Energy Review FY21

Blackburn WwTW

United Utilities Bioresource & Energy Services

Revision	Date	Description	Author	Reviewer	Approver
Rev 1	4th August 2021	First Draft	J Harper		
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Energy Review FY21

Blackburn WwTW

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Energy Management

Our energy management strategy aims to achieve an appropriate balance between managing energy consumption, use of renewables and self-generation and being smart about how we operate our assets to get best value while maintaining security of supply. This is achieved through our energy management programme which brings together management processes, asset optimisation and data analytics.

This programme of work allows Energy Services and our operational teams the opportunity to work closely in order to raise engagement around energy awareness, reduce overall consumption and concentrate on new innovative ways in order to run our treatment process in most efficient way. After a series of workshops with key stakeholders on a participating site and consideration of the various opportunities which have been identified to be more efficient, Energy Services are able to develop an Energy Management Plan that underpins the sites action plan, sites specific STOD Rates and a day by day working strategy for site to follow. Keeping up with this allows us as a business to maintain a work ethic geared around being more efficient, flexible and smarter in the way we use our energy.

Energy Standard

To support our energy management plan we have developed an Energy Standard which is scoring matrix where Energy Services can highlight areas for a participating site to focus on as part of the Energy Management Programme. This scoring matrix is scored by key stakeholders with the guidance of the programme lead and energy engineers. Through providing the key stakeholders the ability to peer assess their own performance gives a strong indication of areas they need to focus on, and the opportunity to discuss ways in which better practice can be achieved. The scoring is based on the following criteria:

- Leadership
- Monitoring
- TRIAD Management
- Flexible Operation
- Maintaining the Energy Management Plan
- Unit Cost to Treat
- Unit cost of energy
- Engagement and awareness
- Training completion

Each unit is scored 1 to 5 and an action plan is devised on the back of this piece of work for site to improve. Dependant on the sites score they receive a certificate of completion varying from Platinum, Gold, Silver and Bronze. Energy Services run through this yearly with each site with the aim to achieve a higher score next time highlighting improvement on performance.

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Energy Awareness & Training

We have developed a set of bespoke energy training packages which are delivered through our e-learning platform, the aim of these courses is to build awareness and engagement around energy use and to improve understanding across the business to enable us to use less, use smarter and generate more.

There are three energy training courses available, the first is centred on our energy use, cost and goals, and to encourage everyone in UU to help reduce our energy use and costs. There are also two further training courses which are specific to our water and wastewater operational teams which provide a walkthrough of our main treatment processes and the associated activities we can implement to improve the efficiency of our operations.

Energy Savings Opportunity Scheme (ESOS)

In 2019 we submitted our declaration to the EA for ESOS (Energy Saving Opportunities scheme) which confirms our approach for energy management across the business. In our overall ESOS compliance report, Bioresource, as a large consumer of energy was identified as one of the key areas of specific energy consumption (SEC). The phase 2 ESOS report and analysis provided an overarching energy review for Bioresources and surfaced energy opportunities which are being investigated over AMP7. These overarching opportunities include for example focusing on biogas production & utilisation, optimisation of CHP engine performance, energy efficiencies in sludge handling & dewatering, a reduction in the use of fossil fuels for heating to support digestion and utilisation of waste heat.

Analytics

The continued development of our energy analytics and reporting capability allows us to effectively monitor energy consumption and generation across the business and to identify opportunities for efficiencies to reduce consumption, avoid peak tariffs and to generate more renewable energy. Investment in powerclips will allow us to monitor individual energy consuming assets such as pumps to assess their energy efficiency and to determine the most energy efficient operation. Further sub-metering across Bioresource will enable the energy consumption to be reviewed independently of the co-located WwTW and to identify further energy saving opportunities.

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Site Overview

Blackburn Wastewater Treatment Works (WwTW) is located in Samlesbury near Blackburn and serves a population equivalent of circa 325,000. The treatment works is co-located with a Bioresource sludge treatment facility which treats the indigenous sludge along with a mixture of thickened and unthickened liquid sludge imports from neighbouring WwTWs for disposal to agriculture.

The Bioresource facility treats sewage sludge via anaerobic digestion, producing a biogas which is utilized in two combined heat and power (CHP) engines to provide electricity to the Bioresource and WwTW assets and to also provide heat back to the digestion process. Biogas is also consumed by onsite boilers to produce steam to provide additional heat to the digestion process, these boilers can be supplemented by fuel oil if necessary.

In 2017 work began at Blackburn WwTW on a significant four year improvement project to improve the quality of water that's returned to the environment in order to meet new river water quality and bathing water standards. The project involved substantial changes to the WwTW with the installation of an efficient Nereda treatment plant along with associated aeration and pumping equipment.

Energy Balance

The majority of energy use at Blackburn WwTW is from Biogas produced on site, supplemented with electricity imported from grid for the operation of plant and equipment. The flow and use of energy is demonstrated in figure 1 below and is detailed in the following sections, a table of values is presented in the appendix.

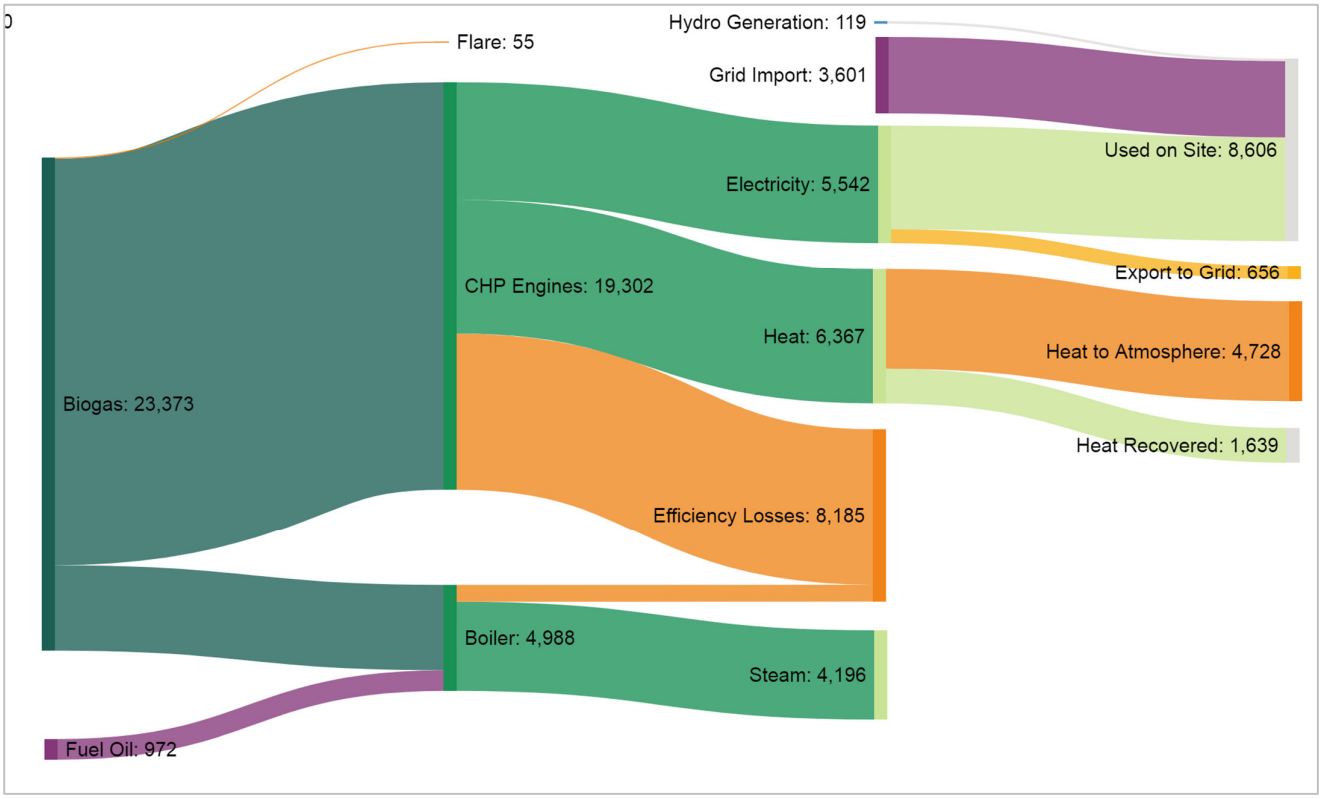

Figure 1- Blackburn WwTW Energy Flow

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Biogas Production and Use

Biogas is the primary source of energy used on site and is produced by the Bioresource facility through the anaerobic digestion of sewage sludge. Biogas production at Blackburn WwTW outperformed expected yields in FY21 with an average of 313 Nm3 produced per tonne of dry solids (tDS) processed, this is against an asset standard of 356 Nm3/tDS which suggests there is an opportunity to improve our biogas production and subsequent energy generation.

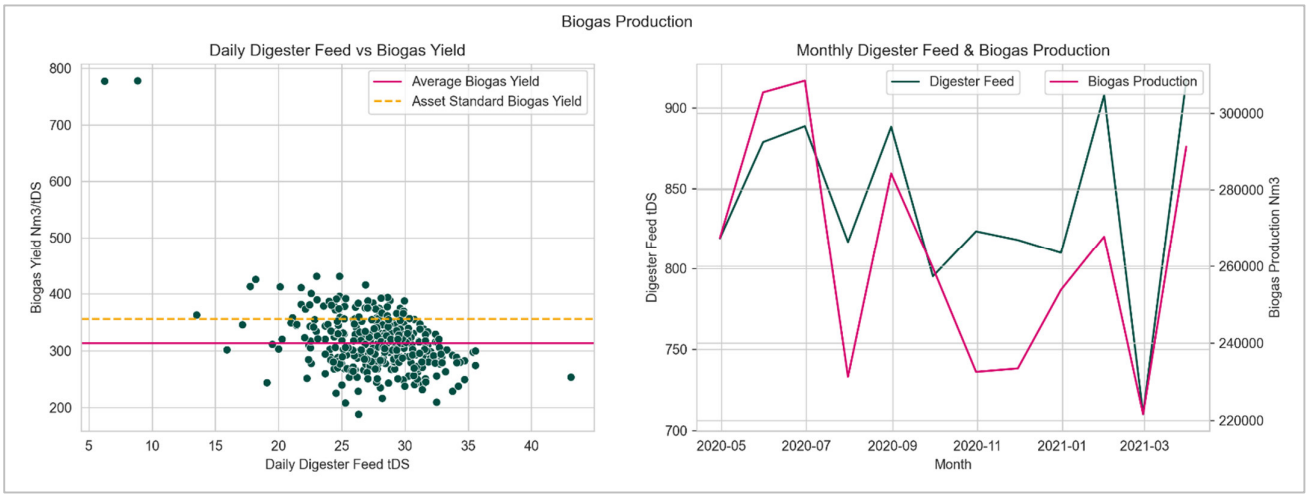

Figure 2 – Blackburn WwTW Biogas Production

Biogas consumption is balanced between the CHP engines and boilers on site (as shown in figure 3 below) in order to meet the electricity and heat requirements of the WwTW and Bioresource facility and to therefore reduce the amount of fossil fuel use in the boilers. Use of the flare has been minimal throughout FY21.

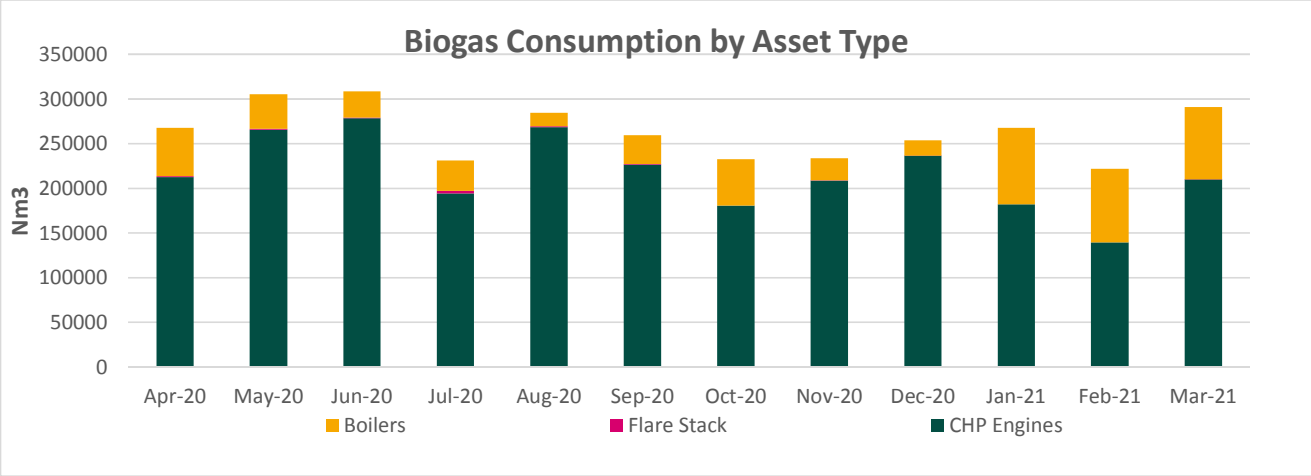

Figure 3 – Blackburn WwTW Biogas Use

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Electricity Consumption

In FY21 average electricity demand across the year for Blackburn WwTW was 982kW from a combination of generation from our biogas fuelled CHP engines, hydro turbine and import from grid (on a renewable tariff). Electricity consumption during peak tariff period decreases as seen in figure 5.

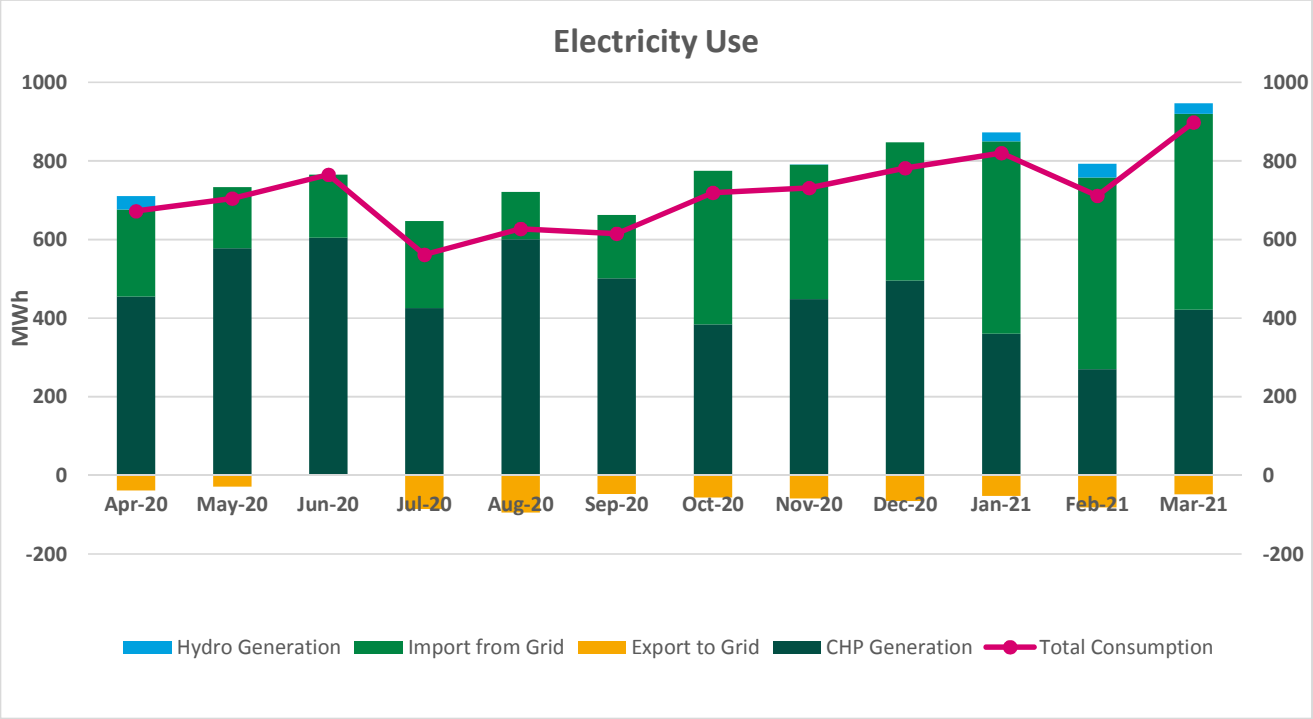

Figure 4- Electricity Consumption

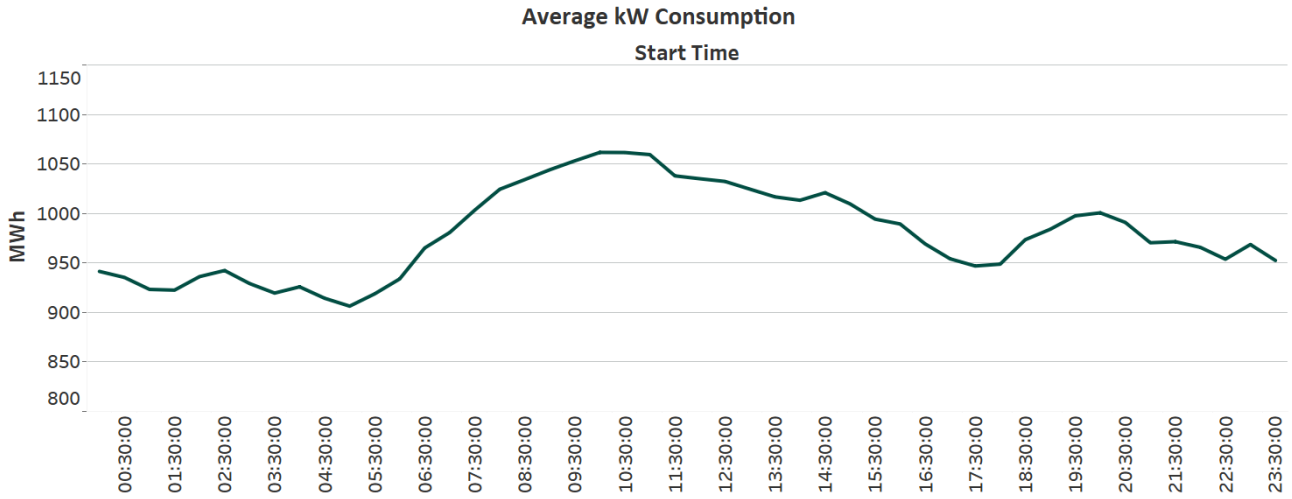

Figure 5 - Average Electricity Consumption by HH Period

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Energy Generation

United Utilities operate and maintain a fleet of combined heat and power (CHP) engines with a dedicated team responsible for the overhaul and maintenance. Proactive maintenance and monitoring of the engines along with further analytics ensures a high-level of engine availability and performance.

At Blackburn WwTW there are two 2 Biogas fuelled CHP engines (625 and 526 kW), an analysis of the electrical efficiencies shows an average electrical efficiency[1] across the year of 30.94% and 33.00% for CHP1 and CHP2 respectively, there is scope to improve the efficiency of the larger 625kW engine.

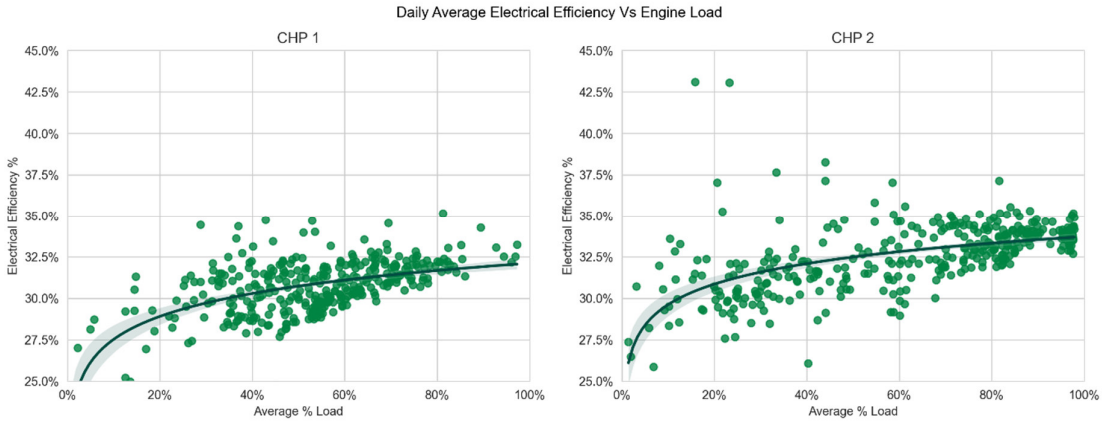

Figure 6- Blackburn WwTW CHP Engine Efficiency FY21

An important aspect of our energy management philosophy is to use (and generate) energy smarter, at Blackburn WwTW both CHP engines are fitted with control software to maximise generation during peak periods as demonstrated below in figure 7.

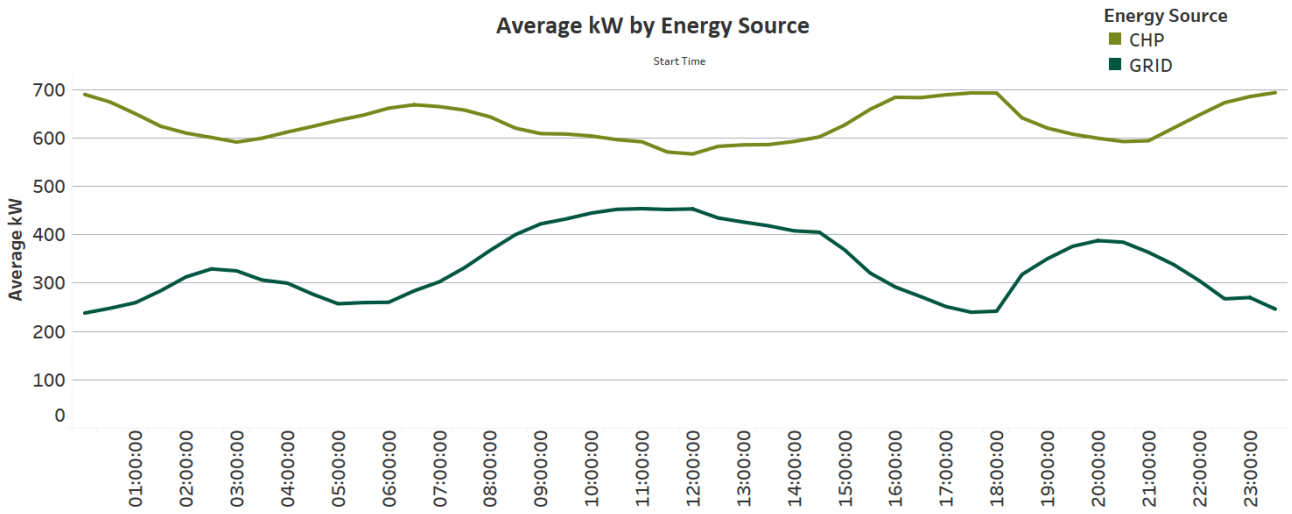

Figure 7 - Average CHP Generation by HH

[1] Electrical efficiencies are expressed based on the net calorific value of the fuel.

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In addition to the two CHP engines there is also a 200kW hydro turbine installed at the WwTW prior to the discharge of the final effluent, the hydro turbine has recently been refurbished and has been operating at an average of 59kW since its reinstatement in January 2021.

Stationary Fuels

Stationary fuels (Gas Oil) are used at Blackburn WwTW as a supplementary fuel to the boilers in order to provide adequate heat to the digestion process, the consumption of Gas Oil is mitigated by consuming Biogas in the boilers when possible.

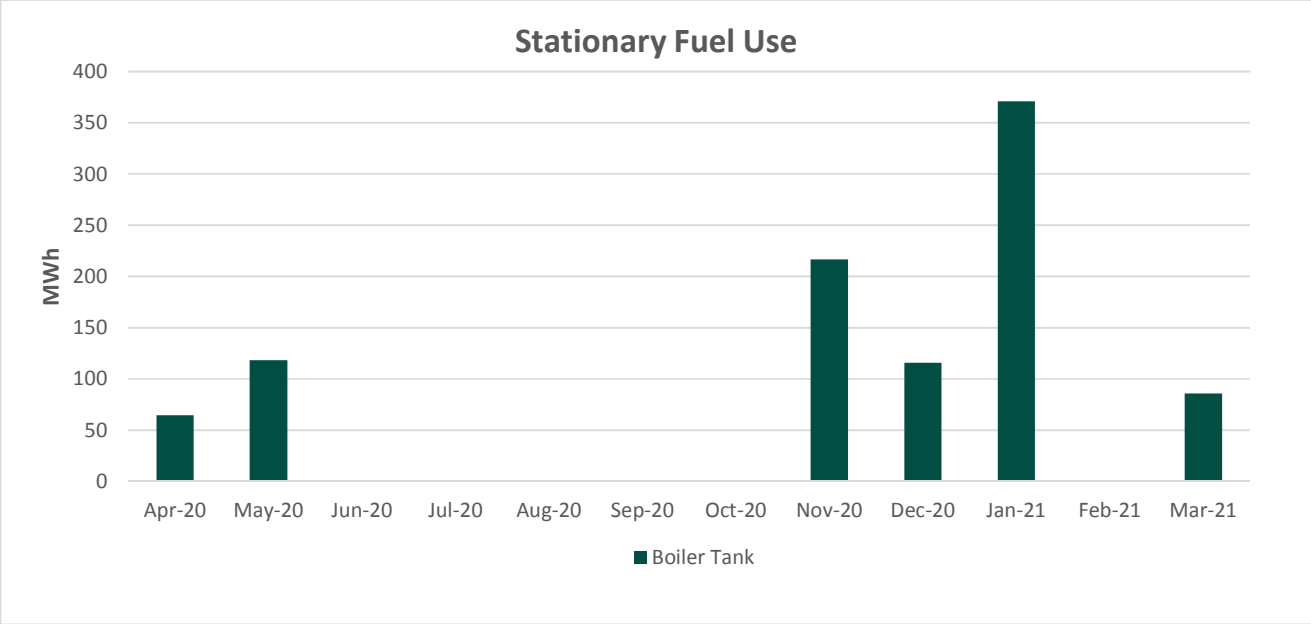

Figure 8- Stationary Fuel Use

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Energy Management Opportunities

There are a number of activities and projects that are being delivered in AMP7 to support energy efficiency and management across the business, in particular those most relevant to Blackburn WwTW are:

Metering & Analytics

Across our operational sites we are installing powerclips on our significant energy consuming assets in order to monitor and review our energy consumption, this allows us to identify individual assets which are performing poorly and to optimise operation. Further to the powerclips we are also planning to install sub-metering across the Bioresource facility which will allow us to determine the energy consumption of the Bioresource operation independently of the WwTW.

Energy Workshops & Energy Standard

Blackburn WwTW obtained a Silver award in our energy standard in 2019 and a number of energy saving opportunities were identified and have been actioned including: Hydro turbine refurbishment, CHP SToD control implementation, optimisation of the WwTW tricking filter rate and dosing set points. Further opportunities to reduce energy consumption are being investigated such as SToD control on the various mixers and pumps in operation, installation of high efficiency blowers on the BAFF plant and the optimisation of the gravity belt thickeners (GBTs).

Summary of Opportunities

Opportunity	Improvement, kWh/yr	Potential Saving, £/yr	Carbon Benefit	Rationale	Time-scales	Owner
Installation of sub-metering (powerclips)	Reduce site consumption by 2-5% (based on our experience at other sites)	In the range of 160,000 – 400,000 kWh which is circa £17-40k	Reduction in the amount of energy imported from grid. UU purchases green energy and therefore action would not reduce carbon emissions (based on carbon accounting practices)	Metering will provide a greater insight to consumption at an asset and process level. Integrate analysis and review into energy management programme	6-12 months	Production Engineer
Reduce fuel oil use in boilers	To be confirmed	To be confirmed	Will reduce carbon emissions from fossil fuel use, using biogas will result in a carbon release but this is from a biogenic source.	Investigate options to maximise biogas use in the boilers and reduce fuel oil use and thereby reduce fuel costs and carbon emissions.	12-24 months	Production Engineer
Improve Biogas Yield	Potential to increase by circa 40Nm3 per tDS (based on asset standard)	Potential circa 400,000 Nm3 of biogas (40 x 10,000 tDS) resulting in circa 800,000 kWh of generation and £120k of revenue (grid import + ROC)	Will increase renewable generation of heat and power allowing off-set of fuel oil use in boilers and a reduction in grid electricity import.	Analysis shows biogas yield lower than expected. Further investigation required to determine the root cause and potential increase in production. The site has changed Ww treatment process and it is possible the sludge from this has a lower calorific value and there improvement may not be possible	6-12 months	Production Engineer
SToD Management	To be confirmed	To be confirmed	None, energy consumption would remain roughly the same	There are multiple assets on site which could benefit from SToD	12-24 months	Production Engineer

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			but be consumed during non-peak times.	software control such as mixers and pumps which would allow a reduction in consumption during peak tariff periods.		

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Appendix

Energy Balance Data

Blackburn WwTW	2020/21	
Sludge Treatment	**m3**	**tDS**
Digester Throughput	185,378	10073

Energy Use		
Biogas Use	**Nm3**	**MWh**
Boilers	545,612	4,016
CHP	2,603,905	19,302
Flare	7,392	55
Total Biogas Produced	3,156,909	23,373

Electricity	**MWh**
CHP Electricity Generation	5,542
Hydro Electricity Generation	119
Renewable Electricity Export to Grid	656
Electricity Import from Grid	3,601
Total Site Consumption	8,606

Heat	**MWh**
Boilers Heat from Biogas	3,408
Boilers Heat from Gas Oil	787
CHP Heat Utilised	1,639
CHP Heat to Atmosphere	4,728
Total Heat	10,563

Stationary Fuels	**Litres**	**MWh**
Gas Oil - Boilers	90,478	972
Total Gas Oil	90,478	972

Energy Input	MWh
Biogas	23,373
Electricity from Grid	3,601
Hydro Generation	119
Gas Oil	972
Total Energy In	28,065

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Energy Output	
CHP Electricity Generation	5,542
CHP Heat	6,367
Boiler Heat	4,196
CHP Efficiency Losses	7,393
Boiler Efficiency Losses	792
Electricity from Grid & Hydro Used on site	3,720
Flared Biogas	55
Total Energy Out	28,065

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