Pure World Energy,
1650 Waterside Drive
Arlington Business Park
Theale, Reading
RG7 4SA

# FRAMPTONS LTD- COMBINED HEAT AND POWER

# MEDIUM COMBUSTION PLANT DIRECTIVE

# SUPPORTING DOCUMENTATION FOR
# 4 X C200KW MICROTURBINES AND HEAT RECOVERY COMPOSITE BOILER & C65 MICROTURBINE
# ALL-NATURAL GAS FIRED

| Revision | Issue Comments | Date | Author |
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| 01 | Issued with revised MCPD Submission | 9/01/2023 | AB |
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## Contents

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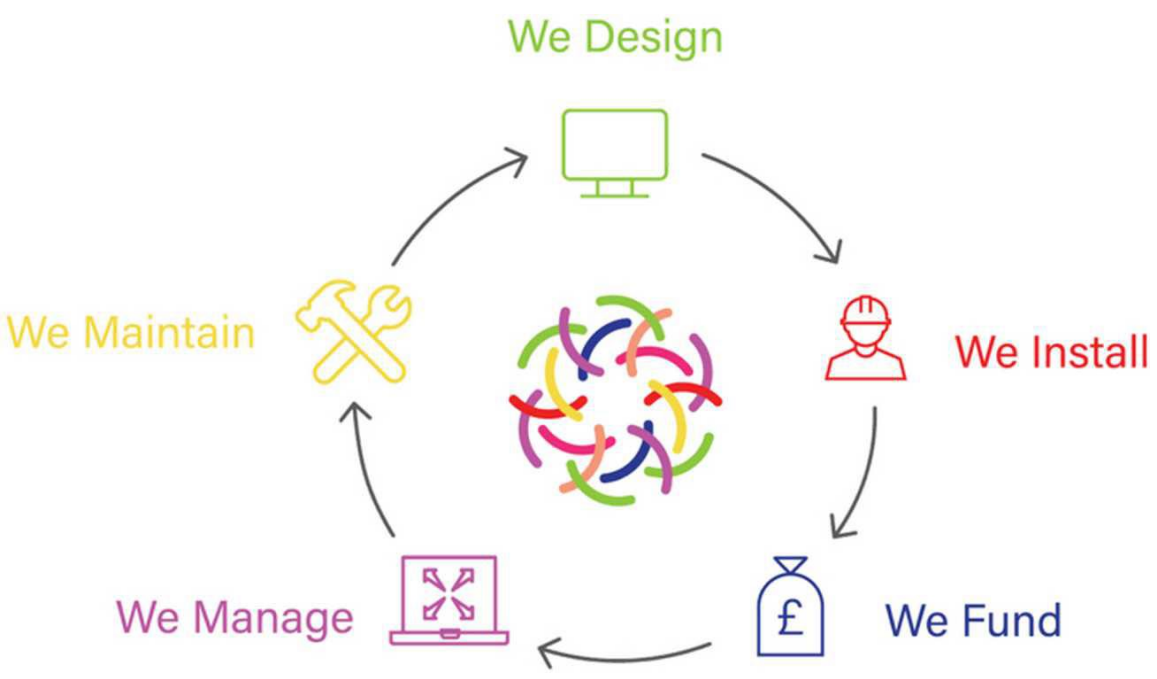
# 1 Introduction

**Pure World Energy (PWE) is an engineering-based company specialising in financed net zero solutions.**

Established in 2013, we deliver integrated generation solutions throughout the UK and Ireland, enabling a wide variety of businesses from commercial and industrial sectors to enjoy the benefits of cost-effective, reliable and environmentally friendly energy.

The UK and Ireland share an admirable yet ambitious target of achieving carbon neutrality by 2050. For this to be achieved, significant reductions in carbon emissions are required, particularly within the energy sector. Many businesses are consequently under pressure to comply with stricter emissions standards, which presents a range of commercial challenges. This is where we can help.




PWE provides “Energy-as-a-Service” (EaaS) solutions, whereby we finance, design, build, operate and maintain environmentally friendly on-site energy provision. This turnkey approach is highly beneficial for our clients, with no upfront capital expenditure required, plus guaranteed savings on their energy bills.
Our solutions – often with near-zero emissions - include CHP, CCHP and power-only configurations. Many of these are powered by **Capstone microturbines -** the world's leading developer and manufacturer of clean and green microturbine power generation systems. We also offer many renewable technology solutions, including solar PV, waste-to-energy and battery storage.

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**Location - Framptons Ltd, 76 Charlton Road, Shepton Mallett, Somerset, BA4 5PD**

Framptons Limited have embarked on a major expansion plan to increase production of its processed food range.

Framptons Ltd are planning to build an Energy Center, housing gas turbines, heat recovery boiler and a biomass boiler.

The biomass boiler, which is supplied by others (Novalux Ltd), is subject to a separate application. For information purposes the "Chimney height and AQA assessments" from Visage Environmental on behalf of Novalux Ltd has been included in this submission. Dispersion analysis does include the data from the PWE installation and the Novalux Ltd biomass boiler.

1. CHP General Description

With reference to the General Process Diagram (Fig 1)

General

Exhaust gas energy from the 4 x 200KWe Natural Gas Fired micro-turbines is directed to a 'Composite' Heat Recovery Boiler. Natural gas supplementary firing has been included in the boiler design.
An additional 1 x 65KWe Natural Gas Fired micro-turbine is installed to support the installation parasitic load, hot exhaust gas energy is directed to a heat recovery module to transfer energy to the installations boiler feedwater system.

The 3 exhaust stacks are combined within a windshield type assembly, exiting the building. Final stack heights, within the windshield, are 18.445m with a building ridge height of 10.525m.

The entire installation is installed with a purpose designed building at the Frampton site.

Natural Gas Fired Microturbines

The Microturbine are manufactured by Capstone Turbine Corporation. (USA) The design is established and proven, a significant number of units have been installed worldwide, including the UK and Europe, and meet all required legislation and existing standards.

The Capstone Microturbines generate a total of 800KWe from 4 x 200KWe turbines, and are installed within a purpose designed container. Exhaust gases from the turbines are directed towards the heat recovery boiler module. The cooled flue gases are vented to atmosphere via stack.

A smaller Gas Turbine 65KWe has also been installed. This unit is installed to support system parasitic loads. It has a heat recovery module that is used for boiler feedwater heating purposes. Cooled flue gases are vented to the atmosphere via a stack.

Steam Generation

The Composite boiler is designed and manufactured by ICI Caldaie. Spa in Italy. The design is proven and ICI Caldaie has previously collaborated on CHP projects with Capstone Corporation.

The 4000kg/h steam boiler will supply steam to Framptons process lines. The fire tube boiler is designated as a 'Composite Type' with a section of the heat exchanger designed to recover energy from the exhaust gases of the 4 x 200KWe gas turbines.

The energy recovered from the turbine exhaust is equivalent to 555KWt which is converted to 836kg/h of dry saturated steam at 11.0bara.

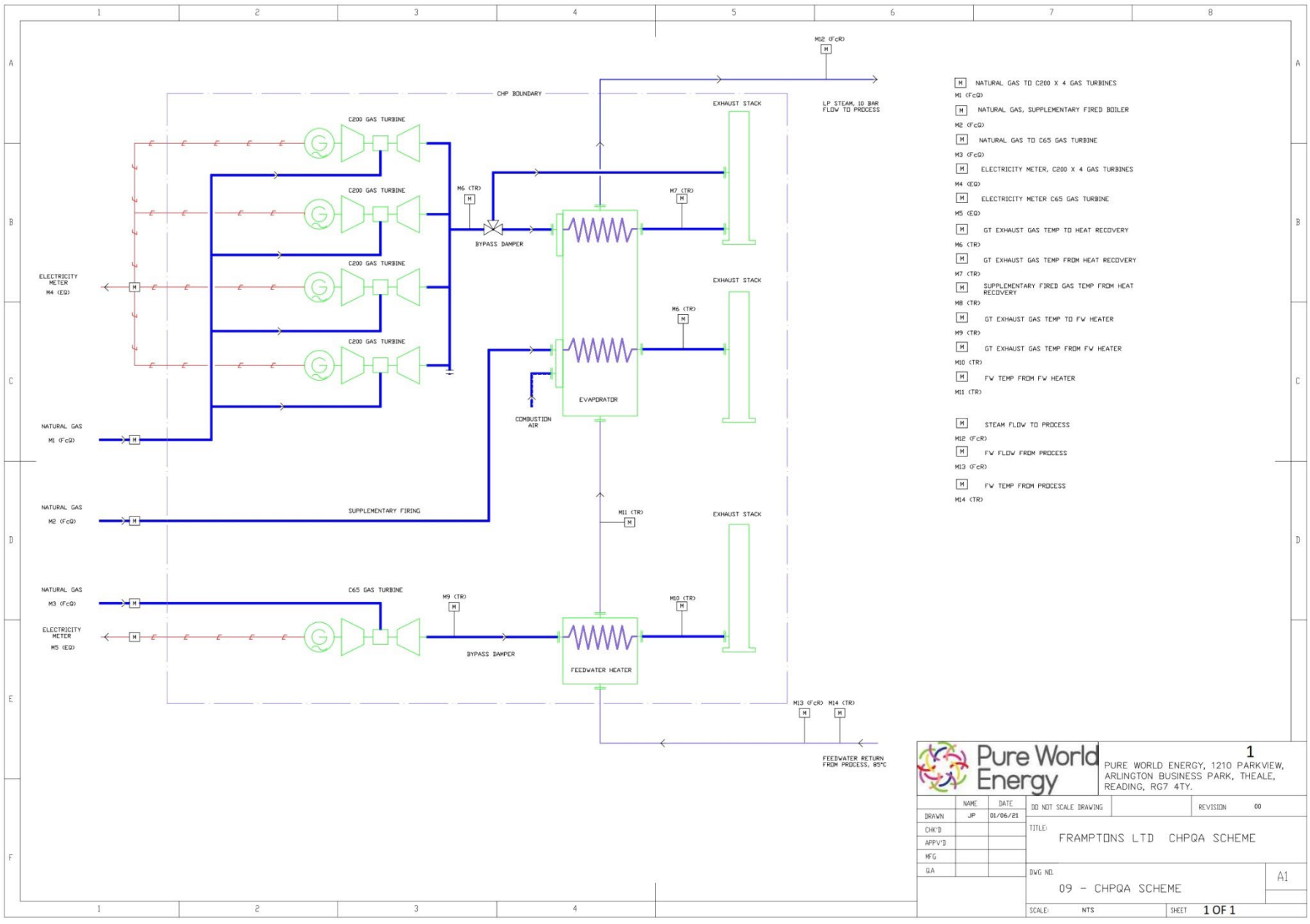
The Natural Gas fired supplementary fired section of the boiler has been designed to produce 4000kg/h of dry saturated steam at 11.0bara when operated in a stand-alone mode. The Natural Gas burner (Low NOx) is of modulating output design. The design allows the boiler to manage a varying steam demand whilst maintaining 100% exhaust recovery from the 4 x 200KWe gas turbines.

Timeframe

Commissioning and reliability trials of the CHP and supporting gas turbine (C65) are now ongoing. The program is expected to take 30 days.

On completion steam demand initially will be between 2500kg/h and 4000kg/h for a period of 12 - 18 months. Thereafter steam demand is expected to continue for total of 4000kg/h reflecting Framptons Ltd installation of increased processes capacity and de-commissioning of existing steam raising plant.

*Figure 1 General Process Diagram*



## 2 Rated Thermal Input

Natural Gas, from the site source, is compressed to 5.5barg and distributed to the Gas Turbine container and to the single C65 turbine.

**Capstone Models – 4 x C200 Installed. Designated HP Natural Gas**

**Table 1. C200 Model Designations**

| C200 Model Designations | External Heat Recovery Module | Certifications[1] | | Dual Mode Capable | Fuel Capability | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CE | CARB [2] | | Natural Gas | Landfill Gas | Digester Gas | Propane Gas | Liquid Fuel |
| HP Natural Gas | Accessory | Option | | Option | X | | | | |
| LP Natural Gas | Accessory | Option | | Option | X | | | | |
| CARB Certified LP Natural Gas | Included | | X | Option | X | | | | |
| Landfill | Accessory | Option | Option | | | X[3] | | | |
| Digester | Accessory | Option | Option | | | | X[3] | | |
| Propane | Accessory | Option | | Option | | | | X | |
| Liquid Fuel | Accessory | Option | | Option | | | | | X |

**Notes:**

(1) All versions are planned to be UL Listed except the CE certified and liquid fuel models
(2) Systems are in process of being certified by the California Air Resources Board for exhaust emissions
(3) Operation on these fuels may be limited – see sections below

**Capstone Performance Rating – Designation 'All other C200'**

### Performance Ratings at Full Load Power

Table 2 summarizes performance ratings at full load power and ISO conditions.

**Table 2. Performance Ratings**

| Parameter | C200 Low Pressure NG | All Other C200[3] |
|---|---|---|
| **Net Power Output** | 190 (+0/- 4) kW net | 200 (+0/- 4) kW net |
| **Net Efficiency (LHV)** | 31 (± 2)% | 33 (± 2)% |
| **Nominal Net Heat Rate (LHV)** | 11,600 kJ/kWh (11,000 Btu/kWh) | 10,900 kJ/kWh (10,300 Btu/kWh) |
| **Nominal Generator Heat Rate (LHV)** | 10,700 kJ/kWh (10,200 Btu/kWh) | 10,200 kJ/kWh (9,700 Btu/kWh) |
| **Nominal Steady State Fuel Flow (HHV) [1] [2]** | 2,400,000 kJ/hr (2,280,000 BTU/hr) | 2,400,000 kJ/hr (2,280,000 BTU/hr) |

**Notes:**

**Capstone Models – 1 x C65 Installed. Designated Natural Gas**

**Table 1. C65 Model Designations**

| C65 Model Designations | ICHP Core Material | | Certifications [1] | | Dual Mode Capable | Fuel Capability | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Copper | SS | CE | CARB [2] | | Natural Gas | Landfill Gas | Digester Gas | Propane (HD-5) |
| Standard | Option | Option | Option | | Option | X | | | X [4] |
| CARB | X | | | X | Option | X | | | |
| Low NOx | Option | | | | Option | X | | | |
| NYC [3] | Option | | | | Option | X | | | X [4] |
| Landfill | | | Option | Option | | | X [4] | | |
| Digester | | Option | Option | Option | | | | X [4] | |

**Capstone Performance Rating – Designation 'All other C65'**

**Table 2. Performance Ratings**

| Parameter | C65 CARB & Low NOx | All Other C65 |
|---|---|---|
| **Net Power Output** | 65 (+0/-3) kW net | 65 (+0/-2) kW net |
| **Net Efficiency (LHV)** | 28 (± 2)% | 29 (± 2)% |
| **Nominal Net Heat Rate (LHV)** | 12,900 kJ /kWh (12,200 Btu /kWh) | 12,400 kJ /kWh (11,800 Btu /kWh) |
| **Nominal Generator Heat Rate (LHV)** | 12,100 kJ /kWh (11,400 Btu /kWh) | 11,600 kJ /kWh (11,000 Btu /kWh) |
| **Nominal Steady State Fuel Flow (HHV)** Notes (1) and (2) | 919,000 kJ/hr (871,000 Btu/hr) | 888,000 kJ/hr (842,000 BTU/hr) |

**Rated Thermal Input at Full Design Operations**

| | Gross Heat Input KW | Net Heat Input KW |
|---|---|---|
| **C800 KWe Microturbines** | 646 KW x 4 = 2584 KW | 582 KW x 4 = 2328 KW |
| **C65 KWe Microturbine** | 258 KW | 233 KW |
| **NG Fired supplementary at 3.162 t/h** | 2459 KW | 2218 KW |
| | | |
| **Totals** | **5301 KW** | **4779 KW** |

# 3 Description of Medium Combustion Plant

A purpose-built container, complete with 4 x C200 Gas Turbines, includes natural gas management and electrical management systems. Export electrical power, from each C200, is coupled to an export enclosure. The export enclosure, as well as each C200 electrical and management enclosure, is constantly monitored with safety management and shutdown systems and local / remote operational capabilities.

Each microturbine is a stationary power generating system that provides on-site electrical power for primary or standby applications, and for base loading and/or capacity additions. Each microturbine can generate power in parallel with an electrical utility (Grid Connect mode), or isolated from the utility (Stand Alone mode). The system consists of a turbine engine, solid-state power electronics, fuel system, and an outdoor-rated enclosure.

Major turbine engine components include a compressor, a recuperator (exhaust gas heat exchanger), a combustor, a turbine, and a generator. The turbine engine is air cooled and supported on air-lubricated foil bearings (air bearings). The compressor impeller, turbine rotor, and generator rotor are mounted on a single shaft. The power electronics are solid-state, double conversion type, producing three-phase alternating current output power from the high frequency alternating current engine output.

Exhaust gas, from each unit, is directed through the roof of the container into a common exhaust gas duct and then onto the heat recovery section of the Composite Boiler.

The composite boiler, supplementary firing section, comprises a modulating Low NOx gas burner. Manufactured by CIB Unigas, the burner comes complete with $O_2$ control and inverter operations. NOx emissions <80mg/$Nm^3$ are in compliance with (EU) 2015/2193

## 4 Type and share of fuel as laid down in Annex 11

The single fuel used is Natural Gas

## 5 Emission Values

*Table 2*

Emission limit values (mg/Nm³) for new engines and gas turbines

| Pollutant | Type of medium combustion plant | Gas oil | Liquid fuels other than gas oil | Natural gas | Gaseous fuels other than natural gas |
|---|---|---|---|---|---|
| $SO_2$ | Engines and gas turbines | — | 120 (27) | — | 15 (28) |
| $NO_x$ | Engines (29) (30) | 190 (31) | 190 (31) (32) | 95 (33) | 190 |
| | Gas turbines (34) | 75 | 75 (35) | 50 | 75 |
| Dust | Engines and gas turbines | — | 10 (36) (37) | — | — |

**Emission limit values for new medium combustion plants**

*Table 1*

Emission limit values (mg/Nm³) for new medium combustion plants other than engines and gas turbines

| Pollutant | Solid biomass | Other solid fuels | Gas oil | Liquid fuels other than gas oil | Natural gas | Gaseous fuels other than natural gas |
|---|---|---|---|---|---|---|
| $SO_2$ | 200 (19) | 400 | — | 350 (20) | — | 35 (21) (22) |
| $NO_x$ | 300 (23) | 300 (23) | 200 | 300 (24) | 100 | 200 |
| Dust | 20 (25) | 20 (25) | — | 20 (26) | — | — |

**C200 KWe and C65 KWe Exhaust Conditions. Manufacturers Data Sheet**

**Table 4. Emission for Different Capstone Microturbine Models in [mg/m3] at 15% $O_2$**

| Model | Fuel | NOx | CO | VOC (5) |
|---|---|---|---|---|
| C30 NG | Natural Gas (1) | 18 | 50 | 6 |
| CR30 MBTU | Landfill Gas (2) | 18 | 620 | 30 |
| CR30 MBTU | Digester Gas (3) | 18 | 310 | 30 |
| C30 Liquid | Diesel #2 (4) | 72 | 11 | 6 |
| C65 NG Standard | Natural Gas (1) | 19 | 50 | 5 |
| C65 NG Low NOx | Natural Gas (1) | 8 | 50 | 5 |
| C65 NG CARB | Natural Gas (1) | 8 | 9 | 2 |
| CR65 Landfill | Landfill Gas (2) | 18 | 160 | 5 |
| CR65 Digester | Digester Gas (3) | 18 | 160 | 5 |
| C200 NG | Natural Gas (1) | 18 | 50 | 5 |
| C200 NG CARB | Natural Gas (1) | 8 | 9 | 2 |
| CR200 Digester | Digester Gas (3) | 18 | 160 | 5 |

Notes: same as Table 1

The emissions stated in Tables 1, 2, 3 and 4 are guaranteed by Capstone for new microturbines during the standard warranty period. They are also the expected emissions for a properly maintained microturbine according to manufacturer's published maintenance schedule for the useful life of the equipment.

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**Stack Dimensions and Discharge Conditions**

| Combustion Process Description | | | Gas turbine exhaust gas, C800KWe Exhaust gas from GT's, after heat recovery | | NG Fired steam boiler Low Nox NG burner | | Gas turbine exhaust gas, C65KWe Exhaust gas from GT, after heat recovery | |
|---|---|---|---|---|---|---|---|---|
| | | | Multiflue stack with windshield | | | | | |
| | | Units | | | | | | |
| Stack Diameter | | m | 0.80 | | 0.40 | | 0.25 | |
| Stack Height | *Note 01* | m | 15.20 | | 15.20 | | 15.20 | |
| Efflux Temperature | | C | 178.00 | | 110.00 | | 139.70 | |
| Efflux Velocity | | m/s | 13.40 | | 11.80 | | 14.01 | |
| Actual flowrate | | $Am^3/s$ | 6.73 | | 1.48 | | 0.69 | |
| Normalised flow rate | | $Nm^3/s$ | 4.06 | at 0C and 1013mb | 1.05 | at 0C and 1013mb | 0.46 | at 0C and 1013mb |
| Moisture | | % | 4.41 | | 15.90 | | 4.069 | |
| Oxygen (wet) | | % | 17.15 | | 4.22 | | 17.53 | |
| Oxygen (Dry) | | % | 17.95 | | 5.03 | | 18.27 | |
| Pollutant discharge rates (Actual) | | | | | | | | |
| Nox (actual) | | g/s | 0.064 | | Burner manufacturer and boiler manufacturer state Nox emissions will be <100mg/Nm3 at 3% O2 concentration | | 0.0072 | |
| CO | | g/s | 0.214 | | | | 0.022 | |
| VOC | | g/s | 0.015 | | | | 0.001 | |

## 6 Date of start of operation

Following commissioning the planned date for full operations is the end of January 2023

## 7 Sector of activity in which the plant is applied

The NACE Code is 46.33

## 8 Expected number of annual operating hours and average load in use.

| | | |
|---|---|---|
| C800 KWe Natural gas fired microturbines | 8400h | load 100% |
| C65 KWe Natural gas fired microturbine | 8400h | load 100% |
| NG Fired supplementary boiler | 6240h | load 80% |

## 9 Name and registered office of the operator, address of plant location

**Operator**

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Spaces,
1650 Arlington Business Park
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0118 327 2100

**Plant Location**

Framptons Ltd
76 Charlton Road,
Shepton Mallet,
Somerset
BA4 5PD

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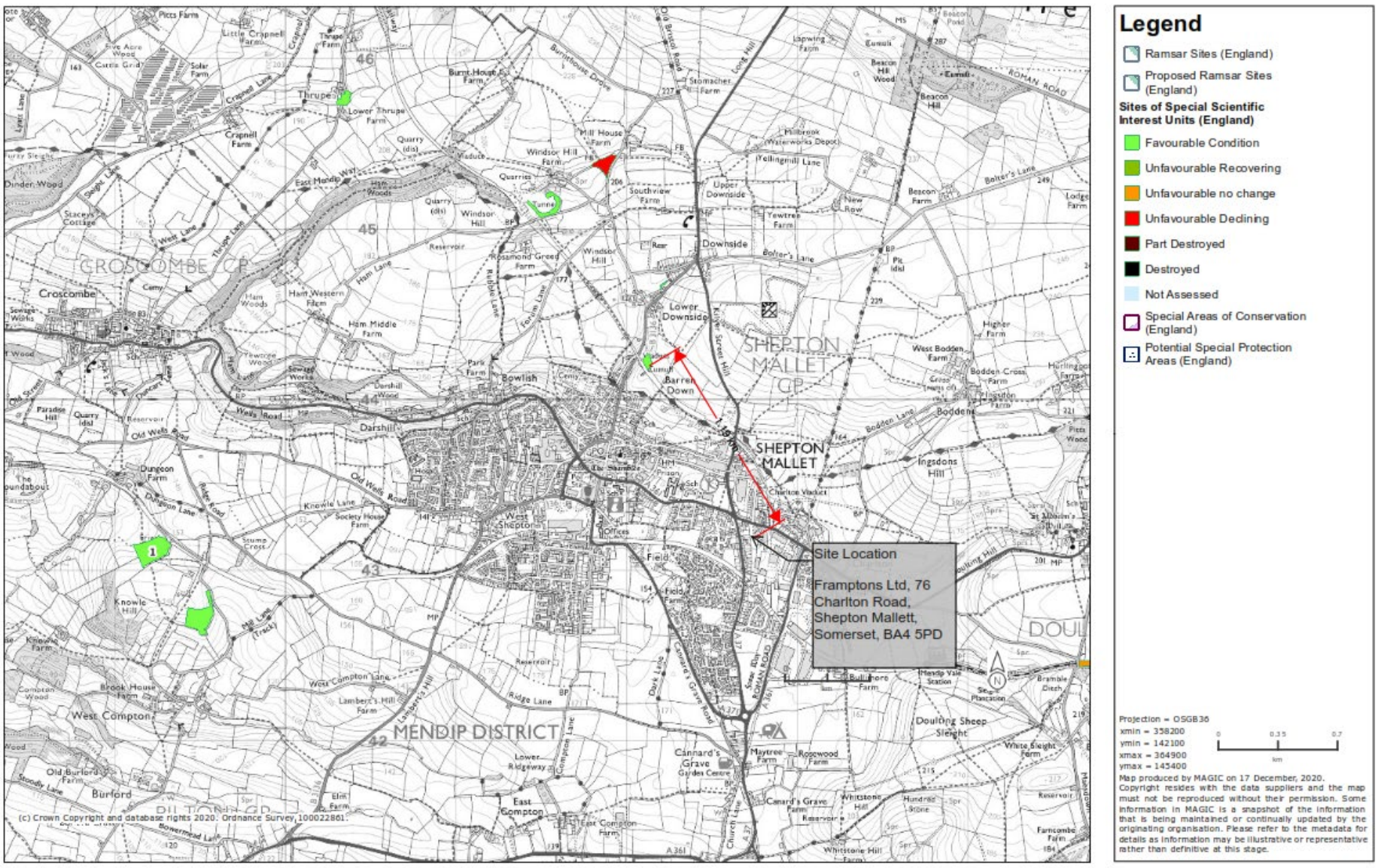
## 10 Appendix 01 Framptons Ltd Map Location




## 11 Appendix 02 Energy Center Location Map

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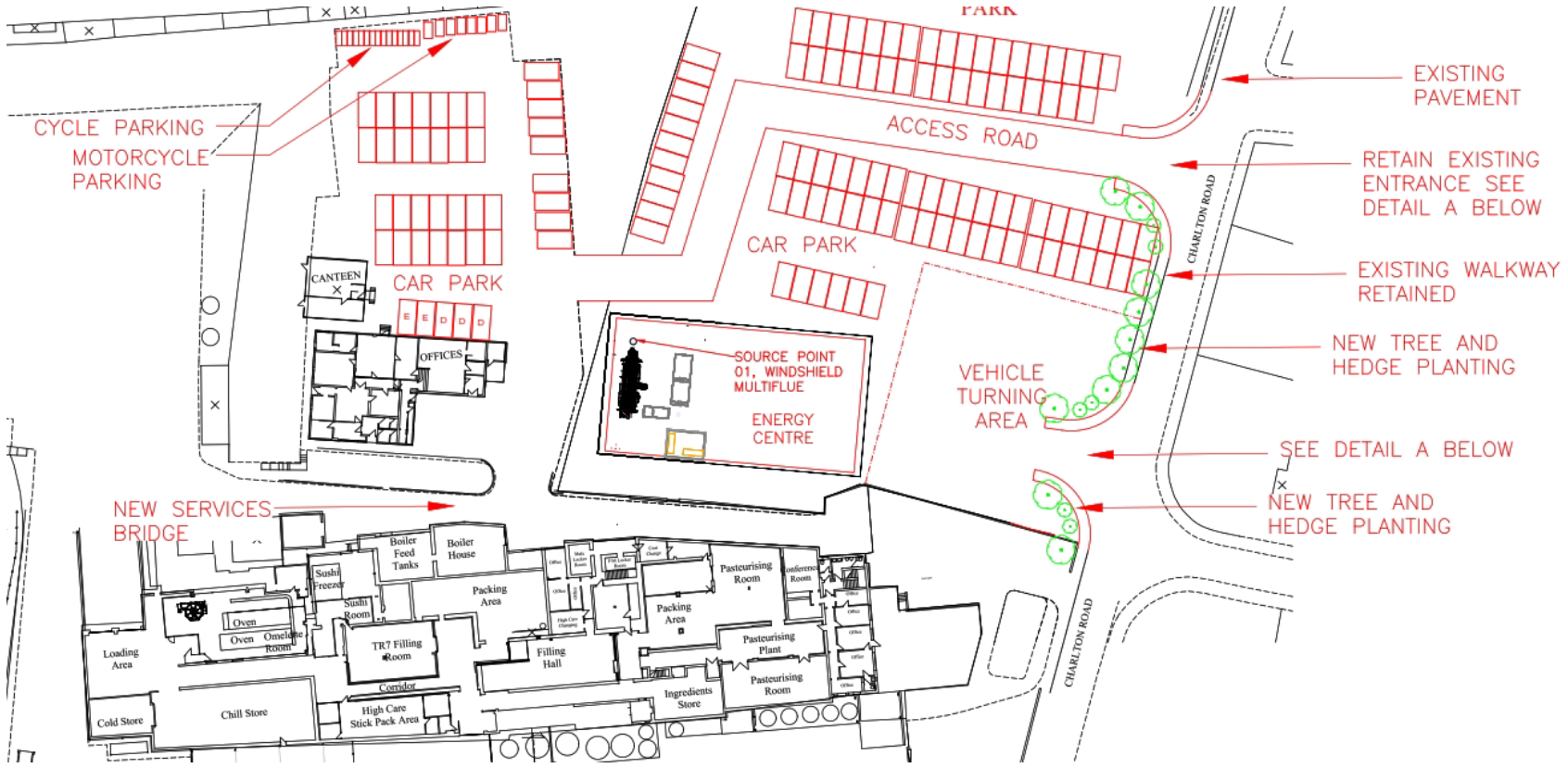


## 12 Appendix 03 – 2020 Air Quality Annual Status (ASR) Mendip District Council

Whitstone is the nearest receptor to Framptons Ltd

**Table A.3 – Annual Mean $NO_2$ Monitoring Results**

| Site ID | X OS Grid Ref (Easting) | Y OS Grid Ref (Northing) | Site Type | Monitoring Type | Valid Data Capture for Monitoring Period (%) [1] | Valid Data Capture 2019 (%) [2] | $NO_2$ Annual Mean Concentration (µg/m³) [3] [4] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| Frome - Christchurch Street | 377741 | 147759 | Roadside | Diffusion Tube | 75 | 75 | 25.84 | 22.56 | 27.53 | 23.66 | 18.06 |
| Frome - Portway | 376065 | 147662 | Roadside | Diffusion Tube | 100 | 100 | 24.25 | 25.69 | 23.42 | 27.9 | 21.27 |
| Glastonbury | 350363 | 138606 | Roadside | Diffusion Tube | 92 | 92 | 26.39 | 27.96 | 21.31 | 31.1 | 21.66 |
| Wells - St Thomas | 355486 | 146152 | Roadside | Diffusion Tube | 100 | 100 | NA | 27.52 | 25.15 | 30.66 | 23.61 |
| Shepton Mallet - Paul Street | 361965 | 143516 | Roadside | Diffusion Tube | 100 | 100 | 27.09 | 27.52 | 25.96 | 27.95 | 22.56 |
| Shepton Mallet - West | 361563 | 143436 | Roadside | Diffusion Tube | 100 | 100 | 26.89 | N/A | 14.44 | 24.59 | 20.61 |
| Wells - Glastonbury Road | 354466 | 145126 | Roadside | Diffusion Tube | 100 | 100 | 15.65 | 16.59 | 14.00 | 15.64 | 11.62 |
| Wells - Tucker Street | 354473 | 145576 | Roadside | Diffusion Tube | 92 | 92 | 24 | 24.43 | 23.66 | 26.19 | 21.02 |
| Frome - Garsdale/Vicarage | 377956 | 147774 | Roadside | Diffusion Tube | 100 | 100 | 26.66 | 23.32 | 22.64 | 24.26 | 19.26 |
| Walton - Main Street | 345900 | 136300 | Roadside | Diffusion Tube | 100 | 100 | 27.92 | 29.41 | 26.20 | 26.11 | 21.50 |
| Frome - Monmouth Drive | 376600 | 146500 | Urban Background | Diffusion Tube | 100 | 100 | 13.22 | 13.43 | 8.66 | 14 | 10.75 |
| Street - Green Lane Avenue | 348174 | 135677 | Urban Background | Diffusion Tube | 100 | 100 | 9.06 | 10.96 | 8.32 | 9.55 | 7.52 |
| Haybridge | 353114 | 146150 | Rural | Diffusion Tube | 100 | 100 | 11.1 | 12.67 | 11.43 | 12.37 | 9.33 |
| Wookey Hole - Glencot Road | 353357 | 146767 | Rural | Diffusion Tube | 100 | 100 | 7.71 | 8.92 | 8.51 | 8.16 | 6.77 |
| Buckland Down | 372329 | 151964 | Rural | Diffusion Tube | 100 | 100 | 9.36 | 10.69 | 8.95 | 10.67 | 8.79 |
| Frome - Market Place (Triplicate Tubes) | 377617 | 146027 | Roadside | Diffusion Tube | 100 | 100 | 35.09 | 33.66 | 24.27 | 33.11 | 26.66 |
| Frome - 38 The Butts (Triplicate Tubes) | 377255 | 147353 | Roadside | Diffusion Tube | 100 | 100 | 37.59 | 36.53 | 25.01 | 32.64 | 27.94 |
| Shepton Mallet - Whitstone | 362265 | 143223 | Roadside | Diffusion Tube | 100 | 100 | NA | 25.24 | 21.52 | 20.95 | 21.50 |
| Frome - 87 The Butts | 377124 | 147206 | Roadside | Diffusion Tube | 100 | 100 | 20.34 | 20.8 | 17.41 | 20.76 | 15.96 |
| Gurney Slade | 362310 | 149166 | Rural | Diffusion Tube | 100 | 100 | NA | NA | NA | NA | 16.7 |

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