# BlueScope Steel (AIS) Pty Ltd

# Port Kembla Steelworks Renewables and Emissions Reduction Study

# LESSONS LEARNT REPORT #4

**Project Details**

| | |
|---|---|
| **Recipient Name** | BlueScope Steel (AIS) Pty Ltd |
| **Primary Contact Name** | Andrew McClure |
| **Contact Email** | andrew.mcclure@bluescope.com |
| **Reporting Period** | Jan - April 23 |
| **Date of Submission** | 18 April 2023 |

*This Project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program.*



## PROJECT OVERVIEW

With the support of ARENA, as part of ARENA's Advancing Renewables Program, BlueScope is investigating the technical and economic feasibility of renewable energy and decarbonisation technology pathways that have the potential to decarbonise the steelmaking process at the Port Kembla Steel Works (PKSW).

Both Smart Carbon Usage (SCU) and Direct Carbon Avoidance (DCA) technologies are considered in identifying a set of Prioritised Options for further analysis, with the study looking to identify potential activities for further investigation. These activities might include research, technical development, demonstration trials and plant engineering design investigations.

As part of the project, BlueScope is looking to conduct trials to assess the risks of the pneumatic conveyance of biochar, mixed with pulverised coal, for injection into the Blast Furnace (BF). Biochar

from renewable sources has the potential to replace some of the coal used within an integrated steelworks and thereby reduce Green House Gas (GHG) emissions.

This Lessons Learnt provides an update following the biochar plant trials.

**PROGRESS**

We have recently completed the plant trials which consisted of up to 30% biochar addition to the coal that is pulverised, pneumatically conveyed and injected into the Blast Furnace. The trials were completed during February and March 2023. Lessons around biochar supply chain and characteristics are included in Lessons Learnt#1 and Lessons Learnt#2 reports.

**SUMMARY OF LESSONS LEARNT**

This report focuses on the learnings from the plant trials, where blends of coal with up to 30% biochar were elevated, dried, ground and injected into the Blast Furnace with minimal effect on either the Pulverised Coal Injection (PCI) Plant or Blast Furnace operation. The results provided here are preliminary, with a more detailed analysis to be provided in the next couple of months.

## KEY LEARNINGS

**Category:** Preliminary results from biochar plant trials

**Objective:** To trial the addition of biochar into a blend with coal that is to be ground, dried and injected into the Blast Furnace via pneumatic conveying.

**Detail:** The following table sets out the different trials undertaken, beginning with small scale biochar additions to coal, followed by staged trials from 10% to 30% biochar addition for 12 and 24 hours.

Table 1 – Trial summary

| Trial | Date | Aim Biochar Proportion (%) | Tonnes Biochar used (dmt) | Injection Time (hrs) | Comment |
|---|---|---|---|---|---|
| 1A – 1D | 13/2 – 16/2/23 | 5 – 8 | 36 | 1 – 6 | Small scale trials for short durations using a premixed blend of biochar and coal loaded into a single hopper of the mixing plant to test the mixing plant, the mill and injection equipment function with low risk. No issues found |
| 2A | 21/ 2 – 22/2/23 | 10 | 46 | 12 | From here on, biochar was added directly into one of the PCI plant mixing bins, with the plant capable of delivering the desired coal/biochar ratio to the furnace. No negative impacts on the mixing plant, mill, injection or BF, despite higher biochar input moisture. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Grinding rate of 50t/hr and injection rate of 40-45t/hr easily maintained |
| 2B | 23/2 – 24 2/23 | 10 | 80 | ~24 | Biochar used as an individual material. Results as per Trial 2A., but a grinding rate of 60t/hr was used on this occasion, whilst 40t/hr injection rate was easily maintained. |
| 3A | 28/2 – 1/3/23 | 20 | 98 | 12 | No negative impacts seen on the grinding/drying process or at the BF, with grinding rates of 60tph and injection rates of 40-45t/hr easily maintained. Pulverised coal slightly coarsened while moisture increased slightly. Biochar also seemed to affect injected coal density measurement, necessitating a slight increase in fluidization nitrogen, but while notable none of these were significant enough to be an issue. |
| 3B | 21/3 – 22/3/23 | 20 | 223 | 24 | No negative impacts seen on the grinding/drying process or at the BF. Grinding rate aim of up to 65t/hr easily maintained, however notable that the pulverised coal storage bin filling rate was reduced, likely due to lower density biochar. Pulverised coal coarsened again as per Trial 3A, but this was controlled with a minor increase to classifier speed. Moisture of pulverised coal was slightly higher too, with burner load increased. Coal density increased as per Trial 3A with minor increase to fluidization nitrogen. Despite these changes, none were significant enough to be a cause for concern. |
| 4A | 23/ - 24/3/23 | 30 | 170 | 12 | No negative impacts seen on the grinding/drying process or at the BF. Changes in some process parameters notable as per previous trials, particularly moisture control, necessitating a slight decrease in grinding rate to 58t/hr to reduce dryer burner load. Pulverised coal sizing slightly coarser but was being controlled with the slight increase in classifier speed as per Trial 3B. Injection rates maintained at around 45t/hr. Despite notable process changes again nothing was of particular concern. |
| 4B | 28/3 – 29/3/23 | 30 | 320 | ~24 | No negative impacts seen on the grinding/drying process or at the BF. Changes in some process parameters notable as per Trial 4A. Moisture of pulverised coal increased again as did dryer burner load, but not sufficiently to trigger a reduction in grinding rate from 60t/hr. Injection rate at 46t/hr easily maintained with 50t/hr reached for short periods. Notable change in coal concentration again, necessitating increase to fluidization |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | nitrogen. Overall, however changes were not a particular cause for concern. |

There is still considerable analysis work to be completed, however, lessons learnt to date are as follows:

- A blend of coal and up to 30% biochar appears to be easily handled through the PCI mixing plant and elevation sequence without any issues. No bridging or flow issues were detected through standard hoppers, weighfeeders, vibrofeeders, bucket elevators and drag-chain conveyors.
- Biochar appeared to grind reasonably well – some coarsening of the pulverised coal/biochar blend was noticeable once the proportion of biochar was 20% or greater, however this was able to be mitigated with a 1% increase in classifier speed from 70% to 71%.
- Biochar appeared to dry reasonably well. Despite the high biochar moisture (27%) – no significant affects were notable on the drying/grinding operation until the biochar proportion reached 30%, where significantly higher moistures were measured in the ground product. Minor reductions in grinding rate were able to correct this. This could be problematic in the future; however, the moistures of the trial biochar were exceptionally high and are not expected to be repeated.
- Biochar addition up to 30% to the coal/biochar blend did not seem to inhibit injection with no significant changes to injection parameters notable (aside from those taken pre-emptively to account for lower biochar density). No segregation or unstable flow were seen during pneumatic conveying. Injection rates of 46t/hr were easily achieved with rates up to 50t/hr also able to be sustained for short periods.
- Biochar addition did appear to affect the injected coal density measurement, thereby triggering increases in fluidization nitrogen flow, however this is thought to be due to calibration of a the in-line density measurement device, given it was setup purely for coal. Further work is required to re-calibrate this instrument to account for biochar addition.
- Biochar addition did not appear to affect blast furnace operation in any way – blast furnace production was able to be maintained at a high level with seemingly no impacts on tuyere combustion, process stability or hot metal quality.
- Given these good results, there appears to be no significant barrier to the use of up to 30% biochar in a blend with coal for grinding/drying and injection into the BF. However, these trials were of relatively short duration, so further testing for longer durations (weeks/months) will be required to check that there are no longer term effects on the process from the use of biochar. Further work however will be constrained by regulatory limitations (EPA licence) and biochar supply.

**Conclusion:** Preliminary results from the trials indicate that biochar can replace up to 30% of the blend of pulverised materials to be injected into blast furnace with no negative effects on either the PCI Plant or Blast Furnace process.

As noted, the results shown here are only preliminary. Further work will be undertaken to evaluate in more detail the biochar proportion in coal and then link this with an investigation of PCI Plant and Blast Furnace plant data to better understand the interactions of the biochar with key aspects of these processes. This latter investigation will focus particularly on the effects of biochar addition on grinding and drying, pneumatic conveying and tuyere combustion of biochar/coal blends along with blast furnace stability and hot metal chemistry.