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Section I

Considers the impact of local air quality that arise from elimination of local combustion of gas and biofuels and the concentration of combustion at district energy centres

Introduction

AECOM was commissioned to undertake an air quality assessment as part of the Croydon Decentralised Energy Study. The air quality assessment considered current and future emissions to air within Croydon as well as existing local air quality in order to provide a baseline against which the future proposal of replacing existing domestic and commercial power sources with the proposed Decentralised Energy scheme could be assessed.

The effect of the proposed scheme on emissions of NO_x and PM_{10} was calculated and the subsequent impact on local concentrations of NO_2 and PM_{10} predicted using dispersion modelling. The significance of predicted impacts was assessed with reference to the relative change in pollutant emissions and the predicted changes in pollutant concentrations.

Legislative Background

Local Planning Guidance
The council is currently in the transitional process of replacing the Unitary Development Plan (UDP) which included the Structure Plan and City Local Plan 2001, with the Local Development Framework (LDF) as the main collection of planning policy documents within the council.

The London Plan
The consolidated London Plan was published on 19 February 2008. Replacing the previous strategic planning guidance for London issued by the Secretary of State, Regional Planning Guidance 3 (RPG3), the London Plan is a requirement of the Greater London Authority Act 1999 and only deals with matters that are of strategic importance to Greater London.

Specifically in terms of air quality the Plan makes reference to the Mayor of London's Air Quality Strategy and states the following proposal:

Policy 4A.6 Improving air quality
The Mayor will, and boroughs should, implement the Mayor's Air Quality Strategy and achieve reductions in pollutant emissions and public exposure to pollution by:

improving the integration of land use and transport policy and reducing the need to travel, especially by car (London Plan Policy 3C.1);
promoting sustainable design and construction (London Plan Policy 4A.3)
promoting sustainable construction to reduce emissions from the demolition and construction of buildings (London Plan Policy 4A.22);
ensuring at the planning application stage, that air quality is taken into account along with other material considerations, and that formal air quality assessments are undertaken where appropriate, particularly in designated Air Quality Management Areas;
seeking to reduce the environmental impacts of transport activities by supporting the increased provision of cleaner transport fuels, including hydrogen, particularly with respect to the refuelling infrastructure;
working in partnership with relevant organisations, taking appropriate steps to achieve an integrated approach to air quality management and to achieve emissions reductions through improved energy efficiency and energy use (London Plan Policy 4A.7).

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Unitary Development Plan (UDP)
The current Unitary Development Plan sets out the following policies relevant to this study:

SP13
The Council will seek to minimise the energy requirements of new developments and will expect the use of renewable energy technologies and sustainable materials.

EP1 Control of Potentially Polluting Uses
Development that may be liable to cause or be affected by pollution of water, air or soil, or pollution through noise, dust, vibration, light, heat or radiation will only be permitted if:

the health, safety and amenity of users of the site or surrounding land are not put at risk; and the quality and enjoyment of the environment would not be damaged or put at risk.

The Council will impose conditions, or seek a planning obligation, to implement this policy.

The Core Strategy
A key document within the LDF is the Core Strategy which sets out the Councils vision for future development throughout the borough and identifies suitable locations for new development such as industrial, commercial, and residential. Whilst drawing together the new portfolio of documents the council will still make reference to the existing plans and policies as set out in the UDP.

Interim Policy Guidance: Standards and Requirements for Improving Local Air Quality
This document provides detailed advice on how the Council will consider, and how developers should deal with, planning applications that could have an impact on air quality. The document is designed to help ensure consistency in the approach to dealing with air quality and planning in Croydon and help ensure that development contributes to delivering the Government’s and the Council’s air quality objectives. This Interim Policy Guidance (IPG) amplifies the requirements of policies in the Croydon Unitary Development Plan (adopted 13th July 2006), and conforms to Government policy.

Overview of Recent Air Quality Literature and Policy
The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities in England, Scotland and Wales to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the standards prescribed in the UK Air Quality Strategy[1] and the Air Quality Standards Regulations 2007[2] will not be met, the local authority is required to designate an Air Quality Management Area (AQMA). Action must then be taken at a local level to ensure that air quality in the area improves. This process is known as ‘local air quality management’.

UK Air Quality Strategy
The UK Air Quality Strategy (AQS) identifies nine ambient air pollutants that have the potential to cause harm to human health. These pollutants are associated with local air quality problems, with the exception of ozone, which is instead considered to be a regional problem. The Air Quality Regulations set standards for the seven pollutants that are associated with local air quality. These objectives aim to reduce the health impacts of the pollutants to negligible levels.

The air quality objectives and limit values currently applying to the UK can be split into two groups. Each has a different legal status and is therefore handled differently within the framework of UK air quality policy. These are:

[1] Defra; The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, 2007.
[2] Defra; The Air Quality Standards Regulations, 2007.

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UK air quality objectives set down in regulations for the purposes of local air quality management; and
EU limit values transcribed into UK legislation.
These objectives and limit values are described in full in Appendix A.

Assessment of Results

In order to determine the significance of the assessment results, reference was made to the following planning guidance and strategic documents:

the policy and technical guidance notes, LAQM.PG(09)[3] and LAQM.TG(09)[4], issued by the Government to assist local authorities in their Local Air Quality Management responsibilities;
the UK Air Quality Strategy;
Planning Policy Statement 23 (PPS 23): Planning and Pollution Control[5];
Institute of Air Quality Management, Position on the Description of Air Quality Impacts and the Assessment of their Significance[6];
Interim Policy Guidance: Standards and Requirements for Improving Local Air Quality; and
London Borough of Croydon Air Quality Review and Assessment Reports[7].

Significance Criteria for Air Quality Impacts

In line with the Council IPG guidance, the significance of the predicted air quality impacts have been assessed against the criteria recently promoted by the IAQM:

IAQM Significance Criteria

Air quality impacts of a proposed scheme may be considered to be significant if air quality objectives are predicted to be breached or if the development leads to significant impacts on air quality at sensitive receptors. According to the Institute of Air Quality Management (IAQM) there are two main aspects which need to be taken into account when describing predicted impacts. These are:

the magnitude of the change; and
the absolute concentration in relation to air quality objectives.

The first aspect is addressed in Table 1, in which impacts are assigned a magnitude according to the absolute change in pollutant concentrations, derived based upon the predicted change in pollutant concentrations relative to the specific air quality objective or limit value in question.

Table 1: Assessment of the Magnitude of Change

Magnitude of Change	Annual Mean NO_2/PM_{10}
Large	Increase / decrease >4 µg/m^3
Medium	Increase /decrease 2-4 µg/m^3
Small	Increase / decrease 0.4-2 µg/m^3
Imperceptible	Increase / decrease <0.4 µg/m^3

The magnitude of change can then be compared to the absolute concentration in relation to the relevant air quality standard in order to describe predicted air quality impacts as detailed in Table 2.

Table 2: Air Quality Impact Descriptors

[3] Defra; Local Air Quality Management, Policy Guidance LAQM.PG(09), 2009.
[4] Defra; Local Air Quality Management, Technical Guidance LAQM.TG(09), 2009.
[5] Office of the Deputy Prime Minister; Planning Policy Statement 23: Planning and Pollution Control, 2004.
[6] Institute of Air Quality Management, Position on the Description of Air Quality Impacts and the Assessment of their Significance (http://www.iaqm.co.uk/text/News/IAQM_PS_Significance_16_11_2009.pdf), November 2009.
[7] London Borough of Croydon Air Quality Review and Assessment http://www.croydon.gov.uk/environment/pollution/airpollution/review .

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Absolute Concentration in Relation to Standard	Magnitude of Impact		
	Small	Medium	Large
Above Objective/Limit Value With Scheme (>40 µg/m^3)	Slight Adverse / Beneficial	Moderate Adverse / Beneficial	Substantial Adverse / Beneficial
Just Below Objective/Limit Value With Scheme (36-40 µg/m^3)	Slight Adverse / Beneficial	Moderate Adverse / Beneficial	Moderate Adverse / Beneficial
Below Objective/Limit Value With Scheme (30-36 µg/m^3)	Negligible	Slight Adverse / Beneficial	Slight Adverse / Beneficial
Well Below Objective/Limit Value With Scheme (<30 µg/m^3)	Negligible	Negligible	Slight Adverse / Beneficial

The IAQM suggest that the following factors should be taken into account when determining the overall significance of predicted air quality impacts:

The magnitudes of the changes and the descriptions of the impacts at the receptors;
The number of people affected by increases and/or decreases in concentrations and a judgement on the overall balance;
Where new exposure is being introduced into an existing area of poor air quality, then the number of people exposed to levels above the objective or limit value will be relevant;
Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased;
Whether or not the study area exceeds an objective or limit value and this exceedence is removed or the exceedence area is reduced;
Uncertainty, including the extent to which worst-case assumptions have been made; and
The extent to which an objective or limit value is exceeded, e.g. an annual mean NO_2 of 41 µg/m^3 should attract less significance than an annual mean of 51 µg/m^3.

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Pollutants of Concern

Nitrogen Dioxide (NO_2)

Overview

The Government and the Devolved Administrations adopted two Air Quality Objectives for NO_2 to be achieved by the end of 2005. In 2010, mandatory EU air quality limit values on pollutant concentrations will apply in the UK (unless the government is successful in applying for derogation). The EU limit values for NO_2 are the same as the national objectives for 2005:

An annual mean concentration of 40 µg/m^3; and

An hourly mean concentration of 200 µg/m^3, to be exceeded no more than 18 times per year.

In practice, meeting the annual mean objective has been and is expected to be considerably more demanding than achieving the 1-hour objective. The annual mean objective of 40 µg/m^3 is currently widely exceeded at roadside sites throughout the UK, with exceedences also reported at urban background locations in major conurbations.

There is considerable year-to-year variation in the number of exceedences of the hourly objective, driven by meteorological conditions which give rise to winter episodes of poor dispersion and summer oxidant episodes. Analysis of the relationship between 1-hour and annual mean NO_2 concentrations at roadside and kerbside monitoring sites indicate that exceedences of the 1-hour objective are unlikely where the annual mean is below 60 µg/m^3. Exceptions were found to be related to a regional pollutant event in December 2007.

NO_2 and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as NO_X. All combustion processes produce NO_X emissions, largely in the form of NO, which is then converted to NO_2, mainly as a result of its reaction with ozone in the atmosphere. Therefore the ratio of NO_2 to NO is primarily dependent on the concentration of ozone and the distance from the emission source.

In addition, in recent years a trend has been noted whereby NO_2 concentrations have been increasing at certain roadside monitoring sites, despite emissions of NO_X falling. The 'direct NO_2' phenomenon is having an increasingly marked effect at many urban locations around the country and must be considered when undertaking modelling studies and in the context of future local air quality strategy.

Particulate Matter

Overview

This assessment considers the annual mean and daily mean air quality standards, as specified in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Two objectives have been adopted for PM_{10}, to be achieved by the end of 2010:

An annual mean concentration of 40 µg/m^3 (gravimetric); and
A 24-hour mean concentration of 50 µg/m^3 (gravimetric) to be exceeded no more than 35 times per year.

Particulate matter is composed of a wide range of materials arising from a variety of sources, and is typically assessed as total suspended particulates or as a mass size fraction. National and European Objectives/Limit Values apply for the PM_{10} fraction and national objectives also apply for the $PM_{2.5}$ fraction. These express particulate levels as the total mass size fraction at or below an aerodynamic diameter of 10 and 2.5 µm respectively.

Both short-term and long-term exposure to ambient levels of particulate matter are consistently associated with respiratory and cardiovascular illness and mortality as well as other ill-health effects. Particles of less than 10 µm in diameter have the greatest likelihood of reaching the thoracic region of the respiratory tract.

It is not currently possible to discern a threshold concentration below which there are no effects on the whole population's health. Recent reviews by WHO and the Committee on the Medical Effects of Air Pollutants have suggested exposure to a finer fraction of particles ($PM_{2.5}$, which typically make up around two thirds of PM_{10} emissions and concentrations) give a stronger association with the observed ill health effects, but also warn that there is evidence that the coarse fraction (between PM_{10} – $PM_{2.5}$) also has some effects on health.

Emissions of PM_{10} have decreased considerably since 1970, mainly due to the decline in coal use and the result of legislative and technical control of emissions from both road traffic and industrial sources. Industrial processes and road transport were the main sources of PM_{10} in 2005. In general diesel vehicles emit a greater mass of particulate per vehicle kilometre than petrol-engined vehicles.

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Baseline Conditions

Summary of Local Air Quality Management

The first round of the review and assessment process for the London Borough of Croydon identified exceedences of the air quality objectives for annual mean NO_2. Consequently, Croydon Council designated a network of busy roads in the centre of Croydon as an AQMA on the 2nd October 2000. The AQMA was further revised and extended to cover the whole Borough of Croydon on the 24th April 2003. The remaining six pollutants in the Government's Air Quality Strategy (benzene, 1,3 butadiene, carbon monoxide (CO), lead, particulate matter (PM_{10} and sulphur dioxide (SO_2) were found not to exceed air quality objectives.

Following a second stage of Review and Assessment, no changes were reported with continued exceedences of the objective for annual mean NO_2 highlighted; therefore the Borough's AQMA status was maintained.

An Updating and Screening Assessment (USA)[8], carried out in August 2006 as part of the third round of review and assessment, concluded that NO_2 continued to exceed the annual objective near busy roads. Similar conclusions were presented in the most recent Air Quality Action Plan & Review and Assessment progress report 2007/2008[9]. Exceedences of the annual mean NO_2 objective were determined at three of the continuous monitoring locations in the Borough. The hourly NO_2 objective was also breached at the George Street air quality monitoring station which may be attributed to construction works involving the nearby tramline. As a result, the existing AQMA for annual mean NO_2 was upheld and not re-designated to include the hourly mean NO_2 objective.

Local Air Quality Monitoring

Continuous monitoring of NO_2 is carried out at four sites across the Borough. Information about site types and locations are presented in Tables 3 and 4, alongside fully ratified monitoring results for NO_2 and PM_{10} respectively.

Table 3: Annual Average NO_2 Monitoring Results

Ref.	Monitoring Site	Type	Grid Ref	Ratified Annual Mean NO_2/µg/m^3			
				2005	2006	2007	2008
CR2	Purley Way	Roadside	531121, 164294	**45**	**48**	**46**	**45**
CR4	George Street	Roadside	532584, 165630	**58**	**54**	**59**	**49**
CR5	London Road, Norbury	Kerbside	530630, 169696	**70**	**64**	**66**	**66 (51)***
CR6	Euston Road	Suburban	531369, 166096	34	35	34	32

Note: Figures in bold indicate an exceedance of the relevant national air quality objective.
**Figures in brackets represent exceedences of the 1 hour objective.*

With the exception of CR6 Euston Road, a suburban site, annual mean concentrations of NO2 exceeded the UK annual mean NO2 objective of 40 µg/m3 between 2005 and 2008, at all sites. Concentrations of NO2 measured at CR5 London Road were the highest in all three years. The only year showing an exceedence of the hourly mean of >200ug/m3 (not to be exceeded more than 18 times a year) was 2008 at CR5, which shows 51 exceedences.

[8] Cambridge Environmental Research Consultants On Behalf of London Borough of Croydon , Updating and Screening Assessment for the London Borough of Croydon, 2006.
[9] London Borough of Croydon, Air Quality Action Plan & Review and Assessment Progress Report 2007/8.

PM10 is also measured at two sites in the Borough. The monitoring results, both annual mean and the number of days where PM10 concentrations exceeded 50 µg/m3, from 2005 to 2008, are presented in Table 4 below.

Table 4: PM_{10} Continuous Monitoring Results

Ref.	Monitoring Site	Type	Grid Ref	Annual Mean PM_{10}/µg/m^3				Number of Days PM_{10} > 50 µg/m^3			
				2005	2006	2007 c	2008	2005	2006	2007 c	2008
CR 3	Thornton Heath	Suburban	532330, 168943	24	23	22	20	3	6	7	11
CR 4	George Street	Roadside	532584, 165630	29	30	32	22	11	17	31	14

Note: Figures in bold indicate an exceedance of the relevant national air quality objective.

Continuous monitoring of PM10 indicates that the UK annual mean PM10 objective of 40 µg/m3 was achieved at both sites within the Borough during the period 2005 to 2008. The UK daily mean PM10 objective (not more than 35 days) was also achieved during this period.

Table 5: Nitrogen Dioxide Diffusion Tube Monitoring Results

Ref.	Monitoring Site	Type	Grid Ref	Annual Mean NO_2/µg/m^3		
				2006	2007	2008
CY59	Park Lane	532553, 165384	Roadside	**59**	**59**	**56**
CY98	George Street Continuous Monitoring Station (Co-located tubes)	532597, 165637	Roadside	**53**	**55**	**47**
CY58	Wellesley Road Northbound	532383, 165957	Roadside	**76**	**76**	**74**

Note: Figures in bold indicate an exceedance of the relevant national air quality objective.

Croydon Council also operate a network of NO2 diffusion tubes at 16 sites across the Borough. The results from three of these sites are presented in Table 5. These sites have been presented as they are within the study area.

The results displayed in Table 5 show the 40 µg/m3 annual mean NO2 objective was exceeded at all locations from 2005 to 2008.

Emissions of NOx and PM10 within Croydon

Total emissions of NOx (as NO2) and PM10 for the London Borough of Croydon were obtained from the National Atmospheric Emissions Inventory (NAEI)[10] for the year 2007 (the latest year for which data are available). These data are reproduced below in Table 6.

Table 6: NO_x and PM_{10} Emissions in London Borough of Croydon (2007)

Pollutant	Emissions in LB Croydon (T/yr)
NO_x (as NO_2)	1,897
PM_{10}	125

Modelling Methodology

Scope of the Assessment

The assessment of the proposed scheme has considered a number of scenarios in terms of both local air quality impacts as well as changes in overall emissions.

Existing and future road traffic was modelled using the AAQuIRE regional dispersion model with both area and point sources modelled using BREEZE AERMOD. The assessment was undertaken for the base year 2008, and the proposed opening year 2020.

The following scenarios have been assessed:

Existing (2008). Sources include major roads, the Rolls-Royce station, emissions from commercial premises and large residential developments;

Future (2020) Do-Minimum. The same sources as the existing scenario with an assumed level of traffic growth if identified. It was assumed that new commercial development would not powered by proposed Energy Centres;

Future (2020) Do-Something 1. The same sources as the existing scenario with an assumed level of traffic growth if identified. It was assumed that new commercial development (and relevant identified existing development) would be powered by the proposed Energy Centres;

Future (2020) Do-Something 2. The same sources as the existing scenario with an assumed level of traffic growth if identified. It was assumed that heating for new commercial development (and relevant identified existing development) would be delivered via pipe by excess heat from the present operation at the Rolls Royce plant.

Air Quality Assessment Methodology

Local Air Quality Assessment – AAQuIRE

Concentrations of NO_2 and PM_{10} were predicted at locations across the study area using the AAQuIRE regional dispersion model, which was developed by AECOM and has been used widely for the past 15 years. The model uses the dispersion algorithms, CALINE4 and AERMOD, which have been independently and extensively validated. A more detailed description of the AAQuIRE dispersion model is included in Appendix B.

There are four main categories of air pollutant sources: road traffic sources; industrial sources (Part A and B processes); diffuse sources (e.g. domestic heating); and mobile sources (e.g. airports, rail and shipping).

The modelling procedure adopted calculates the NO_2 and PM_{10} annual mean concentrations at receptors covering the study area using a Cartesian grid of receptors at a height of 1.5 metres above ground level to simulate human exposure. The receptors were evenly spaced at 20 metre intervals to ensure a sufficiently high level of spatial resolution was obtained. The results produced allowed the generation of NO_2 and PM_{10} concentration contours, as shown in the Appendix F.

Local Air Quality Assessment – BREEZE AERMOD

Concentrations of NO_2 and PM_{10} emitted from the Energy Centre have been calculated using Breeze AERMOD (Version 6.1.2.4), which is a new generation air quality modelling system

[10] http://www.naei.org.uk/mapping/mapping_2007.php

supplied by Trinity Consultants. The proposed energy centre was modelled as a point source. Emissions from existing and future commercial and residential; development were modelled as area sources.

AERMOD is a state-of-the-science dispersion modelling system that simulates essential atmospheric physical processes and provides refined concentration estimates over a wide range of meteorological conditions and modelling scenarios. AERMOD includes two data pre-processors for streamlining data input:

AERMET, a meteorological pre-processor, computes boundary layer and other necessary parameters for use with AERMOD and accepts data from both on-site and off-site sources.
AERMAP is a terrain pre-processor that simplifies the computation of receptor elevations and effective height scales for numerous types of digital data formats, including USGS 1 Degree and 7.5 minute digital elevation model (DEM) files and U.K. Ordnance Survey® digital elevation data.

For the purpose of this assessment likely pollutant release heights for the modelled area sources were estimated from the known height of existing buildings. These are given in the appendix.

Background Pollutant Concentrations

A large number of small sources of air pollutants exist, which individually may not be significant, but collectively, over a large area, need to be considered in the modelling process. The emissions from these background sources were applied to the model as background concentrations. NO_X and PM_{10} background concentrations used in this study were sourced from the UK National Air Quality Information Archive[11] listed for the 1-km square centred on (530500, 166500), as shown below in Table 7. The concentrations were determined for the relevant future year according to the method outlined in LAQM.TG(09).

The UK background concentration mapping, aggregates all emissions sources over each 1km grid square, therefore it is important to disaggregate (where possible) the sources being modelled as part of the assessment, to prevent double counting. For the purpose of this assessment the following sources have been disaggregated from the background PM_{10} and NOx maps.

Roads traffic sources; and
Industrial and commercial combustion sources.

The resulting background pollutant concentration values used in the assessment is shown in Table 7.

Table 7: Background Pollutant Concentrations for Base Year and Opening Year (µg/m^3)

Pollutant	Base Year 2008	Future Year 2020
NO_2	27.5	19.0
NO_X	40.0	25.0
PM_{10}	22.7	20.6

Meteorological Data

As agreed with the Council a meteorological dataset was compiled using data from Gatwick 2005, which is considered to be representative of the study area.

The windrose for this location is shown in Appendix C along with further details about the methodology used to compile the meteorological data ready for the model.

[11] www.airquality.co.uk

Traffic Data
Traffic data were obtain from the London Atmospheric Emission Inventory (LAEI) and inputted in the form of AADT flows and HDV percentages. This data is shown in Appendix D.

Conversion of NO_x to NO_2 for Road Traffic Emissions
The proportion of NO_2 in NO_X varies greatly with location and time according to a number of factors including the amount of ozone available and the distance from the emission source.

AQEG[12] reported that urban NO_X concentrations had declined since the early 1990s as a result of decreasing road traffic emissions. Decreases in NO_2 were not as distinct, resulting in an increase in the NO_2/NO_X ratio. The magnitude of the increase was inconsistent with the increase expected solely as a consequence of reduced NO_X concentrations. The findings were supported by monitoring data from a number of locations in London and AURN data from across the UK.

The observations prompted research into the NO_2/NO_X relationship and an updated version of the relationship were published.[13]. The spreadsheet[14] provides a revised methodology for converting NO_X to NO_2 for any given year. This methodology has been used for the purpose of this assessment for all scenarios as the best representation of the NO_2/NO_X relationship for Croydon.

Assessment of Overall Emissions of NO_x and PM_{10}
Local air quality is characterised by pollutants with short term, immediate impacts, but many of these pollutants can travel longer distances, and can have impacts on a regional, national, or international scale. These impacts, which include acidification, excess nitrogen deposition and generation of tropospheric (ground level) ozone, may be felt by humans or ecosystems at considerable distance from the source of emissions.

As well as local air quality impacts therefore, consideration must be given to the potential impacts of the proposed schemes on emissions at a regional level. In order to do this total emissions of NOx and PM_{10} associated with each of the proposed schemes has been calculated and compared to the Do-Minimum scenario as well as existing emissions within the London Borough of Croydon.

Estimating the economic benefits of air quality improvements
Some air quality improvements can be valued using economic evidence to produce monetary estimates. For example, improved air quality leads to health benefits, reducing the numbers of cases of respiratory hospital admissions from high pollution episodes, and thus reduced health care costs, lost time at work, and the pain and suffering of individuals. These benefits can then be valued using economic evidence from resource savings, health valuations, productivity losses etc.

Detailed methods have been developed to quantify and value the health and environmental benefits of air pollution improvements. These methods were used in the economic analysis to inform the 2007 review of the Air Quality Strategy. Similar methods were also used by the European Commission in developing the Thematic Strategy on Air Quality, published in 2008.

The approach taken for the Air Quality Strategy review was very detailed, and used modelling together with the impact pathway approach, following an estimation of emissions, dispersion and pollution modelling, calculation of receptor exposure, quantification of impacts and valuation. However, summary values were also provided that can be used in appraisal. These are known as damage costs and present the monetary benefits of marginal air quality improvements per tonne of pollutant reduced.

Damage costs are based on values for a range of health impacts, including mortality and morbidity effects, and non-health impacts such as damage to buildings and effects on crop

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[12] Air Quality Expert Group; Nitrogen Dioxide in the United Kingdom; 2004
[13] Deriving NO_2 from NO_x for Air Quality Assessments of Roads –Updated to 2006, Air Quality Consultants.
[14] UK Air Quality Archive, NO_x from NO_2 Calculator, 2008.

yields. They also take account of both primary and secondary air pollution changes. The damage cost approach is intended for use across government in project appraisals (project cost-benefit analysis) and Regulatory Impact Assessments (policy cost-benefit analysis). It is not, however, considered a replacement for detailed modelling and analysis. The use of damage costs is only recommended for policies aiming to reduce pollution over a period of less than 20 years, as part of a filtering mechanism to narrow down a wide range of policy options into a smaller number that are then taken forward for more comprehensive assessment, or where air quality impacts are expected to be ancillary to the primary objectives or are relatively small.

IGCB damage costs are given for primary PM_{10}, SO_2 and NO_x. Multiple values are given for PM_{10}, reflecting the complexity of this pollutant. For some secondary pollutants - particulates forming from NO_x and SO_2 - one uniform value has been derived for damage costs in the UK. This reflects the fact that local issues are less important for these pollutants. These secondary pollutants form in the atmosphere over time, and so the immediate local environment is less important in determining damage costs.

Damage costs do not presently capture the effects of ozone formation. The use of a single value for ozone (i.e. for precursor emissions of NO_x and VOCs) is more uncertain than other pollutants, especially in relation to NO_x, which is strongly non-linear due to the titration effects in urban sites. However, ozone damages (when expressed in £) are small compared to secondary PM effects, and so have little effect on the results for NO_x.

Not all potential benefits of air quality have been assigned damage costs because in some cases quantification is not possible or highly uncertain, for example impacts on ecosystems. The values also only include the benefits that occur in the UK i.e. they do not include benefits from reductions in trans-boundary pollution. It should be noted that the economic benefits of air quality improvements change over time. This has been accounted for by using the damage cost calculator produced by Defra[15] which has been used in this assessment.

External costs of air pollution vary according to a range of environmental factors, including overall levels of pollution, geographic location of emission sources, height of emission source, local and regional population density, meteorology and so on. The damage cost numbers take these issues into account to a certain degree only. Although the values are potentially more relevant for central government policies than specific local analysis, they can still play a useful role in the latter.

[15] http://www.defra.gov.uk/ENVIRONMENT/airquality/panels/igcb/tools.htm

Model Results and Discussion

Model Verification

For a detailed dispersion modelling assessment such as this, it is necessary to consider and account for random errors in both the modelling and the monitoring data. The modelling results discussed in this section were verified by a consideration of the errors associated with the modelling process and the model input data.

Systematic errors in modelling results can arise from many factors, such as uncertainties in vehicle flows, speeds and the composition of the vehicle fleet. Such errors can be addressed and corrected for by making comparisons with monitoring data.

The accuracy of the future year modelling results is relative to the accuracy of the base year results, therefore greater confidence can be placed in the future year concentrations if good agreement is found for the base year.

NO_2

Concentrations modelled using the AAQuIRE model were verified against monitored data collected at the two monitoring sites given in Table 8.

Initially, the AAQuIRE model under-predicted NO_2 concentrations at the monitoring sites and with no further improvement of the model considered feasible (such as reducing vehicle speeds or using different pollutant background, etc), an adjustment factor (F), of 3.4 was calculated to adjust modelled roadside NO_x concentrations, in accordance with LAQM.TG(09).

A summary of the comparison between monitored NO_x concentrations and modelled NO_x results (adjusted and unadjusted) and calculated verification factor is shown in Table 8.

Table 8: Model Verification (NO_x)

Site	OS Grid Reference	Monitored (roads)	Modelled (Unadjusted)	Modelled (Adjusted)	Factor (NO_x)
CY59	532559, 165360	69.5	34.4	116.8	3.4
CY58	532383,165957	157.4	30.8	104.5	

PM_{10}

The option of using PM_{10} monitoring at Site CY4 (the only site in the study area) for the purpose of model verification was discounted due to unexpected local roadside concentrations which were below the mapped background for that area. Therefore in line with LAQM.TG(09) the model has been adjusted using the same adjustment factor calculated for NO_x.

Random Error of the Model

In addition to the systematic errors the model is still likely to predict concentrations slightly different to actual ambient values. This is termed random error, and must also be considered. It is possible to account for the degree of random error, according to guidance provided by the Environmental Protection UK (formerly known as the NSCA).

'Stock U Values', figures provided by Environmental Protection UK, allow the standard deviation of the model (SDM) to be calculated. The Stock U Value for NO_2 is between 0.1 and 0.2 for an annual mean (it is higher for shorter averaging periods). The SDM can be calculated according to:

$$SDM = U \times Co$$

Where Co is the air quality objective (40 µg/m^3 for the NO_2 UK annual mean objective).

Therefore:

$$SDM = 0.1 \times 40 = 4 \mu g/m^3$$

This calculation quantifies the uncertainty in the identification of areas where an exceedence of the air quality objective can be considered possible. This region, therefore, extends between 36 µg/m^3 to 44 µg/m^3 at 1 standard deviation from the objective.

The following terminology is used in conjunction with the modelling uncertainty results.

Table 9: Probability of Exceedence of Annual Mean NO_2 Objective

Probability of Exceedence	Uncertainty	Concentration Range (µg/m^3)
Very likely	> Mean + 2 SD	>48
Likely	Mean + 1 SD – Mean +2 SD	44 – 48
Probable	Mean - Mean + 1 SD	40 – 44
Possible	Mean - Mean – 1 SD	36 – 40
Unlikely	Mean - 1 SD – Mean - 2 SD	32 – 36
Very Unlikely	< Mean – 2 SD	< 32

The concentration range given in Table 9 can be directly compared to the contour plots in Appendix F.

Local Air Quality Assessment Results

The following impacts have been identified for assessment as a result of the proposed scheme:

changes in local air quality pollutants over the study area as a result of new developments coming on line in the Do-Minimum scenario; and
changes in local air quality pollutants at specific locations as a result of the proposed Energy Centres in the Do-something Scenario (1) and the increase output from the existing Rolls Royce gas turbine plant, in the Do-something Scenario (2).

Concentrations of NO_2 and PM_{10} were predicted over the entire study area and are presented as contour plots in the appendix. In order the show the relative impacts of the different scenarios the following plots are presented.

All Sources (including local traffic and existing background)

2008 baseline NO_2 and PM_{10} concentrations for all sources;
2020 Do-minimum NO_2 and PM_{10} concentrations for all sources;
2020 Do-Something (1) NO_2 and PM_{10} concentrations for all sources; and
2020 Do-Something (2) NO_2 and PM_{10} concentrations for all sources.

Point and area Sources (including all identified Cluster Areas, the Rolls Royce site and proposed Energy Centres, but not including road traffic or other background sources)

2008 baseline NO_2 and PM_{10} concentrations for cluster areas and Rolls Royce site;
2020 Do-minimum NO_2 and PM_{10} concentrations for cluster areas and Rolls Royce site;
2020 Do-Something (1) NO_2 and PM_{10} concentrations for cluster areas Energy Centres and existing Rolls Royce site;
2020 Do-Something (2) NO_2 and PM_{10} concentrations for developed use of the Rolls Royce das turbine; and
Impact plots to demonstrate the relative change between the 2020 Do-Minimum and Do Something scenarios.

Results.

Section to follow.

NO_x and PM_{10} Emissions Results

The emissions associated with each of the sources considered within this assessment have been calculated based upon the emission factor determined for each source in grammes per second (presented in the appendix) multiplied by the number of seconds in a year. The total emissions calculated for each of the scenarios considered in this assessment are described below in Table 10.

Table 10: Predicted Emissions of NO_x and PM_{10} (T/yr)

Pollutant	Scenario			
	Base 2008	DM 2020	DS 1 2020	DS 2 2020
NO_x	34.5	55.5	51.4	86.2
PM_{10}	0.31	0.61	0.44	0.44[A]

[A] In the absence of PM_{10} emission factors for the Rolls Royce Gas engine, it is assumed that PM_{10} emissions associated with this process will approximate to emissions associated with the proposed CHP plants for which emission factors are available.

Reduction in Emissions as a result of Electricity Generation

Whilst the emissions associated with the operation of the proposed CHP plants and Rolls Royce gas engine have been assessed, the equivalent reduction in emissions as a result of the electricity generated during their operation, which would otherwise have been generated regionally, also needs to be taken into account. The emission factors in Table 11 were produced for the Electricity Supply Industry based upon the assumption that 20% of energy demand in 2020 will be met using renewable sources[16].

Table 11: Electricity Supply Industry Emission Factors (g/kWh)

Pollutant	2000	2005	2010	2015	2020
NO_x	1.22	0.58	0.47	0.44	0.41

The reduction in regional emissions of NO_x as a result of the electricity generated by the proposed CHP plants or Rolls Royce gas engine has been calculated by multiplying the factor for 2020 in Table 11 above by the number of kWh of electricity predicted to be generated by the CHP plants or Rolls Royce gas engine. The results of this assessment are shown below in Table 12.

Table 12: Predicted Reduction in Regional Emissions

	2020
MWh of electricity per year from proposed schemes	154,170
Regional NO_x emissions from ESI (T)	63.2

It should be noted that PM_{10} emission factors for the electricity supply industry are not readily available and so the reduction in regional PM_{10} emissions associated with the electricity generated by the proposed schemes has not be taken into account in the figures below.

[16] http://www.dft.gov.uk/pgr/rail/researchtech/research/railemissionmodel.pdf

Results

The overall emissions associated with each scheme, once regional emissions associated with electricity generation have been taken into account, are shown below in Table 13.

Table 13: Predicted Regional Emissions of NO_x and PM_{10} (T/yr)

Pollutant	Scenario		
	DM 2020	DS 1 2020	DS 2 2020
NO_x	118.7[A]	51.4	86.2
PM_{10}	0.61[B]	0.44	0.44[C]

A Includes emissions associated with regional electricity generation equivalent to electricity generated by proposed schemes.
B Excludes emissions associated with regional electricity generation equivalent to electricity generated by proposed schemes.
C In the absence of PM_{10} emission factors for the Rolls Royce Gas engine, it is assumed that PM_{10} emissions associated with this process will approximate to emissions associated with the proposed CHP plants.

The overall impact of each scheme on emissions of NO_x and PM_{10} is summarised below in Table 14 with a negative value denoting a net reduction in emissions (T/yr) or monetary benefit (£). It should be noted that the economic benefits below have been equated over a five year appraisal period from 2020 to 2024.

Table 14: Overall Impact of Proposed Schemes on NO_x and PM_{10} Emissions

Pollutant	Scenario			
	DS 1 2020		DS 2 2020	
	T/yr	£	T/yr	£
NO_x	-67.3	-£395,781	-32.5	-£194,284
PM_{10}	-0.17[A]		-0.17[A,B]	

A Excludes emissions associated with regional electricity generation equivalent to electricity generated by proposed schemes.
B In the absence of PM_{10} emission factors for the Rolls Royce Gas engine, it is assumed that PM_{10} emissions associated with this process will approximate to emissions associated with the proposed CHP plants.

Capabilities on project:
Energy
Environment

Conclusions

Local Air Quality Assessment

Section to follow.

Total NO_x and PM_{10} Emissions

It can be seen that each of the proposed schemes are predicted to lead to a net reduction in emissions of NO_x and PM_{10}. It is assumed that this reduction reflects the greater efficiencies associated with larger and more modern power plants and the fact that it is easier and more cost effective to control emissions from larger combustion sources than for smaller, more spatially aggregated sources.

It should be noted that the reductions in emissions shown above are relatively small when compared to the emissions from Croydon in 2007 (approximately 3.5% and 1.7% for NO_x respectively and 0.1% for PM_{10}). The monetary values associated with these reductions are also relatively minor.

Overall Summary

AECOM was commissioned to undertake an air quality assessment as part of the Croydon Decentralised Energy Study.

The effect of the proposed schemes on emissions of NO_x and PM_{10} was calculated and the subsequent impact on local concentrations of NO_2 and PM_{10} predicted using dispersion modelling. The significance of predicted impacts was assessed with reference to the relative change in pollutant emissions and the predicted changes in pollutant concentrations. A summary for the overall changes and considered significance is presented in Table 16.

Table 15: Summary of Impacts

Phase	Assessment	Pollutant	Concentration/Emissions Impact	Significance of Impact
Do-Something (1)	Local Air Quality	NO_2	TBC	TBC
		PM_{10}	TBC	TBC
Do-Something (2)	Local Air Quality	NO_2	TBC	TBC
		PM_{10}	TBC	TBC
Do-Something (1)	Change in Emissions	NO_2	small reduction	TBC
		PM_{10}	small reduction	TBC
Do-Something (2)	Change in Emissions	NO_2	small reduction	TBC
		PM_{10}	small reduction	TBC