sustainable and prudent manner. The new guideline is different from its previous guideline. An in-depth study of this new guideline equipped with essential features and a detailed analysis shows that the 2024 guideline will have a far-reaching impact. Due to this, a total of 20 sections/sub-sections have been affected. It has been made logical by adding a total of 5 chapters, 11 definitions and 9 appendices. Some sections have been deleted and some new provisions have also been added. "Just Transformation", "Restoration and Repurposing" and "people and Community", along with a new system has been made to determine the time frame for mine closure - the period after closure of mining will be considered to be 3 (three) years and after the closure the subsequent monitoring period thereafter will be for 2 (two) years. This article will help coal mine managers to better understand all dimensions of mine closure.

Keyword: Just Transformation, Restoration and Repurposing and People & Community

परिचय:

खनिज-एक सीमित और गैर-नवीकरणीय होने के कारण मूल्यवान प्राकृतिक संसाधन हैं। वे कई बुनियादी उद्योगों के लिए महत्वपूर्ण कच्चे माल का निर्माण करते हैं और विकास के लिए एक प्रमुख संसाधन हैं। भारत में खनिज निष्कर्षण (एक्सट्रशन) का इतिहास हड़प्पा सभ्यता के दिनों का है। प्रचुर समृद्ध भंडार के रूप में खनिजों की व्यापक उपलब्धता ने इसे भारत में खनन क्षेत्र की वृद्धि और विकास के लिए बहुत अनुकूल बना दिया। पर आज आवश्यकता है पर्यावरण ीय रूप से स्थायी तरीके से खदानों का बंद करने कि परिकल्पना। खदान बंद का व्यापक सिद्धांत संयुक्त राष्ट्र के सतत विकास लक्ष्यों (SDGs) में भी परिलक्षित होता है, जिसे 2015 में अपनाया गया था। भारत में, खनिज संसाधन निष्कर्षण का बोझ अनियोजित खदान बंद करने और अप्राप्य और परित्यक्त भूमि के बड़े क्षेत्रों की वसीयत पर पड़ा है। हाल के दिनों में खनन कार्य पर्यावरण संरक्षण की परवाह किए बिना दोषपूर्ण तरीकों ओर गैर जिम्मेदारों प्रथाओं के साथ किए जा रहे थे। इस प्रकार की गतिविधियों के परिणामस्वरूप आसपास के क्षेत्रों में खनन के प्राकृतिक पारिस्थितिक तंत्र की अपरिवर्तनीय हानि हुई है।

कोयला मंत्रालय, भारत सरकार व माइन क्लोजर

खदान बंद करना एक एकल-चरण की प्रक्रिया नहीं है, इसलिए केवल जीवन के अंत चरण के बजाय पूरे खनन जीवनचक्र में एक निर्बाध संक्रमण प्राप्त करने के लिए बहुआयामी रणनीतियाँ, दीर्घकालिक प्रबंधन और उचित परिश्रम महत्वपूर्ण हैं। इसके लिए भारत सरकार ने समय-समय पर कई गाइडलाइन जारी किए हैं। कोयला खदानों को जिम्मेदार और पर्यावरण के प्रति जागरूक होकर बंद करने को सुनिश्चित करने की दिशा में एक महत्वपूर्ण कदम के रूप में, कोयला मंत्रायल ने परित्यक्त और बंद पड़े खदानों के समाधान के लिए पहल की है। ऐतिहासिक रूप से, खदानों को बंद करने की प्रक्रियाएँ अनियंत्रित रही हैं, जिनके तहत उपकरण और सामग्री को छोड़ दिया जाता है और खदान स्थल उपेक्षित पड़े रहते हैं। एक व्यवस्थित दृष्टिकोण की आवश्यकता की जरूरत को समझते हुए, मंत्रालय ने 2009 में खदान बंद करने के दिशानिर्देश पेश किए, जिन्हें बाद में 2013 और 2020 में संशोधित किया गया। इसके साथ ही खान मंत्रालय, भारत सरकार ने 2009 से पहले बंद हुई खदानों के प्रबंधन के लिए अक्टूबर 2022 में दिशानिर्देश जारी किए और उन्हें वर्तमान में बंद, परित्यक्त या अंतिम रूप से बंद के रूप में वर्गीकृत किया। इनमें पर्यावरणीय प्रभाव को कम करते हुए सुरक्षित और स्थाई आधार पर खदान बंद करने पर जोर दिया गया है।

कोल इंडिया व माइन क्लोजर

कोल इंडिया लिमिटेड ने मंत्रालय के दृष्टिकोण के अनुरूप खदानों की पहचान की है और उन्हें बंद करने की दिशा में सक्रिय कदम उठाए हैं। 2009 से पहले की 169 और 2009 के बाद की 130 खदानों की पहचान की गई है, जिन्हें वर्तमान में बंद, परित्यक्त या अंतिम रूप से बंद माना जाता है। इनमें से 2009 से पहले की 66 खदानें अंतिम रूप में बंद करने के लिए चिन्हित की गयीं हैं, जिनमें से 63 खदानों के लिए अंतिम रूप से खदान बंद करने की योजनाएँ (एफएमसीपी) परिश्रमपूर्वक तैयार की गई हैं। इसके अतिरिक्त, 2009 से पहले की 16 खदानों को अस्थायी तौर पर बंद करने के लिए चिन्हित किया गया है, जिनमें से प्रत्येक के लिए खदान बंद करने की व्यापक अस्थायी योजना (टीएमसीपी) विकसित की गई है।

2009 के बाद की खदानों के संबंध में, कोल इंडिया लिमिटेड सक्रिय रूप से 35 एफएमसीपी तैयार कर रहा है, जो खदान बंद करने की जिम्मेदार प्रतिबद्धता को प्रदर्शित करता है। इसके साथ ही, सिंगरेनी कोलियरीज कंपनी लिमिटेड (एससीसीएल) ने 2009 से पहले की छह खदानों को अस्थायी रूप से बंद करने के लिए और 2009 के बाद की पाँच खदानों को अंतिम रूप से बंद करने के लिए चिन्हित किया है। उल्लेखनीय है कि इन चिन्हित खदानों के लिए खदान बंद करने की गतिविधियाँ पहले से ही चल रही हैं, जो सतत् पर्यावरण के लिए कोल इंडिया लिमिटेड और एससीसीएल, दोनों की प्रतिबद्धता को रेखांकित करती हैं।

सीएमपीडीआई व माइन कॉलजर

खदान बंद करने की इन व्यापक गतिविधियों को सुव्यवस्थित करने और निगरानी करने के लिए, सेंट्रल माइन प्लानिंग एंड डिजाइन इंस्टीट्यूट (सीएमपीडीआई) ने एक पोर्टल विकसित किया है। यह केंद्रीकृत स्रोत, खदान बंद करने की गतिविधियों की निगरानी की सुविधा देता है, जिनमें पुर्नप्राप्ति, बंद होने के बाद वायु और जल की गुणवत्ता, भूमि पुर्नउपयोग और सामाजिक समर्थन उपाय शामिल हैं। सामूहिक रूप से ये पहले खदान बंद करने की जिम्मेदार और वैज्ञानिक रूप से सुदृढ़ प्रयास के रूप में एक आदर्श बदलाव का संकेत देती हैं, जो पर्यावरण प्रबंधन और सामुदायिक कल्याण के लिए कोयला मंत्रालय की प्रतिबद्धता के अनुरूप भी हैं।

सीएमपीडीआई एक परामर्श संस्थान के रूप में कोल इंडिया के अनुषंगी इकाइयों के साथ-साथ कोयले से जुड़ी अन्य संस्थानों के लिए भी माइन क्लोजेर, प्रग्रेसिव एवं फाइनल माइन क्लोजेर रिपोर्ट तैयार करती है। सीएमपीडीआई को कार्यादेश मिलने पर 3rd पार्टी ऑडिट भी करती है। सीएमपीडीआई के अनुभव एवं श्रमता को देखते हुए इसे एक प्रमुख ऑडिट संस्थान के रूप में मान्यता मिली है। इस संस्था को नए गाइडलाइन के परिशिष्ट-V में एक विशिष्ट स्थान दिया गया है।

प्रभावी माइन क्लोजर योजना के परिणाम:

- हितधारकों के साथ लगातार और पारदर्शी जुड़ाव।
- सफल समापन को रेखांकित करने वाली कार्रवाइयों की योजना बनाने और उन्हें लागू करने में सामूदायिक भागीदारी।
- समापन निर्णयों का हितधारक समर्थन।
- खनन जीवन चक्र के दौरान समापन का बेहतर प्रबंधन।
- अधिक सटीक समापन लागत अनुमान।
- जोखिमों की शीघ्र पहचान और शमन रणनीतियाँ।
- देनदारियों में उत्तरोत्तर कमी।
- समापन के बाद की अवधि के लिए एक सहमत दृष्टिकोण की दिशा में काम करना।
- जैसे-जैसे खदान परिचालन से बंद होने की ओर बढ़ रही है, प्रभावित हितधारकों के लिए एक बेहतर सामाजिक परिवर्तन।
- स्थायी लाभ के अवसरों को पहचाना जा रहा है और पर्याप्त रूप से योजना बनाई जा रही है कोयला मंत्रालय ने खदान बंद करने की व्यापक रणनीतियों की पहल की शुरूआत की। परित्यक्त/वर्त्तमान में बंद पड़े खदानों को वैज्ञानिक ढंग से बंद करने पर विशेष ध्यान, अब तक 299 खदानों की पहचान की गई।

माइन क्लोजर व वर्त्तमान गाइडलाइन

भारत सरकार ने समय-समय पर खदान बंद करने की रूपरेखा को मजबूत करने और सर्वोत्तम अंतरराष्ट्रीय तौर-तरीकों को अपनाने के लिए मौजूदा खदान योजना दिशानिर्देशों की समीक्षा करने के लिए एक विशेषज्ञ समिति नियुक्त की है। कोयला और लिग्नाइट ब्लॉक के लिए खान मंत्रालय, भारत सरकार द्वारा जारी खनन योजना दिशानिर्देश के अनुसार खदान बंद करने की योजना 2024 के संशोधनों को तालिका 1 में दिखाया गया है।

तालिका 1: खनन योजना दिशानिर्देश के अनुसार खदान बंद करने की योजना में संशोधन

पारा संख्या			पारा संख्या	
2020	**2024**		**2020**	**2024**
2	3.1		2.11	3.7
2.1	4.8		2.12	4.10
2.2	3.4			3.5.5 (i)
2.3	4.8		2.13	4.11
2.4	4.9		2.14	4.11 (ii)
2.5	3.5		2.15	3.5.4
2.6	3.5.1		2.16	3.8
2.7	3.5.2		2.17	3.9
2.8	3.5.3		2.18	3.5.5 (iii)
2.9	3.6		2.19	4.12
2.10	3.6 a.			

स्रोत : कोयला और लिग्नाइट ब्लॉक के लिए खान मंत्रालय, भारत सरकार द्वारा जारी खनन योजना दिशानिर्देश 2020 व 2024.

खनन कंपनी/खान मालिक/प्रस्तावक की जिम्मेदारी

कोयला और लिग्नाइट ब्लॉक के लिए खान मंत्रालय, भारत सरकार द्वारा जारी खनन योजना दिशानिर्देश के अनुसार खनन कंपनी/खान मालिक/प्रस्तावक की जिम्मेदारी को तालिका 2 में संकलित की गई है:-

तालिका 2: खनन कंपनी/खान मालिक/प्रस्तावक की जिम्मेदारी

गतिविधि	विवरण	दिशानिर्देश का पैरा संख्या	
		2020	2024
माइन क्लोजर प्लान की मंजूरी।	माइन क्लोजर प्लान व फाइनल माइन क्लोजर प्लान खनन योजना का अभिन्न अंग होगी। माइन क्लोजर प्लान व फाइनल माइन क्लोजर प्लान की अलग से मंजूरी के प्रावधान को खत्म कर दिया गया (2020 के प्रावधान) था को यथावत रखा गया है।	1	1.1(C)
प्रगतिशील माइन क्लोजर प्लान।	खनन कार्य शुरू होने के हर पाँच साल की अवधि के लिए प्रगतिशील माइन क्लोजर प्लान तैयार की जाएगी।	2.2	3.4
प्रत्येक 5 वर्ष के बाद प्रगतिशील माइन क्लोजर प्लान का पुनरीक्षण।	प्रगतिशील माइन क्लोजर प्लान की हर पाँच साल की अवधि में पुनरीक्षण किया जाएगा और समय-समय पर केंद्र सरकार द्वारा अनुमोदित तीसरे पक्ष की एजेंसियों द्वारा इसकी जाँच/निगरानी की जाएगी।	2.2	3.4
फाइनल माइन क्लोजर प्लान को तैयार करना एवं उसका अनुमोदन।	खनन योजना का विवरण जिसमें फाइनल माइन क्लोजर प्लान की विभिन्न गतिविधियों की अद्यतन लागत अनुमानों का ब्यौरा तथा पहले से स्थापित एस्क्रो खाता की जानकारी ही साथ खदान के बंद होने के कम से कम पाँच साल पहले अनुमोदन के लिए अनुमोदन प्राधिकारी को प्रस्तुत करना होगा।	2.9	3.6
एफएमसीपी की पूर्णता के लिए तीसरे पक्ष की लेखापरीक्षा हेतु संस्थान/संगठन/एजेंसी को नियुक्त करना।	फाइनल माइन क्लोजर प्लान का समापन तभी माना जाएगा जब माइन क्लोजर प्लान के सभी प्रावधानों के अनुपालन पर कोयला नियंत्रक द्वारा तृतीय-पक्ष ऑडिट रिपोर्ट की स्वीकृति हो गई हो। इस उद्देश्य के लिए सरकार द्वारा निर्दिष्ट किसी भी संस्थान/संगठन/एजेंसी को एक आत्मनिर्भर पारिस्थितिकी तंत्र बनाने के लिए तीसरे पक्ष के ऑडिट के लिए नियुक्त किया जा सकता है। निर्दिष्ट अवधि के भीतर बहाली में विफलता के परिणामस्वरूप पैरा 3.5.1 और 3.5.2 के अनुसार बनाए गए एस्क्रो खाते को जब्त किया जा सकता है। फाइनल माइन क्लोजर प्लान की विभिन्न गतिविधियों की अद्यतन लागत अनुमान और पहले से स्थापित एस्क्रो खाते के विवरण के साथ फाइनल माइन क्लोजर प्लान का विवरण फाइनल माइन क्लोजर प्लान के अनुमोदन के समय प्रस्तुत किया जाना होगा।	2.10	3.6a

गतिविधि	विवरण	दिशानिर्देश का पैरा संख्या	
		2020	2024
एस्क्रो खाते से निकासी के लिए तीसरे पक्ष के ऑडिट के लिए संस्थान/संगठन/एजेंसी को शामिल करना।	एस्क्रो खाते से निकासी के लिए माइन क्लोजर प्लान की हर पाँच साल की अवधि में समय-समय पर जाँच की जाएगी एवं इसकी ऑडिट किसी तीसरे पक्ष यथा सीएमपीडीआईएल, राष्ट्रीय पर्यावरण इंजीनियरिंग अनुसंधान संस्थान (एनईईआरआई), भारतीय प्रौद्योगिकी संस्थान (आईआईटी-आईएसएम) या इस उद्देश्य के लिए समय-समय पर निर्दिष्ट कोई अन्य संस्थान/संगठन/एजेंसियाँ जैसी केंद्र सरकार द्वारा अनुमोदित एजेंसियों (परिशिष्ट-V देखें) द्वारा की जाएगी।	2.2	3.4 3.5.5 (i)
सीसीओ से प्रतिपूर्ति के लिए दावा करना।	पैरा 3.4 के अनुसार क्लोजर प्लान की आवधिक जाँच के उपरांत एस्क्रो खाते में अर्जित ब्याज सहित कुल जमा राशि का 50% तक हर पाँच साल के बाद प्रतिपूर्ति दावा कर निकासी कि जा सकती है।	2.12	3.5.5 (i)
स्वीकृत माइन क्लोजर प्लान का कार्यान्वयन।	स्वीकृत माइन क्लोजर प्लान का कार्यान्वयन हेतु खनन को चरणबद्ध तरीके से किया जाना है यानी खदान की भू-खनन स्थितियों के आधार पर संचालन के अनुक्रम को इंगित करते हुए खनन गतिविधियों को एक चरण से दूसरे चरण तक जारी रखना होगा।	2.12	4.10 3.5.5 (i)
अनुपालन रिपोर्ट एवं वचनपत्र।	फाइनल माइन क्लोजर अंत में एस्क्रो खाते में जमा की गई शेष राशि (एस्क्रो फंड+अर्जित ब्याज-प्रगतिशील खदान बंद करने के लिए पहले से ही प्रतिपूर्ति की गई राशि) जारी करने के लिए, खदान के मालिक को कोयला नियंत्रक संगठन द्वारा जारी प्रमाण पत्र के साथ विधिवत हस्ताक्षरित अनुपालन रिपोर्ट जमा करनी होगी, जिसमें कहा गया होगा कि खदान बंद करने में सभी वैधानिक नियमों एवं केंद्र या राज्य सरकार, वैधानिक संगठनों, न्यायालय आदि द्वारा बनाए गए सभी आदेश व विनियम का पालन किया है। इसमें निकाले जाने योग्य अनुमानित कोयला भंडार और वास्तव में खनन किए गए कोयले कि भी जानकारी होनी चाहिए।	2.12 एवं 2.18	4.10 3.5.5 (i) 3.5.5 (iii)
पुनर्ग्रहण एवं पुनर्वास सहित सुरक्षात्मक उपायों का कार्यान्वयन।	कंपनी के मालिक को यह सुनिश्चित करना होगा कि खदान बंद करने की योजना में शामिल सुरक्षात्मक उपाय, जिसमें सुधार और पुनर्वास कार्य शामिल हैं, अनुमोदित माइन क्लोजर प्लान व फाइनल माइन क्लोजर प्लान के अनुसार किए गए हैं।	2.13	4.11

गतिविधि	विवरण	दिशानिर्देश का पैरा संख्या	
		2020	2024
संरक्षण एवं पुनर्वास की वार्षिक रिपोर्ट (प्रतिवेदन)।	कंपनी के मालिक को प्रत्येक वर्ष 1 जुलाई से पहले कोयला नियंत्रक को एक वार्षिक रिपोर्ट प्रस्तुत करनी होगी, जिसमें अनुमोदित खदान बंद करने की योजना (प्रगतिशील और फाइनल माइन क्लोजर प्लान) में परिकल्पित उपाय के अनुसार किए गए सुरक्षात्मक और पुनर्वास कार्यों का ब्योरा होगा।	2.14	4.11(ii)
अनुसूचित बैंक में सावधि जमा एस्क्रो खाता खोलना।	खदान खोलने की अनुमति प्राप्त करने से पहले खदान का परियोजना क्षेत्र पर किसी भी गतिविधि को शुरू करने के लिए विशेष लाभार्थी के रूप में कंपनी के मालिक को वित्तीय आश्वासन के एक भाग के रूप में कोयला नियंत्रक संगठन (केंद्र सरकार की ओर से) के साथ एक सावधि जमा एस्क्रो खाता खोलना होगा। खदान खोलने की अनुमति मिलने से पहले इसे कोयला नियंत्रक संगठन (सीसीओ) को प्रस्तुत करना होगा। कंपनी का मालिक उस शेड्यूल (अनुसूचित) बैंक का चयन कर सकता है जहाँ एस्क्रो खाता खोला जाना है और इसकी सूचना कोयला नियंत्रक, सीसीओ, कोलकाता को देना होगा।	2.7 एवं 2.15	3.5.2 एवं 3.5.4
एस्क्रो खाता खोलने के लिए चयनित अनुसूचित बैंक के साथ समझौते का निष्पादन।	कंपनी के मालिक को एक अनुसूचित बैंक का चयन कर एस्क्रो खाता खोल उस अनुसूचित बैंक के साथ समझौते का निष्पादन कर इसकी सूचना कोयला नियंत्रक, सीसीओ, कोलकाता को देना होगा।	2.7	3.5.2
पैरा 3.5.1 के प्रावधानों की गणना के अनुसार एक निश्चित राशि एस्क्रो खाते जमा कराना।	कंपनी के मालिक को पैरा 3.5.1 में दर्शाए अनुसार गणना की गई दर से एक निश्चित राशि अनुसूचित बैंक के एस्क्रो खाते में जमा करना होगा। खदान की भूमि पर किसी भी विकास गतिविधि के शुरू होने के पहले कुल परियोजना क्षेत्र के प्रति हेक्टेयर के हिसाब गणित धनराशि उपलब्ध कर इसे हर साल जमा की जानी है। यदि खदान मालिक पैरा 3.5.1, 3.5.2 और 3.5.3 के अनुसार आवश्यक वार्षिक राशि जमा करने में विफल रहते हैं, तो सरकार खनन अनुमति वापस ले सकती है।	2.15 एवं 2.8	3.5.3 एवं 3.5.4

गतिविधि	विवरण	दिशानिर्देश का पैरा संख्या	
		2020	2024
वचनपत्र	खदान बंद होने के पाँच साल पहले खदान मालिक (कोल कंपनी) को ''खदान बंद करने की लागत को कवर करने के लिए सुरक्षा'' एवं ''पैरा 2.3, 2.6, 2.7, 2.8 और 2.9 में शामिल क्षेत्रों सहित फाइनल माइन क्लोजर प्लान लागू करने की वास्तविक लागत'' के बीच वित्त पोषण के अंतर के बराबर अतिरिक्त निधि प्रदान करने का वचन देगा। ऐसा न होने पर सक्षम प्राधिकारी इस संबंध में उचित समझे जाने वाले अन्य तरीकों से इसकी वसूली कर सकता है।	2.16	3.8
खदान बंद करने के लिए अतिरिक्त धनराशि का प्रावधान	यदि कोयला नियंत्रक यह निर्धारित करता है कि खदान बंद करने के लिए अतिरिक्त धनराशि की आवश्यकता है, तो परियोजना प्रस्तावक अतिरिक्त राशि जमा करने के लिए बाध्य है।		4.13
अंतिम समापन प्रमाणपत्र	खदान मालिक (कोल कंपनी) द्वारा राज्य सरकार को रिक्लेम्ड भूमि सौंपने के पहले कोयला नियंत्रक भारत सरकार से खदान बंद करने का प्रमाणपत्र प्राप्त करना होगा। खदान मालिक को यह सुनिश्चित करना होगा कि सुरक्षात्मक, पुनर्ग्रहण पुनर्वास कार्य और स्थिरता से संबंधित कार्य अनुमोदित खनन योजना के अनुसार किया गया है व फाइनल माइन क्लोजर प्लान के प्रावधानों/गतिविधियों को शामिल किया गया है।	2.17	3.9
स्रोत: कोयला और लिग्नाइट ब्लॉक के लिए कोयला मंत्रालय, भारत सरकार द्वारा जारी खनन योजना दिशानिर्देश 2020 व 2024.			

कोयला मंत्रालय, भारत सरकार द्वारा जारी खनन योजना दिशानिर्देश 2024 के कुछ खंड विलोपित व कुछ अन्य खंड जोड़े गए हैं।

विलोपित खंड:

1. पारा संख्या 2 के कुछ प्रावधानों को विलोपित कर पारा संख्या 3.1 में कुछ प्रावधानों का समावेश किया गया है।
2. पारा संख्या 2.4, 2.19 के प्रावधानों को क्रमश: 4.9, 4.12 नई पारा संख्या में समावेशित किया गया है।
3. पारा संख्या 2.1, 2.3 को मिलाकर नए पारा संख्या 4.8 में उद्धृत किया गया है।
4. पारा संख्या 2.2 में दिए गए सरकारी एजेंसीस के लिस्ट को विलोपित कर इसे परिशिष्ट-V में जोड़ा गया है।
5. अबनडोनमेंट कॉस्ट (पारा 2.5, चैप्टर पारा 8.10) को विलोपित कर इसके बदले माइन क्लोजर कॉस्ट (पारा 3.5, चैप्टर पारा 8.10) जोड़ा गया है। पारा 2.5 के ही ''कार्य क्षेत्र के चारों और कंटीले तारों की बाड़ लगाना'' के प्रावधान को विलोपित किया गया है और इसके बदले नए प्रावधान लाए गए है (जोड़े गए प्रावधान में देखें)।
6. क्लोजर कॉस्ट (पारा 2.8) को बदल कर ''फाइनैन्शल एसुरेंस कॉस्ट'' (पारा 3.5.3) किया गया है।
7. पारा 2.6 में दिए गए माइन क्लोजर कॉस्ट में बदलाव करते हुए पारा 3.5.1 जोड़ा गया जिसके तहत ओपनकास्ट के लिए 9 लाख प्रति हेक्टेयर के बदले 14 लाख प्रति हेक्टेयर एवं भूमिगत खदान के लिए 1.5 लाख प्रति हेक्टेयर के बदले 2 लाख प्रति हेक्टेयर का प्रावधान किया गया है। साथ ही बेस वर्ष 01.04.2019 को बदल कर 01.04.2024 किया गया है। इस बेस वर्ष का पूर्व के भांति भारत सरकार समय-समय पर इसमें बदलाव कर सकती है।
8. सभी जगह CCO कोलकाता (पारा 2.7, 2.8) में कोलकाता शब्द को विलोपित (3.5.3, 3.5.1) किया गया है।
9. अबंडोनमेन्ट (2.11) शब्द को विलोपित करते हुए माइन क्लोजर (3.7) शब्द को डाला गया है।
10. पारा 2.18 में उपबंधित फाइनल माइन क्लोजर को विलोपित करते हुए 2024 के पारा 3.5.5 (iii) में पोस्ट माइनिंग क्लोजर पीरियड को जोड़ा गया है। इसके साथ प्रस्तावका/खदान मालिक के साथ पट्टेदार को भी शामिल किया गया है।
11. पारा 2.11 में दिए अबंडोनमेन्ट प्रक्रिया (प्रग्रेसिव एवं प्राइनल माइन क्लोजर) के किए बार चार्ट का जिक्र पारा 3.7 में करे पूरी चार्ट कि रूपरेखा को एपेंडिक्स vi में उपबंधित किया गया है। पूरे बार चार्ट को दो भागों में विभक्त (तालिका 3) किया गया है।

तालिका 3: अबंडोनमेन्ट प्रक्रिया

अ	प्रग्रेसिव क्लोजर	
ब	पोस्ट माइन क्लोजर की गतिविधियाँ	• बुनियादी ढाँचे का डिसमेंटलिंग एवं खनन मशीनरी का पुनर्वास • बचाव और सुरक्षा • खनन की गई भूमि और ओबी डंप का तकनीकी और जैविक पुनर्ग्रहण/रेकलेमेशन • पोस्ट क्लोजर प्रबंधन और पर्यवेक्षण • सस्टैनिबिलिटी

12. पोस्ट क्लोजर के समय में बदलाव करते हुए सभी तरह कि माइनिंग - यथा ओपेनकास्ट व भूमिगत के लिए एक समान पोस्ट माइनिंग क्लोजेर पीरियड का उपबंध किया गया है। 2020 में दिए गए उपबंध जिसमें ओपेनकास्ट खदानों जिसका स्ट्रिपिंग अनुपात 6(छह) मि. क्यूबिक मीटर प्रति टन से कम और सभी भूमिगत खदानों के लिए खदान बंद होने के बाद की पोस्ट माइनिंग क्लोजेर पीरियड की अवधि 3 (तीन) वर्ष और वैसे ओपेनकास्ट खदानों जिसकी स्ट्रिपिंग अनुपात क्यूबिक मीटर प्रति टन से अधिक थी उसके लिए पोस्ट माइनिंग क्लोजेर पीरियड

की अवधि 5(पाँच) वर्ष थी को अब संशोधित कर समान रूप से पोस्ट माइनिंग क्लोजेर पीरियड के लिए 3 साल और पोस्ट क्लोजेर मोनिट्रिंग पीरियड के लिए 2 साल किया गया है।

13. 2020 में सभी प्रोग्रेसिव एवं फाइनल माइन क्लोजर के सभी कार्यों को पूरा करने की कार्य योजना खदान के जीवन की अवधि और पोस्ट माइनिंग क्लोजेर पीरियड की अवधि का बार चार्ट के रूप में प्रस्तुत करने का प्रावधान था जो अब 2024 में यथावत (माइन लाइफ 5 वर्ष) की कार्य योजना को बार चार्ट के रूप में प्रस्तुत करना होगा, इसके लिए अपेन्डिक्स vi के रूप में एक प्रारूप भी संगलग्न किया गया है। परियोजना प्रस्तावक को बार चार्ट के अनुसार समापन गतिविधियों के लिए लक्ष्य स्थापित करने का आदेश दिया गया है। प्रत्येक प्रगतिशील और फाइनल माइन क्लोजर चरण के दौरान एस्क्रो राशि की प्रतिपूर्ति स्थापित लक्ष्यों के अनुसार समापन कार्य के पूरा होने पर निर्भर होगी। परियोजना प्रस्तावक को प्रतिवर्ष स्थापित लक्ष्य का अनुपालन कोयला नियंत्रक को प्रस्तुत करना आवश्यक होगा।

14. पारा 2.8 में कोल नियंत्रक को एस्क्रो खाता खोलने समय डब्ल्यूपीआई (wpi) को अद्यतन किया जाना था जो अब पारा 3.5.3 के अनुसार उनको संबंधित वित्तीय वर्ष के 1 अप्रैल के अनुसार करना होगा।

15. पारा 2.6 में उपबंधित ''खदान बंद करने कि प्रासंगिक समापन गतिविधियों को पूरा करने में विफल रहने पर खदान मालिक को इसकी लागत को सुरक्षा कवर देने का प्रावधान था'' इसमें सुरक्षा के बदले ''वित्तीय सुरक्षा'' उपबंधित किया गया है।

16. पारा 2.17 में उपबंधित फाइनल क्लोजर सर्टिफिकेट के लिए ''खदान मालिक को कोयला नियंत्रक से खदान बंद करने का प्रमाणपत्र प्राप्त करना आवश्यक होगा'' के बदले नई गाइडलाइन में ''सीसीओ इस आशय का खदान बंद करने का प्रमाणपत्र जारी करेगा'' को जोड़ा गया है।

17. साथ ही भूमि को राज्य सरकार को सौंपने को विलोपित किया गया है साथ ही ''फाइनल माइन क्लोजर करने की गतिविधियों के सफल कार्यान्वयन और बंद होने के बाद की निगरानी के बाद, खदान बंद करने को पूरा माना जाएगा'' जैसे प्रावधान जोड़े गए हैं। माइन क्लोजर करने की गतिविधियों में ''स्थिरता (सस्टैनबिलिटी) से संबंधित कार्य को भी जोड़ा गया है।

जोड़े गए प्रावधान:

1. भूमिगत खदानों के लिए स्टोइंग एवं कंटीले तारों की बाड़ के रूप में संवेदनशील क्षेत्र क चारों और निर्धारित सीमा दीवार बनाने के प्रावधानों को जोड़ा गया है।

2. फाइनल क्लोजेर (पारा 2.9) को फाइनल माइन क्लोजेर (3.6) में परिवर्तित किया गया है। साथ ही पारा 3.6 में माइन क्लोजर प्लान के कम्प्लीशन रिपोर्ट में निम्न इनफार्मेशन को जोड़ने के लिए कहा गया है-

   - परिचालन इतिहास;
   - पिछली जाँच और उपचारात्मक प्रयास, यदि कोई हो;
   - माइन वर्किंग के मानचित्र और चित्र;
   - माइन जल निर्वहन और उनका उपयोग;
   - सभी मुख्य वैशिष्ट्य, खदान के सक्रिय एवं सुरक्षित रूप से पहुँच योग्य कार्य क्षेत्र, डंप, डिपिलरिंग क्षेत्र, आंशिक रूप से निकाले गए और स्टैन्डींग पिलर्स के क्षेत्रों और वैसी जगह जहाँ पर किसी उपग्रह एवं फाइनल लैन्स्कैप डेटा की मानिट्रिंग कि आवश्यकता हो उसका जीपीएस निर्देशांक।

3. पारा 2.12 को परिवर्तित कर 3.5.5(i) को जोड़ा गया है। 2024 के गाइडलाइन में केंद्र सरकार द्वारा अधिकृत एजेंसियों कि सूची एक नई परिशिष्ट-V में दी गई है। प्रगतिशील खदान बंद करने पर हुए व्यय की निकासी के आवेदन पर राशि का रिलीज इस पर आधारित होगी

   (ए) प्रमाणित लेखा परीक्षण द्वारा लागत प्रमाणीकरण

   (बी) केंद्र सरकार द्वारा अधिकृत एजेंसियों द्वारा किए गए कार्य का प्रमाणन (परिशिष्ट-V देखें) या समय-समय पर निर्दिष्ट किसी अन्य संस्थान/संगठन/एजेंसियों द्वारा उद्देश्य।

   (सी) परियोजना प्रस्तावक द्वारा प्रस्तुत संसाधित आउटपुट के साथ खदान/ब्लॉकों की उच्च रिजॉल्यूशन वाली भू-संदर्भित ऑर्थोरेक्टिफाइड मल्टीस्पेक्ट्रल उपग्रह छवि या ड्रोन सर्वेक्षण जारी की गई राशि पिछले

वित्तीय वर्ष में प्रगतिशील खदान बंद करने पर हुए व्यय के बराबर या जमा राशि का 50%, जो भी कम हो, के बराबर होनी चाहिए। परियोजना प्रस्तावक को 30 जून तक दावा प्रस्तुत करना आवश्यकता है और सीसीओ 30 सितंबर तक राशि जारी कर देगा।

4. पारा 2.18 में फाइनल माइन क्लोजर के समय जो बाकी बची राशि को निकालने का उपबंध था उसमें परिवर्तित कर पारा 3.5.5(iii) के तहत सिर्फ 90% राशि तक सीमित किया गया है। शेष राशि (10%) पारा 3.5.5(iv) के तहत जस्ट ट्रैन्स्फर्मेशन कि गतिविधि के लिए आवंटित कर दी गई है।

5. पारा 3.5.5 (iv) फाइनल माइन क्लोजर की लागत से जमा की गई शेष राशि के 10 प्रतिशत से जस्ट ट्रांसफॉर्मेशन के लिए एक कोष बनाया जाना है। इस राशि का उपयोग परियोजना प्रस्तावक द्वारा जिला प्रशासन, स्थानीय प्राधिकरण और हितधारकों के परामर्श से खदान बंद होने के बाद सामाजिक परिवर्तन के लिए किया जा सकता है।

6. पारा 3.5.5 (V) के रूप में फ्लाई ऐश संबंधित एक नया उपबंध किया गया है। इस उपबंध में यह कहा गया है कि परित्यक्त खदानों में फ्लाई ऐश डंपिंग के मामले में, जहाँ नई गाइडलाइन के पैरा 4.1 के अनुसार खदानों को अलग किया जा सकता है और एक अलग खनन योजना/खदान बंद करने की योजना तैयार की जाती है, फ्लाई ऐश डंपिंग के लिए आवश्यक क्षेत्र के लिए केवल अनुमानित राशि जैसे लागत शीर्ष मृदा प्रबंधन और जैविक सुधार के लिए, फाइनल माइन क्लोजर होने और बंद होने के बाद तक सुरक्षा और पर्यावरण निगरानी को बरकरार रखा जाना है। शेष राशि खनन बंद होने के बाद की गतिविधियों के पूरा होने के बाद शेष क्षेत्र के लिए जारी की जा सकती है।

7. पारा 2.6 को बदल कर पारा 3.5.1 में समावेशित कर कुछ आंशिक उपबंध को जोड़ा गया है। इसके तहत परियोजना प्रस्तावक को प्रत्येक वित्तीय वर्ष के लिए एस्क्रो राशि संबंधित वर्ष के 30 सितंबर तक जमा करनी होगी, अन्यथा उस संबंधित वर्ष के लिए जमा की जाने काली राशि पर 0.5 प्रतिशत/माह की दर से ब्याज लगाया जाएगा।

8. इसी पारा में एक नई उपबंध के तहत खनन योजना में संशोधन के कारण खदान बंद करने की लागत में संशोधन के मामले में, अनुमोदत खनन योजना के अनुसार खदान बंद करने की लागत या नवीनतम डब्ल्यूपीआई (WPI) के अनुसार अनुमानित खदान बंद करने की लागत, जो भी अधिक हो, उस पर विचार किया जाएगा।

9. पारा 2 को बदल कर पारा 3.1 में समावेशित कर कुछ आंशिक उपबंध जोड़े गए हैं जिसके तहत कोयला मंत्रालय द्वारा 28 अक्टूबर 2022 को जारी वर्ष 2009 से पहले बंद/छोड़ दी गई/बंद की गई खदानों के प्रबंधन के दिशानिर्देशों के अनुरूप, इन दिशानिर्देशों के जारी होने के एक वर्ष के भीतर हालांकि, वर्ष 2009 के बाद किसी अनुमोदित खदान बंद करने की योजना के बिना छोड़ी गई/बंद की गई किसी भी खदान के लिए या किसी अनुमोदित खदान बंद करने की योजना वाली किसी भी खदान को आंशिक निष्कर्षण के बाद छोड़ दिया गया है, परियोजना प्रस्तावक को अस्थायी और अंतिम खदान बंद करने की योजना तैयार करने और अनुमोदन प्राप्त करने के लिए अनिवार्य किया गया है।

अन्य उपबंध

''जस्ट ट्रांसफॉर्मेशन'' को पहली बार नई गाइडलाइन के पारा 3.2 में जगह दी गई है। इस गाइडलाइन में ''रेस्टोरेशन व रिपरपसिंग'' एवं ''लोग व समुदाय'' को क्रमशः पारा संख्या 3.2.1, 3.2.2 में स्थान दिया गया है।

जस्ट ट्रांसफॉर्मेशन, पारंपरिक कोयला खनन की प्रक्रिया को पहले से अधिक टिकाऊ और पर्यावरण अनुकूल तरीकों की ओर संक्रमण की न्यायसंगत प्रक्रिया को संदर्भित करता है। जस्ट ट्रांसफॉर्मेशन यह सुनिश्चित करता है कि:-

अ. पर्यावरण सुरक्षित है,

आ. भूमि बहाल की गई है, और

इ. प्रभावित श्रमिकों, समुदायों और क्षेत्रों को पूरे परिवर्तन के दौरान समर्थन और सशक्त बनाया गया है।

इसमें खदान बंद करने की गतिविधियों से जुड़ी सामाजिक, आर्थिक और पर्यावरणीय चुनौतियों को पहचानना और उनका समाधान करना भी शामिल है। इस गाइडलाइन में यह जोर

दिया गया है कि प्रत्येक खान मालिक/प्रस्तावक को पूर्वेक्षण, खनन और खदान बंद करने की गतिविधियों आदि को पूरा करते समय स्थायी खनन करने के लिए हर संभव सावधानी बरतनी होगी।

पुनर्स्थापन और पुनर्प्रयोजन: जैसी बिंदुओं पर इस गाइडलाइन ने यह व्यवस्था की है कि खनन से होने वाले दीर्घकालिक पारिस्थितिक नुकसान को कम किया जाए और यह सुनिश्चित हो कि भूमि विभिन्न पारिस्थितिक तंत्रों का समर्थक कर सकती है, जैसे कि-

अ. देशी वनस्पति/पौधों को फिर से लगाना,

आ. जल निकायों को बहाल करना ओर

इ. वन्यजीव आवासों का पुनर्वास करना,

इसके साथ परियोजना प्रस्तावक को तकनीकी, जैविक सुधार और पुनर्प्रयोजन यथा-कृषि, मछलीपालन, इको-पार्क, मनोरंजन, भूनिर्माण, जल निकाय से संबंधित गतिविधियों का समायोजन करेगा। अंतिम समापन प्रमाणपत्र जारी करने से पहले जस्ट ट्रांसफॉर्मेशन से संबंधित मिशन अमृत सरोवर के अनुसार संरक्षण या निर्माण, सिंचाई आदि जहाँ भी लागू हो का भी समायोजन सुनिश्चित करेगा।

इस गाइडलाइन में लोगों एवं समुदाय को प्राथमिकता दी गई है। समुदाय के लिए बनाई गई सभी सामजिक सुविधाएँ और बुनियादी ढाँचे (जैसे अस्पताल, स्कूल, सामुदायिक केंद्र आदि) राज्य सरकार को सौंपने होंगे। कार्यालय और अन्य भवनों का उपयोग कौशल विकास केंद्र के रूप में भी किया जा सकता है। खदान के आसपास प्रत्यक्ष या अप्रत्यक्ष रूप से निर्भर समुदायों (पीएपी) के कौशल, आजीविका और रहने की स्थिति को विकसित करने के लिए 5 वर्षों की प्रत्येक प्रगतिशील समापन अवधि में व्यवस्थित रूप से प्रयास किए जाने की आवश्यकता पर जोर दिया गया है। परियोजना प्रस्तावक 5 वार्षिक रिपोर्ट प्रस्तुत करेगा, जिसमें कौशल विकास और प्रभावित समुदायों की आजीविका को बनाए रखने के लिए की गई पहलों की रूपरेखा का विस्तृत विवरण देगा जो कि प्रगतिशील समापन दावों का पूरक भी होगा। परियोजना प्रस्तावक राष्ट्रीय स्तर पर निर्धारित एनडीसी को प्राप्त करने का प्रयास करेंगे और खनन योजना में स्कोप II उत्सर्जन में नवीकरणीय द्वारा वार्षिक उत्पादन के कम से कम 25 प्रतिशत की कमी के लिए लक्ष्य निर्धारित करेंगे। इसके अलावा, परियोजना प्रस्तावक स्थिरता बढ़ाने, ग्रीनहाउस गैस उत्सर्जन जैसे पर्यावरणीय प्रभाव को कम करने और डीजल ईंधन पर निर्भरता कम करने के लिए ओपनकास्ट कोयला खदानों में इलेक्ट्रिक वाहनों (ईवी) और गैस-आधारित वाहनों को बढ़ावा देगा।

पर्यावरण प्रबंधन के लिए परियोजना प्रस्तावक पर्यावरण पर खनन गतिविधियों के प्रतिकूल प्रभावों को कम करना सुनिश्चित करेगा। इसमें हवा, पानी और मिट्टी की गुणवत्ता, जैव विविधता संरक्षण, और संवेदनशील क्षेत्रों की पहचान और भूमि क्षरण के संभावित जोखिमों की सुरक्षा के लिए वैज्ञानिक मूल्यांकन, निगरानी ओर नियंत्रण उपाय शामिल हैं। निर्बाध प्राकृतिक जल प्रवाह के लिए नाले का मार्ग परिवर्तन जरूरत के अनुसार करेगा। परियोजना प्रस्तावक को भूजल पुनर्भरण अरैर कानून के अनुसार जल गुणवत्ता मानकों का पालन करने का भी प्रयास करना होगा।

इस गाइडलाइन के पारा 3.7 में खदान बंद करने के लिए समय निर्धारण कि एक नई व्यवस्था का समावेश किया गया है। इसके तहत खनन बंद होने के बाद की अवधि 3 (तीन) वर्ष मानी जाएगी और बंद होने के बाद की निगरानी अवधि उसके बाद 2 (दो) वर्ष के लिए होगी। सभी खदान बंद करने के कार्यों (प्रगतिशील और फाइनल माइन क्लोजर) को पूरा करने की कार्य योजना खदान के जीवन की अवधि और बंद होने के बाद की अवधि के लिए एक बार चार्ट के रूप में जैसा कि परिशिष्ट-VI में निर्दिष्ट है प्रस्तुत करनी होगी। परियोजना प्रस्तावक को प्रतिवर्ष स्थापित लक्ष्य का अनुपालन कोयला नियंत्रक को प्रस्तुत करना आवश्यक है।

निष्कर्ष:

इस समीक्षात्मक लेख के आधार पर, निम्नलिखित निष्कर्ष निकाले गए हैं:

- 2024 का गाइडलाइन दूरगामी प्रभाव डालेगा। इसके कारण कुल 20 खंडों/उपखंडों पर प्रभाव पड़ा है।
- कुछ अध्याय (5), परिभाषा (11) एवं परिशिष्ट (9) जोड़ कर इसे तर्क संगत किया गया है। कुछ खंडों को विलोपित कर कुछ नए उपबंध भी जोड़े गए हैं।
- ''जस्ट ट्रांसफॉर्मेशन'', ''रेस्टोरेशन व रिपरपसिंग'' एवं ''लोग व समुदाय'' को पहली बार समावेशित किया गया है।
- समुदाय के लिए बनाई गई सभी सामाजिक सुविधाएँ

और बुनियादी ढाँचे (जैसे अस्पताल, स्कूल, सामुदायिक केंद्र आदि) राज्य सरकार को सौंपने होंगे। कार्यालय और अन्य भवनों का उपयोग कौशल विकास केंद्र के रूप में भी किया जा सकता है।

- खदान बंद करने के लिए समय निर्धारण कि एक नई व्यवस्था के तहत खनन बंद होने के बाद की अवधि 3 (तीन) वर्ष मानी जाएगी और बंद होने के बाद की निगरानी अवधि उसके बाद 2(दो) वर्ष के लिए होगी।

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Mitigation of Metallic Pollution of Soil for Ecosystem Sustainability

Prof. Dinesh Mani[1]

Abstract

Agricultural fields are progressively affected by inorganic, organic, and metallic pollution as a result of the fast urbanization and industrialization of the region. Heavy metals primary drawback is their inability to biodegrade, which allows them to build up in the environment and eventually find their way into the food chain. To reduce the toxicity of heavy metals in plants, various strategies can be applied, including soil remediation techniques, phytoremediation using metal-accumulating plants, and genetic engineering approaches aimed at enhancing plant tolerance to heavy metal stress. Additionally, monitoring and regulation of heavy metal emissions and contamination are crucial for preventing adverse effects on plant health and ecosystem integrity.

Our soil is our national heritage, the value of which should be understood by every citizen from the earliest age. From the dawn of history mankind has depended on soil for the production of both food and fodder. In the context of present day shortage of food a scientific inventory of this valuable natural resource assumes considerable importance.

Sustainable development is based on the wise use of earth's natural resource to meet the needs of the present generation without compromising on the ability of future generations to meet their need. The conservation of soil is everybody's duty. Every person relies on products that come from the soil for food, clothing, shelter, and other materials. An increasing population and an increasing standard of living result in an increased demand for these products. This increasing demands need to be translated to careful use of soil and not into exploitation.

Soils are nature's dispose-all, sewage treatment plant, its water purifier, and, at times, also a pollutant. Soils are as valuable as cleansers of the earth's environments as they are as nurtures of its plant life. The soil is a physical filter (sieving action), a chemical filter (adsorption and

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precipitation), and a biological filter (decomposition of organic materials), as well as the receptacle for all things buried and disposed of beneath and on the surface.

Although the soil is the most universal and extensive substance that cleans waters and recycles wastes, it is not infinite on capacity. Already high land costs near most large cities have increased the expense of waste disposal. Not only are soils limited to the present amounts, but they also can be made unusable. Many toxins added to soils can build up to concentrations that become serious threats to plant and animal health. Some toxic substances become residual in the soils; perhaps centuries will pass before they will be removed. Even harmful organic substances that will decompose eventually to nonharmful recycled elements of carbon, oxygen, hydrogen, phosphorus, nitrogen and sulphur are dangerous until decomposition is complete. Materials accumulate when added in larger amounts tan their decomposition rate. Materials that are toxic to soil microorganisms further slow recycling.

Soil has an intimate and extensive role in people's efforts to maintain a suitable environment, as a waste receptacle, and to minimize pollution. Soil is also a part of the environment that receives pollutant. Soil can depollute some materials by decomposing them into harmless end products such as Carbon dioxide and water. Useful plant nutrients are often released by decomposition of pollutants. But, there are some materials that are difficult or impossible to decompose. Accumulations of such materials can pollute the soil.

In recent times, there has been a notable increase in the amount of heavy metals released into water as well as soil due to industrialization and urbanization. These metals are dangerous pollutants that are discharged into rivers and ponds by the direct discharge of effluents, which include sewage, fertilizers, pesticides, and municipal trash, without any prior treatment. Our agricultural resource is incomplete without the soil, which is also essential to the ecological revolution and food safety. Agricultural fields are progressively affected by inorganic, organic, and metallic pollution as a result of the fast urbanization and industrialization of the region. Heavy metals primary drawback is their inability to biodegrade, which allows them to build up in the environment and eventually find their way into the food chain.

Extensive Pb and zinc Zn ore mining and smelting have resulted in contamination of soil that poses risk to human and ecological health. Many reclamation methods used for these sites are lengthy and expensive and may not restore soil productivity. Soil heavy metal environmental risk to humans is related to bioavailability. Assimilation pathways include the ingestion of plant material grown in (food chain), or the direct ingestion (oral bioavailability) of contaminated soil. (Basta,N. T. and Gradwohl, R., 1998).

Heavy metals can enter the soil through two distinct pathways: natural processes and anthropogenic activities. Natural processes involve the release of heavy metals from geological formations into the soil and water through weathering and erosion. Anthropogenic activities, on the other hand, result from human actions such as industrial processes, mining, agriculture, and improper disposal of waste. These activities discharge pollutants into the atmosphere, polluting the air, water, and soil and affecting human health and ecosystems. Heavy metal buildup in the trousers can alter chemical and physiological processes, resulting in chlorosis, growth inhibition, yield loss, minimum nutrient absorption, root browning, and plant mortality. This can also pollute plants, the well-being of people, and the fauna of the soil.

Contamination of heavy metals impairs ecosystems and human health by direct ingestion of contaminated food, physical contact with polluted soil, through the food chain, drinking of polluted water, reducing food quality and reduction of land suitable for farming and subsequent food insecurity (Hassan et al., 2019; Zulfiqar et al., 2019; Hussain et al., 2021).

The presence of heavy metals in water and soil leads to a wide range of ecological and environmental issues. Thus, plant development, nutrient absorption, and photosynthetic output are all adversely affected by the entry and movement of toxic metals into plants. Numerous human-caused activities have a major effect on water and soil resources, such as mining, smelting, sludge creation, and dumping. It has been noted that Cd can hinder seed germination, reduce stem development, and lessen the membrane's plasma permeability. There is a comparable drop in leaf weight when new and leaf area with declining fruit output. Furthermore, it lowers dry matter production. The results include chlorosis, wilting, and stunted growth. One of the most dangerous metals in soil is leading (Pb). It prevents seedlings from growing. It affects the composition, growth, and mechanism of photosynthesis in crops. The Pb concentrations are high, causing oxidative damage. It also reduces the production of seeds. Because they directly affect biochemical and physiological processes, development is slowed, cell organelles are broken down, and photosynthesis is inhibited, heavy metals can be toxic to both macro- and microorganisms. Certain metals particularly lead (Pb), have a tendency to concentrate in the roots rather than the aerial portions of plants due to obstacles that impede their transit from the roots into the aerial parts. Other metals, including Cd, however, are more easily absorbed by plants. In general, soil solutions include essential elements for plant growth and development, including Cu, Fe, Zn, Ca, K, Mg, and Na. But in the process, plants also pick up some inert elements that do not have biological function, such as Cd, As, Cr, Al, and Pb.

Thus, a gradual increase of accumulation of heavy metals in the soils of many agricultural fields owing to the discharge of industrial and municipal residual wastes has caused a serious problem to the crop production and hazards to human and animal health. Therefore, remediation of excessive soil metals in situ is receiving great attention, because the alternative, soil removal and replacement is very expensive. Phytoremediation plays an important role in situ bioremediation of soil contaminated with heavy metals.

To reduce the toxicity of heavy metals in plants, various strategies can be applied, including soil remediation techniques, phytoremediation using metal-accumulating plants, and genetic engineering approaches aimed at enhancing plant tolerance to heavy metal stress. Additionally, monitoring and regulation of heavy metal emissions and contamination are crucial for preventing adverse effects on plant health and ecosystem integrity.

Phytoremediation is an integrated multidisciplinary approach to the cleanup of contaminated soils, which combines the disciplines of plant physiology, soil chemistry, and soil microbiology. These contaminants include heavy metals, radionuclides, chlorinated solvents, petroleum hydrocarbons, organophosphate insecticides, explosives and surfactants. The presence, on specific sites, of species that belong to genera, families and orders known to have high tolerance to particular heavy metal(s) that may play a role of bioindicators.

Phytoremediation, a green technology for soil and water cleanup, harnesses the natural capabilities of plants to absorb, accumulate, and detoxify contaminants, including heavy metals. Using plants to eliminate, break down, or stabilize pollutants from soil, water, and the air is known as phytoremediation, an environmentally friendly form of environmental cleanup. It uses interactions among microbes and plant physiology as natural mechanisms to reduce pollution and rebuild ecosystems. There are several methods for using phytoremediation, such as phytofiltration, phytodesalinization, phytoextraction, phyto-degradation, and phytovolatilation. Several factors, including plant species, medium qualities, metal bioavailability, and the inclusion of a chelating agent, can influence these pathways. (Desai et al. 2019).

Short-lived, quick-growing plants known as hyper accumulators may absorb more heavy metals into their body tissues, generate more biomass, and

be simple to harvest. A small subset of plants is referred to as hyper accumulators, and they share the following two traits: they are able to gather metals or metalloids up to hundreds of times more than they typically would, and they can also detoxify the metals. Most ornamental plants are grown for their aesthetic appeal, but some are also useful for phytoremediating contaminants from the air and soil and beautifying our surroundings. There are economic and environmental benefits to using attractive plants. Ecotourism destinations can be developed in polluted areas while maintaining the area's natural beauty.

Because it is an environmentally benign and cost-effective means of cleaning up pollutants in soil, water, and the air, phytoremediation is a sustainable technology. Plants have proven to be remarkably effective at cleaning up pollutants in our environment, including organic pollutants and heavy metals. But issues like choosing the right plant species, site-specific requirements, and scalability still exist. All things considered, heavy metal phytoremediation has a lot of potential, but more study is required to maximize its effectiveness and suitability for use in different environmental settings. Collaborative efforts among researchers, policymakers, and stakeholders are crucial for the development and implementation of sustainable phytoremediation strategies that contribute to the restoration and protection of our ecosystems.

Despite facing challenges such as slow treatment rates and limited plant species suitability for certain contaminants, ongoing research focuses on genetic engineering, species selection, and optimization of growth conditions to enhance its efficacy. As awareness of environmental issues increases and regulatory pressures grow, there is a rising demand for sustainable remediation methods,

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2	कोयला शैलिकी
3	खुली खान का आयोजन
4	झेन प्रबंधन तकनीक
5	खनन इलेक्ट्रॉनिकी
6	खान की गैसें
7	विस्फोटकों का सुरक्षित उपयोग (I)
8	विस्फोटकों का सुरक्षित उपयोग (II)
9	सपोर्ट प्लान एवं डिजाईन का मार्गदर्शन (I)
10	सपोर्ट प्लान एवं डिजाईन का मार्गदर्शन (II)
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14	करणीय एवं अकरणीय: मैग्नेटाइट प्रिपरेशन प्लांट
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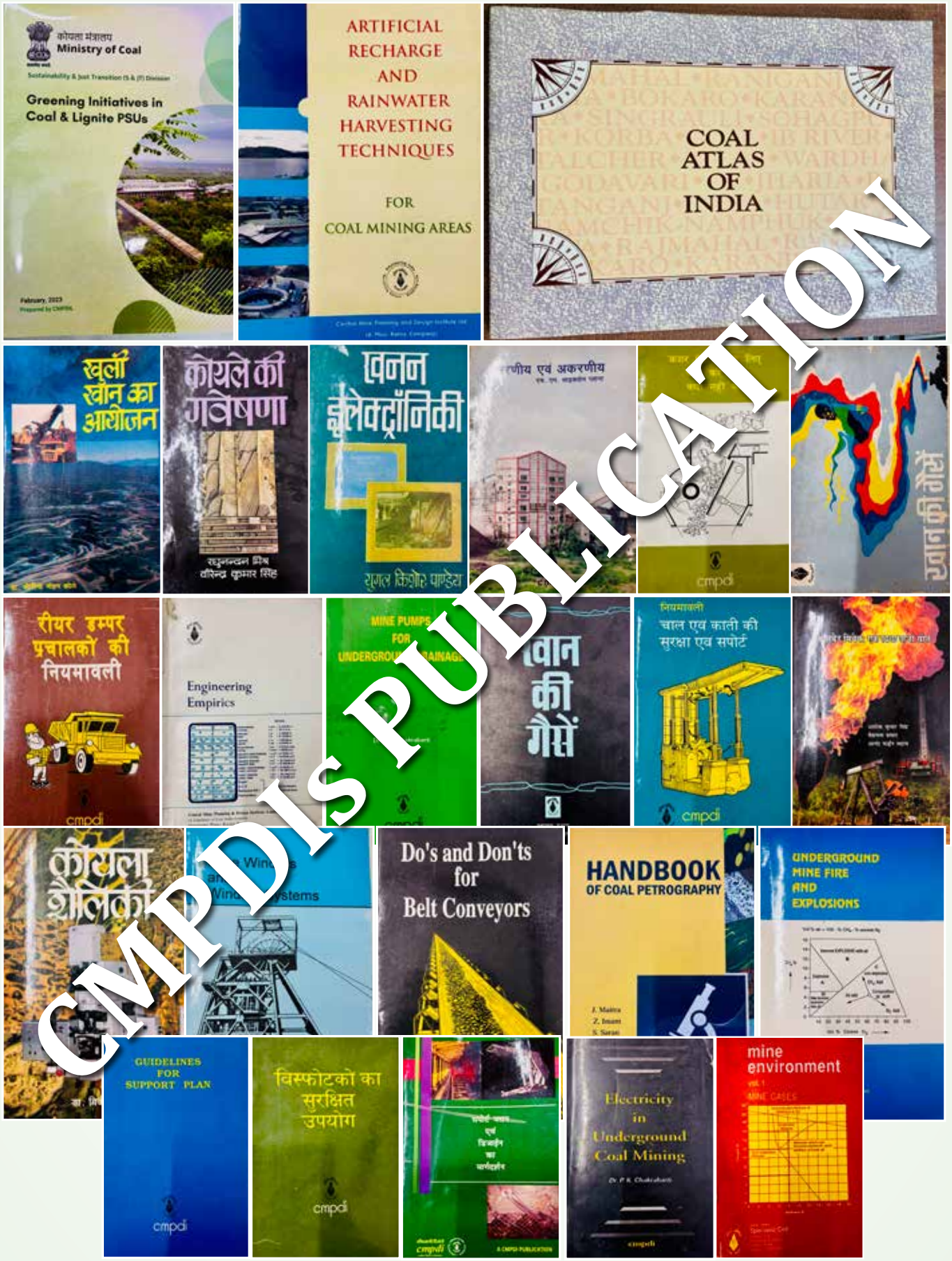

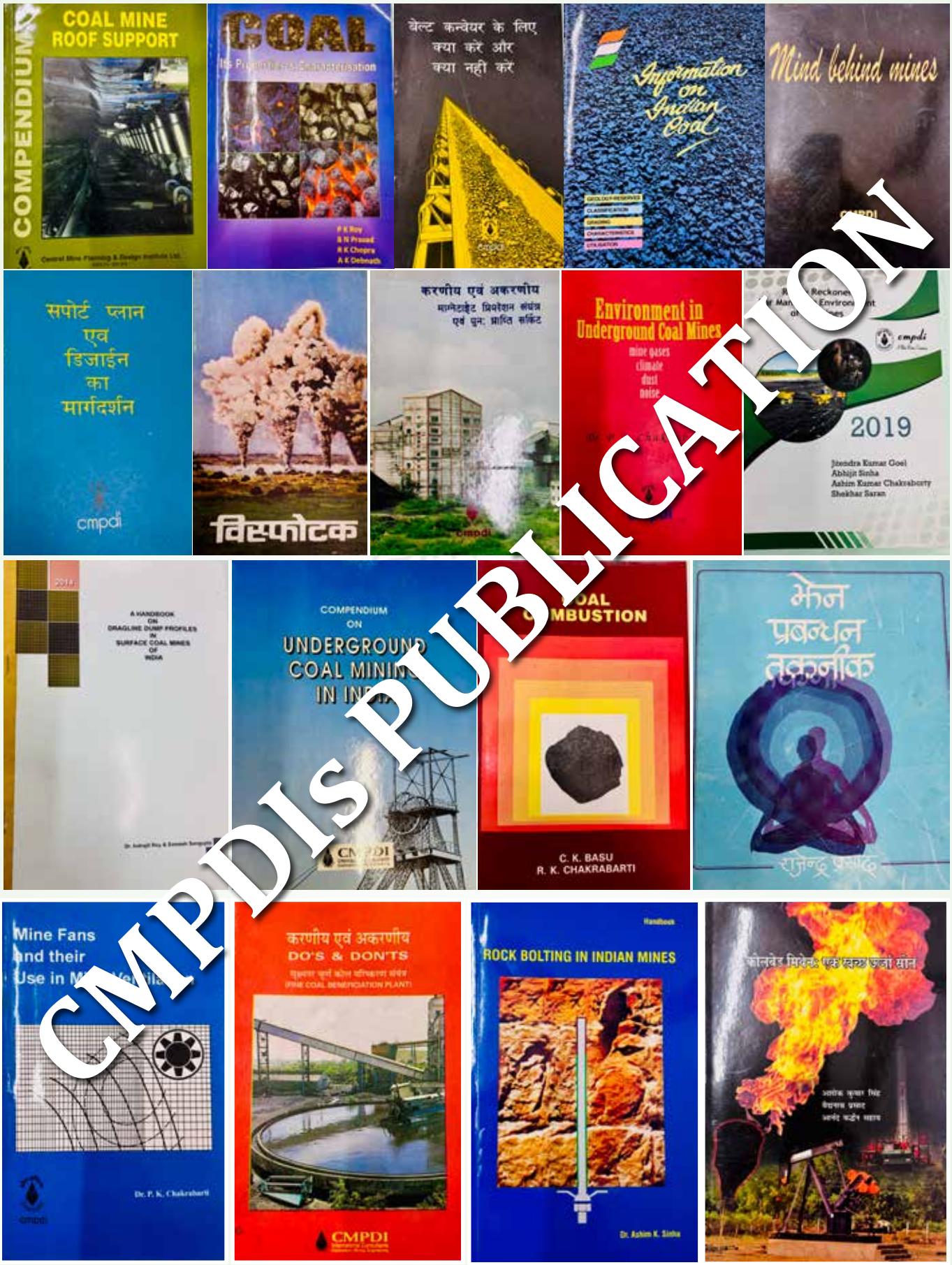

Smart Grid

"Advancements in Smart Grid Technologies: A Comprehensive Overview"

Shantanu Virnave[1]

Abstract

The phase shift of power grids into smart grids is a drastic significant change in the energy sector which offers enormous opportunities for efficiency, reliability and sustainability result in real-time frame. The abstract provides a complete overview that reflects smart grid technologies, highlighting key concepts, components and benefits. It explores integration of advanced communication, control and monitoring systems enabling or gathering real-time data analytics and take decision accordingly. In addition, this has the important role by using renewable energy sources with capacity of energy storages and method of managing the demand-side in optimizing of grid operations. The smart grid represents a pivotal advancement in energy infrastructure that also helps us to integrate digital technologies which help in the enhancement of efficiency, reliability, creditability and sustainability of electrical systems. It also provides an overview of smart grid concepts with latest technologies and their implications. Furthermore; it examines the challenges such as cybersecurity, interoperability and regulatory frameworks. Overall we can say that this abstract must emphasizes the transformative potential that make a dynamic change of grid to smart grids in the way of recasting the traditional way of generating electricity i.e. properly distributed and consumed accordingly with sustainable energy ecosystem. By revolutionizing grid management and fostering a more flexible and sustainable energy ecosystem, smart grids hold immense promise for meeting the evolving needs of society while mitigating environmental impacts.

Keyword: Efficiency, Reliability, Sustainability, Technologies, Security

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Introduction

It is based upon the re equipped based methodology of normal electrical grid which is based on digital communication technology & is in practice to detect, synchronize and react accordingly with any types of changes in electricity usage in real-time. Here renewable energy sources are incorporated with energy storage systems by using intelligent tools for monitoring and control systems which tend to improve efficiency, reliability, credibility and sustainability of electricity delivery system. It enable better management of energy demand, combination of renewable energy sources and optimization of energy distribution in a proper manner leading to reduced costs and environmental impact. It integrates various renewable energy sources, based on two-way communication system i.e. between the consumers and utility providers and leads toward the better management of energy demand and supply. The implement action of smart grids marks significant changes in electricity infrastructure, revolutionizing about the method of energy which is generated, transmitted, distributed and at last consumed. Unlike traditional grids the smart grids is equipped with digital technologies to enhance efficiency, reliability and sustainability.

Key features include :

1. Advanced Metering Infrastructure (AMI) : It utilizes smart meters to provide real-time guided data which is based on the amount of energy consumption that enables the consumers and service provider to make healthy environment without any dispute.
2. Coalescing of Renewable Energy: Smart grids facilitate the proper way of integration for the renewable energy sources and managing the intermittent nature more effectively.
3. Two-Way Communication: This mode of communication between consumers and utilities allows for better monitoring, control and govern the flow of electricity, leading towards optimized operations and reduced downtime.
4. Grid Automation: Automation technologies enable self-healing capabilities, meaning the grid can perform diagnosis and respond to faults in real-time, minimizing disruptions and improving faithfulness.
5. Demand Response: Smart grids draw attention of the users to vigorously participate in managing energy demand through programs like demand response, where they can adjust usage during maximum peak hours in exchange for incentives.
6. Energy Efficiency: By providing insights of the patterns of energy consumption the smart grids enable utilities and consumers to identify inefficacy and implement measures to reduce waste and minimizing the overall energy consumption.
7. Grid Security: Enhanced cyber security measures protect against potential threats, ensuring the integrity and security of the grid infrastructure and data.

Definition:

- A smart grid is the emerging technology based on the digitalised format that transform energy landscape. It refers to two way power flow between the consumers and the providers in real time frame.
- A smart grid just simply the advanced version of the normal grid. The smart grid is well equipped with modern based communication system which shares proper information in real time frame along with enhancement in efficiency, reliability, accountability, creditability and sustainability among consumer and utilizers.
- Smart grid comes with intelligence and automated based components systems which enables to guide, protect and minimise fault in generation, transmission and distribution system.
- Smart grid is incorporates with sensing devices, controlling equipment and modern communication which helps the both parties to monitor, sense, protect and control of electric flow.

Grid:

"Grid" can refer to the traditional power grid which is old conventional form of electricity distribution system that was in practice from several years. It can mean that a network of lines like cobweb, which form squares or rectangles like in a spread sheet or a city layout. It can also refer to a system for distributing electricity or data, like an electrical grid or a computer network grid. The electrical grid is a complex network of power generators, transmission lines, substations and distribution lines from power plants station to consumers. It is the infrastructure that allows electricity i.e. generated, transmitted and distributed to consumers of different types according to their demand. The power grid, also known as the electrical grid or energy grid, is a network of interconnected transmission lines, substations and transformers that enable the generation, transmission and distribution of electrical power from power plants to consumers. It enables the reliable supply of electricity to the consumers. The power grid includes three main components i.e. generation, transmission and distribution. Generation involves the production of electricity at power plants, Transmission involves the high-voltage transportation of electricity over long distances and Distribution involves the delivery of electricity to end-users at lower voltages through local distribution networks.

Working Procedure:

Smart grid is digitally based electric network that implement digital technology to optimize the generation, transmission, distribution and consumption of electricity. This is based on various types of devices, sensors and communication system technologies which enhances the efficiency of the power system. It integrates various renewable energy sources, improves efficiency and enhances reliability through monitoring based on real-time and control based method. They are:

1. Digital Technology Integration : It is merged with advanced power communication and I.T to enhance the efficiency and constant supply to fulfil the electricity delivery.
2. Two-way Communication : They permit two-way power flow communication between utilities and consumers which allows real-time based vigilance and control of energy consumption and production.
3. Renewable Energy Integration : The grid incorporates with renewable energy sources for managing its variability and optimizing their contribution to the grid.
4. Grid Automation : Automation of grid operations allows for faster detection and response to faults and improving reliability.
5. Demand Response : Smart grids acts according to demand responses programs that stimulate consumers to adjust their electricity usages as per the need during maximum peak hours and thus reduce the strain of the grid and lowering costs.
6. Energy Storage : They facilitate and guide the energy storage systems such as batteries to stockpile the excess energy during periods of low demand and release it during peak time demand.
7. Efficient Transmission and Distribution : By optimizing the flow of electricity, smart grids minimize transmission losses and improve the efficiency of distribution networks.
8. Data Analytics : Smart grids leverage data analyser to analyse consumption patterns, predict demand and optimize the grid operations for maximum efficiency and cost-effectiveness techniques.
9. Cybersecurity Measures : Due to the increased connectivity and more reliance on digital technology, the smart grids implement robust cybersecurity measures for protection against cyber threats and ensure the security of the grid infrastructure.
10. Interoperability: Smart grids strive for interoperability, allowing different systems and technologies to work together seamlessly, regardless of vendor or origin, to create a cohesive and efficient energy ecosystem.

Function:

The smart grid serves multiple functions, including improving reliability, efficiency and flexibility distribution of electricity among consumers. It enables better method of renewable energy sources, facilitates real-time system of monitoring and control with two-way communication between utilities and consumers & keeps the grid secure or protected. It is a technology based electrical grid that utilizes digital technology, automation and communication to enhance the efficiency, effective electricity delivery.

They are:

1. Bilateral Mode of communication (B.M.C): Smart meters allow for bilateral mode of communication between consumers and utilities, enabling the real-time data monitoring of electricity usage. The data obtained thus helps us to identify outages more quickly and implement demand-response programs.
2. Smart grid technologies enable real-time monitoring and control of the grid, allowing utilities to detect and respond to issues such as voltage fluctuations, line faults and, equipment failures more efficiently. This improves grid reliability and minimizes the downtime.
3. The smart grid facilitates accumulating ofrenewable energy sources by providing mechanisms for managing its intermittency. It empowers utilities to forecast renewable energy output, balance supply and demand for optimize grid operations accordingly.
4. Demand Response and Energy Management: Smart grid systems helps utilities to manage demand more effectively reduce peak load and avoid costly infrastructure upgrades.
5. The smart grid supports integration of distributed energy resources. These resources can be aggregated and managed to provide grid services such as peaccaving, voltage support and frequency regulation.
6. Enhanced Grid Security and Resilience: By incorporating cyber security measures and decentralized control mechanisms, the smart grid enhances grid security and resilience against cyber attacks, natural disasters and physical threats. It allows for rapid identification and isolation of compromised components to prevent widespread outages.
7. Smart grid infrastructure can support widespread adoption of electric vehicles by providing charging infrastructure and implementing smart charging algorithms. This helps to manage the entire EV charging on grid operations and enables vehicle-to-grid capabilities for grid services.
8. Data Analytics and Predictive Maintenance: The smart grid generates huge number of data that can be used or needed to analyzed the identify patterns, optimize operations and for prediction equipment failures. Predictive maintenance techniques help utilities schedule maintenance system proactively and thus save time in improving asset longevity.
9. Policy and Regulatory Framework : The Government of India reconstructed certain policies and regulations to encourage, & support to update Grid technologies across the country. Various initiatives and several steps were taken by Indian Government in this aspect.

Limitation:

1. Initial Investment : Implementing a smart grid needs significant beforehand investment in infrastructure, technology with proper training.
2. Cyber security Risks : Smart grids are vulnerable to cyber-attacks, which could disrupt energy supply, compromise data security or even cause physical damage to the grid infrastructure.
3. Privacy Concerns : Smart meters and other monitoring devices collect complete information about energy usage by raising concerns about consumer privacy and data protection.
4. Interoperability Challenges : Integrating diverse technologies from various vendors into a cohesive smart grid system can be complex

and may result in interoperability issues.

5. Reliability : While smart grids aim to enhance reliability, they can introduce new points of failure, such as software glitches or communication breakdowns, which may disrupt service.
6. Regulatory Hurdles : Regulatory frameworks may not implement with the same pace with advancements in this grid technology, hindering deployment and innovation.
7. Grid Congestion : Increased connectivity and proper distribution of energy resources may lead to congestion in certain parts of the grid, requiring additional infrastructure upgrades.
8. Socioeconomic Equity : The benefits of this grid technology may not be equally distributed, potentially exacerbating socioeconomic disparities, if it is not implemented equitably.

Comparison:

Traditional Power Grids :

1. One-Way Communication: Traditionally grids primarily tend towards flow of electricity in unidirectional i.e. from generating station to the consumer with limited feedback on usage patterns.
2. Centralized Generation: Power is generated mainly by large and streamline which may be located far from the end-users, leading to energy losses during transmission.
3. Manual Monitoring: It leads towards the grid rely heavily on manual processes, with limited practice based on real-time flow of data on energy consumption and system activities performance.
4. Limited Flexibility: Traditional grids have limited ability to accommodate green energy sources with proper energy storage or demand-response mechanisms leading to inefficiencies in grid management.

Smart Grids :

1. Two-Way Communication : It enables bidirectional communication between the providers and consumers, allowing the system to do real-time monitoring of energy consumed and grid conditions.
2. Distributed Generation : Smart grids integrate resources like renewable and energy storage systems by allowing for decentralized power generation nearer to the point of consumption
3. Automation : Smart grids uses sensors, meters and control systems to automate grid operations, optimize energy distribution and respond to fluctuations in supply and demand more efficiently.
4. Enhanced Reliability : With self-healing capabilities and predictive maintenance, smart grids are more resilient to outages and disruptions, ensuring more trusted electricity supply.
5. Integration of Renewables : Smart grids facilitate the integration of renewable energy sources enables smooth grid operation to manage fluctuations in demand and supply.

New Technologies:

These are constantly done with new technologies aimed at improving the efficiency, faithfulness and sustainability. Some emerging technologies are:

1. Advanced Metering Infrastructure(AMI): This enables bilateral mode of communication between utilities and consumers, providing real-time data on energy consumption and enabling demand response programs.
2. Distributed Energy Resources (DERs): It includes energy storage systems deployed at the distribution level, helping to combine the R.E.S into the grid and enhance resilience.
3. Grid Edge Technologies: Devices and systems located at the edge of the grid, such as smart inverters and sensors, makes real-time observation and control of distributed

energy resources, improving grid stability and efficiency.

4. Internet of Things (IoT) : This device can be implemented to observe and control various components of the grid, optimizing operations and reducing maintenance costs.
5. Artificial Intelligence (AI) : It can dissect huge amounts of data generated by smart grid sensors to optimize the grid proper operations by predicting equipment failures and detect anomalies.
6. Block-chain : This technology can exalt the security and transparency of transactions in the smart grid, particularly in peer-to-peer energy trading and microgrid operations.
7. Virtual Power Plants (VPPs) : These aggregate and coordinate the operations of distributed energy resources to provide a better way of grid services, such as frequency regulation and peak shaving, while maximizing economic benefits for participants.
8. Microgrids : Localized grids that can operate independently or in conjunction with the main grid, providing resilience during outages and enabling communities to coupled renewable energy sources more effectively.
9. Energy Management Systems (EMS) : These software platforms optimize energy usage and generation within buildings, industrial facilities and campuses, contributing to overall grid efficiency.
10. Grid Modernization Initiatives : Governments and utilities are investing in upgrading aging infrastructure and implementing smart grid technologies boost up the reliability, resilience and sustainability.

Scope in India:

India's smart grid initiatives aim to modernize the country's electricity infrastructure, enhancing efficiency, reliability, and sustainability. These grids integrate advanced technologies like IoT, AI, ML and renewable energy sources to optimize power distribution and consumption. Key goals include reducing losses, integrating renewables and improving demand-response mechanisms to meet the nation's growing energy needs while minimizing environmental impact. The scope of smart grids in India is vast and multifaceted. It encompasses various aspects such as:

1. Modernizing Infrastructure : Smart grids involve upgrading existing infrastructure with advanced aid technologies to improve efficiency, reliability and security in power distribution.
2. Renewable Energy Integration: With India's increasing focus on renewable energy the smart grids gets involved in a key role for integrating these fitful energy sources into the grid efficiently.
3. Demand Response Management: Smart grids enable better management of electricity demand by implementing technologies that indicates the consumers to adjust accordingly with their usage during peak times, thereby reducing strain on the grid.
4. Energy Efficiency: Through real-time monitoring and data analytics, smart grids can identify areas of inefficiency and optimize energy usage, leading to reduced wastage and lower costs.
5. Stability and Resilience: Smart grids enhance grid stability by detecting and responding to disruptions more rapidly, minimizing downtime and improving overall reliability.
6. Electric Vehicle Integration: With the growing demand and increase in price of crude oil, electric vehicles (EVs), smart grids provide the infrastructure required to support widespread charging networks while managing the increased demand on the grid.
7. Microgrid Implementation: These grids allow the development of microgrids, which are smaller-scale, localized energy systems that can

operate without depending on others sources or in conjunction with the main grid, providing resilience and energy security, especially in rural areas.

8. Data Analytics and Management: The implementation of smart grids led to generates large amounts of data, which can be analyzed to gain insights into consumption patterns, grid performance and predictive maintenance, leading to more informed decision-making.

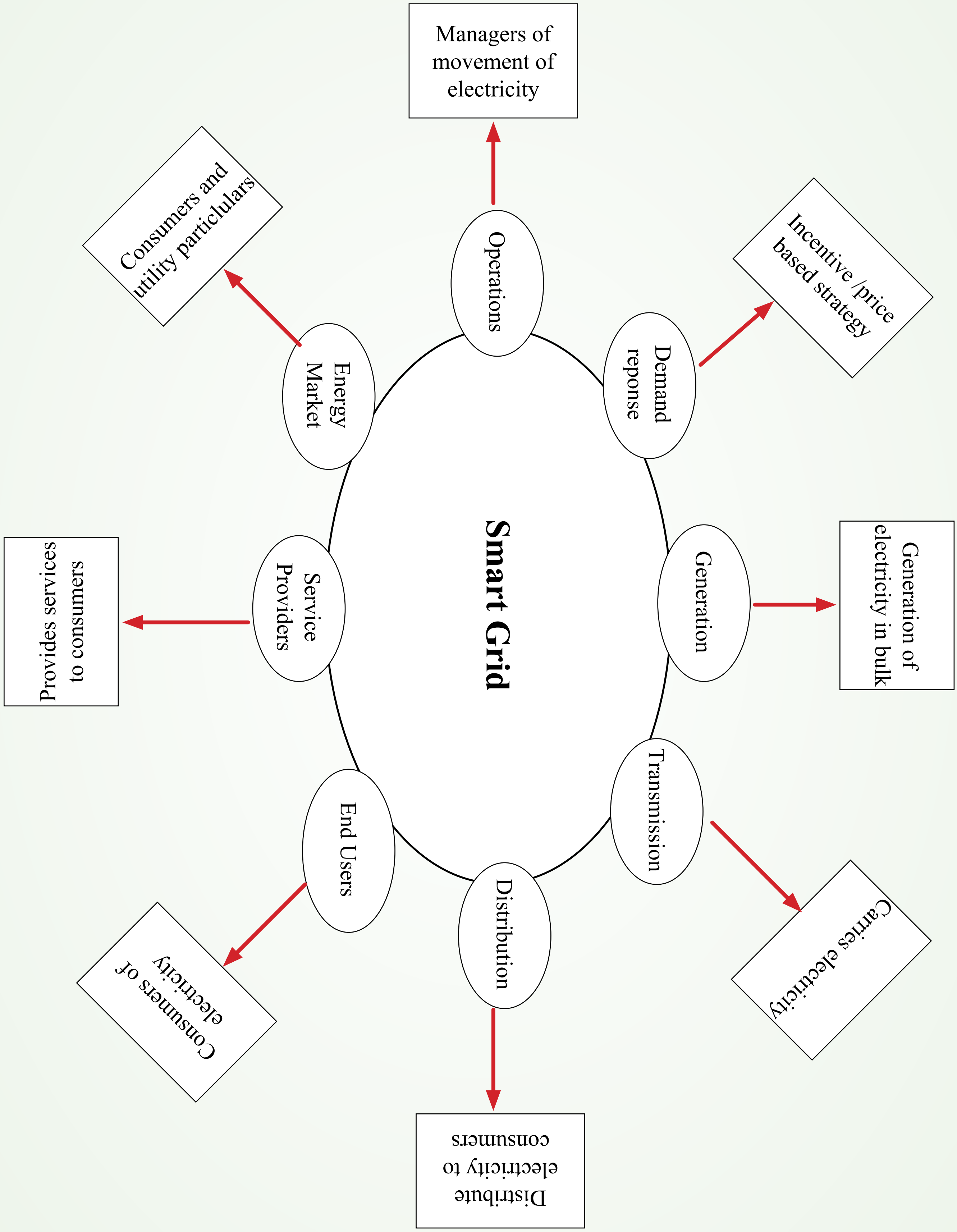
Overall the scope of smart grids in India is vast with the potential to transform the country's energy landscape by improving efficiency, sustainability and reliability, while meeting the growing energy demands of a rapidly developing nation.

Challenges:

While smart grids offer numerous benefits but they also face several challenges, particularly in the reference of a developing country like India :

1. Cost : The initial investment required to implement smart grid technologies can be significant, posing a financial challenge, especially for cash-strapped utilities and governments.
2. Infrastructure : India's existing power infrastructure is often outdated and is in need of significant upgradation to support smart grid implementation, which may tend towards a huge logistical and technical challenge.
3. Interoperability : Ensuring compatibility and interoperability among the profuse components of a smart grid, including sensors, meters, networks communication and control systems can be more complex and requires robust standards and protocols.
4. Cybersecurity : Due to huge demand of connectivity and digitalization, it has with the risk of cyberattacks, which provide enhance security and reliability of the grid. Protecting smart grid infrastructure against cyber threats requires robust cybersecurity measures and continuous vigilance.
5. Management and Privacy of Data : Smart grids generate vast amounts of data, raising concerns about data management, privacy and protection of consumer information. Establishing appropriate data governance frameworks and ensuring compliance with privacy regulations is essential.
6. Regulatory Framework : Developing and implementing supportive regulatory frameworks that incentivize investment in smart grid technologies while ensuring affordability, fairness and transparency can be challenging.
7. Skilled Workforce : Building and maintaining smart grid infrastructure requires a skilled workforce capable of operating, maintaining, and troubleshooting complex systems. Investing in training and capacity-building programs is essential.
8. Public Awareness and Acceptance : Educating consumers about the benefits of smart grids and addressing concerns related to privacy, security and reliability is crucial for gaining public acceptance and support.

Addressing these challenges requires a coordinated effort involving collaboration among government agencies, utilities, industry stakeholders and the public to overcome barriers and realize the full potential of smart grids in India.


Smart Grid
Operations
Managers of movement of electricity
Demand reponse
Incentive /price based strategy
Generation
Generation of electricity in bulk
Transmission
Carries electricity
Distribution
Distribute electricity to consumers
End Users
Consumers of electricity
Service Providers
Provides services to consumers
Energy Market
Consumers and utility particulars

The Architecture:

The architecture of a smart grid typically consists of several key components. They are:

1. Sensing and Measurement : This includes sensors and meters deployed throughout the entire grid to measure parameters such as voltage, current, power flow and system conditions in real-time.
2. Communication Infrastructure : A robust communication network is very much essential for transmitting data collected by sensors and meters to control centers and other relevant entities. This network makes real-time monitoring, control and guide together the smooth grid operations.
3. Data Management and Analytics : Smart grids generate vast amounts of data, which must be collected, processed and analyzed to derive actionable insights. Data management systems and analytics platforms are used to handle this data and support decision-making processes.
4. Control and Automation : Control systems and automation technologies are deployed to optimize grid operations, including load balancing, fault sensing and isolation, voltage regulation and demand response management.
5. Integration of Distributed Energy Resources : Smart grids facilitate the integration of distributed energy resources, such as solar panels, wind turbines with energy storage devices and electric vehicles into the grid. This involves bidirectional power flow and coordination of DERs to enhance grid stability and reliability.
6. Demand Response and Consumer Engagement: Smart grids enable demand response programs that motivate the consumers to adjust their electricity usage in response to price signals or grid conditions. Consumer engagement platforms provide tools and information to empower consumers to make smart informed decisions about their energy consumption.
7. Cybersecurity and Resilience : Given the increased connectivity and digitalizing the smart grids, robust cybersecurity measures are essential to protect against cyber threats and ensure the resilience of grid operations.
8. Regulatory and Policy Framework : A supportive regulatory and policy framework is necessary to incentivize investment in smart grid technologies, promote innovation, and ensure the alignment of grid modernization efforts with broader energy policy objectives.

Components:

The components of a smart grid can be categorized into several key areas:

1. Advanced Metering Infrastructure (AMI) : They are installed at consumer premises to measure and record electricity usage in real-time. These meters facilitate two-way mode of contact between consumers and utilities, enabling remote meter equipped with sensor to make reading, outage detection, and demand response programs.
2. Sensors and Monitoring Devices : Various types of sensors and monitoring devices are deployed or installed throughout the grid to collect data based on the parameters such as voltage, current, power quality and system conditions. These devices provide real-time information to operators for grid monitoring and control.
3. Communication Networks : Robust communication networks, including wired and wireless technologies, enable the transmission of data between different components of the smart grid. These networks facilitate real-time based monitoring and coordinationing in grid operations.
4. Grid Control and Automation Systems : Grid control and automation systems utilize advanced algorithms and control strategies to optimize operations. This includes functions such as load balancing, voltage regulation, fault detection, isolation and outage management.

5. Distributed Energy Resources (DERs): DERs such as solar photovoltaic (PV) systems, wind turbines, energy storage systems and electric vehicles are integrated into the grid to enhance flexibility, reliability and sustainability. This technology enables the efficient management and control of DERs to support grid stability.
6. Demand Response Technologies : Demand response technologies allow utilities to manage electricity demand by incentivizing consumers to adjust their usage during peak times or in response to grid conditions. This may involve dynamic pricing, automated load control devices and consumer engagement platforms.
7. Data Management and Analytics Platforms : Data management and analytics platforms process and analyze the vast amount of data generated by smart grid components. These platforms provide insights into grid performance, consumption patterns and operational efficiency by supporting decision-making processes.
8. Cybersecurity Measures : With increased connectivity and digitalization, cybersecurity measures are essential to protect smart grid infrastructure against cyber threats and ensure the integrity and reliability of grid operations. This includes measures such as encryption, access controls and intrusion detection systems.
9. Regulatory and Policy Frameworks : A supportive regulatory and policy framework is necessary to incentivize investment in smart grid technologies, promote interoperability and standards, and address issues related to privacy, security and consumer protection.

Transmission Automation:

The automation associated with the transmission are following:

1. Dynamic Line Voltage and Current Rating
2. High Temperature Control
3. Sag Minimization
4. HVDC
5. FACTS
6. Wide area Monitoring Systems(WAMS)
7. Stand Alone Power Supply (SAPS) System
8. Renewable Energy Management System (REMS)

Future Scope:

The future scope of this is vast and holds promise for transforming the energy landscape in several ways:

1. Enhanced Integration of R.E: It will play a crucial role in integrating a higher share of R.E. sources like solar and wind into the grid. Advanced forecasting, real-time monitoring, and control capabilities will enable better management of intermittent renewable generation, ensuring grid stability and reliability.
2. Electric Vehicle (EV) Combination: With the increasing adoption of electric vehicles, smart grids will facilitate the combination of EV charging infrastructure using the grid. Smart charging technologies will optimize charging patterns, manage grid impact and support bi-directional power flow between vehicles and the grid, enabling vehicle-to-grid (V2G) capabilities.
3. Energy Storage Optimization: Smart grids will enable the efficient integration and management of energy storage devices, including batteries and other storage technologies. These systems will help to maintain the balance between the supply and demand, support grid stability and mitigate the variability of renewable energy sources.
4. Grid Edge Technologies: The deployment of advanced sensors, controls and communication technologies at the grid edge will enable localized decision-making and control. This includes capabilities such as micro grids, distributed energy resources and demand response programs, empowering consumers to participate actively in grid operations.

5. AI and Data Analytics : AI and data analytics thus deals by playing significant role in optimizing grid operations, predictive maintenance and asset management. Machine learning algorithms will inspect the vast amounts of data to identify patterns, optimize energy flows and improve grid efficiency and reliability.
6. Cyber-Physical Systems : Smart grids will evolve into cyber-physical systems that integrate digital technologies with physical infrastructure while authorizing real-time monitoring, control and optimization. This convergence will enhance grid resilience, cybersecurity and adaptability to changing conditions.
7. Grid Resilience and Adaptability: Smart grids will become more resilient and adaptable to disruptions, including natural disasters, cyberattacks and extreme weather events. Advanced sensing, control and automation capabilities will enable rapid response and restoration of grid operations.
8. Consumer Empowerment and Engagement: It will empower consumers to actively participate in energy management decisions, including energy usage, generation, and storage. Consumer engagement platforms, real-time feedback and personalized energy services will enhance energy awareness and efficiency.
9. Policy and Regulatory Support: Continued policy and regulatory support will be crucial for accelerating the deployment and adoption of smart grid technologies. This includes incentives for investment, regulatory frameworks that promote interoperability and cybersecurity and standards development to ensure compatibility and reliability.

Conclusion:

In conclusion, smart grids represent a transformative approach to modernizing and optimizing our energy infrastructure. It offers a range of benefits, including enhanced efficiency, reliability and sustainability by combining the advanced technologies such as IoT, AI, ML and R.E.S. Through real-time based monitoring, control and optimization, smart grids enable better management of energy resources, integration of renewables and support for emerging technologies like electric vehicles and energy storage. They enable the consumers to actively participate in energy management decisions and contribute to a more resilient and adaptive grid. However the smart grids require overcoming various challenge, including cost, infrastructure, cybersecurity and regulatory hurdles. Continued investments, collaboration among stakeholders by supportive policies are essential to unlock the full potential of it and thus realize a more efficient, reliable and sustainable energy for upcoming future. Overall we can say that smart grids offer a promising future.

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CALL FOR MORE QUANTITY DOESN'T MEAN ENDORSEMENT FOR COMPROMISING ON QUALITY

Tadimalla H Mohan Rao

Abstract

Today, the Indian coal sector is at a crossroads. On the one hand, the Indian economy is expected to grow considerably in the coming years, and so too are the three largest coal consuming sectors - electricity, iron and steel, and cement. However, the climate commitments made by India (within the framework of the Paris Agreement), and the declining costs of renewables, in particular solar photovoltaic (PV) panels, are impacting the business case of the coal sector in the country at large. The main certainty is that, given its central role in the energy and economy in India, a part of India's success in the future is essentially linked to the successful and efficient management of the coal sector (Source: IEA India 2020Energy Policy Review).

India is the world's second largest producer of coal after the People's Republic of China. As we all know, coal, the lifeline behind the nation's energy security, is not going to last forever. As this humble bundle of energy is non-renewable, the strategic and efficient utilization of the remaining coal reserves is essential, if we intend to ensure that our future generations do not end up facing energy crisis.

Coal accounts for 47.73% of the overall total installed capacity, and 86.74% of the total thermal (coal, lignite, gas, and diesel combined) installed capacity in the country, as on 31.03.2024. Exactly a decade ago, ie., as on 31.03.2014, these figures were 58.44%, and 86.34% respectively (Source: CEA).

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Following table helps in depicting the above picture in a more coherent way:

(Installed capacity in MW)

As On	Coal-based installed capacity	Overall total installed capacity	Total thermal installed capacity	Coal's share out of Overall	Coal's share out of Thermal
(1)	(2)	(3)	(4)	(5)	(6)
31.03.2024	210969	441970	243217	47.73%	86.74%
31.03.2019	194444	356100	226279	54.60%	85.93%
31.03.2014	145273	248554	168255	58.44%	86.34%

Following inferences can be drawn from the above table:

- There has been a huge jump of 77.82% [from 248554 MW (as on 31.3.2014) to 441970 MW (as on 31.3.2024)] in the overall capacity addition during the last one decade (Col 3)
- *There has been a considerable jump of 45.22% [from 145273 MW (as on 31.3.2014) to 210969 MW (as on 31.3.2024)] in the coal-based capacity addition during the last one decade (Col 2)*
- *While the rise in coal-based capacity addition during the first half of the last decade was considerably high at 33.84% (from 145273 MW as on 31.3.2014 to 194444 MW as on 31.3.2019), the same during the second half of the last decade remained significantly low at only 8.49% (from 194444 MW as on 31.3.2019 to 210969 MW as on 31.3.2024) (Col 2)*
- *Share of coal in thermal energy matrix has more or less remained constant at 86% during the last one decade (col 6)*
- *However, share of coal in the overall energy matrix has significantly dropped by 10.71% from 58.44% (as on 31.3.2014) to 47.73% (as on 31.3.24) during the last one decade (Col 5)*
- *This shows that coal's share in the country's overall energy matrix is falling down, at a rate of + 1% every year.*

Considering the steady shift towards the non-conventional sources of energy being witnessed in the country, especially towards solar, the annual fall in coal's share in the overall energy matrix is projected to rise at further higher rates of around 2-3% or even more, in the coming years.

No effort is required to understand the reasons behind the shift slowly happening from coal to other renewable sources in order to meet the rising energy needs. Considering the environmental externalities linked to production and use of coal, viz., air pollution, impact on water at different stages of the production and consumption processes, and rise in CO_2 emissions, to quote a few, the damage caused to the country's eco

systems due to mining operations doesn't require any emphasis. Despite these perils, India's coal dependence is unlikely to disappear in the medium term and it is therefore a must for policy makers, industry and, more generally, the Indian society, to minimise its negative impacts by using state-of-the-art technology in a cost-efficient way, which essentially involves a pin-point focus on sustenance of the natural quality of coal, through the entire spectrum of activity starting from mining to end-use. The impact caused to the environment in a big way due to emission of the greenhouse gases because of use of coal notwithstanding, production and delivery of coal with all its contaminants ensured 'intact' by the coal companies still remains the major cause of concern.

Needless to say, the failure on the part of the coal companies in ensuring 100% delivery of coal in the grades notified is the major factor that is causing further rise in the damaging impact to the environment. The fact that grade conformity against supplies from CIL's mines during 2023-24 stood at around 76% (source: CIL's Press Release dt. 01.4.2024) cannot be taken as a factor to remain complacent. Though the reported 76% grade conformity was no doubt, commendable, the fact to remember is, the gap was still 24%! The track record shows grade conformity has always remained vastly inconsistent. This vast inconsistency is the foremost reason that is triggering the above shift away from coal, forcing the policy makers to initiate all necessary measures so that the said shift happens completely, and quickly. CIL would be failing in meeting its national responsibility, if 100% grade conformity is not realized every year, year after year, since sporadic performance on quality front is not what the Nation is looking for!

Despite this scenario, and considering that coal still singularly accounts for nearly 50% share (47.73% precisely) in the nation's present energy matrix, it's no surprising that the annual coal production targets in the country are being pegged at higher and higher levels year after year. This clearly emphasizes that coal's share is expected to continue to remain significant in the country's total primary energy supply (tpes) position at least for another couple of decades.

In order to meet the growing Energy needs, the country is required to be geared up to produce and deliver more quantity of coal, at least over the next couple of decades. Continued use of coal for electricity generation in the country thus having become inevitable, the absolute need for 100% grade conformity assumes far more significance.

During the financial year (2023-24) just gone by, the country has produced 997.23 million tonnes (mt) of coal (against the national target of 1012 mt), compared to 893.19 mt produced during the earlier fiscal of 2022-23. Out of the 997.23 mt produced during FY 24, CIL alone produced 773.64 mt, constituting a whopping 77.57% of the country's total coal output. This was 99.16% of CIL's target of 780 mt set by the Ministry for FY 24. With its production and offtake targets for the current fiscal 2024-25

having been pegged at 838 mt, which constitutes 77.6% of the country's target of 1080 mt, it's clear that the nation has yet again placed onerous responsibility on CIL, in meeting its energy requirements in a qualitative way. Therefore, Coal companies across the country, especially the coal-producing subsidiaries of CIL, need to meet this huge target by producing and delivering coal in grades notified, but not by producing and delivering anything and everything the Mine Manager lays his hands on, above the earth and below the earth! Clearly Call for More Quantity doesn't mean Endorsement for Compromising on Quality!

The question here is, how this can be ensured? The answer is simple….. by rooting out the insensitivity to coal quality issues prevailing amongst the rank and file of CIL and its coal producing subsidiaries. This, of course, requires a major attitudinal change. Needless to say, CIL is well equipped to enforce this change. However, what's required is the 100% willingness to implement the change. The willingness to unequivocally adopt and absorb the QUALITY CULTURE as the fundamental policy. The willingness to put Quality before Quantity and produce Quantity WITH Quality. After all, coal without energy cannot produce energy! And, India is a signatory to the Paris Climate Treaty!! The ensuring paper is a modest attempt focusing on the right deliverables……

1.0 Introduction

The demand for energy is consistently on the rise and coal, being the primary source of commercial energy in the country, plays a crucial role in ensuring India's energy security & economy. Coal ensures a reliable and steady energy supply, crucial for sustaining industrial growth, and powering urbanization.

India is the second largest consumer (as well as producer, as stated in the abstract above) of coal and coal has hitherto played a crucial role in India's energy sector, accounting for 55% of the country's energy needs and over 75% of its electricity needs. In addition, coal is also a vital ingredient and energy source in production of many important material/ products viz. Steel, Cement, Fertilizer, Paper etc. With significant availability of indigenous coal reserves and its affordability, coal is likely to continue as primary source of energy for a considerable period of time to meet the developmental needs of rising economy (Source: NITI Aayog's Sept-2021 report of the Inter-ministerial Committee on Just Transition from Coal)

Coal without energy cannot produce energy:

Thus, strategic and efficient utilization of the remaining coal reserves is essential, if the country's future energy security is to be ensured. This onerous task unequivocally calls for responsible and qualitative mining. In this context, the data outlined in the following table on the role played by coal more than ten years ago against different parameters, and likely to be played by coal in future as well (when India celebrates its century of Independence) against the same parameters but under two different scenarios (BAU-Business As Usual, and Ambitious), shall be of lot of relevance:

Parameters	Role of Coal		
	Existing as in 2012	Anticipated by 2047 Under	
		BAU Scenario	Ambitious Scenario
Energy Mix in India	46%	50%	42%
Import Dependence	17%	65%	34%
Domestic Production (mt)	582	1157	1400
Installed Capacity (GW)	125	333	459
Energy Supply (Twh)	3272	15155	9790

(Source: Overall Energy Scenario of India Till 2047 – By Ripunjaya Bansal (Energizing India – A joint Project Report of NITI Aayog and IEEJ (The Institute of Energy Economics, Japan) dt. 16th June 2017)

From the above table it may be seen that if the figures shown against each parameter outlined under the ambitious scenario by 2047 are to be truly accomplished, it's obvious that the quality of coal delivered must be able to produce the required heat content; and this is possible, only when 100% conformity is realized. Else the nation shall be left with no choice but to stay contented with the figures shown under the BAU scenario. After all, coal without energy cannot produce energy!

Besides providing gainful employment and economic sustenance to millions world-wide, coal provides electricity to billions of people across the globe. Its abundance, low price, and availability make it the fuel of choice. At the Paris Climate Treaty, India has committed that its non-fossil fuel based (other than thermal) installed generating capacity would be about 40% of its total installed capacity, and India has already surpassed this target with its 'other than thermal' installed capacity having clocked at 41.12% two years ago, by 30.4.2022 itself. This figure has further gone upto 45% by 31.03.2024, as can be seen from Col 7 of the following table (Source: CEA).

In order that the balance 55% installed capacity of India, which is fully thermal (Col 6 of the following table) remains totally accessible, it's obvious that India needs to secure electricity largely from the coal-based thermal plants using the HELE technologies like super critical and ultra-super critical, IGCC (Integrated Gasification Combined Cycle), etc. Needless to say, this requires coal of higher heat value, lower ash content and consistent size. Therefore, India would need to ensure a pin-pointed focus on use of the HELE technologies for coal-based thermal generation, which in turn calls for use of its coal reserves efficiently and effectively.

Installed capacity position as on 31.03.2024 (MW):

Thermal			Total other than thermal (nuclear + renewable)	Overall Total (3+4)	Share of 'thermal' in overall	Share of 'other than thermal' in overall
Coal	Other than coal	Total				
(1)	(2)	(3)	(4)	(5)	(6)	(7)
210969	32248	243217	198753	441970	55.00%	45.00%

It's an uncontested fact that generation of quality power is directly dependent on use of state of the art technologies by the thermal plants, and on the production and delivery of quality coal by coal companies. In order to meet the rising demand for electricity, we need more and higher quantities of coal. However, one significant fact to remember here is, increase in coal consumption is not only because of new capacity addition but also because of deterioration in coal quality in terms of its heating value (Siddhartha Bhatt M and Rajkumar N -The Journal of CPRI, Vol. 11, No. 4, December 2015 pp. 773-786), which clearly implies that the lower the quality of coal, the higher will be the quantity of coal required for generation of the same quantum of electricity and vice versa. Therefore, the focus needs to be not only on production of more and more quantity of coal, but simultaneously on ensuring 100% grade conformity of the coal so produced and delivered to the power sector-consistently-year after year. Otherwise, the statement that appears on the homepage of CIL's website viz., "Ensuring Energy Security with Sustainability" may face the threat of appearing hollow, bringing CIL's integrity in this regard under a shadow, since the essence of this very important statement is directly linked to production and delivery of coal in absolute conformity with the grades/quality declared. Further, as we all know, the word 'quality' is an integral part of CIL's Mission Statement!

By putting quality before quantity as in the dictionary and producing quantity with quality only, the nation's rising energy requirements can be more effectively met with, simultaneously ensuring conservation of the precious and priceless national resources and the environment. Therefore what really matters is 'what has been produced', rather than 'how much has been produced'! And this is a very important question to think, pause and ponder.

QE Calls for QE (Quantitative Expansion Calls for Qualitative Enrichment):

The production graph of CIL has grown from a modest 79 mt at the time of inception (during 1975-76) to 773.64 mt during 2023-24, almost a 10-fold growth, which is nevertheless massive. This means there was unarguably a huge Quantitative Expansion in the coal production of CIL. However, the moot question is, whether there was a simultaneous Qualitative Enrichment of its product, too!

In this context, it may be of a lot of relevance if a reference is made to a booklet titled "Human Values in Management" authored by Swami Ranganathananda, which was published by CIL during 1986.

The late Swami Ranganathananda was the Trustee of the Ramakrishna Math and Member of the Governing Body of the Ramakrishna Mission and an eminently renowned and widely respected scholar monk of the Ramakrishna Order and the above booklet is the compilation of the lecture series of the Swamiji.

During Sept 1983, Swami Ranganathananda addressed the officers of the Punjab National Bank, New Delhi on the contemporary subject of Human Values in Management. The Bank later published his impromptu talk in a book form, which was subsequently published again by Coal India during 1986 for the benefit of its employees and for those who are intimately connected with the subject of management. With the preface by Shri G.L. Tandon, the then Chairman of CIL, the booklet also contains a personal letter addressed to all Coal Indians by Shri Tandon.

Chapter 8 of the booklet abbreviated as "QE calls for QE" is of particular relevance here. In "QE Calls for QE" while the first QE stands for "Quantitative Expansion", the second QE stands for "Qualitative Enrichment". A little about these two QEs..

The book says that Quantitative Expansion calls for a pari passu Qualitative Enrichment. Here the Latin phrase pari passu means "Side by Side", "At the Same Time", "On Equal Footing", "Moving Together", etc.

"QE calls for QE" applies to all departments, organizations and service institutions, whether public or private, without exception. Looking

at the issue from the perspective of CIL, from just 11 collieries at the time of formation of NCDC, and about 79 mt production at the time of nationalization, the no. of coal mines under CIL has grown to 322 (as on 1.4.2023), registering almost a 30-fold growth. Further, with the coal production of CIL having registered at 773.64 mt during FY 24 (2023-24), there has been an almost 10-fold growth in its coal production as of now, compared to the coal production of the mid '70s. Thus, CIL's Quantitative Expansion both in terms of coal mines owned by it and coal production from those mines, has been colossal.

However, such Quantitative Expansion calls for a pari passu Qualitative Enrichment. This, as enshrined in the book, calls for infusion of human values in CIL's operations, since Qualitative Enrichment can be ensured only by individuals who uphold values. In the event the values get stifled and blunted under the guidance of a wrong philosophy of work and life, the Qualitative Enrichment of neither CIL as an organization, nor its product coal as an acceptable fuel, can happen.

In order that there remains a perfect balance between the Qualitative Enrichment of its work (coal production) and life (organization) components in CIL, there is a need to orient CIL's human resources towards these two vital ingredients, so that these two dynamic parameters can become simultaneously qualitative. This can be done only when, rather than the intellect, the heart is accorded more priority. It is when heart responds to heart, a static management becomes transformed into a dynamic and developmental management, leading to infusion of values into its human resources, which ultimately ensures the Qualitative Enrichment of the work and life components of an organization in the desired blend, says the Swamiji.

Now, applying the above philosophy to CIL, it is essential to keep in mind that CIL's commitment of ensuring energy security is not confined to just slogans. The slogans must be translated into 100% reality. Otherwise, no matter how much Quantitative Expansion of collieries and thus coal production keeps on happening year after year, the Qualitative Enrichment of CIL's product cannot happen unless quality-oriented values are infused into its rank and file.

Effectiveness Defined - The P/PC Balance:

In his timeless bestseller "The 7 Habits of Highly Effective People", which has sold more than 25 million copies and named the "No. 1 Most Influential Business Book of the 20th Century", and which has captivated the readers the world over for more than 2 ½ decades, Stephen R. Covey says that effectiveness is always in harmony with a natural law called "P/PC Balance".

As per the above natural law, effectiveness is a function of two things, viz., the product and the producing asset, says Covey. Emphasizing that the P/PC Balance concept can be made applicable to any situation and to all the three kinds of basic assets, physical, financial and human, Covey concludes that only by preserving and maintaining the asset, one can enjoy the fruits of that asset. Conversely, Covey adds, one cannot have more fruits than the asset is capable of producing! This is what is known as the concept called P/PC Balance, in a nutshell.

Applying the above natural law to the coal industry, if a pattern of functioning that focuses only on the product (coal) is adopted neglecting the producing asset (mine), soon there will be no mine left out that produces coal. On the other hand, if only the mine is taken care of with no aim to produce coal, soon there won't be resources to take care of the mine any further and the wellbeing of its manpower. Effectiveness therefore lies in what is known as the P/PC Balance, where P stands for the Product (Coal) and PC stands for the Production Capability (of the mine,) in the context of CIL.

In the quest for short-term returns or results, the prized mines are often ruined, and thereby the product, coal, which suffers serious deterioration in its quality thus becoms unfit for consumption, finally losing its demand. In order that the mines produce coal of the required quantity & quality, it is therefore essential that total care of the mines is first secured by following proper, precise and

scientific methods of coal extraction before going for actual production of coal, in strict conformity with the mine's production capability and quality, as stipulated in the mines' Project Reports. Keeping the P (Product) and the PC (Production Capability) always in perfect balance makes a tremendous difference to the effective use of the physical assets, the mines.

On the other hand, if the P/PC Balance is not respected in the use of the physical assets, the trust of the customers reposed would stand violated and the biggest ever asset, called customer loyalty, would be permanently lost. Once this happens, it shall lead to a serious drop in the organizational effectiveness, which ultimately jeopardizes the national interests. Needless to say, the single most important responsibility and the national duty of the leaders of the coal industry is therefore to safeguard the assets of the country, by keeping a perfect balance between the P and PC factors while extracting the priceless non-renewable national resource.

Conclusion:

Careful reading of what has been said above reveals that quality plays the major role in shaping the overall destiny of any organization, and the coal-producing companies are, therefore, not an exception to this rule. The health, wealth and mirth of the people, consequently of the organization they work for, and consequently of the nation they represent, all are hence dependent on the quality of the product they produce, on the quality of the work they discharge and on the quality of life they possess. Focus only on the quantity of the product, with no focus on the quality of the product so produced, shall end up in detrimental consequences. As such it's highly essential to always remember that 'call for more quantity doesn't mean endorsement for compromising on quality'!

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