



# Newton Aycliffe Clinical Waste

## Assessment on R1 based on Expected Performance

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## Executive Summary

The Newton Aycliffe facility is being developed to provide a thermal treatment solution to Clinical and other specialist material streams.

The facility has been designed to comply with the definition of a “recovery” facility that is compliant within the hierarchy of waste management set out previously within the Waste Framework Directive (Directive 2008/98/EC).

In order to achieve this, Fornax has identified consumers to be attached to a heat distribution network such that a large proportion of heat generated from the facility can be utilised to replace the use of other fossil fuels at those sites.

This report details the calculation used and demonstrates that the plant design allows for sufficient heat to be supplied to meet the R1 requirement.

It is important to note that the calculations within this report detail the performance of the plant and its heat distribution network at a level which just satisfies the requirements to achieve R1. When in operation, the heat distribution network is intended to supply an even greater proportion of heat to consumers, thereby achieving an even better environmental performance.



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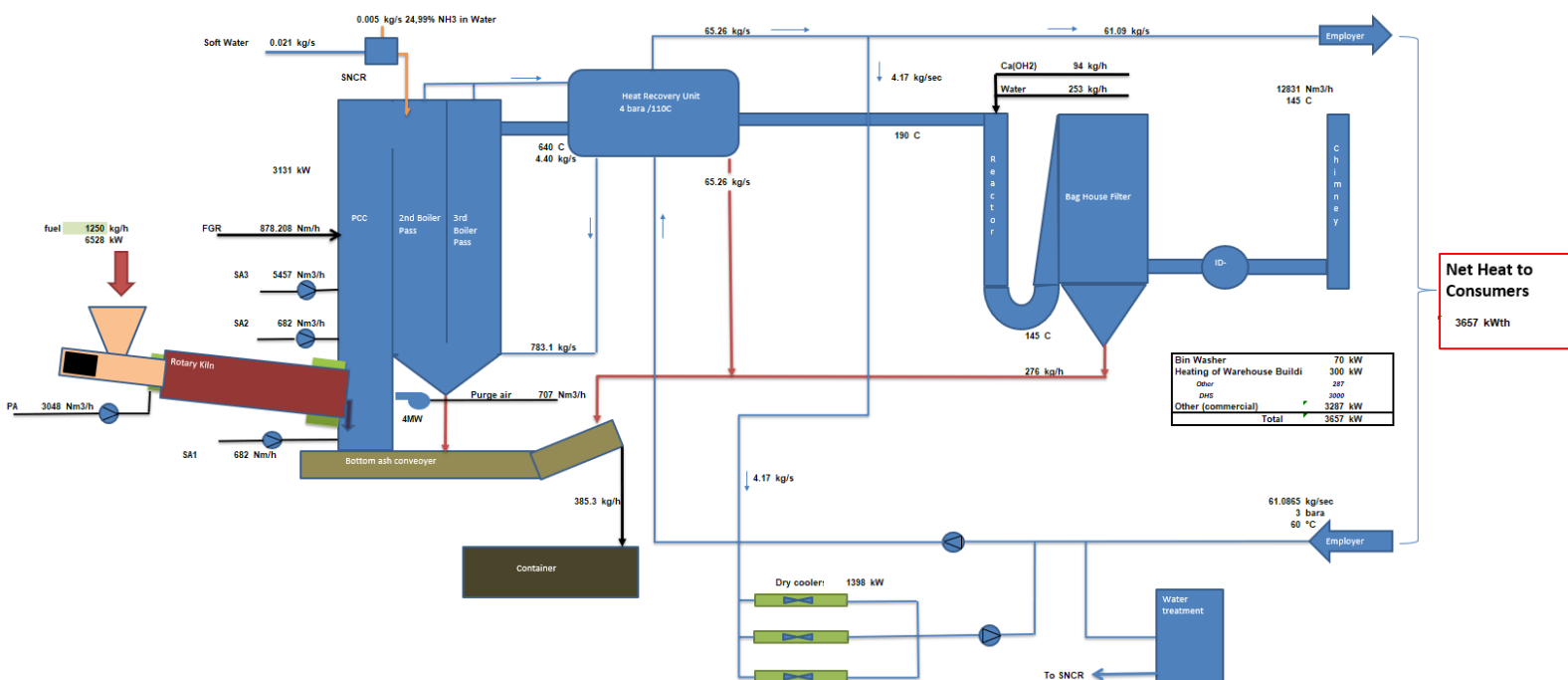
## 1.0 Introduction

This document provides an in-depth overview of the R1 process, including the Process Flow Diagram (PFD), the R1 Data Sheet, and a Sankey diagram. Each section contains detailed descriptions to facilitate a comprehensive calculation of R1 value and understanding of the process and its components. Additionally, the document discusses the significance and value of the R1 process in the context of energy recovery and efficiency.

## 2.0 R1 Process Flow Diagram (PFD)

The Process Flow Diagram (PFD) illustrates the flow of materials and energy within the R1 system. Key components include the Bin Washer, which consumes 70 kW of power to clean bins, and the Heating of Warehouse Building, which requires 300 kW to maintain optimal temperature conditions. The system also includes Dry Coolers that dissipate excess heat, and the SNCR System, which reduces NOx emissions by injecting ammonia or urea into the flue gas. The Heat Recovery Unit captures waste heat from the process, enhancing overall energy efficiency. The PFD details various flow rates, temperatures, and energy inputs and outputs at different stages, providing a comprehensive overview of the operational setup.

Figure 2-1 Process Flow Diagram



## 3.0 R1 Data Sheet

The R1 Data Sheet presents critical operational data for the R1 process. It specifies one boiler line operating for 8300 hours annually, with a waste feed rate of 1250 kg/hr, totalling 10,375 tonnes per year. The system uses 209 MWh of natural gas for start-up, with a total fuel energy input of 6580.195 kW. The total electrical consumption is 1,099.1 MWh per year,



while electricity production stands at 33,388 MWh per year. This data highlights the system's capacity to handle significant waste volumes and its efficiency in converting energy inputs to outputs. The R1 value, calculated at 66.44%, indicates a high conversion rate of energy inputs to useful outputs, demonstrating the system's effectiveness in energy recovery.

Figure 3-1 Data Sheet

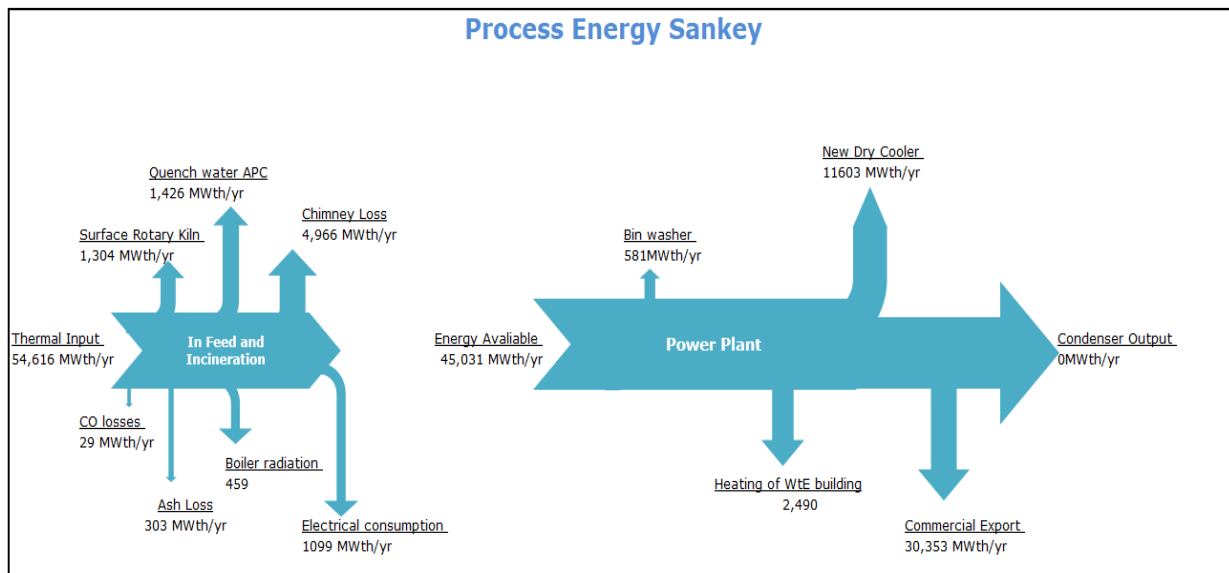
| Raw Data                            |          |          | R1 Calculation - SLR                       |             |          |
|-------------------------------------|----------|----------|--|-------------|----------|
| Parameter                           | Unit     | Value    | Ew - Energy input to the system from waste |             |          |
| 1 Boiler lines                      |          | 1        | Amount                                     | Units       |          |
| 2 Yearly operating hours            | hrs/yr   | 8300     | Waste Feed                                 | 1250        | kg/hr    |
| 3 Waste Energy Input                |          |          | Waste Feed                                 | 1.250042553 | tonne/hr |
| 3.1 Waste Feed                      | kg/hr    | 1,250    | Waste Feed                                 | 10,375      | tonne/yr |
| 3.2 Waste NCV                       | kJ/kg    | 18800    | Ew   | 178         | MJ/yr    |
| 3.2.1 NCV                           | MJ/kg    | 17.2     | Ew   | 178,456     | GJ/yr    |
| 3.2.2 NCV                           | MJ/tonne | 0.0172   | Ew   | 49,571      | MWh      |
| 4 Start Up                          |          |          | Ef - Energy imported for steam production  |             |          |
| 4.1 Annual start-up                 | pcs      | 8        | Amount                                     | Units       |          |
| 4.2 Full load period                | hrs      | 4        | Natural gas for start up                   | 209         | MWh      |
| 5 Fuel Energy Input                 |          |          | Ei - Energy imported                       |             |          |
| 5.1 Fuel                            | kW       | 6528     | Amount                                     | Units       |          |
| 5.2 Combustion air                  | kW       | 0        | Electrical consumption                     | 1099        | MWh      |
| 5.3 SNCR                            | kW       | 11       |  |             |          |
| 5.4 FGR                             | kW       | 41       | Ep - Electricity production                |             |          |
| 5.5 Total Fuel Energy Input         | kW       | 6580.195 | Amount                                     | Units       |          |
| 6 Electricity Consumption           |          |          | Heat Reuse                                 | 3,657       | kW       |
| 6.1 CA-fan                          | kW       | 23       | Heat Reuse (x1.1)                          | 4,023       | kW       |
| 6.2 ID-fan                          | kW       | 24       | Total Heat Reuse                           | 33,388      | MWh/yr   |
| 6.3 Dry coolers                     | kW       | 0        |  |             |          |
| 6.4 Feed water pump                 | kW       | 35       | Electricity Reuse                          | 0           | kW       |
| 6.5 Boiler circulation pump         | kW       | 0        | Electricity Reuse (x2.6)                   | 0           | kW       |
| 6.6 Aux consumption                 | kW       | 50       | Total Electricity Reuse                    | 0           | MWh/yr   |
| 6.7 Total Electrical Consumption    | kW       | 132      |  |             |          |
| 6.7.1 Total Electrical Consumption  | MW       | 0.13     | Ep - Energy production                     | 33,388      | MWh/yr   |
| 6.7.2 Total Electrical Consumption  | MWh/yr   | 1,099.1  |  |             |          |
| 7 Electricity production            |          |          | R1 (MWh)                                   |             |          |
| 7.1.1 Bin Washer                    | kW       | 70       | 66.44%                                     | %           |          |
| 7.1.2 Heating of warehouse building | kW       | 300      |  |             |          |
| 7.1.3 Other (commercial)            | kW       | 3,287    |  |             |          |
| 7.1.4 Condenser                     | kW       | n/a      |  |             |          |
| 7.1.5 Dry Coolers                   | kW       | 1398     |  |             |          |
| 7.1 Heat Reuse                      | kW       | 3,657    |  |             |          |
| 7.2.1 Turbine Output                | kW       | 0        |  |             |          |
| 7.2 Electricity Reuse               | kW       | 0        |  |             |          |
| 8 Equivalence factor                |          |          |  |             |          |
| 8.1 Heat Equivalence factor         | -        | 1.1      |  |             |          |
| 8.2 Electricity Equivalence factor  | -        | 2.6      |  |             |          |

## 4.0 Sankey Diagram

The Sankey diagram visualizes the energy distribution within the R1 process, emphasizing the flow of energy inputs, outputs, and losses. Energy inputs primarily come from the waste feed and natural gas used for start-up. Energy outputs are distributed to various applications, including the heating of the warehouse, bin washing, and commercial export. The diagram also identifies energy losses occurring at different stages, such as through exhaust gases and cooling processes. This visualization is instrumental in identifying areas for potential improvement in energy efficiency, allowing for targeted optimizations in the R1 process.



**Figure 4-1 Process Energy Sankey Diagram**

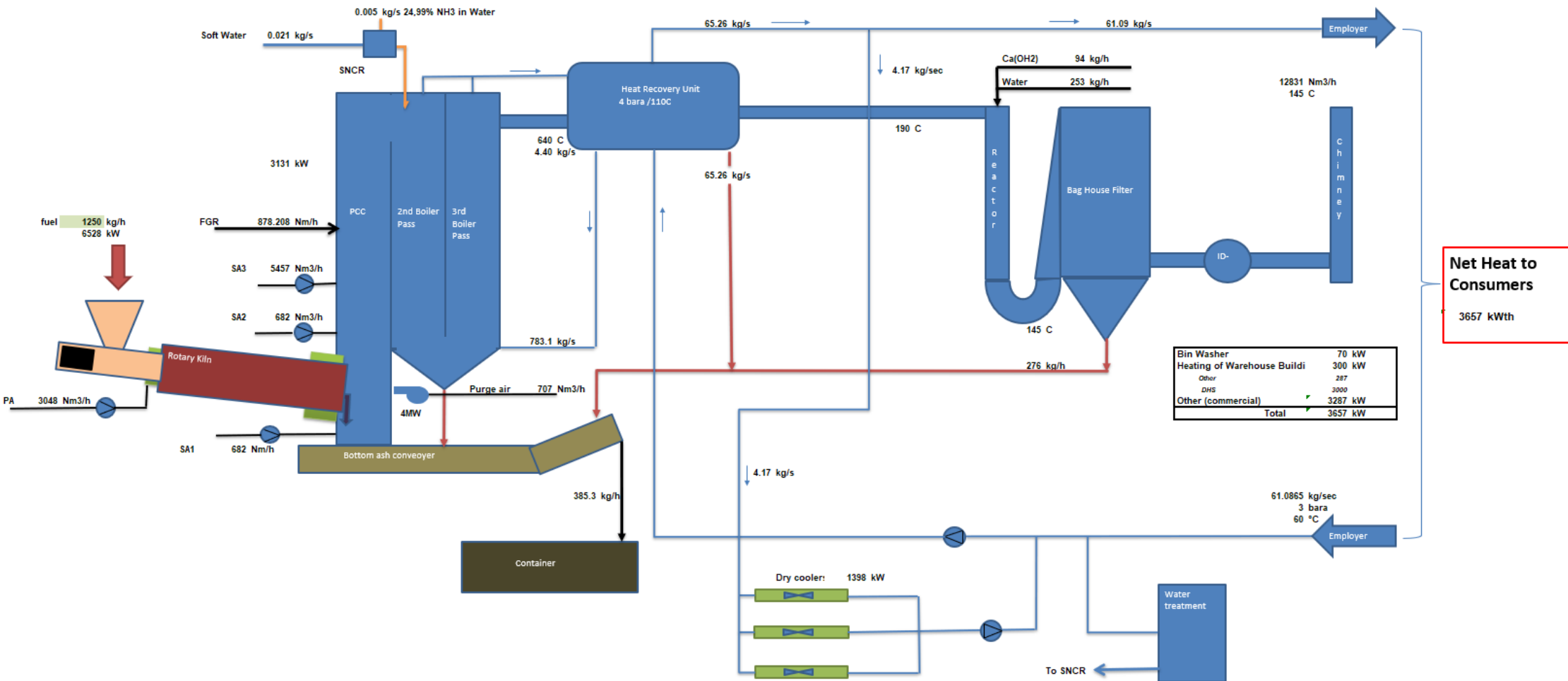


## 5.0 Conclusion

The R1 process demonstrates a calculated value of 66.44%, reflecting a high efficiency in energy recovery. This value aligns well with regulatory-defined standards for waste-to-energy systems, which require an R1 value of at least 60% to qualify as efficient energy recovery facilities. The high R1 value indicates that the system effectively converts a significant portion of the energy input from waste materials into useful outputs, such as heat. The efficient energy recovery capabilities of the R1 system position it as a viable solution for meeting both operational efficiency and regulatory requirements.



## 6.0 Appendix A – Enlarged Process Flow Diagram









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