Loganholme carbonisation journey

Strategic Challenges and Opportunities

November 2024

Objective

To provide an understanding of the Gasification journey for Logan Water, Pyrocal and the QLD Water Directorate; its complexity, opportunities and challenges, so that we may galvanise industry support for better policy development and improve regulatory decision-making.

Innovation share

Yorkshire Water ATC Gasification Project wins share of £40 million In Ofwat's latest Water Breakthrough Challenge

Source: Yorkshire Water

HOT OFF THE PRESS!

UK water regulator awards
a coalition funds to trial gasification at
Yorkshire water

Biochar - a useful, safe end-product

- Recovers energy from waste
- Reduces biosolids volumes by >90% from 34,000 to 2,200 tonnes per year
- Reduce Carbon emissions (-54% reduction)
- Destroys POPs like PFAS and micro/nano plastics
- Retains nitrogen, phosphorus and potassium (bio-available)
- Reuse options for e.g. soil improver, potting mix additive amongst others (construction materials, road base, filter media)

The ask – shared outcomes

The road travelled…

Introduction

Design development

Drivers for change / Value Proposition

Biosolids Gasification overview

- Dewatering
- Drying
- Gasification

Challenges for Regulators and Industry

- Gasification Environmental Authority
- Draft End of Waste Code for Biochar
- Sector challenges

The call to arms…

Introduction

Background

- Loganholme is Logan City's largest wastewater treatment plant (circa 65-70ML/day), circa 110,000 EP
- 1.1 MW solar farm, old versus new tert. plant (oxidation ditches/MBR)
- Produces 34,000 tonnes of biosolids each year
- Six truckloads of biosolids transported 300km for disposal daily
- Project established to provide an alternative to the biosolids disposal and realign to the "end of waste code - biochar"
- Reduces the amount of biosolids requiring disposal by 90% and reduces the carbon footprint of the Loganholme WWTP

Driver for Change

People, planet, prosperity

- Disposal: Trucks a day x 6 days a week to Darling Downs
- Disposal costs: $1.8 million per year and rising ~ 30% of WWTP operating costs
- Future biosolids treatment and disposal costs increases will be driven by:
    a. Electricity prices
    b. Disposal rates
    c. Changes in regulations
- Council targeted achieving carbon neutrality for its operations by 2022 – a strategic move towards a circular economy

Services

- Biosolids trials at Pyrocal's Wellcamp facility to determine PFAS levels, heat/energy balance, fouling rate, biochar properties
- Mobile dryer to produce dry biosolids for trials and testing
- Business case input
- System design
- Dryer supply and integration
- Operating and maintenance support
- Biochar product and market development
- Biochar offtake agreements
- Cardon credit support

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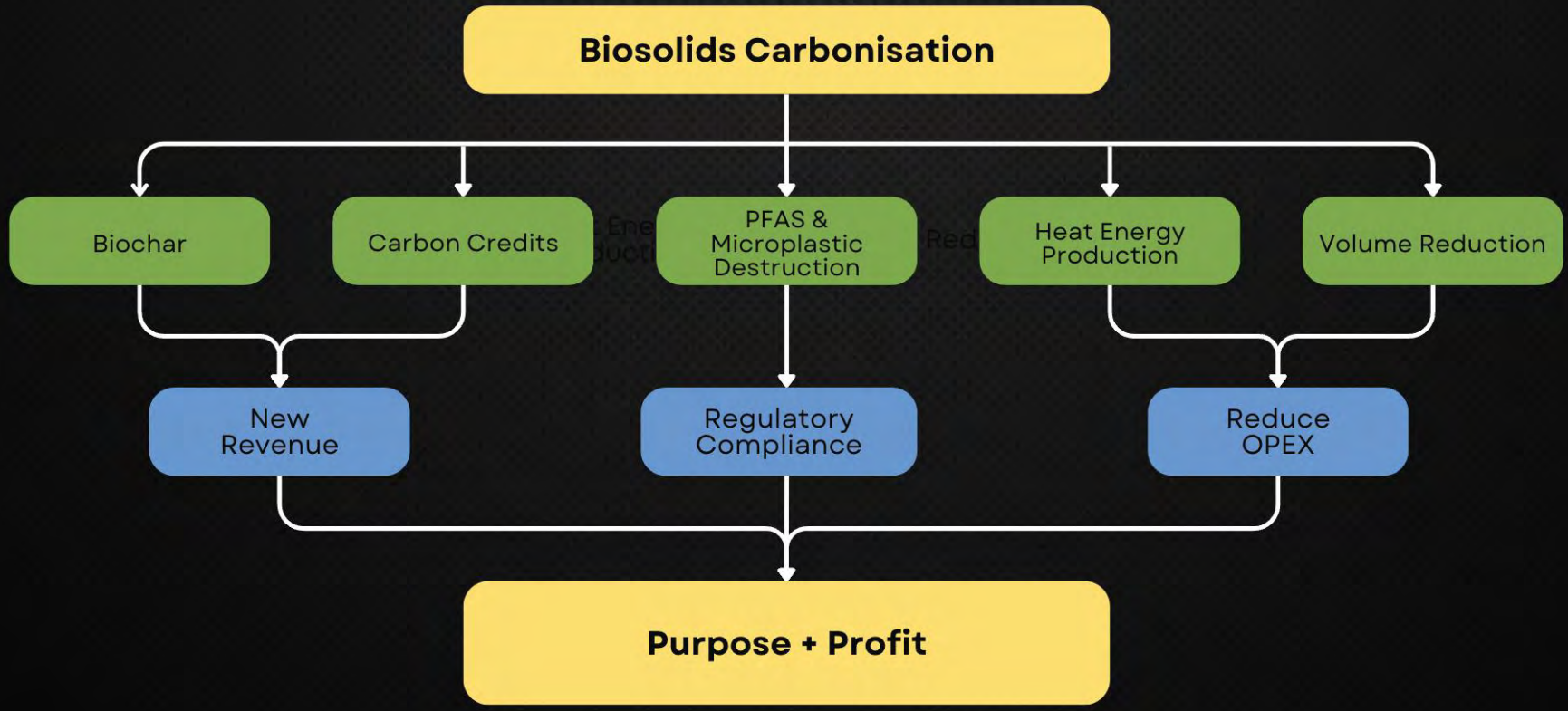
Value Proposition



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Biosolids Evolution

2016
First biosolids trial at Pyrocal's facility

2018
Partnership with Downer

2019
Logan Water Demonstration Plant contract awarded

2020
Logan Water Commercial Plant contract awarded

Biosolids biochar research with USQ

2022
Logan Water Commercial Plant start-up

2023
Technology Development

- Thermal oxidiser
- Heat exchanger

2024
Technology Development

- Wet scrubber

EA trial permit for biosolids processing at Wellcamp

2025
Mobile drying service to enable biosolids trials

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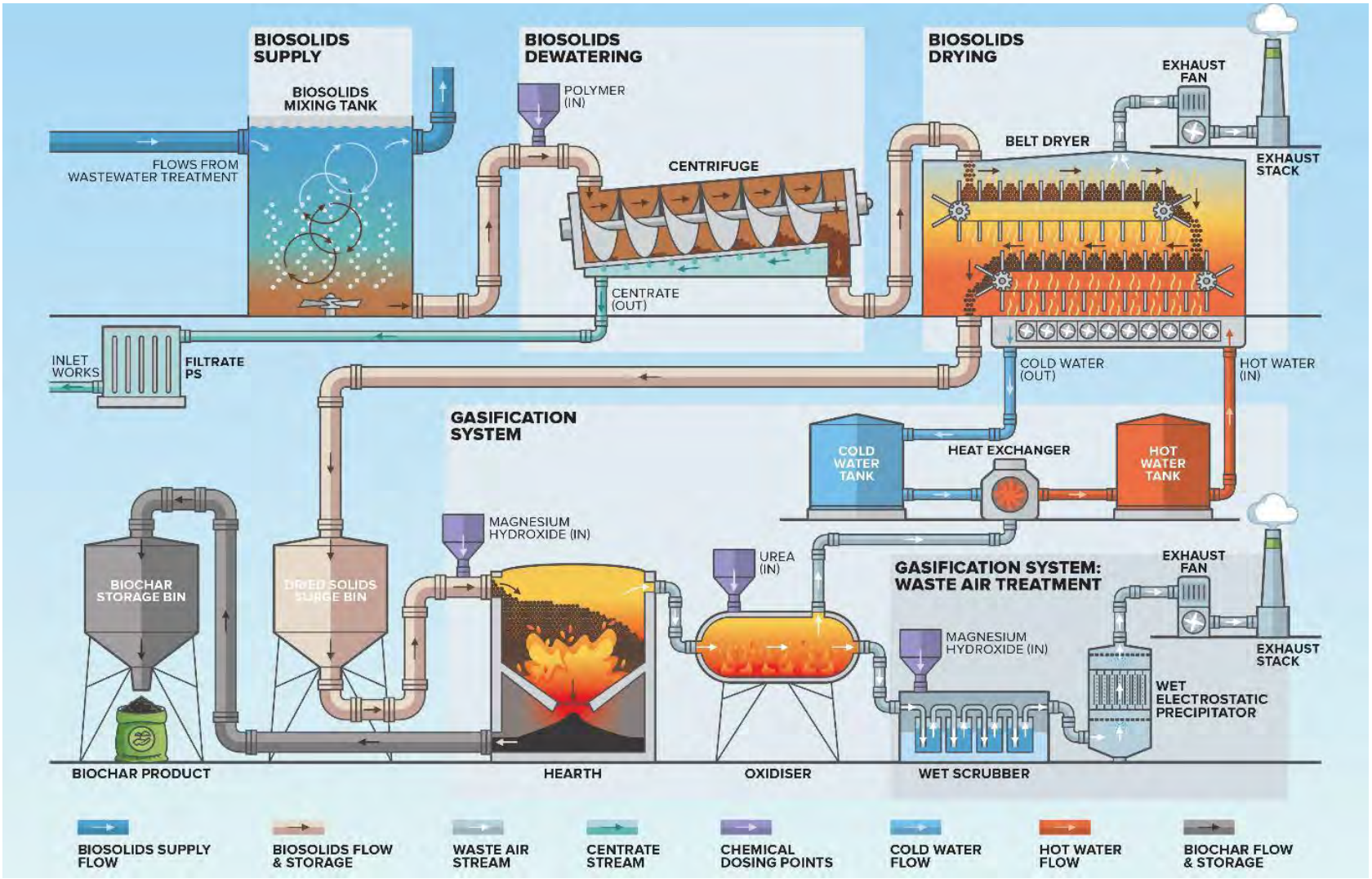
Design Development

- Undertook dewatering trials on the Loganholme WWTP biosolids using a portable centrifuge
- Detailed trials on dried biosolids using our gasification demonstration plant
- Use a 3D model and shared this with various remotely located designers and delivery partners, including internationally based team members.
- Optimisation and improvements have been ongoing

Biosolids Gasification Overview



Dewatering

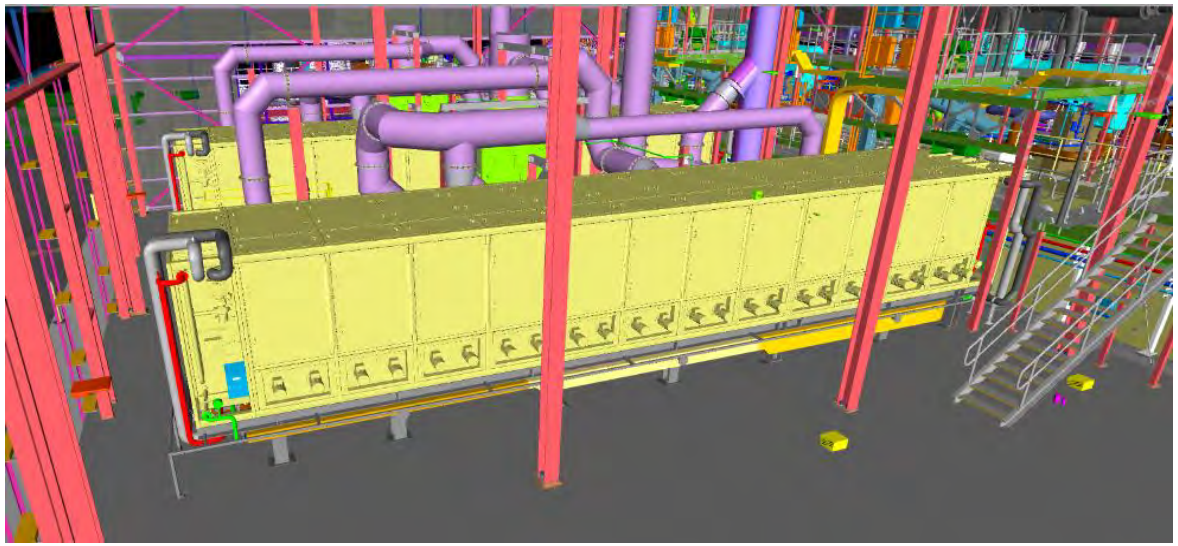
Centrifuge

- Target minimum 22% dry solids

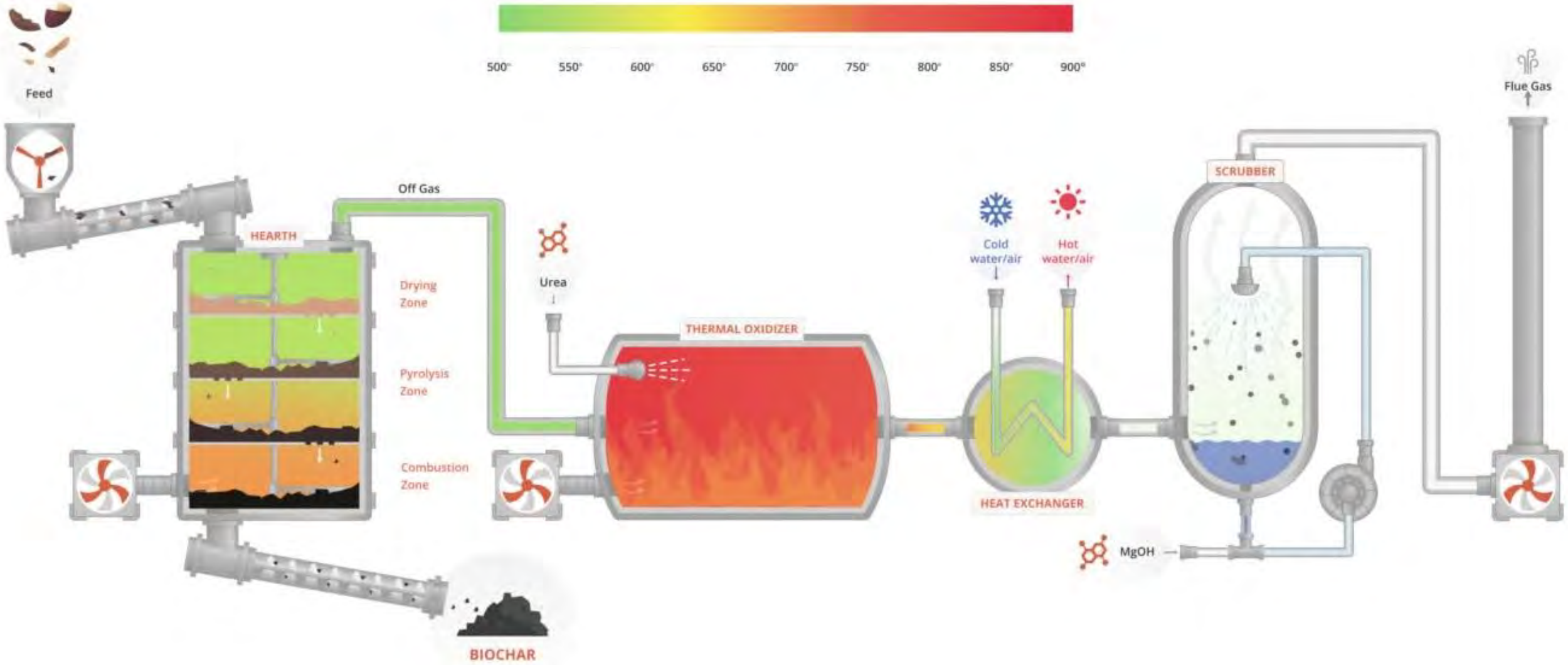
Drying

Belt Dryers

- Target >90% dry solids
- Consistent Particle size
- Requires 95°C water
- 22 fans per dryer



Pyrocal's Technology


500°
550°
600°
650°
700°
750°
800°
850°
900°
Feed
Flue Gas
Off Gas
HEARTH
Drying Zone
Pyrolysis Zone
Combustion Zone
Urea
THERMAL OXIDIZER
Cold water/air
Hot water/air
HEAT EXCHANGER
SCRUBBER
MgOH
BIOCHAR

Technology Developments

Hearth

- Internal components for greater durability

Thermal Oxidiser

- Higher operating temperature
- Improved NOx removal

Heat Exchanger

- Increased heat recovery
- Easier cleaning
- Less fouling

Venturi Scrubber

- Increased particulate removal

Future

- Carbonisation system optimisation
- Process design optimisation

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Gasification – key areas for CoC

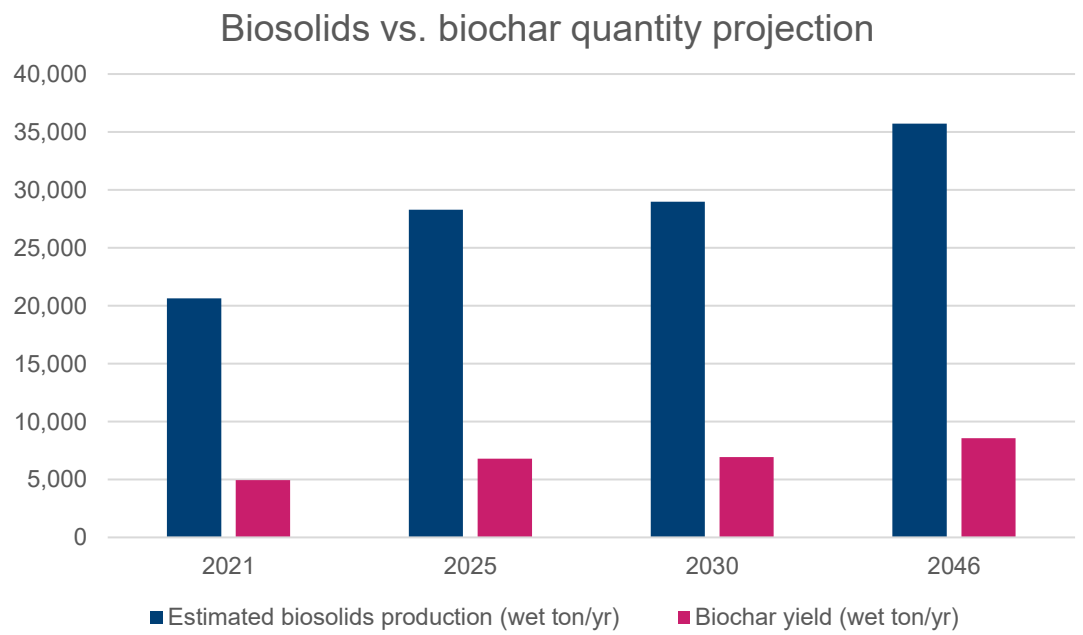
- Destroy POPs in the oxidiser
- Ensure PFAs destruction through stable and consistent treatment temperature
- Ensure air emissions are compliant – wet scrubber / wet electrostatic precipitator

Biochar and Biosolids Quantity – Mass Reduction

Biochar production through gasification achieves significant mass reduction (i.e. ~90%) from dewatered biosolids, therefore:

- ***Significantly reduced cost for haulage***
- ***Significantly reduced environmental impact from transport***

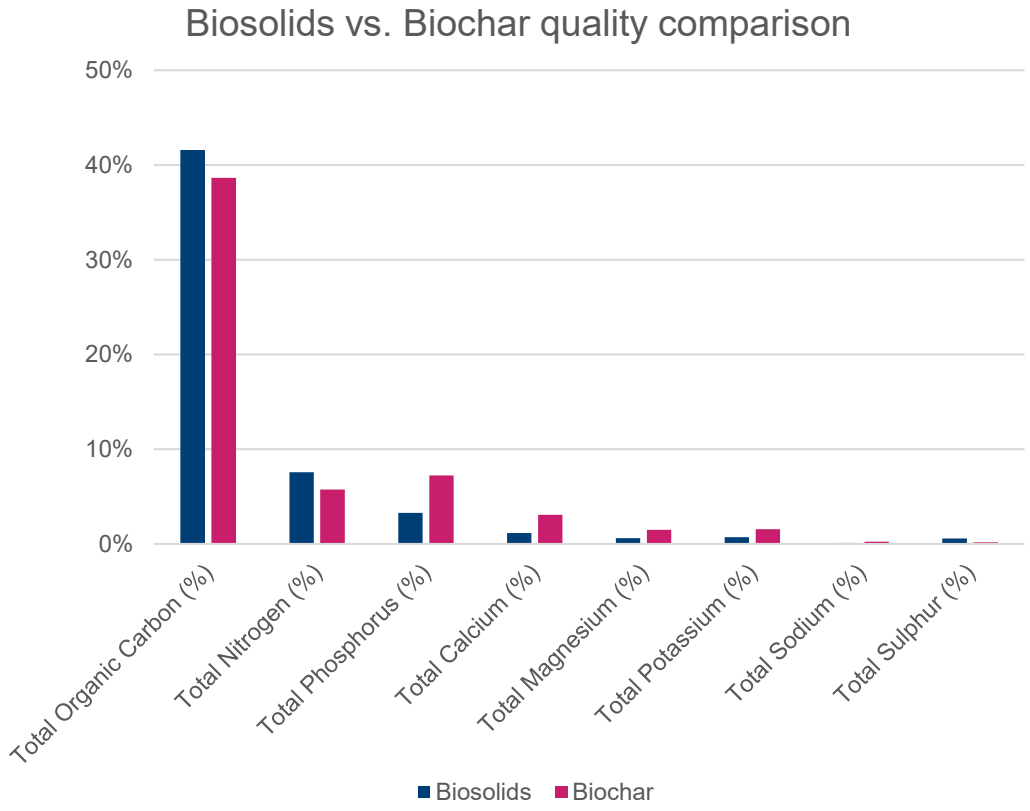
Image from Logan Holme Wastewater Treatment Plant



Biochar and Biosolids Quality – Nutrient and mineral value

Biochar retains the carbon, nutrient and mineral values in the material for land application

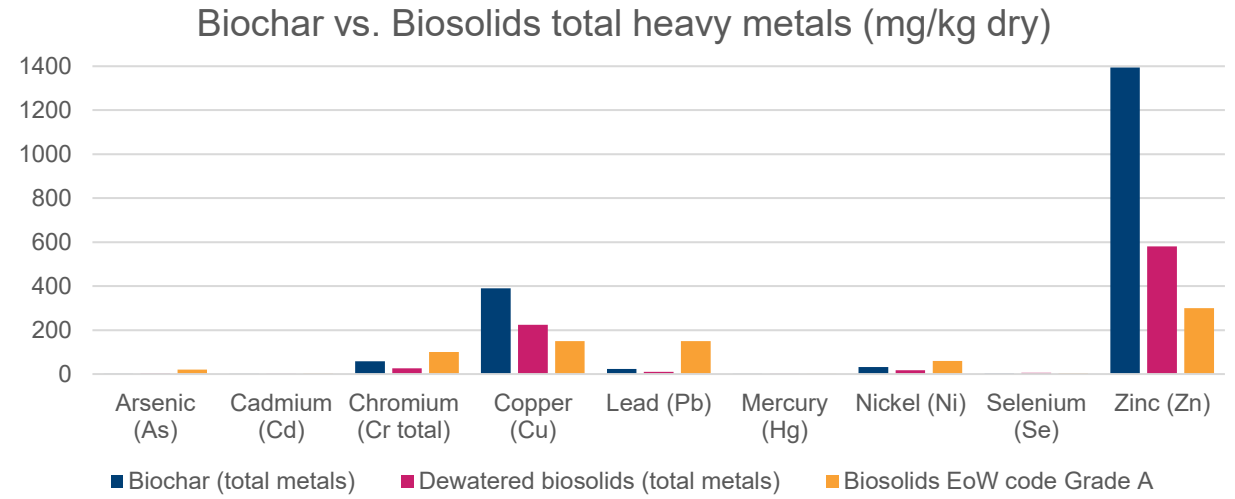
Image from Food and Agriculture Organization of the United Nations

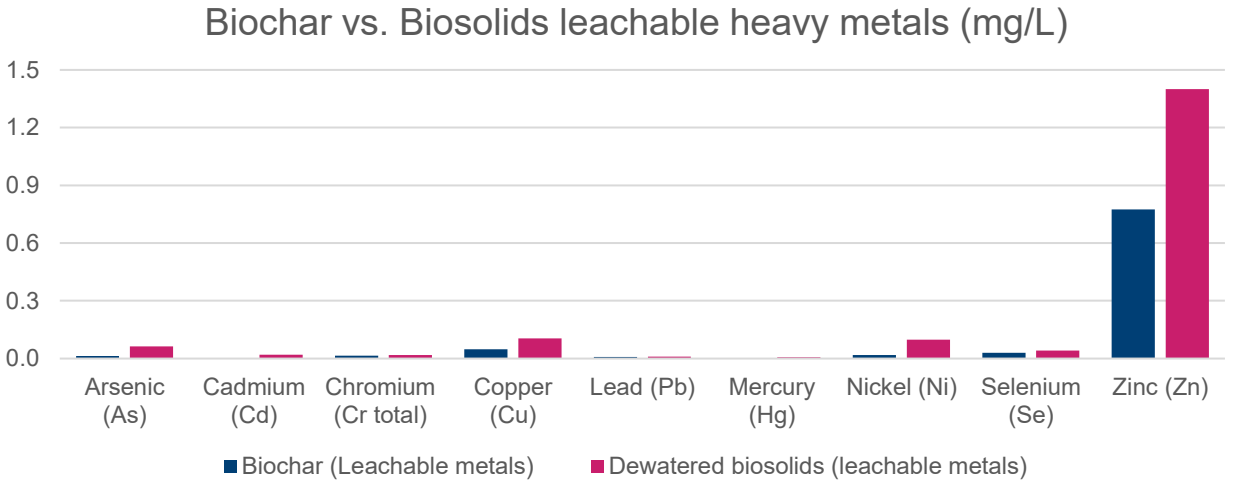


Biochar and Biosolids Quality – heavy metal comparison

Neither biosolids nor biochar could meet contaminant Grade A for Biosolids EoW code, HOWEVER,

- ***Biochar showed minimal leachable heavy metal concentrations during Toxicity Characteristics Leaching Procedure (TCLP), representing nearly 100% concentration reduction compared to total metals***





Biochar and Biosolids Quality – PFAS reduction

Biochar production through gasification achieves significant PFAS removal from dewatered biosolids

- ***Long-term biochar PFAS validation data are required to better understand concentrations***
- ***Laboratory PFAS capability and regulations are evolving to support more reliable PFAS test results***

Image from PDCE Conservation & Bioenergy

PFAS compounds	Biochar_20 grab samples (ug/kg)	Biosolids_Typical (ug/kg)
PFOS	1.6	22.6
PFOS + PFHxS	1.6	25.1
PFHxS	0	2.5
PFOA	TBA	2.6
PFBA, PFPeA, PFHxA	4	7.8
Sum C9 -C14 Perflouroalkyl carboxylic acids	0	22.8
Perfluoroalkyl sulfonamides	0	17.5
N:2 Fluorotelomer Sulfonic acids	0	10.4

Gasification Environmental Authority

Challenges with PFAS requirements

- Current licence requires 99.99% destruction efficiency PFAS in the air stream between oxidisers and plant stack
- The practicality and challenges of sample collection at oxidiser duct
- Consistency of lab results (i.e. Matrix Interference)

Historical context - Pilot Plant Limits

Contaminant	Target Limits for Demonstration Plant
Total Solids Particulates (TSP)	30 mg/Nm3 (dry)
Carbon Monoxide (CO)	125 mg/Nm3 (dry)
Oxides of Nitrogen (as NO2)	400 mg/Nm3 (dry)
Sulphur Dioxide (SO2)	200 mg/Nm³ (dry)
Hydrogen Chloride (HCl)	60 mg/Nm³ (dry)
Total fluoride (as HF)	4 mg/Nm³ (dry)
Volatile Organic Compounds	20 mg/Nm³ (dry)
Cadmium and it compounds	0.05 mg/Nm³ (dry)
Mercury and its compounds	0.05 mg/Nm³ (dry)
Total Heavy Metals (see Note 1)	0.5 mg/Nm³ (dry)
Dioxins and furans (I-TEQ for PCDDs and PCDFs including half LOD)	0.1 ng/Nm³ (dry)
Polycyclic Aromatic Hydrocarbons (PAH) (see Note 6)	
PFAS (see Note 2)	
Carbon tetrafluoride (CF4)	
Odour concentration	

Current versus proposed EA limits

Location	Contaminant	Demonstration Plant Trial Limits	Current EA Limits	Proposed EA Limits	Limit Details	Comments
Gasification Plant Stack	Total Solids Particulates (TSP)	30 mg/Nm3 (dry)	30 mg/Nm3 (dry)	30 mg/Nm3 (dry)	Annual	
	Carbon Monoxide (CO)	125 mg/Nm3 (dry)	100 mg/Nm3 (dry)	125 mg/Nm3 (dry)	Annual	
			50 mg/Nm3 (dry)	125 mg/Nm³ (dry)	CEMS	Excludes system start-up & shut-downs
	Oxides of Nitrogen (as NO2)	400 mg/Nm3 (dry)	400 mg/Nm3 (dry)	400 mg/Nm3 (dry)	Annual	
			200 mg/Nm3 (dry)	400 mg/Nm3 (dry)	CEMS	Excludes system start-up & shut-downs
	Sulphur Dioxide (SO2)	200 mg/Nm³ (dry)	200 mg/Nm³ (dry)	200 mg/Nm³ (dry)	Annual	
			50 mg/Nm³ (dry)	200 mg/Nm³ (dry)	CEMS	Excludes system start-up & shut-downs
	Hydrogen Chloride (HCl)	60 mg/Nm³ (dry)	60 mg/Nm³ (dry)	60 mg/Nm³ (dry)	Annual	
	Total fluoride (as HF)	4 mg/Nm³ (dry)	4 mg/Nm³ (dry)	4 mg/Nm³ (dry)	Annual	
	Volatile Organic Compounds	20 mg/Nm³ (dry)	20 mg/Nm³ (dry)	20 mg/Nm³ (dry)	Annual	
	Cadmium and it compounds	0.05 mg/Nm³ (dry)	0.05 mg/Nm³ (dry)	0.05 mg/Nm³ (dry)	Annual	
	Mercury and its compounds	0.05 mg/Nm³ (dry)	0.05 mg/Nm³ (dry)		Annual	Reporting only
	Total Heavy Metals (see Note 1)	0.5 mg/Nm³ (dry)	0.5 mg/Nm³ (dry)	0.5 mg/Nm³ (dry)	Annual	
	Dioxins and furans (I-TEQ for PCDDs and PCDFs including half LOD)	0.1 ng/Nm³ (dry)	0.1 ng/Nm³ (dry)	0.1 ng/Nm³ (dry)	Annual	
	Polycyclic Aromatic Hydrocarbons (PAH) (see Note 6)		-	-	Annual	
	PFAS (see Note 2)		see Note 2	96%	Annual	Total Mass Flow Destruction efficiency
	Carbon tetrafluoride (CF4)		0.1 ng/Nm³	0.1 ng/Nm³	Annual	
	Odour concentration		-	-	Annual	
Dryer Stacks	Total solid particulate		30 mg/Nm3 (dry)	30 mg/Nm3 (dry)	Annual	
	Volatile organic compounds		20 mg/Nm3 (dry)	20 mg/Nm3 (dry)	Annual	
	Ammonia		-	-	Annual	
	PFAS (see Note 2)		see Note 2		Annual	
	Odour concentration		-	-	Annual	

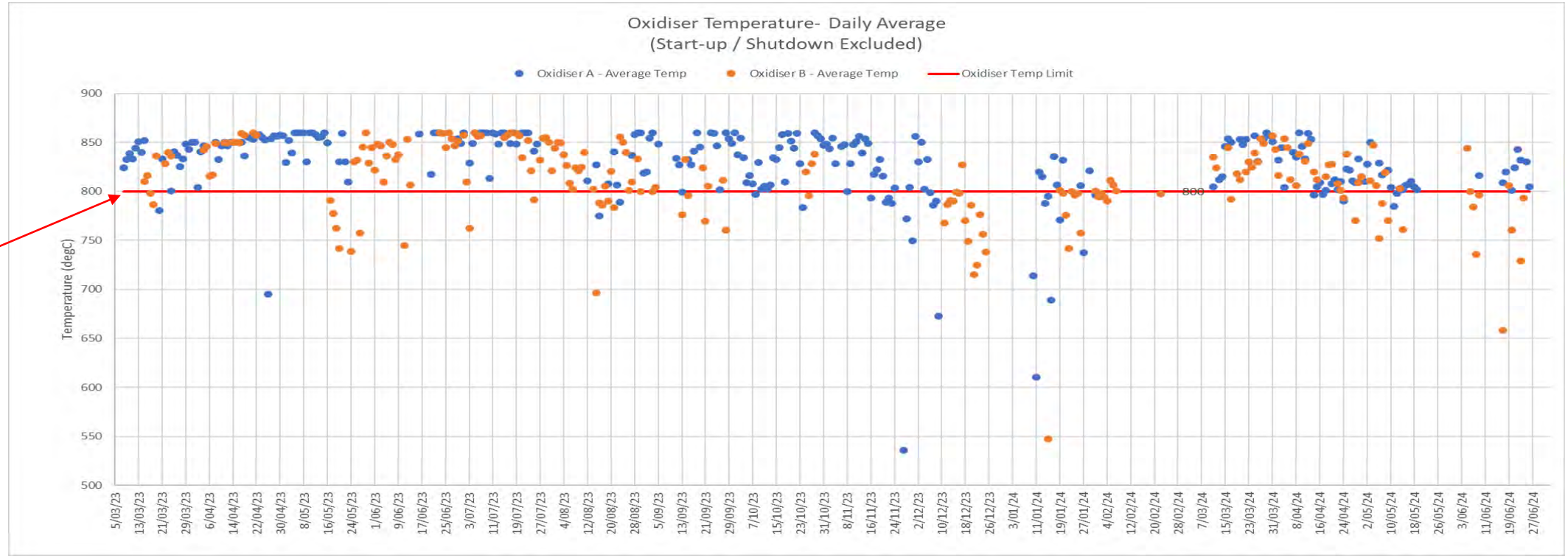
Production targets and limits

Production targets and limits

November 2024	Solids Wasting			Hearths Uptime		Gasifier	Daily Stack Emissions					
	CFG	BP Trucks	BP			24hr kg/hr	Ox Temp (°C)		Temp	mg/Nm3		
	kgDS/d	Needed	Trucks	A	B	Average	1	2	°C	CO	NOx	SOx
TARGET	14560			90%		525	800	800	43	50	200	50

How is the asset performing currently?

Oxidiser Temp ºC:

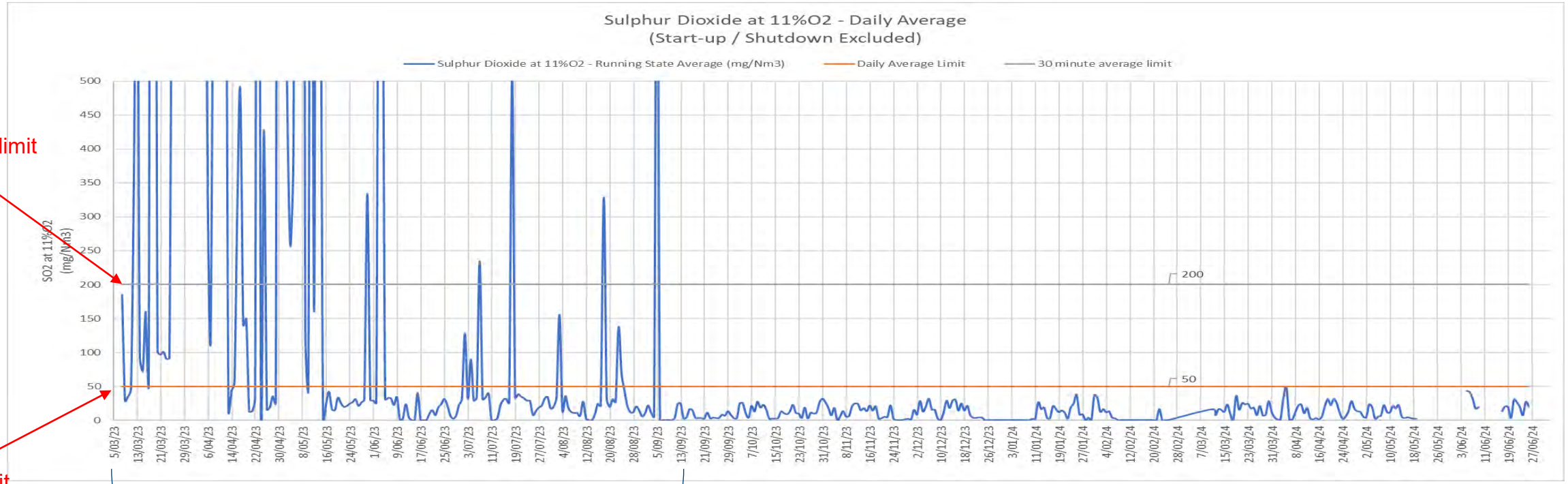


LGN-A12 requirement for >800°C

Issues with heat exchanger blockages and start-up / shutdowns. Modifications to improve

How is the asset performing currently?

Sulphur Dioxide (SO_2):



Annual release limit

Daily CEMS limit

Early commissioning period/learning

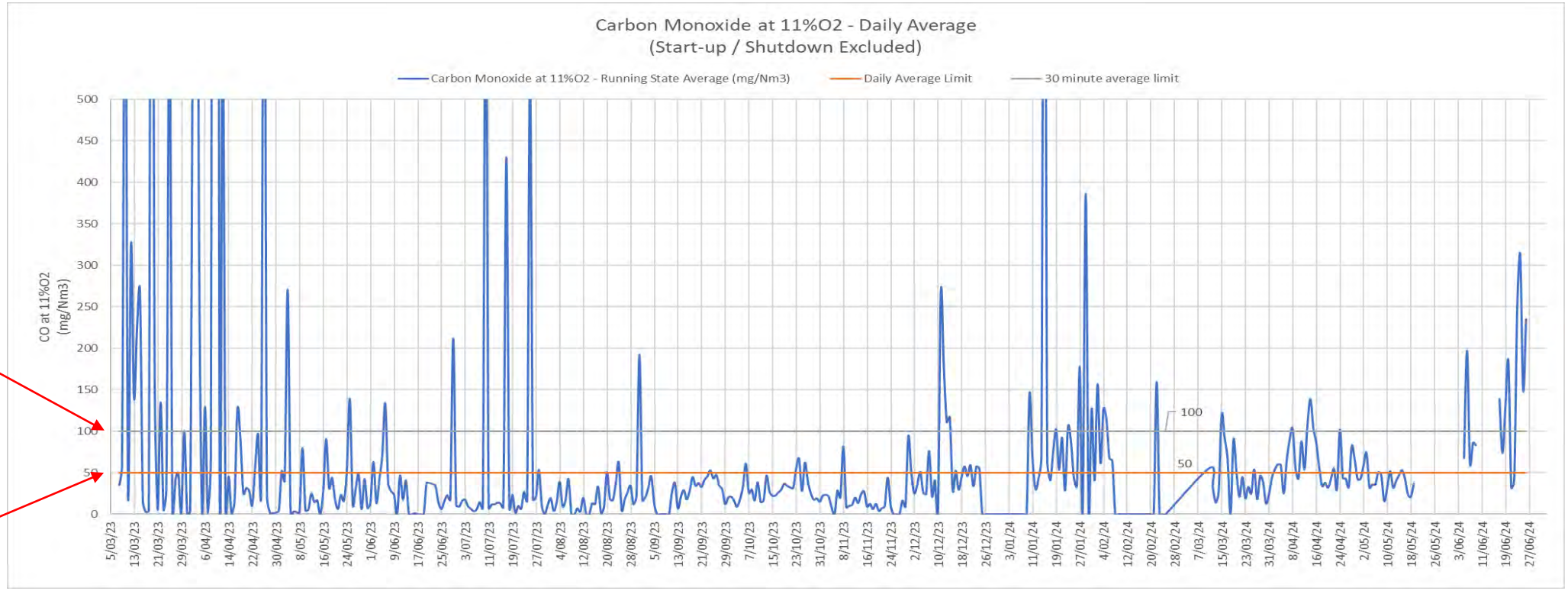
Generally compliant, linked to Magnesium Hydroxide usage

How is the asset performing currently?

Carbon Monoxide (CO):

Annual release limit
(previously 125mg/Nm3)

Daily CEMS limit



Issues with compliance, linked to oxidiser heat, but hard to achieve current limits (100).
Target was originally 125mg/Nm3, Daily CEM is 50 mg/Nm3

Gasification Environmental Authority

Challenges with CEMS requirements

- The current CEMS limits are a challenge to meet
- Continuous CEMS monitoring has lower rates than the annual grab samples that are NATA Tested
- We propose the CEMS limits match the annual testing requirements

Challenges with Draft End Of Waste Code

Changes to EOW Code

- Approved uses are too prescritive
- Changes to Resource Quality Criteria for soil application (Table 1 Draft Final EOW Code Biochar)

Table 1: Resource quality criteria (soil application)		
Total maximum concentration (mg/kg, dry weight)	Consultation draft	Final draft
Copper	500	150
Zinc	2500	300
Cadmium	10	1

- Change in PFAS requirements-Analysis of PFOS, sum PFOS and PFHxS, PFOA, PFBA, PFPeA, PFHxA, Sum C9-C14 Perflouroalkyl carboxylic acids, Perfluoroalkyl sulfonamides, N:2 Fluorotelomer Sulfonic acids
- Addition of Resource Quality Criteria (Construction applications) (Table 2 Draft Final EOW Code Biochar)
- New Condition 6.5 Sampling and recording of quality characteristics must be undertaken

  a) at least every six months; and

  b) within one month where there is change in the feedstock and production process.

Use (s) of Biochar – limiting utilisation…

Key issue: As per Draft Final Code LW Biochar is not fit for any listed uses – it is currently waste.

The limits for Table 2 Resource Quality Criteria (construction applications) are similarly strict (i.e. Pb, Cu and Zn) which will limit potential uses and customers of Biochar

Resource quality criteria is not practically achievable which limits Logan Water to sell biochar.

High priority for Logan Water

Approved uses	
(7.2)	The approved resource is **biochar** which complies with *Requirement (6.3)* of this EOW code and is used for the following purposes: a) Soil applications: a. composting; b. **fertilisers**; c. **irrigation management**; d. land remediation and stabilization; and e. **soil conditioner**. b) Construction applications[7]: a. Bound applications: i. concrete (non-structural/structural); ii. asphalt for road pavement; iii. building and construction materials for insulation, tiles and lightweight aggregates b. Unbound applications: i. road stabilisation (dirt roads, roadbase and embankments).

PFAS

Key issue: Increased number of PFAS compounds with stringent limits, regulatory burden along with monitoring and testing costs.

Requirement to test multiple compounds is very expensive

Recommendation:

Keep PFAS monitoring requirement as in consultation draft “Not detected at a limit of 0.002µg/L”

Thermochemical decomposition of biosolids in the absence or limited supply of oxygen substantially destroys over 99% of PFAS products.

Table 1: Resource quality criteria (soil application)

Quality characteristics	Total maximum concentration (mg/kg, dry weight)
PFOS (PFHxS not detected)	0.001
Sum of PFOS and PFHxS	0.002
PFHxS (PFOS not detected)	0.003
PFOA	0.004
PFBA, PFPeA, PFHxA	0.001
Sum C9 -C14 Perflouroalkyl carboxylic acids	0.01
Perfluoroalkyl sulfonamides	0.001
N:2 Fluorotelomer Sulfonic acids	0.004
Sum of PFAS	0.01

Challenges with Draft End Of Waste Code

Challenges of Proposed Limits

- Feedstock requirement uncertainty
- Revised limits are not practical to achieve (Zn and Cu).
- Regulatory burden along with monitoring and testing costs
- New requirement for sampling & recording is expensive
- Proposed resource quality criteria may mean Logan Water Gasification plant ceases/reduces biochar production and reverts to biosolids to landfill
- The limits for Resource Quality Criteria (construction applications) are stricter which will limit potential uses and customers of Biochar

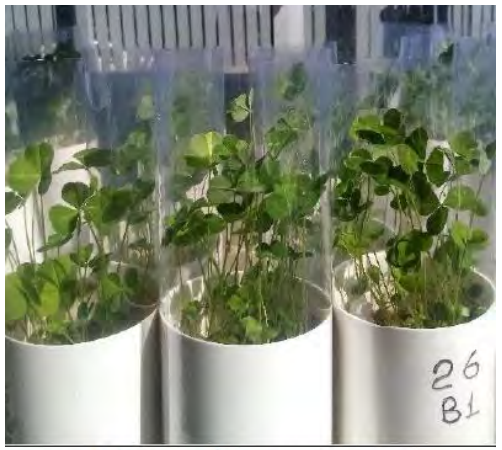
Sector Concern for EoW Code for Biochar

EoW Code for Biochar - Must

- Must not form a barrier to the adoption of advanced thermal treatment in Queensland (and elsewhere).
- Provide investment certainty
- Must not unnecessarily restrict the future of biosolids-derived biochar as a resource.
- Include evidence-based resource criteria
- The EOW Code should complement other codes and guidelines
- Provide access to safe and environmentally sustainable options
- Reduce landfill, enhance resource recovery, circularity
- Must not create a financial burden for the community

Current approach

- Ongoing liaison with DETSI, QLD Water Directorate, Pyrocal and stakeholders via the Technical Reference Group process
- Technical site tours for DETSI (28 DETSI representatives from three teams) July 2024, with more planned post augmentation
- Further research, the ARC Nice HUB research through Professor Bernadette McCabe at University of Southern QLD
- Ongoing literature review
- Workshops planned
- Advocacy via other pathways



21 days after emergence

The call to arms!

Thank you

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LOGAN WATER

CITY OF LOGAN