CREATENERGY
delivering outcomes

WASTE OIL IN BLASTING

ISEE Conference November 2016

Presented by: Adrian Abbott

International Society of Explosives Engineers
Australian Chapter

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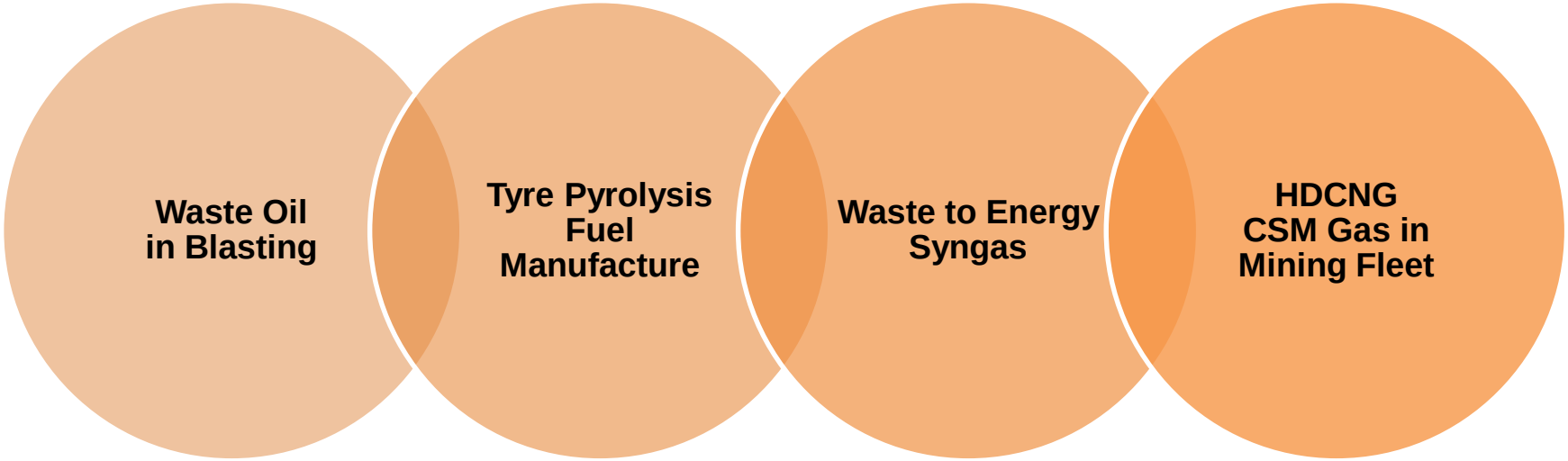
Strategy and Capability – Play to our Strength

CREATENERGY^{e} is committed to innovating waste to energy projects that provides immediate commercial and environmental benefits for the mining industry.



Waste Oil in Blasting Trials

RTIO / Shell ~ 1996

Used Oil – Waste or Resource

Shell assisted a leading iron ore producer, Hamersley Iron, turn what was regarded as a waste product into a valuable energy source for their blasting explosive.

Hamersley Iron, a member of the Rio Tinto group, is one of the largest iron ore producers in the world; accounting for about 10% of the worlds traded iron ore. The company operates several open pit mines and associated rail and port facilities in the remote Pilbara region of Western Australia.

Shell has been the fuel and lubricants supplier to the company for the past 35 years.

The first stage of the production process is the drill and blast to create broken stock. Large face shovels load the ore into haul trucks for transport to the crushing and screening plants.

The most common explosive is referred to as ANFO , a blend of Ammonium Nitrate and Fuel Oil. The fuel oil is traditionally automotive diesel fuel, but can be any suitable hydrocarbon.

The combined operations generate in excess of 1 million litres of used lubricants per annum. Disposal of such large volumes of used oil posed a serious environmental problem for Hamersley.

In 1996, Hamersley established a project team to investigate waste oil disposal methods. The team quickly realised that it was not simply an issue of disposal of a waste product but a much wider issue of hydrocarbon management. Used oil was no longer a waste to be disposed of but a resource to be managed to minimise environmental impact.

At that time, the only outlet for used oil was to transport it 1600 km to Perth for burning in brick kilns. Transport was expensive and there was no guarantee that this avenue of disposal would be available in the long term as supply was rapidly exceeding demand.

Research indicated that used oil could displace up to 50% of the diesel fuel in the ANFO. Apart from a limit on the water content, there were no other limitations on the composition, so segregation of oil types was not necessary.

An emulsion explosive also offered another option for use of limited volumes of used oil. Because the emulsion characteristics are critical, a segregated used engine oil supply was necessary. A suitable supply was readily available at the locomotive workshops.

Because of the limited experience with used oil in ANFO and to overcome the natural conservatism of the Drill & Blast crews, Hamersley decided to construct a demonstration facility at the Marandoo minesite. Shell was approached by Hamersley to design, construct and manage the facility as an extension of the Shell Cradle to Grave service program.

The plant at Marandoo incorporated floating suction to limit water in the blend and positive displacement metering pumps driven from a common shaft to ensure accurate blend control. The plant was commissioned in 1998. The initial blend ratio was 33% used oil to diesel, but was soon changed to 50% based on satisfactory blast performance.

Following the success at Marandoo, Hamersley and Shell are currently designing and building similar plants at other major Hamersley minesites.

Once these plants are operational, Hamersley expects to consume in excess of 0.5 million litres of used oil which otherwise would be treated as waste. Annual net savings are predicted to exceed $200,000.

Shell will continue to work with Hamersley to implement other initiatives aimed at reducing the volume of used oil generated. Together with a possible increase in the used oil in ANFO, Hamersley may achieve their ultimate goal of reprocessing all used oil on site.

Drill pattern on a bench

Waste Oil in Blasting

Industry Position

Waste Oil Fuel Blends Deliver a Fuel Oil Cost Reduction for Bulk Explosive

Project Summary

WASTE OIL FUEL BLENDS DELIVER UP TO A 25% FUEL OIL COST REDUCTION FOR BULK EXPLOSIVES

Dyno Nobel have worked collaboratively with CREATENERGY® to bring new technology to the processing of site-based waste oil and blending with diesel fuel oil for the onsite manufacture of bulk explosive products. The result has been a reduction in bulk explosive fuel oil cost of up to 25% for customers adopting this new technology.

The containerised solution to enable onsite waste oil processing and blending with diesel fuel oil provides a system that has a small footprint and full automation, enabling a 24/7 operation that can be easily integrated into a mine site waste oil recovery and storage system.

Dyno Nobel has undertaken extensive laboratory testing and blast trials in Eastern Australia to ensure that the use of a waste oil diesel fuel blend delivers, as a minimum, equivalent blasting results in ANFO and ANFOmulsion blends. The results in emulsion based products are underpinned by the robust formulation of Dyno Nobel's TITAN® range of emulsions, allowing the inclusion of processed waste oil into the ANFO fuel blend.

Background

WASTE OIL DIESEL FUEL BLENDS IN ANFO

The use of waste oil diesel fuel blends in ANFO and ANFOmulsion blends has been employed for many years to achieve:

Reductions in the cost of blasting

The direct replacement of up to 50% of the diesel in ANFO with waste oil delivers an immediate reduction in bulk explosives fuel oil costs to mining operations.

Improved environmental and social management

The consumption of waste oil onsite in explosives is strongly aligned with mine site environmental objectives, and the reduction of road transport for both waste oil removal and diesel delivery to site improves local social outcomes by reducing road traffic and the potential for environmental damage due to spillage during transport and handling.

While the onsite processing of waste oil is not new technology, the rapid development of satellite communications and rugged processing platforms has enabled the most recent development of remote processing plants.

Robust emulsion technology

The robust formulation of Dyno Nobel's TITAN range of emulsions enables the partial replacement of fuel oil with processed waste oil without affecting performance for emulsion based products.

Advanced processing and blending technology

CREATENERGY has developed purpose-built proprietary equipment and processes to enable the safe, reliable and consistent processing of waste oil to a standard required to replace up to 50% of the diesel in blasting. The equipment is containerised and modular to facilitate ease of transport, installation and customisation to specific site needs.

DYNO
Dyno Nobel
Groundbreaking Performance™

Orica has developed a Waste Oil Specification
Refined waste oil must meet this spec

ORICA

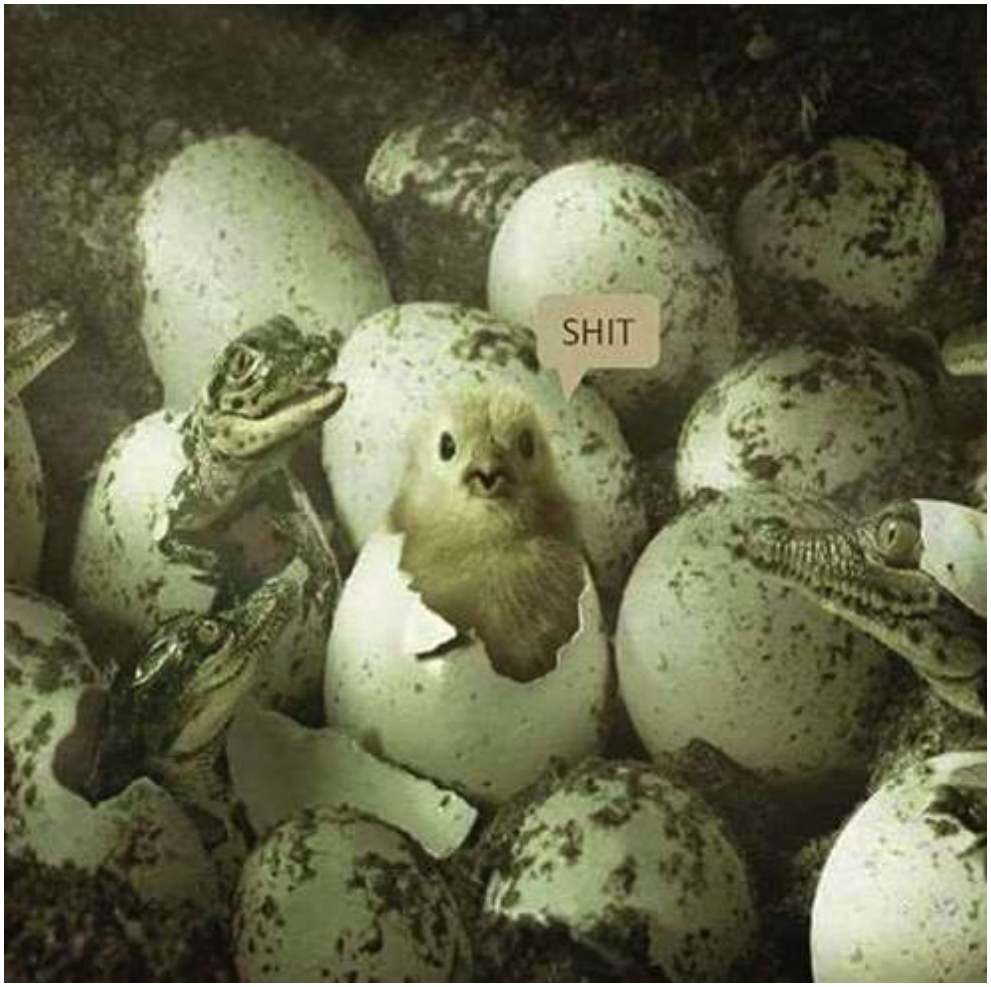
• Arsenic	<5ppm
• Cadmium	<2ppm
• Chromium	<10ppm
• Lead	<100ppm
• Halogens	<1000ppm
• Polychlorinated Biphenyls	<2ppm
• PAHs	<1000ppm
• Glycol	<0.2% volume
• Particulates	<25 micron
• Density	<0.90 g/cc at 15degC
• Flash point	>65 degC
• Viscosity	<50 Cp
• Water	<2.0%

Australian Chapter

CREATENERGY®

Challenging existing Industry

Competitive feedback . . .



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Waste Oil Processing Project

2010 - Trial & Testing Units

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Proof of Concept

Product and process testing

Velocity of Detonation (VOD) – product self sustains as required in a production shot environment (4,500+ m/s)

Fume – No fume noted on shot at firing

Visual – Motion and still photography was captured during and after blasts identified no abnormal observations. A power–trough allowed visual observation down into the blasted strata exposing successful fragmentation

Heave Profile – An even profile across the heave pile, indicating a similar energy release between standard bulk explosive and the processed oil product. No evidence of fly-rock, fume, over-pressure or air blast

Fragmentation – Statistical evidence from plant performance, combined with visual and photographic evidence indicates fragmentation and diggability are consistent

Waste Oil Processing

QLD Coal (2015)

Project: Process site generated WEO for use as a Diesel Substitution in Blasting
WEO Generated: 1.2 million litres p.a
Design: 40' High Cube Containerised / fully automated operation
Processing: 1kl per hour
Storage: Waste Tank feed from Tank Farm / Internal Processed Tank 41 kl
Sludge Waste: Added to existing site Oily Water pit

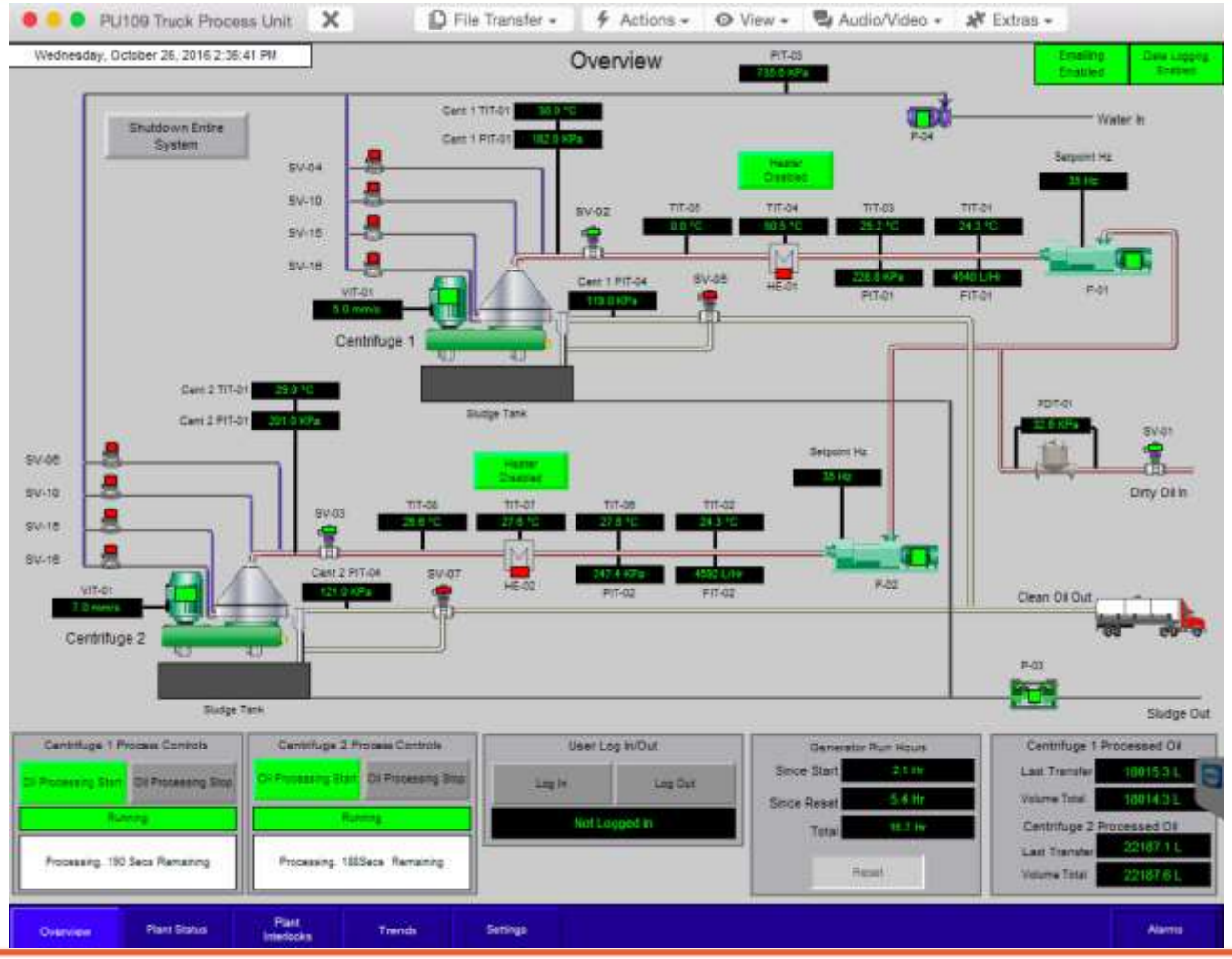
Waste Oil Processing Unit

QLD Bowen Basin

Project: Develop a Mobile Processing Unit to service multiple Clients within a geographic region
WEO Volume: 10 million litres per annum
Design: Fully automated operation (4G monitored HMI)
Processing: 1kl – 8 kl per hour
Storage: Tri-Axle ~ 30kl mobile storage
Sludge Waste: Discharge to Client Oily Water circuit

Waste Oil Processing Unit

HMI 4G live and operational



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Waste Oil Process / Blend Project

QLD Coal (2015) ~ Blend

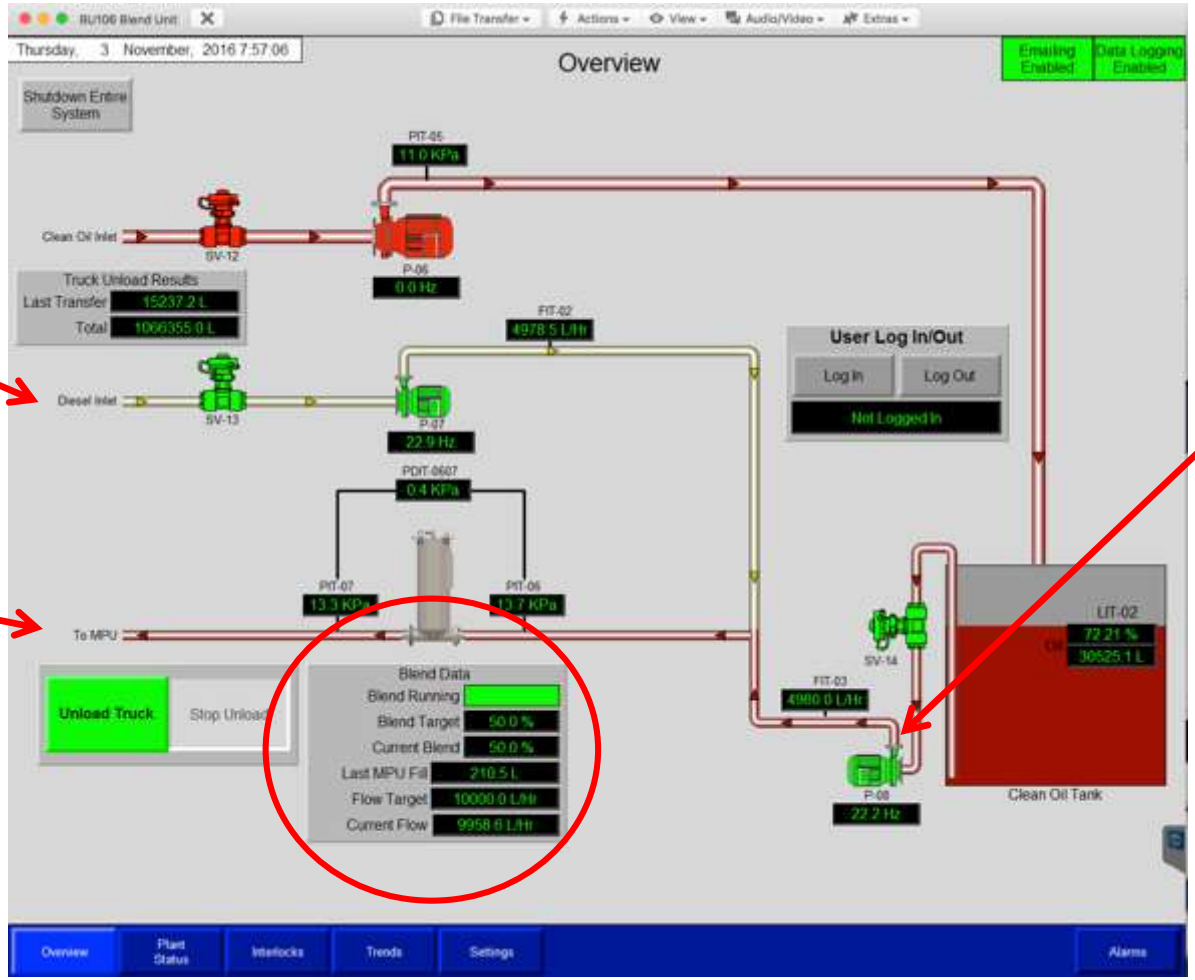
Project: Blend site generated PFO @ 50% as a Diesel Substitute for use in Blasting Trucks
PFO Throughput: 1.2 million litres p.a
Design: 40’ High Cube Containerised / fully automated operation (3G monitored HMI) / in-built Generator
Storage: Storage Tank 41kl
Dispensing Flow: 245 lpm
Dispensing Fuel Gun: Banlaw

Re-Load Blend & Dispensing Unit

Operational Performance

Diesel Inlet

MPU Outlet
Banlaw Gun



PFO Pump

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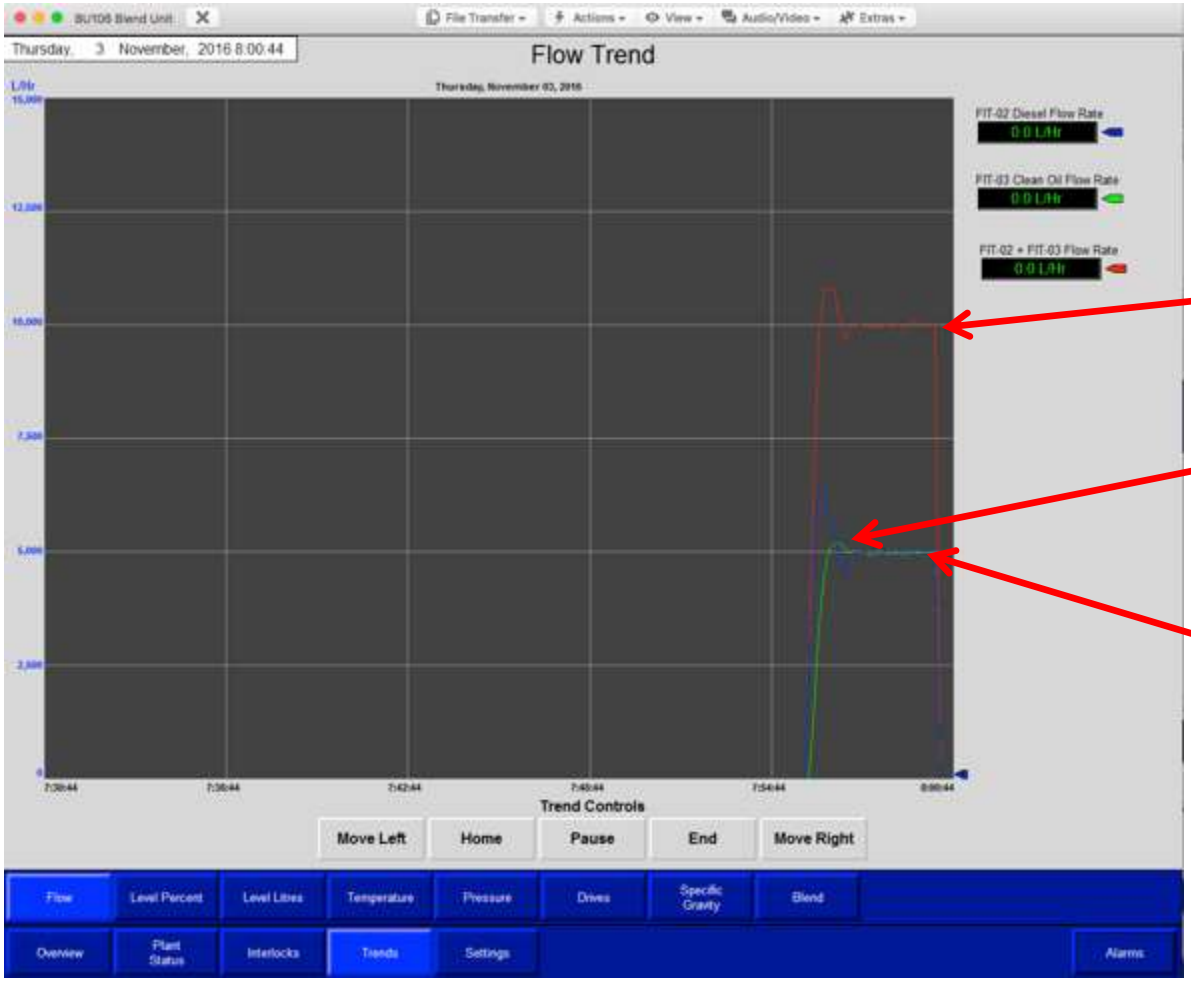
Re-Load Blend & Dispensing Unit

Operational Performance



Total MPU flow rate

Diesel flow rate

PFO flow rate

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Benefits

- Immediate 25% ANFO fuel cost saving
- Immediate 50% reduction in diesel use at the Reload facility – for ANFO use
- A consistent high quality of waste oil into processed fuel oil (ANFO) as a diesel fuel substitute
- 100% use for the waste oil generated at site – completing the cradle to grave usage of lubricants
- Complete auditability & traceability of product
- No charge in the unlikely event of equipment unavailability due to equipment downtime
- A small footprint, containerised solution
- Fully automated (no on-site resources required)
- Monthly reporting for sustainability & blasting detailing quantity processed, blended & used
- 24 Hour service centre support
- 3G/4G remote HMI monitoring
- Monthly analysis and quality control

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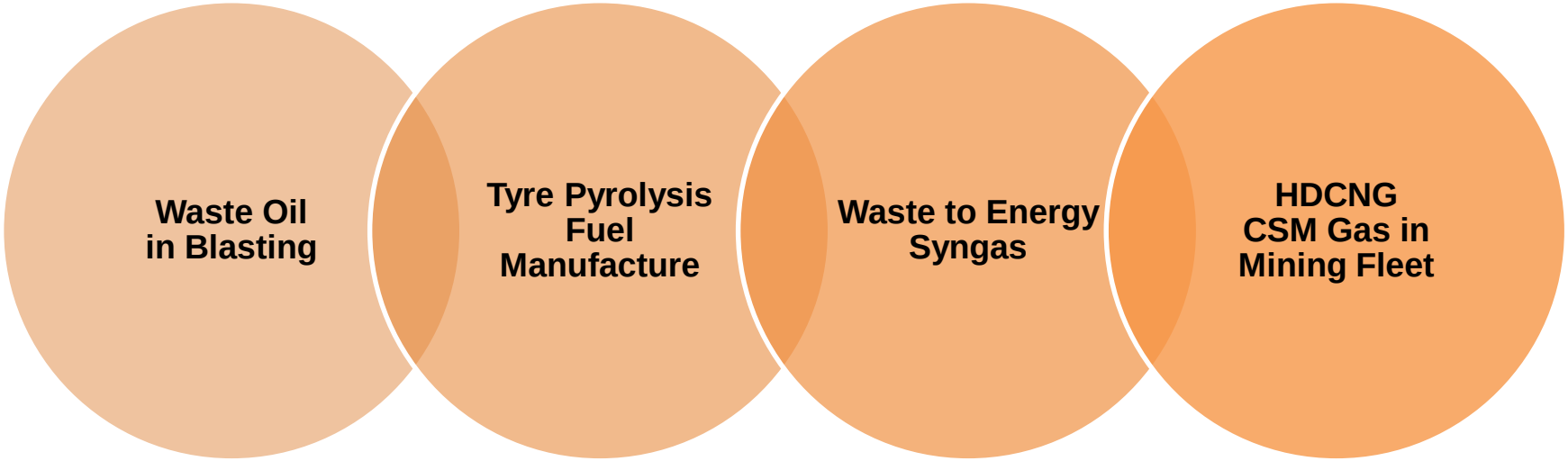
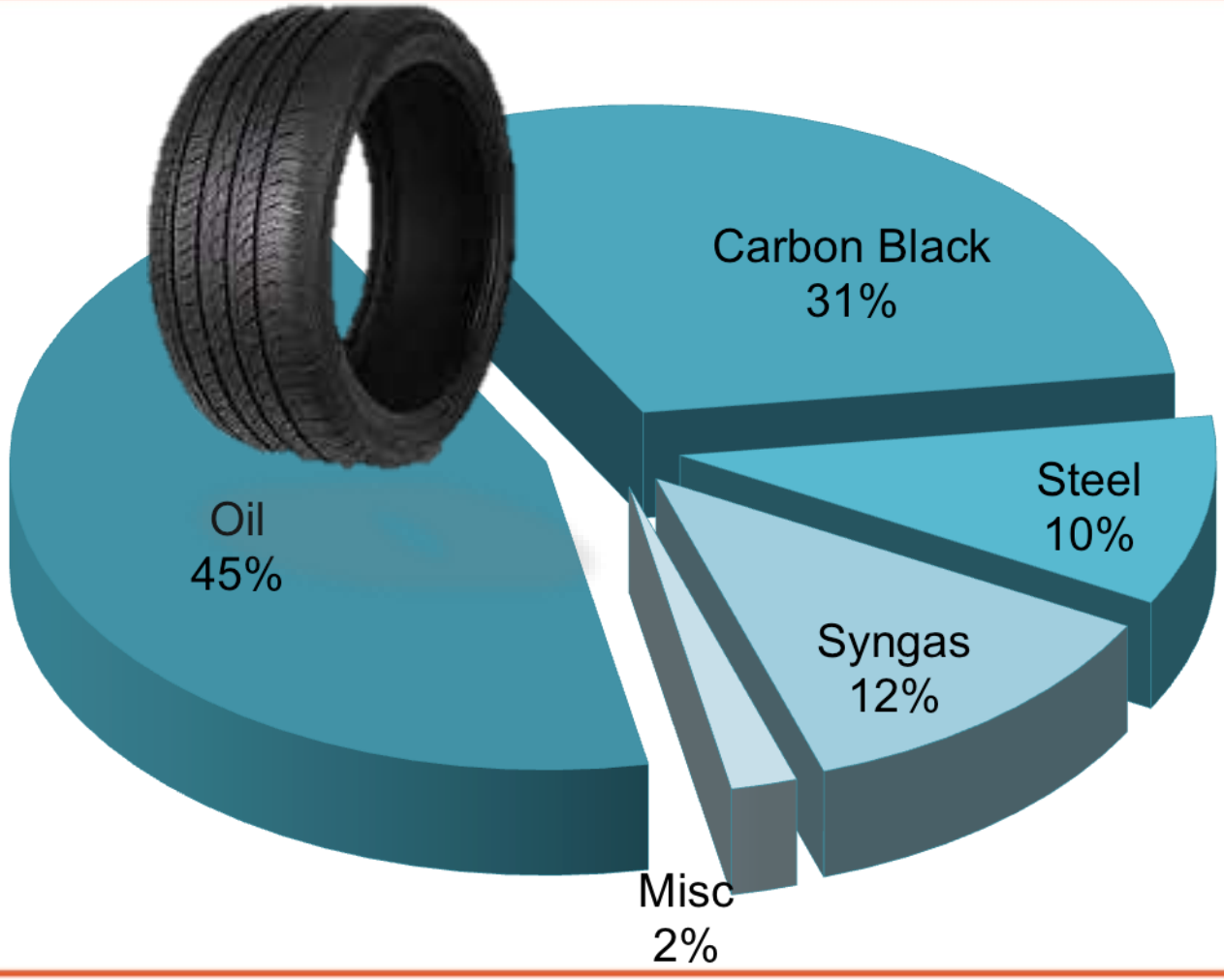


Tyres 2 Liquids

What's the value



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Waste 2 Energy

Trial Processing

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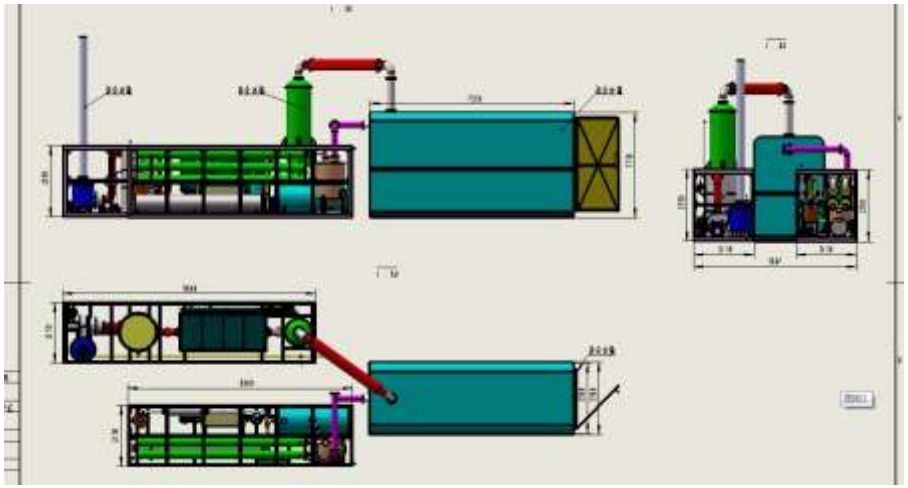
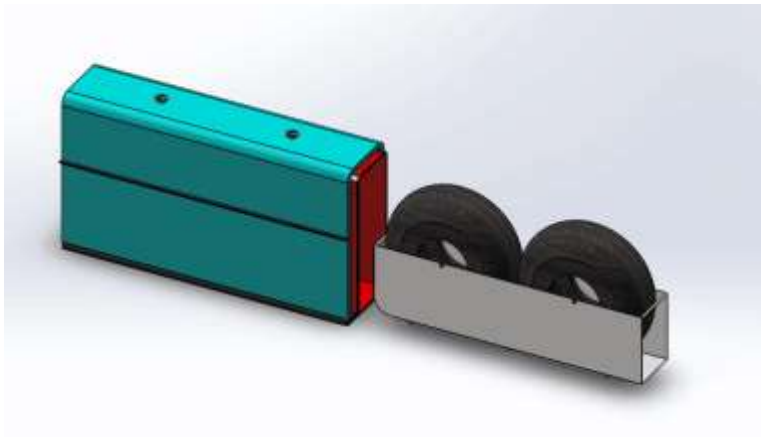
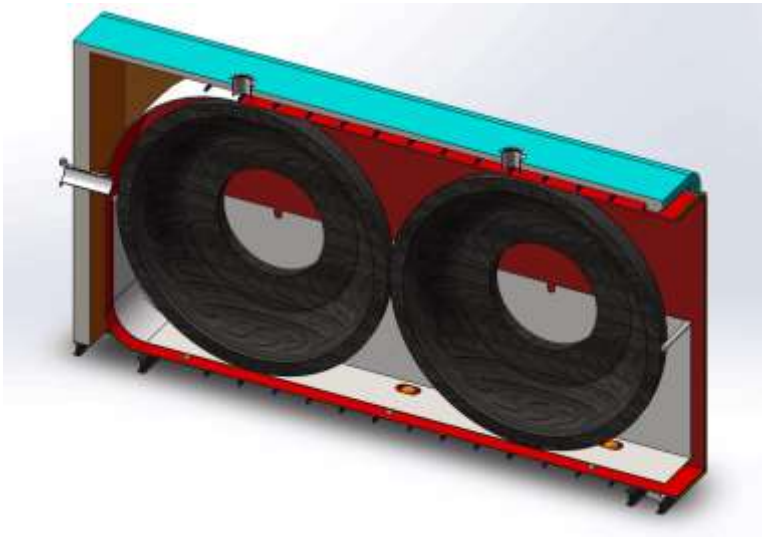
Waste 2 Energy

OTR Mining Tyres to Liquids (Diesel Substitute)







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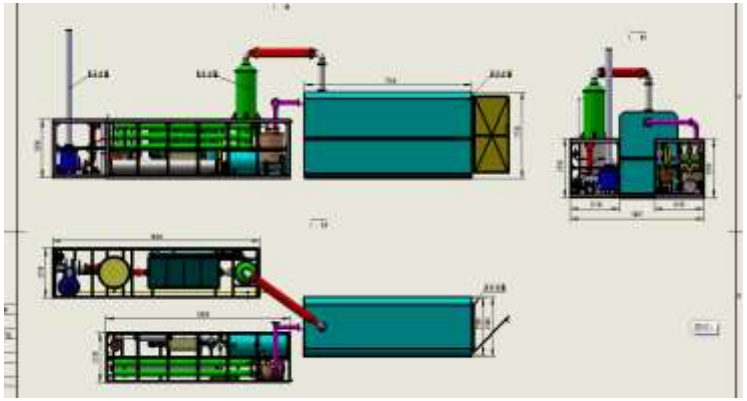
OTR Mining Tyres to Liquids (Diesel Substitute)



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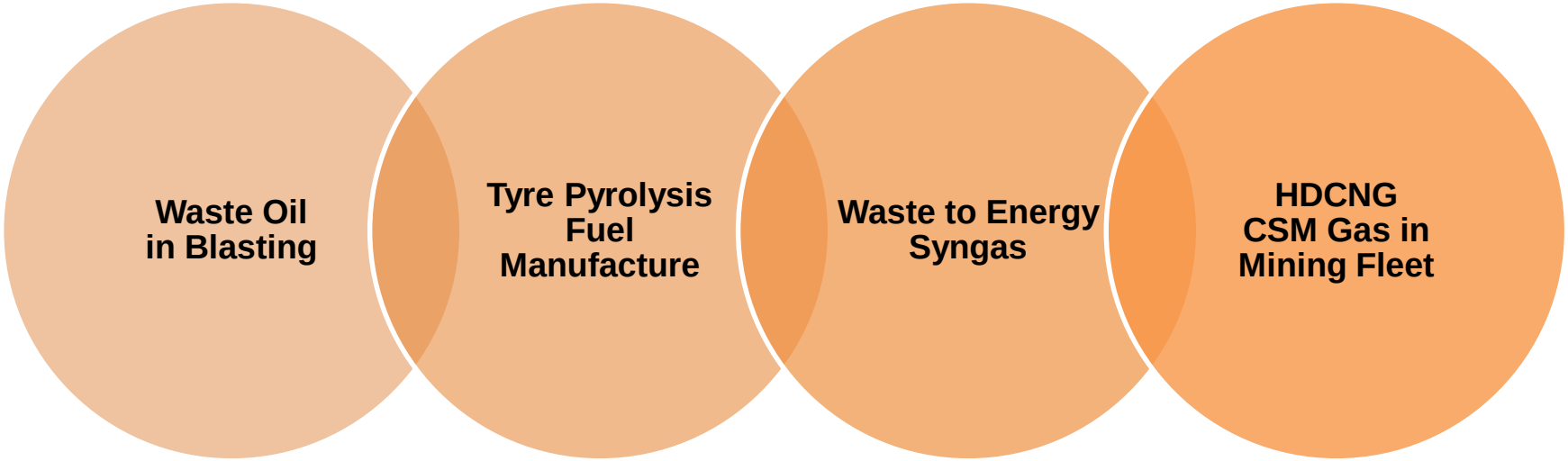

Waste 2 Energy
HDCNG Research & Development

VIDEO

Waste 2 Energy

HDCNG Research & Development

Waste 2 Energy

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MINE ENERGY SOLUTIONS

HDCNG™ In Field Trials

Site Test and Demonstrations

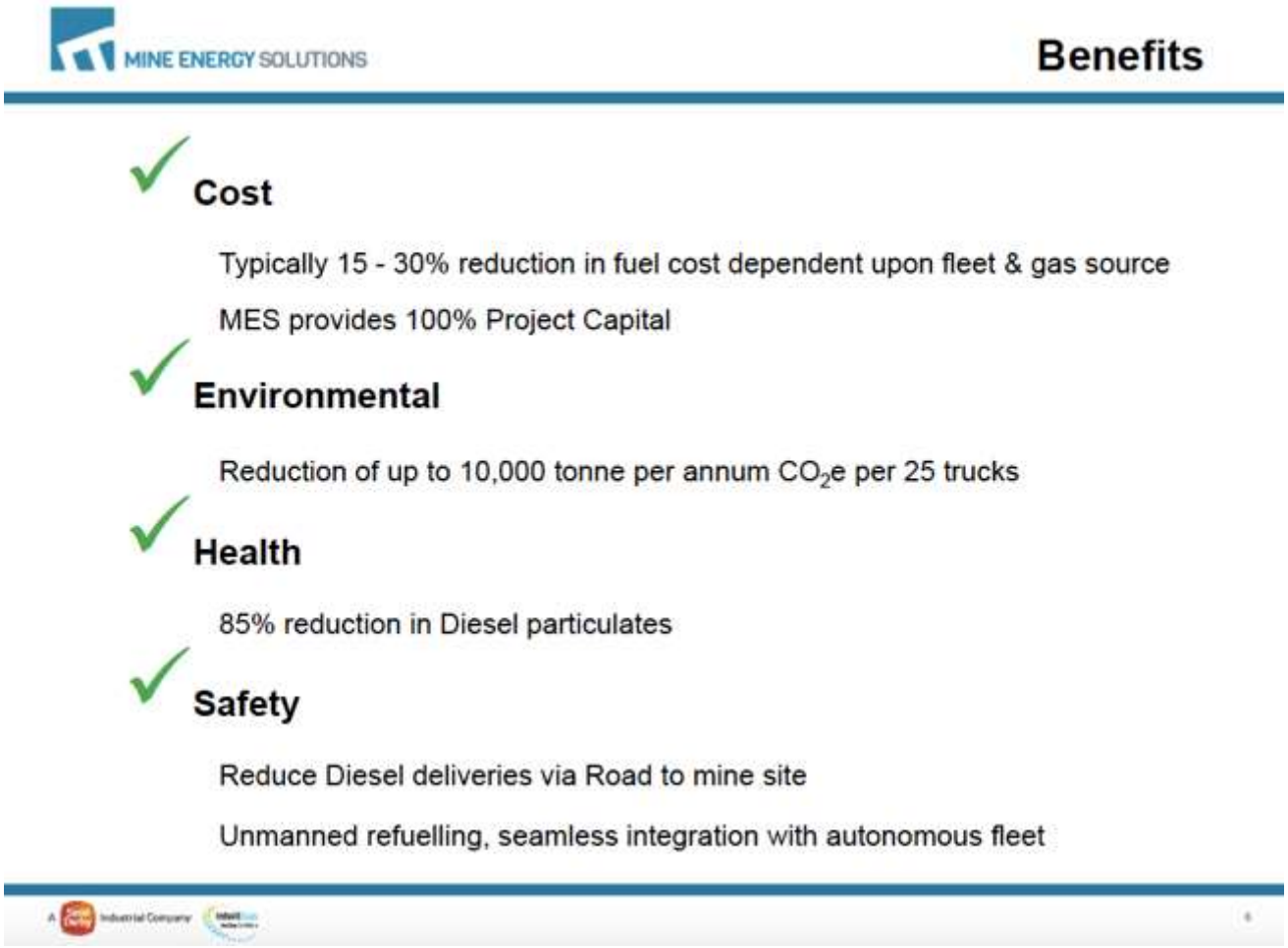
- Truck was run unloaded and fully loaded
- Pictures shows truck climbing out of pit fully loaded with 164 tonne payload
- Real time telemetry screen snip taken at full throttle during fully loaded run
- Diesel displacement of 88.3% typical for full throttle operation up to 1750 rpm with peak of 90% set for trial.
- Part load substitution figures around 80%.

- Analysis of operating trucks on 5 sites indicate 82% to 85% average displacement over the drive cycle.

- ❑ Industry experts were given the opportunity to drive the truck and gain first hand feedback on the performance of Truck 573.
- ❑ The overwhelming conclusion was that there was no discernable difference in engine or truck performance utilizing the HDCNG™ dual fuel configuration; however, the reduction in vibration and noise was noteworthy.

Waste 2 Energy

HDCNG Research & Development



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First to be Second

"I want you to find a bold and innovative way to do everything exactly the same way it's been done for 25 years."

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Innovation for the Mining Sector

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