NRG CONSULTING

# Land East of Mons Block St. Andrews Park Uxbridge

## Air Quality Neutral Assessment

October 2024

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| Document Control Sheet | |
|---|---|
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| Report Prepared For | Vinci St. Modwen |
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# 1 Executive Summary

NRG Consulting have been commissioned to undertake an Air Quality Neutral Assessment based on the potential impacts of future building and vehicle emission levels on a new development at **Land East of Mons Barrack, St Andrews Park, Hillingdon Road, Uxbridge.**

The description of development is:

*Reserved matters (internal access, layout, scale, appearance and landscaping) pursuant to Condition 2 of planning permission reference 585/APP/2017/2819 dated 14-03-19 (Outline planning application with means of site access from the central access road (internal access, layout, scale, appearance and landscaping reserved for subsequent approval) for the erection of up to 90 dwellings (Use Class C3), sustainable urban drainage features and all other necessary ancillary and enabling works).*

The scheme comprises of 90 dwellings.

This report is intended to discharge **Planning Condition 20** of planning consent ref: 585/APP/2022/665 which states:

*"No development shall commence until a neutral air quality assessment has been submitted to and approved in writing by the Local Planning Authority. The updated neutral assessment report will clearly state the traffic data used and demonstrate that the proposed development is neutral as required.*

*REASON*
*As the application site is within an Air Quality Management Area and a Focus Area, and to comply with paragraph 181 of the NPPF, policy 7.14 of the London Plan, and policy EM8 of the Hillingdon Local Plan: Part 1- Strategic Policies (November 2012)".*

An Air Quality assessment was submitted with the outline consent for the site (ref. 585/APP/2017/2819). However, this document did not contain an Air Quality Neutral Assessment.

The aim of this Air Quality Neutral Assessment is to satisfy the above planning condition by evaluating the building and vehicle emissions relating to the future use of the development and, thereby, its residents. The pollutants assessed as part of an Air Quality Neutral assessment are nitrogen oxides (NOx) and particulate matter ($PM_{10}$).

The document has been written in-line with the guidance provided by the Air Quality Neutral – London Plan Guidance (February 2023). As per the contents of this report, the proposed development qualifies as *Air Quality Neutral.*

**Figure –** Proposed Site Layout

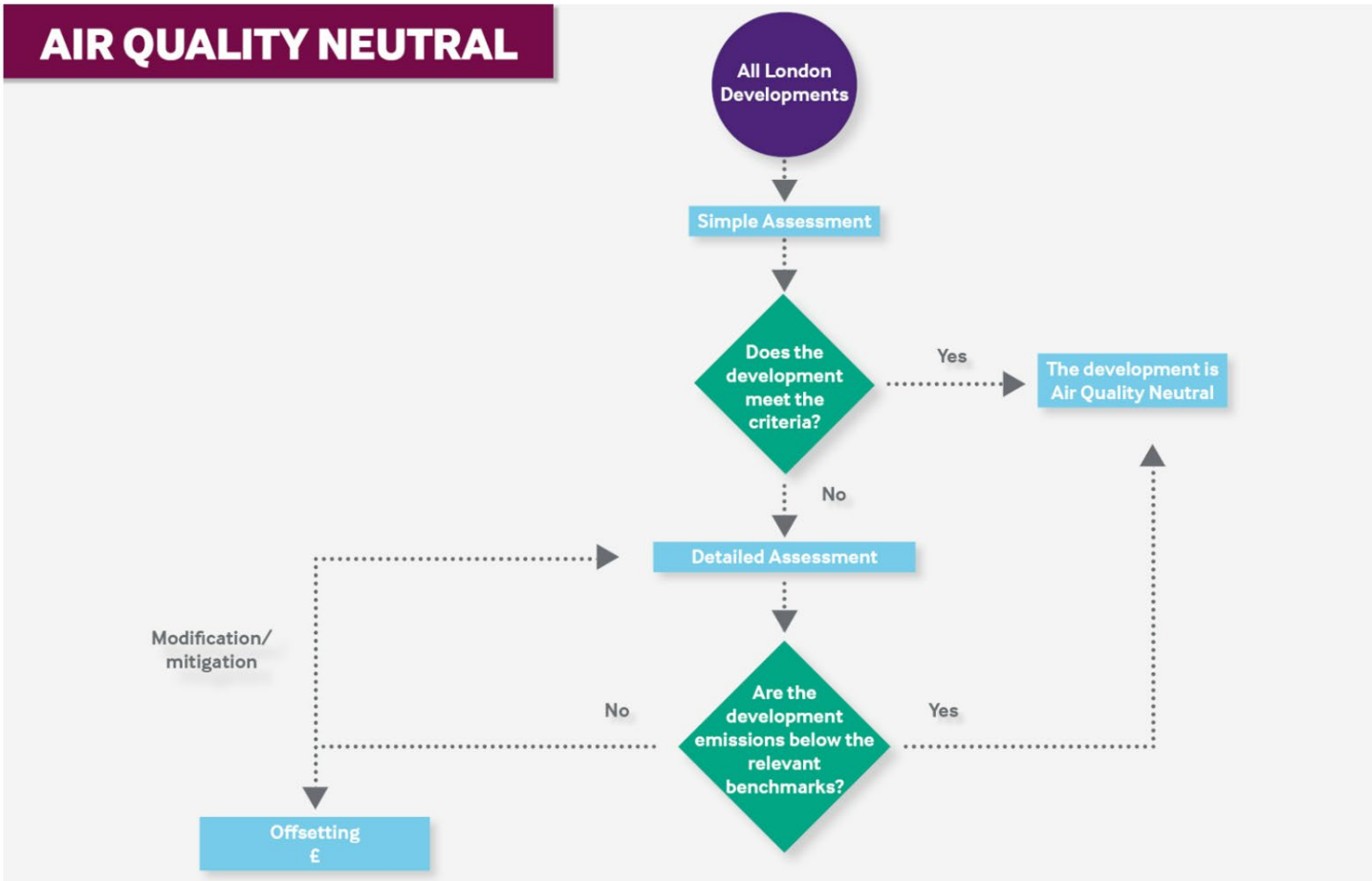
# 2 Air Quality Neutral Assessment

## 2.1 Introduction

### Air Quality Neutral - London Plan Guidance (2023)

This guidance sets out how an 'air quality neutral' assessment should be undertaken. The guidance sets benchmarks for building emissions (emissions from equipment used to supply heat and energy to buildings) and for transport emissions (for private vehicles travelling to and from the development).

It is important to note that the transport emissions benchmarks (TEB) only consider car or light van trips, and that "*deliveries and servicing, taxis or heavy vehicle movements from non-occupiers' assessment of these trips, for example, should be captured in the wider air quality impact assessment where one is required and should therefore be excluded from the TEB calculations*".




The air quality neutral assessment has followed the methodology outlined in the Air Quality Neutral LPG. Within this document, benchmarks have been provided in relation to building and transport emissions, together with a methodology for calculating the building and transport related emissions for a particular development.

## 2.2 Building Emissions

### Benchmark Emissions

The Building Emissions Benchmarks (BEBs) for the land use category applicable to residential properties are provided in Table 3. Emissions of $PM_{10}$ have not been considered as oil and/or solid fuel are not proposed to be used at the development.

| Land Use Class | Heating System Type | $NO_x$ ($gNO_x/m^2/annum$) |
|---|---|---|
| C3 | CHP + gas boiler network | 7.8 |

***Table:*** Building Emissions Benchmarks (BEBs)

Using the method described within the London Plan Guidance, the site-specific benchmarked emissions have been calculated using the emission rate in the table above. The total building $NO_x$ emissions have then been calculated. A comparison of the actual versus the benchmark can then be found.

These calculations follow the example in Appendix 1 of the Air Quality Neutral LPG which translates the results into kg/annum.

| Land Use | GIA ($m^2$) | Building Emissions Benchmarks ($gNOx/m^2/annum$) | Benchmarked Emissions (kg/NOx/annum) |
|---|---|---|---|
| C3 | 9,913 | 7.8 | **77.32** |

**Table:** Calculation of Benchmark Building $NO_x$ Emissions

### Actual Emissions

In terms of Building Emissions for the scheme, this phase of the development connects to the central energy centre. This energy centre is comprised of gas-fired boilers and gas-fired CHP. As per the approved Low Emissions Strategy (April 2024) the specification of these elements are:

**Plant Selection**

The following plant has been selected:

| Item | Manufacturer | Model | Stated $NO_x$ emissions |
|---|---|---|---|
| Gas-boilers | Hoval | UltraGas 2D 2200 | 41mg/kWh |
| CHP | 2G | Aura 412 EG | 65.7mg/$Nm^3$ |

**Table 2 – Selected plant and associated stated $NO_x$ emissions**

With overall emissions of **65.65**mg/kWh:

## Appendix A - St Andrews LEOMB

**Inputs**

| | Parameter | Value | Units |
|---|---|---|---|
| B | Gas-boiler annual heat demand contribution (refined) | 14.8% | - |
| C | CHP annual heat demand contribution (refined) | 85.2% | - |
| D | Gas-boiler stated emissions (@0% O2) | 41.00 | mg/kWh |
| E | CHP stated emissions (@5% O2) | 50.00 | mg/Nm3 |
| F | 5% to 0%O2 correction factor | 1.31 | |
| G | Conversion factor mg/m3 to mg/kWh | 0.86 | |
| H | Gas-boiler AQA emissions (@0% O2) | 41.00 | mg/kWh |
| I | CHP AQA emissions (@0% O2) | 95.00 | mg/Nm3 |
| O | Gas-boiler annual heat demand contribution (AQA) | 39.0% | - |
| P | CHP annual heat demand contribution (AQA) | 61.0% | - |

**Outputs**

| | Parameter | Value | Units |
|---|---|---|---|
| J=E*F | CHP stated emissions (@0% O2) | 65.72 | mg/Nm3 |
| K=J*G | CHP stated emissions (@0% O2) | 56.32 | mg/kWh |
| L=B*D+C*K | **Average weighted emissions(plant)** | 54.06 | mg/kWh |
| M=G*I | CHP stated emissions (@0% O2) | 81.42 | mg/kWh |
| N=O*D+P*M | **Average weighted emissions(AQA)** | 65.65 | mg/kWh |
| | | 11.60 | |

In terms of the estimated gas-usage, the total scheme has $CO_2$ emissions of 48.3 tonnes per annum as per the SAP calculations:

| | $m^2$ | DER | Total $kCO_2$ per unit | No. of units | Total $tCO_2$ per annum |
|---|---|---|---|---|---|
| **2B Mid Terrace - Mid Floor** | 62.9 | 7.64 | 480.6 | 45 | 21.6 |
| **2B Mid Terrace - Ground Floor** | 62.9 | 8.47 | 532.8 | 21 | 11.2 |
| **3A - Mid Floor** | 104 | 7.27 | 756.1 | 1 | 0.8 |
| **3B - Top Floor** | 104 | 7.98 | 829.9 | 1 | 0.8 |
| **TOTAL – Regulated $CO_2$ Emissions** | | | | | **48.3** |

Based on this being 75% of gas for space heating and hot water (the remaining 25% being for electricity for lighting and pumps and fans) then then the gas usage would be:

| Land Use | GIA ($m^2$) | Carbon Emissions (t) | Carbon Factor for Gas (Part L 2021) | Estimated Gas Usage (kWh/annum) |
|---|---|---|---|---|
| C3 | 9,913 | 36.22 | 0.210 | 172,000 |

**Table:** Calculation of gas usage

| Land Use | Estimated Gas Usage (kWh/annum) | $NO_x$ Emission Rate (mg /kWh) | Total Building Emissions (kg/annum) |
|---|---|---|---|
| C3 | 172,000 | 65.65 | 11.29 |

**Table:** Calculation of Total Building $NO_x$ Emissions

| Total Benchmarked $NO_x$ Emissions (kg/annum) | Total predicted NOx building emissions (kg/annum) | Difference (kg) |
|---|---|---|
| **77.32** | **11.29** | -66.03 |

**Table**: Comparison of Total Building $NO_x$ Emissions and Building Emissions Benchmarks

## 2.3 Transport Emissions

The Transport Emissions Benchmarks (TEBs) are calculated by multiplying the relevant emission benchmarks by the number of properties for residential use.

The traffic data here was taken from traffic surveys undertaken within the Technical Traffic Note which formed the latest transport data approved under the LEOMB Outline consent. This is the note that is referred to in relation to trip generation in the note that was approved under the Reserved Matters consent.

There are 67 residential parking spaces on site (7 of which are accessible).

| Land Use | Number of Dwellings | Benchmark Trip Rate from AQ LPG | Total Benchmarked Trips |
|---|---|---|---|
| C3 | 90 | 447 | 40,230 |

**Table:** Transport Emissions Benchmarks

The proposed development will generate circa **1.2** daily vehicle movements. It is not expected that residents who do not have access to parking spaces will have a car due to the cost of keeping off-site.

As such, the total trip emissions for $NO_x$ and $PM_{10}$ have been calculated in the table below.

| Land Use | Number of Dwellings | Proposed Vehicle Trips Daily | Total Proposed Trips | Benchmarked Trips | Difference |
|---|---|---|---|---|---|
| C3 | 90 | 1.2 | 39,420 | 40,230 | -810 |

**Table:** Comparison of Total Transport Emissions and Transport Emissions Benchmarks

# 3 Conclusion

An Air Quality Neutral assessment has concluded that the proposed development will meet building emission benchmarks (BEBs) and transport emission benchmarks (TEBs).

Therefore, the proposed development can be considered *Air Quality Neutral* and Planning Condition 20 should be discharged.

# Appendix 1

# CONDITION 19 DISCHARGE NOTE

This document has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development to discharge Condition 19 of the planning application ref 585/APP/2017/2819.

## Condition 19

> *"Condition 19: No development shall commence until a quantified low emission strategy has been submitted to and approved in writing by the Local Planning Authority. The Low Emission Strategy shall have targets for emission reduction and time-scales, with pollution savings quantified. At the end of each calendar year an implementation plan shall be submitted for approval in writing by the local planning authority, which on approval shall be fully implemented in accordance with the details and measures so approved. The measures in the agreed scheme shall be maintained throughout the life of the development".*

## Low emission strategy

### Targets

The targets set out for the Low Emission Strategy are the same as those made in the Air Quality Assessment (AQA) produced by Fichtner Consulting Engineers Limited (v2, 29/03/2018) which, in relation to heat generating plant, are the following:

| Item | NOx emissions |
|---|---|
| Gas-boilers | <38mg/kWh |
| CHP | <95mg/Nm$^3$ |

**Table 1 – Air Quality Assessment $NO_x$ emission assumptions**

The excess oxygen percentage (%$O_2$) is not stated, however it is assumed to be 0%$O_2$.

### Plant Selection

The following plant has been selected:

| Item | Manufacturer | Model | Stated $NO_x$ emissions |
|---|---|---|---|
| Gas-boilers | Hoval | UltraGas 2D 2200 | 41mg/kWh |
| CHP | 2G | Aura 412 EG | 65.7mg/Nm$^3$ |

**Table 2 – Selected plant and associated stated $NO_x$ emissions**

The datasheets for the boilers and CHP are provided in Appendix B.

Although gas-boiler NOx emissions are higher than those set out in the AQA, this impact is more than offset by the significantly lower emissions from the CHP. This point is discussed further in the following section.

**Implementation Plan**

**Operational Strategy**

The CHP shall be the lead source of heat, with gas boilers acting as top-up during high demand periods. The approved Sustainability and Energy Strategy allowed for 61%/39% CHP/gas-boiler contribution, respectively. However, these figures were due to be refined, which they were to 85.2%/14.8%, respectively.

This means that the bulk of the heat is expected to be generated by the CHP. This lowers NOx emissions further still due to the lower emission levels generated by the CHP (in comparison to the target).

As per the AQA NOx emissions and the approved Energy Strategy, the average weighted NOx emission expected from the system would be 65.65mg/kWh. Due to the enhanced performance achieved by the selected CHP and the refined CHP/gas-boiler contribution targets, the actual average weighted NOx emission level expected is 54.06mg/kWh.

This represents a pollution saving of 11.60mg/kWh. The calculations are provided in Appendix A.

**Commissioning**

Both gas-boilers and the CHP will be commissioned by their respective manufacturers. As part of the standard commissioning procedures NOx emission measurements will be taken and adjustments will be made accordingly to ensure stated values are met.

**Operation**

Metropolitan (the appointed ESCo) will be carrying out Preventative Planned Maintenance. As part of this, NOx emission measurements will be taken periodically, and adjustments will be made accordingly should the readings exceed the stated values.

## Summary

As described in this note, the design is compliant with the requirements of the condition. The expected NOx emissions are below the emission levels stated in the Air Quality Assessment. Furthermore, the appointed ESCo will ensure the preservation of this performance.

# Appendix A - St Andrews LEOMB

**Inputs**

| | Parameter | Value | Units |
|---|---|---|---|
| *B* | Gas-boiler annual heat demand contribution (refined) | 14.8% | - |
| *C* | CHP annual heat demand contribution (refined) | 85.2% | - |
| *D* | Gas-boiler stated emissions (@0% O2) | 41.00 | mg/kWh |
| *E* | CHP stated emissions (@5% O2) | 50.00 | mg/Nm3 |
| *F* | 5% to 0%O2 correction factor | 1.31 | |
| *G* | Conversion factor mg/m3 to mg/kWh | 0.86 | |
| *H* | Gas-boiler AQA emissions (@0% O2) | 41.00 | mg/kWh |
| *I* | CHP AQA emissions (@0% O2) | 95.00 | mg/Nm3 |
| *O* | Gas-boiler annual heat demand contribution (AQA) | 39.0% | - |
| *P* | CHP annual heat demand contribution (AQA) | 61.0% | - |

**Outputs**

| | Parameter | Value | Units |
|---|---|---|---|
| *J=E*F* | CHP stated emissions (@0% O2) | 65.72 | mg/Nm3 |
| *K=J*G* | CHP stated emissions (@0% O2) | 56.32 | mg/kWh |
| *L=B*D+C*K* | **Average weighted emissions(plant)** | **54.06** | mg/kWh |
| *M=G*I* | CHP stated emissions (@0% O2) | 81.42 | mg/kWh |
| *N=O*D+P*M* | **Average weighted emissions(AQA)** | **65.65** | mg/kWh |
| | | 11.60 | |

## Hoval UltraGas® 2 D (2000-3100)

| Type | | | D (2000) | D (2200) | D (2600) | D (3100) |
|---|---|---|---|---|---|---|
| • Nominal heat output at 80/60 °C, natural gas [1] | | kW | 185-1852 | 203-2076 | 241-2460 | 297-2894 |
| • Nominal heat output at 50/30 °C, natural gas [1] | | kW | 205-1998 | 229-2224 | 269-2640 | 324-3100 |
| • Nominal heat output at 80/60 °C, propane [2] | | kW | 245-1852 | 299-2067 | 362-2455 | 427-2877 |
| • Nominal heat output at 50/30 °C, propane [2] | | kW | 264-1998 | 316-2224 | 385-2640 | 453-3100 |
| • Nominal heat input with natural gas [3] | | kW | 187-1886 | 206-2114 | 247-2502 | 297-2938 |
| • Nominal heat input with propane [2] | | kW | 248-1886 | 306-2114 | 371-2502 | 437-2938 |
| • Operating pressure heating min./max. (PMS) | | bar | 1/6 | 1/6 | 1/6 | 1/6 |
| • Operating temperature max. ($T_{max}$) | | °C | 95 | 95 | 95 | 95 |
| • Boiler water content ($V_{(H20)}$) | | l | 2 x 756 | 2 x 718 | 2 x 1211 | 2 x 1118 |
| • Flow resistance boiler | | | see diagram | | | |
| • Minimum circulation water quantity | | l/h | - | - | - | - |
| • Boiler weight (without water capacity, incl. cladding) | | kg | 2 x 1540 | 2 x 1600 | 2 x 2130 | 2 x 2300 |
| • Boiler efficiency at 80/60 °C in full-load operation (NCV/GCV) [4] | | % | 98.2/88.5 | 98.2/88.5 | 98.2/88.5 | 98.2/88.5 |
| • Boiler efficiency at 30 % partial load (NCV/GCV) [4] | | % | 109.0/98.2 | 108.6-97.8 | 108.7/97.9 | 108.5/97.7 |
| • Room heating energy efficiency | | | | | | |
| - without control | ηs | % | - | - | - | - |
| - with control | ηs | % | - | - | - | - |
| - with control and room sensor | ηs | % | - | - | - | - |
| - annual energy consumption | $Q_{HE}$ | GJ | - | - | - | - |
| • NOx class (EN 15502) | | | 6 | 6 | 6 | 6 |
| • Nitrogen oxide emissions (EN 15502) (GCV) | NOx | mg/kWh | 36 | 41 | 37 | 35 |
| • Carbon monoxide emissions at 50/30 °C (related to 3 % of $O_2$) | CO | mg/Nm$^3$ | 25 | 26 | 23 | 23 |
| • $O_2$ content in flue gas min./max. output | | % | 6.0/5.9 | 6.0/5.9 | 6.0/5.9 | 6.0/6.0 |
| • Heat loss in standby mode | | Watt | 2400 | 2400 | 3200 | 3200 |
| • Dimensions | | | see dimensional drawing | | | |
| • Gas flow pressure min./max. | | | | | | |
| - Natural gas E/LL | | mbar | 17.4-300 | 17.4-300 | 17.4-300 | 17.4-300 |
| - Propane | | mbar | 37-57 | 37-57 | 37-57 | 37-57 |
| • Gas inlet pressure max. (idle pressure) | | mbar | 300 | 300 | 300 | 300 |
| • Gas connection values at 15 °C/1013 mbar: | | | | | | |
| - Natural gas E (Wo = 15.0 kWh/m$^3$) NCV = 9.7 kWh/m$^3$ | | m$^3$/h | 19.3-194.4 | 21.2-217.9 | 25.5-257.9 | 30.6-302.9 |
| - Natural gas LL (G25) - (Wo = 12.4 kWh/m$^3$) NCV = 8.13 kWh/m$^3$ | | m$^3$/h | 23.0-232.0 | 25.3-260.0 | 30.4-307.7 | 36.5-361.4 |
| - Propane (G31) NCV = 24.4 kWh/m$^3$ [2] | | m$^3$/h | 10.2-77.3 | 12.6-86.6 | 15.2-102.5 | 17.9-120.4 |
| • Operating voltage | | V/Hz | 1 x 230/50<br>3 x 400/50 | 1 x 230/50<br>3 x 400/50 | 1 x 230/50<br>3 x 400/50 | 1 x 230/50<br>3 x 400/50 |
| • Electrical power consumption min./max. | | Watt | 203/3746 | 203/3866 | 271/8222 | 301/8282 |
| • Standby | | Watt | 7 | 7 | 5 | 7 |
| • Type of protection | | IP | 20 | 20 | 20 | 20 |
| • Permitted ambient temperature during operation | | °C | 5-40 | 5-40 | 5-40 | 5-40 |
| • Sound power level | | | | | | |
| - Heating noise (EN 15036 part 1) (room air dependent) | | dB(A) | 86 | 85 | 89 | 88 |
| - Flue gas noise radiated from the mouth (DIN 45635 part 47) (room air dependent/independent of room air) | | dB(A) | - | - | - | - |
| • Condensate quantity (natural gas ) at 50/30 °C | | l/h | 136 | 144 | 200 | 276 |
| • pH value of the condensate (approx.) | | pH | 4.2 | 4.2 | 4.2 | 4.2 |
| • Construction | | | B23, B23P, C53, C63 | | | |
| • Flue gas system | | | | | | |
| - Temperature class | | | T120 | T120 | T120 | T120 |
| - Flue gas mass flow at max. nominal heat input (dry) | | kg/h | 2976 | 3338 | 3950 | 4460 |
| - Flue gas mass flow at min. nominal heat input (dry) | | kg/h | 295 | 325 | 390 | 450 |
| - Flue gas temperature at max. nominal heat output and 80/60 °C | | °C | 69 | 70 | 66 | 68 |
| - Flue gas temperature at max. nominal heat output and 50/30 °C | | °C | 47 | 49 | 45 | 46 |
| - Flue gas temperature at min. nominal heat output and 50/30 °C | | °C | 28 | 29 | 29 | 28 |
| - Max. permissible temperature of the combustion air | | °C | 48 | 48 | 48 | 48 |
| - Volume flow of combustion air | | Nm$^3$/h | 2438 | 2732 | 3234 | 3660 |
| - Maximum supply pressure for combustion air supply and flue gas line | | Pa | 60 | 60 | 60 | 60 |
| - Maximum draught/underpressure at flue gas outlet | | Pa | -50 | -50 | -50 | -50 |

[1] In relation to natural gas G20 (100 % methane). With a hydrogen content ($H_2$) of up to 20 % in accordance with DVGW ZP3100 (D), an output reduction of up to 7 % is possible.

[2] Data related to NCV, conditional data

[3] Data related to NCV. The boiler series is tested for EE/H setting. With a factory setting to a Wobbe value of 15.0 kWh/m$^3$, operation in the Wobbe value range from 12.0 to 15.7 kWh/m$^3$ is possible without resetting.

[4] Conversion acc. to EN 15502-1, Appendix J

# Technical specification

aura 412 EG | bt70-1

## Design:

**420 kW el.**
**400 V / 50 Hz**
**natural gas**
**Hi = 10,25 kWh/Nm³**
**NOx 0,05 g/Nm³**
**Exhaust cooling to 100 °C**

Subject to technical changes!

Note: Figure on cover page may differ

# 1 Genset

| 1.1 General power data | 50 % | 75 % | 100 % | Load | |
|---|---|---|---|---|---|
| Electrical power | 210 | 315 | 420 | kW | (5) |
| Recoverable thermal output | 374 | 496 | 605 | kW | (2) |
| Energy input | 628 | 856 | 1089 | kW | (1) |
| Efficiencies electrical | 33,4 | 36,8 | 38,6 | % | (1) |
| Efficiencies thermal | 59,6 | 57,9 | 55,5 | % | (1), (2) |
| Efficiencies total (el. + th.) | 93,1 | 94,7 | 94,1 | % | (1), (2) |
| CHP coefficient | 0,56 | 0,64 | 0,69 | | (1), (2) |

**1.2 Emissions exhaust * gas & sound**

| | with catalytic converter | w/o exhaust aftertreatment | | |
|---|---|---|---|---|
| NOx | < 0,05 | < 6,50 | g/Nm³ | (4), (6) |
| CO | < 0,25 | < 6,5 | g/Nm³ | (4), (6) |
| HCHO | < 5 | k.A | mg/Nm³ | (4), (6) |
| THC (as total carbon) | < 0,30 | k.A. | g/Nm³ | (4), (6) |
| Engine surface noise** (without / with sound encapsulation) (optional) ** | | 105 / 83 | dB(A) | (7) |
| Exhaust outlet noise ** | | 117 | dB | (7) |

## 1.3 Engine

| | | |
|---|---|---|
| Engine manufacturer | 2G | |
| Engine type | aura 412 EG \| bt70 | |
| Type / No. of cylinders | V engine / 12 | |
| Operating method | 4-stroke | |
| Combustion process | λ = 1 | |
| Engine displacement | 25007 | ccm |
| Bore / Stroke | 130 / 157 | mm |
| RPM | 1500 | 1/min |
| ISO standard power (mech.) | 435 | kW |
| compression ratio | 12,5 : 1 | |
| average effective pressure | 13,9 | bar |
| average piston speed | 7,9 | m/s |
| body of balance wheel | SAE 1 | |
| Direction of rotation (based on balance wheel) | left | |
| tooth rim with number of teeth | 137 | |
| Engine dead weight | 2150 | kg |
| Mixture cooling to | 80 | °C |

* With appropriate catalyst configuration!

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635
An increased noise load must be taken into account with fresh air intake from the installation room.

### 1.4 Generator (utility planning data)

| | | |
|---|---|---|
| Manufacturer | Leroy Somer | |
| Type | LSA 47.3 L9 / 4p | |
| Generator type | Synchronous, directly coupled | |
| Voltage regualtor (AVR) | D510C | |
| Rated speed | 1500 | 1/min |
| Frequency | 50 | Hz |
| mechanical fuel shutoff | 435 | kW |
| Effective electrical power | 420,0 | kW |
| Apparent electrical power (cos φ 1.0 / cos φ 0.9) | 420 / 466,7 | kVA |
| Rated generator current (cos φ 1.0 / cos φ 0.9) | 606 / 674 | A |
| Rated generator voltage (± 10 %) | 400 | V |
| Subtransient reactance X"d | 14,6 | % |
| Short-circuit current Ik"3 | 8,12 | kA |
| Power factor cos φ (inductive / capacitive) | 0,9 / 0,9 | |
| Generator circuit breaker | 800 | A |
| Efficiency (full load) at Cos φ = 1 | 96,6 | % |
| Mass moment of inertia | 8,46 | kg · m² |
| Ambient air temperature | 40 | °C |
| Stator circuit | star | |
| Protection class | IP 23 | |
| Generator weight | 1381 | kg |
| Compensation | not available | |
| Engine startup | not available | |

## 2 Mixture composition

### 2.1 Combustion air

| | | |
|---|---|---|
| Combustion air mass flow | 1348 | kg/h |
| Combustion air volume flow (25 °C, 1013 mbar) | 1138 | m³/h |

### 2.2 Fuel

| Fuel requirements in accordance with 'TA-004 Gas' | | |
|---|---|---|
| Reference methane number - minimum methane number | 80 / 70 | |
| Fuel mass flow | 85,3 | kg/h (1) |
| Fuel volume flow | 106,2 | Nm³/h (6), (1) |
| Min. gas pressure at nom. Output * | 20 | mbar |
| Max. gas pressure at nom. Output * | 70 | mbar |
| Gas regulation line safety pressure | 500 | mbar |

* At the inlet to the gas regulation line

# 3 Integrated heat extraction

## 3.1 Heating circuit

| Heating water requirements in accordance with 'TA-002 Heating circuit' | | |
|---|---|---|
| Heating water volume flow (Δt = 20 K) | 26,0 | m³/h |
| Heating water return temperature (max) * | 70 | °C |
| Heating water flow temperature (max) ** | 90 | °C (8) |
| Safety valve | 6 | bar |
| Operating pressure (min.) | 1 | bar |
| Internal pressure loss in heating circuit (approx.) * | 400 | mbar |
| Pressure reserve ca. * | 500 | mbar |

## 3.2 Engine circuit

| Coolant requirements in accordance with 'TA-001 Coolant' | | |
|---|---|---|
| Coolant heat | 366 | kW (2) |
| Engine inflow temperature (min.) | 80 | °C |
| Engine exit temperature (max.) | 88 | °C |
| Balance inflow / exit (max.) | 9 | K |
| Recirculated coolant quantity (min.) | 43,9 | m³/h |
| Total cooling water circulation volume | 43,9 | m³/h |
| Operating pressure (max.) | 2 | bar |
| Operating pressure (min.) | 1 | bar |
| Safety valve | 3,0 | bar |
| Emergency cooling circuit Pressure reserve ca. (optional) * | 250 | mbar |
| Safety temperature limiter | 110 | °C |
| Mixture heat high temperature circuit (HT) | 29 | kW (2) |
| Mixture coolant, inflow termperature high temperature circuit (max.) | 80 | °C |
| Mixture coolant recirculated quantity high temperature circuit (min.) | 14,7 | m³/h |

* Up to / from module interface

** depending on the design of the heating circuit pump group, information applies to design by 2G. Heating water supply temperature max., in partial load operation < 90 °C.

## 4. Exhaust system

| | | |
|---|---|---|
| Exhaust gas temperature downstream of engine | 545 | °C (3) |
| Exhaust temperature after exhaust heat exchanger | 100 | °C (3) |
| Exhaust gas heat | 209 | kW (2) |
| exhaust gas volume flow wet | 1141 | Nm³/h (6) |
| exhaust gas volume flow dry | 940 | Nm³/h (6) |
| exhaust gas mass flow wet | 1433 | kg/h |
| exhaust gas mass flow dry | 1261 | kg/h |
| Exhaust back pressure downstream of engine | 50 | mbar |
| Pressure reserve approx. (with catalytic converter) * | 32 (17) | mbar |
| | | |
| Safety temperature limiter | - | °C |

## 5 Ventilation

| | | |
|---|---|---|
| radiant heat of module (approx.) | 54 | kW |
| Supply air volume flow min. (at Δt = 15 K) | 11986 | m³/h |

## 6 Operating fluids

| | | |
|---|---|---|
| Lubricating oil approvals, see 'TA-003 Lubricating oil' | | |
| Lubrication oil consumption (Ø / max.) | 0,08 / 0,2 | g/kWh |
| Filling capacity lubricant (max.) | 90 | l |
| Lubricating oil filling tank fill capacity (optional) | 190 | l |
| Lubricating oil volume auxiliary tank (optional) | 190 | l |
| Motor circuit coolant fill quantity approx. (module) | 172 | l |
| Mixture cooling circuit LT coolant fill quantity approx. (module) | - | l |
| Coolant approvals, see 'TA-001 Coolant' | | |

## 7 Electronics and software

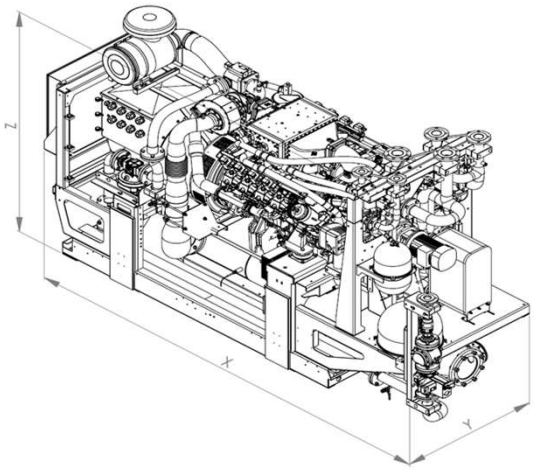
| | | |
|---|---|---|
| Grid protection device | Bachmann GSP | |
| Grid protection software status | > 13414 | |
| Touchscreen display | 10 | " |
| Approval (depending on version) | VDE-AR-N 4105 / VDE-AR-N 4110 | |
| Protection class Control cabinet | IP 54 | |
| Protection class Power switch cabinet | IP 54 | |
| Switch cabinet environmental temperature | 0 - 35 | °C |
| Switch cabinet relative air humidity (max.) | 65 | % |

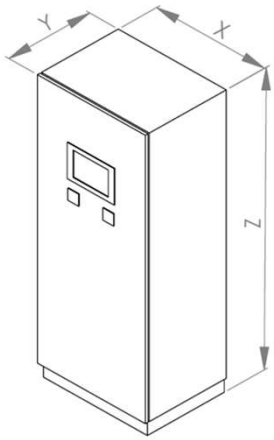
* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

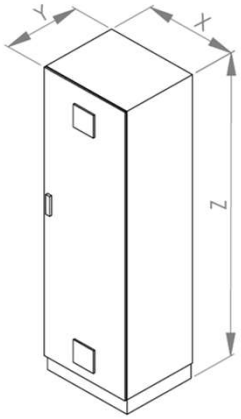
# 8 Interfaces

## 8.1 Dimensions and weights

(Figures may differ)




| | | | |
|---|---|---|---|
| Length Module * | X | 4545 | mm |
| Width Module * | Y | 1310 | mm |
| Height Module * | Z | 2300 | mm |
| Weight Module (without operating fluids) | | 6637 | kg |
| Weight Module with sound encapsulation (optional) | | 8037 | kg |
| Powder-coated CHP frame | | RAL 6002 | |

| | | | |
|---|---|---|---|
| Width Control cabinet | X | 800 | mm |
| Depth Control cabinet | Y | 600 | mm |
| Height Control cabinet | Z | 2000 | mm |
| Weight Control cabinet | | 200 | kg |
| Control cabinet powder coated | | RAL 7035 | |

| | | | |
|---|---|---|---|
| Width Power switch cabinet | X | 600 | mm |
| Depth Power switch cabinet | Y | 500 | mm |
| Height Power switch cabinet | Z | 2000 | mm |
| Weight Power switch cabinet | | 150 | kg |
| Power switch cabinet powder coated | | RAL 7035 | |

*

## 8.2 Water / gas transfer points

| | | |
|---|---|---|
| Interfaces Gas | 50 / 10 | DN / PN |
| Interfaces Exhaust | 250 / 10 | DN / PN |
| Interfaces Heating circuit | 80 / 16 | DN / PN |
| Interfaces Emergency cooling circuit | 80 / 16 | DN / PN |
| Interfaces Mixture cooling circuit LT | - | DN / PN |

## 8.3 Electrical connections / utility interface

| | | |
|---|---|---|
| Grid connection with pre-fuse (customer-provided) | 400 V / 50 Hz | |
| Grid system | TN-S | |
| Short-circuit proof Icc (max.) | 50 | kA |

## 8.4 Data interfaces

| | | |
|---|---|---|
| Remote maintenance access (optional) * | DSL / UMTS (SIM) | |
| Interfaces / Data interfaces (optional): | - | Profibus DP |
| | - | Profinet IO |
| | - | Modbus RTU |
| | - | Modbus TCP |
| | - | Ethernet IP |
| | - | Hardware signals |
| Access virtual power plant (optional) | Possible after technical clarification (bus or hardware signals) | |

* Access for remote maintenance must be provided by the customer

## 9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

(1) Performance conditions in accordance with ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.

(2) The tolerance for heat output is +/- 8 % under normal load.

(3) Data according to new condition.
The tolerance for the exhaust temperature is +/- 8 %.

(4) Corresponding to a residual oxygen concentration in the exhaust of 5 %

(5) Electrical generator terminal power at cos φ = 1.

(6) Volume specifications for normal status:

| | |
|---|---|
| Pressure | 1013 mbar |
| Temperature | 0 °C |

(7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746

(8) The tolerance for the Heating water flow temperature is +/- 1 °C.

Power specifications in this document relate to standard reference conditions.

**Standard reference conditions in accordance with ISO 3046-1:**

| | |
|---|---|
| Air pressure | 1000 mbar |
| Air temperature | 25 °C |
| Relative air humidity | 30 % |

**Power reduction**

Power reduction due to installation at altitude > 300 m a.s.l. and/or air suction temperature > 25 °C shall be determined specifically for each project according "TI-049 Load reduction".

(*) It is possible to retrofit the 2G plant onsite for operation with up to 100% hydrogen. Performance data and interfaces may change.