

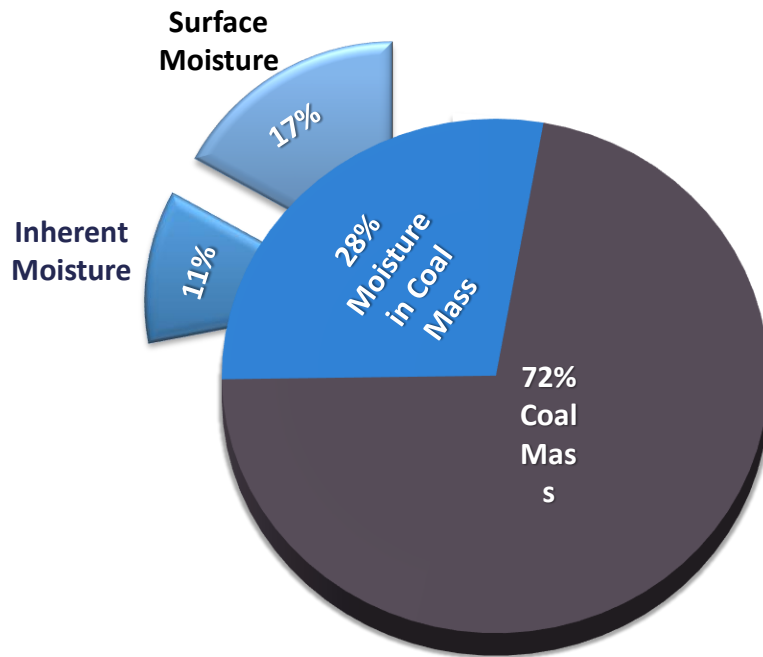
Coomtech Limited

**Drying Coal, Ash and Minerals
For Energy Generation**

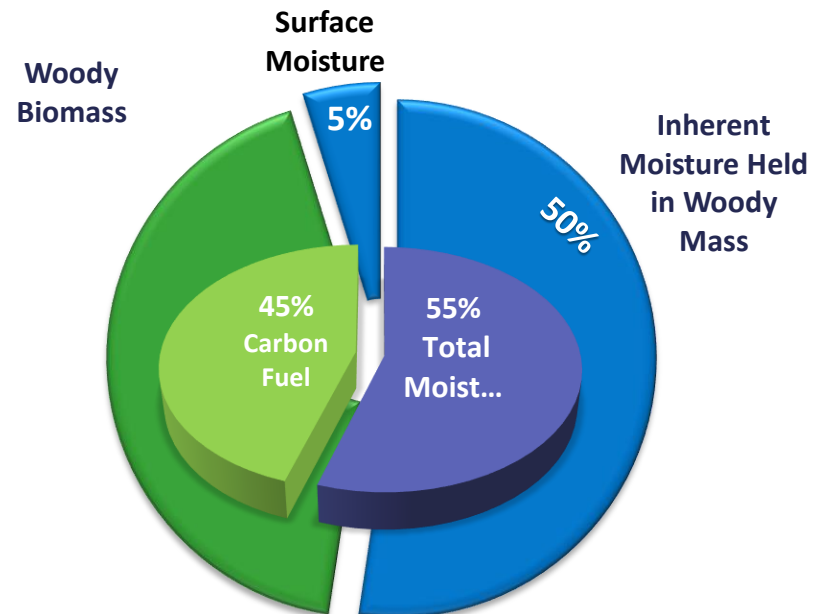
CCT 2017

Drying Coal, Ash & Minerals for Energy Generation

- Unique to Coomtech technology is the separate treatment of surface moisture versus the inherent moistures captured within, utilising the lowest cost non-thermal technology for surface moisture.
- The energy efficient, flexible Coomtech process can demonstrate effective treatment of coals and biomass, minerals, ash, or be configured to treat a pre-blended mix achieving improved homogenous co-firing fuels.
- Ash (PFA/FBA) is similar in behaviour to sand with virtually no internal moisture though physically consisting of glassy, bead-like particles know as cenospheres which are frequently cracked and hollow



EXAMPLE OF THE MAKE-UP OF A HIGH MOISTURE COAL



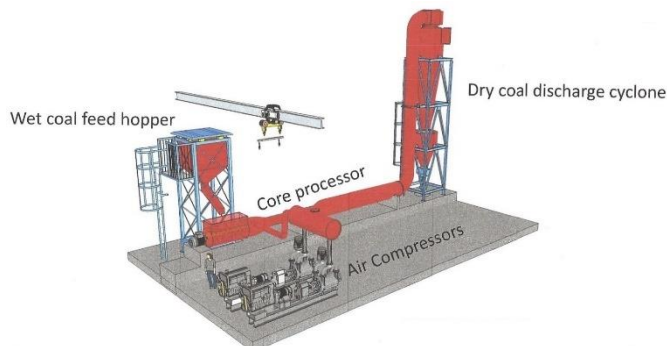
EXAMPLE OF THE MAKE-UP OF MOISTURE IN WOOD CHIP BIOMASS

Unique Dual Drying Approach

- A technology developer in low cost, low energy drying technologies
- Always seeking to develop the lowest cost option to dry and optimise its use before thermal energy is applied
- Targets include coal, ash, waste minerals, minerals and foodstuffs (organic and inorganic)
- Three technologies:

SMR: Surface Moisture Removal

Non-thermal turbulent air drying
Production design ready with extensive trials proven independently + scale up
Bituminous coals, minerals, ash, furnace waste streams

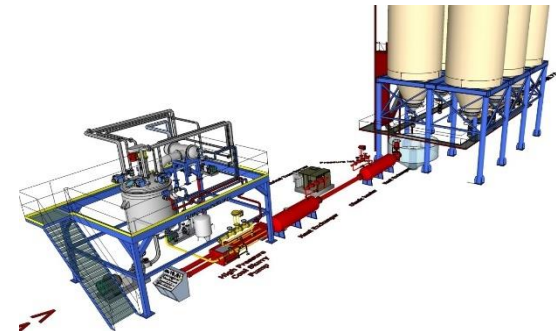


TMR: Micro Moisture Removal

Under development retrofit & co-configured with SMR to push difficult moisture to the surface
Coals, mineral waste streams, minerals, grains

IMR: Inherent Moisture Removal

Unique thermal technology targeting low rank coals & biomass
Under development with C-Tech for late 2017



Invested in these technologies to date circa £3.5m (Incl. £440k State aid)

Coomtech SMR Technology

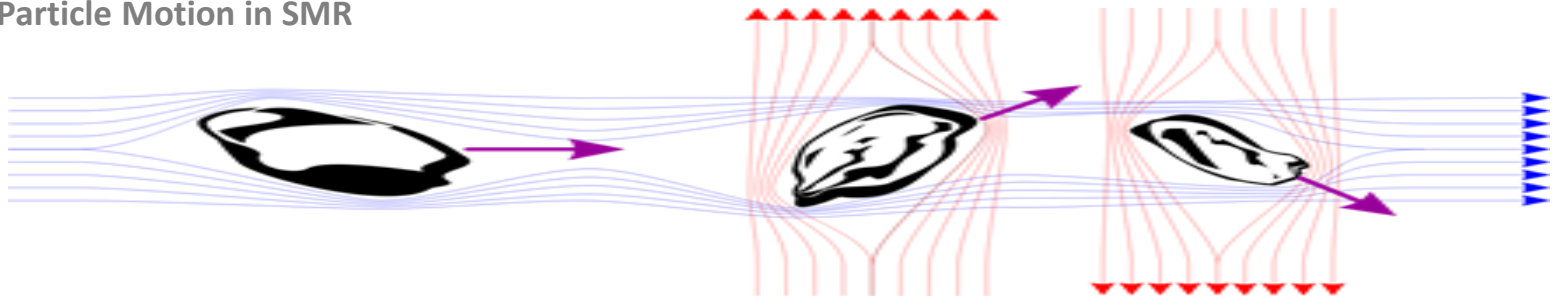
SMR – Surface Moisture Removal Technology (1)

- ❑ Coomtech's Surface Moisture Removal (SMR) process involves feeding material particles into a tubular device which uses high velocity low pressure unheated air to carry the material through the system, and at the same time introduces supplementary high pressure air to create severe aerodynamic turbulence which shears (removes) any surface moisture that is present from the material particles. The force that shears the moisture from the surface of particles arises from two effects:

➤ How the technology works.

- ❑ There are two basic sets of forces at work during this process.
 - There is a centrifugal force caused by the spinning of the coal particles and
 - Second is a linear force caused by the coal particles travelling at a different speed to the basic air flow.

Particle Motion in SMR



Coomtech SMR Development & Iterations

SMR Process – U.o.G Development Plant (Single Drying Zone)

Key Zones – depending on material up to 1.2t/hr throughput test unit



Feed Hopper

Feed Mechanism

Suspension Zone

Turbulence
Zone

Moisture
Extraction

Product
Collection
Filter

Coomtech Single Drying Zone Pilot Pre Industrialisation Configured in Perspex

Ash Run Drying - Optimised 2 Zone System

Large Scale Filter now in use at the Wolfson Centre
All material screened to <5mm pre-treatment

Multi Drying Zone Drying Trials

2 Drying Zones

Ash : received at 12.1%TM

Zone 1 & Zone 2: Continuous running
removing 86% of total moisture in
PFA – e.g.

PFA – ex Ratcliffe on Sour
TM 14.7% to 2.2% in a single pass

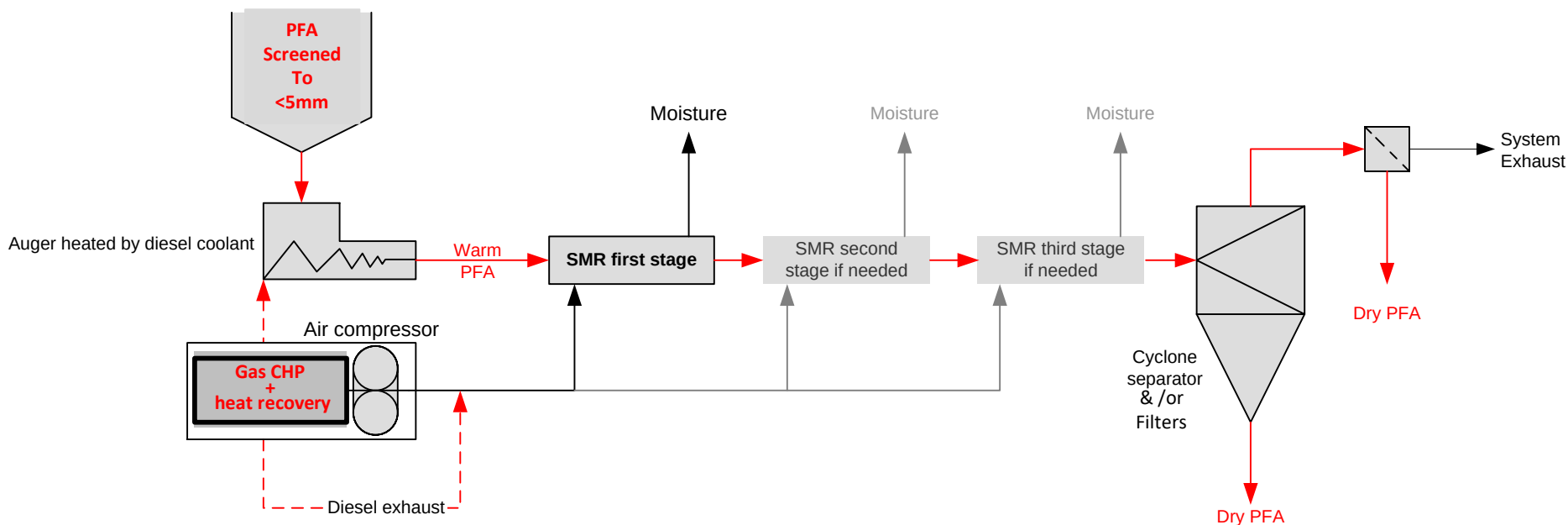
Throughput rates:

Optimisation continues with the
current programme having reached
900Kg/hr with confidence of
meeting 1T/hr dried output at
completion.

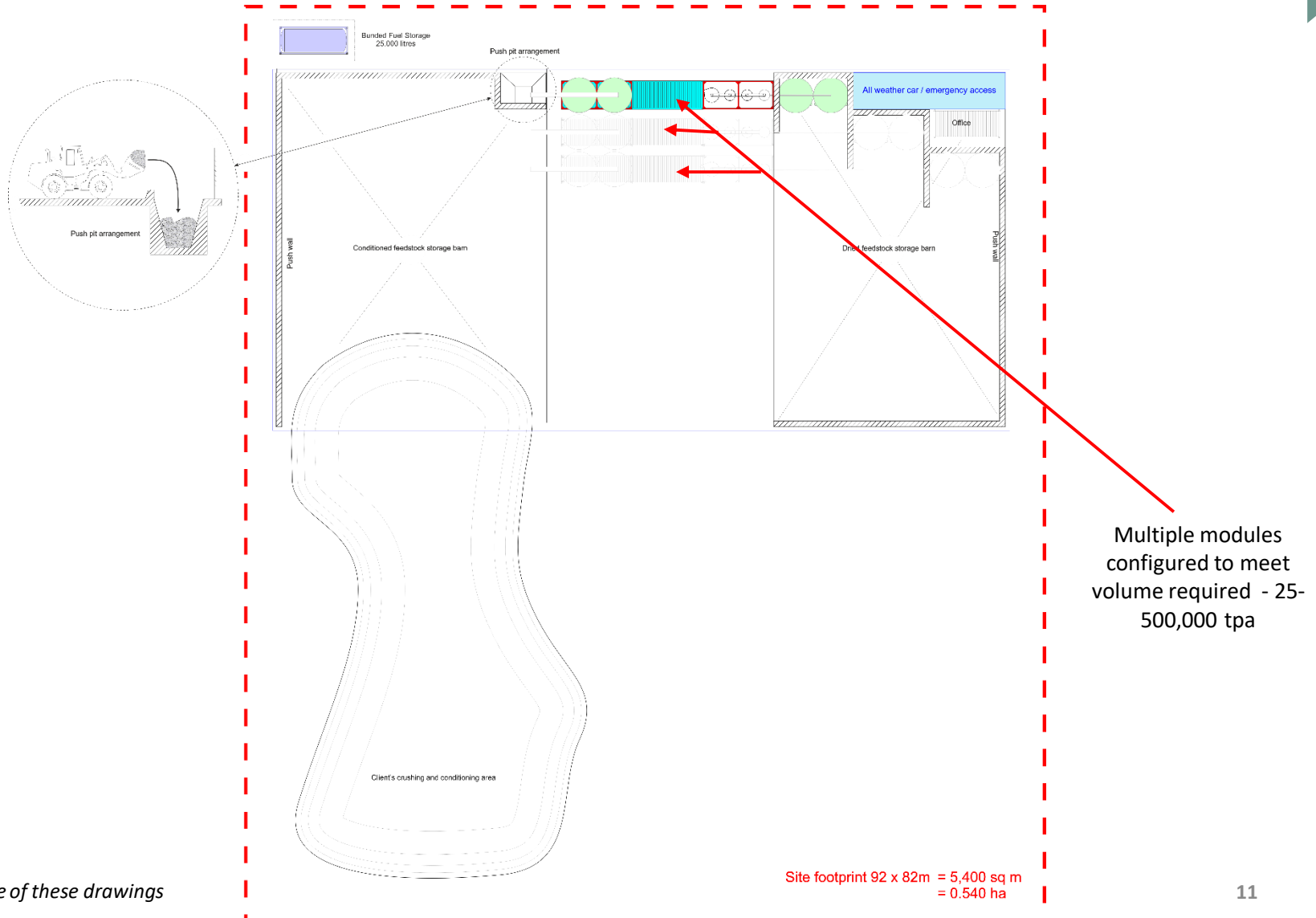


Conceptual System Proposal for PFA Drying

Based upon initial trialling results of PFA material provided by DRAX in the UK the SMR process achieved a drying of TM% reduction from circa 20% to below 3% with the single drying zone testing unit at U.o.G on three passes. The design proposed provides for similar drying conditions by a three zone plant to create a single pass continuous process at scale. Current UK proposed plants run from 50,000tpa to 250,000tpa.

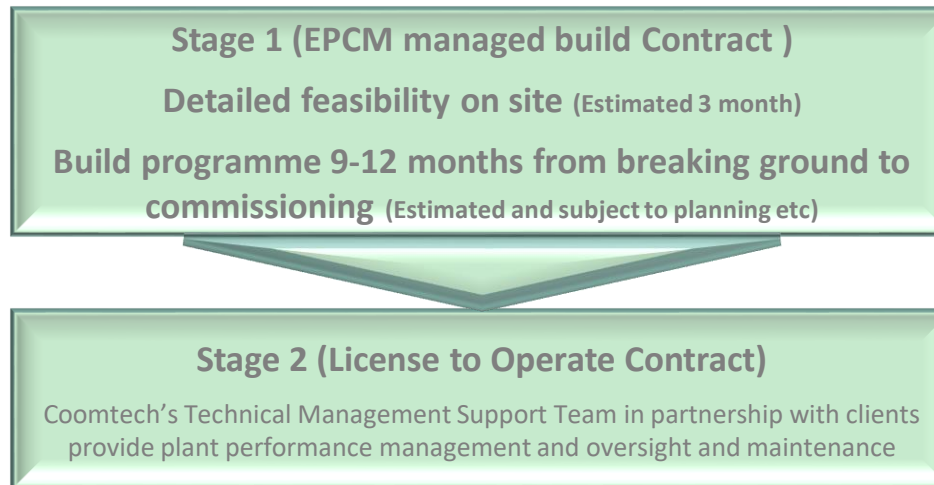


SMR Possible Site Layout – Up to 500,000_{TPA} Output



Coomtech SMR Business Model

Coomtech Business Model



- **Planning & Construction Cost:**
 - Coomtech will provide the design, planning and construction support for each client project with Coomtech's EPC guarantor from Feasibility through to Commissioning Phases : Capital cost to the client's budget or Coomtech can provide financing and insurance package acting as Lessor or Full Service Contractor
- **License To Operate With Coomtech IP – Ongoing Contract:**
 - During operations Coomtech will provide continual monitoring, product development, maintenance services and oversight to clients ensuring optimal performance over a minimum period typically of ten years.
 - License fees per tonne Capacity {£1.75/tonne capacity to Coomtech}
- **Full Service Option:**
 - In a fully serviced contract operations are undertaken by Hargreaves Services plc for and on behalf of Coomtech

Coomtech UK Plant Operating License

- The License will be based upon the relevant sections of the Coomtech License Matrix for a UK Operating Plant as highlighted below:

Material	Market Segment	Territory	Term
PFA	Co-Firing Mitigation	UK	10 years

- License fee at £1.75/tonne output capacity - payable in full from meeting agreed production threshold of moisture removal (refer below)
- A capacity fee – based upon annual output and agreed in principle with client e.g. 185,000tpa
- Payable in 12 x monthly instalments per annum over life of supply contract (usually 10 years renewable +5 year terms)
- Provides the following to Clients:
 - ❑ Access to the Intellectual Property of Coomtech Ltd to operate the Coomtech SMR plant supplied on agreed materials
 - ❑ Ongoing support of the plant to optimise scientific support and performance improvements including greater market experience with agreed materials where relevant
 - ❑ Access to new developments and ongoing continuous improvements of Coomtech IP in engineering, with first user options to upgrade commercially when available
 - ❑ Online support and monitoring of plant performance via link to Coomtech HQ
 - ❑ Drying module maintenance programme (swop out modular design) exclusive of parts costs

Results: Coals & Other Materials Tested

Client Engagement To Date

Since opening our doors to test client coals in June 2015, we have now actively engaged with the following producers and suppliers in testing programs and are actively pursuing commercial discussions.

Client	Coal Type Tested	Coomtech 500K tpa Potential Modules	Global Demand identified
EDF 	Bituminous	2	11m tpa
Hargreaves 	Bituminous	2	3m tpa
RWE 	Lignite	1	100m tpa
EPH 	Lignite	1	80m tpa
BANPU 	Sub-bituminous & Lignite	1	42m tpa
Suek 	Bituminous Sub-bituminous	1	In discussion
PGE 	Sub-bituminous & Lignite	1	50m tpa
Drummond 	Bituminous	1	20m tpa

Coomtech Testing: A Sample Range of Coals

- Coomtech has set out to run trials on a number of coals across the range of qualities from high quality bituminous coal to a Low Rank lignite and to evaluate the impact on the Total Moisture and CV too.
- The following coals have been acquired amongst others and continue testing as a core range for Coomtech technologies to demonstrate the impact of the technologies as seen below:

Type	Source Locations	Total Moisture Av' AR	CV Av' AR	Coomtech Technology
Bituminous	Colombian	16%	5795 Kcal/Kg	SMR
	UK - Waste Coals	18%	5400 Kcal/Kg	SMR
Sub-Bituminous	Russian	31.2%	4317 Kcal/Kg	IMR - SMR
	USA PRB	26.2%	4900 Kcal/kg	IMR - SMR
Lignite	German	48.9%	2330 Kcal/Kg	IMR - SMR
	UK	42%	2490 Kcal/Kg	IMR - SMR

- Coomtech is building a library of results that reflects the diversity in coals and indeed within coal types.
- Detailed internal economic analysis specific to the client sources for these coals indicate commercial viability even at the shaving of 4% TM points of a high quality coal though these remain confidential to those clients presently.
- However specific results of the impact of drying on moisture levels remain available for demonstration of the SMR/IMR performance.

SMR Trial Results – Coals -Targeted TM's

- UK Sourced “Pond Fines” - moisture content up to 16.8%
 - Required below 11%
 - Particle size Screened to <5MM post crush
 - SMR in a series of runs on prepared batches:
 - Average In TM 16.8%
 - Average Out TM 9.9%
 - Average removal of total moisture available – **41.07%**
- Drummond La Loma bituminous - moisture content up to 16%+
 - Required below 12%
 - Particle size Screened to <5MM post crush
 - SMR in a series of runs on prepared batches:
 - Average In up to TM 16. 0+%
 - Average Out TM 11.8%
 - Average removal of total moisture available –**26.25%**
 - CV uplift 4.02%

Powder River Basin – IMR-SMR Initial Results

Black Thunder Mine PRB Coal

Incoming Moisture Specification

Moisture tightly held as Internal / Inherent

TM% = 26.2%

lhM% = 7.1%

Milling

Sizing to 3-5mm

IMR Result: Achieved with Russian sub-bituminous and Lignite too

Coomtech IMR Processing

Pushing circa 60-64% of

Inherent moisture to the surface and disrupting Internal moisture bonds. Hydrothermal process adds Total Moisture

TM% 34/35%

Coomtech SMR Processing

Disruption of Internal /Inherent moisture enables the SMR process to access more free water.

TM% 15.4-16.6%

Hydrophobic
Low reuptake of internal moisture

Reduction of TM
as received –
10.8% - 9.6%points
41% to 36% Reduction

Pyrophobic
Reduced thermal instability

Tests targeting a mid-teens TM to blend the Black Thunder Coal with bituminous grades

Ash Run Drying Multi Zone (3) System

NB: Fine dry dust at filter joints from
<3% TM Ratcliffe PFA being run



Initial Small Filter System

All material screened to <5mm

Runs of material repeated under controlled conditions to reflect multi zone drying in production.

Multi Drying Zone Drying Trials

2 Drying Zones

Ash A: received at 12.1%TM

Zone 1: 1: 6.2%

Zone 2: below 3%

Drax

3 Drying Zones

Ash B: received 23.1%TM

Zone 1:

Zone 2:

Zone 3: below 2%

Ratcliffe on Sour

Throughput rates:

Original design capacity: 250Kg/hr

Peak with PFA reached :950Kg/hr

Peak with Metal Oxide Waste – 1.2T/hr

Coomtech - Impact for Europe

- Europe is a major producer and power consumer of lignite. European lignite production is currently in excess of 430 million tonnes (mt) which is nearly half of total global production of around 1 billion mt
- Of total European lignite production, 43 percent of comes from Germany, of which 95 percent is used for electricity or heat generation. Lignite power plays a major role in Germany's power generation which accounts for 26% of total generation, used mostly for base-load with hard coal accounting for a further 19% of total power production.
- Other top European Union producers include Greece, Poland and the Czech Republic, while the most significant producers outside of the EU include Turkey (75.6 million mt) and Serbia (37.5 million mt).

<u>Country</u>	<u>Millions Tonnes p.a.</u>	<u>Country</u>	<u>Millions Tonnes p.a.</u>	<u>Country</u>	<u>Millions Tonnes p.a.</u>
Germany	185.5	Czech Republic	43	Hungary	9
Poland	64	Bulgaria:	31	Slovenia	4.5
Greece	62,8	Romania	30	Slovak Republic	2.5
				Total	423.3

END

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