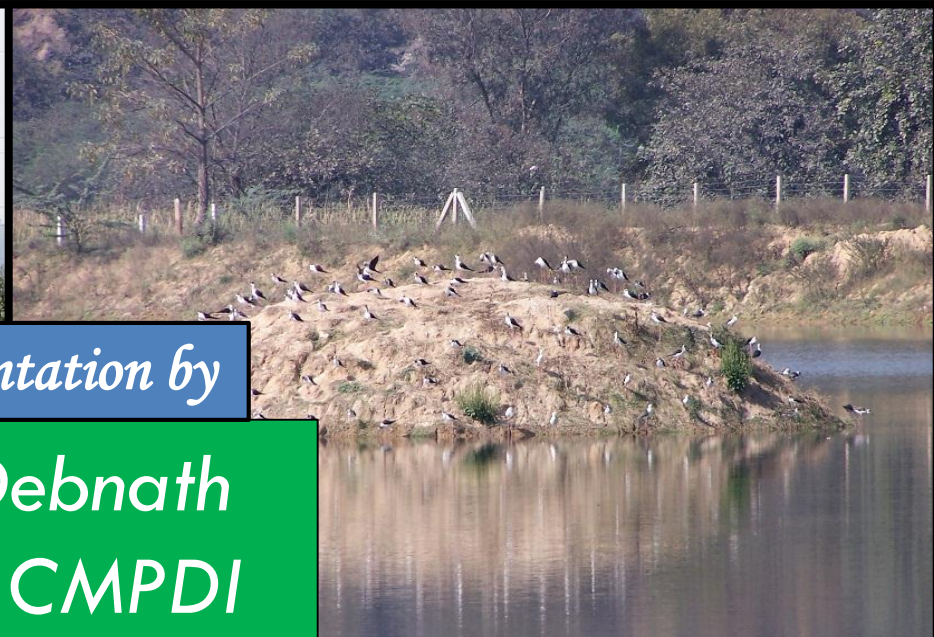
SUSTAINABLE MINING IN INDIA



- a presentation by

A K Debnath
CMD, CMPDI

Contents of Presentation

Brief of Indian Coal Industry

Environmental Issues & Mitigation measures adopted by CIL

Coal Beneficiation

Adoption of Renewable Sources of Energy

Brief of Indian Coal Industry

Brief of Indian Coal Industry

Coal Contribution towards energy

Coal meets over 52% of primary commercial energy needs in India against 29% the world over

Around 72% of India's power generation is coal based (2012-13)

CIL contribution towards coal production

81%(452 Mt) of total production (557.5 Mt)

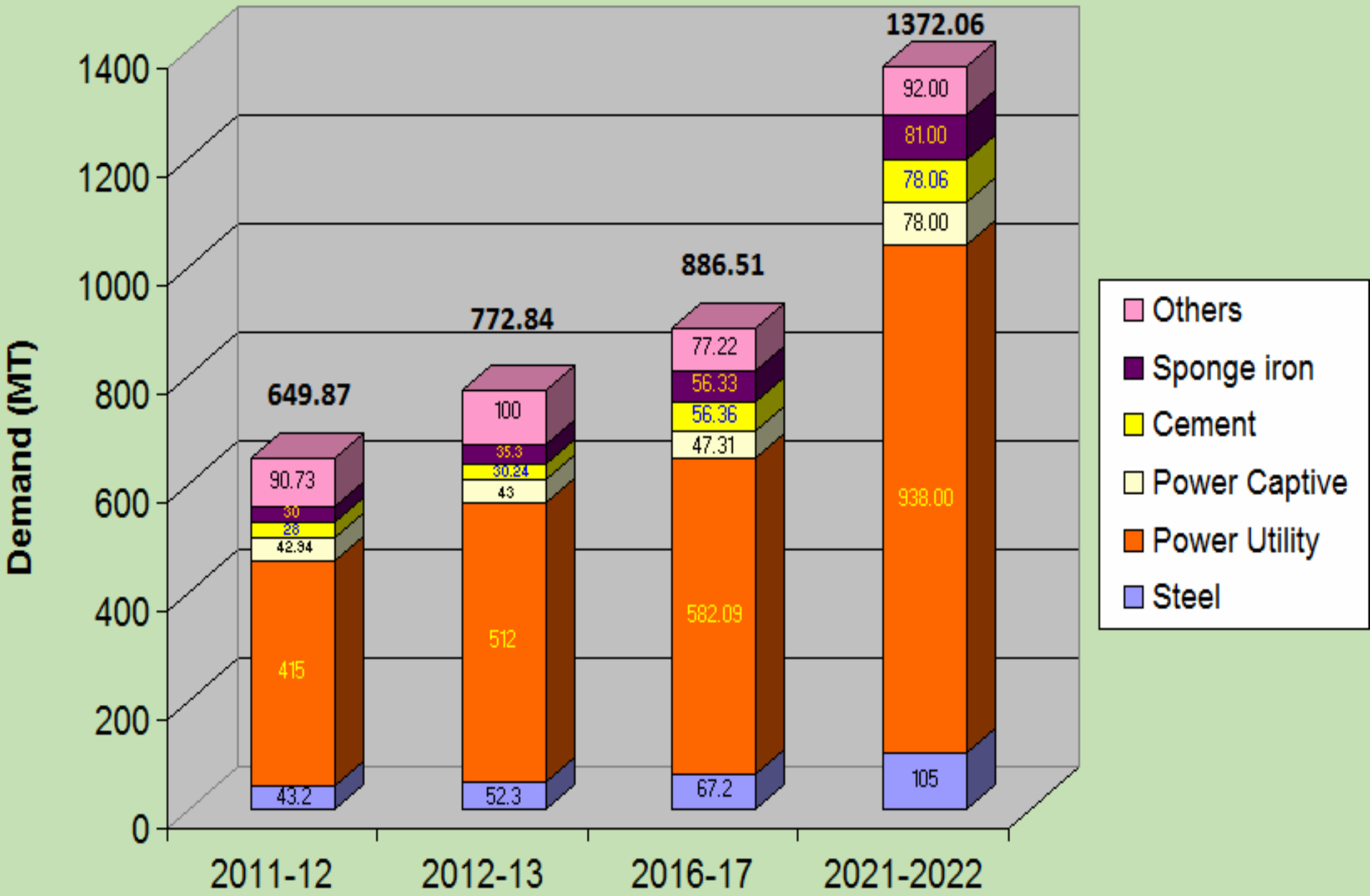
Opencast mines contributes 90% towards total coal production in India

Demand and availability of Coal

Demand of coal is expected to touch 980.5 Mt by 2016-17, of which, demand from Power Sector constitutes 70%

Availability of indigenous coal is optimistically projected at 795 Mt in 2016-17

Coal Demand Scenario (MT) during XI, XII & XIII Plan

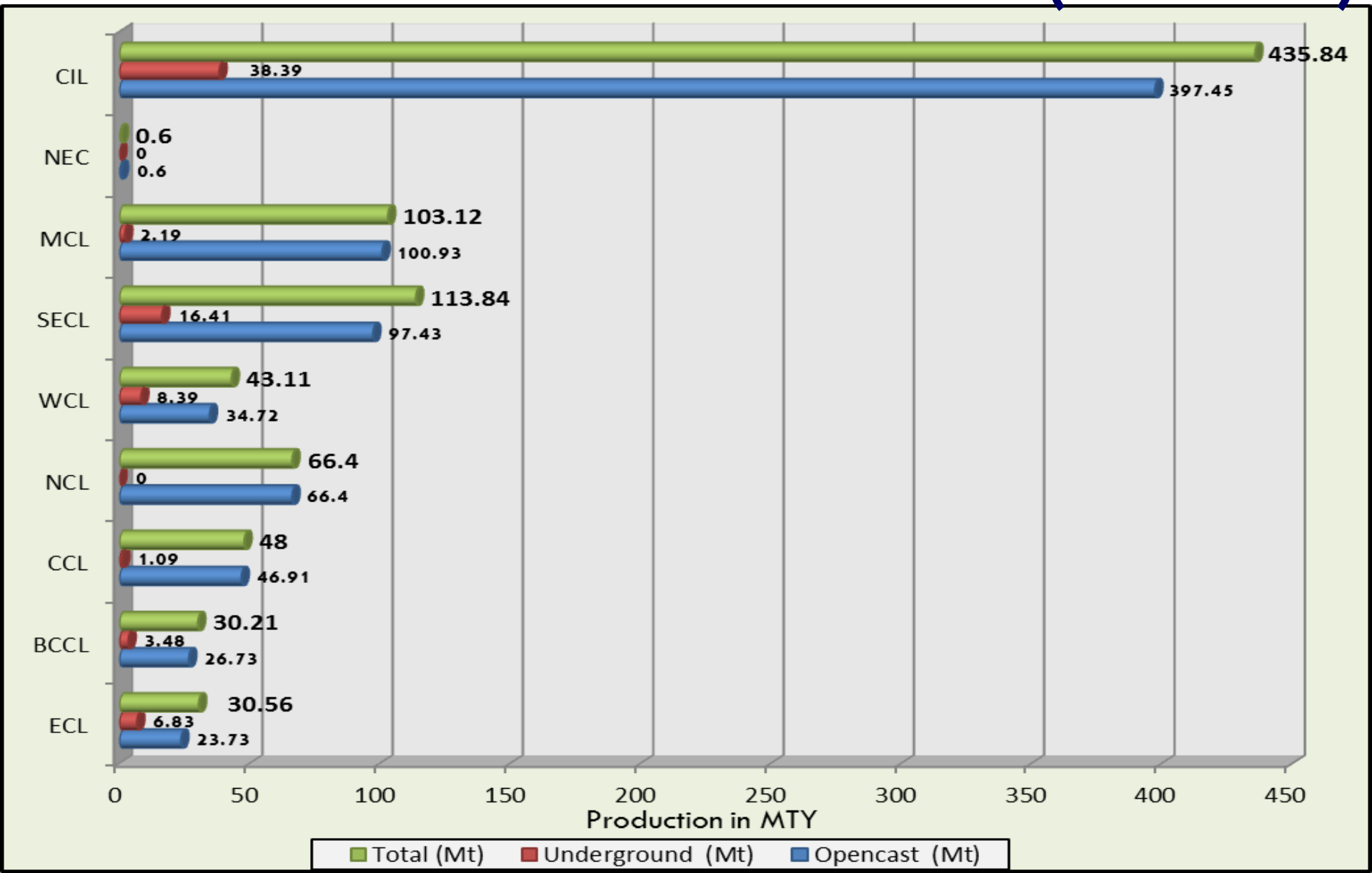


COAL PRODUCTION PROJECTION – XIIth & XIIIth Five Year Plan

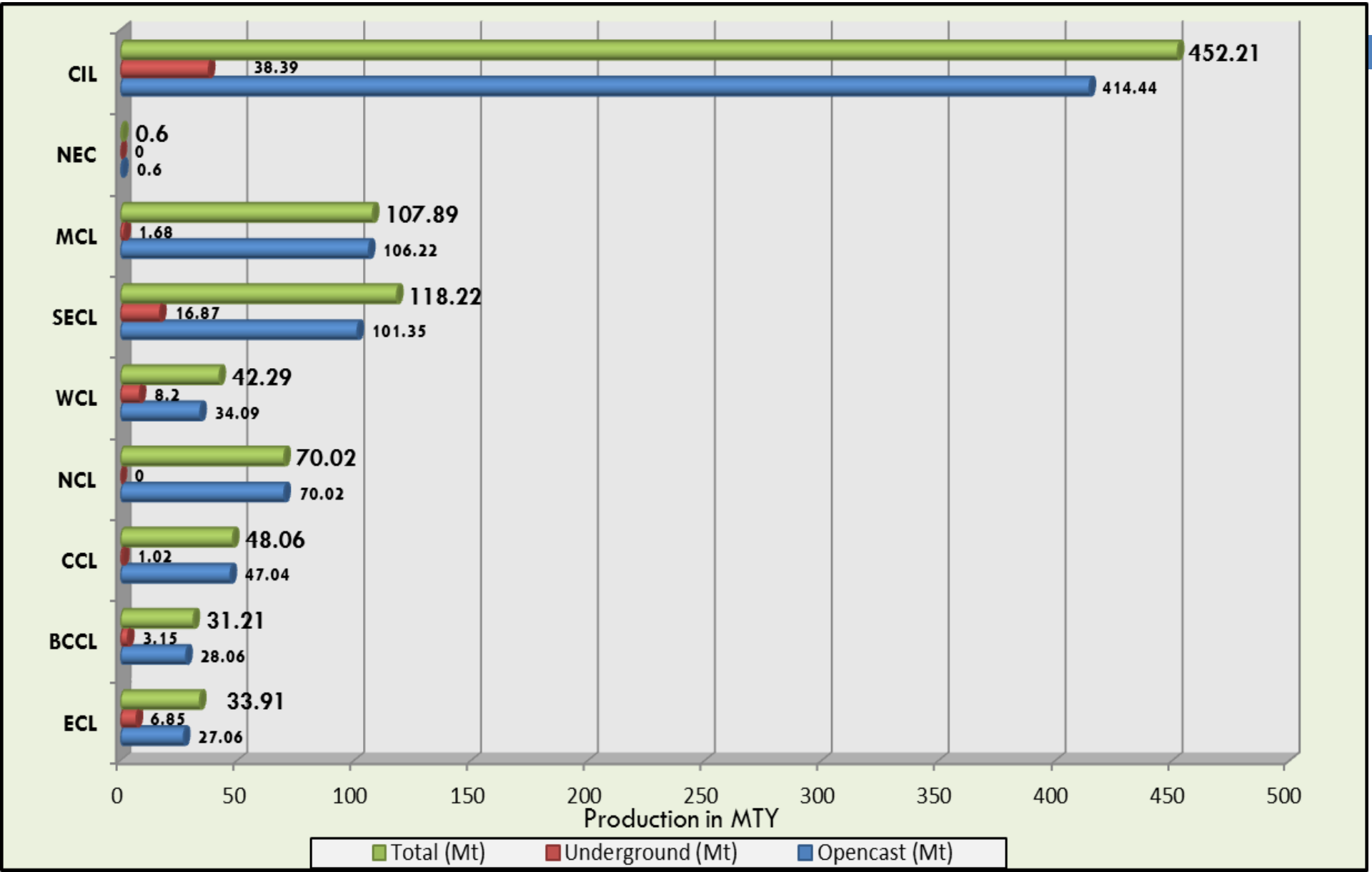
Company	XII Plan (2016-17) (Mt)		XIII Plan (2021-22) (Mt)	
	Business as Usual	Optimistic	Business as Usual	Optimistic
CIL	556.40	615.00	650.00	700.00
SCCL	57.00	57.00	63.00	63.00
Captive	79.60	100.00	215.00	315.00
Others	22.00	23.00	22.00	24.00
All India	**715.00**	**795.00**	**950.00**	**1102.00**

Source – Report of Working Group on Coal and Lignite for XIIth Five Year Plan, Nov 2011

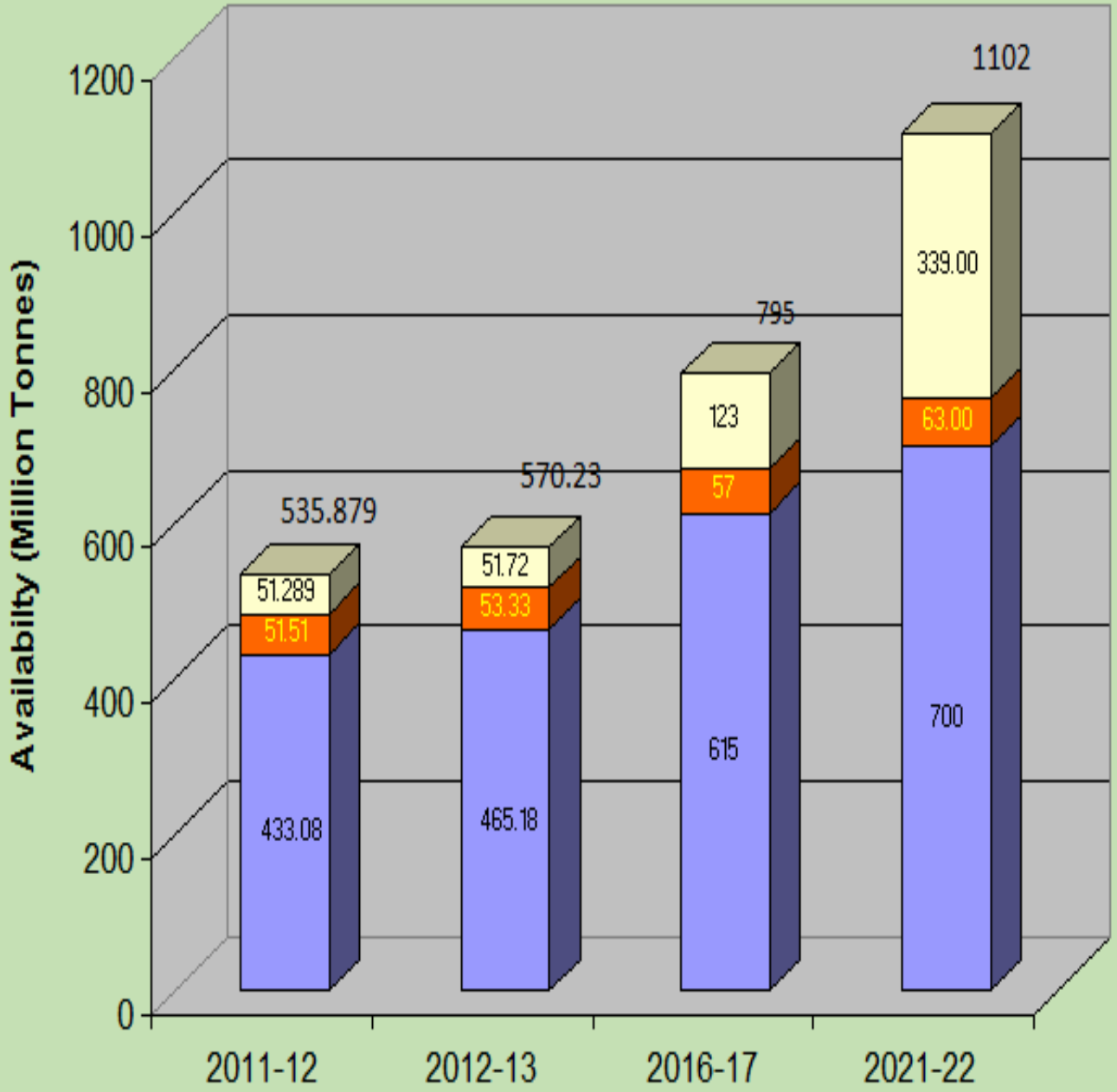
CIL Production in Terminal Year of XI Plan (2011-12)



CIL Production during 2012-13



Coal availabilty (Indigenous) (Actual & Projection)- XI,XII &XIII Plan (in MT)



* Import excluded in availabiilty during

2011-12 = *102.85 mt*

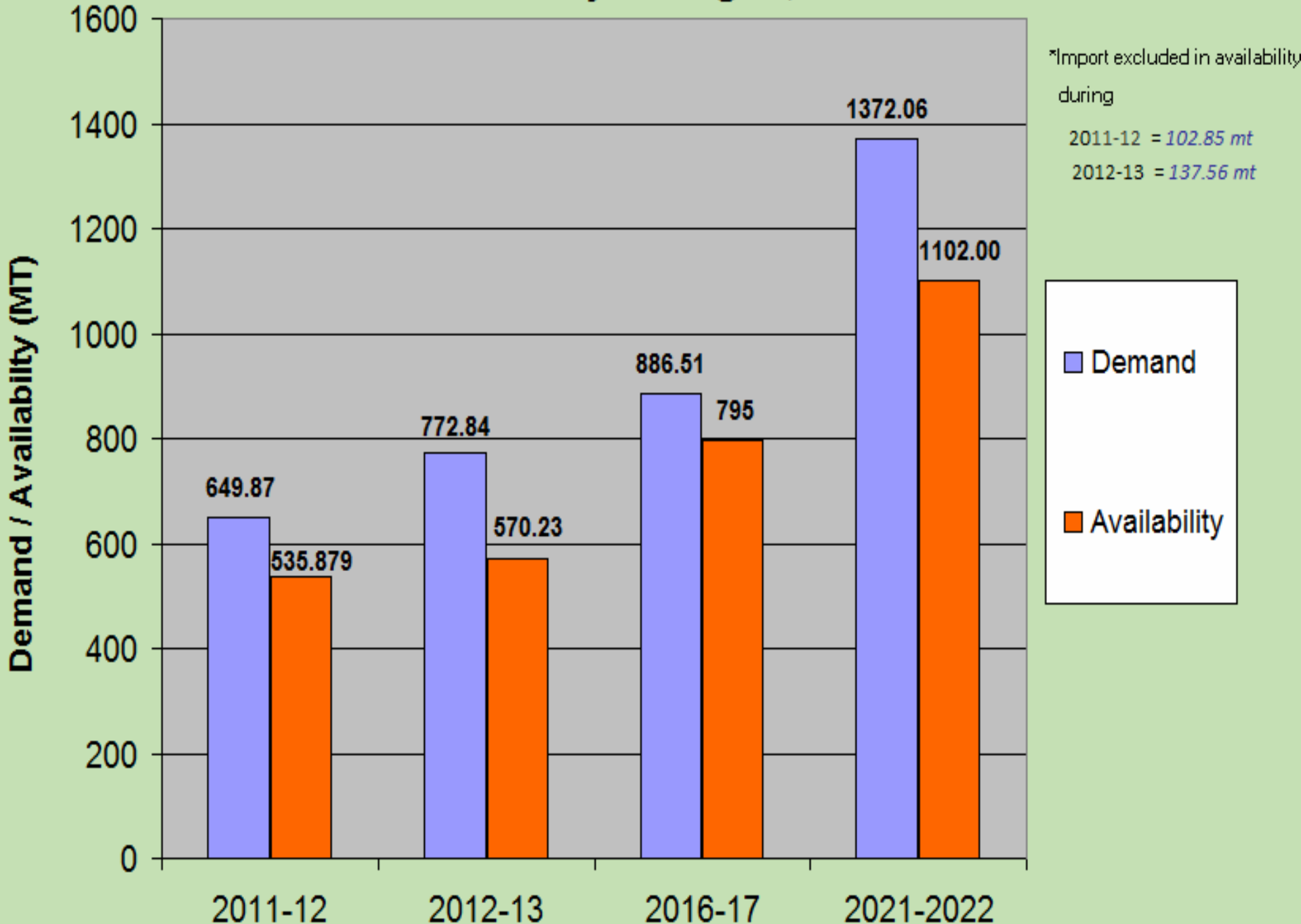
2012-13 = *137.56 mt*

Captive & Others

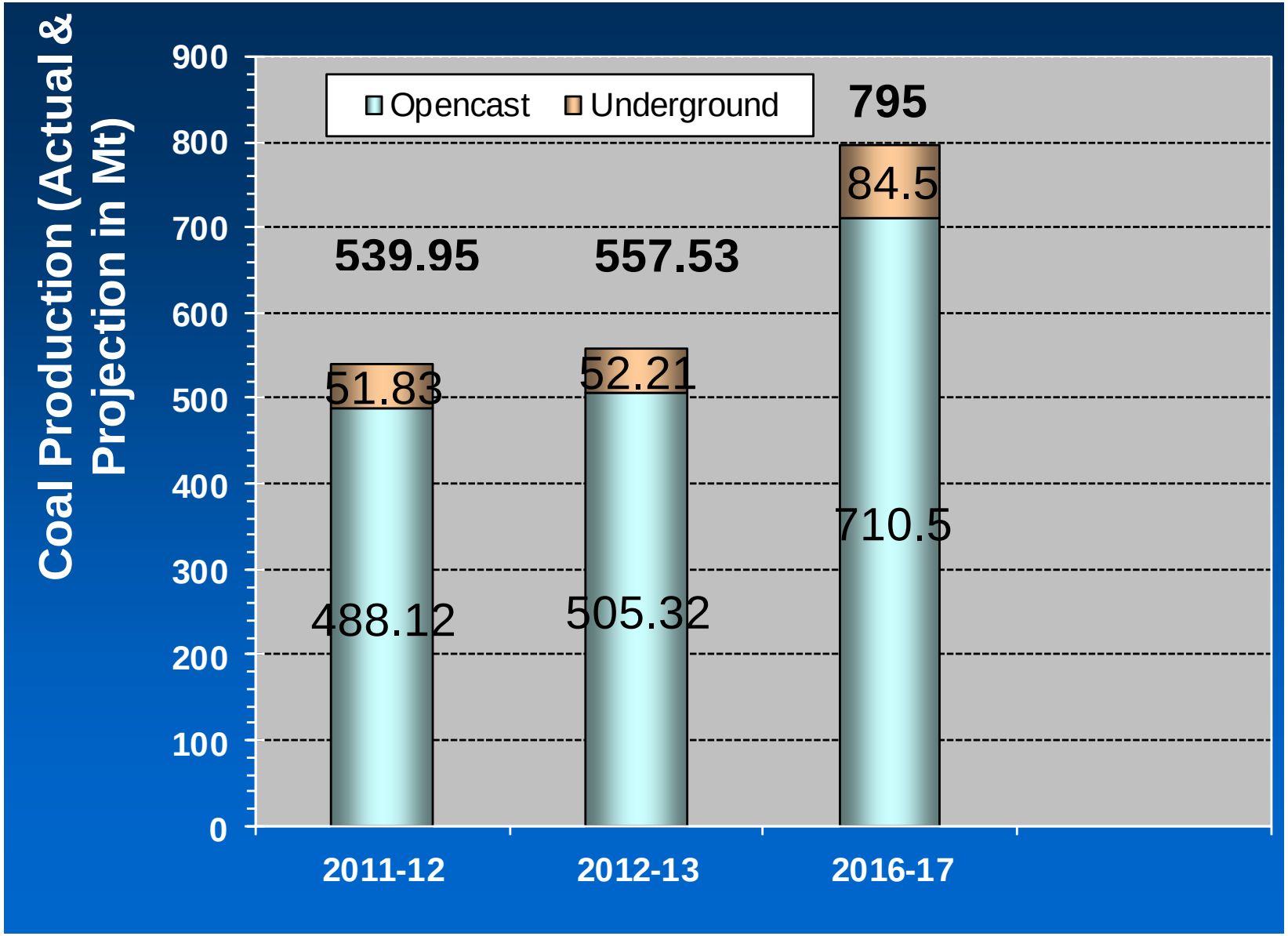
SCCL

CIL

Demand vs Availability during XI, XII & XIII Plan



Technology-wise Coal Production (Actual & Projection)



Environmental Issues & mitigation measures adopted by CIL

Environmental & Social Concerns

Major coal production from opencast mines
MoEF stresses upon UG mining but productivity lesser

Large part of future OC projects under forest areas in Jharkhand, Orissa and Chattisgarh

ENVIRONMENTAL CONCERN

Degradation of land including forest land,
Conservation of flora-fauna, and
Air pollution, primarily with dust

SOCIAL CONCERN

Problems arising out of displacement of inhabitants including tribals

Strategies to enhance sustainability in Coal Mining

Strategies to enhance Sustainability

- Integrated planning of coal mines taking into account the environmental concerns arising out of mines, Environmental Impact Assessment and management planning
- Implementation of pollution mitigation measures (Air, Water Noise, Subsidence & land, OB dump Management) including monitoring of environmental attributes
- Mine Closure Planning for post-mining land-use acceptable to the community & to generate sustainable revenues as social asset
- Compensatory afforestation as per the prevailing laws
- Voluntary afforestation as an advance action prior to starting the project, in the wasteland, to develop green area against the forest land to be acquired with an aim to earn green credit
- Finalization of amicable rehabilitation & resettlement package involving state governments and stakeholders.
- Emphasis on clean coal technology including washery
- Emphasis on adoption of renewable energy resources in command area

Chapters on "Environment" and "Mine Closure" form part of Project Reports

EIA & EMPs are prepared for all projects and EC obtained

Effective Environmental monitoring

Emphasis given on conservation of forest, soil, water & flora-fauna and minimum displacement of population

'Mine Closure' addresses technical, environmental & social issues to restore mined-out area in a safe & acceptable state which is beneficial to local community

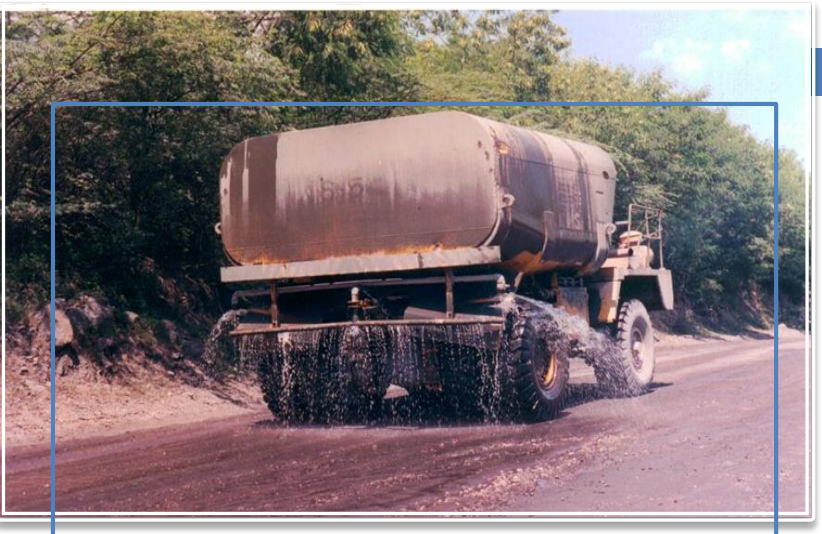
CIL Efforts towards sustainability

Attractive R&R package with due emphasis on community development and sustainable livelihood for the project affected people (PAPs)

Emphasis on Coal Washing

Emphasis on reclamation of degraded land

Air Pollution Control Measures



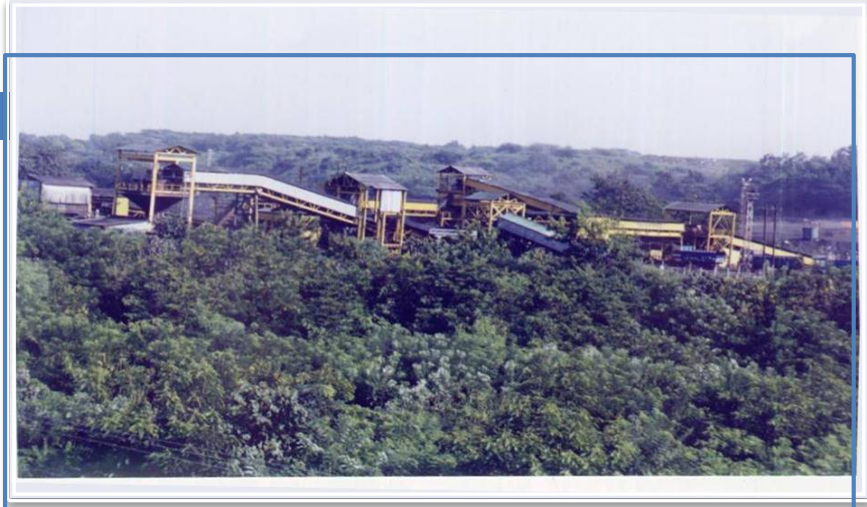
Water spraying on haul-roads

Water spraying at Railway Siding.

Water spraying in coal crushing units

Air Pollution Control Measures.. Contd.

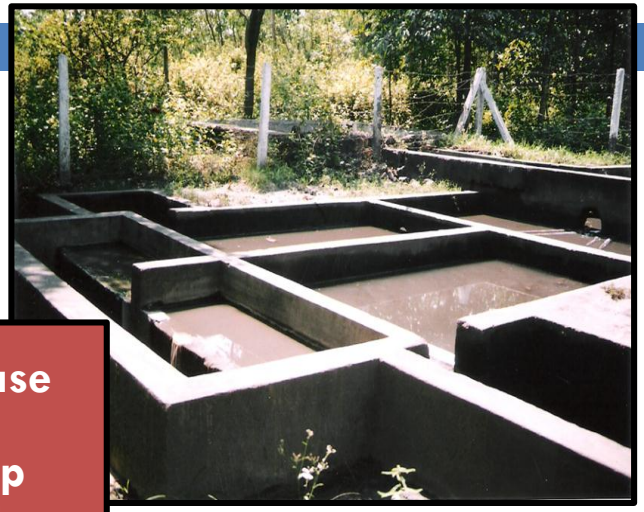
Fully covered Coal Handling Plants and Cross country conveyor



Sufficiently wide Green Belts developed around dust generating sources

Water spraying in bunkers

Water Pollution Control Measures



Oil & grease trap for Workshop effluent treatment

ETP for treating mine and workshop effluent

ETP for treating mine and workshop effluent

Water Pollution Control Measures

Ground water conservation and management including rain water harvesting for augmentation of ground water resource

Impact of mining on ground water regimes :

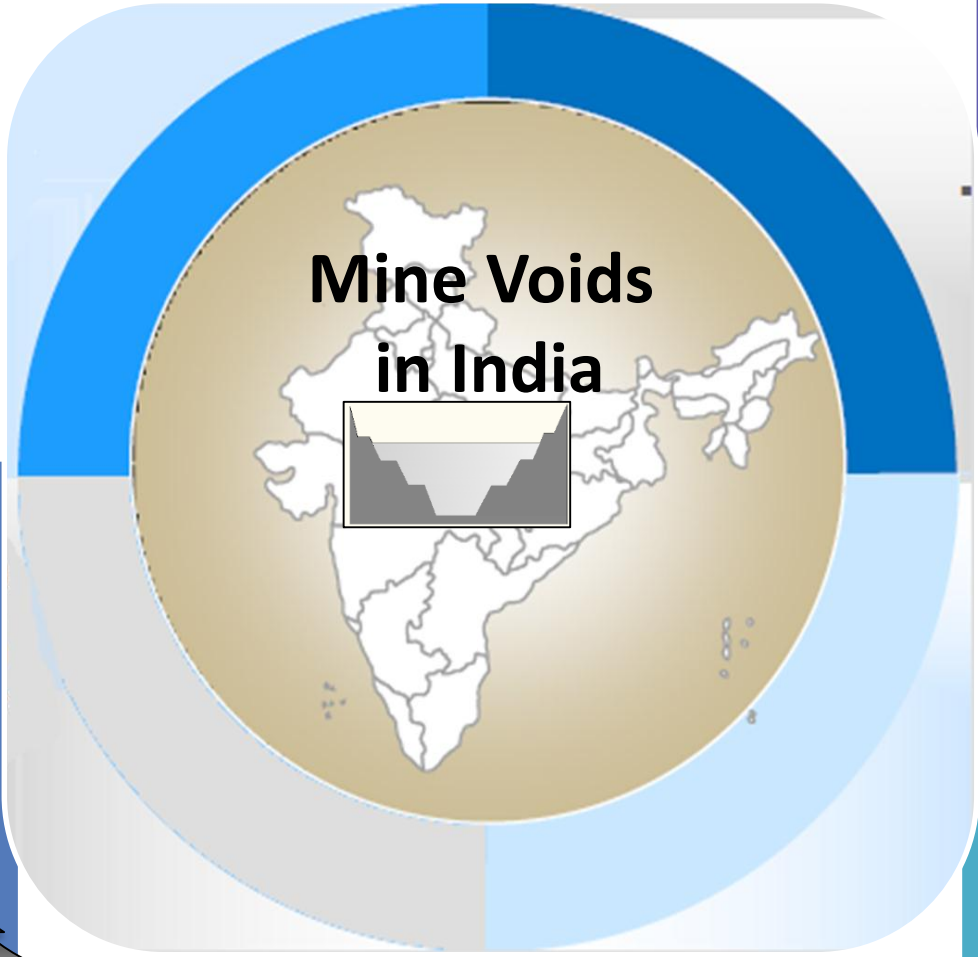
- Ground water generally does not deplete in areas beyond 300 to 400m from the top edge of quarries.
- Water bodies created in the opencast and underground mines act as sources of water for the people residing in and around coalfields other than the company employees also.

Mine Water Utilization in CIL

Subsidiary of CIL	Average Mine Discharge (cum/day)	Demand			Mine water supply	Balance Mine Discharge (cum/day)	Mine water Utilization on total demand
		Domestic	Industrial	Total			
Eastern Coalfields Ltd.	146045	71721	44180	115901	100458	45587	87.00%
Bharat Coking Coal Ltd	106050	82552	18746	101298	78425	27625	77.00%
Central Coalfields Ltd.	121140	41105	49371	90476	81511	39629	90.00%
Western Coalfields Ltd.	292030	67200	30509	97709	69403	222627	71.03%
South Eastern Coalfields Ltd.	411866	85226	54283	139549	97927	313939	70.17%
Northern Coalfields Ltd.	64800	15956	35576	51532	26797	38003	52.00%
Mahanadi Coalfields Ltd.	101185	16632	24641	41273	24721	76464	60.00%
Overall	**1243116**	**380392**	**257306**	**637738**	**479242**	**763874**	**75.14%**

Mine Void as Water Reservoir: Coping with the problem of Water Scarcity

The mine voids created on account of coal mining provides an excellent opportunity for storage of fresh water

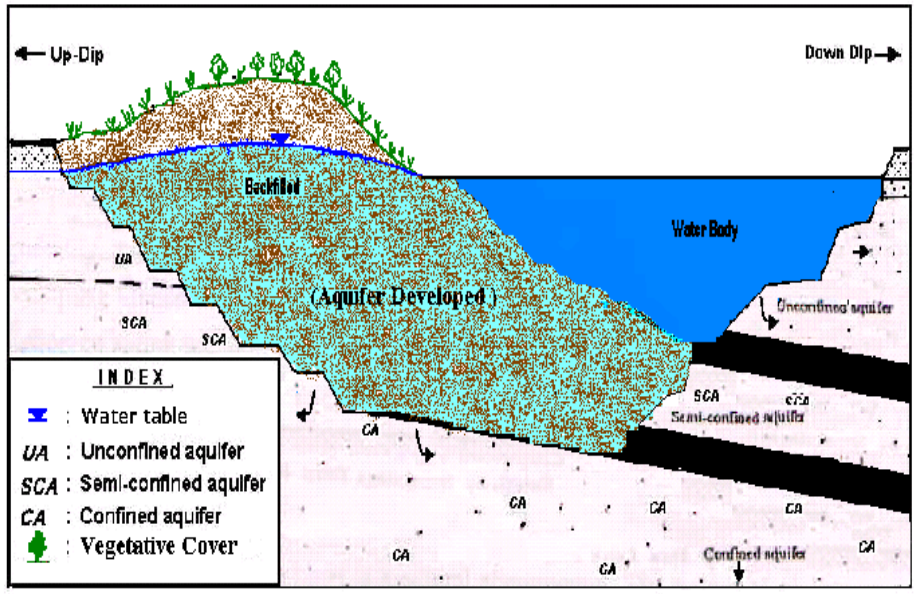


India, in general, has no acid mine drainage (AMD) problem in its coal mines

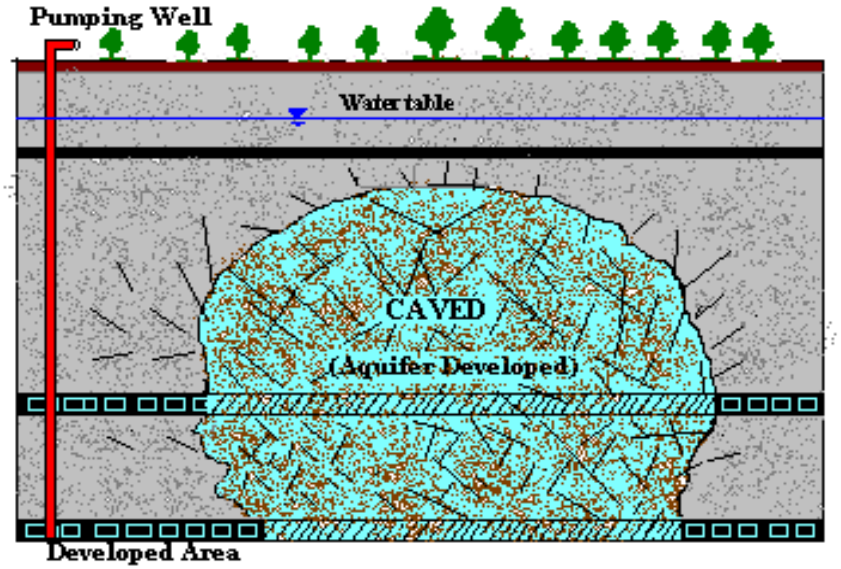
This situation makes the mine voids favourable for storage of fresh water

These reservoir can supplement the effort of Government of India for water conservation

Mine Void as Water Reservoir



Schematic Diagram showing Aquifer Development in an Opencast Mine Working



Schematic Diagram Showing Aquifer Development in Caved Underground Workings

Presently, 75% of water demand of the coal mining project is being met from water stored in the mine pits.

In future, CIL is likely to create about 3.3 billion m^3 of water resource, on an average, in its opencast mines alone and can contribute significantly towards water security of the country

Mine Water Storage Sumps in CIL

View of Nigahi Mine Water Sump, NCL

Potential for Water Conservation in some mega projects of CIL

Relative depth is between 4-15%, and therefore can be considered halomictic

Sl. No.	Mine	Void area, Ha	Mine Void Depth, m	Relative Depth, %	Volume of water stored, million m^3
1	Gevra OC	659.25	290	10.01	1035
2	Dipka OC	570.00	128	4.75	425
3	Kusmunda OC	199.32	235	14.75	300
4	Manikpur OC	188.00	60	3.87	85
5	Kartali OC	233.61	242	14.03	273
Total volume of water storage potential (in million m^3)					**2118**

Additionally, this can also be used to promote tourism, aquaculture, scientific study and socio-economic development of the area.

These mine voids can also be filled by diverting the flood water from the adjacent rivers/nallas *i.e.* Lilagar nadi and Hasdeo river

Post mining, these pit lakes will be available with sweet and fresh water at no additional expenditure

It is estimated that these pit lakes once developed can provide irrigation to 1,238,600 hectares command area or support 43,000 MW power generation

Noise Pollution Control Measures

Green-belt around fixed noise generating sources

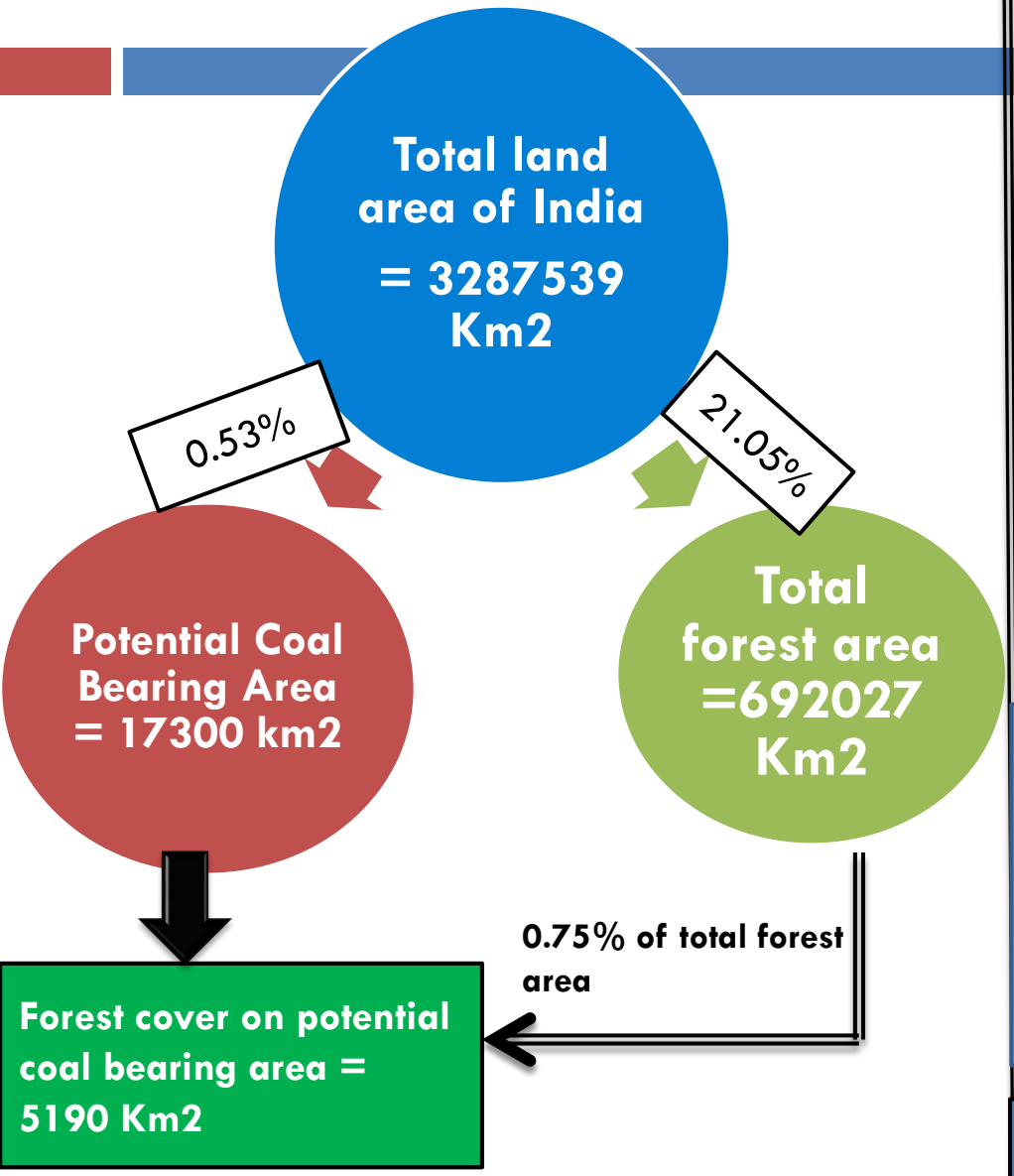
Avenue plantation along roads

Proper and regular maintenance of HEMM

Providing protective devices like earmuffs and earplugs to machine operators

Land Management in CIL

Details of forest and Potential coal bearing land



Details of land acquired by CIL

National Parks and Sanctuaries are not touched even if they have coal

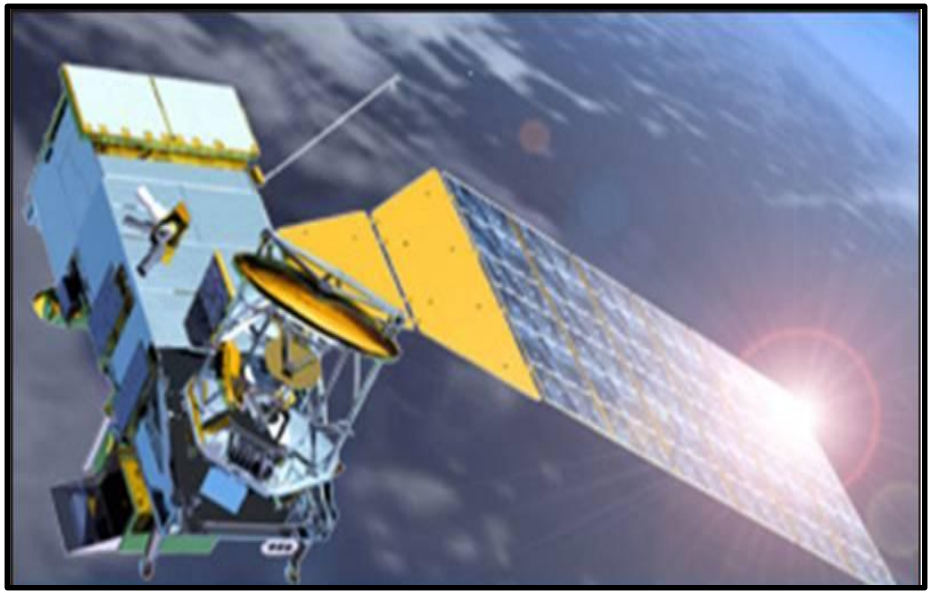
Land Management in CIL

Total forest land acquired	**12534.853 Ha**
Area biologically reclaimed & afforested so far	**27962.505 Ha (123% more)**
Green cover created for every hectare of forest land	**2.23 Ha**
Area yet to be biologically reclaimed	**14998.87 Ha**
Total afforested area	**42961.98 Ha (243% more)**
Green cover that will be created for every hectare of forest land	**3.43 Ha**
Plantation done so far(Upto March,2013)	**More than 78 million plants(in 33700 Ha)**

- Subsidence and its management specially in forest area is monitored through remote sensing technique
- CIL is paying Net Present Value (NPV) against acquisition of Forest Land (already paid over INR 12.00 billions) and compensatory afforestation as per statues to create new forest areas.

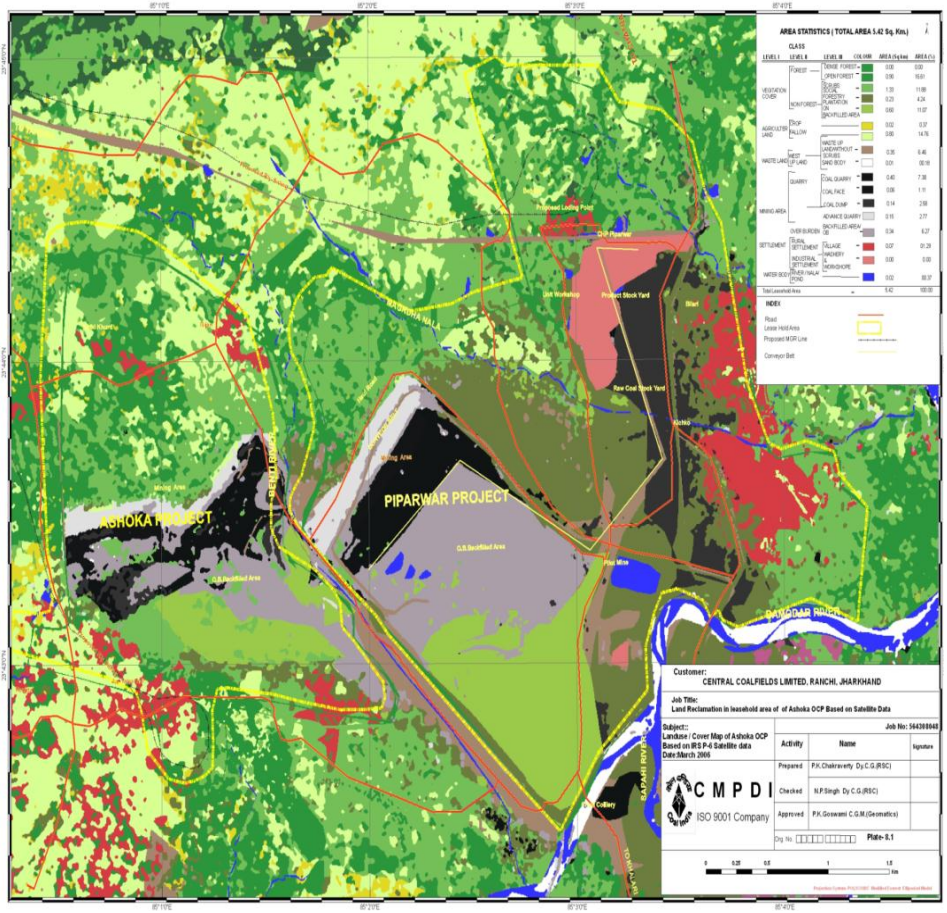
LAND RECLAMATION MONITORING IN CIL

High Resolution, temporal satellite data used for land reclamation monitoring of all the opencast mines of CIL

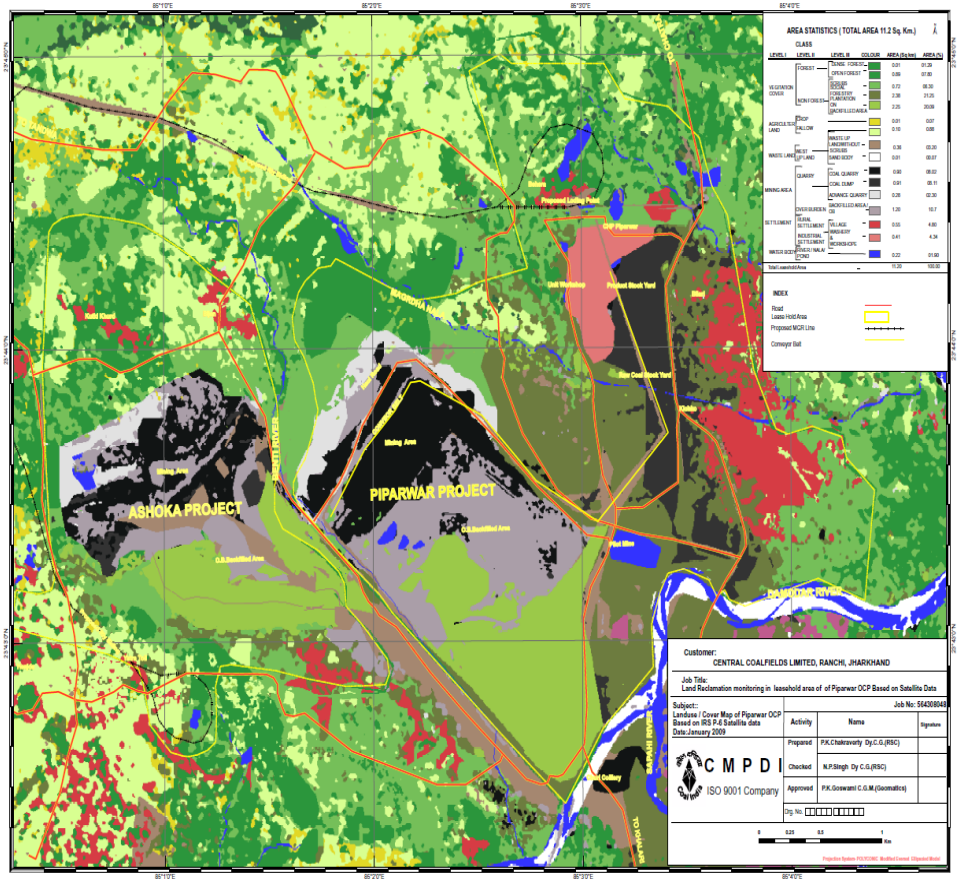


50 OC Projects	Producing > 5m.cu.m.(Coal+OB)	Monitored on annual basis
113 OC Projects	Producing <5m.cu.m.(Coal+OB)	Monitored at an interval of 3 years

Land Reclamation Monitoring in Piparwar & Ashoka Mining Area, CCL



Year2009

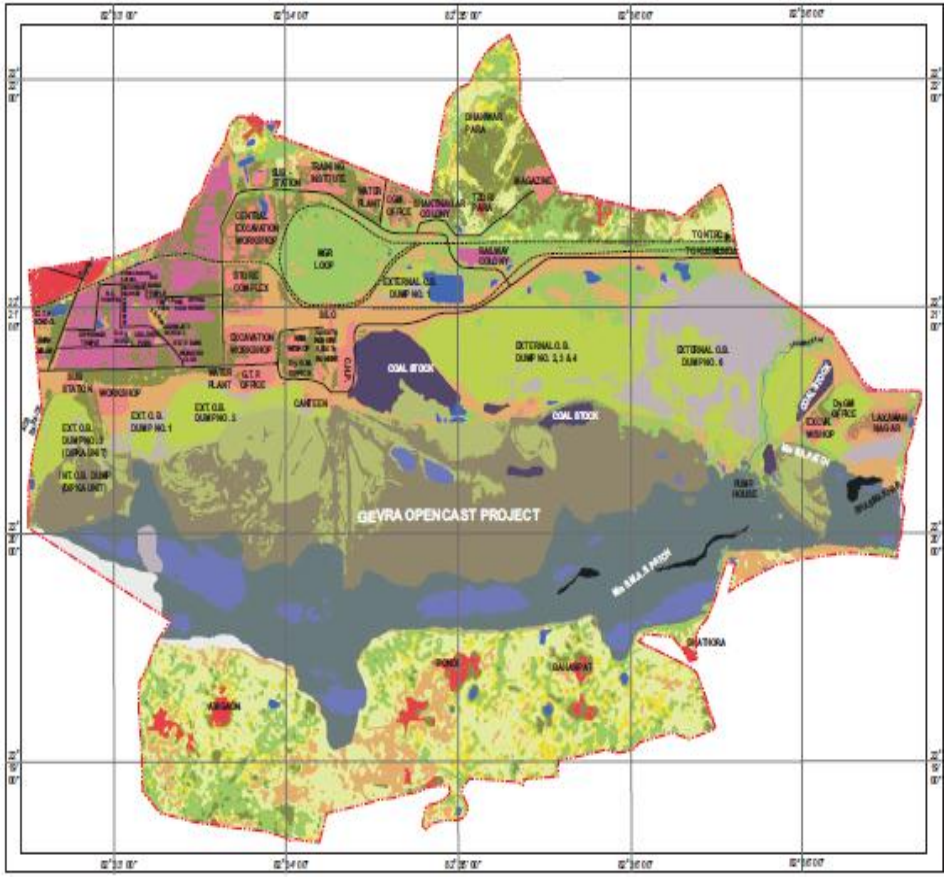


Year2011

Land Reclamation Monitoring in Gevra OC, SECL

Year-2010

Year-2011

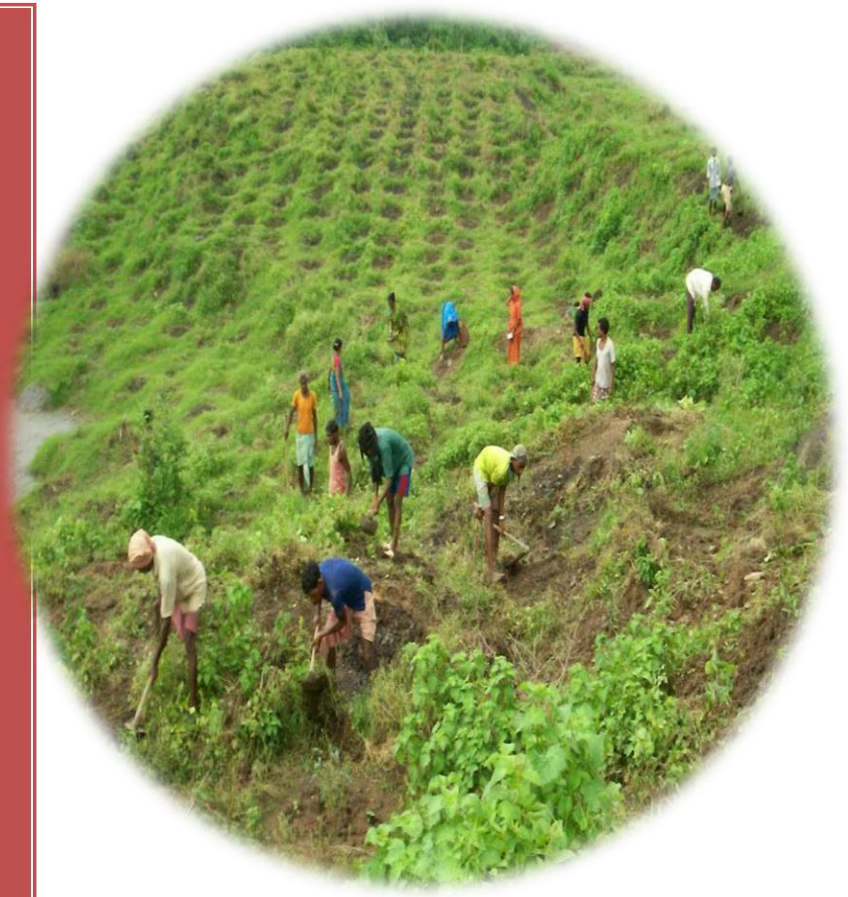


Plantation carried out by CIL during last 3 years

Subsidiary	Plantation carried out (nos.) during		
	2010-11	2011-12	2012-13
ECL	62500	195000	51000
BCCL	13215	343000	46916
CCL	100000	405800	302000
MCL	98550	75600	31000
WCL	302000	226000	160000
SECL	417600	386000	483000
NCL	482000	441000	452247
NEC (CIL)	100500	-	60000
TOTAL	**1,576,365**	**2,072,400**	**1,586,163**

Land and OB Dump Management

- Scarce top soil is conserved as a separate top soil dump and is used subsequently by biological reclamation for plantation purpose.
- Care is taken to minimise external dumping.
- OB dumps and backfilled mined-out areas are biologically reclaimed progressively with native plant species for dump stability and green cover.
- Last mine cut is developed as water reservoir for ground water recharge and as a source of water for the consumption of nearby population.
- Satellite Imagery technique is applied for pre-mining & during mining stages for ascertaining land-use status and the progress of reclamation process

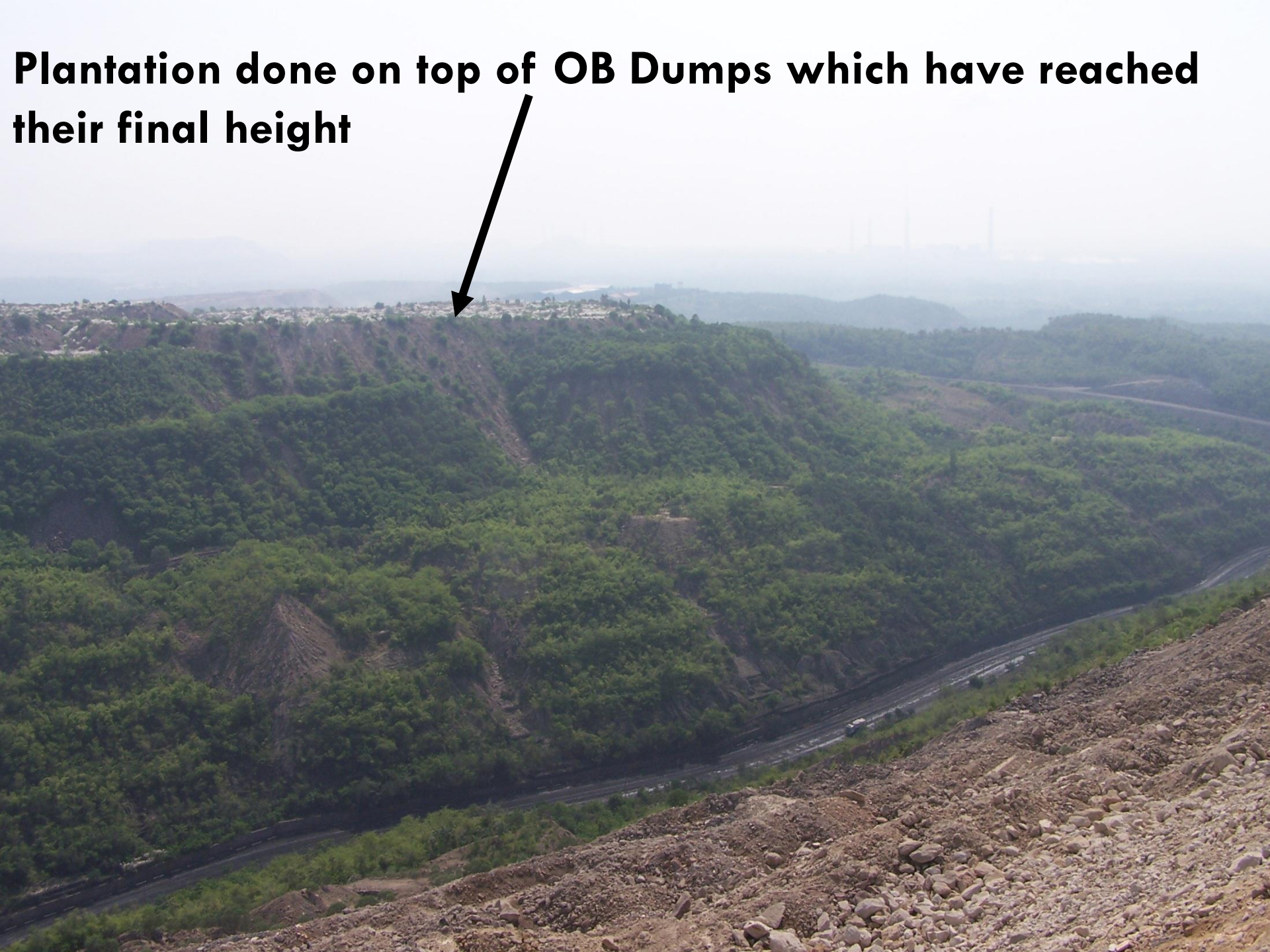


Progress of Reclamation along OB Dump Slope

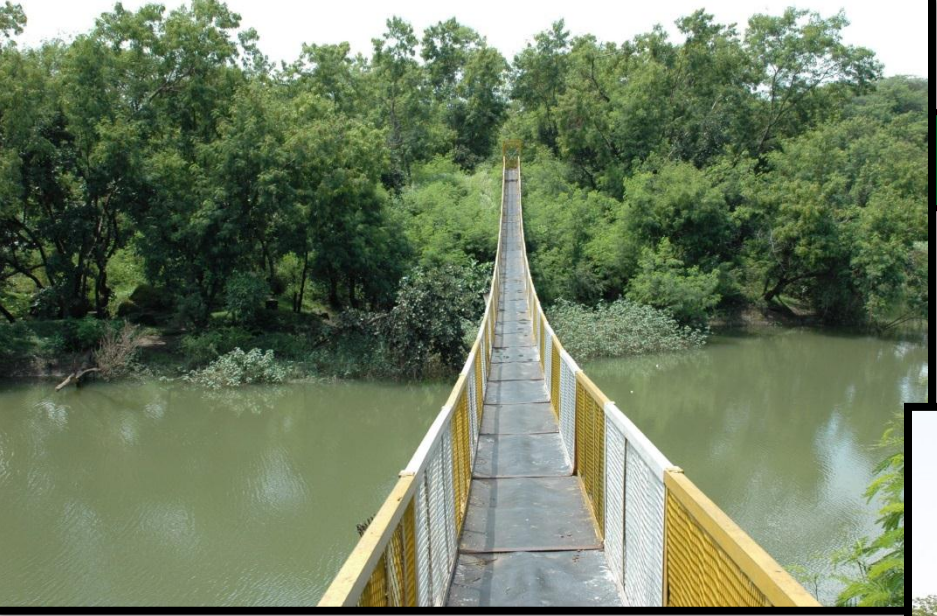
Biological Reclamation in steps/stages

Dumps which have reached their final height are laid with top soil

Graded and levelled dumps


Plantation done on top of OB Dumps which have reached their final height

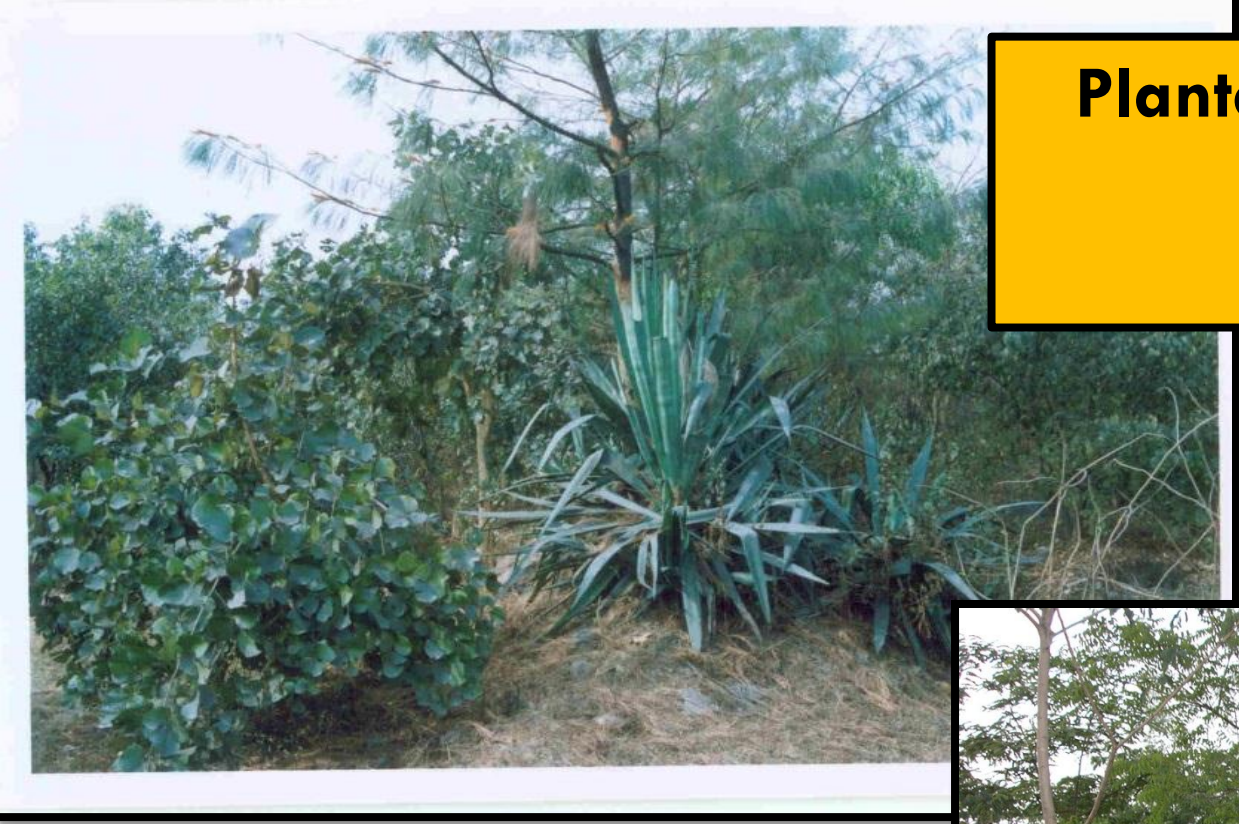
OB Dump Showing Technical and Biological Reclamation at CIL



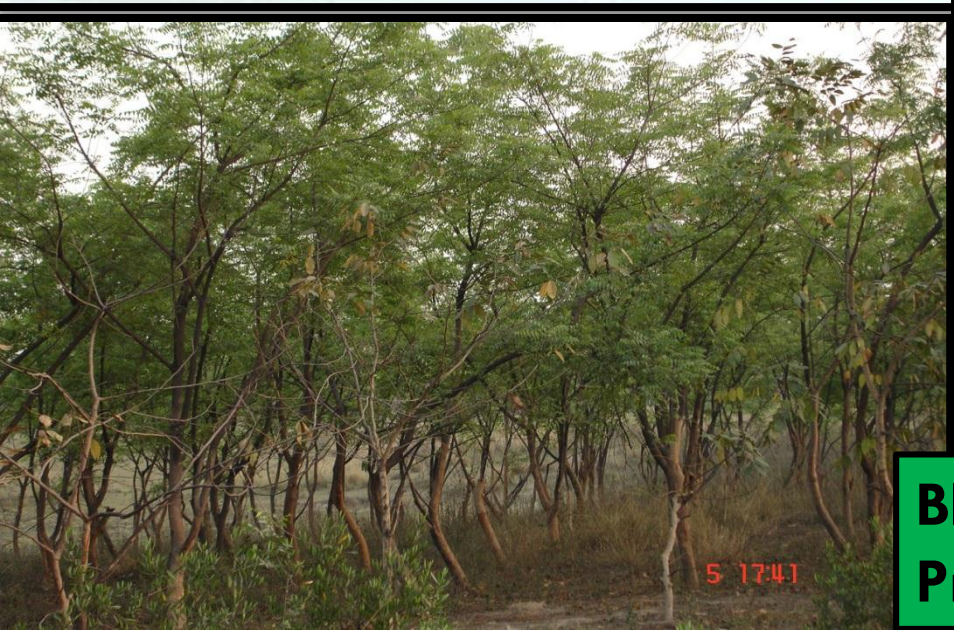
Restoration of Bio-Diversity

Plantation on Backfilled Area

Medicinal Garden on Backfilled Area



Plantation of Agaves on dump slopes



Block Plantation in an Opencast Project

Plantation over Dump

Plantation over External Overburden Dump

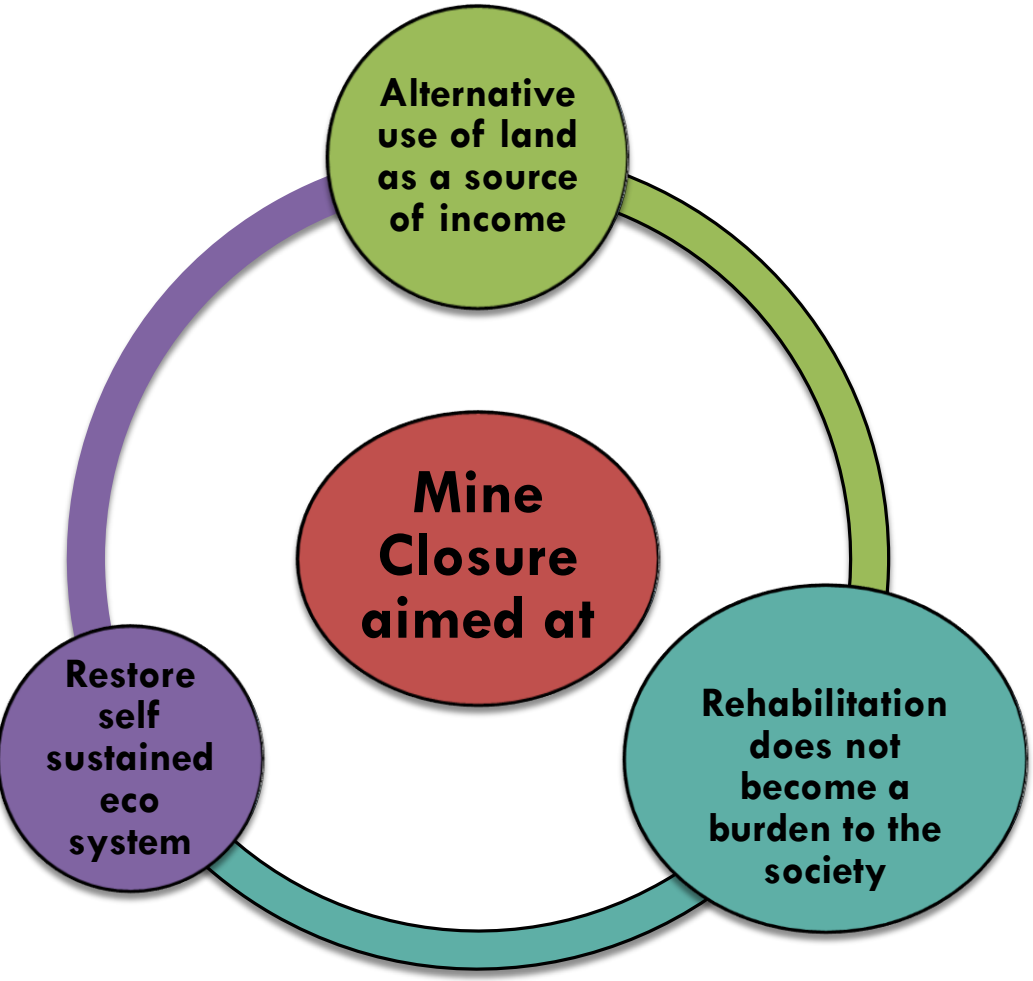
Lush Green External Overburden Dump

Roadside Gabion for Toe Protection of Overburden Dump

A View of Forest Developed

Fruiting in the Planted Saplings of Exotic Species

Mine Closure Planning and Cost



Mine Type	Mine Size (km^2)	Mine Closure Cost (Million Rs)
Opencast Mining	10	600.00
	20	1200.00
	30	1800.00
Underground Mining	10	100.00
	20	200.00
	30	300.00

Post Mine Closure Planning

Open Void

Avoided due to safety risks associated with them.

Waste Dumping

Concurrent dumping of the waste material in the mine voids is planned including biological reclamation depending upon the end use of the land during post-mining period

Water Storage

Water storage in the mines is considered best practice approach in Indian context in view of :

a. The water stress situation being faced by the local community,
b. Growing industrial and domestic requirement,
c. Shrinking fresh water resources and
d. The thrust given by regulatory agencies.

- **The last cut at the end of mine life is developed into a water reservoir for storage of mine water.**
- **Considered as infrastructure for storage of mine water.**
- **Thus, additional water resources get created and a clean potential source of potable water is developed**
- **This is need of the present day situation due to substantial increase in water requirement and decreasing water resources.**

Coal Beneficiation

Construction of New Coal Washeries in CIL

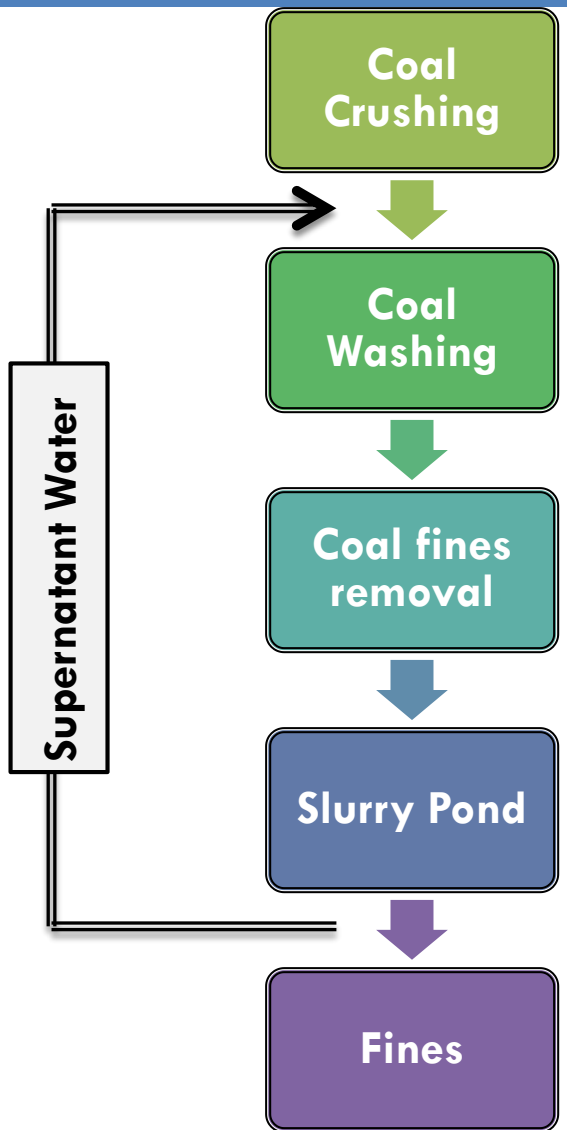
Number of Coking Coal (NLW) Washeries	6
Total Capacities of Coking Coal (NLW) Washeries	18.6 MTY
Number of Non Coking Coal Washeries	10
Total Capacities of Non Coking Coal Washeries	73.5 MTY
Total number of Washeries	**16**
Total Capacities of Washeries	**92.1 MTY**

Benefits of using Washed Coal having 34% ash instead of Unwashed Coal having 41% ash

Particulars	Benefits
1. Transport	
▪ Reduction in transport cost	saving of 15% for 1000 Km distance
▪ Reduction in CO_2 emissions due to reduced fuel consumption	15% reduction in CO_2 emission
2. Power Plant Site	
▪ Decrease in auxiliary power	10% decrease for every 10% reduction in feed coal ash
▪ Improvement in thermal efficiency	1.50% improvement for every 10% reduction in feed coal ash
▪ Improvement in plant load factor	10% improvement for every 10% reduction in feed coal ash
▪ Reduction in operating and maintenance costs	20% cost reduction for every 10% reduction in feed ash coal
▪ Reduction in capital investment for new power plants	5% reduction in capital investment
▪ Reduced water requirement for ash disposal	Reduction of water consumption by approx. 30%
▪ Reduction in CO_2 emission	Reduction in the range of 2-3% when using washed coal
▪ Improvement in ESP efficiency	Improvement in ESP efficiency from 98% to 99%

Washeries on Zero Discharge Concept

Washeries are designed on zero discharge concept having closed water circuit system



Advantages

- Reduces adverse impact on the environment
- Helps in conservation of water
- Enhances project profitability

Fly Ash Utilization in Coal Mining Sector

Potential Utilization in Mining Sector

Backfilling/ Stabilization of OB dumps:

Fly Ash increases water holding capacity, provides micro nutrients enhancing afforestation, being finer material fills the inner spaces of OB and stabilizes the same due to its binding property

Stowing of underground mines with fly ash (in lieu of sand) :

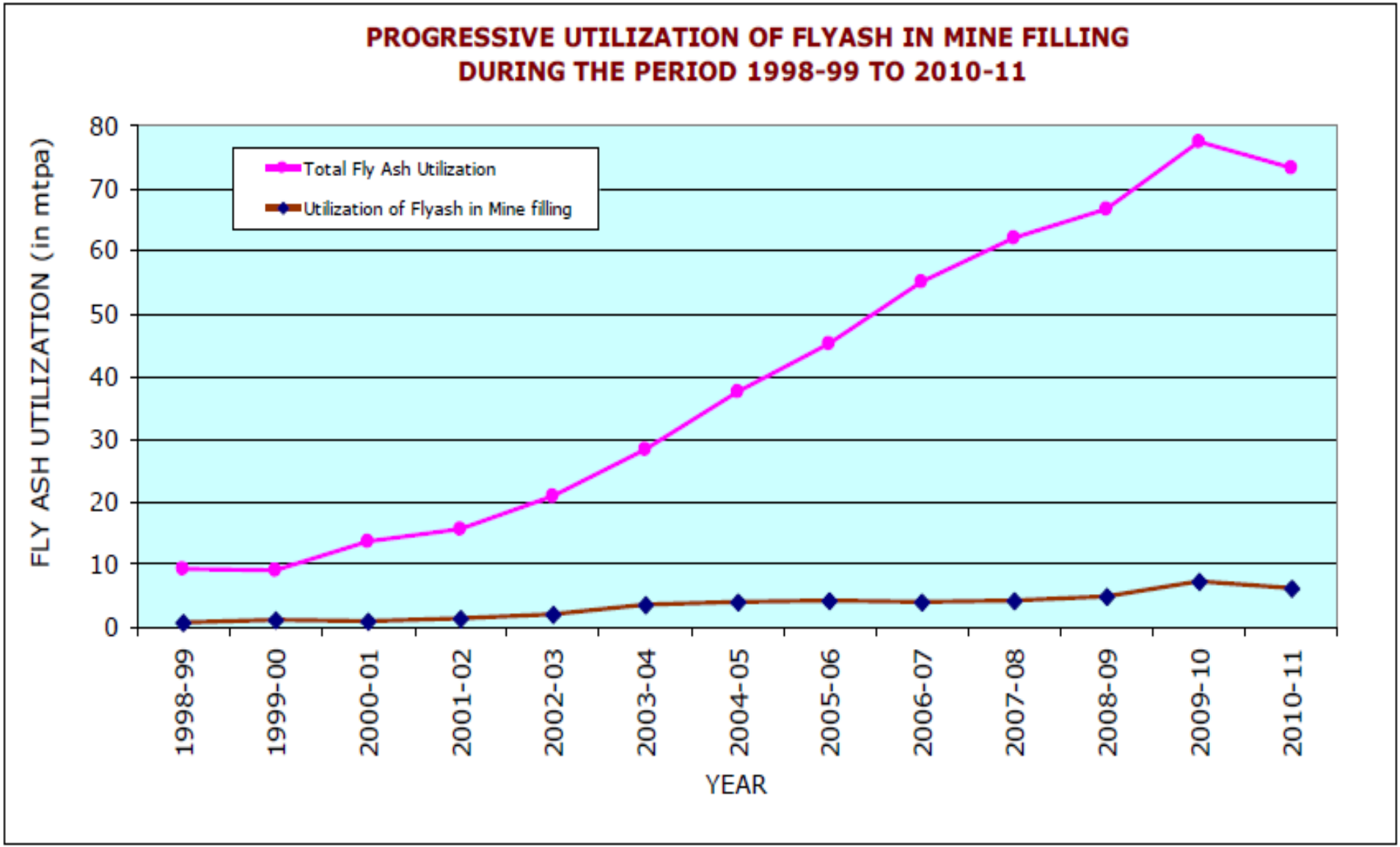
Stowing with fly ash reduces water requirement by about 50 per cent and also power requirement for recirculation of water by 50 per cent Fly ash fills well up to the roof of the cavity as it is easily flowable and does not form cone like heep that happens in case of sand stowing

Construction of Haul roads:

Use of Fly Ash improves the life considerably, reduces maintenance cost, improves output and reduces consumption of tyres of dumpers as well as the down time for maintenance.

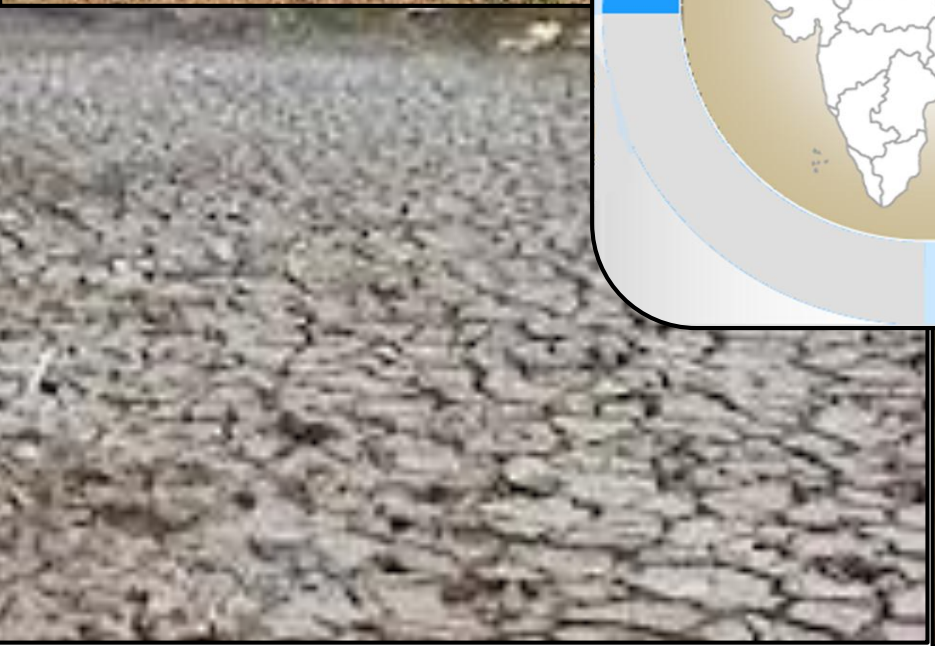
Use of Fly Ash in Ventilation stopping, fire stopping, dosing of mine fire

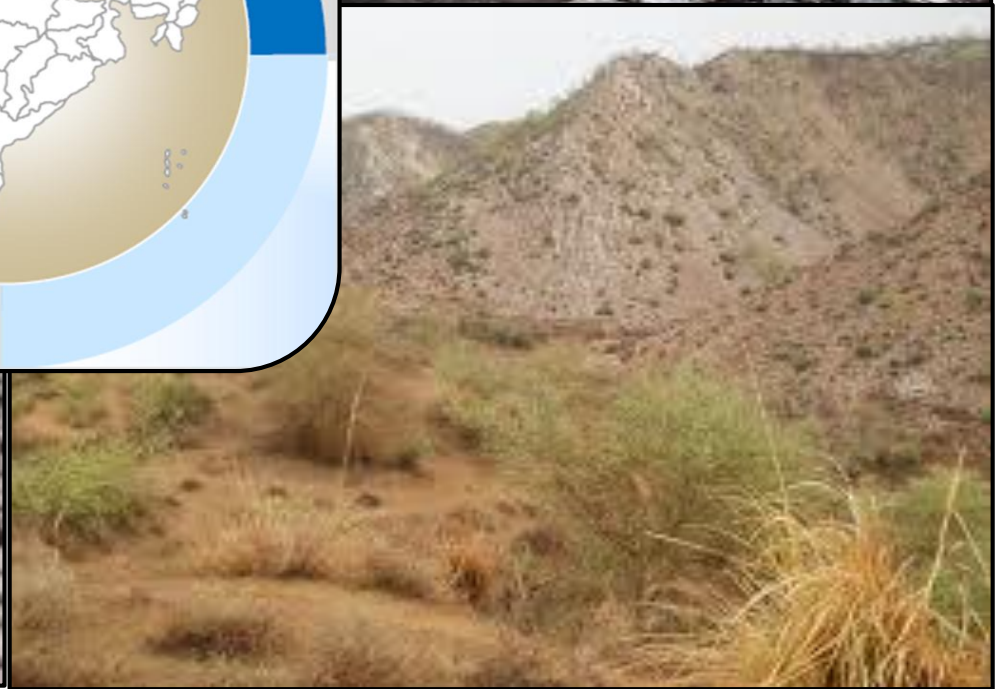
Progressive utilization of fly ash in Mine Filling during the period 1998-99 to 2010-11



Wasteland in India

(Source: Wastelands Atlas Of India, NRSC,2011)

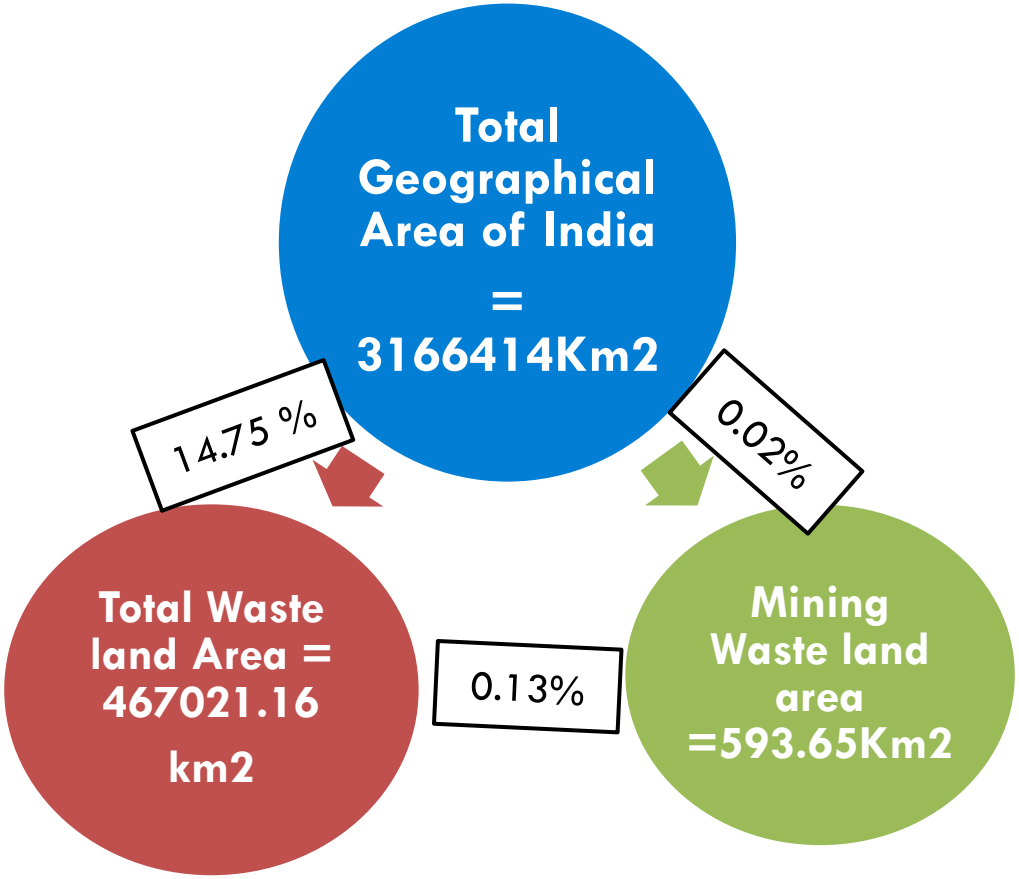




State wise total area under Wasteland (Sq.km.) during 2008-09

Sl.No.	State	Total Geographical Area	Total Waste Land 2008-09	Total Mining Wasteland
1	Andhra Pradesh	275068	37296.62	15.52
2	Arunachal Pradesh	83743	14895.24	0.00
3	Assam	78438	8453.86	2.13
4	Bihar	94171	9601.01	3.78
5	**Chattisgarh**	**135194**	**11482.18**	5.97
6	Delhi	1483	90.21	0.04
7	Goa	3702	489.08	22.86
8	Gujarat	196024	20108.06	14.13
9	Haryana	44212	2145.98	33.18
10	Himachal Pradesh	55673	22347.88	7.98
11	Jammu and Kashmir	101387	75435.77	3.70
12	**Jharkhand**	**79706**	**11017.38**	27.37
13	Karnataka	191791	13030.62	27.62
14	Kerala	38863	2445.62	12.91
15	Madhya Pradesh	308252	40113.27	98.68
16	**Maharashtra**	**307690**	**37830.82**	40.62
17	Manipur	22327	5648.53	0.00
18	Meghalaya	22429	4127.43	0.04
19	Mizoram	21081	4958.64	0.00
20	Nagaland	16579	5266.72	0.00
21	**Odisha**	**155707**	**16425.76**	7.96
22	Punjab	50362	936.83	0.00
23	Rajasthan	342239	84929.10	116.18
24	Sikkim	7096	3273.15	0.00
25	Tamil Nadu	130058	8721.79	94.97
26	Tripura	10486	964.64	0.00
27	Uttarakhand	53483	12859.53	1.60
28	**Uttar Pradesh**	**240928**	**9881.24**	26.75
29	**West Bengal**	**88752**	**1929.20**	29.66
30	Union territories	9490	315.00	0.00
	Total	**3166414**	**467021.16**	**593.65**

Details of Mining Waste Land

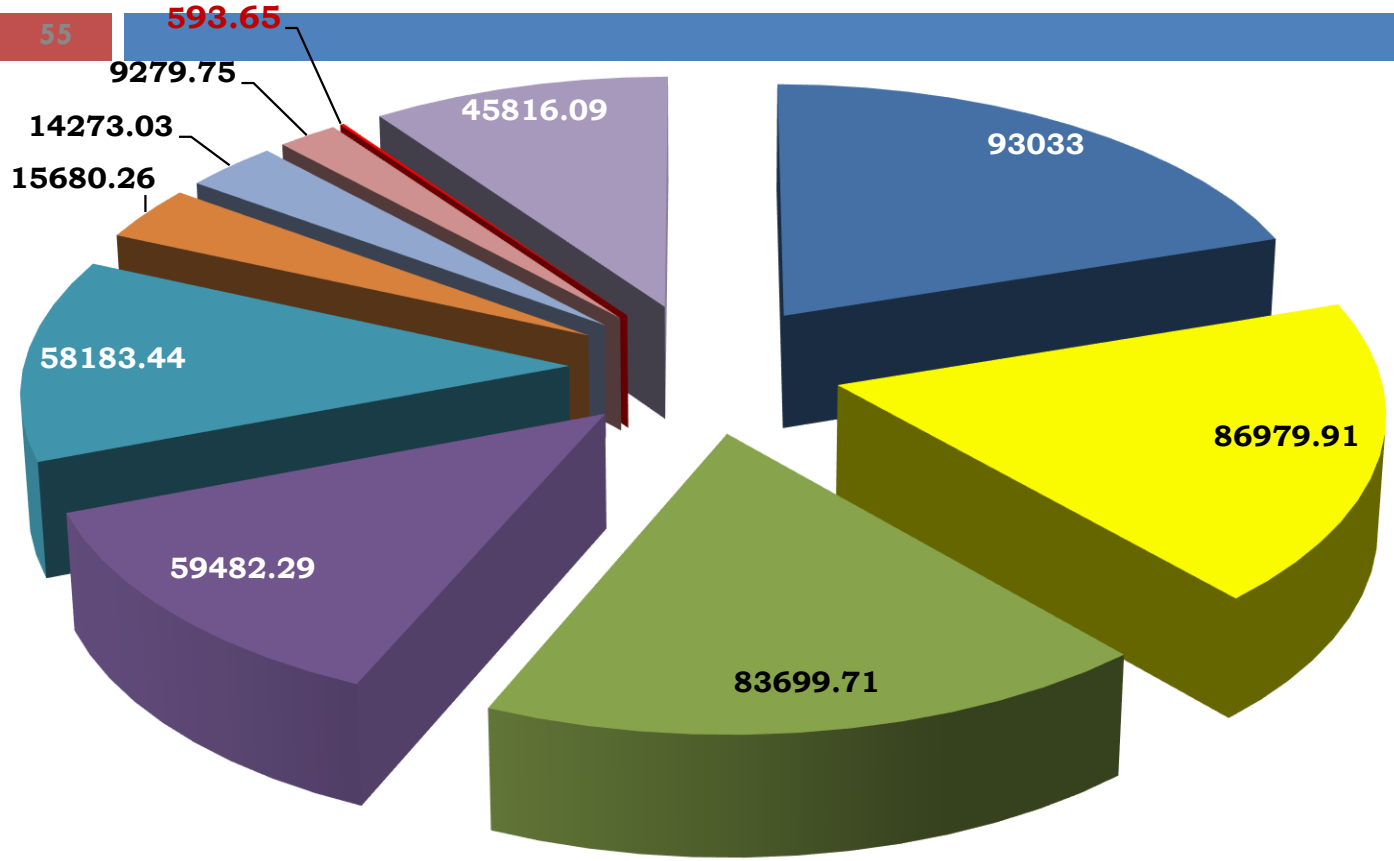


Category wise total area under wastelands (sq.km.) during 2008-09

S.no.	Category	Total Wasteland 2008-09
1	Gullied and/or ravenous land-Medium	6145.96
2	Gullied and/or ravenous land-Deep/very deep ravine	1266.06
3	Land with dense scrub	86979.91
4	Land with open scrub	93033.00
5	Waterlogged and Marshy land-Permanent	1757.07
6	Waterlogged and Marshy land-Seasonal	6946.31
7	Land affected by salinity/alkalinity-Moderate	5414.53
8	Land affected by salinity/alkalinity-Strong	1391.09
9	Shifting cultivation area-Current Jhum	4814.68
10	Shifting cultivation area-Abandoned Jhum	4210.46
11	Under-utilized/degraded forest-Scrub dominated	83699.71
12	Agricultural land inside notified forest land	15680.26
13	Degraded pastures/grazing land	6832.17
14	Degraded land under plantation crops	278.53
15	Sands-Riverine	2111.96
16	Sands-Coastal sand	654.47
17	Sands- Desert Sand	3934.80
18	Sands- Semi-stabilized to stabilized (>40m) dune	9279.75
19	Sands-Semi-stabilized to stabilized moderately high (15-40 m) dune	14273.03
20	Mining Wastelands	**593.65**
21	Industrial wastelands	58.00
22	Barren rocky area	59482.29
23	Snow cover and/or glacial area	58183.44
	Total	**467021.16**

Only 0.13% of total wasteland

Category wise total area under wastelands (sq.km.) during 2008-09



- Land with open scrub
- Land with dense scrub
- Under-utilized/degraded forest-Scrub dominated
- Barren rocky area
- Snow cover and/or glacial area
- Agricultural land inside notified forest land
- Sands-Semi-stabilized to stabilized moderately high (15-40 m) dune
- Sands- Semi-stabilized to stabilized (>40m) dune
- Mining Wastelands
- Others

State wise distribution of Mining Wasteland

State	Wasteland Area (Sq Km)
Andhra Pradesh	15.52
Arunachal Pradesh	0.00
Assam	2.13
Bihar	3.78
Chattisgarh	**5.97**
Delhi	0.04
Goa	22.86
Gujarat	14.13
Haryana	33.18
Himachal Pradesh	7.98
Jammu and Kashmir	3.70
Jharkhand	**27.37**
Karnataka	27.62
Kerala	12.91
Madhya Pradesh	98.68
Maharashtra	**40.62**
Manipur	0.00
Meghalaya	0.04
Mizoram	0.00
Nagaland	0.00
Odisha	**7.96**
Punjab	0.00
Rajasthan	116.18
Sikkim	0.00
Tamil Nadu	94.97
Tripura	0.00
Uttarakhand	1.60
Uttar Pradesh	**26.75**
West Bengal	**29.66**
Union territories	0.00
Total	**593.65**

1% of total mining wasteland

4.61% of total mining wasteland

6.84% of total mining wasteland

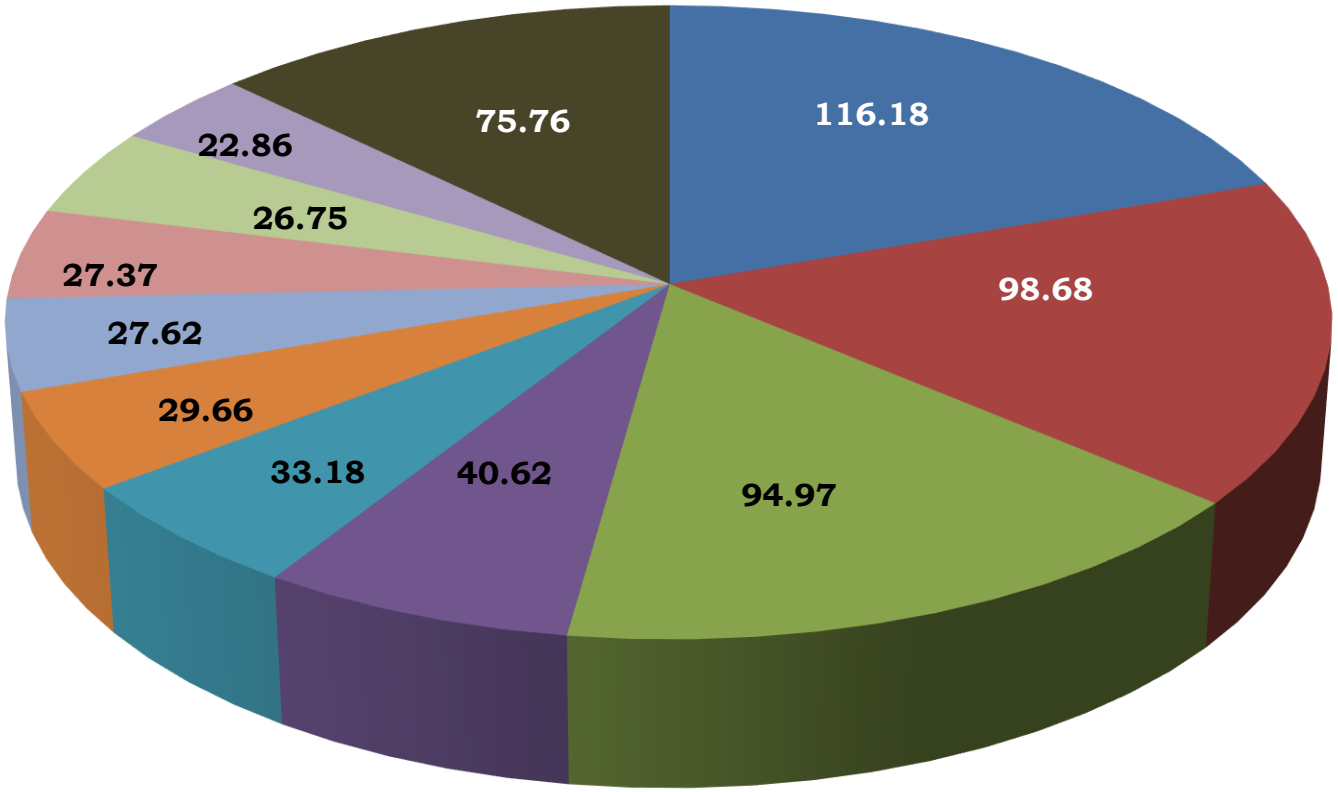
1.34% of total mining wasteland

4.5%

4.99%

Of total mining wasteland

State wise distribution of Mining Wasteland



- Rajasthan
- Madhya Pradesh
- Tamil Nadu
- Maharashtra
- Haryana
- West Bengal
- Karnataka
- Jharkhand
- Uttar Pradesh
- Goa
- Others (12 States)

Gainful utilization of mining waste land

Converting mining wasteland (593.65 sq km) into eco-parks using fly ash – DADRI Experience

593.65 sq.km of the mining waste land can accommodate about 20730 Mm3 of fly ash (based on data provided by DADRI, NTPC)

Resettlement & Rehabilitation

- Explore alternative sites and project designs to avoid / minimize disturbance to local population to the extent possible.
- Development of RAP in consultation with PAPs and NGOs
- Safeguard that PAPs improve their former standard of living and earning capacity.
- RAP should be conceived and executed as a development programme and complementary to government schemes in rural development.
- Intensification of corporate social responsibility (CSR) activities in and around the mining areas.

CSR Expenditure Incurred by CIL

Company	CSR Expenditure (Rupees in Lakhs)		
	2010-11	2011-12	2012-13
ECL	475.00	1314.00	624.00
BCCL	315.00	553.00	795.00
CCL	1098.00	1100.00	121.50
WCL	712.00	786.00	202.10
SECL	1570.00	1766.00	466.30
MCL	5345.00	1477.00	255.60
NCL	435.00	925.00	176.40
CMPDI	19.00	49.00	106.00
CIL (HQ)	871.00	259.00	817.00
Total	**10840.00**	**8199.00**	**14561.00**

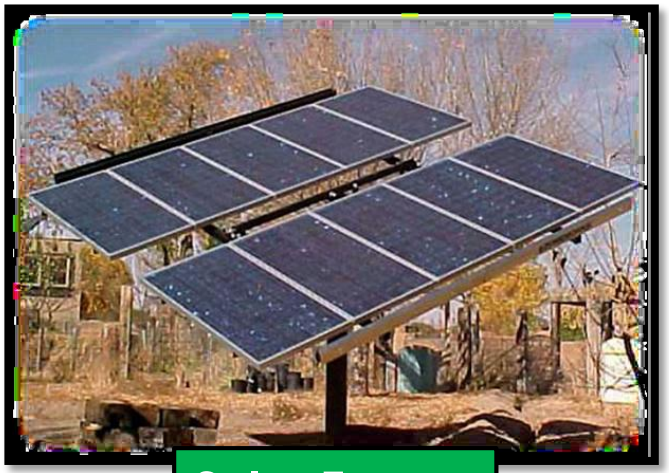
Source: CIL SD Report 2012-13

Renewable Sources of Energy

Renewable Energy Options

Wave Energy

Wind Energy



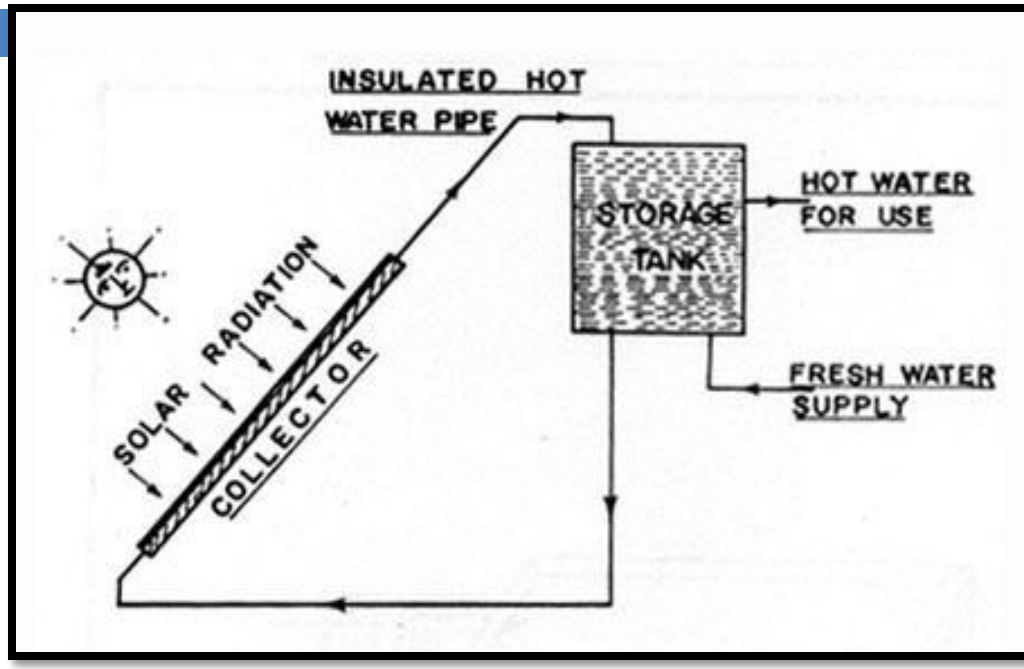
Solar Energy

Geothermal Energy

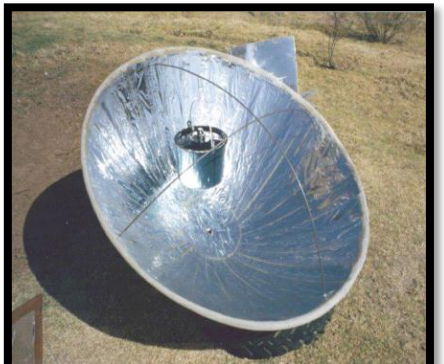
Hydro-Electric Energy

Solar Thermal Energy Conversion

Utilizes the **'HEAT'** of sunlight.



Sunlight striking earth in 1 hour carries more energy than annual world energy requirement.



Solar Energy Utilization Potential in CIL

It is planned to utilize the solar energy in all the big coal mining projects of CIL. This will help in energy conservation.

- An R & D proposal towards "Design, Develop and Demonstrate a Micro-Grid System for Optimization & Control of Multiple Sources of power supply", has been taken up by CMPDI as principle implementing agency and M/s Gujarat Energy Research & Management Institute (GERMI), Gandhinagar as Sub-implementing agency.
- Major objectives of this project are:

1. Design and demonstrate a pilot micro-grid project at CMPDI office premises and residential colonies
2. Develop in-house technical expertise to design solar PV systems and replicate it at other subsidiary companies of CIL
3. Long term performance evaluation to study and identify best module and inverter technology suitable to atmospheric and climatic conditions prevails in coal field areas.

Future Scenario – Green Mining

Introduction of Surface Miners for coal exploitation with interlocked water spraying arrangement. This technology has already been introduced in some coal mines.
In-pit belt conveying system eliminating coal transport by trucks in big opencast projects
Transportation of coal by covered conveyor belts in CHPs
Wagon loading through silos in big opencast projects
Setting-up of more coal washeries to reduce coal consumption per unit of power generated resulting in reduction in greenhouse gas emission.

Future Scenario – Green Mining

Disposal of fly-ash in backfilling of opencast projects as well as in underground mines with due regard to ground water quality
Introduction of Clean Development Mechanism (CDM) *i.e.* Coalbed Methane (CBM), Coal Mine Methane (CMM), Abandoned Mine Methane (AMM), Ventilation Air Methane (VAM), Coal-to-Liquid (CTL), and CO_2 sequestration

Challenges Ahead…

Return of reclaimed land to the local community for productive usage and as a source of income.
R & D efforts for aforesaid arrangement and also for use of the reclaimed areas as possible resettlement sites. The reclaimed areas may act as a pool of land for locating resettlement sites.
Minimizing external OB dumps to the extent possible.

CMPDI has taken a number of steps to meet the aforesaid challenges.

Conclusion

The Opencast mining is likely to play a dominant role in foreseeable future for meeting the coal requirement of the country.

A number of efforts has already been taken by CIL to address the environmental issues associated with coal mining.

CIL is not only committed to restore the ecological balance but also in creating new environmental resources i.e.

- Enhancing forest cover, 3.43 Ha against each Ha of forest land used
- Creating huge water resource for future

Necessary fund is made available by CIL for promoting sustainable development namely, afforestation, NPV and mine closure.

CIL will continue to undertake additional activities and financially support to broaden the scope of sustainable development in the coal sector


Thank
You!