OPTIWOOD
Improving the Performance and Efficiency of Biomass Boilers

A joint UK-France Project 2018-2020

Under the INTERREG PROGRAMME

Report– Greenhouse-Retail Pilot Site

Optiwood Biomass Boiler Monitoring and Assessment of Site Operating Efficiencies and Recommendations

Late 2018 start to early 2020

Introduction to Biomass Boiler System:-
Heizomat RHK-AK 990kW wood chip boiler with ash bins. 10,000 litre buffer tank located outside. Commissioned 2015. Biomass heating circuit fitted with a heat meter installed to provide information to claim the Renewable Heat Incentive (RHI).

Fossil Fuel Boiler:-
Gas fired boilers used as backup when required. They are generally not used due to the cost of fossil fuel.

Plant Room Layout:-
The plant room houses the boilers, water makeup and expansion unit, heating water pump sets serving a low-loss pipe header before the water services exit the boiler house in pre-insulated pipework underground to the main building. A buffer storage tank is located external to the boiler house and not under cover.

990kW Heizomatt boiler (orange) with fuel silo to left   Outdoor Buffer Tank

The buffer tank set up is shown above. The tank has no stratification, just a simple flow and return set of connectors. The insulation material is a zipped up insulation jacket, designed for internal rather than external use. Due to a combination of ultra-violet light and rain, the insulation jacket is showing signs of significant deterioration (notice the bulges as the material is sagging). It is not providing decent thermal insulation to the tank and heat losses are likely to be high in winter.

Fuel Store Layout:-
An above ground round silo wood chip store is adjacent to the boiler house with a simple rotary outfeeder and spring agitators to feed the fuel to two off transport augers before entering the biomass boiler. An access flap to the silo is sometimes left open allowing rain-snow to enter

Boiler Training Session with client **External Buffer tank**

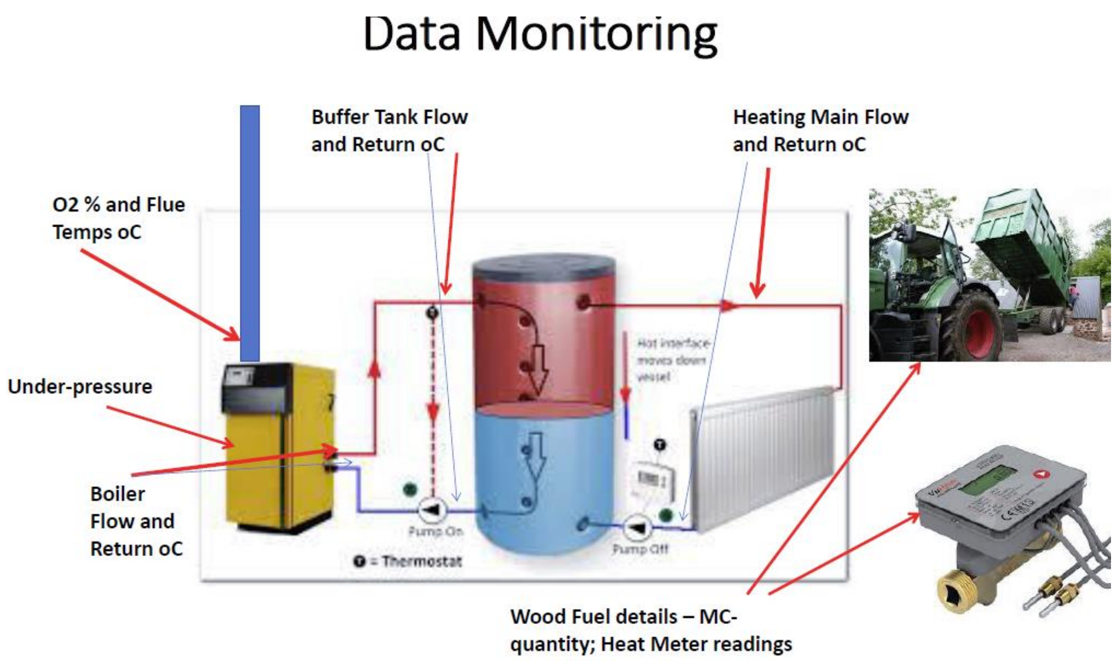
Hatch for Fuel Delivery Access **Overhead heating pipes in Greenhouses**

Maintenance:-
We met with the service engineer for the site. They carry out an annual service and respond to call-outs. Day to day maintenance is carried out via on-site technicians.

Data Collection:-
The boiler panel interface was initially in Polish and via the on-site service technician this was changed to English. Battery powered data loggers were installed (see diagram below) to measure the biomass boiler flue oxygen content, boiler flue temperature, boiler combustion under-pressure, boiler flow and return temperatures, buffer vessel storage temperatures high and low level, ambient temperature and humidity, and the flow and return water temperatures of the heating circuit to the main building.

SEWF have detailed wood fuel delivery information though the moisture content data may need to improve via some detailed MC checks.

Overall Boiler System Efficiency
c.65% (+/-8%) (see further refinement of this below)



Main Results from Pilot Project Review and Data Logging Output

This is a very basic biomass boiler set up to run at temperatures that work for the greenhouses and retail-public area. The system essentially puts out heat, using the buffer tank mainly as a very temporary heat store and without any stratification. The buffer tank is located outside with an indoor specification insulation jacket so higher heat losses can be expected from water ingress, lower than expected ambient temperatures, and in due course sun/weather damage to the fabric covering.

The boiler is cycling regularly and one option we reviewed was to restrict the effective size of the boiler so that it runs for longer at a reduced % of its 990kW capacity. The SEWF engineer met with the service engineer in late May 2019 to review control settings for the boiler. The conclusions were as follows:

- The boiler is clearly over-sized for the existing heat load (which has fallen significantly since the boiler was purchased). The peak heat load is estimated to be less than 50% of the rated capacity of the boiler. This means that the boiler rarely gets a long duration run at anything approaching full capacity.
- In response to this, the service engineer and on-site staff have set the boiler to run as low a capacity as possible by reducing fuel inputs as low as possible to minimise the potential for cycling
- Examining the varying options of settings for the boiler, its current settings are about as low a reduction in the effective capacity as can be achieved with actually de-rating the boiler

Action Points

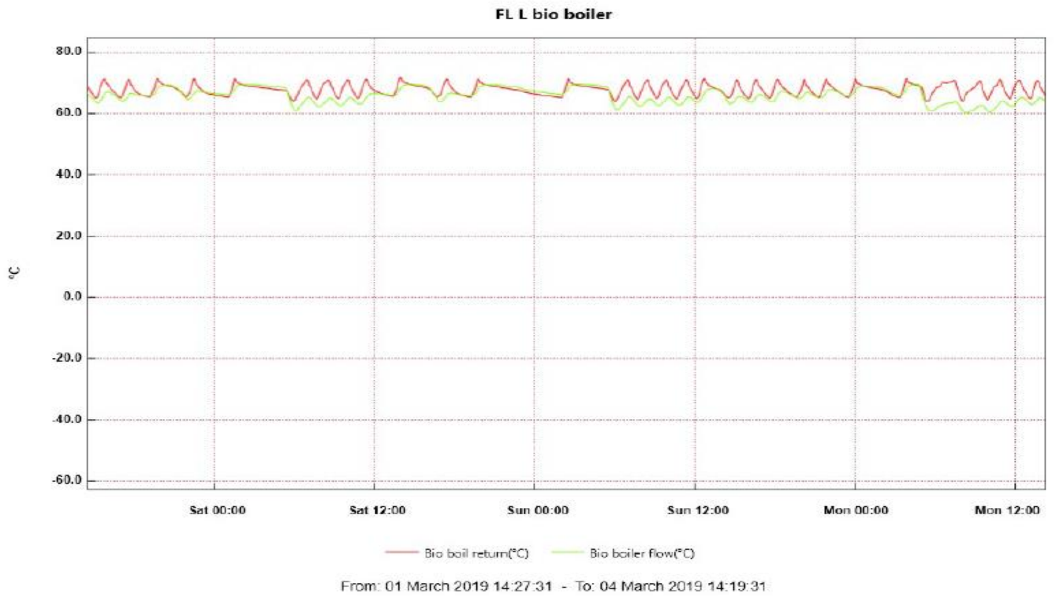
- Review the buffer tank insulation issue. We recommend that proper insulation be applied (e.g. spray-on foam) to replace the deteriorating current insulation jacket, and that the tank have a simple structure built around it to keep it away from the weather. Discussion took place with the client on this but as of January 2020 no final decision had been made to action the work

- Install a timer in the existing control set up which delays the boiler from running through a 30-45 minute delay, allowing the buffer tank temperature to reduce and providing a better heat load profile and longer boiler run times

TECHNICAL DATA OUTPUT FROM OPTIWOOD MONITORING PROGRAMME

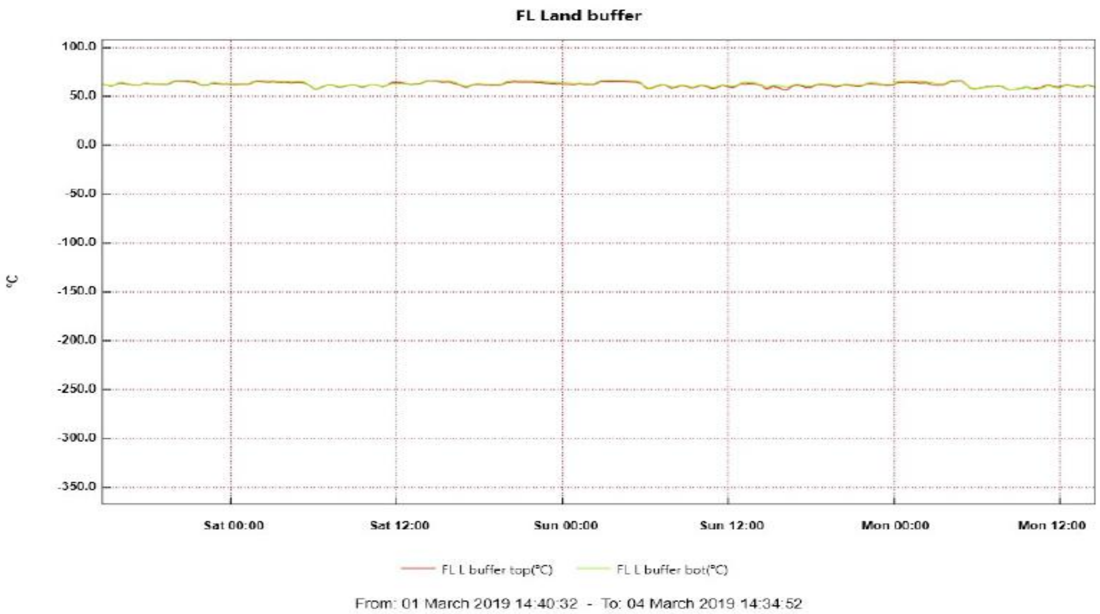
The purpose of the data logging and related equipment is to assess how well the boiler system is operating in terms of combustion efficiency, day to day operation, overall efficiency and the temperatures sent out into the downstream heating network.

Biomass Boiler Flow and Return Temperatures (3 days duration)



Note the evidence of 'cycling' of the boiler at frequent intervals.

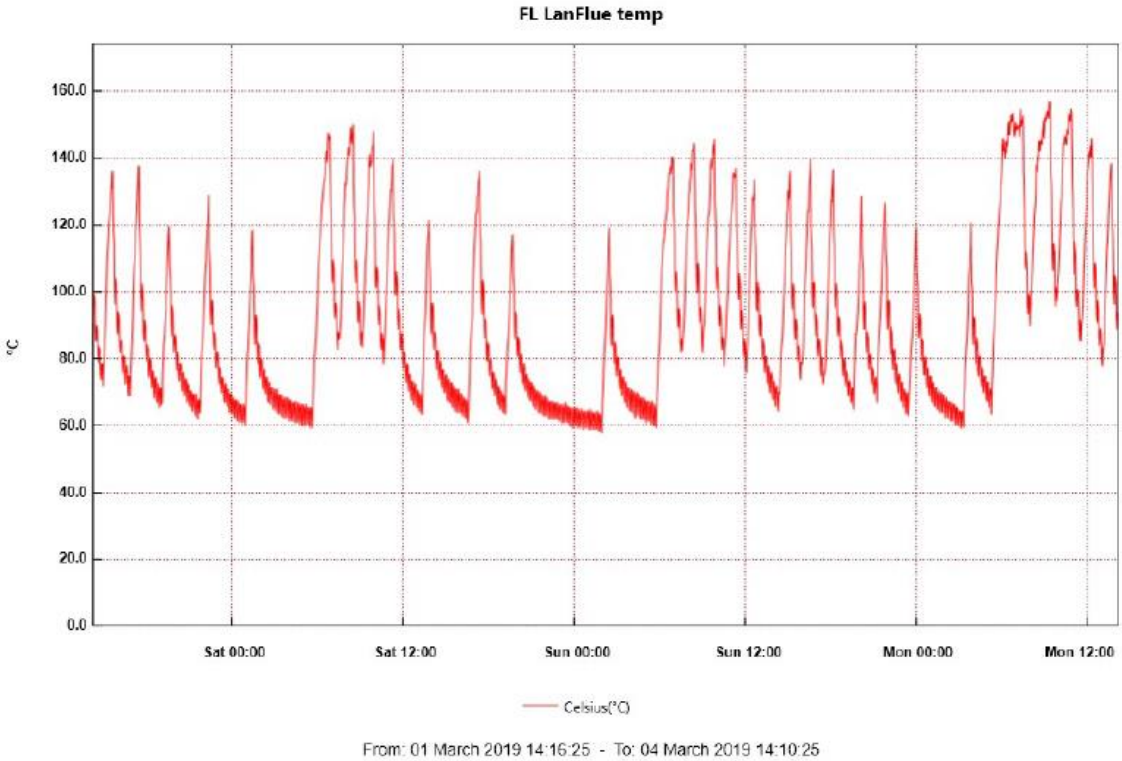
Buffer Tank Flow and Return Temperatures



Note above the lack of any real temperature differentiation between flow and return of the buffer tank. The tank exists as a virtual pass-through of hot water with only a short delay in the tank.

Heating Loop Flow and Return Temperatures

Biomass Exhaust Flue Temperatures (over 12 days)



Note the frequent fluctuations in flue temperatures as the boiler cycles frequently and drops down to low kindling-slumber mode. This is mirrored in the O_2 levels shown below.

Exhaust Flue O_2 levels (% of total mass)

Conclusions from Data Monitoring, Wider Technical Assessments and Action Plan

- This is a very basic design for a biomass boiler system, set up to run at temperatures that work for the greenhouses + retail-public area. The heat load has dropped considerably since the original design and a c.400kW boiler would normally be sufficient for this lower heat load
- There is no option under the current design set-up to shut off the boiler frequently when demand is not there (no automatic ignition), hence the boiler runs for long periods at close to slumber mode, wasting both fuel and reducing the boiler temperatures. This may add stresses to the boiler by introducing excessive moisture into the combustion area.
- The boiler efficiency levels are an estimated 65-68% (+/-8%). This was refined to a higher level of accuracy via improved data and further checks on moisture testing of the fuel. Additional fuel testing confirmed that actual moisture content of the delivered fuel is within +/-5% of that assumed
- The system essentially puts out heat, using the buffer tank mainly as akin to a further low-loss header without any temperature stratification (see temperature flow and return graphs above).
- The two main Action Points – reducing the heat losses from the buffer tank and reducing the level of ‘cycling’ in the boiler by delaying the demand control from the system through a ‘delay timer’ - **could lead to an estimated 5-8% improvement in overall efficiency levels**