FICHTNER
Consulting Engineers Limited

Powerfuel Portland
ERF

Climate Change, Air Quality, Health and Permit

Appendix SO6 to Proof of Evidence of
Stephen Othen
Extracts from Imperial College Website

ENGINEERING CONSULTING

133

Incinerators study

Frequently asked questions

Project Background:

The use of incineration for waste disposal in the UK is increasing due to EU restrictions on the use of landfill. A number of new Municipal Waste Incinerators (MWIs) have been built and between 2003 and 2010 there were 22 operating in England, Scotland and Wales. The incineration process and emissions of modern MWIs are regulated by the Waste Incineration (England and Wales) Regulations 2002 which sets operational conditions, technical requirements, and emission limit values. However there is public concern over any possible health risks associated with modern incineration and this study has been commissioned to extend the evidence base and provide more information to the public on this subject.

This study investigating potential associations between reproductive and infant health and emissions from municipal waste incinerators (MWIs) in England, Scotland and Wales was announced in January 2012 by the Health Protection Agency, whose functions have since been transferred to Public Health England.

Aims of the study:

The study has been commissioned to extend the evidence base and to provide further information to the public about any potential reproductive and infant health risks from MWIs.

The study proposes to investigate the following questions:

Are the emissions from incinerators required to operate under the standards set by the EU Waste Incineration Directive (WID) (2000/76/EC) linked with adverse reproductive and infant health outcomes?

134

1. Is living near a municipal waste incinerator linked with adverse reproductive and infant health outcomes?
2. Both of these questions will be considered with respect to implementation of the EU Waste Incineration Directive (WID) (2000/76/EC), which came into force in 28 December 2002 for new incinerators and 28 December 2005 for existing incinerators.

Associations will be investigated between adverse reproductive and infant health outcomes and daily modelled ground level concentrations of incinerator emissions from all 22 MWIs in England, Wales and Scotland, modelled using regulatory monitoring information from the English and Scottish Environment Agencies. Linkage between HES maternity and ONS/NN4B birth records has been requested to provide birth records with gestation weeks for interpretation of some outcomes (e.g. birthweight) and to assign trimester-specific exposure estimates. Statistical analyses will look at associations with modelled exposure estimates during pregnancy and distance from an incinerator, as well as rates of outcomes before and after an incinerator opened, adjusting for relevant confounders such as deprivation. Regulatory monitoring information on incinerator emissions provided by the Environment Agency, Natural Resources Wales and Scottish Environment Protection Agency for each incinerator will be used to estimate ambient exposures to emissions from MWIs. The atmospheric dispersion model ADMS-Urban will be used.

Health Data:

This study will use health data from the Office for National Statistics, Hospital Episode Statistics database, National Community Child Health Database (NCCHD - Wales), Scottish Information Services Division and British Isles Network of Congenital Anomaly Registers. The following health outcomes will be considered:

- Preterm delivery
- Birth weight
- Small for gestational age
- Sex-ratio at birth
- Multiple births
- Congenital anomalies
- Stillbirths
- Infant deaths

The analyses will provide information on the population exposures from UK incinerator emissions and explore whether there is any epidemiological evidence of an association between living near an incinerator and adverse reproductive and infant health outcomes. Daily particulate emissions from incinerators will be used to provide a modelled estimate of exposure during the entire pregnancy and for important periods during pregnancy, such as the first three months, which is when many body organs start to develop. The modelled

135

exposure estimates for the mothers babies with these outcomes will be compared to those of mothers whose babies did not have these outcomes from the national births register held by SAHSU.

In an additional analysis, distance from an incinerator will be investigated for evidence of an association with these outcomes. A third analysis will look at rates of outcomes before and after an incinerator opened or was modified to comply with the EU Waste Incineration Directive, in comparison with rates in similar areas. Analyses will take into account the level of deprivation in the area where the mother lives, their ethnicity and other potential factors that may influence any observed association (or lack of association) between MWIs and the outcomes.

In addition to daily particulate emissions, incinerators are required to take periodic sampling (two to four times a year) of heavy metals and dioxin emissions. The potential to model these emissions will be investigated in conjunction with a separate validation study using national air pollution monitoring data to investigate whether the contribution of MWIs to air pollution exposures can be distinguished from other sources. Also, a separately funded biomonitoring study will look at exposures of mothers living near incinerators and will analyse data from questionnaire and biological samples. The validation and biomonitoring studies will help to inform interpretation of the main study findings.

Methods have been informed by discussion with an independent scientific advisory group with epidemiological and statistical expertise in this area of work and, for incinerator emissions, by discussion Defra and input from the UK regulators.

Benefits to Public:

The study was commissioned to extend the evidence base and to provide further information to the public about any potential reproductive and infant health risks from MWIs and to extend the evidence base with respect to exposures and any potential reproductive and infant health risks from MWIs. Study information will be provided on the SAHSU website for the public.

Publications:

Parkes, B; Hansell, AL; Ghosh, RE; Douglas, P; Fecht, D; Wellesley, D; Kurinczuk, J; Rankin, J; de Hoogh, K; Fuller, GW; Elliott, P; Toledano, MB Risk of congenital anomalies near municipal waste incinerators in England and Scotland: Retrospective population-based cohort study. https://www.sciencedirect.com/science/article/pii/S0160412019308104

136

Freni-Sterrantino, A; Ghosh, RE; Fecht, D; Toledano, MB; Elliott, P; Hansell, AL; Blangiardo, M. Bayesian spatial modelling for quasi-experimental designs: An interrupted time series study of the opening of Municipal Waste Incinerators in relation to infant mortality and sex ratio. Environment International. 128 (2019) 106-115. https://doi.org/10.1016/j.envint.2019.04.009

Ghosh RE, Freni Sterrantino A, Douglas P, Parkes B, Fecht D, de Hoogh K, Fuller G, Gulliver J, Font A, Smith RB, Blangiardo M, Elliott P, Toledano MB, Hansell AL. Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population based cohort and case-control study. Environment International. 2018. https://doi.org/10.1016/j.envint.2018.10.060

Douglas P, Freni-Sterrantino A, Leal Sanchez M, Ashworth DC, Ghosh RE, Fecht D, Font A, Blangiardo M, Gulliver J, Toledano MB, Elliott P, de Hoogh K, Fuller GW, Hansell AL .Estimating Particulate Exposure from Modern Municipal Waste Incinerators in Great Britain. Environ Sci Technol. 2017 Jul 5;51(13):7511-7519. http://pubs.acs.org/doi/abs/10.1021/acs.est.6b06478

Ghosh RE, Ashworth DC, Hansell AL, Garwood K, Elliott P, Toledano MB. Routinely collected English birth data sets: comparisons and recommendations for reproductive epidemiology. Arch Dis Child Fetal Neonatal Ed. 2016 Sep;101(5): F451-7. http://fn.bmj.com/content/101/5/F451.long

Font A, de Hoogh K, Leal-Sanchez M, Ashworth DC, Brown RJC, Hansell AL, Fuller GW. Using Metal Ratios to Detect Emissions from Municipal Waste Incinerators in Ambient Air Pollution Data. Atmospheric Environment. July 2015. http://www.sciencedirect.com/science/article/pii/S1352231015300753

Ashworth DC, Fuller GW, Toledano MB, Font A, Elliott P, Hansell AL, de Hoogh K. Comparative assessment of particulate air pollution exposure from municipal solid waste incinerator emissions. Journal of Environmental and Public Health. 2013 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3725787/

Ashworth DC, Elliott P, Toledano MB. Waste incineration and adverse birth and neonatal outcomes: a systematic review. Environ Int. 2014 Aug;69:120-32 http://www.sciencedirect.com/science/article/pii/S0160412014001147

Frequently asked questions:

Please see our FAQ page.

Funding:

The study is funded by Public Health England (PHE), the Scottish

137

government, the MRC-PHE Centre for Environment and Health and the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Health Impact of Environmental Hazards at King's College London and Imperial College London (HPRU-2012-10141) in partnership with Public Health England (PHE). The work of the UK Small Area Health Statistics Unit is funded by Public Health England as part of the MRC-PHE Centre for Environment and Health, funded also by the UK Medical Research Council (MR/L01341X/1). Danielle C Ashworth was funded by a MRC PhD studentship. PE is director of the MRC-PHE Centre for Environment and Health and acknowledges support from the NIHR Imperial Biomedical Research Centre. PE is associate director of Health Data Research UK-London. The funders had no role in study design, analyses, interpretation of the data, or decision to submit results.

138
Campus
London
SW7
2AZ,
UK
tel:
+44
(0)20
7589
5111

Frequently asked questions

Expand all

What was the aim of this study? +

The aim of this study was to investigate possible health effects associated with (i) Municipal Waste Incinerator (MWI) emissions of particulate matter ≤10 µm in diameter (PM10) as a proxy for municipal waste incinerator emissions more generally, and (ii) living near a municipal waste incinerator, in relation to fetal growth, stillbirth, infant mortality, congenital anomalies and other birth outcomes.

What is Municipal Waste Incineration? +

Incineration is the process of burning waste to dispose of it. An incinerator is a furnace where waste is burnt. There are many types of incinerators; this study concerns Municipal Waste Incinerators (MWIs). Municipal waste incinerators (MWIs) are used to burn residual municipal solid waste, which is waste that comes from households after recycling, reuse or composting and that would otherwise be sent to a landfill. MWIs typically operate at approximately 850°C, and are fitted with abatement technologies to reduce the concentrations of pollutants emitted from them. All UK MWIs are designed to recover energy by using the heat to generate steam to drive turbines for electricity, and some also provide heat to the local area. Emissions are tightly regulated to keep these pollutants at low level, with regular monitoring carried out and evaluated by the Environment Agency.

In the SAHSU studies, we found extremely low exposures at ground-level from MWI particulate emissions – these were 1/100 to 1/10,000 of background levels of ambient particulate air pollution. (Douglas et al 2017) . We found that metals from MWI emissions could not be detected at ground level or were detected rarely – we looked at six MWIs with air quality monitoring stations nearby measuring metals in air. We did not detect ground level metals characteristic of incineration for four of six incinerators and for the other two it was 0.2% and 0.1% of the time. Further, we were able to calculate contribution of MWI emissions to the ambient air levels of Cadmium and Chromium and these were very small (ranging from 0.001% to 0.08%) (Font et al., 2015). We were unable to directly assess dioxins and similar compounds but deposition of

particulate emissions was taken to be representative of exposure to other components of incinerator emissions. We found that the spatial spread of PM10 from MWIs is also likely to reflect the exposure patterns of other gaseous emissions (such as sulphur dioxide (SO2) and nitrogen oxides (NOx) from MWIs (see Ghosh et al., 2018, supplement C).

What is emitted from Municipal Waste Incinerators (MWIs)? +

As with any combustion process, the main pollutant emitted from MWIs is oxides of nitrogen (NOx). In addition, MWIs emit small amounts of particulate matter, sulphur dioxide (SO2), hydrogen chloride (HCl), carbon monoxide (CO), volatile organic compounds (VOCs), heavy metals and persistent organic pollutants (POPs), such as polychlorinated dibenzo-p-dioxins/furans (PCDD/Fs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Emissions from MWIs are strictly controlled by their environmental permits. This study focuses on PM10 emissions and concentrations.

Why was this study conducted? +

The use of incineration for waste disposal in the UK is increasing due to restrictions on the use of landfill. The incineration process and emissions from Municipal Waste Incinerators are tightly regulated, however there is public concern over possible health risks and this study was commissioned to extend the evidence base and provide more information to the public on this subject.

What did the study find regarding reproductive and infant health? +

The study found that living near an incinerator and being exposed to emissions from an incinerator were not associated with risk infant death or stillbirth, low birthweight, preterm delivery, multiple births (twins, triplets etc.) or the baby's sex (Ghosh et al., 2018). A further paper looked at birthweight and infant mortality before and after a new MWI opened.

For congenital anomalies, no increased risk was found in relation to exposure to emissions from MWIs (see "What is a dispersion model and can we rely on the results?"), but small increased risks of 2% for all congenital anomies combined and up to 7% for genital anomalies were observed for living near an MWI for all congenital anomalies combined, congenital heart defects and genital anomalies, specifically hypospadias. These findings in proximity to MWI might reflect residual confounding (see "What does "residual confounding" mean and what were the

limitations of the confounding factors used in the study on congenital anomalies?"), although it is not possible from these data to exclude a potential causal effect even in the absence of associations with modelled emissions.

What does "confounding" mean and how has the study taken it into account in the study on congenital anomalies?

When you are looking to see if there is any relationship between an independent variable (in this case either exposure to emissions from an MWI or proximity to an MWI) and a dependent variable (in this case congenital anomalies), you also need to consider whether there could be any other factors which could be associated with both variables and which could distort the results. For example, higher levels of deprivation are known to lead to higher numbers of congenital anomalies, and so the level of deprivation in the area an MWI is located in will be an influencing factor on the results and will need to be taken into account. Such factors are also known as "confounding factors" or "confounders", and the process of taking them into account is known as "confounding".

In plain terms, a confounding factor for the purposes of the study on congenital anomalies was any factor that could have an influence on congenital anomalies, other than the ones which the study was testing i.e. exposure to emissions and proximity to the MWI.

The confounding factors that were taken into account can be divided into those at the individual level (i.e. known for the individual mother) and the area level (i.e. known for the area in which the mother lived). Individual level confounders were maternal age and year of birth or termination. Area-level confounders were deprivation, area-level ethnicity, major road density and other sources of emissions.

What does "residual confounding" mean and what were the limitations of the confounding factors used in the study on congenital anomalies?

One of the conclusions of the study is that the "findings in proximity to MWI might reflect residual confounding". What this means is that there may be other compounding factors which were not possible to take into account (e.g. because no data exists for them or it would be too difficult or time-consuming to generate such data) but which may nevertheless have had an influence on the rate of congenital anomalies and explain the results obtained in the study.

All of the area-level confounders (see above) were best available information, but also limited in that they did not apply to individual mothers, i.e. just because a mother lives in an area with a high level of deprivation does not necessarily mean she herself is experiencing the same high level of deprivation, and vice-versa.

Road density based on the length of motorways, A-roads and B-roads also only gives an approximate indication of the relative level of transport emissions that may arise in a particular area, as they do not into account the amount of traffic that actually uses those roads, nor the density of any smaller roads in that area.

The confounding factor for other sources of emissions was also limited in that it only took into account emissions [reported above the reporting threshold] for larger industrial processes regulated by the Environment Agency, Natural Resources Wales or Scottish Environmental Protection Agency, and therefore did not capture any smaller industrial processes regulated by local authorities (or that do not require an environmental permit).

What factors might explain the results of the congenital anomalies study?

The following factors may explain the associations detected with distance:

- Emissions from waste handling including waste transportation to the MWI
- Incomplete accounting for emissions from traffic and industry in the area due to the limitations of the dataset used
- Using deprivation and ethnicity data for the area rather than for individual mothers (residual confounding)
- Ambiguity on the coding of diseases under the International Classification of Diseases system
- Inconsistent reporting of the severity of certain anomalies across registries and differences between English and Scottish datasets
- Reporting systems in place that were unlikely to provide effective surveillance of hypospadias.

Does the study show that MWIs are causing increased congenital anomalies in populations living nearby?

No. The study does not say that the small excess risks associated with congenital heart disease and genital anomalies in proximity to MWIs are caused by those MWIs, as these results may be explained by residual confounding factors i.e. other influences which it was not possible to

take into account in the study. This possible explanation is supported further by the fact that the study found no increased risk in congenital anomalies due to exposure to emissions from incinerators.

Should I be worried about living near an incinerator? +

No increased risk was observed for any of the health effects investigated in relation to exposure to the emissions from MWIs.

The small increased risk of congenital anomalies observed in proximity to MWIs may well reflect residual confounding, although it is not possible to completely exclude a possible causal effect even in the absence of associations with modelled emissions.

The findings of the study provide support for the current PHE position statement “While it is not possible to rule out adverse health effects from modern, well-regulated municipal waste incinerators with complete certainty, any potential damage to the health of those living close-by is likely to be very small, if detectable. This view is based on detailed assessments of the effects of air pollutants on health and on the fact that modern and well managed municipal waste incinerators make only a very small contribution to local concentrations of air pollutants”. (https://www.gov.uk/government/publications/municipal-waste-incinerators-emissions-impact-on-health).

How do you interpret the OR and 95%CI and what do they mean? +

The odds ratio (OR) is a measure of association between exposure and outcome, such that an odds ratio of 1.03 can be interpreted as an increase in risk of 3%. The 95% confidence interval (95%CI) is used to quantify the uncertainty in the estimates of odds ratios and is usually interpreted that we are 95% certain that the true odds ratio is with the 95%CI.

What do these distance findings mean in terms of numbers of excess cases of congenital anomalies? +

In the UK, congenital heart defects affect approximately 5.3 in 1000 births and 1.9 per 1000 males are born with hypospadias (NCARDRS, 2016). In terms of excess risk, the team estimates that the associated increase in risk for these two birth defects could be around 0.6 cases per 1,000 total births for congenital heart defects and 0.6 cases per 1,000 male births for

hypospadias within 10 km of an incinerator. The study as a whole had 1,232 cases of congenital heart disease and 407 cases of hypospadias.

How serious are these congenital anomalies and what are the national rates? +

Hypospadias and congenital heart defects typically require surgery but are rarely life-threatening. Note that we found no association with proximity to nearest MWI when specifically analysing severe congenital heart defects.

Which municipal waste incinerators were investigated in the study? +

All 22 municipal waste incinerators operating in Great Britain between 2003 and 2010 were included for the majority of the health effects considered. The sites were: Allington, Bolton, Chineham, Coventry, Crymlyn Burrows, Dudley, Dundee, Eastcroft, Edmonton, Grundon(Lakeside), Isle of Wight, Kirklees, Marchwood, Newlincs (Grimsby), Porthmellon, Portsmouth, SELCHP, Sheffield, Stockton-on-Tees, Stoke-on-Trent, Tyseley, Wolverhampton.

For the investigation into risks of congenital anomalies, only the 10 municipal waste incinerators located in areas covered by a local congenital anomaly register could be included. These were: Chineham, Dundee, Eastcroft, Isle of Wight, Marchwood, Newlincs (Grimsby), Porthmellon, Portsmouth, Sheffield, Stockton-on-Tees. Other areas did not have complete information on congenital anomaly cases.

Why only study the births to people living within 10km of an incinerator? +

The 10 km distance was chosen for consistency with screening criteria used for implementing the Habitats Regulations: incineration plants that are within 10 km of a European Site require an assessment of their impact for short-range air emissions, so this was taken as the likely range of impact on the local environment. (See Ashworth et al., 2013)

How many births occur within 10 km of an incinerator? +

Over 1 million births between 2003 and 2010 were included in the study of 22 incinerators in Great Britain. For the investigation into risks of congenital anomalies, approximately 220,000 births were included in the

study.

Are there results specific to the municipal waste incinerator nearest to me? +

The health outcome results given in the published papers were from pooled data across all the incinerators included in the study. The numbers of births around individual incinerators were not large enough to produce meaningful (i.e. statistically significant) results.

Why did we take into account the potential effects of ethnicity and deprivation in our investigations around incinerators? +

Both ethnicity and deprivation are associated with higher risks for some of the outcomes studied, independent of any potential effects from MWI exposures, so we included an adjustment for these factors in our analyses.

(References for effects of ethnicity and deprivation:

van der Zanden LFM, van Rooij I, Feitz WFJ, Franke B, Knoers N, Roeleveld N. Aetiology of hypospadias: a systematic review of genes and environment. *Human Reproduction Update* 2012; **18**(3): 260-83.

Varela M, Nohr EA, Llopis-Gonzalez A, Andersen AMN, Olsen J. Socio-occupational status and congenital anomalies. *European Journal of Public Health* 2009; **19**(2): 161-7.)

How does this study compare with other studies? +

This is the largest study to date to examine potential impacts of modern MWIs operating to current EU regulations on a range of outcomes. Other studies have used distance as a measure of exposure or modelled emissions (either particulate air pollution less than 10 microns in diameter (PM10) or another airborne pollutant) but this was the first study to look at both distance and modelled emissions. Results from most studies were consistent with ours, although two studies Candela et al. (2013) and Sontoro et al. (2016) found associations between preterm births and MWI related PM10 exposure, which we did not. Of the previous investigations of municipal waste incineration and health specifically focussed on congenital anomalies, the start dates of all studies pre-date the implementation of the Industrial Emissions Directive for existing MWIs (28 December 2005) so emissions levels are likely to have been

higher.

Five separate studies have found some increased risks with specific congenital anomaly groups, including: facial clefts (Cordier et al., 2004, ten Tusscher et al., 2000); renal and urological anomalies (Cordier et al., 2004; 2010); neural tube defects, spina bifida and lethal congenital heart defects (CHDs) (Dummer et al., 2003); and deaths due to all congenital anomalies combined (Tango et al., 2004). We did not find associations with these anomalies, but with genital deformities and congenital heart anomalies with distance, but not with emissions (see "What did the study find regarding reproductive and infant health?"). However, other studies have found no associations between MWIs and congenital anomalies for example Vinceti et al. (2008; 2009).

The study relates to health effects in 2003-2010. Is it relevant now? +

Yes, the same emissions standards are in place today as in 2003-10. Municipal waste incinerator emissions standards in Great Britain were previously set by the European Union Waste Incineration Directive (EU-WID)(2000/76/EC), which came into operation for new and existing MWIs on 28 December 2002 and 2005, respectively. Some of the older MWIs were potentially operating to different standards at the start of the study, but from end 2005 all were operating to EU-WID standards. Those same emissions standards have been subsequently incorporated in the current Industrial Emissions Directive (IED) (2010/75/EU).

Hazardous and medical wastes are handled by other types of incinerators and are not included in this study.

Why were both modelled emissions of particulate matter and distance from an MWI examined? Which is better? +

Using modelled emissions allowed us to take account of the volumes of MWI emissions (measured within the flues) and meteorological conditions (wind strength and direction etc.) to give the best scientific estimate of likely exposures from a MWI.

Even though distance is a cruder measure of exposure with greater potential for exposure misclassification, there were several reasons for also using it. Most early studies have used distance, so including this in our study allowed us to make comparisons. It also may be a proxy for non-flue (non-chimney) related exposures such as road transport to incinerators.

What is PM10? +

PM_{10} is shorthand for any particulate matter in the air that has a diameter of 10µm or less (1 µm is a millionth of a metre). Therefore PM_{10} is small in size and invisible to the naked eye. PM_{10} particulates can come from both natural (such as dust blown from open land, wildfires etc.) and human activities (such as emissions from motor vehicles, wood burning stoves, dust from construction sites, industrial sources etc.).

How are Municipal Waste Incinerators regulated? +

All MWIs must comply with Chapter IV of the European Union Industrial Emissions Directive (2010/75/EU) (EU-IED), which is enforced by the Environment Agency (EA) in England, Natural Resources Wales (NRW) in Wales, and the Scottish Environment Protection Agency (SEPA) in Scotland, through Environmental Permitting Regulations.

The EU-IED incorporated the Waste Incineration Directive (2000/76/EC) (EU-WID) that was implemented in Great Britain on the 28th of December 2002 for new incinerators. Existing incinerators had until the 28th of December 2005 to comply. The EU-WID/EU-IED Chapter IV limits Municipal Waste Incinerator (MWI) emissions to a daily average total dust limit value of 10 mg m-3 per flue, as well as providing emission limit values for a number of other pollutants.

Have particulate emissions from MWIs reduced after the EU-WID implementation? +

There was no clear change in particulate emissions overall following the adoption of EU legislation on MWIs in the UK, which may be due to facilities already meeting the EU standards at the time they were introduced. This was investigated in the papers by Douglas et al. (2017) and Freni-Sterrantino et al. (2019).

What is a dispersion model and can we rely on the results? +

We used a standard and well-validated dispersion model (ADMS) to estimate exposures at each postcode near an incinerator. The model uses a series of equations and algorithms to simulate how pollutants disperse in the atmosphere.

We did additional work to see if plumes from MWI stacks reach the ground by comparing the ratio of PM10 to NOx concentrations in a MWI stack with those found at ground-level air pollution monitoring sites

within 10 km of four MWIs (Edmonton, SELCHP, Tyseley and Wolverhampton) (Douglas et al., 2017). Ratios at the monitoring sites were usually those typically seen from traffic sources, suggesting that emissions from MWIs are diluted before reaching ground-level.

Who funded the study? +

The study is funded by Public Health England (PHE), the Scottish government, the Medical Research Council MRC-PHE Centre for Environment and Health and the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Health Impact of Environmental Hazards at King's College London and Imperial College London (HPRU-2012-10141) in partnership with Public Health England (PHE).

Who conducted this study? +

The work was conducted at the UK Small Area Health Statistics Unit, which is funded by Public Health England as part of the MRC-PHE Centre for Environment and Health, funded also by the UK Medical Research Council (under grant MR/L01341X/1).

Where did the data come from for this study? +

Births and deaths data were from the Office for National Statistics (ONS) National Mortality, Births and Stillbirth registers for England and Wales and the National Health Service (NHS) Numbers for Babies (NN4B). Welsh births data were from the National Child Community Health Dataset (NCCHD) from the NHS Wales' Informatics Service (NWIS)/ Health Solutions Wales (HSW). Scottish births and deaths were from the Information Services Division (ISD) Scotland.

Incinerator emissions data came from the Environment Agency (EA), Scottish Environment Protection Agency (SEPA), and Natural Resources Wales (NRW).

Data on industrial sites came from the Environment Agency Environmental Permitting Regulations – Industrial sites (England), Natural Resources Wales - Environmental Permitting Regulations –

Industrial sites and the Scottish Pollutant Release Inventory.

2011 Census aggregate data came from the Office for National Statistics (for England and Wales) and the National Records of Scotland (2016): UK Data Service (Edition: June 2016). Road length data came from Meridian 2014 road lengths. Ordnance Survey data © Crown copyright and

database right 2014. CACI tobacco expenditure data is © Copyright 1996-2014 CACI Limited. We attest that we have obtained appropriate permissions and paid any required fees for use of copyright-protected materials.

English data on congenital anomalies are from the British and Irish Network of Congenital Anomaly Researchers (BINOCAR) as well as individual regional congenital anomaly registers (RCARs): Congenital Anomaly Register for Oxfordshire, Berkshire and Buckinghamshire (CAROBB); East Midlands & South Yorkshire Congenital Anomaly Register (EMSYCAR); Northern Congenital Abnormality Survey (NorCAS); South West Congenital Anomaly Register (SWCAR); Wessex Antenatally Detected Anomalies Register (WANDA)

Terminations of pregnancy for fetal anomaly (TOPFA) data were from the Department of Health.

Current UK/EU Guidance

- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211852/pb13897-ep-core-guidance-130220.pdf
- https://www.gov.uk/government/publications/environmental-permitting-guidance-the-waste-incineration-directive/environmental-permitting-guidance-waste-incineration
- http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32000L0076
- http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF
- http://www.euro.who.int/__data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf
- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/334356/RCE-18_for_website_with_security.pdf

Reference list of publications referred to in FAQs

Ashworth, D. C.; Fuller, G. W.; Toledano, M. B.; Font, A.; Elliott, P.; Hansell, A. L.; de Hoogh, K. Comparative assessment of particulate air pollution exposure from municipal solid waste incinerator emissions. *J. Environ. Public Health* 2013, **2013**, 560342.

Ashworth DC, Elliott P, Toledano MB. Waste incineration and adverse birth and neonatal outcomes: a systematic review. *Environment International* 2014; **69**: 120-32.

Candela S, Ranzi A, Bonvicini L, et al. Air pollution from incinerators and reproductive outcomes: a multisite study. Epidemiology 2013;24:863–70.

Cordier S, Chevrier C, Robert-Gnansia E, Lorente C, Brula P, Hours M. Risk

of congenital anomalies in the vicinity of municipal solid waste incinerators. *Occupational and Environmental Medicine* 2004; **61**(1): 8-15.

Cordier S, Lehebel A, Amar E, et al. Maternal residence near municipal waste incinerators and the risk of urinary tract birth defects. *Occupational and Environmental Medicine*2010; **67**(7): 493-9.

Douglas P, Freni-Sterrantino A, Leal Sanchez M, *et al.* Estimating particulate exposure from modern Municipal Waste Incinerators (MWIs) in Great Britain. *Environ Sci Technol*2017;**51**:7511–9.

Dummer TJB, Dickinson HO, Parker L. Adverse pregnancy outcomes around incinerators and crematoriums in Cumbria, north-west England, 1956-93. *Journal of Epidemiology and Community Health* 2003; **57**(6): 456-61.

Font, A., de Hoogh, K., Leal-Sanchez, M., et al. Using metal ratios to detect emissions from municipal waste incinerators in ambient air pollution data. *Atmos. Environ.* 2015, **113**, 177–186.

Freni-Sterrantino, A., Ghosh, R., Fecht, D., Toledano, M.B., Elliott, P., Hansell A.H., Blangiardo, M. Bayesian spatial modelling for quasi-experimental designs: An interrupted time series study of the opening of Municipal Waste Incinerators in relation to infant mortality and sex ratio. *Environment International* 2019, **128**, 109-115.

Ghosh, R.E., Freni Sterrantino, A., Douglas, P., *et al.* Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population-based cohort and case-control study. *Environment International* 2019, **122**, 151-158

NCARDRS, 2016 – 'National Congenital Anomaly and Rare Disease Registration Service: Congenital anomaly statistics 2016 – tables'

Parkes, B., Hansell, A.H., Ghosh, R.E., et al. Risk of congenital anomalies near municipal waste incinerators in England and Scotland: retrospective population-based cohort study. *Environment International* 2019. https://doi.org/10.1016/j.envint.2019.05.039.

Ranzi, A.; Fano, V.; Erspamer, L.; Lauriola, P.; Perucci, C.; Forastiere, F. Mortality and morbidity among people living close to incinerators: a cohort study based on dispersion modeling for exposure assessment. *Environ. Environ. Health* 2011, **10** (1), 22.

Santoro M, Minichilli F, Linzalone N, et al. Adverse reproductive outcomes associated with exposure to a municipal solid waste incinerator. *Ann Ist Super Sanita* 2016;**52:**576-581.

Tango T, Fujita T, Tanihata T, et al. Risk of adverse reproductive outcomes associated with proximity to municipal solid waste incinerators with high

dioxin emission levels in Japan. *Journal of Epidemiology* 2004; **14**(3): 83-93.

ten Tusscher GW, Stam GA, Koppe JG. Open chemical combustions resulting in a local increased incidence of orofacial clefts. *Chemosphere* 2000; **40**(9-11): 1263-70.

Vinceti, M., C. Malagoli, S. Fabbi, S. Teggi, R. Rodolfi, L. Garavelli, G. Astolfi, and F. Rivieri, 2009, Risk of congenital anomalies around a municipal solid waste incinerator: a GIS-based case-control study: International Journal of Health Geographics, v. 8.

Vinceti, M., C. Malagoli, S. Teggi, S. Fabbi, C. Goldoni, G. De Girolamo, P. Ferrari, G. Astolfi, F. Rivieri, and M. Bergomi, 2008, Adverse pregnancy outcomes in a population exposed to the emissions of a municipal waste incinerator: Science of the Total Environment, v. 407, p. 116-121.

152

Lo
South
Kensington
Campus
London
SW7
2AZ,
UK
tel:
+44
(0)20
7589
5111

153

Imperial College London

Major study finds no conclusive links to health effects from waste incinerators

by Ryan O'Hare
21 June 2019

Researchers have found no link between exposure to emissions from municipal waste incinerators (MWIs) and infant deaths or reduced foetal growth.

However, they show living closer to the incinerators themselves is associated with a very small increase in the risk of some birth defects, compared to the general population.

But whether this is directly related to the incinerator or not remains unclear.

The findings come from the largest and most comprehensive analysis to date of the effects of municipal waste incinerators (MWIs) on public health in the UK.

> The findings on birth defects are inconclusive, but our study design means we cannot rule out that living closer to an incinerator in itself may slightly increase the risk of some specific defects
>
> ***– Professor Paul Elliott***
> *Imperial College London*

MWIs are used to burn waste that is not recycled, composted or sent to landfill and can include materials such as paper, plastic, wood and metal.

While MWI emissions are governed by EU regulations, public concern remains around their potential impact on public health and scientific studies to date have been inconsistent or inconclusive.

The analysis, led by a team at Imperial College London and funded by Public Health England and the Scottish Government, looked at MWIs at 22 sites across the UK between 2003 and 2010.

Researchers from the UK Small Area Health Statistics Unit (SAHSU) at Imperial first analysed concentrations of fine particles called PM10 (particulate matter measuring 10 micrometres or less in diameter) emitted from the chimneys of the incinerators as waste is burned.

Effects of small particles

Computer models generated from the data showed how these particles spread over a 10 km radius around 22 MWIs in England, Scotland and Wales.

The models show that MWIs added very little to the existing background levels of PM10 at ground level – with existing PM10 concentrations at ground level on average 100 to 10,000 times higher than levels emitted by the chimneys (Environment Science & Technology, 2017).

Using these models, the team then investigated potential links between concentrations of PM10 emitted by MWIs and any increased risk of

154
adverse birth outcomes.

In an earlier study (*Environment International*, 2018), they found that analysis of records covering more than one million births in England, Scotland and Wales revealed no evidence of a link between small particles emitted by the incinerators and adverse birth outcomes such as effects on birthweight, premature birth, infant death, or stillbirth, for children born within 10 km of MWIs in Great Britain.

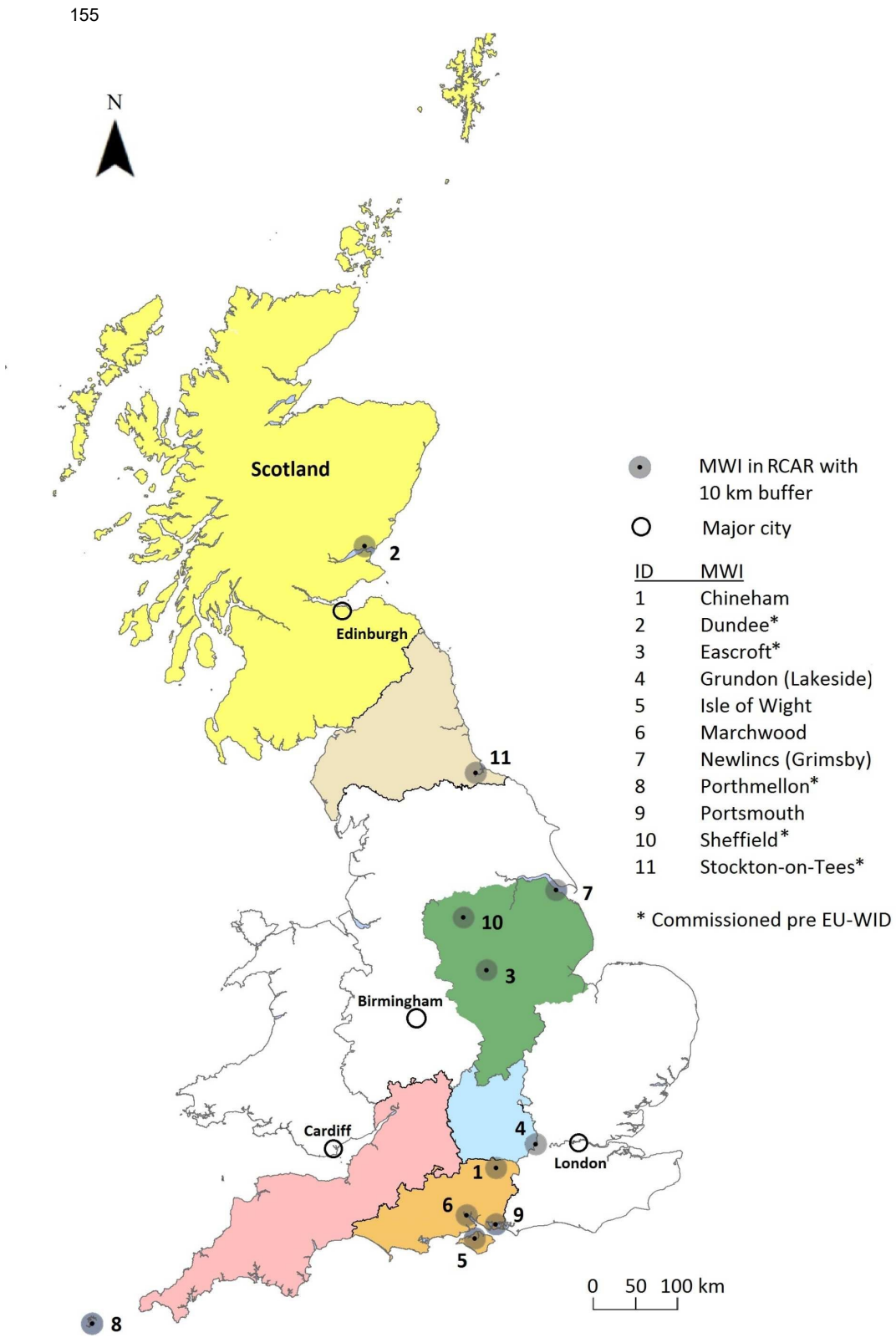
> We found a small increase in risk for children living within 10km of an MWI being born with a heart defect, or a genital anomaly affecting boys
>
> ***– Professor Mireille Toledano***
> *Imperial College London*

The team's latest findings, published in the journal *Environment International*, looked at occurrence of birth defects within 10 km of a subset of 10 incinerators in England and Scotland between 2003 and 2010.

In their analysis, the team used health data on more than 5000 cases of birth defects among over 200,000 births, still births and terminations in England and Scotland.

They found no association between birth defects and the modelled concentrations of PM10 emitted by MWIs, but there was a small increase in the risk of two birth defects among those living closer to MWIs – specifically congenital heart defects and hypospadias (affecting the male genitalia – where the opening of the urethra is not at the top of the penis). These birth defects typically require surgery but are rarely life-threatening.

In the UK, congenital heart defects affect approximately 5.3 in 1000 births and 1.9 per 1000 males are born with hypospadias (Source: NCARDRS 2016*).



The team's latest findings looked at occurrence of birth defects within 10 km of a subset of 10 incinerators in England and Scotland between 2003 and 2010. Grundon (Lakeside) was excluded due to insufficient data on birth outcomes. *(Credit: Parkes et al. 2019)*

Excess risk

In terms of excess risk, the team estimates that the associated increase in risk for these two birth defects could be around 0.6 cases per 1,000 total births for congenital heart defects and 0.6 cases per 1,000 male births for hypospadias within 10 km of an incinerator.

Professor Paul Elliott, Director of the UK Small Area Health Statistics Unit (SAHSU) said: "Based on the available data, our findings showing that there is no significant increased risk of infant death, stillbirth, preterm birth or effects on birthweight from municipal waste incinerators are reassuring.

"The findings on birth defects are inconclusive, but our study design means we cannot rule out that living closer to an incinerator in itself may slightly increase the risk of some specific defects – although the reasons for this are unclear."

Professor Mireille Toledano, Chair in Perinatal and Paediatric Environmental Epidemiology at Imperial, said: "In these studies we found a small increase in risk for children living within 10 km of an MWI being born with a heart defect, or a genital anomaly affecting boys, but did not find an association with the very low levels of particulates emitted.

156

The researchers explain they cannot rule out a link between the increased incidence of the birth defects and the activities of the MWIs, such as increased industrial road traffic or other pollutants. (*Credit: Shutterstock*)

"This increase with proximity to an incinerator may not be related directly to emissions from the MWIs. It is important to consider other potential factors such as the increased pollution from industrial traffic in the areas around MWIs or the specific population mix that lives in those areas."

Professor Anna Hansell, Director of the Centre for Environmental Health and Sustainability at the University of Leicester, who previously led the work while at Imperial College London, added: "Taken together, this large body of work reinforces the current advice from Public Health England – that while it's not possible to rule out all impacts on public health, modern and well-regulated incinerators are likely to have a very small, or even undetectable, impact on people living nearby."

> While it's not possible to rule out all impacts on public health, modern and well-regulated incinerators are likely to have a very small, or even undetectable, impact on people living nearby
>
> ***– Professor Anna Hansell***
> *University of Leicester*

The team explains that while the results of the emissions studies are reassuring, they cannot rule out a link between the increased incidence of the two birth defects and the activities of the MWIs.

They add that while they adjusted their results for socioeconomic and ethnic status, these may still influence birth outcomes findings. Poorer families may be living closer to MWIs due to lower housing or living costs in industrial areas, and their exposure to industrial road traffic or other pollutants may be increased.

The researchers highlight that their findings are limited by a number of factors. Also, they did not have measurements (for the hundreds of thousands of individual births considered) of metals or chemical compounds such as polychlorinated biphenyls (PCBs) and dioxins, but used PM10 concentrations as a proxy for exposure to MWI emissions – as has been used in other incinerator studies.

They add that ongoing review of evidence is needed to explore links further, as well as ongoing surveillance of incinerators in the UK to monitor any potential long-term impacts on public health.

The research was funded by Public Health England and the Scottish Government, with support from the Medical Research Council and the National Institute for Health Research.

-

(i) 'Risk of congenital anomalies near municipal waste incinerators in England and Scotland: retrospective population-based cohort study' by Brandon Parkes et al. is published in Environment International DOI: 10.1016/j.envint.2019.05.039

(ii) 'Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population-based cohort and case-control study' by Rebecca Ghosh et al. is published in Environment International DOI: 10.1016/j.envint.2018.10.060 https://www.sciencedirect.com/science/article/pii/S0160412018316398

(iii) 'Estimating Particulate Exposure from Modern Municipal Waste Incinerators in Great Britain' by Philippa Douglas et al. is published in Environment Science & Technology DOI: 10.1021/acs.est.6b06478 https://pubs.acs.org/doi/abs/10.1021/acs.est.6b06478

The Imperial team has also published a further four papers from their study on MWIs:

(iv) 'Bayesian spatial modelling for quasi-experimental designs: An interrupted time series study of the opening of Municipal Waste Incinerators in relation to infant mortality and sex ratio' by Anna Freni-Sterrantino et al. is published in Environment International DOI: 10.1016/j.envint.2019.04.009 https://www.sciencedirect.com/science/article/pii/S0160412018326060

157

(v) Using metal ratios to detect emissions from municipal waste incinerators in ambient air pollution data by Font et al., 2015
https://www.sciencedirect.com/science/article/pii/S1352231015300753

(vi) Waste incineration and adverse birth and neonatal outcomes: a systematic review by Ashworth et al., 2014
https://www.sciencedirect.com/science/article/pii/S0160412014001147

(vii) Comparative assessment of particulate air pollution exposure from municipal solid waste incinerator emissions by Ashworth et al., 2013
https://www.taylorfrancis.com/books/e/9781315366074/chapters/10.1201/9781315366074-13

Birth outcome data were taken from multiple sources, including the Office for National Statistics, NHS Wales' Informatics Service (NWIS)/ Health Solutions Wales (HSW), the Information Services Division (ISD) Scotland, Department of Health, and the British and Irish Network of Congenital Anomaly Researchers (BINOCAR) and constituent regional congenital anomaly registers.

*NCARDRS 2016 – 'National Congenital Anomaly and Rare Disease Registration Service: Congenital anomaly statistics 2016 – tables'
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/749734
/Congenital_anomaly_statistics_2016_data_tables.pdf

The 10 incinerators in the births defects study were: Chineham, Hampshire; Dundee, Scotland; Eastcroft, Nottinghamshire; Isle of Wight; Marchwood, Hampshire; Grimsby, Lincolnshire; Porthmellon, Scilly Isles; Portsmouth, Hampshire; Sheffield, South Yorkshire; Stockton-on-Tees, County Durham.

Supporters

Public Health England

Reporter

Ryan O'Hare
Communications and Public Affairs
CONTACT DETAILS

TAGS: Global-challenges-Health-and-wellbeing, Strategy-collaboration, Pollution, Public-health, School-of-Public-Health, Child-health, 4IR
See more tags

FICHTNER
Consulting Engineers Limited

Powerfuel Portland ERF

Climate Change, Air Quality, Health and Permit

Appendix SO7 to Proof of Evidence of Stephen Othen Odour Mitigation Measures

ENGINEERING CONSULTING

FICHTNER
Consulting Engineers Limited

Powerfuel Portland Limited

Portland ERF

Odour Mitigation Strategy

1 Introduction

The Environmental Permit (EP) application for the Portland ERF (the Facility) was submitted to the Environment Agency in December 2020. At the time that the application was submitted, the nearest odour sensitive receptor was located over 600 m from the installation boundary.

The Bibby Stockholm ("the barge) arrived at Portland Port on 17th July 2023 and is contracted to remain at the Port for 18 months. Whilst the contract end date occurs some years before the ERF would be operational, the Environment Agency has requested that the Bibby Stockholm be included as a sensitive receptor in relation to potential odour effects.

Within this note, an explanation is provided for the odour mitigation strategy and the assessment of odour impacts from the Facility, giving particular consideration to the barge.

It should be noted that the only point of '*high-sensitivity*' is the barge, and not the wider areas of the Port.

2 Odour Strategy

The most significant risk of off-site odour impacts associated with the Facility is from the handling and storage of waste prior to processing. Details of the measures proposed to be incorporated into the design of the Facility to minimise odour impacts are contained in section 2.4.3 of the Supporting Information documentation submitted with the EP application. However, these have also been extracted below:

> *Odour will be controlled and contained within the waste reception area by maintaining these areas at a negative pressure. Air from the waste reception areas (bale storage area and waste storage bunker) will be extracted to be used as combustion air within the waste incineration plant.*
> *During normal operation of the Facility, daily inspections will be undertaken to monitor for odour and will include the following:*
>
> - *waste reception area;*
> - *external boundary;*
> - *monitoring the position of louvres; and*
> - *monitoring combustion air flow, with odorous air extracted via the boiler and the stack.*
>
> *During periods of shutdown the frequency of the above inspections would be extended, including monitoring combustion air flow if the Induced Draft fan operation can be maintained, for instance during periods of maintenance. In addition, during shutdown, a daily 'sniff test' and inspection around the boundary of the Facility would be conducted.*

In addition to the above, it is also worthwhile noting, and as explained in more detail within this note that:

1. Incoming waste will be stored within a dedicated waste reception and storage area.
2. The waste reception and storage area and all incoming waste handling activities will be undertaken within a fully enclosed building.
3. Under normal operation, potentially odorous air from waste storage areas will be combusted as 'combustion air' within the waste incineration process.

Overall, the above is considered to represent BAT for the abatement of odour.

3 Odour mitigation measures

The following odour mitigation measures have been allowed for within the design and operation of the Facility:

- Incoming waste
  - The Facility will process a mix of baled and loose waste/RDF. The baled waste will be wrapped which will contain potential odours.
  - During normal operation, the waste reception area, waste bunker and the volume above the waste bunker will be maintained under slight negative pressure to reduce any emissions of odour, dust or litter, with fast acting shutter doors to the entrance/exit of the waste reception area to be kept closed when no waste deliveries are occurring.
- To reduce or prevent impacts from odour emissions from door openings and building structure:
  - The waste reception area, waste bunker and the volume above the waste bunker will be maintained under slight negative pressure to reduce any emissions of odour, dust or litter, with fast acting shutter doors to the entrance/exit of the waste reception area to be kept closed when no waste deliveries are occurring.
  - Access to the waste reception hall is located on the northern elevation and is located nearly 500m from the barge.
- To prevent or reduce odour emissions from the process during normal operation:
  - During normal operation, negative pressure will be maintained by drawing the combustion air from above the waste bunker, so that odours and airborne dust are drawn from the bunker into the combustion process (thus preventing their escape to atmosphere). Waste feed hoppers will be designed to ensure that emissions of dust and odour are minimised. By ensuring that the hopper dimensions exceed those of the grab, the potential for stray items of waste accumulating on the floor, and for dust and waste to be blown from the hoppers, will be minimised.
  - Bunker management procedures (mixing and periodic emptying and cleaning) will be developed and implemented to avoid the development of anaerobic conditions in the waste storage bunker, which could generate odorous emissions.
  - The Industrial Emissions Directive (IED) requires that any combustion gases passing through a waste incineration plant must experience a temperature of 850°C or more for at least two seconds. Due to the high temperature experienced by the flue gases, almost all odorous chemicals would be destroyed. Any surviving volatile odorous chemicals would be absorbed by the powdered activated carbon in the flue gas treatment system and captured on the bag filters.
- To prevent or reduce odour emissions from the process during periods of shutdown:

  - In the event of a shutdown, which might result in waste being held in the waste bunker for a period of time, the doors to the waste bunker will be kept shut. If necessary fresh waste will be used to cap older waste to minimise odours.
  - The quantities of fuel within the bunker will be run down prior to periods of planned maintenance, until there is minimal waste retained within the bunker. In addition, during short periods of unplanned maintenance, the doors to the building will be closed to prevent the escape of odour.
  - Should an extended period of unplanned shutdown occur, there will be facilities in place for waste to be back-loaded from the bunker if required for transport off-site to suitable waste treatment facilities. An open truck will be positioned on the designated backloading area. The operator in the control room will then use the crane grab to fill the tipper on the truck via the proposed backloading hopper.
  - During periods when the Facility is offline, where practicable, negative pressure will be maintained by using the ID fan to draw air from above the waste bunker into the boiler and release from the stack to aid dispersion of potential pollutants.
- With regard to the residues generated by the process:
  - Incinerator bottom ash (IBA) will have reached in excess of 500°C during combustion, and that it will have a Loss on Ignition (LOI) of less than 5% or a Total Organic Carbon of less than 3%, as required by the IED. Therefore, no organic or putrescible solid material would be present within the IBA. Therefore, there will not be any discernible odours from the handling, storage and transport of IBA.
  - Air Pollution Control residues (APCr) will be stored in a silo. APCr will consist of:
    - fly ash which will have reached a temperature of 850°C or higher during combustion within the boiler; and
    - the flue gas treatment chemicals (lime or activated carbon) dosed within the FGT system.

    Therefore, no organic or putrescible solid material will be present within the APCr. Consequently, odours will not be generated from the handling, storage and transport of APCr.

4 Risk Assessment

An assessment of odour risk was provided within the Environmental Risk Assessment submitted in support of the EP application. This has been revised to take into consideration the proximity of the barge to the Facility (refer to Table 1).

As set out in the risk assessment, releases of odour from the Facility will not have a significant impact on the barge, or any other sensitive receptors within the Port of Portland.

Table 1 - Assessment of odour risk from the Portland ERF

What Do You Do That Can Harm and What Could Be Harmed?			Managing The Risk	Assessing The Risk		
Hazard	**Receptor**	**Pathway**	**Risk Management**	**Possibility of Exposure**	**Consequence**	**What is the Overall Risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains? The balance and probability and consequence.**
Odorous emissions may occur during the delivery of waste, reception of waste and the storage and handling of waste prior to processing	Immediate area. The nearest receptor (the barge) to the installation is located approximately 300 m to the west of the installation boundary.	Air- Easterly winds only occur for 6% of the time.	All wastes received at the Facility will be unloaded inside the enclosed waste reception area. Wastes will be processed on a first-in, first-out principle. The reception hall will be retained at negative pressure. Potentially odorous air within waste reception area will be combusted within the ERF.	Minimal.	Odour annoyance will have more impact in the summer, when temperatures are higher and people are outdoors and more likely to be exposed to odour.	Not significant if managed well.
The escape of odorous emissions from the building during periods of planned shutdown	Immediate area. The nearest receptor (the barge) to the installation is located approximately 300 m to the west of the installation boundary.	Air- Easterly winds only occur for 6% of the time.	During periods of planned shutdown, waste stored within the waste reception area will be minimised. Where practicable, odorous air from the waste reception area will be released to atmosphere via the stack.	Minimal	Odour annoyance, which will more impact in the summer, when temperatures are higher and people are outdoors and more likely to be exposed to odour.	Not significant due to the management systems in place.

What Do You Do That Can Harm and What Could Be Harmed?			Managing The Risk	Assessing The Risk		
Hazard	**Receptor**	**Pathway**	**Risk Management**	**Possibility of Exposure**	**Consequence**	**What is the Overall Risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains? The balance and probability and consequence.**
			Sniff tests will be undertaken around the perimeter of the installation boundary and any additional locations requested by the Port.			
The escape of odorous emissions from the building during periods of unplanned shutdown	Immediate area. The nearest receptor (the barge) to the installation is located approximately 300 m to the west of the installation boundary.	Air- Easterly winds only occur for 6% of the time.	During periods of unplanned shutdown, the doors to the waste reception area will be kept closed to prevent the escape of odour. Where practicable, odorous air from the waste reception area will be released to atmosphere via the stack. Sniff tests will be undertaken around the perimeter of the installation boundary and any additional locations requested by the Port.	Highly unlikely for a period of unplanned shutdown to coincide with winds from an easterly direction	Odour annoyance, which will more impact in the summer, when temperatures are higher and people are outdoors and more likely to be exposed to odour.	Not significant due to the mitigation measures in place.

What Do You Do That Can Harm and What Could Be Harmed?			Managing The Risk	Assessing The Risk		
Hazard	**Receptor**	**Pathway**	**Risk Management**	**Possibility of Exposure**	**Consequence**	**What is the Overall Risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains? The balance and probability and consequence.**
An extended period of unplanned shutdown	Immediate area. The nearest receptor (the barge) to the installation is located approximately 300 m to the west of the installation boundary.	Air- Easterly winds only occur for 6% of the time.	During periods of unplanned shutdown, the doors to the waste reception area will be kept closed to prevent the escape of odour. Sniff tests will be undertaken around the perimeter of the installation boundary and any additional locations requested by the Port. During an extended unplanned shutdown, if required, waste will be backloaded from the bunker for transfer off-site to a suitably licenced waste management facility.	Minimal	Odour annoyance, which will more impact in the summer, when temperatures are higher and people are outdoors and more likely to be exposed to odour.	Not significant due to the management systems in place.

5 Conclusions

As set out within this note, the Facility has been designed to mitigate the impact of odour on the Port of Portland, including the barge.

As explained within this note, the design of the Facility includes a number of mitigation measures to mitigate odour impacts within the Port during periods of normal operation and shutdown. As set out in the environmental risk assessment, the mitigation measures are not expected to result in significant odour impacts on sensitive receptors, including the barge.

Powerfuel understands that an Odour Management Plan is not a mandatory requirement for waste incineration plants, such as the Facility. In the event that it is identified that the operation of the Facility gives rise to unacceptable odour impacts to any areas of the Port, not just the barge, Powerfuel is committed to developing and implementing an Odour Management Plan to identify additional measures to further mitigate odour impacts.

We trust that the information contained within this note addresses the concerns raised regarding potential odour impacts from the ERF on the Bibby Stockholm.

Yours sincerely

FICHTNER Consulting Engineers Limited

James Sturman
Lead Consultant

Stephen Othen
Technical Director

FICHTNER
Consulting Engineers Limited

Powerfuel Portland
ERF

Climate Change, Air Quality, Health and Permit

Appendix SO8 to Proof of Evidence of
Stephen Othen
Note on Waste Types

ENGINEERING CONSULTING

FICHTNER
Consulting Engineers Limited

Powerfuel Portland Limited

Portland ERF

Consideration of the form of residual waste to be treated

1 Introduction

This note relates to the Portland Energy Recovery Facility (ERF). Its purpose is to explain why there are no planning, environmental or technical / operational consequences arising from the ERF treating non-Refuse Derived Fuel (RDF) residual waste alongside RDF formed from residual waste.

Regardless of whether the waste input would be RDF or non-RDF residual waste, it would be non-hazardous, mixed residual waste comprising Local Authority Collected Waste (LACW) and similar wastes from commercial and industrial (C&I) sources (i.e. municipal waste).

In particular, this note has considered the treatment of RDF and non-RDF residual waste in the context of the following aspects of the planning application/EIA:

1. The design constraints of the combustion process;
2. Waste Net Calorific Value (NCV);
3. The overall physical design constraints of the Facility;
4. The assumptions associated with the traffic movements to deliver fuel and transfer raw materials to and residues from the Facility;
5. The air dispersion modelling and air quality impacts;
6. The carbon assessment; and
7. The type and composition of the waste.

2 Design Considerations

2.1 Type and composition of the waste

Typically waste is not a homogenous fuel, and it has a varying chemical composition. Therefore, waste incineration plants, such as the Facility, are designed to maintain operation whilst processing a range of waste types which have a varying NCV.

Residual municipal waste is classified using the European Waste Catalogue (EWC)[1] code of 20 03 01: Mixed Municipal Waste. Fichtner understands that all of the operational waste incineration facilities in England are permitted to process this EWC code, as well, amongst other combustible non-hazardous wastes, the EWC code for RDF – '19 12 10: Combustible waste (refuse derived fuel)'

Refuse Derived Fuel (RDF) is typically derived from LACW Waste and C&I waste sources. It should conform to a specification in a contract between the supplier and end user which should include its

[1] Also referred to as the List of Waste (LoW) codes.

CV and moisture content. There are no requirements as what those should be. In order to conform, nearly all RDF is subject to a form of treatment. The treatment can be either minimal or more intensive and could take place in a transfer station (inside or outside of a building) or a waste treatment facility. It can include, for example, shredding, metal extraction, removal of bulky materials and non-combustible items, or biological treatment of the waste to reduce moisture content.

Whilst the treatment of the waste will result in a 'processed fuel', the chemical composition of the waste will not have changed. Therefore, residual LACW and C&I waste will have a very similar chemical composition to RDF.

Taking the above into consideration, the Facility is designed to allow for the processing of residual municipal waste as well as RDF formed from residual waste.

2.2 Waste NCV

Powerfuel's market analysis indicates that at the point in time the ERF would be commissioned, the likely NCV range of the target wastes will be circa 9.5 MJ/kg to 11.5MJ/kg. The lower end value is broadly reflective of unprocessed residual municipal waste, the upper value of a well processed RDF.

Incoming waste will be mixed in the bunker and would create a blended residual waste of a CV falling between the above values. The market area produces high quantities of RDF and thus the likely blended NCV is likely to be towards the higher value. Accordingly, Powerfuel has planned for a design NCV of 11 MJ/kg with a minimum NCV of 9.95 MJ/kg. Hence the ERF has been designed such that it can receive unprocessed residual municipal waste as well as RDF formed from residual waste.

2.3 Combustion process

The combustion process has been designed with a thermal capacity of 69.7 MWth and will be able to process waste with a range of NCV's. Due to the range of NCV wastes that the Facility is able to combust it can process between 22.8 tph (11 MJ/kg) and 25.3 tph (9.95 MJ/kg).

The nominal design capacity of the combustion process is approximately 22.8 tonnes per hour of waste with an NCV of 11 MJ/kg – this is equivalent to approximately 550 tonnes of waste per day. The Facility has an expected availability of approximately 8,000 hours per annum. On this basis, the Facility will process approximately 183,000 tonnes per annum. In the event that the waste received at the Facility has a lower NCV than the nominal design capacity, then the annual capacity of the Facility would increase. At the lower end of the NCV range (9.95 MJ/kg), the annual throughput could be up to 202,000 tonnes per annum.

Finally, the flue gas treatment systems have been designed to process a varying waste composition, which includes for LACW and C&I waste. Therefore, the designs of the flue gas treatment systems will not change to allow the Facility to process LACW and C&I waste.

Taking the above into consideration, the combustion process is designed for the processing of residual municipal waste as well as RDF formed from residual waste and if the plant were to treat high quantities of non-RDF residual waste, with an overall waste CV of 9.95 MJ/kg, the throughput would not exceed 202,000 tpa.

2.4 The overall physical design constraints of the Facility

As explained within para 2.50 of Chapter 2 of the EIA, the Facility has been designed to receive RDF in the form of both wrapped bales and loose waste. Loose waste will be delivered directly into a 'pit', which will provide short term storage prior to it being transferred to the waste bunker via a crane grab. Therefore, the Facility already allows for the delivery of loose waste, such as the unprocessed LACW and C&I waste.

The capacity of the waste bunker is 2,700 tonnes[2], which is equivalent to up to 5 days waste processing on the basis of an NCV of 11 MJ/kg (or 4.5 days waste processing on the basis of an NCV of 9.95 MJ/kg).

Taking the above into consideration, the overall physical design constraints of the Facility allow for the processing of non- RDF residual waste as well as RDF formed from residual waste.

Taking the above into consideration, the overall design of the Facility allows for the processing of residual municipal waste as well as RDF formed from residual waste.

2.5 Traffic assumptions

As stated in para 6.4 of the Traffic Assessment (Technical Appendix L, Part 1) of the EIA, the calculation underpinning the assessment *'are based upon 202,000tpa RDF delivered by road*'.

As explained in para 2.70 of Chapter 2, the payload of waste delivery vehicles is assumed to be 24 tonnes per vehicle, and the payload of the waste delivery vehicles will be the same when delivering residual municipal waste as well as RDF formed from residual waste.

Taking the above into consideration, the assumptions underlying the traffic assessment allow for the processing of residual municipal waste as well as RDF formed from residual waste.

2.6 Air dispersion modelling

The inputs for the air dispersion modelling have been calculated based on the assumption that the Facility will operate continuously (i.e. 8,760 hours per annum) at the thermal capacity, refer to section 2.1.

The thermal capacity of the boiler will not change when combusting residual LACW and C&I waste; therefore, the inputs to the modelling will be the same and the results from the modelling will not change.

Taking the above into consideration, the assumptions within the air dispersion modelling allow for the processing of residual municipal waste as well as RDF formed from residual waste.

2.7 Carbon assessment

As explained in section 2.1, the chemical composition of LACW and C&I waste is the same as RDF.

The carbon assessment has assumed two design cases - an NCV of 9.95 and 11 MJ/kg – both of these are within the design constraints of the combustion process, refer to section 2.3.

Therefore, the conclusions of the carbon assessment will remain valid when processing LACW and C&I waste.

[2] This is stated in the EP application.

Taking the above into consideration, the assumptions within the carbon assessment allows for the processing of residual municipal waste as well as RDF formed from residual waste.

3 Conclusion

As set out within this note, the Facility has been designed to process a range of waste types, including residual waste from LACW and C&I waste.

As demonstrated within this note, the overall design constraints of the Facility considered within the EIA/planning application include for the processing of residual municipal waste as well as RDF formed from residual waste.

In conclusion, were the ERF to treat 'unprocessed' residual waste as well as RDF formed from residual waste, there are no planning, environmental or technical / operational consequences; and all of the assessment work carried out in support of the planning application remains robust.

FICHTNER
Consulting Engineers Limited

Powerfuel Portland
ERF

Climate Change, Air Quality, Health and Permit

Appendix SO9 to Proof of Evidence of
Stephen Othen
Extracts from Government Response to CCC Progress Report 2023

ENGINEERING CONSULTING

HM Government

Responding to the Climate Change Committee's (CCC) 2023 Annual Progress Report to Parliament

October 2023

HC 1919

HM Government

Responding to the Climate Change Committee's (CCC) 2023 Annual Progress Report to Parliament

Presented to Parliament pursuant to Section 37 of the Climate Change Act (2008)

Ordered by the House of Commons to be printed 26 October 2023

HC 1919

This publication is available at www.gov.uk/official-documents

Any enquiries regarding this publication should be sent to us at NZhub@beis.gov.uk

ISBN 978-1-5286-4525-6

E03009808 10/23

Printed on paper containing 40% recycled fibre content minimum.

Printed in the UK by HH Global on behalf of the Controller of His Majesty’s Stationery Office

Contents

Responding to the Climate Change Committee's (CCC) 2023 Annual Progress Report to Parliament

Foreword

Our mission is to achieve energy security for this country, powering Britain from Britain, by replacing imported fossil fuels with green renewables and nuclear energy. This will not only help us reach net zero by 2050; it will also underpin our resilience and prosperity as a nation.

We are seeing increasing evidence of how greenhouse gas emissions are changing the global climate. Record-breaking temperatures and wildfires have become the norm in many parts of the world and terrible floods in Libya recently have killed thousands. Global energy markets have also become more volatile after Putin's weaponisation of energy pushed up electricity bills for millions of families.

That is why the UK has established itself as a global leader on tackling climate change. We have overdelivered on every target to cut emissions so far and decarbonised faster than any other major economy. Make no mistake, this Government is committed to seizing the opportunity of a greener future for our green and pleasant land and is confident in meeting our future emissions targets.

We are phasing out coal and powering ahead on renewable energy.

Coal's share of our electricity generation has already declined significantly in recent years – from almost 40% in 2012 to around 2% in 2022. In line with our net zero target, we are phasing out unabated coal-fired power generation by 2024 and all remaining coal fired power stations in Great Britain are scheduled to close before this date.

In quarter one of 2023, 48% of our power came from renewables, up from just 7% in 2010. The UK has built the world's five largest operational offshore wind farms, partly thanks to the funding provided by our world-leading Contracts for Difference scheme. The most recent funding round secured 3.7GW of new low carbon energy from onshore wind, solar, tidal and geothermal sources, with the next round to be held in 2024 and future rounds annually thereafter.

This Government's investments are not only bolstering our energy security for the future, they are also boosting our economy now. Since 2010, the UK has seen £198 billion of investment into low carbon energy, through a mixture of government funding, private investment and levies on consumer bills, and our global leadership is expected

to attract at least a further £100 billion in private investment by 2030. In 2021, there were nearly a quarter of a million people working directly in low carbon businesses across the country, generating a turnover of more than £50 billion – and creating further jobs and growth in supply chains. We will continue to seize the opportunities of net zero to benefit people across the UK. For example, in Teesside SeAH Wind are investing over £400 million to build a new factory, producing steel monopile foundations for offshore wind turbines, creating up to 800 jobs by 2030.

We are reversing the neglect and short-termism of previous governments with our revival of nuclear power. This Government is ensuring the UK is at the forefront of global leadership when it comes to nuclear innovation. £700 million has already been announced to help make the UK a global hub for nuclear fusion, the same reaction that fuels our sun. I recently announced the six companies that have been shortlisted to build the first small modular reactors, which could transform how nuclear power stations are built and result in billions of pounds of investment in the UK. We are continuing to back the existing site at Hinkley Point C, which will provide reliable energy at an affordable cost, powering nearly six million homes for around 60 years and in August, we announced £341 million of investment for Sizewell C, building on the government's existing £870 million stake and helping to ensure we secure the future of the nuclear industry in this country.

This Government also recognises that some industries are harder to decarbonise than others and that not addressing this problem risks cheap, high-polluting imports from abroad undermining products produced here in the UK. That is why the UK emissions trading scheme, a key component of the UK's world-leading carbon pricing regime, is designed to give industries the confidence to decarbonise as efficiently as possible, whilst helping reduce emissions in line with our net zero objectives. Reducing the burden on UK industry, while helping us to achieve our net zero targets.

In light of all this progress, we have to be realistic. The UK economy has historically benefitted from cheap, abundant fossil fuels. The UK still relies on oil and gas and this will continue to be the case over the coming decades, as the CCC itself acknowledges. As the Government takes forward a pragmatic and proportionate response to the path to net zero, a key part of this will be maintaining our domestic oil and gas industry to reduce the need for costly foreign imports, which have higher emissions and leave us at the behest of foreign regimes. Oil and gas assets remain crucial to our national infrastructure, providing more than 200,000 UK jobs in 2021. The jobs and skills from the oil and gas sector will be vital to enabling the growth of new sectors such as Carbon Capture, Usage and Storage (CCUS) and hydrogen. This Government's approach to oil and gas will underpin our energy security and boost the economy.

It is our responsibility to protect the natural environment and leave a legacy of a greener future for generations to come. The Prime Minister's recent speech committed us to a common-sense approach and a more honest debate about how we get to net zero. One that does not prevent people from enjoying things like eating meat, or flying abroad on holiday and does not force the public to make costly changes to their cars or boilers at a time when cost of living pressures are so high.

Our duty is to fight global warming with sensible policies that the British people support, not by imposing extra financial costs on them. That is why we will meet our net zero targets in a pragmatic, proportionate and realistic way that eases the burdens on families.

This Government will ensure the UK maintains its global leadership on tackling climate change, from decarbonising our power system, to protecting our natural environment, to working with our international allies to combat global deforestation.

I thank the CCC for their report on the Government's progress and for their help in ensuring we can have an honest and pragmatic debate on how we get to net zero. I look forward to continuing to work with the CCC and am confident that we will meet our carbon budget targets and achieve net zero by 2050.

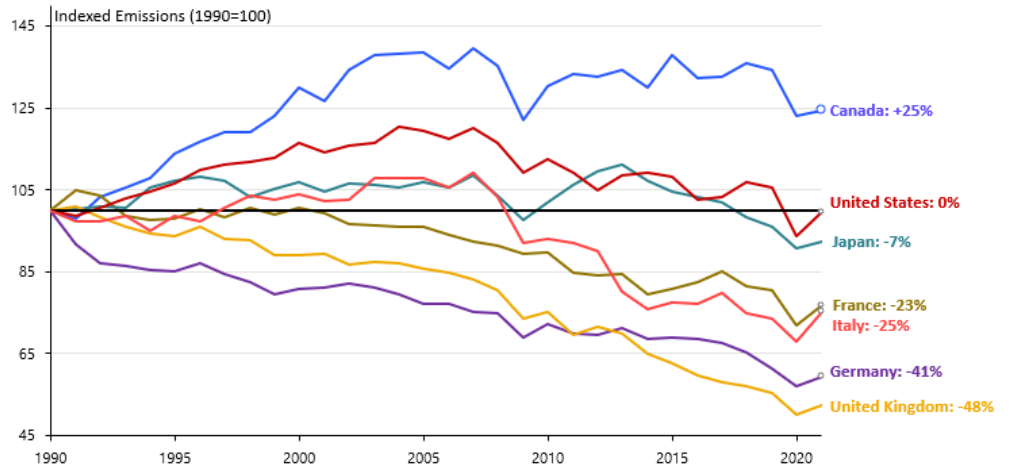
RT HON CLAIRE COUTINHO MP
Secretary of State for Energy Security & Net Zero

1. Introduction

1.1. In 2008, the Government passed the Climate Change Act, setting a target for the year 2050 for the reduction of targeted greenhouse gas emissions, providing a system of carbon budgeting and establishing the Climate Change Committee (CCC). Government values the strength of our legal frameworks and the contribution the CCC makes to the discussion on tackling climate change and reducing our greenhouse gas emissions.

1.2. We have a proud history of raising global climate ambition and leading by example. The UK has one of the most ambitious targets for emissions reductions by 2030 of any major economy and has the fastest reduction in greenhouse gas emissions of any major economy, down almost 50% since 1990 (chart 1).

1.3. **Chart 1: Greenhouse Gas emissions for the UK and major economies, 1990 – 2021**

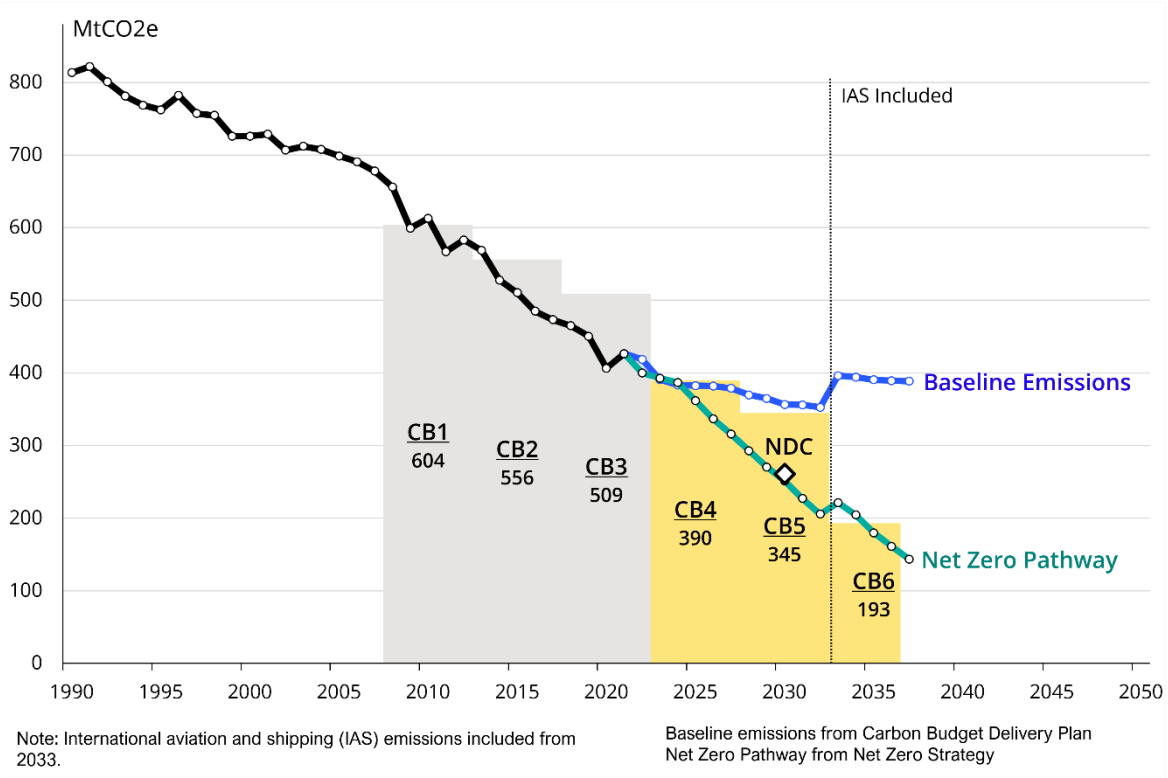


Note: GHG including land use, land-use change and forestry. Figures may differ slightly from official inventory submissions.

UNFCC reported inventory data for non-UK countries UK GHGI data (to exclude Crown Dependencies and Overseas Territories), 2023.

1.4. In March this year, we published unprecedented levels of detail on our plan to deliver energy and climate security in *Powering Up Britain*, which represents a marked shift – from target setting to getting on with delivery. We are proud that the UK has overshot all our carbon budgets to date (chart 2) and the CCC acknowledge in their report that their confidence in the UK meeting the Fourth Carbon Budget (2023-2027) has increased in the last year. The Government acknowledges the challenges of meeting future carbon budgets but is working hard to ensure delivery.

1.5. **Chart 2: Emission Levels Required to Meet our Carbon Budgets**



1.6. We are determined to safeguard our energy independence and power up Britain from Britain as we transition to a greener economy. This Government recognises that investing in low carbon technologies like wind, solar, nuclear and carbon capture – moving faster on these than many other countries – to deliver the energy security is essential for a strong growing economy.

1.7. Earlier this year, the Prime Minister signalled his intent by creating the new Department for Energy Security and Net Zero, with the ambition to enhance the UK's energy security, seize the economic opportunities of the transition, and deliver on net zero commitments.

1.8. More recently in September, the Prime Minister committed to a pragmatic, proportionate, and realistic approach to meeting net zero that eases the burdens on working people whilst maintaining commitment to our world leading, ambitious targets. He made further commitments to accelerate planning for the most nationally significant projects, speed up grid access and support leading scientists to develop green technologies.

1.9. The Department of Energy Security and Net Zero's objectives remain the same:

- **Climate security** – transforming our economy to ensure we reach net zero emissions by 2050.

- **Energy security** – protecting our energy security while setting the UK on a path to greater energy independence and delivering the system transformations necessary to meet current and future demand.
- **Consumer security** – minimising costs of the system for consumers, bringing bills down, and keeping them affordable.
- **Economic security** – seizing the opportunities of our green energy future to create new energy industries and high skilled jobs and boost growth.

1.10. We thank the CCC for their advice and challenge over the last 15 years. In response to the CCC's 2023 report, this document:
- Reiterates the Government's priorities, demonstrating the UK will continue to have one of the most ambitious targets in the G20, cutting emissions by at least 68% by 2030 on 1990 levels;
- Demonstrates the actions we will be taking this year and addresses the CCC's main areas of concern – responding to all of the CCC's recommendations;
- Demonstrates the progress we are making towards net zero against the metrics outlined in the *Net Zero Strategy*.

2. The UK as a global leader on the net zero transition

Delivering on our priorities: Climate security

2.1. Despite only currently contributing 1% of annual global emissions, the UK has been – and will remain – at the centre of global efforts to tackle climate change and transition to a global net zero economy. Between 1990 and 2021, we cut our emissions by 48%, decarbonising faster than any other G7 country whilst growing the economy by 65% (chart 1). The *2030 Strategic Framework for International Climate and Nature Action* sets out an ambitious vision over this critical decade to keep 1.5°C alive by halving global emissions, building resilience to current and future climate impacts, and halting and reversing biodiversity loss.

2.2. Domestically, we will reach our net zero target in a way that protects energy security, supports green growth and innovation, and maximises benefits for businesses and consumers. Globally addressing the challenges of climate change will require an unprecedented level of international action and collaboration.

2.3. We remain committed to keeping 1.5 degrees within reach. We will:
- Spearhead efforts to accelerate decarbonisation in key sectors globally (e.g. power, hydrogen and steel) through the Breakthrough Agenda to reach positive tipping points for clean tech this decade;

- Remain committed to spending £11.6 billion of International Climate Finance between financial years 2021/22 and 2025/26 building on the Prime Minister's recent announcement of the UK's largest ever contribution to international climate through the $2 billion contribution to the Green Climate Fund.
- Remain committed, with other donors, to delivering on the goal to mobilise $100 billion in climate finance this year, and on the commitment to double adaptation finance by 2025. The UK will triple our funding for adaptation from £500 million in 2019 to £1.5 billion in 2025.
- Champion the need for multilateral reform of the global financial system to align with the Paris Agreement and Global Biodiversity Framework, backed up by our role as a leading global hub for green finance, a shareholder of International Financial Institutions and our international climate finance and commitment to have the world's first net zero aligned financial centre.
- Accelerate the phase out of unabated fossil fuels and scale up clean energy globally through targeted support such as Just Energy Transition Partnerships and the Powering Past Coal Alliance, utilising our expertise in wind, solar and grids.
- Champion action on protection and restoration of nature including halting and reversing forest loss by 2030 through initiatives such as the Forest and Climate Leaders Partnership and delivering on the Global Biodiversity Framework, recognising that the climate crisis and biodiversity loss are inextricably linked.
- Help scale up efforts to adapt to climate change, through championing the need to double adaptation finance, establish a clear framework for the Global Goal on Adaptation and ensuring the voices of vulnerable countries are heard.

2.4. Building on the UK's strengths, we continue to show strong leadership in the renewables revolution. Renewable energy is already starting to make up the majority share of our electricity mix, with 48% of our power coming from renewables in quarter one of this year. Solar and wind are currently the cheapest forms of power, and these technologies will continue to play an important role in our energy system. The UK is home to the world's five largest operational offshore wind farm projects.

2.5. Under the UK's COP26 presidency, 90% of the world's GDP committed to net zero, up from 30% when the UK took on the COP Presidency. More than 170 countries have now put forward new 2030 climate plans, known as Nationally Determined Contributions (NDC), amounting to around 6 gigatonnes in emissions reductions.

2.6. The UK rallied 144 partners - covering over 90% of global forests and some 14 million square miles of forests – behind the Glasgow Leaders' Declaration on Forests and Land Use (GLD).

2.7. During COP27, our focus was building on the Glasgow Climate Pact. We welcome the landmark progress made on loss and damage and the agreement to establish a fund to support those most vulnerable to the effects of climate change. We also saw progress on key work programmes launched in Glasgow as well as through our International Climate Finance commitments and our diplomatic networks.

2.8. Looking ahead to COP28, the UK Government will continue to press for urgent action and ambition to keep 1.5 alive and will seek to drive progress through initiatives such as the Breakthrough Agenda and Forest and Climate Leadership Partnership.

2.9. We welcome the progress of other countries on tackling climate change over the last 12 months. The UK remains committed to our Nationally Determined Contribution and playing a leadership role internationally on climate change prevention and building resilience to climate impacts.

Delivering on our priorities: Energy security

2.10. When Putin invaded Ukraine in February 2022, it exposed Europe's over-dependence on Russian gas and put the need for energy security into sharp focus. While Britain has little direct exposure to Russian gas, we face significant indirect impacts through our links to European gas networks and global markets.

2.11. *Powering Up Britain* set out the steps the UK Government is taking to ensure the UK is more energy independent, secure and resilient. Our net zero ambitions go hand in hand with this.

2.12. We will do this by boosting our electricity generation capacity through to the late 2030s and will make use of our domestic production from UK oil and gas as the North Sea basin declines.

2.13. We have already set out ambitious plans to decarbonise the power system by 2035, subject to security of supply. That is why we continue to drive deployment of low carbon infrastructure, for example, we aim to deliver up to 50GW offshore wind by 2050, and up to five times our current solar capacity by 2035.

2.14. Earlier this year, the Chancellor announced up to £20 billion for Carbon Capture, Usage and Storage (CCUS) at the Spring Budget 2023. We launched the £120 million Future Nuclear Enabling Fund and will announce a shortlist of applications soon. We launched Great British Nuclear to progress new nuclear. We also invested approximately £700 million to become a project shareholder in Sizewell C in November 2022, and made a further £511 million of funding

available over summer 2023 to support continued project development and prepare for the start of construction.

2.15. Our Contracts for Difference (CfD) scheme is a UK success story, having contracted more than 30GW of capacity, including 20GW of offshore wind, since 2014. The results of the most recent funding round, known as Allocation Round 5 (AR5), were announced on 8 September. Supported by an annual budget of £227 million, a record 95 renewable electricity projects across Great Britain were successful, at a combined total capacity of 3.7GW – enough to power the equivalent of 2 million homes. We saw significant numbers of onshore wind and solar projects win contracts, nearly four times as many tidal stream projects as the previous auction in 2022 and, for the first time, geothermal projects.

2.16. The UK has a world-class renewables sector, and we must ensure we are taking full advantage of our success and getting the increased supply of homegrown, clean energy to people's homes and businesses. This is why the Government commissioned the Electricity Networks Commissioner, Nick Winser, to advise on accelerating the rollout of electricity transmission infrastructure, which will be crucial to moving electricity generated from renewable sources to the places that need it.

2.17. To unleash the energy from projects waiting to be connected to the grid, which could generate over half of our future electricity needs, the Government is bringing forward comprehensive new reforms to energy infrastructure, including the UK's first ever spatial plan for infrastructure to give industry certainty and communities a say. In addition, planning for the most nationally significant projects will be sped up and there will be reforms to ensure those projects that are ready first, will connect first. The Government will be considering Nick Winser's recommendations published in August closely and will work towards achieving an energy system led by renewables, nuclear and other clean, homegrown technologies.

2.18. We continue to work on removing barriers to supercharge the rollout of low carbon and renewables projects, including streamlining the planning process and connections to the electricity network. This will help us to secure strong private investment in renewables projects creating clean, British energy.

2.19. The UK Emissions Trading Scheme (UK ETS) will also be aligned with our net zero targets starting from January 2024. This will drive climate ambition, smooth the transition while maintaining net zero consistency and support industry to invest in greener energy sources. The UK ETS Authority has also committed to consult on further ambitious design changes, such as measures to maintain its well-functioning and stable market including examining the potential merits of a supply adjustment mechanism.

2.20. Despite the declining role of oil and gas in our energy mix, there will still be a role for oil and gas in our energy system up to 2050 and beyond. Britain will still need to continue to import energy and our own production is key to our export strategy.

2.21. We will continue to work with our friends and allies in securing a flexible and resilient market for exports, and we will build relationships with strong, trusted partners and diversify our supply where we will need to import. We will build resilience into our system to ensure that any disruptions to imports are minimised so that consumers have a reliable supply of energy.

2.22. This Government will not ban new oil and gas in the North Sea. Our oil and gas sector is vital to our economy as we transition to a greener economy. It provides vital engineering skills and high-quality jobs that will be crucial and transferable as we continue the expansion of our offshore wind sector. Oil and gas assets remain crucial to our national infrastructure. In 2021, the sector provided 200,800 UK jobs, which is 22,300 more than in 2020. The jobs in this sector will be vital to enabling the growth of new sectors such as CCUS and hydrogen. The Government will continue to ensure emissions from oil and gas projects are minimised and manage the transition to low carbon forms of energy to ensure the UK's energy security.

Delivering on our priorities: Consumer security

2.23. Despite the UK having very little direct exposure to Russian gas, we have all seen the consequence of Putin's war in our bills. Economies have slowed or contracted, inflation has risen, and household energy bills have soared across much of the western world. A secure, cheap and resilient energy system is vital in reducing these pressures on consumers and businesses. We are taking steps to protect our environment and reduce our emissions, but doing it in a proportionate and pragmatic way.

2.24. As we make the transition to a secure and low carbon electricity system, affordability will remain at the heart of our thinking. Ensuring we are powered by clean, homegrown, and cheap energy is a priority.

2.25. The Government has already spent nearly £40 billion protecting households and businesses from spiralling energy bills over last winter. Additional support is already being delivered through the welfare system via Cost-of-Living payments this year. Vulnerable households will receive a larger £900 Cost-of-Living payment through the welfare system for FY 23/24, up from £650 in FY 22/23, that coincides with the reduction of government energy bills support.

2.26. As set out in the 2022 Autumn Statement, we are exploring the best approach to consumer protection from April 2024, as part of the wider retail market

reforms. Until then, the Energy Price Guarantee (EPG) remains as a safety net, which will provide support should energy prices spike again this coming winter, ensuring typical energy bills are no higher than £3,000. Going forward, the Government welcomes recent reductions to household energy bills, whilst continuing to closely monitor energy prices and keeping energy support schemes under review.

2.27. As part of the transition, we will continue to consider how these schemes evolve to support those who need them most. The Government is committed to working with Ofgem to take steps to make our retail energy markets more resilient, investable, and better for consumers.

2.28. The pathway Government will take to reach net zero will follow a market-led approach, going with the grain of consumer choice to minimise impacts on consumers. Action is being progressed to support the transition, including a new approach to gas and electricity price rebalancing, which we will provide further information on in due course. This will incentivise the move to electrification, reducing over reliance on gas and helping to protect UK energy consumers from the price shocks experienced recently. The Prime Minister also announced in his speech a 50% increase in the Boiler Upgrade Scheme which now offers £7,500 to replace gas boilers with lower emitting alternatives like heat pumps.

Delivering on our priorities: Economic security

2.29. There are huge opportunities in our green energy future to create new industries, jobs, investment and economic growth and the UK is well placed to seize them. McKinsey estimate $1 trillion of value to UK businesses over the period to 2030.

2.30. The UK has demonstrated that green and growth go hand in hand over the last decade and we are determined to build on this. We have delivered the second highest amount of recorded low carbon investment cumulatively across Europe over the last 5 years and estimate that since 2010, the UK has seen £198 billion of investment into low carbon sectors, through a mixture of government funding, private investment and levies on consumer bills. Over 2021 and 2022 alone, it is estimated that £50 billion of new investments have been made in low carbon sectors in the UK. This investment has had an impact across renewables, hydrogen, CCUS, nuclear, sustainable materials, energy storage, electrified transport and clean heat.

2.31. The UK is already home to five of the world’s largest operational offshore wind farms and we’re improving our auction process to maximise private investment, including by considering whether to introduce Non-Price Factors into the Contracts for Difference Scheme, which could further incentivise supply chain development and increase supply chain security. The Government is also investing in four new clusters to capture and store carbon

from the atmosphere which will help to decarbonise hard to abate sectors and is building new nuclear power stations for the first time in thirty years. Just recently, a significant long-term decision was taken to raise funding for Sizewell C – demonstrating Government action to both provide and secure investment in the low carbon technologies of the future.

2.32. The UK is no longer alone in recognising the economic benefits the transition will bring and we welcome increased global ambition on climate change. The US have taken decisive action through the Inflation Reduction Act and the EU has set out plans to grow green industries through its Green Deal Industrial Plan. Over the last decade, the UK has developed a tremendous record for attracting investment into green industries through a range of financing mechanisms, policy and market frameworks and targeted public investment, and we are determined to build on this. Since 2010, our public and private investment in low carbon energy sectors has been 50% higher than the US as a share of GDP, and that's why 40% of our power came from clean energy sources last year, nearly twice that of the US.

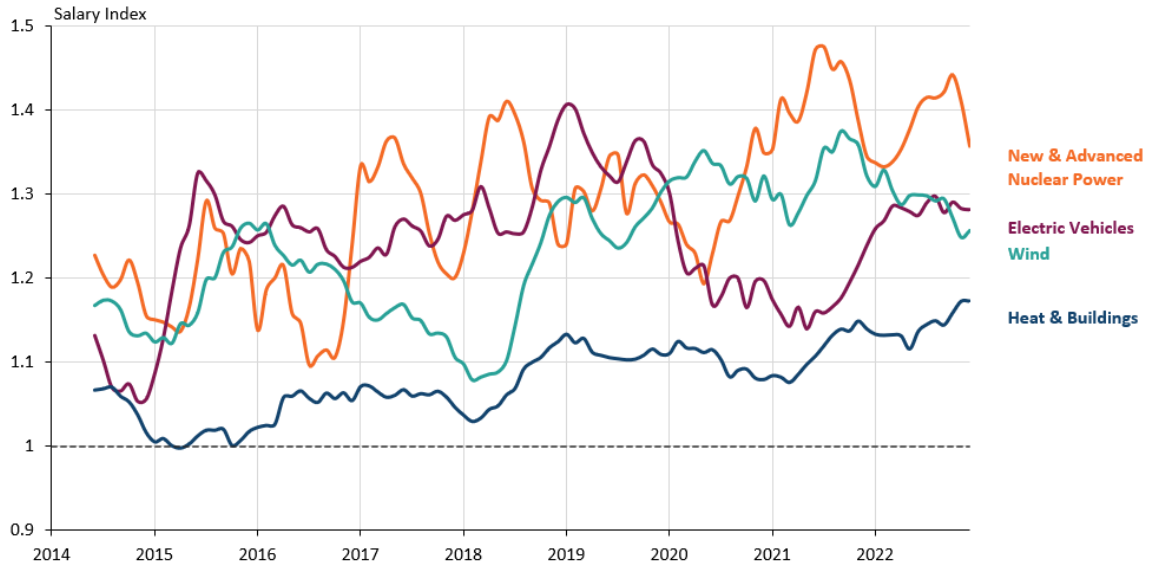
2.33. All economies will need to take decisive steps to reduce global emissions and increased investment in net zero technologies globally will unlock innovation and drive costs down, as well as creating opportunities for UK exports. As a country that currently emits less than 1% of the world's carbon emissions annually, one of the most powerful contributions the UK can make is our unique ability to develop new technologies that can help the world. The Prime Minister recently announced £150 million Green Future Fellowships that will support at least 50 leading scientists and engineers to develop real, breakthrough green technologies, building on the £4.2 billion being invested by Government in net zero research and innovation over the period from 2022-2025 and ensuring the UK maximises its existing world leading strengths in R&D to put innovation at the centre of our strategy to get to net zero.

2.34. The Government is supporting the development and growth of resilient UK supply chains and targeting public funding strategically for key industries - critical to delivering net zero and energy security. Our Floating Offshore Wind Manufacturing Investment Scheme will aim to provide up to £160 million to kick start investment in port infrastructure projects, supporting the growth of wind power manufacturing in the UK. To secure the economic opportunities of the transition to clean heat, £30 million will aim to be provided through the Heat Pump Investment Accelerator, leveraging up to £270 million of private investment into manufacturing and associated supply chains. We will continue to anchor and support the development of those supply chains critical to delivering our net zero and energy security ambitions, while promoting the rules-based international system. We have also published the Critical Minerals Strategy in July 2022, the Critical Minerals Refresh in March 2023 and the Semiconductor Strategy in May 2023.

2.35. The transition will be financed by entrepreneurs, businesses and investors that recognise the huge benefit of investing in the green economy. As we set out in the *2023 Green Finance Strategy*, private investment will provide the bulk of the financial support for the transition, removing the burden on working families by driving down costs. That is why our plans build on our strengths and provide businesses with long-term certainty through our policy and regulatory frameworks to help de-risk and drive investment into net zero sectors.

2.36. The transition to net zero also opens opportunities to create well-paid and high-skilled jobs, support levelling up and reinvigorating our industrial heartlands. It is estimated that over 80,000 green jobs are currently being supported or in the pipeline across the UK economy as a result of new government policies and spending since November 2020. North East and North West England, Yorkshire and the Humber, the Midlands, Scotland, Wales and Northern Ireland will each have unique benefits from the transition.

2.37. **Chart 3: Advertised salary index by net zero sector using Lightcast™ online job advert data, UK, 2014 to 2022. Average salary index by sector (6-monthly rolling average)**



Note: Salary index is the monthly average salary of job adverts for select net zero sectors relative to the monthly average salary for all UK online job adverts.

DESNZ's experimental analysis of Lightcast online job advertisement data, 2023.

2.38. The ONS estimate a 16% increase in direct employment in low carbon businesses across the economy from 2020 to 2021. Separately, analysis of green jobs advertisements by the Department for Energy Security and Net Zero suggests that within some parts of the green economy, jobs advertised offer higher salaries compared to the UK average.

3. Achievements and progress since March

3.1. Since *Powering Up Britain* was published in March of this year, the Government has been delivering on commitments and ensuring it meets its objectives. Since March, the Government has:

Table 1:
Achievements and progress since March

DATE	What we did
March	• **Published Powering Up Britain:** setting out how the Government will enhance our country's energy security, seize the economic opportunities of the transition, and deliver on our net zero commitments. • **Published the Research & Innovation Framework Delivery Plan**: to outline the Government's £4.2 billion investment in net zero R&D programmes for the current Spending Review period 2022-25 and how these are aligned to the priorities in the Framework. • **Published 2023 Green Finance Strategy**: setting out how the UK will maintain its leading position at the forefront of the global green finance market and provide the financing needed for our energy security, net zero and environmental targets.
April	• **Delivered more bill discounts for energy and trade intensive sectors:** Opened applications to energy and trade intensive sectors most affected by the unprecedented rise in global energy prices to claim further discounts on their bills between 1 April 2023 and 31 March 2024.
May	• **Opened applications for the £40 million biodiversity research programme**: Helping projects around the world put the power of biodiversity at the forefront of our fight against climate change and poverty. • **Convened the first Net Zero Council meeting:** Working with business, industry, investors and finance leaders to identify and secure existing and future economic opportunities for the UK and support delivery of our net zero target. • **Issued a call for evidence relating to the near elimination of biodegradable waste to landfill.** Government is committed to achieving the near elimination of biodegradable municipal waste to landfill from 2028. This call for evidence will support the exploration of policies to achieve this commitment. • **Reported progress on the £1 billion Net Zero Innovation Portfolio and £385 million Advanced Nuclear Fund for 2021:** This investment aims to accelerate the commercialisation of ten priority green technologies and has so far created nearly 4,000 jobs, spent 80% of

	funding outside of London and the South East and attracted £345 million of matched funding.
June	• **Secured funding for Fusion Energy:** Seven organisations secured contracts with the United Kingdom Atomic Energy Authority (UKAEA) to develop their innovative solutions and technologies to the 'proof of concept' stage worth £6.8 million in total. • **Received the Lowland Agricultural Peat Task Force Chair's Report:** In the Government Response we committed to taking forward action on all 14 recommendations, to ensure lowland peat soils can be managed more responsibly.
July	• **Delivered an uplift to Contracts for Difference (CfDs):** At Energy Security Week the Government announced a £22 million uplift for flagship CfD renewables scheme and announced new powers to protect UK energy supplies. • **Launched Great British Nuclear:** Supporting the UK Government's ambition to provide up to a quarter of the UK's electricity from homegrown nuclear energy by 2050 and achieve among the cheapest wholesale electricity prices in Europe, whilst supporting jobs across the country. • **Confirmed a further £170 million investment of previously allocated funding for Sizewell C:** Subject to final approvals, the project will boost UK energy security, as well as reduce dependence on volatile fossil fuel imports and deliver government priority to grow the economy. • **Published the third National Adaption Programme:** Setting out a strategic five-year plan to boost resilience and protect people, homes, businesses and our cultural heritage against climate change risks such as flooding, drought and heatwaves. • **Secured one of the largest ever investments in the UK auto industry, supporting the creation of thousands of jobs and over £4 billion in UK gigafactory investment:** Tata Group announced that it will invest over £4 billion in a new UK gigafactory which will create thousands of jobs. • **Enabling industrial electrification call for evidence launched:** Seeking evidence to understand how to enable industry to switch away from fossil fuels to electricity. • **Announced tighter limits on industrial, power and aviation emissions:** The UK Emissions Trading Scheme (UK ETS) Authority responded to the consultation it held in Spring 2022 on the development of the scheme. The response confirmed the ETS cap would be tightened to align with net zero from 2024, there would be no reductions to industry free allocations before 2026 and that free allowances for domestic aviation would be phased out in 2026, and the scheme would be expanded to cover emissions from domestic maritime and energy from waste from 2026 and 2028 respectively. • **Announced further plans for Greenhouse Gas Removals:** Confirmed that the UK Emissions Trading Scheme (UK ETS) is an appropriate long-term market for GGRs. The UK ETS may also be an appropriate market

	for high quality nature-based GGRs, subject to further work to consider permanence, costs, and wider land management impacts. • **Recycling consultation response:** Published Simpler Recycling consultation response (formerly known as Consistency in Recycling). This policy will make recycling easier and ensure there is a comprehensive, consistent service across England.
August	• **Published the Biomass Strategy:** Setting out the role sustainable biomass can play in reaching net zero, what government is doing to enable that objective, and where further action is needed. • **Published the Low Carbon Hydrogen Agreement, the contract which underpins the Hydrogen Production Business Model:** Enabling us to announce successful projects that will be awarded the first contracts for electrolytic hydrogen production in 2023, supporting our ambition of up to 10GW of low carbon hydrogen production capacity by 2030. • **Launched the revamped UK Business Climate Hub and sector roadmap framework and released Net Zero business sector roadmap guidelines:** o Relaunched the UK Business Climate Hub, providing up to date, practical and tailored advice for businesses to reduce emissions. o Published a robust, credible and consistent set of criteria that all business sector roadmaps should meet to ensure they can effectively reduce emissions. This framework will support the creation of tailored action plans for different sectors to decarbonise. • **Provided funding for peatland restoration:** Announced a further £16 million of government funding for an additional twelve peatland restoration projects as part of the Nature for Climate Peatland Grant scheme. • **Made a further £341 million of funding available to the Sizewell C project:** To continue supporting the project's development towards a Final Investment Decision this Parliament.
September	• **Increased the amount available from the Boiler Upgrade Scheme:** Increasing cash grants to replace boilers by 50% to £7,500. • **Announced $2 billion for the Green Climate Fund:** The single biggest commitment of its kind the UK has ever made. • **Announced a £160 million international climate finance package:** Targeting the acceleration of clean tech solutions in developing countries. • **Green Future Fellowship:** Announcing £150 million to support at least 50 leading scientists and engineers to develop real, breakthrough green technologies. • **Started a pre-qualification process for potential investors to invest in the Sizewell C project:** Launching the first stage of an equity raise process for the project. • **Launched the Great British Insulation Scheme:** Providing £1 billion to ensure families in lower council tax bands with less energy-efficient homes will be offered vital upgrades - such as roof, loft or cavity wall insulation - which could cut their annual energy bill by an average of between £300 to £400. This also announced a further £80 million to

	insulate thousands of social homes, saving families on average £240 each year. • **Set out the path to zero emissions vehicles by 2035:** Meaning the UK will have the most ambitious regulatory framework for the switch to electric vehicles (EVs) in the world. This requires 80% of new cars and 70% of new vans sold in Great Britain to be zero emission by 2030, increasing to 100% by 2035.
October	• **Published Simpler Recycling consultation response:** (formerly known as Consistency in Recycling). This policy will make recycling easier and ensure there is a comprehensive, consistent service across England.

4. Taking Further Action

4.1. We are taking action to continue to drive the transition. The Government is currently delivering an ambitious package to drive towards our existing carbon budgets and NDC whilst preparing to receive advice from the CCC on Carbon Budget 7.

4.2. This includes addressing the CCC's recommendations – many of which are in train. Government is partly or fully acting upon 85% of the CCC's priority recommendations and is acting on the majority of the remaining 273 recommendations - demonstrating our commitment to seizing the economic opportunities presented from the energy transition and net zero and the value of the CCC's advice. Table 2 below demonstrates the action we are taking on the CCC's recommendations across all areas of our *Net Zero Strategy*.

4.3. That being said, this Government is determined to get the consent of the public to ensure net zero is achieved. As the Prime Minister set out in his speech on 20 September, we will take a pragmatic, proportional and realistic approach to net zero. That means not taking forward CCC recommendations on policies that force families to make costly and burdensome changes to their lifestyles. For example, we are anti-aviation emissions, not flying, and want to deliver sustainable flying for everyone to enjoy holidays, visit friends and family overseas and to travel for business.

4.4. The full list of the CCC's recommendations and the Government's response can be found in Annex A at the end of this document.

#	Recommendation	Response
Priority R2023-073	Implement a whole-systems approach to address Energy from Waste (EfW) emissions, including setting out the implications of rising EfW use for waste decarbonisation and confirming plans to include EfW within the UK ETS. A moratorium on additional EfW capacity should be introduced subject to a review of capacity needs and how they align with Government emissions pathways. Further clarity is also needed on how decisions on allowing further EfW plants will be made. **Primary responsibility**: DESNZ	The Government is already undertaking several actions to reduce emissions from Energy from Waste (EfW). For example, the waste Industrial Carbon Capture (ICC) business model has been designed to incentivise the deployment of carbon capture technology in the residual waste management sector, where there is no viable alternative to achieve deep decarbonisation. Two waste carbon capture and storage (CCS) projects have been shortlisted on the Track-1 Project Negotiation List to proceed to the negotiations phase of the CCUS Cluster Sequencing Process. These projects will, subject to negotiations, demonstrate the commercial viability of CCUS in the residual waste management sector and help facilitate future deployment of the technology and decarbonisation of the sector. Furthermore, to ensure future new build EfW plants are built ready to decarbonise, we have consulted on including EfW within Decarbonisation Readiness requirements and later this year we will be publishing an addendum to the *Resources and Waste Strategy,* which will focus on net zero. The UK Emissions Trading Scheme (ETS) Authority has announced its intention to include EfW installations in the ETS from 2028, preceded by a 2-year monitoring, reporting and verification (MRV) period. The ETS sets a cap on emissions that can be released by covered sectors, and the cap will reduce in line with Net Zero targets. In line with the commitment in the *Resources and Waste Strategy* to monitor residual waste capacity, officials are currently assessing planned incinerator capacity against expected future residual waste arisings so we can understand

#	Recommendation	Response
		what future incineration capacity may be required following implementation of key commitments in the *Resources and Waste Strategy*. This further assessment of residual waste treatment capacity needs will be published in due course. Planning consent for large EfW plants (>50MW) in England & Wales is determined by the SoS in accordance with the *National Policy Statement for Renewable Energy Infrastructure*. For an application to be granted the Secretary of State should be satisfied, with reference to the relevant waste strategies and plans, that the proposed plant is in accordance with the waste hierarchy.
Priority R2023-080	Develop policies for industrial electrification that address general barriers such as investment constraints, as well as specific barriers for different industrial sub-sectors. **Primary responsibility**: DESNZ	The *Net Zero Growth Plan* reiterated the ambition to replace 50 TWh of fossil fuels per year by 2035 with low carbon alternatives, such as hydrogen, electricity and biomass. In March 2023, analysis in the *Net Zero Growth Plan* highlighted that fuel switching to electricity has the potential to reduce annual industrial emissions by between 7 and 19 MtCO2e by 2050, contributing between 15% and 40% of the (necessary) carbon abatement in industry by 2050. Currently, the Government provides support for fuel switching (including electrification) through the Industrial Energy Transformation Fund (IETF) and the Scottish IETF, which provides grants to help with the upfront costs of installing or retrofitting industrial equipment associated with electrifying industrial processes, and the Industrial Fuel Switching Competition (IFSC), which is innovation funding for electrification and enabling technologies. The Government recognises that there are several barriers to fuel switching to electricity. For example, electricity is currently