Benefits of "Drying" Indonesian Low Rank Coals

Bart Lucarelli
LP Power Consultants, Ltd

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Topics

- Indonesia’s Coming Shift to Low Rank Coals (LRC)
- Coal drying systems being marketed worldwide
- Coal Producer benefits of selling dried LRC
- Power Producer benefits of using dried LRC
- Qualitative discussion on carbon footprint impacts
- Summary

Indonesia's coming shift to low rank coals

Sub-bituminous coals

- Measured: ~ 4.5 billion tonnes
- Inferred : ~ 17.0 billion tonnes
- Measured resources sufficient to last 25 years at current production rates
- But a number of Indonesia's major coal suppliers claim that they are already sold out of their sub - bituminous coals

Typical Specification

- *CV : 4700 – 6000 kcal/kg*
- S : 0.3% – 0.6%
- Ash : 3.0% – 7.0%
- TM : *20.0% – 28.0%*

Low rank coals (LRCs)

- Measured: ~2 billion tonnes
- Inferred : Many more billions of tonnes
- Major producers are starting to shift production to these LRCs
- But creating a LRC market will be a slow process – unless TM of LRC can be reduced to levels of sub-bituminous coals

Typical Specification

CV : 3900 – 4500 kcal/kg

- S : 0.3% – 0.6%
- Ash : 3.0% – 7.0%

TM : *35.0% – 40.0%*

Sample of technologies available for drying coal

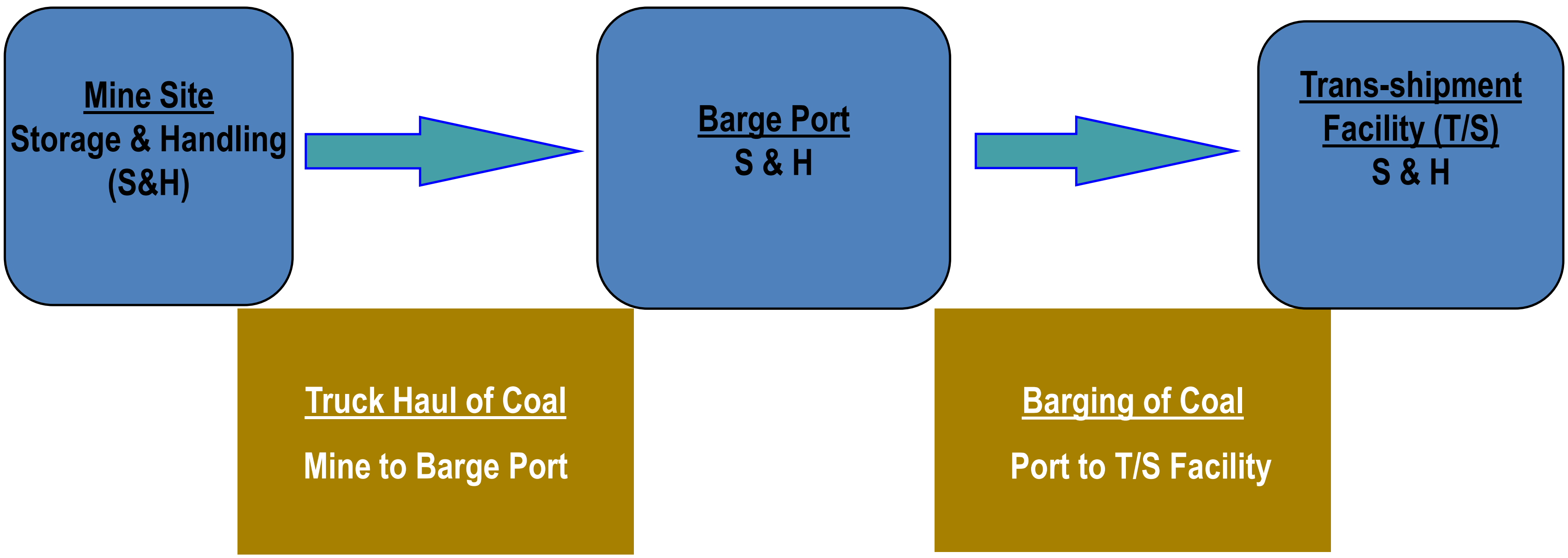
Technology	Primary Energy Source(s)	Company
Fluidized Bed Dryer	Waste heat from power plant condenser (~50 °C), aux load for fans & pumps	Great River Energy (USA) Lehigh University (USA)
Fluidized Bed Dryer	Low temperature steam from power plant turbine; aux. load for fans & pumps	RWE (WTA Process) Alsthom Power
Binderless Briquetter	Heat from burning coal in furnace -flash dryer	White Energy (Australia)
Pyrolysis System	Both heat and power from power plant	Evergreen Energy (USA)

Sample of technologies available for drying coal (cont.)

Technology	Primary Energy Source(s)	Company
UBC Process	Power & Kerosene as Binder for briquettes	Kobe Steel
Microwave Dryer	Power –lots of it!	CoalTek (USA) AMTECH (USA)

Coal Producer's Perspective

Cost Savings per GJ will occur at each point in the supply chain if cost-effective means of drying LRC can be found.



Indonesia's 6 largest Coal Producers, which account for ~68% of 2007 coal production & exports, have very different internal transportation arrangements but all offer opportunities for the application of coal drying systems

Company	2007 Production (mt)	2007 Exports (mt)	Mine Site to Barge Port (km)	Barge Port to T/S Facility (km)	Remarks
KPC	37.4	35.8	13 (conveyor)	1/9 km (conveyor)	Geared/gearless vessels
Adaro	36.1	26.5	80 (truck)	215/450 (barge)	Taboneo anchorage/IBT
Kideco	20.6	14.5	39 (truck)	58 (barge)	From TMCT to FC via 8KT - 12KT barges
Arutmin	14.3	13.7	7 (truck)	15/120 (barge)	Geared vessel/ Satui Port via 3.5KT – 7KT barges to NPLCT
Berau	11.2	7.7	13 (truck)	74 (barge)	From Lati to Muara Pantai
Indominco	11.4	11.1	35 (truck)	0/9 (conveyor)	Barge Port to Bontang CT

Coal Producer's Perspective

Storage, Handling and Transport Costs from Mine to T/S Facility

Activity	Location of Activity/Value Range	Cost analysis assumptions
Storage & handling (S&H)	@Mine site $1.20 - $2.40/tonne (t)	$1.80/t
Trucking	Mine to barge port/ $0.07 - $0.18/t-km 7 - 80 km haul distance	$4.50/t ($.09/t-km x 50 km)
S&H	@Barge port $1.20 - $2.40/t	$1.80/t
Barging (3KT – 12KT)	Port to T/S facility $0.02 - $0.12/t-km 1 – 450 km	$6.00/t ($0.03/t-km x 200 km; via 10KT barges)
S&H	@T/S facility $1.80 - $3.00/t	$2.40/t

Coal Producer's Perspective

- Hypothetical Coal Producer could save $0.19/GJ on S&H and Transport Costs if LRC is dried from 38% to 25% TM.
- The savings on logistical costs = $53 million for a coal supplier producing 20 mt of LRC per year or for a 600 MW plant ~ $7million per year.

	Cost ($/t)			Average Cost ($/GJ)	
	Low	**Average**	High	LRC@38%TM	LRC@25%TM
1. Storage & handling (S&H) @ Mine site	$1.20	**$ 1.80**	$ 2.40	$0.10	$0.08
2. Trucking- mine site to barge port (50 km)	$4.20	**$ 4.50**	$ 4.80	$0.26	$0.22
3. S&H @ Barge Port	$1.20	**$ 1.80**	$ 2.00	$0.10	$0.08
4. Barging- Port to T/S facility (200 km)	$4.80	**$ 6.00**	$ 7.20	$0.36	$0.29
5. S&H T/S Facility	$1.80	**$ 2.40**	$ 3.00	$0.12	$0.10
Total Cost	$13.20	**$16.50**	$19.80	$0.98	$0.79

- Between 2006 and July 2008, the price of Indonesian sub-bituminous coal increased by 160% while LRC prices increased by only 72%.

- Bottom Line: For a 600 MW plant fired on LRC (~2.5 mt of LRC/yr), a coal producer selling dried LRC w/25% TM will earn an additional $60.5 million/yr as a price premium plus reduce its inland transport costs by around $7 million/yr.

Coal type	2006 Price	Jul 2008 Price	2006 Price	Jul 2008 Price	% change
	(USD/tonne)		(USD/GJ)		(USD/GJ)
Indo Sub-Bit (5000 kcal/kg; 25%TM)	$35	$93	$1.68	$4.47	166%
Indonesian LRC (4000 kcal/kg; 40% TM)	$25	$43	$1.49	$2.56	72%

Power Plant Owner's Perspective
Negative Impact on Plant Performance and Increase in Plant Costs

Existing Plants

- If fired on LRC @4000 kcal/kg with 40%TM, plant will suffer losses in efficiency and output due to:
  - The coal mills, fans and boiler reaching their capacity limits
  - Increases in auxilary loads
  - Waste of energy in coal to vaporize moisture in the coal.
- With new coal-fired power plants costing between $1100/KW - $1500/KW, the value of the lost MWs = significant opportunity cost.

New Plants

- If designed to burn LRC, plant owner will suffer higher costs due to:
  - Extra capex for jetty, coal-handling system, boiler, & mills
  - Extra O&M for fuel storage
  - Extra transport costs
  - Lower efficiency
- Will push EPC costs to higher end of EPC cost scale and lower plant rank in merit order.

Despite large revenue potentials from coal drying, available technologies have not been widely implemented for four reasons.

1. For some technologies being proposed, drying costs at mine > savings + revenue gains:
    - Cost of fuel to generate heat and electricity for drying coal
    - Capex and O&M costs for drying device
    - Unrealistically high royalty expectations of technology companies.

2. Some drying technologies create changes in the physical properties of the coal, rendering the dried coal less marketable:
    - Dried coal crumbles more easily increasing % of fines & fugitive dust
    - Potential for moisture recovery leading to lost value from drying and greater risk of spontaneous combustion.

3. Some technologies are still considered “unproven” by coal producers.

Because of these issues, coal drying technologies applied at either the mine site or the power plant site currently are niche applications at best.

Implications for Carbon Emissions

- LRC Dried at Mine Site will:
  - require the burning of coal to generate heat and power to operate drying systems; and
  - result in increased net CO_2 emissions over case where undried LRC is burned in power plant even with savings in transportation and improved plant efficiency.

- LRC Dried at Power Plant Site should:
  - result in reduced CO_2 emissions over mine site application; but
  - with a significant loss of revenue and increased cost to coal producer.

Summary

- LRC is destined to become the primary coal brand of Indonesia by 2015 as existing reserves of sub-bituminous coal are depleted
- Coal drying technologies can hasten the shift to LRC by allowing boilers, optimized to fire either sub-bituminous or bituminous coals, to run on dried LRC.
- Cost savings and revenue gains to both coal and power producers are huge and growing with coal price increases.
- In Asia, many power plant boilers have been optimized to run on coals with 15% to 25% TM. Moving LRC into this existing market is the preferred way forward.

Summary – Technology Assessment

- Dryer applications at the mine-mouth are intuitively preferred due to the large savings in coal handling & transport costs but other factors – cost of heat and power and effect on coal physical properties – will determine whether mine site or power plant provides best location .

- Great River Energy's waste heat drying system and RWE's WTA drying system, should have near term potential at power plant sites in SE Asia.

- Binderless briquetters from White Energy may have attractive commercial applications at mine sites. Low cost LRC can be used to fire their flash dryer, product is very stable and transportation resistant. The final product is suited for plants designed to burn Australian bituminous coals, not Indonesian sub-bits.

- Pyrolysis systems, such as the K-Fuel process, will also have their most attractive commercial applications at mine sites and offer the best potentials for US and Chinese coals, where removal of S, Chlorine and Hg from the raw coal will add value. However, questions remain whether product is transportable & stable.

- Microwave drying is unlikely to find any near-term application and has the greatest technological and economic uncertainty attached to it.

Summary- Impact on Coal's Carbon Footprint

- Application of coal drying technologies at the mine site will likely lead to an increase in the carbon footprint of coal producers which will need to dry LRC by burning coal to generate heat for drying the coal.

- Recovering waste heat from a combined heat and power plant at the mine site will be limited by small loads on Kalimantan.

- Applications at the power plant site, however, will allow the use of either waste heat from the condenser or low temperature steam from the turbine to provide the heat source for fluidized bed dryers.

- On balance, power plant applications are likely to have a lower carbon footprint than mine site applications.

Comments may be sent to:
bart1@lppower1.com