COAL BASE POWER: ENVIRONMENTAL CHALLENGES

A NEW FRAME WORK FOR MANAGEMENT OF FLY ASH: INDIAN PERSPECTIVE

By

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COAL BASE POWER: ENVIRONMENTAL CHALLENGES

WAY FORWARD

1. Perceptions about fly ash
2. Existing policy frame work
3. Other major impediments
4. Current scenario: fly ash generation & utilization
5. Fly ash a pollutant or environment saviour
6. Economic worth and employment generation potential
7. A new frame work

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

PERCEPTION ABOUT FLY ASH (as of mid 1990's)

- A waste material
- Of no use
- Hazardous
- Radioactive
- Contains heavy metals Hg, Pb, As, Cr, Ni, etc.
- Carcinogenic
- Leads to bronchitis, skin diseases, etc.
- Pollutes water
- Pollutes air
- Requires large stretches of land for dumping
- A cost centre for TPPs

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PERCEPTION ABOUT FLY ASH (2015-16)

- Image of fly ash is transformed
- Number of technologies developed, scaled up and transferred to industry for gainful utilization of fly ash as a resource material and as part-substitution of minerals and other materials
- Properties of fly ash relevant to various applications are use specific.
- Standards, specifications and guidelines prepared & issued
- Legislation as well as facilitation and technology transfer centre in place

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Fly ash products manufactured at CASHUTEC, Raichur

Fly ash blocks

Fal-G blocks

Mosaic tiles

Interlocking pavers

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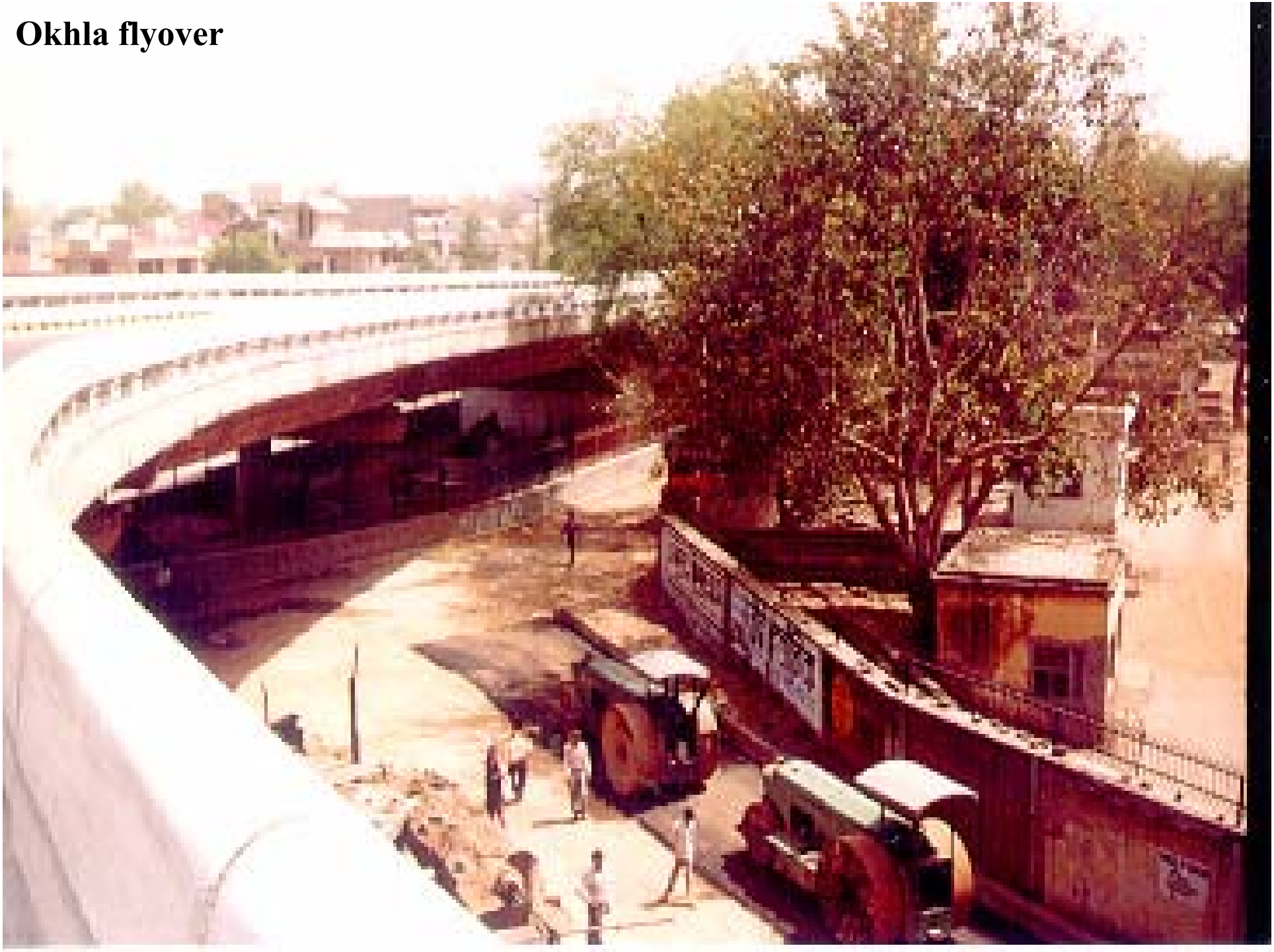
Concrete paver blocks in a circular pattern

Concrete paver blocks in a rectangular pattern

Okhla flyover



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Approach road embankement, Nizamuddin

Construction of Sarita Vihar fly over, New Delhi

APPROACH ROAD EMBANKMENT IN FLOOD ZONE, NIZAMUDDIN


Punjabi Bagh flyover

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Rural Road at Raichur

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Saline soil reclamation using fly ash

Forestry at BTPS ash pond

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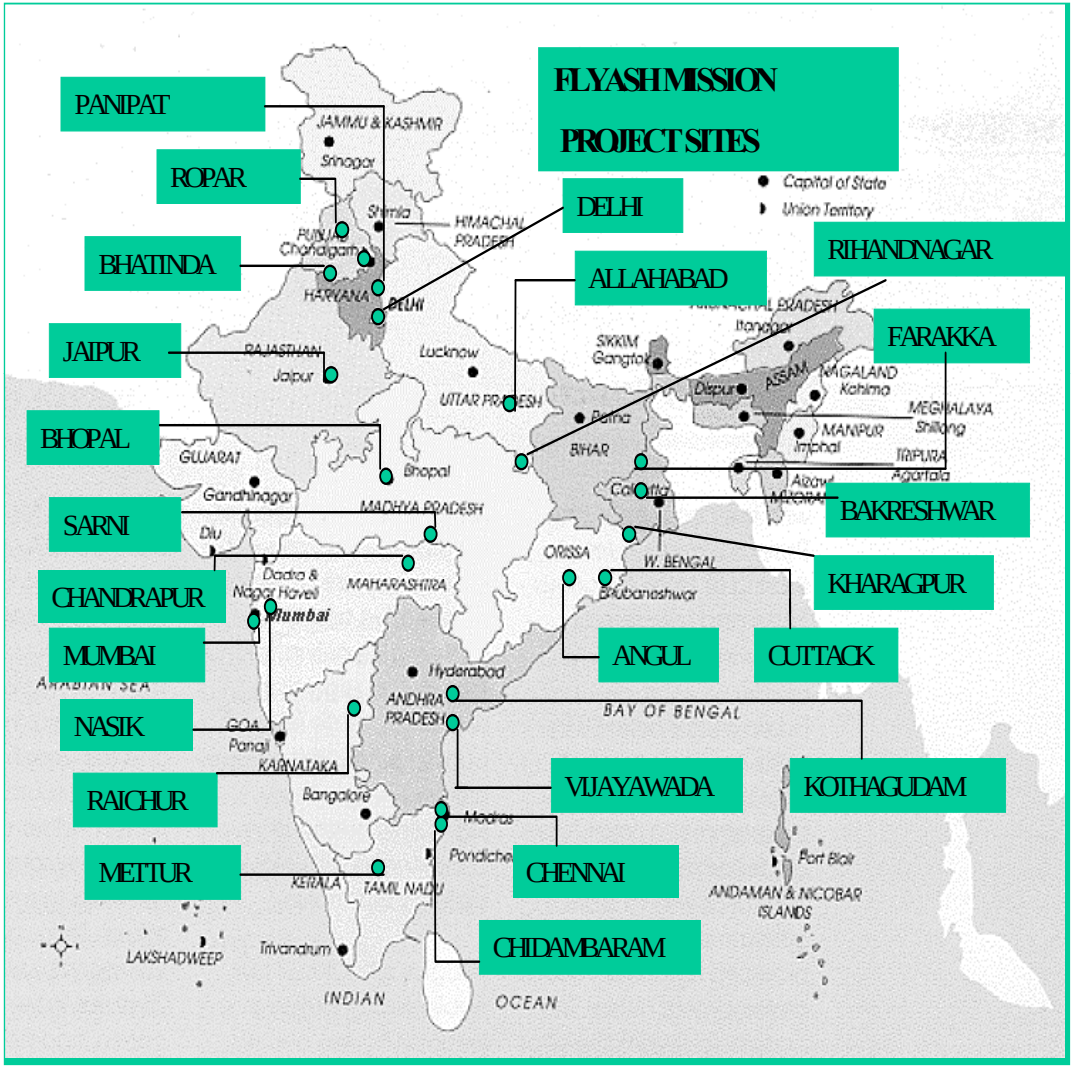
SPREAD OF PROJECTS



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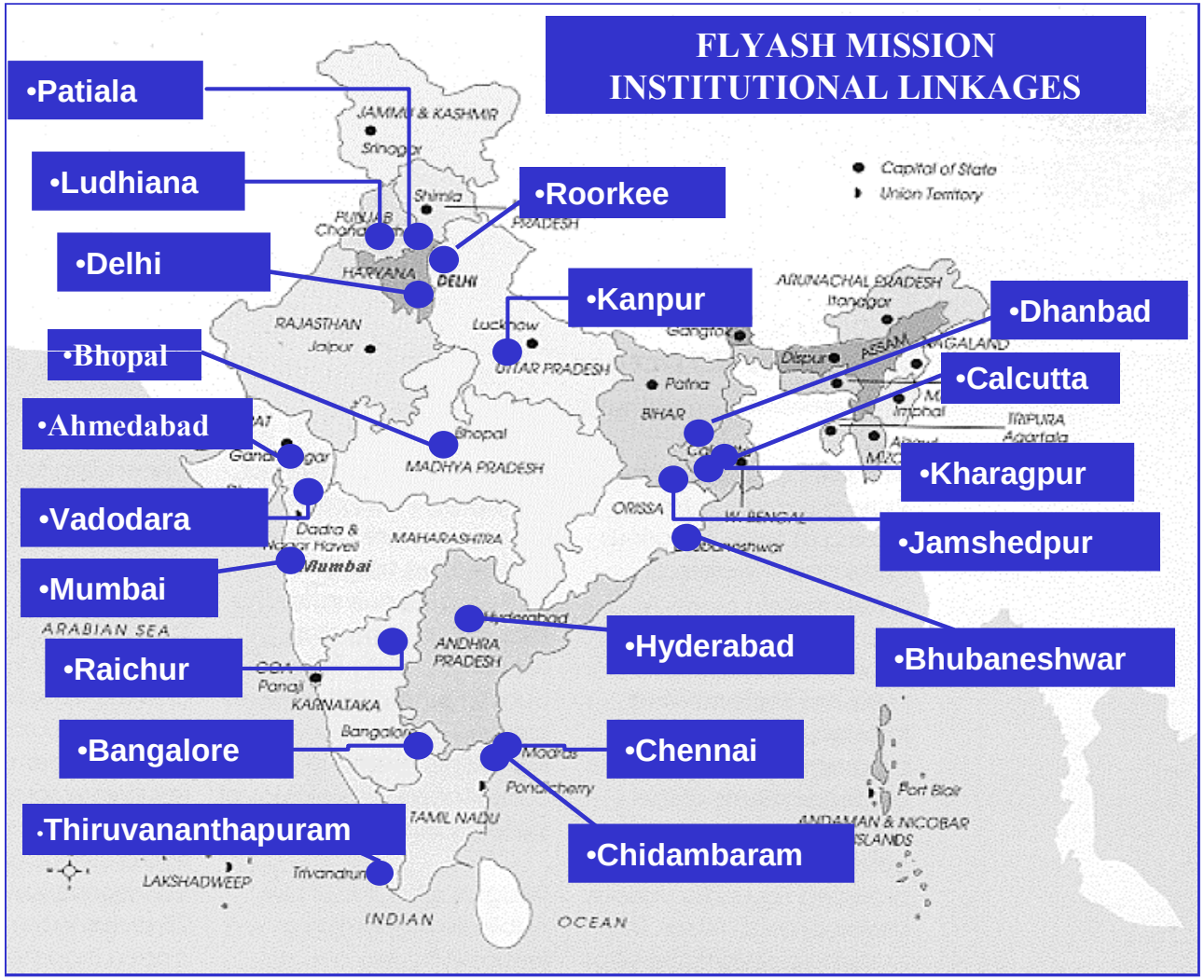
SPREAD OF LINKAGES



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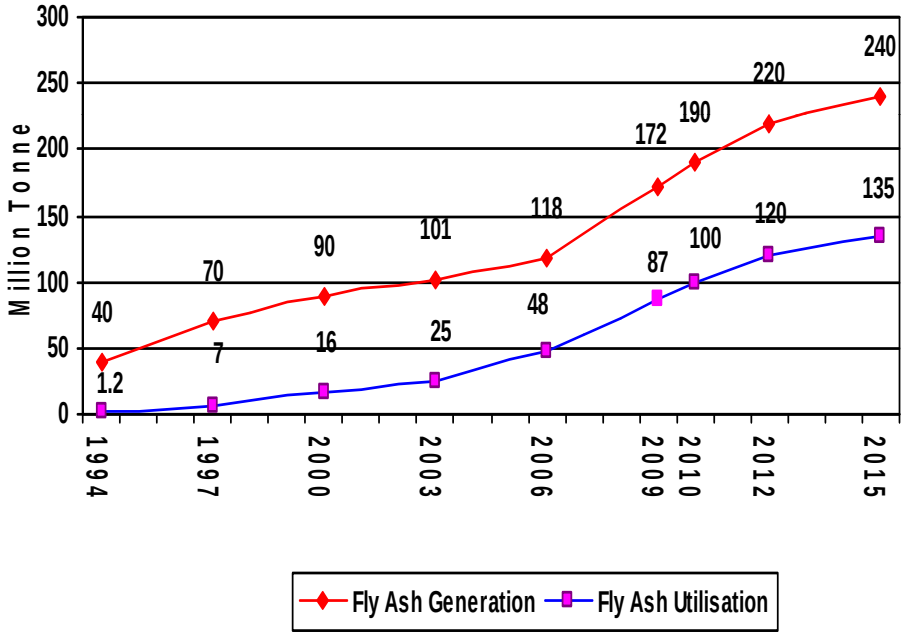
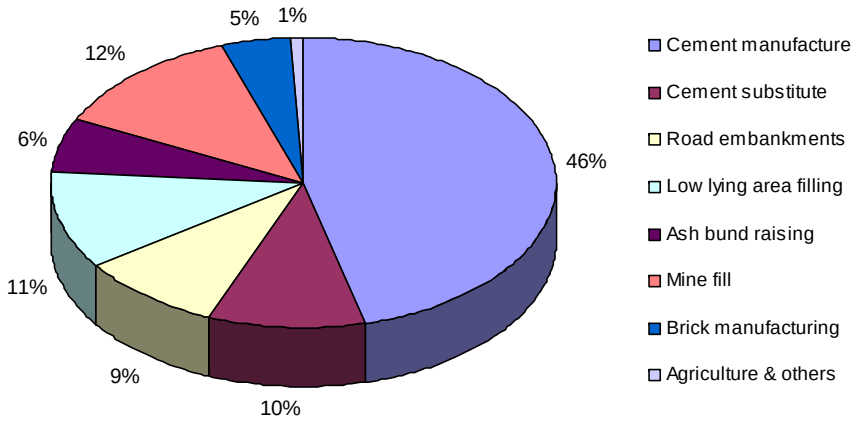
CURRENT SCENARIO: Generation & Utilization

- **Technologies developed and field application catalyzed by Fly Ash Mission, Fly Ash Utilization Programme and Fly Ash Unit, Dept. of Science & Tech.**



Fly Ash Generation & Utilization



Application wise ash utilization (2015)

PROJECTION: 1000 Mn.t per annum by 2031-32

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Dr. T. Ramasami, Secretary, Department of Science and Technology, and V. V. Nagovitsin, Chairman of the Inter-regional Association of the Economic Cooperation of the Constituent Entities of the Russian Federation signed the Protocol on Fly Ash in presence of Dr. Manmohan Singh, Prime Minister of India and Mr. Dmitry Medvedev, The President of Russia at The Kremlin on 16th December, 2011 after the bilateral summit level talks between the two sides.

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THE PROTOCOL PROPOSES

(i) **Exchange of experience and expertise of fly ash utilization and safe management technologies developed and applied for similar applications both in the Republic of India and the Siberian Federal District.**

(ii) **Development and implementation of investment projects of companies/government organizations to establish enterprises applying fly ash technologies for its safe management and utilization both by the Indian part as well as the Siberian Federal District.**

(iii) **With the aim of enhancing cooperation between Russian and Indian scientists:**

- **Organize mutual exchange of specifications, guidelines and overview materials concerning usage of ash and slag material.**
- **Advice mutual invitation of scientists of the both countries to take part in R&D and conferences dedicated to the issues of ash and slag materials usage.**

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

EXISTING POLICY FRAMEWORK

- Power sector is responsible for fly ash utilization
- Collection of fly ash in dry condition and dispensing through silo is mandatory
- Ash pond area restricted to 50 ha/500 MW
- 100% ash utilization in 4-5 years.

  50% in 1st year itself
- Fly ash utilization facilitation expenses not accounted for tariff

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COAL BASE POWER: ENVIRONMENTAL CHALLENGES

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EXISTING POLICY FRAMEWORK

- No ash utilization targets for ash user agencies
- No incentive for fly ash industry
- Supercritical/ ultra super critical plants becoming norm of the day
- FGD is being made mandatory

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OTHER MAJOR IMPEDIMENTS

- **Fly ash users agencies do not own the responsibility of fly ash utilization**
- **Inadequate bulk transport infrastructure for inland (railways) and off-shore (at ports)**
- **Intermittent directives for fly ash utilization**

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

Total and Available Trace/Heavy Metals in Fly Ash and Soil

Trace/heavy Metals	Total (per cent)		Available (ppm)	
	Fly Ash	Soil	Fly Ash	Soil
Se	0.60-2.60	1.20-2.90	0.10-0.40	0.30-0.80
Cr	50.00-150.00	5.00-40.00	0.30-0.60	BDL-0.50
Pb	10.00-70.00	5.00-30.00	BDL-0.60	BDL-0.50
Co	10.00-50.00	8.00-35.00	0.05-0.15	0.04-0.20
Ni	50.00-150.00	60.00-200.00	0.15-0.25	0.25-0.40
Cd	5.00-10.00	3.00-6.00	0.03-0.07	BDL-0.06
As	1.00-4.00	0.10-1.50	BDL-0.03	BDL-0.02
Hg	BDL	BDL	BDL	BDL

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

Characteristics of Ash Pond effluent and well water collected from Ash bund Area of Chandrapur STPP and Bhusawal TPS

Parameters	A	B	C	Industrial Effluent Standards IS:2490	Drinking Water Standards IS: 10500
pH	8.28	8.14	8.19	5.5-9.0	6.5-8.5
TSS (mg/1)	218.00	362.00	219.10	100.00	-
TDS "	510.00	467.30	487.90	-	500.00
Ca "	65.40	54.20	62.80	75.00	75.00
Mg "	31.00	18.90	29.70	30.00	30.00
$N\text{-}NO_3$ "	3.43	2.21	3.39	45.00	45.00
F "	0.89	1.45	0.97	2.00	0.6-1.2
I "	0.029	0.032	0.026	-	-
Fe "	0.15	0.09	0.11	1.00	0.30
Pb "	0.02	0.05	0.01	0.10	0.10
Cd "	0.003	0.001	0.004	2.00	0.10
Ni "	BDL	BDL	BDL	3.00	-
Cr "	BDL	BDL	BDL	0.10	0.05
Co "	BDL	BDL	BDL	-	-
As "	BDL	BDL	BDL	0.20	0.05
Hg "	BDL	BDL	BDL	0.01	0.001
Radioactivity (Bq/kg)					
α- emitters	<0.1	<0.1	<0.1	-	-
β- emitters	<0.8	<0.8	<0.8	-	-

A : Water sample from Farmer's well Village- Chargaon collected on 15.02.97, Chandrapur

B : Drain water (Ash Effluent), well no. 5 discharge point collected on 15.02.97, Chandrapur

C : Water from Farmer's well near ash bund area collected on 19.08.97, Chandrapur

BDL- Below detection limit

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

Impact of radioactivity & heavy metal content of fly ash on soil and produce

Sample	Radioactivity(Bq/kg)			Trace & Heavy metals (ppm)			
	^{40}K	^{226}Ra	^{228}Ac	B	Mo	As	Se
ESP fly ash	280-432.5	43.6-115.4	55-129	17.1-28.0	2.5-6.7	1.0-4.0	1.6-2.6
Pond ash	280-353	69-92	77-108	18.3-23.1	2.6-5.3	1.4-3.6	1.2-2.3
Soil	160-326	30-58.8	37-80	13-17	0-4.8	1.9-2.9	2.4-4.0
Grain	9-95	0.29-0.75	0.60-1.60	0.2-1.6	0-1.2	0-0.45	0.10-1.0
Straw	8.4-10.9	039-0.72	078-1.00	0.29-0.42	0-0.67	0-.40	018-0.55
Vegetables	0.6-85	0.1-0.5	0.4-0.8	0.72-1.3	0.2-0.06	0.10-0.50	0-0.14
Oil seeds	60-110	0.3-0.8	0.6-1.0	0.1-1.3	0.2-0.6	0.3-0.4	0.10-1.06
Normal range in soil	4000*	1000*	1000*	2-100**	0.1-40**	5-100**	0.1-10**

* Source: Atomic Energy Regulatory Board, Radiological Safety Division, Dept. of Atomic Energy, Govt. of India letter no AERD/RSD/28/2002/6007 on dated. July 26, 2002

** Source: P.C Srivastava and U.C. Gupta (1996): trace element in crop production, oxford and IBH publishing Co. Pvt. Ltd., New Delhi.

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

Per cent yield increase in fly ash amended soils over control (without fly ash) for various crops

Sl. no.	Crop	No. of sites	Range	Mode range ave rage (représentative ave rage)*
Cereals				
1.	Wheat	36	2.85-99.20	17.25
2.	Paddy	34	2.90-41.71	13.50
3.	Maize	16	4.00-88.41	21.95
4.	Jowar	07	5.60-32.42	13.47
5.	Bajra	03	7.10-25.00	13.00
6.	Sorghum	03	7.70-28.15	17.00
7.	Oat	01	22.20	22.20
8.	Pearl millet	01	32.30	32.30
Pulses				
1.	Chickpea	04	9.70-30.62	21.00
2.	Green gram	04	5.70-28.20	21.00
3.	Black gram	03	6.20-13.85	11.00
4.	Arhar	01	25.00	25.00
5.	Lentil	01	5.50	5.50

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COAL BASE POWER: ENVIRONMENTAL CHALLENGES

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Per cent yield increase in fly ash amended soils over control (without fly ash) for various crops

Sl. no.	Crop	No. of sites	Range	Mode range ave rage (représentative ave rage)*
Oil seeds				
1.	Ground nut	17	7.10-77.40	22.23
2.	Sunflower	09	2.60-67.00	28.43
3.	Soybean	08	8.70-63.60	27.22
4.	Mustard	05	5.80-61.80	15.27
5.	Sesamum	02	2.50-7.70	5.10
6.	Raya	01	3.30	3.30
7.	Til	01	40.00	40.00
8.	Linseed	01	21.40	21.40
Cash crops				
1.	Cotton	11	9.30-38.20	18.60
2.	Sugarcane	06	8.70-63.60	27.22
3.	Jute	03	5.00-20.00	19.00

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COAL BASE POWER: ENVIRONMENTAL CHALLENGES

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Per cent yield increase in fly ash amended soils over control (without fly ash) for various crops

Sl. no.	Crop	No. of sites	Range	Mode range ave rage (représentative ave rage)*
Horticulture crops				
1.	Brinjal	06	0-137.80	12.5
2.	Tomato	04	4.50-29.00	16.50
3.	Potato	04	9.20-37.00	24.50
4.	Onion	02	18.40-26.60	22.50
5.	Banana	01	14.00	14.00
6.	Beetroot	01	14.00	14.00
7.	Bhendi	01	16.70	16.70
8.	Bottle gourd	01	15.80	15.80
9.	Chilli	01	6.70	6.70
10.	Palak	01	11.10	11.10

* Representative average-the per cent increase in yields has wide range for the same crop in the same soil and agro-climatic conditions. There can be many reasons for it. To arise at representative average the following procedure has been adopted.

* The percentage increases are listed in the block of 1-10%, 11-20%, 21-30% and so on. Thus 10 blocks would have the percentage increase figures pertaining to representative block. Extreme blocks containing practically same number of entries on the higher side as well as on lower side have been excluded. The central blocks (generally two blocks) having maximum number of entries (representative mode like blocks and also medium type blocks) have been taken and average of all the readings in these blocks are taken as representative average.

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

ENVIRONMENTAL IMPACT (135 mt use of fly ash)

- **Reduction of CO_2 emission by 80 mtpa**
- **Conservation of 110 mt lime stone and 50 mt coal per year**
- **Conservation of 20,000 Ha land per year**
- **Conservation of 1,000 Mm^3 water per year**
- **Conservation of 3 mt sand per year**

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

BUSINESS & EMPLOYMENT GENERATION (135 mt use of fly ash)

- 55 mt additional cement production per year with half the investment, half the gestation time and half the cost as compared to those for integrated cement plant
- Production of 3 billion fly ash bricks per year
- Production of 30 million clay-fly ash bricks per year
- Transportation of 135 mt fly ash per year i.e., 40,000 truck trips per day
- Employ more than 1 million people
- Economic value of business developed is more than US $5 billion per year

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

FLY ASH UTILIZATION POTENTIAL

USAGE	2015		Realizable Potential (estimate)	
	Realizable Potential**	Actual Utilization	2021-22	2031-32
Cement manufacture	95	62	140	300
Cement substitution	20	14	50	50
Road embankments	20	12	25	25
Low lying area filling	20	15	30	30
Ash bund raising	15	8	20	15
Mine fill	50	16	100	300
Manufacturing of bricks, blocks, tiles, etc.	15	7	100	150
Agriculture and others	4	1	30	120
High value added applications	1		5	10
Total	240	135	500	1000

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

POTENTIAL OF 1000 MT FLY ASH PER YEAR

ENVIRONMENTAL BENEFITS

It would reduce:

- **350 mt of carbon dioxide in cement, ready mix concrete and brick industry**
- **Consumption of 550 mt lime stone in cement and concrete industry**
- **Consumption of 200 mt coal in cement, concrete and brick industry**
- **Consumption of 200 mt top soil in road construction, filling of low lying areas, brick industry, etc.**
- **Consumption of 200 mt sand in stowing of underground mines**
- **Environment pollution by virtue of reduced mining activity due to conservation of mineral resources.**

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COAL BASE POWER: ENVIRONMENTAL CHALLENGES

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POTENTIAL OF 1000 MT FLY ASH PER YEAR

BUSINESS & EMPLOYMENT GENERATION

It would provide:

- **350 mtpa additional cement at half the cost, half the investment and half the gestation period as compared to integrated cement plant.**
- **100 mtpa extra coal production from underground mines**
- **Contribute to food security to the country by increasing agriculture yield by 10 per cent and reclamation of degraded and waste lands**
- **Employment to 5 million people**
- **Additional business worth US $ 20 billion / year**

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

NEW FRAMEWORK

- **Fly ash is a resource and environment savior**
- **Invest in value addition to fly ash**
- **Each sector to use it to maximize the benefits**
- **To make it a habit, let us have targets**
- **Orient Departmental guidelines/ policies towards the above**
- **Continued R&D and induction in academic curriculum**
- **Let us not waste, fly ash a resource**

COAL BASE POWER: ENVIRONMENTAL CHALLENGES

Thank you for your time & attention