Sleaford Renewable Energy Plant

Waste Streams: Nature, Handling, Disposal and Change				
Stream	**Nature**	**Estimated quantity**	**Storage & handling**	**Disposal or Use**
Bottom ash	Wet ash, variable particle size.	62 t/day	Dedicated silo and handling system	Removed from site by covered lorry for use as a soil conditioner
Fly ash and APC residues	Dry ash, fine particle size	10 t/day (excluding lime content)	Dedicated silo and handling	Removed from site by covered lorry for use as agricultural fertiliser.
Rain water		120 m^3/day	Collected by surface water drainage system	Discharged to sewer via oil interceptor
Process effluents	Process effluents from water treatment plant effluent, boiler blowdown, steam plant drains, etc	129.3 m^3/day	Collected for recycling/reuse for bottom ash quenching.	Surplus water discharged to trade effluent pit prior to discharge to sewer.
Cleaning & Vehicle wash waters	Water and sludge	7 m^3/day	Site effluent drainage system	Discharged to sewer via trade effluent pit
Rejected feedstock	Rejected straw	1 t/week	Held in straw barns for collection	Removed off site by specialist contractor
Plant waste, waste oil, waste metals, waste electrical and office waste.	Oil filters, oily water, oil contaminated rags, sludge, interceptor waste, electrical waste, metal, packaging, office waste, road sweepings.	0.1 t/week	Segregated, labelled, documented and disposed of by licence waste contractors. Storage in closed skip.	

(Extract from the supporting Environmental Statement)

4.1 Proposed Site Operations

4.1.1 For the purposes of this description, it is helpful to consider the process as a combination of two interlinked systems:

- the combustion line, consisting of fuel storage, fuel feeding, combustion, flue gas treatment and ash handling; and
- the water / steam cycle, comprising the steam raising heat exchangers, the steam turbine generator and the air-cooled condensers.

4.1.2 The two systems above are linked at the furnace, where heat released by burning the fuel is transferred to water / steam cycle in various heat exchangers. The process description is shown on Figure 4.11.

The Combustion Line – Fuel Handling

Vehicle Access / Egress – All Fuel

4.1.3 All lorries accessing the site would use a swipe card system or similar to raise the security barrier at the site entrance. All HGV movements from the site will turn left onto Boston Road.

Straw Deliveries

4.1.4 Straw will typically be delivered in the form of Hesston bales. These bales will be delivered in large loads on HGVs with flat bed trailers, normally carrying three layers of 12 bales or 36 bales per load. Once on site, lorries will be directed to one of the two straw barns. The lorries would not need to pass over the weighbridge at the site entrance as straw is weighed as it is lifted off the cranes in the straw barns.

4.1.5 Each straw barn contains two overhead cranes which are capable of unloading two lorries at the same time. The specially designed cranes contain 6 pairs of grabs that remove a layer of 12 straw bales at a time. Each grab records the

weight and moisture content of their particular bales for stock control and payment purposes.

4.1.6 The cranes may, if required, unload a lorry directly to the straw conveyors to feed into the furnace. However, fuel is normally stored within the fuel hall until required. Each straw barn is capable of storing enough bales for 36 hours operation, giving 72 hours storage overall.

4.1.7 An unloaded lorry will be swept clean of any remaining straw within the straw barn, prior to leaving the site.

Wood Deliveries

4.1.8 Wood will be delivered in chip form in bulk tipping lorries. Wood lorries will drive onto the weighbridge situated just beyond the automatic entrance barrier and their gross weight will be recorded. The lorry will then travel to the north of the site, via the perimeter road, and enter a manoeuvring space in front of the wood chip storage building main doors.

4.1.9 The wood chip storage building would have sufficient space to enable two lorries to stand side-by-side in front of a push floor system. The push floor carries wood chip from the front of the stockpile to the rear of the building and onto the fuel feeding system for the combustors.

4.1.10 Wood chips are stored in a stockpile directly on top of a push floor mechanism that delivers the chips into the feeding line (described later). Lorries will reverse into the wood chip storage building, up to the wood chip pile and tip directly onto the front face of the wood chip pile.

4.1.11 Wood chip is not intended to be the primary fuel for the plant. As such, it is only expected to be consumed during the day and only limited storage capacity is required. The store will hold approximately 300 tonnes (t) of wood, which is sufficient for 10 hours' operation at the maximum wood fuel feeding rate.

4.1.12 Lorries that have discharged their loads will drive forward out of the wood chip storage building and turn down the eastern perimeter road. They will be weighed

at the weighbridge before leaving the site in order that the net weight of the load can be calculated.

Fuel Feeding

4.1.13 Each straw barn contains two cranes. Each crane is capable of carrying 12 bales at a time out of the fuel hall and onto a fuel conveyor that carries the fuel.

4.1.14 The fuel conveyor transfers the bales onto one of four fuel feed systems, which are enclosed, inclined conveyors. At the entrance to the fuel feed systems are seal gates which limit air flow into the system to minimise the risk of fire. The feed systems are also equipped with fire fighting nozzles. Towards the top of the fuel feed system is a dosing conveyor that controls the rate at which straw is fed into the onward feeding system. Immediately after this is a twine cutter that cuts the string binding the bale in preparation for the next stage.

4.1.15 At the top of each fuel feed conveyor there is a scarifer, which breaks up the straw bales and chops up the stalks in readiness for combustion. The straw drops down through a damper onto a screw conveyor, called the stoker that pushes straw into the combustion chamber through a fire damper and water-cooled duct. This feeds the fuel into the conveyor at a controlled rate whilst maintaining an airtight seal.

4.1.16 Wood chips would be tipped directly onto a push floor that uses a hydraulic system of raised bars to drag the wood chip to the rear wall of the wood chip storage building. Here wood chips would enter a feed chain that incorporates screening for over-size material and a magnetic separator for the removal of ferrous metal.

4.1.17 Wood chip is then transferred to the boiler house via an enclosed, inclined conveyor where it is fed into the straw feeding system at the scarifiers. The fuel feed system for both baled straw and wood chip is shown on Figures 4.12 and 4.13.

The Combustion Line – The Furnace

Combustion

4.1.18 Straw, or a combination of straw and wood chips, are burned on a water-cooled vibration grate that is specially designed to ensure high burn-out of such fuels, with low emissions, whilst ensuring the safe transport of ash towards the end of the grate where it can be handled effectively.

4.1.19 The grate is water cooled, which is ideal for dry, volatile fuels such as straw by virtue of the fact that up to 100% the combustion air can be supplied above the grate (with no air required to cool the grate itself).

4.1.20 Air is blown into the furnace at various points to ensure complete combustion of the fuel while minimising the formation of nitrogen oxides that would otherwise have to be removed during flue gas treatment.

4.1.21 Auxiliary fuel burners (probably fired by natural gas) would be installed in the furnace. These would only be used during start up to raise the temperature of the boiler before any biomass is burned, thus ensuring that emissions from the plant stay within regulatory limits.

4.1.22 The end of the grate is sealed by a water bath containing a submerged conveyor onto which ash drops. The conveyor transfers the ash to an ash storage room. Ash is periodically removed from this room and onto a lorry for removal from site using a front-end loader.

Heat Exchange

4.1.23 The furnace is surrounded by water tubes which form the primary heat exchanger in which water is converted to steam. The combustion gases themselves flow around the furnace structure up and down through several passes. The temperature in the furnace is around 1100ºC; as the combustion gases pass through the various passes of the furnace they transfer their heat to other heat exchangers that are arranged within the furnace passes. These heat exchangers are described in the water / steam cycle description (see below). The last heat

exchangers transfer heat from the combustion gas into incoming combustion air pre-heaters, offering further increases in the overall efficiency of the process.

The Combustion Line - Flue Gas Treatment

4.1.24 Lime is injected into the flue gas stream after it leaves the furnace. This reacts with and thus removes any acid gases in the flue gas, principally HCl (hydrogen chloride) produced from the small amount of chlorine that is naturally present in biomass fuel.

4.1.25 The flue gases then enter a bag filtration house. Particles, including ash carried over from the furnace, reacted lime and any unreacted lime, collect on the surface of hundreds of filter bags while the flue gas itself passes through the bags. The bag filters are periodically cleaned and the solid residue drops into silos below the filter housing.

4.1.26 The final part of the flue gas train is the induced draft fan and stack. The induced draft fan pulls the flue gases out of the system and into the stack, the action of the fan, combined with the natural buoyancy of the warm gas and the height of the stack itself ensures good dispersion of the cleaned flue gases into the atmosphere. Emissions limits and consequent impacts on air quality are described in Section 11.0 of this ES.

4.1.27 Lime and fly ash is collected in silos following which it is transported off site by tanker for re-se as a fertiliser.

The Water / Steam Cycle

Steam Production

4.1.28 Water is pumped from the air-cooled condensers by the boiler feed water pumps into a feed water tank. This marks the start of the high-pressure side of the water / steam cycle (from the exit of the boiler feed water pumps to the entrance of the steam turbine).

4.1.29 Water from the boiler feed water tank passes to the steam drum (at the top of the boiler itself) via the economiser. The economiser is one of the heat exchangers

located within the furnace. It is used to raise the temperature of the boiler feed water to boiling point whereupon; the water is transferred to the steam drum at the top of the boiler.

4.1.30 The steam drum is a vessel that holds boiling water and steam. The water sits in bottom of the steam drum and water flows from here through downcomers to the bottom of the furnace wall where it then circulates up the pipes which form the furnace wall. The water in the pipes absorbs heat from the furnace which turns some of it into steam and the water / steam mixture, being less dense than the cooler water behind it, rises to the top of the furnace and returns to the steam drum.

4.1.31 At the steam drum, water from the water tubes in the furnace is separated from the steam and returns to the boiler tubes once more. The steam leaves the top of the steam drum from where it passes to the superheaters. These are heat exchangers that are located in the path of the combustion gases in the hottest parts of the furnace and its subsequent passes. The superheaters use the hot combustion gases to raise the temperature of the steam to much higher than boiling point, resulting in very high quality steam at a temperature of 540ºC and a pressure of 112 bar. This steam is ready for use in the steam turbine.

Electricity Generation

4.1.32 Superheated steam from the last superheater passes into the steam turbine. The steam turbine converts the thermal energy in the steam into mechanical energy that rotates the turbine. The turbine turns the rotor in an electricity generator. This electricity is delivered, via a transformer and appropriate switchgear, into the distribution system of the regional electricity company.

The Air Cooled Condenser

4.1.33 Steam leaves the steam turbine at low temperature and pressure. This steam must be condensed back into water before returning to the boiler. This is achieved in an air-cooled condenser, in which the steam flows through a series of pipes; air is blown over these pipes and this cools and condenses the steam.

4.1.34 The water that leaves the air-cooled condenser returns to the boiler feed water pumps and so the water / steam cycle begins again.

Operating and Maintenance Regime

4.1.35 The biomass plant is designed to operate continuously, 24 hours a day 7 days per week. Operational staff would be required to operate the plant around the clock on a 5-shift pattern, Monday to Sunday. There would be 4 staff per shift. In addition, 10 other office / administration staff would work a normal working day, typically 8.30am to 5pm, Monday to Friday.

4.1.36 Plant maintenance shall be required once a year, halting the operation for a period of two weeks (typically scheduled during the summer).

4.1.37 Fuel delivery periods shall be limited to:

- 0700 to 1900 hrs from Monday to Friday;
- 0800 to 1400 hrs on Saturdays

No fuel deliveries shall be accepted on Sundays or public holidays

4.1.38 steam cycle straw-fired power station.