4.0 DETAILED SCHEME DESCRIPTION AND ALTERNATIVES

4.1 Introduction

4.1.1 This section provides a description of the intended layout and design of the Brigg REP, together with details regarding its construction. It also outlines the processes that would take place at the facility and sets out the alternatives that have been considered.

4.2 Intended Layout and Design of the Proposed Development

4.2.1 The Brigg REP development would be based around four main buildings comprising the turbine and boiler hall (circa 1,935m^2 and 30.61m high), two straw storage barns (circa 3,158m^2 each and 16.82m high) and a wood storage building (circa 563m2 and 13.9m high). These four buildings would be linked by a series of high level conveyors. In addition, there would be a stack (chimney) of 62m in height. The development would also include the following ancillary / infrastructure elements:

- an air cooled condenser;
- a vehicle weighbridge;
- offices, control room and staff welfare facilities;
- site fencing and a security barrier;
- external hardstanding areas for vehicle manoeuvring / parking;
- internal access roads and car parking;
- compensatory flood storage;
- surface water attenuation pond;
- radiator fans;
- sedimentation tank;
- water tank;
- bottom ash storage and transfer area;
- transformers;
- silos;
- extensive new areas of landscape planting.

4.2.2 The disposition of these elements is shown on Figure 4.1 (the Site Layout) and Figures 4.2 and 4.3 (Site Sections). Elevations, layouts and sections of the buildings are shown on Figures 4.4 – 4.9 inclusive.

4.2.3 The facility would have an electricity generating capacity of 40MW and would use circa 240,000 tonnes per annum of biomass, consisting primarily of baled straw sourced from the local area.

4.2.4 This chapter describes the intended layout and design of the proposed development under the following headings.

- design philosophy;
- landscaping;
- employment;
- access;
- drainage and flood mitigation infrastructure;
- lighting;
- construction;
- security fencing and gates;
- car parking;
- waste management.

Design Philosophy

4.2.5 Eco2 has appointed award winning architects, RPS Burks Green (who specialise in large scale industrial architecture) to design the facility.

4.2.6 The rational behind the chosen design / architectural solution is outlined below under the following headings:

- layout;
- scale;
- appearance.

Layout

4.2.7 The layout of the individual buildings and access to them has been designed to take into account various operational constraints in relation to the functional requirements of the facility.

4.2.8 For safe and efficient operation, the facility will have an internal vehicular circulation road that will allow the delivery of fuels and the export of ash residue. A perimeter one-way system will be operated on the site to link all the building functions. Leading from the perimeter circulation road will be access spurs and service areas located as appropriate to serve the particular operational areas / processes.

4.2.9 The straw barns require constant access during delivery hours for straw laden trailers in a double lane format without causing disruption to other vehicular movements. The arrangement of the buildings therefore takes into account the manoeuvring space of long trailer vehicles.

4.2.10 Biomass fuel (i.e. straw / wood chip) will be transferred to the boiler house by a series of enclosed, overhead conveyors. The conveyors will be at a sufficient height to allow the continued circulation of vehicles throughout the site.

4.2.11 In connection with the operation of the boiler and turbine, certain equipment associated with the process is located externally. The siting of this equipment is intrinsic to the function of that process.

- the air cooled condenser is a large item of plant which cools the circulating water to an acceptable temperature, for re-introduction into the heat exchanger. The equipment requires significant volumes of air and is therefore raised on legs to achieve sufficient air flow;
- the storage silos hold lime and ash residue. The latter is exported for recycling as fertiliser. The lay-by is necessary for the loading of export lorries;
- the filters are components necessary for cleaning flue gases;
- the flue stack is for the effective dispersal of treated flue gases;

- the transformers are located close to the turbine house and form the primary connection point to the local electricity supply network.

4.2.12 In addition to these built elements, the site contains a series of interconnected flood compensatory storage basins. These features wrap around the main buildings and provide flood mitigation. Compensatory flood storage would also be provided beneath the straw barns, which would be raised 800mm above ground level, such that the ground beneath the structures also operates as flood storage in more extreme events.

Scale

4.2.13 The design of the Brigg REP has been based around a compact building arrangement which is aimed at minimising the overall scale of the facility. The total gross floor area of the buildings 10,118m^2 which is allocated as follows:

Table 4.1: Building Area Schedule

Building element		**Area (m^2)**	**Area (ft^2)**
Straw Barn 1		3,158	33,992
Straw Barn 2		3,158	33,992
Wood Storage		563	6,061
Boiler House/ Turbine Hall		1,935	20,828
Offices, workshop, stores and plant	Ground floor	652	7,018
	First floor	652	7,018

4.2.14 The volumes of the individual buildings have been determined to be sufficient to satisfy the spatial requirements of the process equipment. The height of the tallest building, the Boiler House, is dictated by the process equipment that it houses. Low pitched roofs have been adopted on all buildings to keep the ridge heights as low as possible and minimise overall building heights.

Appearance

4.2.15 The REP is made up of a series of simple forms that respond to the functional requirements of the internal processes. The overall image created is one of a contemporary modern industrial facility that offers architectural character and aesthetic quality through the use of visually strong materials.

4.2.16 The composition of the elevational treatment has a strong horizontal emphasis using different types and proportions of vertical and horizontal cladding material that help to break-down the scale of the large buildings.

4.2.17 The elevational treatment of the buildings has been designed to minimise visual impact, through consideration of the juxtaposition of the buildings with each other and their integration into the landscape.

4.2.18 The strategic use of feature timber cladding provides a response to the approach views from the town of Brigg and assists in providing an appropriate scale. Timber as a material in this context makes a striking visual statement as regards to the sustainable objectives of this project.

4.2.19 The chosen cladding materials are of a high quality and are appropriate for large industrial buildings. The finishes of the proposed panels are durable and the colour coatings used achieve an industry standard design-life consistent with the life of the facility. This will ensure that the aesthetic result remains suitable for an appropriate length of time.

4.2.20 Colour-coated metal sheeting will form the predominant cladding material to the various buildings. A standard palette of horizontally laid white micro-rib flat panels combined with vertical Goose-wing Grey profiled cladding will be used to give a consistent theme to the elevations. The timber cladding will be maintenance free and will weather over time to a greyish brown colour after approximately 1 year. Where glazing is provided it will comprise Merlin Grey powder-coated frames with tinted glass.

Landscaping

4.2.21 In order to provide a level of mitigation against the potential adverse landscape and visual effects of the development, landscape works would be implemented as part of the proposal. An indicative landscape design is shown on Figure 7.3.

4.2.22 An extensive area of new woodland planting would extend north from the site entrance along the western and northern boundaries of the site. This would, as the trees mature, provide a degree of visual screening for the properties at

Scawby Brook from the effects of the development (with the exception of the upper parts of the building and the chimney stack). The woodland would also be in keeping with the guidelines for the Flat Valley Bottom Farmland landscape type as set out in North Lincolnshire Landscape Character Assessment & Guidelines, which include planting medium-sized blocks of woodland concentrated near to areas with intrusive impacts.

4.2.23 The species mix for both the woodland itself and the woodland edge would be drawn from the species' indicated in North Lincolnshire Council's SPG 3 Design in the Countryside. Trees and shrubs would be set in an appropriate ground flora seed mix. Indicative planting mixes are shown on Figure 7.3.

4.2.24 The southern and eastern boundaries of the site would be marked by new hedgerow planting with trees, again in keeping with guidelines for the landscape type. The hedgerow trees would, to some degree, provide screening to the south and east in the longer-term.

4.2.25 The area between the proposed site buildings and the woodland at the western boundary would be seeded with a species-rich mix which would be low in maintenance costs and would enhance wildlife diversity.

Employment

4.2.26 During the operation phase, the following permanent jobs would be created:

- operational staff - 5 shifts of 4 jobs each (20 in total)
- administration and management staff - approximately 10 jobs;
- baling, management and haulage of straw - approximately 50 jobs;
- Total - **approximately 80 Jobs**.

4.2.27 It should also be noted that further (temporary) employment opportunities should be available during both the construction and operation of the facility. The socio-economic benefits of the scheme are set out within Appendix 4-1.

Access

4.2.28 The existing site access road connects to B1206 Scawby Road at an off-set cross-roads layout. The other side road access arm to the junction being Brigg Road, which provides local access to the village of Scawby. This cross-roads junction is of a ghost island layout design to allow for the storage of right turn vehicles ‘off-line’ from main through movements on the B1206, thereby assisting in managing both highway capacity and safety. The site access road connection and the Scawby Road connection are off-set by approximately 100m (measured centre to centre).

4.2.29 At the connection to B1206 Scawby Road, the existing site access route is of the order of 6.5 – 7.0m in width and is bounded on its immediate northern side by buildings and land associated with an animal kennels business. The existing junction connection provides left turn entry / exit radii of the order of 8.5m. Existing lateral visibility in the critical leading direction is considered to be entirely suitable for observed approach traffic speeds on the B1206 Scawby Road. Available sightlines of 150m in this direction exceed maximum visibility requirements, even including for snow covered road conditions. Existing visibility provision in the non-leading direction is considered suitable for 50-60 mph operation based on typical road surface conditions when measured to the outside of the main approach road. The current good visibility provision at the junction is considered to be reflected by the excellent highway safety record, which has seen no accident incidents at the site access over the past 5 year period.

4.2.30 The B1206 Scawby Road acts as the main local distributor route for the Scawby Brook area and would accommodate all traffic movements to / from the Brigg REP proposal site. B1026 Scawby Road to the north serves the immediate local settlement of Scawby Brook and onward connections to the town of Brigg and the A18 / M180.

4.2.31 The B1026 to the north of the site terminates at a mini-roundabout junction with the A18. This junction has been designed to incorporate larger HGV service vehicles and includes for significant hatching / narrowing of approach lanes to the junction to promote safe operation. To the east of this junction the A18 provides local connections to Brigg Town Centre. To the north / west the

A18 route provides district distributor road connections to the A15 main roundabout connection some 3.3km to the west. The A15 provides immediate connections to M180 junction 4 and onward southern links to Lincoln and surrounding settlements. The A18 continues westwards to provide connections to the town of Scunthorpe.

4.2.32 It is proposed that all HGVs entering and leaving the site do so via an agreed routeing scheme (controlled by either a planning condition and / or Section 106 Agreement). In this context it should be noted that Eco2 has contractual control over all HGVs serving the facility. The ‘agreed‘ route would involve (travelling from the site) a right turn onto Scawby Road (B1206) north, left at the mini-roundabout onto the A18, with vehicles then routeing onto either the A18, A15 or M180 depending upon destination. Vehicles travelling to the site would follow this route in reverse. It is anticipated that virtually all Brigg REP operational movements would utilise this proposed route corridor.

Drainage and Flood Mitigation Infrastructure

4.2.33 Foul water drainage would connect to the existing on-site infrastructure which served the site when it was an operating sugar factory.

4.2.34 Surface water drainage would be via new on-site infrastructure. The full principles of the scheme are set out in Appendix 10-1. In summary, future surface water flows would drain, via infrastructure, to an on-site surface water pond. From the on-site pond surface water would be discharged, via pump, into Scawby Beck at an attenuated rate of 7.3l/s.

4.2.35 In addition to flood mitigation by virtue of the aforementioned surface water attenuation feature, a series of interlinked flood compensation storage basins would be developed. These provide compensatory floodplain capacity of a volume greater than the volume of floodplain lost to the proposed development. This aspect of the proposal and its functions is described more fully in Chapter 10.0 Surface Waters and Flood Risk and the accompanying Appendix 10-1.

Lighting

4.2.36 Once commissioned the Brigg REP would operate on a continuous basis. During hours of darkness there would be a need for a degree of illumination to ensure a safe working environment for operatives on site. The lighting proposals would be as follows:

- there would be no building mounted lights and no lighting of external façades;
- lighting of external yard and parking areas would use modern flat glass high pressure sodium (or similar) lanterns which achieve full ‘cut-off’, meaning that all of the light shines down with minimal upwards or sideways spill. The lit surfacing would not materially extend beyond the operational boundary of the site;
- the full external lighting system would only operate during hours of darkness (i.e. in winter) when vehicle deliveries are occurring, this being during the normal working day. After this time the main lighting would automatically be switched off.
- In order to cater for the health and safety needs of night shift workers at the plant, a reduced, low level lighting system would remain in operation after dark, utilising low level lanterns and restricted to required walking routes and staff parking areas;
- similarly, internal building lighting to the upper floors of the proposed office accommodation, which would be vacant outside of the normal working day, would incorporate intelligent lighting control systems and as such would switch off after operational hours;
- the internal operational areas of the REP would be lit to provide a safe working environment according to task in specific working areas, rather than to provide a consistent light level. This approach would ensure that light spillage from within the plant would be kept to a minimum.

4.2.37 It should be noted that any impact of the proposed lighting scheme beyond the site boundaries would be further mitigated by the peripheral landscaping.

4.2.38 It is suggested that full details of a lighting scheme be controlled by way of a suitably worded planning condition.

Construction

4.2.39 Construction of the Brigg REP and associated infrastructure would involve typical / standard construction practices, with specialist fit-out on the boiler house.

4.2.40 The building shells are likely to be constructed upon piled foundations (this is the assumption used in predicting construction impacts). The buildings themselves would be steel framed structures with the external envelope formed from a combination of masonry blocks, cold rolled sheeting rails, timber and metal cladding and glazing. The roofs of the buildings would be constructed of cold rolled perlins.

4.2.41 External hardstanding and roads would be a combination of bitmac and concrete construction, with the actual specification depending upon vehicular usage.

4.2.42 From commencement of site operations, the total construction, fit-out and commissioning period is likely to be approximately 30 months. Further details on the construction phase of the development are contained within Section 14.0.

Security Fencing and Gates

4.2.43 The REP complex perimeter would be secured by a 3.0 metre high weld mesh boundary fence (e.g. Betafence Securifor 358 high security fencing) with matching lockable steel gates to provide means of access. All fencing would be dark green in colour.

4.2.44 Further security would be provided by virtue of a CCTV monitoring system.

Car Parking

4.2.45 Twenty car parking spaces will be provided on the site to accommodate a regular requirement for twelve spaces and an overspill of eight spaces to allow for visitors, shift overlap and annual maintenance periods. At least one disabled car parking space would be provided. A shelter with a capacity of ten spaces would also be provided for bicycles and motorcycles.

4.2.46 Designated lorry parking spaces are not considered necessary. Any temporary / short-term requirement for lorry parking can be accommodated within the service yards and circulation roads provided.

4.2.47 There would also be parking area capable of accommodating two coaches.

Waste Management

4.2.48 It should be noted that the site would be subject to a Site Waste Management Plan which, in accordance with the Site Waste Management Plans Regulations 2008, would be produced prior to construction.

4.2.49 The REP would produce limited quantities of waste. The quantities of which, and method of management, would be as set out within Table 4.1 below. As described within the subsequent text (within this section) all ash (bottom and fly ash) arising from the combustion process would be in the form of a saleable by-product used as a fertilizer.

Table 4.2: Waste Streams: Nature, Handling, Disposal and Change

Stream	**Nature**	**Estimated quantity**	**Storage & handling**	**Disposal or Use**
Process effluents	Process effluents from water treatment plant effluent, boiler blowdown, steam plant drains, etc	129.3 m3/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 m3/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 licenced waste contractors.	Storage in closed skip.

4.2.50 In addition, there would be very limited waste arising from the office and staff welfare facilities. This would be source separated into the following elements:

- paper / card;
- plastics;
- metals;
- glass;
- general.

4.2.51 This material would then be dispatched for either recycling or disposal at a suitably licensed facility.

4.3 Proposed Site Operations

4.3.1 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.

4.3.2 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 4.10.

The Combustion Line – Fuel Handling

Vehicle Access / Egress – All Fuel

4.3.3 All lorries accessing the site would use a swipe card system or similar to raise the security barrier at the site entrance.

Straw Deliveries

4.3.4 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.

4.3.5 Each straw barn contains two overhead cranes which are capable of unloading two lorries at the same time (in each barn). 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. Where possible, straw that is found to be improperly bound, or otherwise out of specification for use in the main straw line, will be transferred to the wood chip storage facility and fed into the plant via that line.

4.3.6 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.

4.3.7 An unloaded lorry will be swept clean of any remaining straw within the straw barn, prior to leaving the site. In addition, each barn will have vacuum facilities for collecting loose straw which will then be fed into the furnace.

Wood Deliveries

4.3.8 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 would then continue to the south of the site, via the perimeter road, and enter a manoeuvring space in front of the wood chip storage building main doors.

4.3.9 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.

4.3.10 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.

4.3.11 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 of wood, in a stockpile directly above the push floor mechanism. This is sufficient for 10 hours' operation at the maximum wood fuel feeding rate.

4.3.12 Lorries that have discharged their loads will drive out of the wood chip storage building onto the south 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

4.3.13 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.

4.3.14 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.

4.3.15 At the top of each fuel feed conveyor there is a scarifier, 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.

4.3.16 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.

4.3.17 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 4.11 and 4.12.

The Combustion Line – The Furnace

Combustion

4.3.18 Straw, or a combination of straw and wood chips, is burned on a water-cooled vibrating 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.

4.3.19 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).

4.3.20 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.

4.3.21 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.

4.3.22 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. A front-end loader is used to remove the ash periodically and load it onto lorries for removal from site for reuse, see Table 4.3 below.

Table 4.3: Bottom Ash Quantities and Method of Management

Stream	Nature	Estimated quantity	Storage & handling	Disposal or Use
Bottom ash	Wet ash, variable particle size.	62 t/day	Dedicated storage room and handling system	Removed from site by covered lorry for use as a soil conditioner

Heat Exchange

4.3.23 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 through the furnace structure up and down through several passes. The temperature above the grate is around 1100ºC; as the combustion gases pass through the various passes of the furnace they transfer their heat to 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

4.3.24 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.

4.3.25 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 hoppers below the filter housing. The residues are transferred from these hoppers to the silos.

4.3.26 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 Chapter 12.0 of this ES.

4.3.27 Lime and fly ash is collected in silos following which it is transported off site by tanker for re-use as a fertiliser. The quantities of fly ash and method of management are described below in Table 4.4.

Table 4.4: Fly Ash Quantities and Method of Management

Stream	Nature	Estimated quantity	Storage & handling	Disposal or Use
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.

The Water / Steam Cycle

Steam Production

4.3.28 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).

4.3.29 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.

4.3.30 The steam drum is a vessel that holds boiling water and steam. The water sits in the 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.

4.3.31 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

4.3.32 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

4.3.33 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.

4.3.34 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

4.3.35 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.

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

4.3.37 Fuel delivery periods shall be limited to:

0700 to 1900 hrs from Monday to Friday; and

0800 to 1400 hrs on Saturdays.

No fuel deliveries shall be accepted on Sundays or public holidays.

4.4 Alternatives Considered

4.4.1 The requirement to consider alternatives stems primarily from the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999. Schedule 4 of the Regulations identifies the information for inclusion in Environmental Statements. Parts 1 (2) and 2 (4) include:

"An outline of the main alternatives studied ………. and an indication of the main reasons for his choice, taking into account the environmental effects".

4.4.2 Paragraph 83 of Circular 2/99 which accompanies the Regulations notes that:

"Although the Directive and the Regulations do not expressly require the developer to study alternatives, the nature of certain developments and their location may make the consideration of alternatives sites a material consideration…."

4.4.3 The appraisal of alternatives includes:

- alternative locations / sites;
- alternative designs;
- alternative technologies.

The consideration of each has been outlined below.

Alternative Locations / Sites

4.4.4 The Brigg REP site is appropriately allocated for employment / industrial uses within the statutory development plan. Thus, from a planning perspective there would not normally need to be any considerations of alternative sites. However, as the site falls within Flood Zone 3a, national planning guidance in PPS25 requires that a Sequential Test is undertaken. This involves demonstrating that there are no reasonably available sites in areas with lower probability of flooding that would be appropriate to the type of development proposed. This requires the consideration of alternative sites. The Sequential Test, contained as Appendix 10-2 to the ES, evaluated 23 alternative locations within North Lincolnshire and concluded that the Brigg site was the preferred location.

Alternative Designs

4.4.5 With regards to alternative designs, prior to selecting the current proposals, the consultancy team developed a number of design options. Options that were considered and discounted included:

- alternative building orientations and configurations;
- alternative boundary treatments (i.e. fencing, bunding and landscaping);
- alternative arrangements for the access road;
- alternative building materials.
- alternative compensatory flood storage and surface water schemes including the proposal that accompanied the May 2008 application.

4.4.6 Following discussions and further assessment between the consultancy team, the present scheme was adopted as:

- it maximises screening of operational activities from the nearest and most sensitive receptors;
- it provides the optimum vehicular access solution;
- it benefits from the use of sympathetic building materials (including timber panelling);

- it is based around a compact building arrangement aimed at minimising the overall scale of the facility.
- it avoided off-site flood mitigation works that could have potentially adversely affected Silversides SNCI;
- it provides suitable on-site compensatory flood storage and surface water attenuation.

4.4.7 Based upon the above, the current scheme is considered to be the preferable option in terms of site specific location and design.

Alternative Technologies

4.4.8 The generation of electricity from biomass is an established, proven renewable energy technology whose development is supported by Government Policy. The Brigg REP would use straw which is readily available, in excess quantities, in the East of England (recognised in the UK Biomass Strategy – May 2007). Biomass based renewable energy production within the Yorkshire and Humber Region is supported by the Regional Spatial Strategy and the Regional Energy Infrastructure Strategy.

4.4.9 Given the aim of generating electricity from straw, there were two main choices concerning the technology to be employed. These were: (a) the thermal process used to generate electricity and (b) the generating capacity.

4.4.10 A great deal of research has been undertaken that reviews the feasibility of various generating cycles based on biomass fuels. The conventional approach is to burn the fuel to raise steam for use in a steam turbine; other options involve the use of conversion technologies, pyrolysis or gasification, which turn the biomass fuel into a liquid or gaseous fuel. The theory is that these intermediate fuels can then be burned more efficiently in internal combustion engines or gas turbines. The reality is that most if not all of the efficiency gains from burning the intermediate fuel are lost in the fuel conversion process. Moreover, the advanced technologies are relatively unproven and present more risk to third parties that might otherwise fund the project. For these reasons, the applicant decided to adopt the proven combustion and steam turbine process.

4.4.11 With regard to scale of the development, all biomass-based generating technologies offer significant economies of scale as plant capacity increases. These are eventually outweighed by the costs of transporting fuel ever increasing distances to supply plants as they get larger. Smaller plants, with an output of less than 5 MWe can sometimes be made viable by sharing overheads with existing infrastructure but this is unlikely in the case of straw because of the expensive bespoke equipment required to store, handle and feed straw bales into a combustion unit. At the larger scale, the optimum balance between capital and operating cost savings and the cost of fuel is achieved at around 30-40 MWe. Above 40MWe, economies of scale at the plant are limited by the increase in fuel costs due to the increase in fuel haulage distances.

4.4.12 In light of the above, Eco2 proposes to build a 40MWe combustion / steam cycle straw-fired power station.