GF Environmental Limited

Reliance Energy

Air Quality Assessment for the Proposed FlexGen Facility, Barugh, Barnsley

Version 3 – Cumulative Impact Assessment

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Authorisation Sheet

Client: *Reliance Energy*

Project: *Air Quality Assessment for the Proposed FlexGen Facility, Barugh, Barnsley*

Version: **Version 3 – Cumulative Impact Assessment (Final)**

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DISTRIBUTION

Statutory Consultees

Reliance Energy

Glossary and Abbreviations

The following abbreviations and terms were used in this report:

Air Quality Management Area (AQMA)

If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area there. This area could be just one or two streets, or it could be much bigger. Then the local authority will put together a plan to improve the air quality - a Local Air Quality Action Plan

Air Quality Objective

Objectives are policy targets generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences, within a specified timescale.

Air Quality Standard (AQS)

Standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive sub-groups.

Environmental Assessment Level (EAL)

Used to assess the potential impact of pollutant emissions in the absence of a statutory air quality standard or objective level. The most common EALs are those recommended by the Northern Ireland Environment Agency, or derived from Occupational Exposure Levels specified by the Health & Safety Executive.

Exceedence

A period of time where the concentration of a pollutant is greater than, or equal to, the appropriate air quality criteria. For air quality standards an exceedence is a concentration greater than the standard value. For air quality bands an exceedence is a concentration greater than, or equal to, the upper band threshold.

Microgramme per cubic metre (μg m^{-3})

A measure of concentration in terms of mass per unit volume. A concentration of 1 μg m^{-3} means that one cubic metre of air contains one microgramme (millionth of a gramme) of pollutant.

Predicted Environmental Concentration (PEC)

The overall impact of process emissions on local air quality taking into account the contribution of emissions from the process itself, and the existing concentration of a pollutant at a specific location.

Process Contribution (PC)

The contribution of emissions from a process to ground level pollutant concentrations at a specific location, disregarding the existing background concentration.

CERC	Cambridge Environmental Research Consultants
GFE	GF Environmental Ltd
CO	Carbon Monoxide
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_3	Ozone
PM_{10}	Particulates (smaller than 10 microns in diameter)
$Am^3 h^{-1}$	Actual $m^3 h^{-1}$
ha	Hectare
hr	Hour
km	Kilometre
LT	Long Term
$m\ s^{-1}$	Metre per second
m	Metre
m^3	Cubic metre
min	Minute
mm	Millimetre
°C	Degrees centigrade
$\mu g/m^3$	Microgram per cubic metre (10^{-6} g m^{-3})
µ	micro 10^{-6}

Summary

A detailed assessment has been undertaken of the potential impact on local air quality of operations to be carried out at a Flexible Generation (FlexGen) power generation facility, to be installed on land within the Redbrook Industrial Estate, Barnsley. The FlexGen Facility incorporates twenty gas engines and associated electrical generators, and will operate for up to 3,000 hours per year to generate ~20MW_e of electricity for supply to the National Grid during periods of peak demand.

An earlier report considered the potential impact on local air quality due to the operation, in isolation, of Reliance Energy's FlexGen Facility. Subsequent to the submission of the planning application for the FlexGen facility, a second application was received by Barnsley Council for a 22MW_e (11 x 2MW_e) natural gas-fired power generation plant on the same industrial estate, to be developed by Peak Power Connections Ltd (PPCL). At the request of Barnsley Council, the air quality assessment for Reliance Energy's FlexGen facility has been updated to take account of the cumulative impact of the two power generation facilities operating concurrently.

Information relating to the operation of the PPCL facility was provided by Air Quality Consultants Ltd (AQC) who undertook the air quality assessment for the second power generation facility. Following discussions with AQC, it was agreed that the modelling strategy would be based on that followed in their original report to support the second planning application. AQC undertook the modelling work using the ADMS Version 5.2 model to assess the cumulative impact of the two facilities and provided the output data to GFE to enable this report to be prepared.

Representative background pollutant concentrations were obtained from the DEFRA 2013 Background Maps website for the area covered by Barnsley Council, as well as measured data from Council's extensive air quality monitoring programme.

The results from the cumulative impact assessment can be summarised as follows in relation to the annual average and hourly average NO_2 AQS objectives:

Annual Average NO_2 Process Contribution

The conclusions from the cumulative assessment of long term air quality impacts can be summarised as follows:

- There will be no significant effects outside of the contours shown in Figure 4-1; and
- Within these contours, impacts will depend on the sensitivity of any receptors exposed to the additional emissions due to the operation of the Reliance Energy FlexGen facility and the PPCL STOR facility. Based upon the assessment criteria recommended by EPUK and the IAQM, impacts are predicted to be negligible to slight adverse, with the resulting Predicted Environmental Concentrations well below the annual mean objective.

Hourly Average NO_2 Process Contribution

The conclusions from the cumulative assessment of short term air quality impacts can be summarised as follows:

- The results from the cumulative impact assessment indicate that there is an insignificant (<1%) risk of a breach of the hourly average NO_2 AQS objective at relevant receptors, when both facilities are operating simultaneously.

The overall conclusion from the cumulative assessment is that air quality effects due to the simultaneous operation of Reliance Energy's FlexGen facility and PPCL's STOR facility, and taking into account local existing emission sources, will be "not significant".

1. Introduction

1.1 Background to the Study

1.1.1 GF Environmental Ltd (GFE) was appointed by Reliance Energy to carry out an assessment of the potential impact on local air quality arising from the operation of a new Flexible Generation (FlexGen) Facility to be built on land within the Redbrook Industrial Estate, in the Barugh Green area of Barnsley. An earlier report[1] considered the potential impact on local air quality due to the operation in isolation of the natural gas-fired FlexGen Facility, operating for up to about 3,000 hours per year, for the generation of up to ~20MW_e of electricity on an "as required" basis for supply to the Local Distribution Network, which forms part of the National Grid.

1.1.2 Subsequent to the submission of the planning application for the FlexGen facility, a second application was received by Barnsley Council for a 22MW_e (11 x 2MW_e) natural gas-fired power generation plant on the same industrial estate, to be developed by Peak Power Connections Ltd (PPCL). At the request of Barnsley Council, the air quality assessment for Reliance Energy's FlexGen facility has been updated to take account of the cumulative impact of the two power generation facilities operating concurrently.

1.1.3 Information relating to the operation of the PPCL facility was provided by Air Quality Consultants Ltd (AQC) who undertook the air quality assessment for the second facility. Following discussions with AQC, it was agreed that the modelling strategy would be as followed in their original report to support the second planning application[2]. AQC undertook the modelling work to assess the cumulative impact of the two facilities and provided the output data to GFE to enable this report to be prepared.

1.1.4 This report should be read in conjunction with the previous reports prepared by both GFE and AQC, which provide the background to the two proposed developments, and provide a description of the local setting.

[1] GF Environmental Ltd, Air Quality Assessment for the Proposed FlexGen Facility, Barugh, Barnsley. Version 2 July 2017

[2] Air Quality Consultants Ltd, Air Quality Assessment: Gas Power Generation Facility, Whaley Road, Barnsley. Report No. J2676C/2/F1. June 2017

2. Operational Impacts

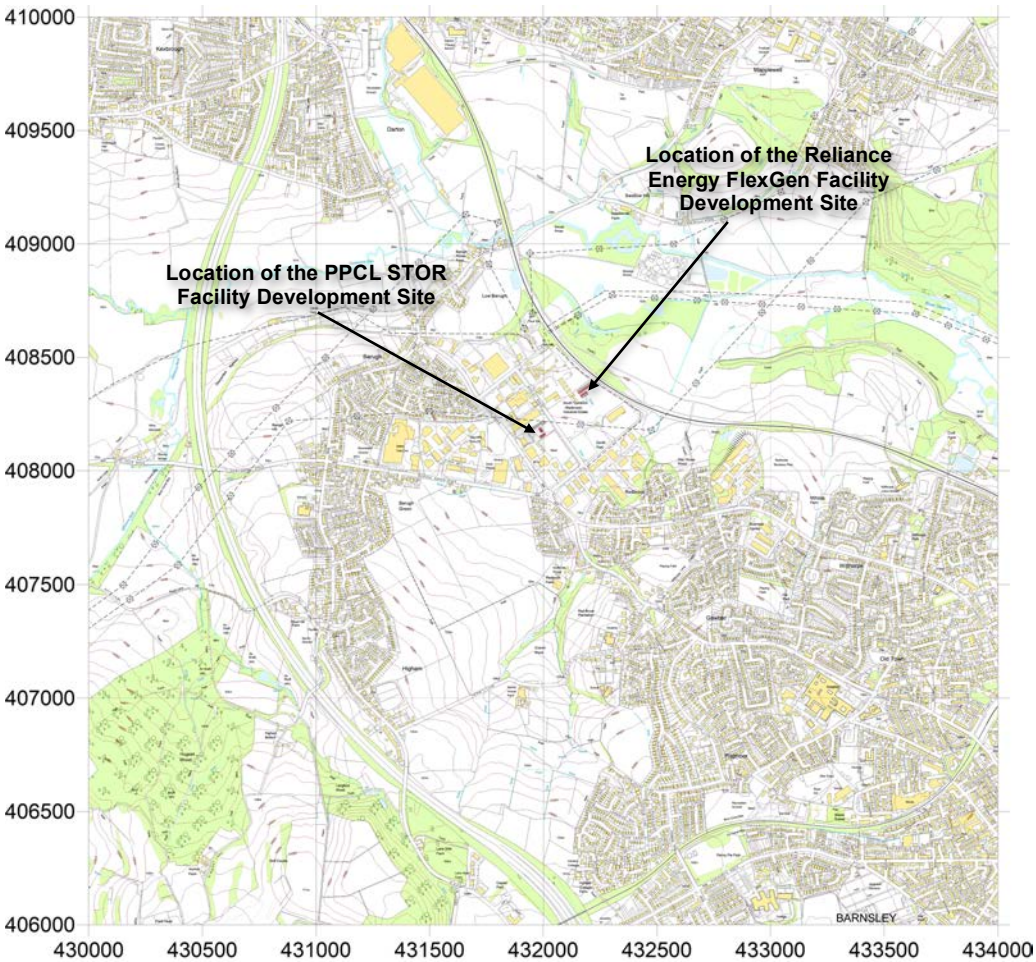
2.1 Introduction

2.1.1 The main focus of the assessment of operational activities at the two natural gas-fired power generation facilities, relates to the cumulative short term and long term impacts on local air quality. Detailed atmospheric modelling has been undertaken of emissions from the natural gas-fired engines at the two development sites, and this section provides a summary of the input data used in the ADMS model.

2.2 Site Location and Local Setting

2.2.1 The site where the Reliance Energy FlexGen facility and the PPCL STOR facility are to be located is on land within the Redbrook Industrial Estate, in the Barugh Green area of Barnsley, as shown below.

Figure 2-1 The Local Setting Showing the Location of the Development Sites



2.3 Process Details

2.3.1 Reliance Energy's FlexGen Facility comprises twenty (20) Perkins 4016-61 TRS2 natural gas-fired engine power generation units, with a combined output of ~20MW$_e$, and the

facility will operate for up to ~3,000 hours per year, to supply electricity to the national grid during periods of peak demand. The PPCL facility comprises eleven (11) MTU gas engines with a combined output of 22MW_e and will operate for up to 2,000 hours per year.

2.3.2 The ADMS model requires that sources of emissions are defined in terms of dimensions, location and physical characteristics of temperature and velocity. The atmospheric dispersion modelling study has been carried out to assess the potential cumulative impact on local air quality due to releases of atmospheric pollutants from the exhausts of the natural gas-fired engines associated with the two power generation facilities. The assessment focussed on the impact of emissions of oxides of nitrogen (NO_X) on ambient concentrations of nitrogen dioxide (NO_2), the most significant pollutant associated with the operation of the natural gas-fired engines.

2.4 Emissions Data

2.4.1 The Process information and pollutant emissions data for the natural gas-fired engines associated with the FlexGen Facility were taken from information provided by Reliance Energy, and represent emissions from each of the twenty engine exhausts. The corresponding data for the PPCL STOR facility were provided by MTU Onsite Energy, as reported in AQC's report.

Table 2-1 Emission Source Parameters for the Engine Exhausts

Parameter	Reliance Energy	PPCL
Release Height (m)	4.5	7.0
Flue Diameter (m)	0.35	0.6
Efflux Temperature (°C)	468	412
Efflux Velocity (m s^{-1})	35.9	21.4
Exhaust Gas Flowrate (Am^3/s)	3.45	6.04
Exhaust Gas Flowrate (Nm^3/s)	1.27	1.14

Table 2-2 Modelled Pollutant Emissions Data

Substance	Emission Concentration (mg Nm^{-3})		100% Output (g/s)	
	Reliance Energy's FlexGen Facility	PPCL's STOR Facility	Reliance Energy's FlexGen Facility	PPCL's STOR Facility
NO_X	480	250	0.391	0.374

2.4.2 It should be noted that the engines specified for installation at Reliance Energy's FlexGen facility were based upon a guaranteed NO_X emission concentration of 480 mg Nm^{-3}, and formed the basis for the previous air quality assessment undertaken in July 2017. The cumulative impact assessment has been based upon NO_X emissions at this higher level to provide a worst case basis for assessment.

2.5 Atmospheric Chemistry

2.5.1 The atmospheric chemistry module in ADMS was not used for the current assessment. Instead, an empirical approach recommended in the Environment Agency's guidance[3] on the modelling of NO_X emissions from combustion process, was used to calculate annual

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[3] http://www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

average and hourly average NO_2 ground-level concentrations from model reported average NO_X concentrations.

Equation 1 Calculation of Annual Average NO_2 Predicted Environmental Concentration (PEC)

(Annual $NO_{X\ Modelled}$ x 0.7) + Annual $NO_{2\ Monitored}$

Equation 2 Calculation of Hourly Average NO_2 Predicted Environmental Concentration (PEC)

(Hourly $NO_{X\ Modelled}$ x 0.35) + (Annual $NO_{2\ Monitored}$ x 2)

2.5.2 This method represents a worst case as it may overestimate the PEC for NO_2 in close proximity to the site as conversion of NO_X to NO_2 is unlikely to be instantaneous, as it requires a chemical reaction involving mixing of the plume with the ambient air and its associated oxidant species. Local circumstances can also affect the availability of atmospheric oxidants required for the conversion of NO_X to NO_2. This conservative approach has been accepted by the EA.

2.6 Meteorology

2.6.1 The original assessment for the Reliance Energy FlexGen facility utilised hourly average meteorological data from the Doncaster measurement station. The AQC assessment for the PPCL STOR facility involved the use of hourly average meteorological data from the Elmley Moor measurement station, which is located ~10km from the development site. It was agreed that the cumulative impact assessment should be based on the use of the 2012 to 2016 Elmley Moor data.

3. Approach to Modelling

3.1 Introduction

3.1.1 As referred to earlier, it was agreed that the approach to modelling for the cumulative impact assessment would be based upon that followed by AQC in their assessment for the PPCL STOR facility.

3.2 Assessment Relative to the Annual Average Process Contribution

3.2.1 For the calculation of the annual average NO_2 Process Contribution, the model predictions for the 8,760 hours of meteorological data in a complete year were pro-rated in line with either the 3,000 operational hours for the Reliance Energy facility, or the 2,000 operational hours expected for the PPCL facility.

3.3 Assessment Relative to the Hourly Average Process Contribution

3.3.1 The short term AQS objective for NO_2 is based upon the 99.79th percentile value which is based on the eighteen allowable exceedences per year of the 200 µg m^{-3} objective value. For processes that operate for the majority of the year, modelling is undertaken on the basis of the 8,760 hours of meteorological data to ensure that the assessment includes worst case dispersion conditions that could arise at any time during the year. However, for processes that do not operate continuously, and operate for significantly less than a complete year, this approach is considered to be overly conservative.

3.3.2 As an alternative, Environment Agency guidance[4], issued by its Air Quality Monitoring and Assessment Unit (AQMAU), recommends the use of statistical analysis to determine the probability of a breach (>18 exceedences per year) of the hourly AQS objective. In this instance, a hypergeometric distribution can be used to assess the likelihood of exceedence hours coinciding with the operational hours. The hypergeometric distribution can be used to compute the probability of (x) successes in a randomly selected sample size (n) from a population (N) without replacement, where in the population there are (k) successes and (N-k) failures.

3.3.3 This assumes that the operational hours are random at any time of the year. In the case of the proposed power generation facilities, this will not be strictly correct because at times of higher energy demand, the two facilities will operate at times likely to coincide with specific times of the year and times of the day. The Environment Agency in issuing an environmental permit to operate either of the two facilities, would not normally restrict the operation of a facility to specific operational hours, which in the case of Reliance Energy's FlexGen facility could theoretically be any 3,000 hours within a year.

3.3.4 The hypergeometric distribution is recommended by AQMAU as a reasonable

[4] The Environment Agency, Air Quality Monitoring and Assessment Unit (AQMAU), Diesel generator short term NO_2 impact assessment. Report No. AQMAU-C1457-RP01. 1st November 2016.

representation of these unplanned operations. Nineteen exceedences of the 200 µg m^{-3} hourly average objective value in any one year would represent a breach of the Air Quality Regulations, therefore the cumulative hypergeometric distribution is used to calculate the probability of a breach occurring. The probability is dependent on the number of proposed hours of operation, such that the lower the number of operating hours, the lower the probability that nineteen or more of the randomly selected hours will exceed the 200 µg m^{-3} threshold. AQMAU adopted a 5% probability threshold that a breach of the hourly average NO_2 AQS objective could occur, as the basis for acceptable risk. In the original air quality assessment study undertaken by AQC, they applied a 1% probability threshold as a worst case basis for assessment, and this was adopted for the cumulative impact assessment.

3.3.5 AQC describe the statistical analysis technique that they adopted as the basis for assessment of the PPCL facility, as follows:

> *This approach can be applied in reverse so that, when selecting a limited number of hourly values that correspond to the number of operational hours, there is a less than 1% chance that more than eighteen of the selected hourly values exceed the hourly average objective value. This is done by calculating the number of hourly values from a full dataset (8,760 hourly values) that can exceed the 1-hour threshold in order for there to be a less than 1% chance. The number of hours that exceed the threshold in the full dataset can then be used to calculate representative percentiles for the operational scenario.*

3.3.6 The calculated percentile for Reliance Energy's FlexGen facility is presented in the following table, and is based upon the proposed 3,000 operational hours per year.

Table 3-1 Percentage of 3,000 Operational Hours Which Represent a <1% Probability of the Hourly Average NO_2 Objective Value Being Exceeded

Number of Operational Hours	Number of Hourly PC Values in a Complete Year That Can be >200 µg m^{-3}, for a <1% Probability of More Than 18 Hours Being >200 µg m^{-3} in the 3,000 Operational Hours	Corresponding Percentile Value
3,000	36	99.6%

3.3.7 The values in the above table indicate that if there are less than 36 exceedences of the 200 µg m^{-3} hourly average objective value in a complete year (8,760 hours), then there is a corresponding probability of <1% that there will be more than eighteen exceedences of the objective value during the randomly selected 3,000 operational hours. The relevant percentile of 8,760 hourly concentrations to determine a <1% risk, i.e. for 3,000 hours of operation, is the 99.6th percentile of 8,760 hourly concentrations, which will return the 36th highest value.

3.4 Assessment Criteria

3.4.1 The cumulative air quality assessment was undertaken for oxides of nitrogen (NO_X) and their subsequent atmospheric conversion to nitrogen dioxide (NO_2), which is the most significant pollutant emission associated with the operation of natural gas-fired engines.

3.4.2 All combustion processes release a mixture of Oxides of Nitrogen (NO_X) which comprise varying proportions of nitric oxide (NO) and nitrogen dioxide (NO_2). The majority of the NO_X that is released from combustion processes is in the form of NO, which subsequently reacts with atmospheric oxidants such as ozone (O_3) to form NO_2.

3.4.3 The Air Quality Standards for NO_2 include two objective values:

- An annual limit of 40 µg m^{-3}; and,
- A limit for the one-hour mean of 200 µg m^{-3}, not to be exceeded more than 18 times a year (equivalent to the 99.79th percentile).

3.4.4 Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) issued guidance[5] on defining a description of the impacts on local air quality arising from development activities. Impact description involves expressing the "*magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion*".

3.4.5 The EPUK/IAQM descriptor matrix is shown below:

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

3.4.6 The EPUK/IAQM guidance states that impacts on air quality, whether adverse or beneficial, will have an effect on human health that can be judged as 'significant' or 'not significant'.

3.4.7 In applying this matrix the following approach was followed for determining the impact descriptor for increases in annual average NO_2 concentrations at receptors in the vicinity of the development site.

Annual Average Process Contribution At Receptor (µg m^{-3})	**Change in Concentration – NO_2 (µg m^{-3})**				
	<0.2	**0.2 to 0.6**	**0.6 to 2.2**	**2.2 to 4.0**	**>4.0**
<30.2	Negligible	Negligible	Negligible	Slight	Moderate
30.2-37.8	Negligible	Negligible	Slight	Moderate	Moderate
37.8-41.0	Negligible	Slight	Moderate	Moderate	Substantial
41.0-43.8	Negligible	Moderate	Moderate	Substantial	Substantial
>43.8	Negligible	Moderate	Substantial	Substantial	Substantial

3.4.8 The EPUK/IAQM assessment criteria have been applied to the following changes in concentration, as follows:

- Process Contribution <0.5% of the annual average AQS objective (<0.2 µg m^{-3}) will be *negligible*, regardless of the existing air quality conditions;
- Process Contribution <1.5% of the annual average AQS objective value (0.6 µg m^{-3}) will be *negligible* as long as the Predicted Environmental Concentration is less than 94% of the AQS objective value (37.8 µg m^{-3}); and
- Process Contribution <5.5% of the annual average AQS objective (2.2 mg m^{-3}) will be *negligible* as long as the Predicted Environmental Concentration is less than 75% of the AQS objective value (30.2 µg m^{-3}).

3.4.9 The above assessment criteria apply to increases in annual average NO_2 concentrations due to the operation of the two power generation facilities. The hourly average NO_2 AQS objective considers the number of hours exceeding a standard rather than being a single concentration not to be exceeded, and it is therefore not possible to assign a similar

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[5] EPUK and IAQM, Land-Use Planning and Development Control: Planning for Air Quality. January 2017

magnitude of change. Accordingly, a statistical analysis approach, as described in Section 3.3 has been applied to assessment of short term air quality impacts.

4. Detailed Modelling – Cumulative Air Quality Assessment

4.1 Modelled Parameters

4.1.1 Detailed atmospheric dispersion modelling of emissions from Reliance Energy's FlexGen Facility and PPCL's STOR facility was undertaken on the basis of the previous sensitivity analysis undertaken by Air Quality Consultants, as follows:

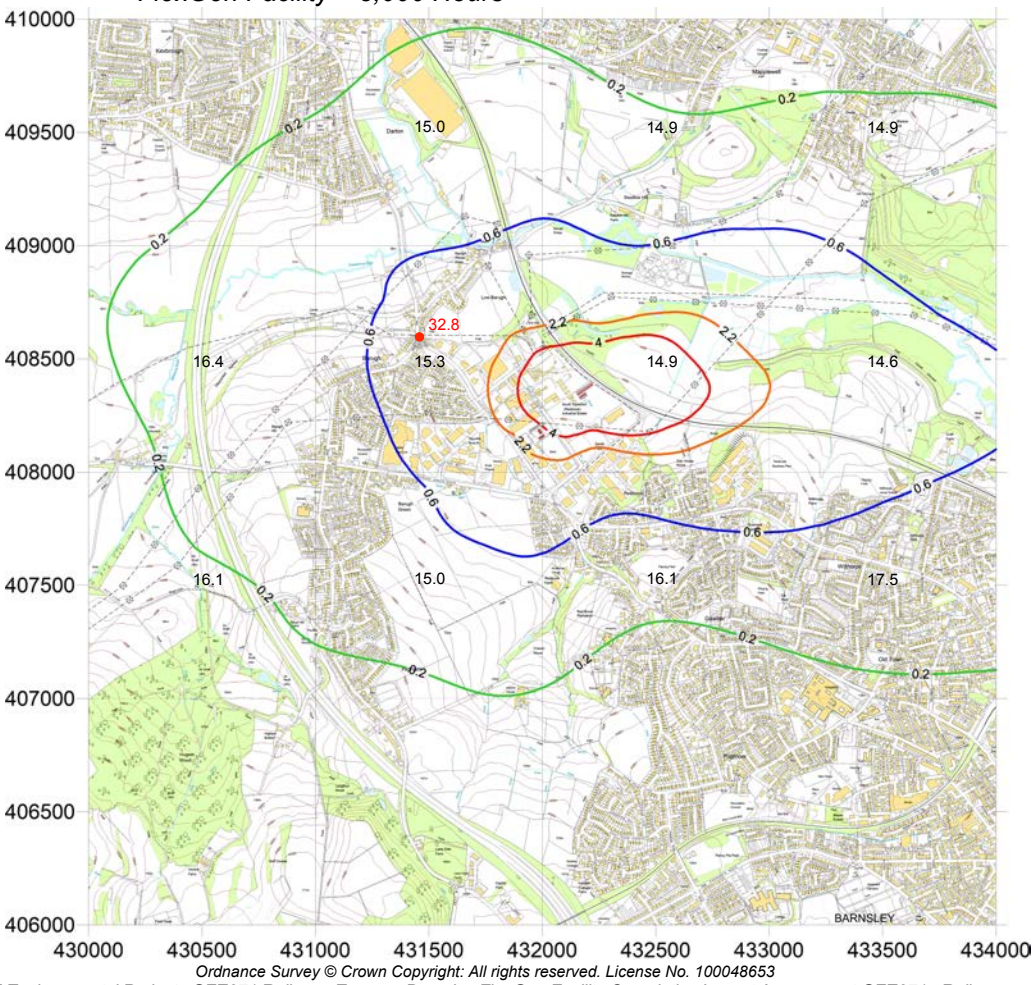
- Building module: Active
- Terrain effects: Active
- Surface roughness: 0.5 metres
- Meteorological data: Elmley Moor 2012 to 2016

4.1.2 Detailed assessment was undertaken on the basis of the discharge characteristics and emissions data for the two facilities, as summarised in Table 2-1 and Table 2-2.

4.2 Nitrogen Dioxide (NO_2) – Long Term

4.2.1 The following figure shows annual average NO_2 concentration contours associated with the operation of the Reliance FlexGen facility, operating for 3,000 hours per year, and based upon the EPUK/IAQM assessment criteria threshold bands.

Figure 4-1 Maximum Annual Average Process Contribution for NO_2 – Reliance Energy FlexGen Facility – 3,000 Hours



4.2.2 The numbers at the centres of each 1km x 1km OS grid square, represent the estimated annual average NO_2 concentration for 2017, taken from the DEFRA 2013 Background Maps website[6]. The figure in red is based upon NO_2 diffusion tube monitoring carried out by Barnsley Council in 2016 at the junction of Claycliffe Road and Barugh Lane.

4.2.3 The following table sets out the exposure that occurs within each of the four Process Contribution contours specified for the EPUK/IAQM assessment criteria (Section 3.4.6), due to the operation of the Reliance Energy FlexGen facility.

Table 4-1 Relevant Exposure Within Each Process Contribution Contour

	Green Contour (0.2 to 0.6 µg m^{-3})	Blue Contour (0.6 to 2.2 µg m^{-3})	Orange Contour (2.2 to 4.0 µg m^{-3})	Red Contour (>4.0 µg m^{-3})
Relevant Exposure	>500 residential properties	~250 residential properties	2 or 3 commercial premises	No relevant exposure

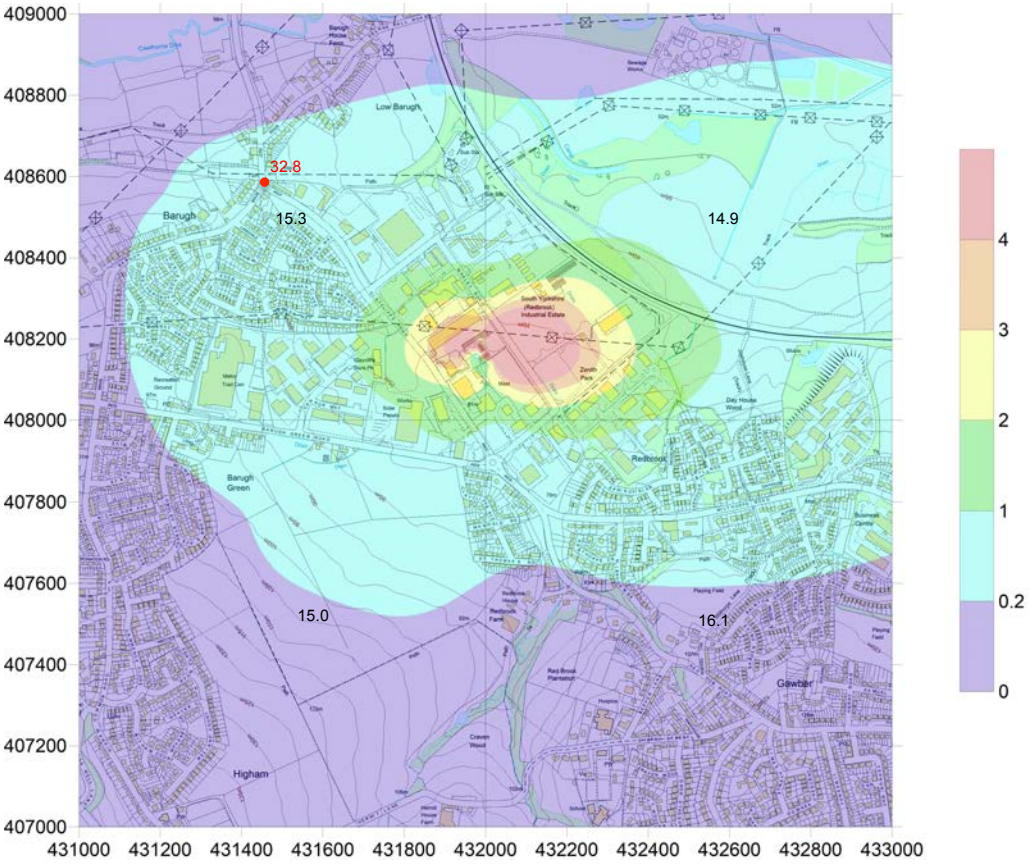
4.2.4 The above data refer to the annual average NO_2 Process Contribution associated with the operation of the Reliance Energy FlexGen facility alone. The associated Predicted Environmental Concentration depends upon the combination of the Process Contribution and the existing baseline conditions. For the cumulative impact assessment it has been assumed that the PPCL STOR facility is operational, and emissions from the PPCL facility are accounted for in the baseline.

4.2.5 The following figure sets out baseline air quality conditions for the area surrounding the Reliance Energy FlexGen facility development site, based upon the following sources of information:

- DEFRA's estimated "background" concentrations, which represent conditions well away from any emission sources, such as road traffic, etc.;
- Diffusion tube measurements undertaken by the Barnsley Council, which represent conditions at the specific monitoring location, and include the influence of existing sources such as local roads; and
- The modelled process contribution due to emissions from the PPCL STOR facility.

[6] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2013

Figure 4-2 Maximum Annual Average Process Contribution for NO_2 (µg m^{-3}) – PPCL STOR Facility Operational for 2,000 Hours per Year



4.2.6 The above figure shows that near to Claycliffe Road the annual mean process contribution concentrations due to the operation of the PPCL STOR facility are in the range of 0.2 to 2.0 µg m^{-3}. The figure also shows the maximum NO_2 concentration from the 2016 diffusion tube monitoring in the vicinity of this area is 32.8 µg m^{-3}, measured at the kerbside at the intersection of Claycliffe Road and Barugh Lane (denoted by the red circle). Residential properties along Claycliffe Road, to the south-east of the diffusion tube location, will be exposed to lower NO_2 concentrations than the measured concentration. Furthermore, the further away from road traffic sources the concentrations (excluding the PPCL STOR) will approach DEFRA's estimated background concentrations, which are shown in Figure 4-2 and are in the range of 14.9 to 16.1 µg m^{-3}.

4.3 Assessment Based Upon the Process Contribution/Process Contribution Process Contribution Criteria

4.3.1 Using the assessment criteria recommended by Process Contribution and the Process Contribution, as described in Section 3.4.8:

- Outside the area enclosed by the 0.2 µg m^{-3} (green) contour, the impacts will be **negligible**, regardless of the receptor-specific Process Contribution (Process Contribution plus existing baseline concentration);
- Between the 0.2 and 0.6 µg m^{-3} (green and blue) contours, the impacts will also be negligible, as long as the total baseline concentration is below 37.2 µg m^{-3} (the contour threshold of 37.8 µg m^{-}

^{3} minus the maximum Process Contribution within the area of 0.6 µg $^{m-3}$);

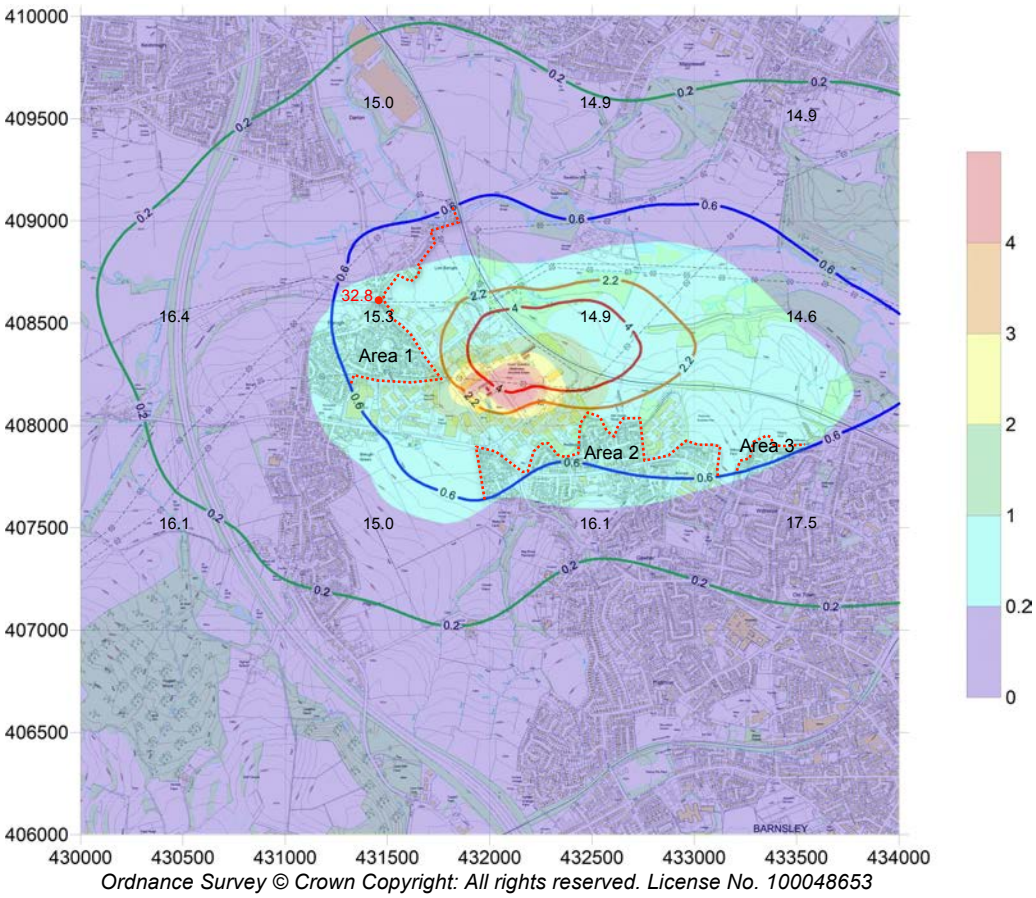
- Between the 0.6 and 2.2 µg m^{-3} (blue and orange) contours, the impacts will be negligible with a baseline concentration below 28.0 µg m^{-3} (the contour threshold of 30.2 µg m^{-3} minus the maximum Process Contribution within the area of 2.2 µg m^{-3}); and
- Non-negligible impacts cannot be discounted inside the 2.2 µg m^{-3} (orange) or the 4.0 µg m^{-3} (red) contour wherever there are locations with relevant exposure in relation to the annual mean objective as described in Table 4-1.

4.3.2 Based upon the EPUK and IAQM assessment criteria, the process contributions between the contour lines would be associated with the impacts presented in the column headings of the following table, depending on the magnitude of the baseline concentration.

Process Contribution Contour	Negligible	Slight Adverse	Moderate Adverse	Substantial Adverse
Green to Blue	<37.2 µg m^{-3}	37.2 - 40.4 µg m^{-3}	>40.4 µg m^{-3}	-
Blue to Orange	<28.0 µg m^{-3}	28.0 - 35.6 µg m^{-3}	35.6 - 41.6 µg m^{-3}	>41.6 µg m^{-3}
Orange to Red	-	<26.2 µg m^{-3}	26.2 - 37.0 µg m^{-3}	>37.0 µg m^{-3}

4.3.3 The following figure shows the contours from Figure 4-1 (the process contribution due to the operation of the Reliance Energy FlexGen facility) superimposed on Figure 4-2 (the baseline conditions including the Process Contribution associated with the operation of the PPCL STOR facility).

Figure 4-3 Maximum Annual Average Process Contribution for NO_2 – Reliance Energy FlexGen Facility – 3,000 Hours Overlaid on the Annual Average NO_2 Baseline Condition



Impacts Within the Orange and Red Contour Lines

4.3.4 The area enclosed by the red and orange contours is limited predominantly to land within the industrial area surrounding the site, and land to the north-east of the railway line. DEFRA guidance states that the annual mean objective only applies at locations where members of the general public might be regularly exposed for the duration of the objective averaging period and therefore, places of work are not regarded as relevant receptors for members of the public. As such, there are no relevant receptors within the red and orange lines, and therefore there will be no impacts within these areas.

Impacts Within the Blue Contour Line

4.3.5 There are approximately 250 residential dwellings within the blue contour line; these are located in the residential areas to the west ('Area 1' in Figure 4-3). The maximum nitrogen dioxide concentration from monitoring in this area is 32.8 µg m^{-3} (2016 diffusion tube measurement), which is mounted on a lamp post on the kerbside at the intersection of Claycliffe Road and Barugh Lane. The diffusion tube monitoring location is nearer to the road traffic emission sources than any of the residential properties in 'Area 1'. It is reasonable to assume, therefore, that roadside concentrations along Claycliffe Road will be lower than this measured concentration.

4.3.6 The PPCL STOR facility is predicted to contribute 0.2 to 1.0 µg m^{-3} within 'Area 1'. Assuming that the PPCL STOR facility is operational then the maximum Predicted Environmental Concentration (at any worst-case location) is expected to be below 33.8 µg m^{-3} (diffusion tube concentration of 32.8 µg m^{-3} plus the PPCL STOR facility process contribution of a maximum of ~1.0 µg m^{-3}). Accordingly, for residential properties nearest to Claycliffe Road, that are influenced by emissions from road traffic, the Predicted Environmental Concentration may potentially be greater than 28.0 µg m^{-3}. Therefore, according to Table 4-1, there may be some **slight adverse** impacts in 'Area 1', although most will be **negligible**.

4.3.7 For those residential properties to the south-east in 'Areas 2 and 3', away from Wilthorpe Road, where the only direct contribution to nitrogen dioxide concentrations are emissions from minor roads, the baseline concentrations can be expected to be closer to the predicted DEFRA estimated background concentration of approximately ~16 µg m^{-3}. Emissions from the PPCL STOR facility will add approximately 0.2 to 1.0 µg m^{-3} to the DEFRA estimated background concentration. When considered cumulatively with the impact of emissions from Reliance Energy's FlexGen facility, the resulting Predicted Environmental Concentration will be well below the 28 µg m^{-3} threshold, and the impacts in 'Areas 2 and 3' will be **negligible**.

4.3.8 The impacts within the 0.6 µg m^{-3} (blue) contour line, taking into account the emissions from the Reliance Energy FlexGen facility, will be between **negligible** and **slight adverse**,

depending on the proximity to the major roads (i.e. close to major roads where baseline concentrations might exceed 28.0 µg m^{-3} the impacts may be **slight adverse**, but will be **negligible** elsewhere).

Impacts Within the Green Contour Line

4.3.9 There are a large number of residential properties located within the 0.2 µg m^{-3} (green) contour line, but outside of the 0.6 µg m^{-3} (blue) contour line. As referred to earlier, the maximum concentration recorded in the area, based upon diffusion tube monitoring in 2016, is 32.8 µg m^{-3}. Assuming that the PPCL STOR facility is operational then the maximum process contribution at the residential receptors between the green and blue contour lines is ~0.5 µg m^{-3} (shown by the shaded coloured areas in Figure 4-3 which intersect with the area defined by the green and blue lines). As such all other concentrations are expected to be below 33.3 µg m^{-3} (diffusion tube concentration of 32.8 µg m^{-3} plus the process contribution of a maximum of 0.5 µg m^{-3} due to the operation of the PPCL STOR facility). This falls well below the threshold for negligible impacts for the 0.2 to 0.6 µg m^{-3} (green) contour (of 37.2 µg m^{-3}); accordingly, the impact of the resulting Predicted Environmental Concentrations in these areas will be **negligible**.

Annual Mean Impacts

4.3.10 The overall annual mean impacts are summarised in the following table.

Table 4-2 Predicted Air Quality Impacts at Receptors Based Upon Location Within Process Contribution Contours

Process Contribution Contour	Predicted Impact
Green to Blue (0.2 to 0.6 µg m^{-3})	Negligible
Blue to Orange (0.6 to 2.2 µg m^{-3})	Negligible to Slight Adverse
Orange to Red (2.2 to 4.0 µg m^{-3})	No Relevant Exposure
Red (>4.0 µg m^{-3})	No Relevant Exposure

4.4 Nitrogen Dioxide – Short Term Impacts

4.4.1 Relevant locations for the short-term objectives are locations where members of the general public may spend one hour or more, at least 18 times in a year. While the majority of the industrial estate would not satisfy this criterion, there is a café which would be considered a relevant location. There are also several car showrooms that are located on the industrial estate, the forecourts of which, where new cars are located, may be considered a relevant receptor for the hourly average NO_2 AQS objective value, as members of the general public may spend extended periods of time browsing the cars.

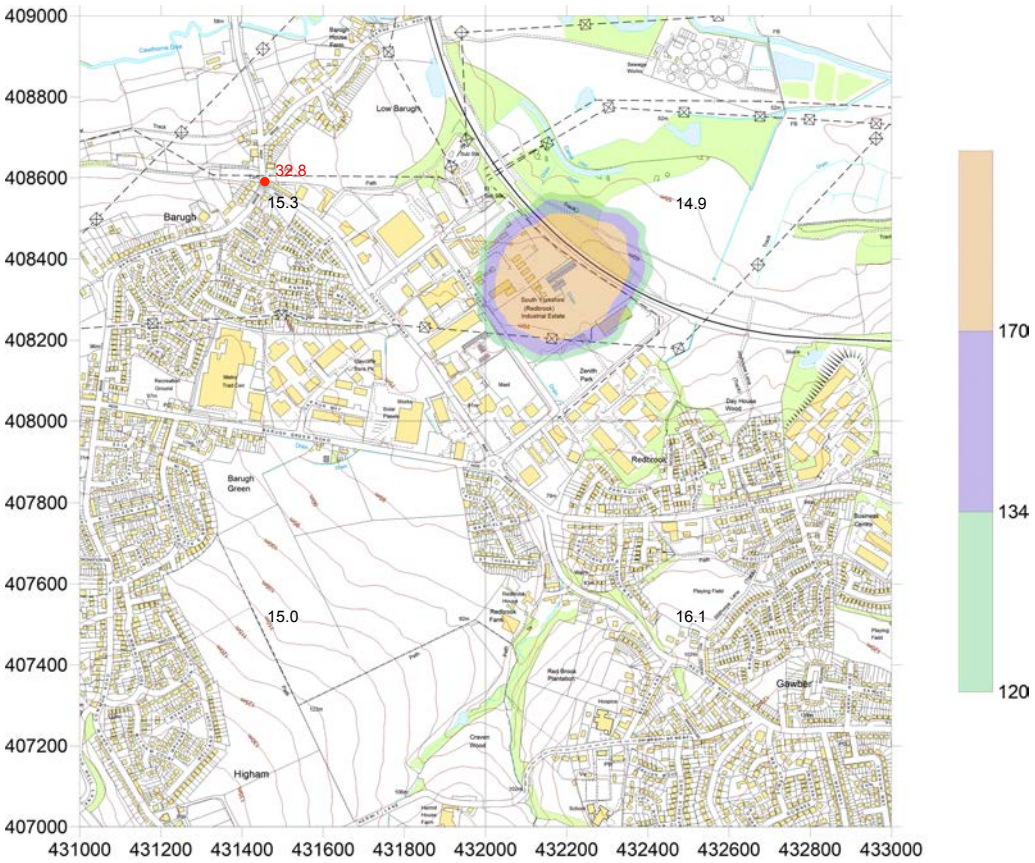
4.4.2 Baseline hourly average NO_2 concentrations within the study area, excluding the process contributions from the two power generation facilities, can be represented as follows:

- Short-term background concentrations in the area surrounding the two sites are approximately 30 µg m^{-3} (twice the annual mean background concentration of ~15 µg m^{-3});
- Short-term roadside concentrations in the area are approximately 66 µg m^{-3} (twice the annual mean measured concentration of approximately 32.8 µg m^{-3}); and
- Short-term concentrations near to the M1 Motorway are not likely to exceed 80 µg m^{-3} (twice the annual mean concentration of 40 µg m^{-3}) because the area is located outside the M1 Motorway

AQMA, and therefore annual average NO_2 concentrations are unlikely to exceed 40 µg m^{-3}).

4.4.3 Figure 4-4 shows the hourly average NO_2 Process Contribution contours representing 99.6th percentile values for the 3,000 hour operational hours scenario for the Reliance Energy FlexGen facility.

Figure 4-4 Hourly Average NO_2 Process Contributions Associated with the Reliance Energy FlexGen Facility – 3,000 Operational Hours



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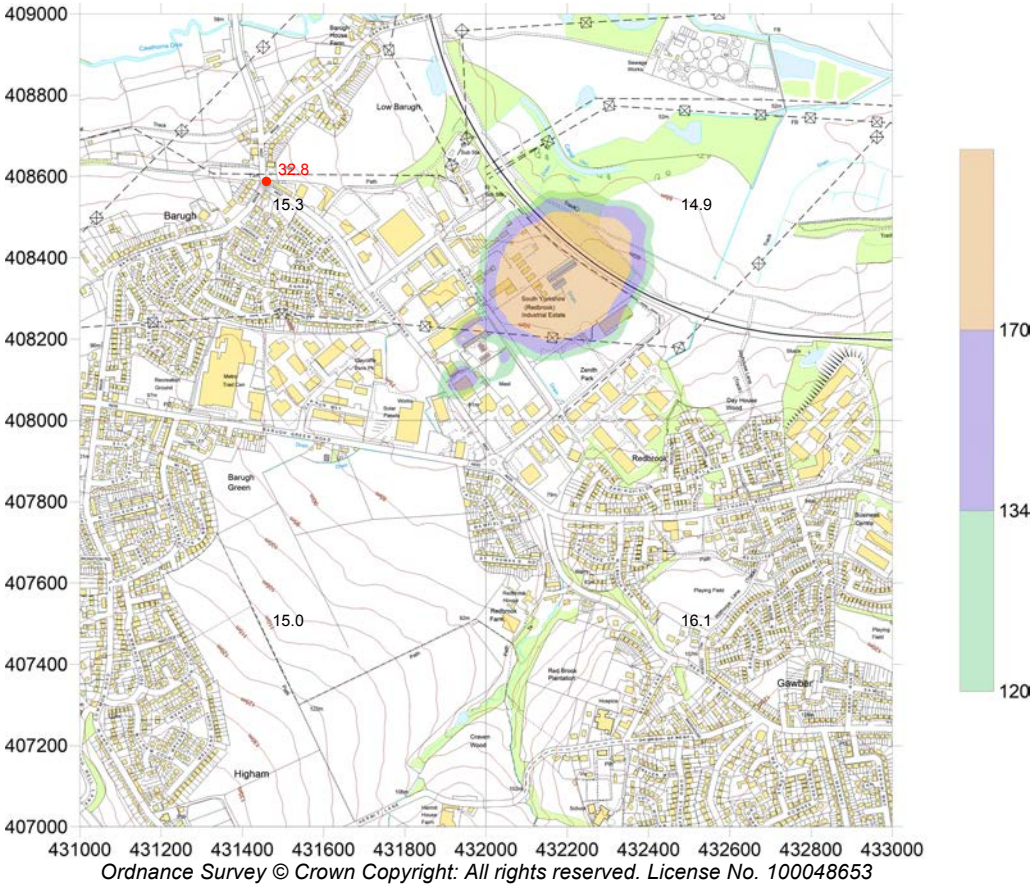
4.4.4 Due to the different annual operating hours of the Reliance Energy and PPCL facilities, it is not possible to consider the impacts of their respective percentile concentrations in combination, therefore, the combined emissions from the two facilities have been modelled together and included within the contour bands.

4.4.5 The corresponding figure for the situation when both the Reliance Energy FlexGen facility and the PPCL STOR facility are both operational is shown in the following figure.

Figure 4-5 Hourly Average NO_2 Process Contributions Associated with the Reliance Energy FlexGen Facility and PPCL STOR Facility



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4.4.6 Relevant receptors located within the orange band (>170 µg m^{-3}) would be exposed to a >1% chance of a breach of the hourly average NO_2 AQS objective, given that the baseline annual average NO_2 concentration is estimated to be ~15 µg m^{-3}, giving a Predicted Environmental Concentration of >200 µg m^{-3};

4.4.7 Relevant receptors located within the blue band (134 to 170 µg m^{-3}) would potentially be exposed to a >1% chance of a breach of the hourly average NO_2 AQS objective, if the baseline annual average NO_2 concentration is greater than 15 µg m^{-3}, but is less than 33 µg m^{-3} (i.e. greater than twice the DEFRA estimated mapped background concentration but less than twice the maximum measured annual average concentration in the area of 32.8 µg m^{-3});

4.4.8 Relevant receptors located within the green band (120 to 134 µg m^{-3}) would potentially be exposed to a >1% chance of a breach of the hourly average NO_2 AQS objective if the baseline annual mean nitrogen dioxide concentration is greater than 33 µg m^{-3}, but less than 40 µg m^{-3} (i.e. greater than twice the maximum measured annual mean concentration in the area of 32.8 µg m^{-3}, but less than 40.0 µg m^{-3}); and

4.4.9 Relevant receptors located outside the green band, baseline concentrations would need to be significantly elevated (annual mean >40 µg m^{-3}) for there to be a risk of a breach of the

hourly average NO_2 AQS objective, which is extremely unlikely.

4.4.10 The above discussion identifies locations where there is the potential for a >1% chance of a breach of the hourly average NO_2 AQS objective, if there are relevant receptors within each contour and depending upon the associated baseline NO_2 concentration.

4.4.11 The Process Contribution contours are confined predominantly to land within the industrial estate, and there is an extremely low risk of a breach of the hourly average NO_2 AQS objective outside of the industrial estate.

4.4.12 Depending on the presence of other emission sources (like road traffic) the baseline concentrations will vary throughout the area. However, the relevant receptors for the hourly average NO_2 AQS objective within the industrial estate (the nearby café and the car showroom forecourts) fall outside the contours, and therefore it is expected that there will not be any relevant exposure.

4.4.13 Accordingly, the results from the cumulative assessment indicate that the simultaneous operation of the Reliance Energy FlexGen facility and the PPCL STOR facility is unlikely to give rise to a breach of the hourly average NO_2 AQS objective at any sensitive location.

5. Conclusions

5.1 Introduction

5.1.1 A detailed assessment has been undertaken of the potential impact on local air quality of operations to be carried out at a Flexible Generation (FlexGen) power generation facility, to be installed on land within the Redbrook Industrial Estate, Barnsley. The FlexGen Facility incorporates twenty gas engines and associated electrical generators, and will operate for up to 3,000 hours per year to generate ~20MW_e of electricity for supply to the National Grid during periods of peak demand.

5.1.2 An earlier report considered the potential impact on local air quality due to the operation in isolation of Reliance Energy's FlexGen Facility. Subsequent to the submission of the planning application for the FlexGen facility, a second application was received by Barnsley Council for a 22MW_e (11 x 2MW_e) natural gas-fired power generation plant on the same industrial estate, to be developed by Peak Power Connections Ltd (PPCL). At the request of Barnsley Council, the air quality assessment for Reliance Energy's FlexGen facility has been updated to take account of the cumulative impact of the two power generation facilities operating concurrently.

5.1.3 Information relating to the operation of the PPCL facility was provided by Air Quality Consultants Ltd (AQC) who undertook the air quality assessment for the second power generation facility. Following discussions with AQC, it was agreed that the modelling strategy would be based on that followed in their original report to support the second planning application. AQC undertook the modelling work using the ADMS Version 5.2 model to assess the cumulative impact of the two facilities and provided the output data to GFE to enable this report to be prepared.

5.1.4 Representative background pollutant concentrations were obtained from the DEFRA 2013 Background Maps website for the area covered by Barnsley Metropolitan Borough Council, as well as measured data from Council's extensive air quality monitoring programme.

5.1.5 The results from the cumulative impact assessment can be summarised as follows in relation to the annual average and hourly average NO_2 AQS objectives:

5.2 Annual Average NO_2 Process Contribution

5.2.1 The conclusions from the cumulative assessment of long term air quality impacts can be summarised as follows:

- There will be no significant effects outside of the contours shown in Figure 4-1; and
- Within these contours, impacts will depend on the sensitivity of any receptors exposed to the additional emissions due to the operation of the Reliance Energy FlexGen facility and the PPCL STOR facility. Based upon the assessment criteria recommended by EPUK and the IAQM, impacts are predicted to be **negligible** to **slight adverse**, with the resulting Predicted Environmental Concentrations well below the annual mean objective.

5.3 Hourly Average NO_2 Process Contribution

5.3.1 The conclusions from the cumulative assessment of short term air quality impacts can be summarised as follows:

- The results from the cumulative impact assessment indicate that there is an insignificant (<1%) risk of a breach of the hourly average NO_2 AQS objective at relevant receptors, when both facilities are operating simultaneously.

5.3.2 The overall conclusion from the cumulative assessment is that air quality effects due to the simultaneous operation of Reliance Energy's FlexGen facility and PPCL's STOR facility, and taking into account local existing emission sources, will be "not significant".