

# **GLOBAL COAL BENEFICIATION SCENARIO AND ECONOMICS OF USING WASHED COAL**

**A PRESENTATION BY:**

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# GLOBAL OVERVIEW OF COAL PREPARATION

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- ❖ **Annual worldwide production of Hard Coal: 5000 Mt (approx)**
- ❖ **Currently more than 2500 CPPs in operation in the world**
- ❖ **More than one-third of world's coal production is beneficiated**

# GLOBAL OVERVIEW OF COAL PREPARATION

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## PRESENT STATUS & FUTURE TRENDS IN COAL PREPARATION IN FOLLOWING COUNTRIES:

- ❖ AUSTRALIA
- ❖ CHINA
- ❖ UNITED STATES OF AMERICA
- ❖ RUSSIA
- ❖ CANADA
- ❖ SOUTH AFRICA
- ❖ INDIA

# AUSTRALIA

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## ■ COAL RESERVES

- ❖ 74.2 Bt
- ❖ 62 Bt (Lignite)

## ■ RAW COAL PRODUCTION

- ❖ 4<sup>th</sup> in the world
- ❖ 397 Mt (2005)

## ■ EXPORTS

- ❖ 234 Mt (124 Mt Metallurgical coal & 110 Mt Thermal coal)
- ❖ 60% of total production exported, accounts for 28% of global coal export market

## ■ COAL WASHING CAPACITY

- ❖ Most of ROM coal produced is routed through CPP. Fraction exported is fully washed

# AUSTRALIA

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## ■ PRESENT STATUS

CP industry enjoying greatest boom in last 25 years. As a result:

- ❖ New processing facilities being established.
- ❖ Existing facilities being upgraded.
- ❖ Rail & port facilities being expanded.
- ❖ Since 2004, additional 20,000 tph washing capacity has been added or under construction to cope up with the buoyant international demand.

# AUSTRALIA

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## TECHNOLOGY IN VOGUE

- **Raw coal crushed to 50/60 mm.**
- **Coarse coal washing**
  - ❖ Mainly by DMC (Dia:1000 mm or more)
  - ❖ Drums or Baths in some plants.
  - ❖ Jigs at few plants.
- **Fine coal washing**
  - ❖ Spiral + Jameson or Microcel technology.
  - ❖ Limited use of froth flotation for metallurgical coal.
- **Dewatering**
  - ❖ Coarse & medium size- Vibrating or scroll type basket centrifuges
  - ❖ Flotation products- Vacuum filters & screen bowl centrifuges.
  - ❖ Tailings- High rate gravity thickener & Belt Press Filter.

# CHINA

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## ■ COAL RESERVES

- ❖ 2<sup>nd</sup> in the world in terms of coal reserves.
- ❖ 2040 Bt (Mineable coal reserves)

## ■ RAW COAL PRODUCTION

- ❖ Largest coal producer.
- ❖ 1960 Mt (2004)
- ❖ Main energy source (60%).

## ■ COAL WASHING CAPACITY

- ❖ 2000 CPPs (2004)
- ❖ 800 Mty (Projected for 2005)

# CHINA

## TECHNOLOGY IN VOGUE

- **Raw coal crushed to 100/50 mm.**
- **Coarse coal washing (100/50 – 25/13 mm)**
  - ❖ **Mainly jigs (60%)**
  - ❖ **Dense medium separator (Drewboy, Vertical lifting wheel separator)**
- **Small coal washing (50/25/13 – 0.5 mm)**
  - ❖ **2-Product Dense medium cyclones (Dia. 660-1300 mm)**
  - ❖ **3-Product Dense medium cyclones (Dia. 1000-1400 mm)**
- **Fine coal washing (-0.5 mm)**
  - ❖ **Mainly flotation.**
  - ❖ **Column flotation (for very fine coal).**



# CHINA

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## TECHNOLOGY IN VOGUE (contd.)

- **Dry separation (limited application)**
  - ❖ Mainly Compound dry separators.
  - ❖ Limited use of Air dense medium dry separator
- **Dewatering**
  - ❖ Mainly High frequency screen
  - ❖ Centrifuge (vertical & horizontal)
  - ❖ Pressure filter
  - ❖ Fast diaphragm filters
  - ❖ Plate-and-frame filters (for slime recovery)

# UNITED STATES OF AMERICA

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## ■ COAL RESERVES

- ❖ 1<sup>st</sup> in the world in terms of proven coal reserves.
- ❖ 111 Bt (Anthracite & Bituminous)
- ❖ 135 Bt (Sub-bituminous & Lignite)

## ■ RAW COAL PRODUCTION

- ❖ 2<sup>nd</sup> in the world.
- ❖ 1100 Mt (2006)
- ❖ About 90% consumed in domestic market.

## ■ COAL WASHING CAPACITY (2006)

- ❖ 265 operating CPPs.
- ❖ 986 Mty raw coal throughput capacity (about 90% of total production).
- ❖ 562 Mty Clean coal production.

# UNITED STATES OF AMERICA

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## ■ PRESENT STATUS

- ❖ Majority of the bituminous coal and anthracite produced beneficiated through specific gravity and froth based coal preparation.
- ❖ Sub-bituminous coal not beneficiated.
- ❖ No commercial scale specific gravity beneficiation of low rank coals except of Bituminous “C” coals
- ❖ Significant amount of mercury removed through specific gravity beneficiation process as mercury present in most coals is associated with pyrite.

# UNITED STATES OF AMERICA

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## TECHNOLOGY IN VOGUE

- **Each CPP employs 3 or more independent processing circuits for different size fractions.**
- **Coarse coal washing (100 - 10 mm)**
  - ❖ **Dense Medium Vessel**
- **Medium coal washing (10 - 1 mm)**
  - ❖ **Dense Medium Cyclones (Dia. < 1000 mm)**
- **Small coal washing (1 - 0.15 mm)**
  - ❖ **Water Only cyclone**
  - ❖ **Spirals**
  - ❖ **Combination of both**

# UNITED STATES OF AMERICA

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## TECHNOLOGY IN VOGUE (Contd.)

- **Fine coal washing (<0.15 mm)**
  - ❖ Froth flotation (after desliming -35/40 micron)
- **Dewatering**
  - ❖ Coarse size fraction
    - ❖ Basket Type Dryers
  - ❖ Fine size fraction
    - ❖ Screen bowl centrifuges
    - ❖ Combination of vacuum filter & thermal dryers.

# RUSSIA

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## ■ COAL RESERVES

- ❖ 2<sup>nd</sup> in the world after USA in terms of proven coal reserves.
- ❖ 170 Bt (Proven)

## ■ RAW COAL PRODUCTION

- ❖ Ranks 6<sup>th</sup> in the world.
- ❖ 300 Mt (2005)

## ■ COAL WASHING CAPACITY (2006)

- ❖ 42 CPPs, 28 concentrators, 17 mechanized sizing units.

# RUSSIA

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## ■ PRESENT STATUS

- ❖ Mainly bituminous & brown coal.
- ❖ Majority of coking coal beneficiated (92% in 2005).
- ❖ Only part of thermal coal beneficiated (13% in 2005).
- ❖ Generally low sulphur content (< 1%).

# RUSSIA

## TECHNOLOGY IN VOGUE

Sl. No.	Equipment	%
1	Heavy media Baths & Cyclones	53.1
2	Jigging	30.1
3	Flotation	9
4	High-angle separators (Water only cyclones)	4.2
5	Spiral separators	2.4
6	Pneumatics (for thermal brown coals)	1.2

### DEWATERING OF FINE COAL

- ❖ High frequency screens
- ❖ Centrifuges (Settling & filtering)
- ❖ Belt press filters
- ❖ Continuous disc filter (operating under pressure)



# CANADA

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- **COAL RESERVES**
  - ❖ 7.3 Bt (Recoverable)
- **RAW COAL PRODUCTION**
  - ❖ 62 Mt (2003)
    - 30 Mt (Bituminous coal)
    - 22 Mt (Sub-bituminous coal)
    - 10 Mt (Lignite)
- **CONSUMPTION/ EXPORTS/ IMPORTS**
  - ❖ 62 Mty Domestic consumption
  - ❖ 28 Mty export & import each
- **COAL WASHING CAPACITY**
  - ❖ 35 Mty beneficiated.

# CANADA

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## ■ PRESENT STATUS

- ❖ Production dropped by about 20% and stabilized since 2003.
- ❖ Coal industry is small compared to oil sands industry.

# CANADA

## TECHNOLOGY IN VOGUE

- **CPPs usually employ 4 independent processing circuits for different size fractions.**
- **Coarse coal washing (100 - 10 mm)**
  - ❖ **Heavy Medium Drums & Baths**
- **Medium coal washing (10 – 0.5 mm)**
  - ❖ **Heavy Medium Cyclones**
- **Small coal washing (0.5 - 0.15 mm)**
  - ❖ **Water Only cyclone**
- **Fine coal washing (<0.15 mm)**
  - ❖ **Froth flotation**
  - ❖ **Column flotation**
  - ❖ **Spirals**

# SOUTH AFRICA

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## ■ COAL RESERVES

❖ 55.5 Bt

## ■ RAW COAL PRODUCTION

❖ 5<sup>th</sup> in the world

❖ 307 Mt (2004)

❖ 241 Mt (2004)- Saleable production

## ■ EXPORTS

❖ 65 Mt (27% of saleable production exported).

# SOUTH AFRICA

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## ■ PRESENT STATUS

- ❖ New generation CPPs utilize the benefits of economies of scale employing single large volume units.
- ❖ About 92% of electricity generated from coal which is highest in the world.
- ❖ Leader (Sasol) in consumption of coal for conversion to liquid fuels which was necessitated due to 2 major oil shocks in 1973 & 1979.
- ❖ Primary product of CPPs is export steam coal.
- ❖ Secondary product is fed to domestic power stations.

# SOUTH AFRICA

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## TECHNOLOGY IN VOGUE

- **Raw coal crushed to 80 mm.**
- **Employs split size wash.**
- **Coarse coal washing (80 – 8 mm)**
  - ❖ **Mainly large diameter pump fed dense media cyclones**
  - ❖ **Dense medium separator (Wemco Drum, Drewboy)**
  - ❖ **Jigs at few plants.**
- **Small coal washing (8 – 0.8 mm)**
  - ❖ **Smaller diameter cyclones.**
- **Fine coal washing**
  - ❖ **Mainly spirals**
  - ❖ **Limited use of froth flotation.**

# COMPARATIVE STATUS OF COAL PREPARATION IN VARIOUS COUNTRIES WORLDWIDE

<b>Sl. No.</b>	<b>Country</b>	<b>Coal Production, Mty</b>	<b>No. of Washeries</b>	<b>Washing capacity (Mty)</b>
1	China	2226 (2005)	2000	800
2	USA	1100 (2006)	265	986
3	India	432 (2006)	53	134
4	Australia	397 (2005)	70	NA
5	South Africa	307 (2004)	NA	NA
6	Russia	300 (2005)	87	95

# INDIA

- **COAL RESERVES (AS ON 1.1.2006)**
  - ❖ 253 Bt (Geological)
  - ❖ 96 Bt (Proved)
- **RAW COAL PRODUCTION (2006-07)**
  - ❖ 405 Mt (Non-coking coal)
  - ❖ 27 Mt (Coking coal)
- **COAL WASHING CAPACITY**
  - ❖ Pre-third party investment
    - 19 in CIL
      - 12 coking-20.1 Mty
      - 7 non-coking- 20.2 Mty
    - 7 Outside CIL (coking- 11.27 Mty)
  - ❖ Post-third party investment
    - 27 Non-Coking CPPs (83 Mty)
  - ❖ Washeries under construction
    - 3 CPPs (24 Mty)



# INDIA

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## ■ PRESENT STATUS

- ❖ Washing capacity of CPP got more than doubled since post-third party investment.
- ❖ Non-coking coal washing capacity: 103 Mty
- ❖ Coking coal washing capacity: 32 Mty

# INDIA

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## TECHNOLOGY IN VOGUE :

- **Raw coal crushed to 100/75/50 mm.**
- **Coarse coal washing (100/75/50 – 25/13 mm)**
  - ❖ ROM jigs (Moving screen jig)
  - ❖ Coarse coal jigs
  - ❖ Dense medium separator
  - ❖ Barrel washer
- **Small coal washing (50/25/13 – 0.5 mm)**
  - ❖ Small coal jig
  - ❖ Dense medium cyclones (Dia. 600-1000 mm)

# INDIA

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## TECHNOLOGY IN VOGUE (contd.) :

- **Fine coal washing (-0.5 mm)**
  - ❖ Flotation
  - ❖ Spirals
  - ❖ Water only cyclones
- **Dewatering**
  - ❖ Vacuum filters
  - ❖ High frequency screen
  - ❖ Centrifuge
  - ❖ Belt press filter

# INDIA

## NON-COKING COAL - ADDITIONAL WASHING CAPACITY REQUIREMENT

■ Proj. Non-coking coal production (XI Plan)	: 639.35 Mty
■ Superior grades with ash content < 34%	: 143 Mty
■ Inferior grades with ash content > 34%	
❖ Linked to pithead TPS	: 160 Mty
❖ Captive mining production	: 104 Mty
❖ Remaining	: 243 Mty
(including non-metallurgical coking coal)	
■ Non-coking coal washing capacity	: 103 Mty
■ Additional capacity requirement	: 140 Mty
■ Non-coking coal washeries under pipeline	: 32 Mty

# INDIA

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## ■ RECENT CIL INITIATIVES

- ❖ Till recently, Third Party investment was the preferred mode for setting up of new washeries whereas in a major shift in Corporate policy, CIL has now decided to set up a number of washeries in CCL & SECL on Build and Operate basis with CIL's own investment.
- ❖ In an FDs and HODs meeting in CIL, Kolkata in January 2007, it has been decided that all inferior quality coal (>34% ash) produced from future mines or expansion projects having capacity 2.5 Mty or above and not linked to pithead power plant needs to be washed.

# ECONOMICS OF USING WASHED COAL

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## Previous studies :

- National Productivity Council at Satpura TPS of MPEB, 1988-89
- CMPDI at Dadri TPS of NTPC in 1998
- BSES Ltd.

# ECONOMICS OF USING WASHED COAL

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## Conclusions of previous Studies :

### Washing leads to -

- Improvement of PUF
- Improvement in Generation
- Reduction in Specific coal consumption
- Increase in Boiler efficiency
- Reduction in smoke (Greenhouse gases) & dust
- Improvement in overall economics

# ECONOMICS OF USING WASHED COAL

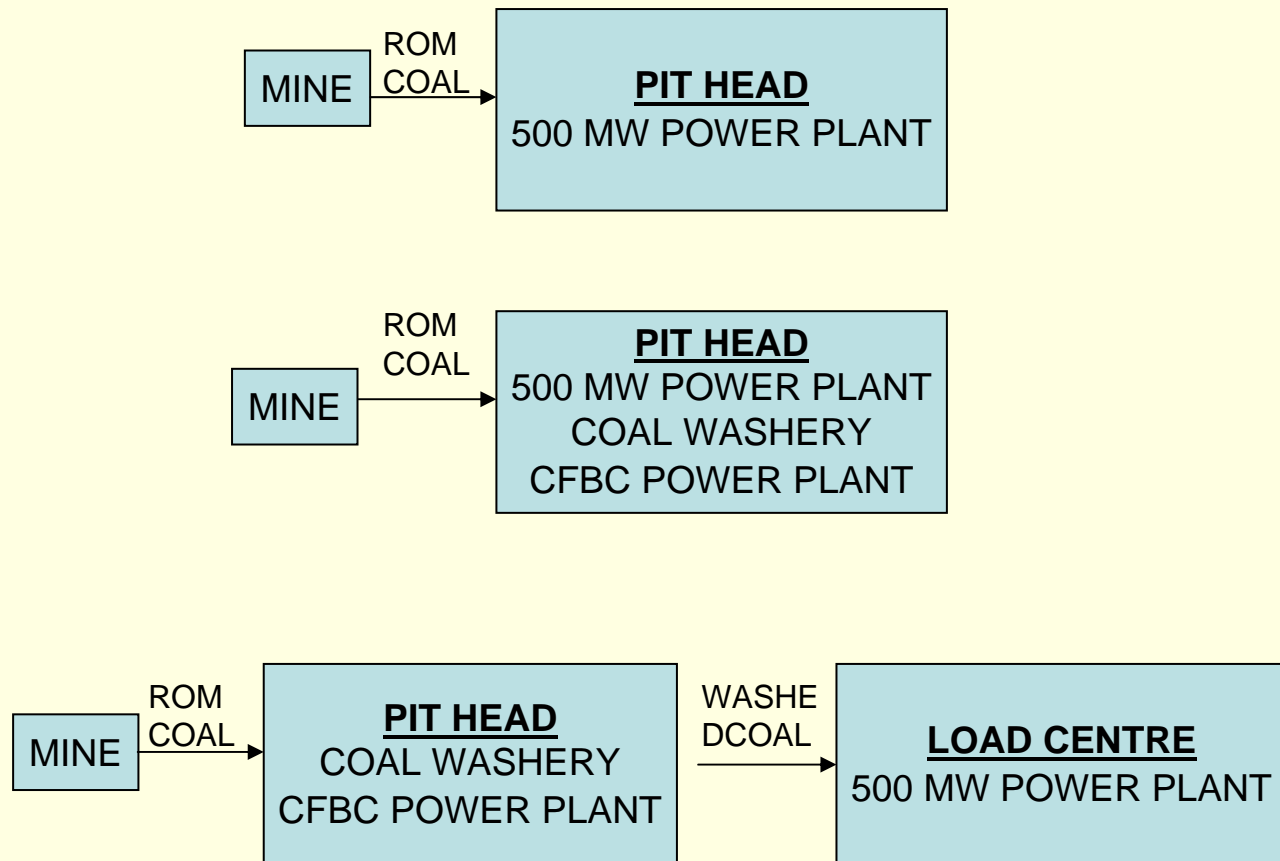
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In July, 2005, a Committee was formed under the chairmanship of Member (Energy), Planning Commission and consisting of representatives from NTPC, BHEL, CEA, CIL, CMPDIL & GSECL. The Committee submitted "Report of Working Group on Suitability of Using Washed Coal in Thermal Power Plants" in May 2006. Major findings are as follows :



# ECONOMICS OF USING WASHED COAL

## Integrated Plant Techno-Economic Analysis :



# ECONOMICS OF USING WASHED COAL

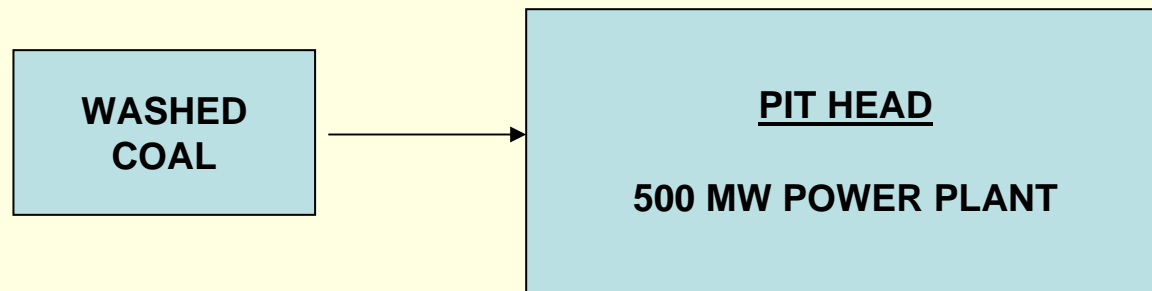
## Integrated Plant Techno-Economic Analysis :

Option	Fuel	COE (Paise/kWh)
A	<b>40% ash ROM coal (Base)</b>	<b>154.99</b>
A1	Washed to 34% ash + Reject in FBC	161.17
A2	Washed to 30% ash + Reject in FBC	163.44
B	<b>44% ash ROM coal (Base)</b>	<b>152.18</b>
B1	Washed to 34% ash + Reject in FBC	163.60
B2	Washed to 30% ash + Reject in FBC	165.52

# ECONOMICS OF USING WASHED COAL

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## Washed Coal Break-even Cost Analysis : (No reject utilization through FBC)



# ECONOMICS OF USING WASHED COAL

## Washed Coal Break-even Cost Analysis :

Location of 2X500 MW power plant	COE paise/kwh (Base value*)	Cost of 40% ash RoM coal (Rs./Ton)	Breakeven cost of washed coal with 30% ash (Rs./Ton)
Pithead	154.99	515.00	692
500 km from mine	194.63	1055.00	1347
1000 km from mine	231.63	1599.00	1962

\*Base value is with 40% ash RoM coal

# ECONOMICS OF USING WASHED COAL

## Break-Even Cost of Washed Coal w.r.t. PLF :

SN	PLF (%)	Break-Even Cost of Washed Coal with 30% Ash (Rs / Ton)	Remarks
1	80	692	Base Case
2	81	714	Valid only for power plants where poor quality of coal is sole reason for low performance of the plant.
3	82	736	
4	83	757	
5	84	778	
6	85	799	

**\*30% Ash Washed coal based 2x500 MW pithead Plant**

# ECONOMICS OF USING WASHED COAL

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## Major Findings are :

- **Integrated Plant Sensitivity Analysis shows that washing is viable in case of load centre power plants if washed coal is transported beyond break-even distance of 300-400 Kms**
- **Washing may be viable for pithead power stations also when use of washed coal leads to substantial improvement of PLF and for power plants running at part load due to deterioration in coal quality**
- **Washing may be viable for pithead power stations also when yield of washed coal is substantially higher**
- **Though quantitatively not established, Economics of an Integrated plant is more favourable than the case when Rejects are not being utilized**

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**THANK YOU**