



EVIDENCE GATHERING ON POLLUTANT EMISSIONS FROM COMBUSTION PLANT WITH EMPHASIS ON MEDIUM AND SMALL PLANT

Gap Analysis

Report for: Defra

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1. INTRODUCTION

Ricardo has been commissioned by the Department for Environment, Food and Rural Affairs (Defra) to carry out a research project of evidence gathering on pollutant emissions from combustion plant, with emphasis on small and medium combustion plant (S/MCP), covering installations in England, Scotland, Wales and Northern Ireland. The project outcomes will form an evidence base for Defra’s requirement as part of the Clean Air Strategy (CAS) to consider strengthening existing regulations on medium combustion plant and bringing currently unregulated smaller plant into the scope of regulation.

The research project is divided into two main work packages (WP):

- WP1, covering combustion plant providing power, including combined heat and power (CHP), and
- WP2, covering combustion plant providing heat only.

Each work package requires:

- Quantitative analysis to improve estimates on the number of existing plant as well as information about these plant such as operating hours, fuel used and geographical locations.
- Qualitative analysis, focusing on the operational behaviour of these plant and drivers of key trends.

This report provides an initial review of the existing datasets available for the quantitative analysis stage of this project, focusing on what data are available and the constraints on the use of these data. It identifies areas where there are gaps in the available data.

Section 2 of this report provides an overview of the data which Ricardo have identified, split into WP1 and WP2, and identifies any constraints to the use of this data. Section 3 describes the gap analysis to determine the completeness of the data available and any known gaps or uncertainties in the data, while Section 4 summarises these data gaps and their potential solutions and next steps.

Table 1 shows the regulatory framework and the respective power capacity of the plants. Where relevant, the gap analysis provides detail on the type of information available for each range of power capacity:

Table 1 - regulatory framework and corresponding plant capacity range

		Part B				
Regulatory framework	Ecodesign	MCP regulations				Industrial Emissions Directive
	Specified Generator (SG) Control					Best Available Techniques
Power rating	<1MWth	1MWth	5MWth	20MWth	50MWth	>50MWth

This report was completed as part of the preliminary research required for the project and additional evidence identified following the completion of this gap analysis report has been considered in the final reports for both work packages. There may therefore be additional or excluded data sources or constraints applied to the final reports compared to this analysis.

2. SUMMARY OF EXISTING DATA

The following tables summarise the datasets included in our data collation exercise. Table 2 covers datasets for Work Package 1 (combustion plant providing power, including CHP) and Table 3 covers datasets for Work Package 2 (combustion plant providing heat). These inform the gap analysis in Section 3.

Table 2 - summary of datasets considered for WP1 (combustion plant providing power, including CHP)

Dataset	Summary	Constraints
CHP Quality Assurance programme (CHPQA)	Provides individual scheme level information on CHP prime movers (power generators) including gas turbines, reciprocating engines, micro steam turbines and organic Rankine-cycles, for approximately 1400 sites. ¹ The data includes heat capacity, electrical capacity, manufacturer name, date of installation, annual fuel consumption by fuel type, electricity, and useful heat generated, and location. Annual fuel and heat data is sometimes separate for CHP and boilers but sometimes only aggregate.	There may be restrictions on the use of this database imposed by DESNZ. Permission would need to be requested to report the results at a reasonable level of disaggregation to meet the objectives of this project. Disaggregation would enable data to be broken down based on capacity, geographical region, fuel type, industry sector and/or operating hours.
Renewable Energy Statistics database (RESTATS)	This dataset is less robust and detailed than CHPQA but covers sites with CHP which are not registered with CHPQA.	There may be restrictions on the use of this database imposed by DESNZ. Permission would need to be requested to report the results at a reasonable level of aggregation to meet the objectives of this project.
CHPSTATS	The database combines data from CHPQA, RESTATS and other sources and contains individual data for approximately 2000 CHPs. It is used to inform the Digest of UK Energy Statistics (DUKES). This data source has had some QA since the original RESTATS source data.	Publicly available dataset, no constraints on use.
Digest of UK Energy Statistics (DUKES)	Contains a chapter dedicated to CHP ² , which is based on aggregating select CHPSTATS data from CHPQA and RESTATS. The data is mostly high-level national aggregation of capacity and annual fuel consumption, and power and heat outputs in various dimensions from CHPSTATS. It might be useful for identifying trends. ³	The data is a high-level aggregation and may not be sufficiently detailed for use in this project. Mostly apportioned good quality CHP values, with non-qualifying power and fuel in the power chapter, so usefulness may be limited in places.
UK National Atmospheric Emissions Inventory (NAEI)	Robust activity and emissions data used to calculate emissions and fuel use from S/MCP, in support of official UK Government statistics and policy. ⁴	Licensing would need to be discussed with the NAEI team at Defra/DESNZ and Ricardo. There is a limitation on how the outputs can be shared (e.g., outputs should not disclose sensitive information from the input data). The licenses would also need to be approved by the ONS for employment statistics and by DESNZ for gas consumption data.
Environment Agency Bespoke Registry	Manually maintained workbook from the Environment Agency (EA) for bespoke MCP and SG permits. Contains data on CHP and SG between 1-50 MWth.	There is a data gap from September 2022 onwards. The workbook does not contain any combustion plants on Part A1, A2 or Part B process.
Environment Agency SPR Registry	The registry records plant level data for combustion plants permitted as standard rules, maintained by IT system. Contains data on CHP and SG that are <20 MWth.	Currently out of date, last updated in July 2022. Does not contain any combustion plants on Part A1, A2 or Part B processes.

¹ <https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme>

² <https://www.gov.uk/government/statistics/combined-heat-and-power-chapter-7-digest-of-united-kingdom-energy-statistics-dukes>

³ <https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes>

⁴ <https://naei.beis.gov.uk/>

Dataset	Summary	Constraints
Elexon / Balancing Mechanism reports	Provide public datasets covering Great Britain's electricity market. There is balancing and transmission data for all plants that transmit electricity to the transmission or the distribution grid. ⁵ . Actual generation can be estimated from electricity that has been committed to be delivered and any changes in the balancing market. There is also a maximum export and import limit to provide capacity data. The datasets do not include Northern Ireland as it is not connected to the GB grid and doesn't distinguish between devolved countries.	The dataset does not show very small generators that trade behind aggregators. The data is publicly available and accessed through the BM reports website.
NETA Reports	Uses Elexon data sources as well as additional sources such as APX, Spectron and LEBA. ⁶	Publicly available dataset, no constraints on use.
Landfill Gas Dataset (2019-2021)	Contains data on permit reference, operator name, facility name, facility address, landfill type description, EA area, volume of landfill gas combusted in an engine	Ricardo will need to liaise with relevant contacts at Defra to request access to this dataset for use in this project.
Environment Agency MCP/SG Installations Public Register	The EA installations public register page provides a list which can be downloaded and includes approximately 240 MCP/SG permits. This does not usually provide information on what is installed.	This register can be accessed publicly online, however, the number of permits registered on the public register is limited.
Northern Ireland, Wales and Scotland register of MCP/SG	Public register information, similar to that provided by the Environment Agency, but for NI, Wales, and Scotland. Needs to be confirmed if these datasets exist or are available.	Investigation regarding the availability of these registries needs to be made by Ricardo.
Register of permitted MCP and SG being collated by the Environment Agency	Data collated in the register of MCP and SGs is currently being assembled by the EA, including location, type of plant, fuel type, permitted hours, ELVs and other categories.	The EA has provided Ricardo with the data collated for the register of permitted MCP and SG, therefore this data can already be explored. However, information is only currently available for plant <5MWth, as not all information is available for all permits.
Greater London Authority (GLA) Study of Combustion	A study conducted by Ricardo of combustion plants in London, based on published datasets and planning databases. It included plants which may not be registered on other databases such as backup generators and smaller CHPs. However, the database is static and has not been updated for 5+ years, so it may be out of date and could refer to a planned plant that was not installed or was changed. Subject to agreement with GLA, this resource could be reviewed to give data for London and/ or extrapolated to give regional or national indications, for example, as a cross check on data obtained from other sources.	The latest available data is from 2018, therefore data may be outdated. It would be necessary to verify whether plant included in the study are operational, as it includes both planned and existing plant. The data is limited to London boroughs only.
City of London Corporation (COLC) Study of PM2.5 Source Apportionment - #1 (MCP) and #3 (CHP)	Ricardo developed a new PM _{2.5} emissions inventory for the City of London. New data were drawn together by COLC to enable a wider range of PM _{2.5} sources to be quantified, including CHP and backup generators.	Estimations were made on operating hours, power ratings were only known for few plants and an estimation of ranges were given for others, therefore, data may not be complete.

⁵ <https://www.bmreports.com/bmrs/?q=help/about-us>

⁶ <https://www.netareports.com/>

Dataset	Summary	Constraints
Capacity Market Register (and other energy market registers)	These registers may provide limited information such as the company name and generating capacity. ⁷ This data has been used within Ricardo previously, for work related to S/MCPs . There is a potential Short Term Operating Reserve (STOR) data source (from DESNZ)	There are potential confidentiality concerns, however, these could be reduced by using previous years data or higher aggregation levels.
Distribution Network Operator Data	Similarly, to the capacity market register above, this database may provide some limited information such as the company name and generating capacity. This may overlap with data from the National Grid (for example, data on who is generating electricity and supplying to the grid).	There are potential confidentiality concerns, however, these could be reduced by using previous years data or higher aggregation levels.
Emissions Trading Scheme (ETS)	Site-specific annual data on fuel use for 20MWth - 50MWth plants. There are constraints on the use of this dataset, but it is used by the NAEI so it may be able to be extended to use on this project.	It would need to be confirmed if data currently used for the NAEI can be extended to this project. Under legislation, data can be used for energy statistics and GHG inventory. All other uses are subject to EA approval. The NAEI only gets limited data from DESNZ, there is no detail beyond site-specific fuel use and associated CO ₂ emission provided to the NAEI. Details of plant numbers and technologies are held by the EA.
Impact assessment for the 2018 amendments to the Extended Producer Responsibility (EPR)	The report includes estimates of number of plant and various other categories, however, this is likely to be covered and updated in other identified sources.	Permission to use associated files would need to be requested from relevant contacts. Data covers England and Wales only
Local Authority	Each local authority keeps a public register of distributed Part B permits within their authority. These could help identify small generators (e.g. <5MWth) that are otherwise unlisted on other databases.	It would potentially be time intensive to collect this data, as it is spread across the various websites of different local authorities. However, when it has been used previously, Defra requested the information and passed it on to Ricardo.
Trade Associations such as the Confederation of British Industry (CBI) and the Combustion Engineering Association (CEA)	Relevant Trade Associations hold information on registered combustion plant operators and traders. Consultation with these associations could supply information on the types of technology which are in use and their operating patterns.	Consultation would need to be sought with each identified Trade Association. This option may be best used as validation of initial findings, rather than as a primary source of information.

⁷ <https://www.emrdeliverybody.com/CM/Registers.aspx>

Table 3 - summary of datasets considered for WP2 (combustion plant providing heat)

Dataset	Summary	Constraints
CHP Quality Assurance programme (CHPQA)	<p>As well as information on CHP plants, as discussed in Table 2, the database provides data for some boilers.</p> <p>The data includes heat capacity, electrical capacity, manufacturer name, date of installation, annual fuel consumption by fuel type, electricity, and useful heat generated, and location. Annual fuel and heat data is sometimes separate for CHP and boilers but sometimes only aggregate.</p>	There may be restrictions on the use of this database imposed by DESNZ. Permission would need to be requested to report the results at a reasonable level of disaggregation to meet the objectives of this project. Information on boilers is limited to schemes that the applicants have chosen to include within the CHPQA scheme boundary (slightly less than 585 of the 1,421 schemes operating in 2022) and in some cases this will not apply to all of the boilers on site.
RESTATS	Less robust and detailed than CHPQA but covers sites with CHP which are not registered with CHPQA, heat only combustion plant and heat-only sites using renewable fuel. This will be useful in providing additional data on the heat generating plant (WP2).	There may be restrictions on the use of this database imposed by DESNZ. Permission would need to be requested to report the results at a reasonable level of aggregation to meet the objectives of this project.
CHPSTATS	Combines data from CHPQA, RESTATS and other sources (ID of sales etc). Individual data for approx. 2000 CHPs. Used to inform DUKES. This data source has had some QA since the original RESTATS source data.	Publicly available dataset, no constraints on use.
Digest of UK Energy Statistics (DUKES)	The report contains some high-level national aggregation information on heat generation. It might primarily be useful for identifying trends.	The data is a high-level aggregation and may not be sufficiently detailed for use in this project.
UK National Atmospheric Emissions Inventory (NAEI)	Robust activity and emissions data used to calculate emissions/ fuel use from S/MCP in support of official UK Government statistics and policy.	Licensing would need to be discussed with the NAEI team at Defra/DESNZ and Ricardo. There is a limitation on how the outputs can be shared (e.g., outputs should not disclose sensitive information from the input data). The licenses would also need to be approved by the ONS for employment statistics and by DESNZ for gas consumption data.
Environment Agency Bespoke Registry	Manually maintained workbook from the EA for bespoke boilers and heating system permits.	There is a data gap from September 2022 onwards. The registry doesn't contain any combustion plants on Part A1, A2 or Part B process.
Environment Agency SPR Registry	Records plant level data for combustion plant permitted as standard rules, maintained by IT system. Contains data on boilers and heating systems <20MWth.	Currently out of date, last updated in July 2022. Doesn't contain any combustion plants on Part A1, A2 or Part B process.
Landfill Gas Dataset (2019-2021)	Contains data on permit reference, operator name, facility name, facility address, landfill type description, EA area, volume of landfill gas combusted in an engine	The dataset only applies to biogas. Ricardo will need to liaise with relevant contacts at Defra to request access to this dataset for use in this project.
EA MCP/SG Installations Public Register	EA installations public register page provides a list which can be downloaded and includes approximately 240 MCP/SG permits. This does not usually provide information on what is installed.	This register can be accessed publicly online, however, the number of permits registered on the public register is limited.
Northern Ireland, Wales and Scotland register of MCP	Public register information, similar to that provided by the Environment Agency, but for NI, Wales and Scotland. Needs to be confirmed if these datasets exist or are available.	Investigation regarding the availability of these registries needs to be made by Ricardo.

Dataset	Summary	Constraints
Register of permitted MCP being collated by the Environment Agency	Data collated in the register of MCP is currently being assembled by the EA, including location, type of plant, fuel type, permitted hours, ELVs and other categories.	The EA has provided Ricardo with the data collated for the register of permitted MCP, therefore this data can already be explored. However, information is only currently available for plant <5MWth, as not all information is available for all permits.
Greater London Authority Study of Combustion	As described in Table 2, this study also included information on centralised boilers.	The latest available data is from 2018, therefore data may be outdated. It would be necessary to verify whether all plants included in the study are still operational.
City of London Corporation Study of PM2.5 Source Apportionment - #1 (MCP) and #2 (Boilers)	Ricardo developed a new PM2.5 emissions inventory for the City of London Corporation. New data were drawn together to enable a wider range of PM2.5 sources to be quantified, including MCPs, some of which were boilers.	Estimations were made on operating hours, power ratings were only known for few plants and an estimation of ranges were given for others, therefore, data may not be complete.
Emissions Trading Scheme (ETS)	Site-specific annual data on fuel use for 20MWth - 50MWth plants. There are constraints on the use of this dataset, but it is used by the NAEI so it may be able to be extended to use on this project.	It would need to be confirmed if data currently used for the NAEI can be extended to this project. Under legislation, data can be used for energy statistics and GHG inventory. All other uses are subject to EA approval. The NAEI only gets limited data from DESNZ, there is no detail beyond site-specific fuel use and associated CO ₂ emission provided to the NAEI. Details of plant numbers and technologies are held by the EA.
Renewable Heat Incentive Data	The Renewable Heat Incentive scheme is now closed, but some information has been published, e.g. the non-domestic scheme for biomass boilers. This data has previously been used within Ricardo for work related to S/MCP commercial boilers.	Permission would be required from OFGEN to use this data.
Impact assessment for the 2018 amendments to the Extended Producer Responsibility (EPR)	The report includes estimates of number of plant and various other categories, however, this is likely to be covered and updated in other identified sources.	Permission to use associated files would need to be requested from relevant contacts. Data covers England and Wales only.
Hy4Heat Study	This study of hydrogen opportunities identified some larger boilers as candidates for conversion. It would need to be reviewed to confirm the extent of useful data. ⁸	The study focuses on the cost-effectiveness of hydrogen heating projects (cost & TRL). It only includes three case studies, which are from Europe. The only other quantifiable information is the number of homes that the projects are planned to heat, therefore there is no data on total power input/output, size or operating hours.
Local Authorities	Each local authority keeps a public register of distributed Part B permits within their authority. These could help identify small generators (e.g. <5MWth) that are otherwise unlisted on other databases.	It would potentially be time intensive to collect this data, as it is spread across the various websites of different local authorities. However, when it has been used previously, Defra requested the information and passed it on to Ricardo.
Trade Associations such as the Confederation of British Industry (CBI) and the Combustion Engineering Association (CEA)	Relevant Trade Associations hold information on registered combustion plant operators and traders. Consultation with these associations could supply information on the types of technology which are in use and their operating patterns.	Consultation would need to be sought with each identified Trade Association. This option may be best used as validation of initial findings, rather than as a primary source of information.

⁸ <https://www.hy4heat.info/>

Dataset	Summary	Constraints
Greater London Authority - Heat Map	A high-resolution heat map that covers 29 London boroughs. Contains the latest available data from the Decentralised Energy Master Planning Programme (DEMaP), with updated heat suppliers and networks, available on London Assembly website ⁹	The data for district heating networks and heat supply units (boilers, CHPs) is sourced from 2009-2012. Therefore, the data is out of date and unlikely to be relevant for use in this project.

3. GAP ANALYSIS – SUMMARY

3.1 WORK PACKAGE 1 – COMBUSTION PROVIDING POWER, INCLUDING CHP

Table 4 summarises the completeness of the types of information required to inform the study under Work Package 1. Where relevant, the most relevant complete datasets are split into granular plant sizes in accordance with Table 1.

Appendix A includes a graphic summarising the completeness of information by plant fuel type and plant size for WP1.

Table 4 - summary of datasets considered under WP1 for all plant sizes

Type of information	Most complete datasets (split by plant size where relevant)	Known gaps / uncertainties
Number of plant	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> RESTATS, DUKES, NAEI, GLA Study, EA SPR Registry <p>MCP Regs (1-5 MWth)</p> <ul style="list-style-type: none"> CHPQA/CHPSTATS, DUKES, NAEI, Local Authority permitting, EA SPR Registry <p>MCP Regs (5-20 MWth)</p> <ul style="list-style-type: none"> Elexon Data (North Scotland), DUKES, NAEI, GLA Study, CHPQA/CHPSTATS, EA SPR Registry, EA Bespoke Registry <p>MCP Regs / Part B (20-50 MWth)</p> <ul style="list-style-type: none"> Elexon Data (All Scotland), DUKES, NAEI, GLA Study, CHPQA/CHPSTATS, Local Authority permitting under Part B, EA Bespoke Registry <p>IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> Elexon Data (England, Scotland, Wales), DUKES, NAEI, CHPQA/CHPSTATS, 	<p>The national grid data from Elexon / BM reports don't include Northern Ireland.</p> <p>RESTATS, CHPQA and CHPSTATS data apply to CHP only.</p> <p>GLA Combustion Study only includes London plant.</p>
Type of plant	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> RESTATS, DUKES, NAEI, EA SPR Registry <p>MCP Regs (1-5 MWth), MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> CHPQA/CHPSTATS, DUKES, NAEI, EA Bespoke Registry 	<p>NAEI data is restricted by the license of use at site level based on an agreement between DEFRA and ONS.</p> <p>There is limited data from Distribution Network Operator Data, Emissions Trading Scheme (ETS), Local Authorities and Trade Associations, GLA Study of Combustion.</p>

⁹<https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/energy/london-heat-map>

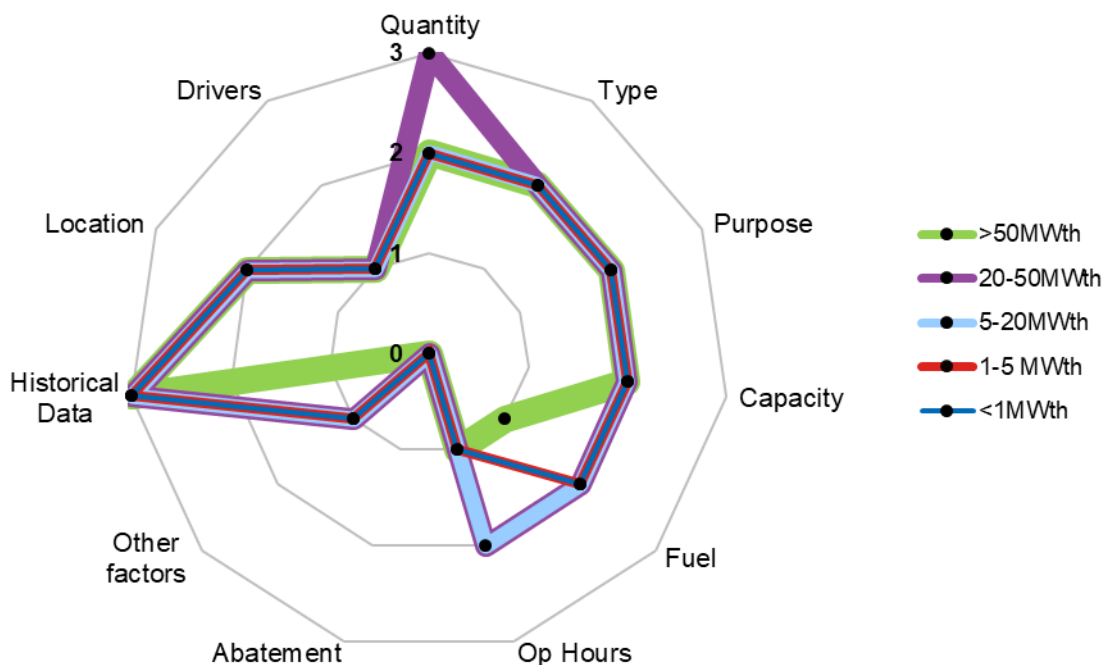
Type of information	Most complete datasets (split by plant size where relevant)	Known gaps / uncertainties
Purpose (e.g., power to grid/ standby etc)	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, NAEI, Distribution Network Operator Data, EA SPR Registry <p>MCP Regs (1-5 MWth), MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, NAEI, Distribution Network Operator Data, EA SPR Registry, EA Bespoke Registry 	<p>Purpose can be inferred from the NAEI with EPC information.</p> <p>Purpose can be inferred from other datasets through provision of certain data (e.g., operating hours, annual energy output).</p>
Size/Capacity of plant and any variation by sector/ purpose	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, EA SPR Registry <p>MCP Regs (1-5 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, Impact assessment for 2018 EPR, GLA Study, EA SPR Registry <p>MCP Regs (5-20 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, Impact assessment for 2018 EPR, Elexon / BM reports (North Scotland), GLA Study, EA Bespoke Registry, EA SPR Registry <p>MCP Regs / Part B (20-50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, Impact assessment for 2018 EPR, Elexon / BM reports (All Scotland), GLA Study, EA Bespoke Registry <p>IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, Elexon / BM Reports (England, Scotland, Wales) 	<p>RESTATS only contains data for CHP, it does not provide SG data.</p> <p>Employee statistics (IDBR) by sector from the NAEI can be used to determine the plant size. However, due to licencing there is a restriction on use at site level.</p> <p>Some datasets only provide ranges of plant size (e.g., DUKES, Trade Association).</p>
Type of fuel used and volume used	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, CHPSTATS, NAEI, ETS <p>MCP Regs (1-5 MWth), MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPSTATS/CHPQA, NAEI, ETS, Environment Agency registries <p>See other data gap charts on fuel type in Appendix A for a comprehensive summary</p>	<p>Data available from Landfill Gas Dataset (2019-2021) only relates to biogas and plant size is not included.</p> <p>Fuel consumption can be estimated based on power generation using data from RESTATS and DUKES.</p> <p>The public register of MCP/SG installations from the Environment Agency provides data on fuel type only, it does not provide data on volume used.</p> <p>Greater London Authority provides information on fuel type, but fuel consumption data is less reliable.</p>

Type of information	Most complete datasets (split by plant size where relevant)	Known gaps / uncertainties
Annual operating hours/ annual fuel use	<p>Ecodesign (<0.5Mwth);</p> <ul style="list-style-type: none"> Distribution Network Operator Data, EA SPR Registry <p>MCP Regs (1-5 MWth); MCP Regs (5-20 MWth);</p> <ul style="list-style-type: none"> Distribution Network Operator Data, EA Bespoke Registry, EA SPR Registry <p>MCP Regs / Part B (20-50 MWth); IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> Distribution Network Operator Data, EA Bespoke Registry 	<p>Annual operating hours from the GLA/COLC data are inferred/estimated for most plants and therefore may not be accurate.</p> <p>Data from CHPQA, RESTATS, DUKES and Elexon / BM reports can be used to estimate operation hours, based on power generation, capacity and type of fuel used.</p> <p>The DNO and EA databases only provide data on annual operating hours (or permitted operating hours), they do not include information on annual fuel use.</p>
Type of abatement installed & abatement potential	<p>All plant sizes</p> <p>The only source for UK-wide abatement installation and potential is from the impact assessment for the 2018 amendments to the EPR. Consultation with trade associations could provide further information on abatement types in the UK, however, it is highly uncertain whether this information could be provided without prior discussion with the associations. The Environment Agency SPR Registry states if a plant has installed abatement, but no further information is provided.</p>	
Any other factors relevant to emissions (e.g., age of plant)	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> RESTATS (age of plant) NAEI (EPC data) EA SPR Register (permitting date, plant manufacturer, plant model, annual load emissions) <p>MCP Regs (1-5 MWth), MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth)</p> <ul style="list-style-type: none"> CHPQA (age of plant) EA Bespoke Register (NOx ELVs, Stack Height) EA SPR Register (permitting date, plant manufacturer, plant model, annual load emissions) 	<p>Emission Limit Values for permitted MCP/SG plants in England, NI and Wales (size of plant unknown) can be sourced from Local Authority permit data.</p> <p>No additional relevant factors for Industrial Emissions Directive Best Available Technique (>50 MWth).</p>
Historical data to inform analysis of trends	<p>All plant sizes</p> <ul style="list-style-type: none"> RESTATS, CHPQA/CHPSTATS, DUKES, NAEI 	<p>None of the other identified datasets in this report contain historic data. Therefore, any gaps that occur in the datasets listed in Table 4 would require further consultation to be filled and establish historic trends.</p>
Locations of plant to inform trends of clustering (e.g., in AQMAs, SCAs, CAZ, LEZs)	<p>Devolved administration level</p> <ul style="list-style-type: none"> Elexon / BM reports <p>Postcode-level</p> <ul style="list-style-type: none"> CHPSTATS, CHPQA, RESTATS (Postcode-level), Local Authority Part B permitting <p>Exact coordinates / GIS data</p> <ul style="list-style-type: none"> NAEI, GLA study, COLC study, EA Bespoke Register, EA SPR Register 	<p>The Elexon / BM reports do not include data for Northern Ireland (only England, Scotland, Wales), as it is not connected to the Great British grid.</p> <p>The GLA Combustion Study only includes information on London plants.</p> <p>The COLC study only includes information on City of London plants.</p> <p>The Impact assessment for the 2018 amendments to the Extended Producer Responsibility (EPR) includes data for England and Wales only.</p>

Type of information	Most complete datasets (split by plant size where relevant)	Known gaps / uncertainties
Drivers of market behaviours and operational trends and predicted likely changes to these trends	<p>All plant sizes</p> <p>Drivers of operational trends can be inferred from historic NAEI and CHPQA data from 2000 onwards for all size of plants. Market behaviours may be determined from Distribution Network Operator Data and Trade Associations consultation. The power panel may also provide insight.</p>	

Figure 1 summarises the availability and certainty of data for WP1 in line with the available datasets and constraints considered in Table 4. Individual radar plots for each range of plant size are presented in Appendix B.

Figure 1 - summary of availability & certainty of data for WP1 (power – CHP, engines, backup generators) for each power rating



Rating	Rating description
0	No available data
1	Data available, with major gaps/uncertainty
2	Data available, with minor gaps/uncertainty
3	Comprehensive

Data coverage is summarised as follows:

- Historical data for all plant sizes is sufficiently comprehensive for analysis in this project for datasets that have historical data.
- The data for type of plant, purpose of plant, capacity of plant and location of plant are similarly available for all plant sizes, with only minor gaps being found across the dataset. Some further research may need to be conducted for complete analysis.

- Data related to the quantity of each plant size is overall relatively available, with minor gaps identified for plants of size: <1MWth; 1-5MWth; 5-20MWth; and >50MWth. Some further data sourcing may need to occur to fill in these gaps for full analysis. Data on quantity of 20-50MWth-sized plants is comprehensive.
- Minor data gaps in fuel type used were found for the majority of plant sizes, with major gaps in availability of data identified for plants of >50MWth.
- There are major data gaps in the operating hours of plants of the following size classes: <1MWth; 1-5MWth; and >50MWth. For plant sizes of 5-20MWth and 20-50MWth, data availability is slightly improved, although some gaps remain.
- There is limited data available on other factors that are relevant to emissions. Major gaps were identified for all plant sizes, except for those >50MWth, where no data was available. For analysis of these other factors, further research would need to be conducted.
- Data on the drivers of market behaviours, operational trends and any predicted changes is limited, with major gaps for plants of all sizes. There should be some opportunity to infer trends from historic NAEI and CHPQA data.
- There are no identified datasets that provide clear information on abatement installations and potential, for plants of any size. The Environment Agency SPR Registry states if a plant has installed abatement, but no further information is provided on what the abatement technology is. Further investigation will need to be conducted to allow for analysis in this project.

3.2 WORK PACKAGE 2 - HEATING

Table 5 summarises the completeness of the types of information required to inform the study under Work Package 2. Where relevant, the most relevant complete datasets are split into granular plant sizes in accordance with Table 1.

Appendix A includes a graphic summarising the completeness information by plant fuel type and plant size for WP2.

Table 5 - summary of datasets considered under WP2 for all plant sizes

Type of information	Applicable datasets	Known gaps
Number of plant (breaking down into existing and future planned where possible)	<p>Ecodesign (<0.5MWth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, NAEI, GLA Study, EA SPR Registry, Renewable Heat Incentive <p>MCP Regs (1-5 MWth)</p> <ul style="list-style-type: none"> • RESTATS, CHPQA/CHPSTATS, DUKES, NAEI, Local Authority permitting, EA SPR Registry, Renewable Heat Incentive <p>MCP Regs (5-20 MWth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, NAEI, GLA Study, CHPQA/CHPSTATS, EA SPR Registry, EA Bespoke Registry <p>MCP Regs / Part B (20-50 MWth)</p> <ul style="list-style-type: none"> • DUKES, NAEI, GLA Study, CHPQA/CHPSTATS, Local Authority permitting under Part B, EA Bespoke Registry <p>IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • DUKES, NAEI, CHPQA/CHPSTATS, 	<p>GLA Combustion Study only includes London plant.</p> <p>CHPQA only has data for some boilers (only those which the applicant has chosen to include these in the scheme boundary, which they have not for most of the smallest schemes).</p> <p>Renewable Heat Incentive data only covers solid biomass and biogas boilers.</p>
Type of plant	<p>Ecodesign (<0.5MWth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, NAEI, EA SPR Registry, Renewable Heat Incentive <p>MCP Regs (1-5 MWth),</p>	<p>NAEI data is restricted by the license of use at site level based on an agreement between DEFRA and ONS.</p>

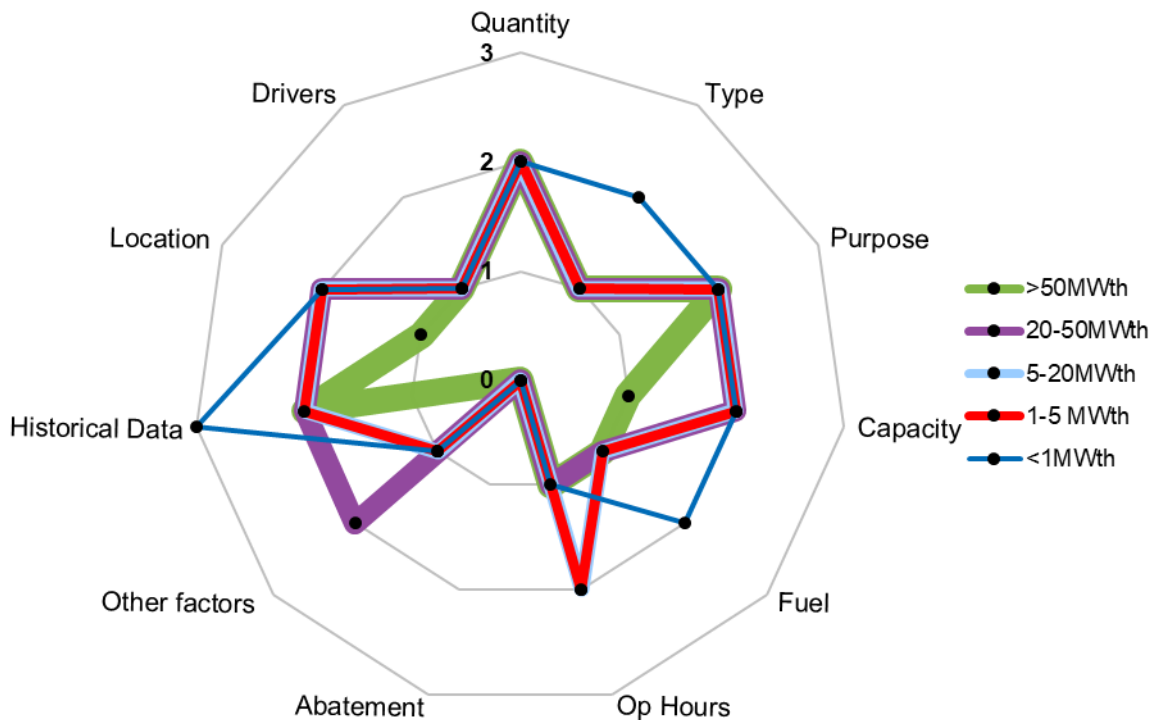
Type of information	Applicable datasets	Known gaps
	<ul style="list-style-type: none"> • DUKES, NAEI, EA SPR Registry, Renewable Heat Incentive <p>MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, NAEI, EA Bespoke Registry 	<p>Limited data from Emissions Trading Scheme (ETS), Local Authorities and Trade Associations, GLA Study of Combustion.</p>
Purpose (e.g. power to grid/ standby etc)	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, NAEI, Distribution Network Operator Data, EA SPR Registry <p>MCP Regs (1-5 MWth),</p> <ul style="list-style-type: none"> • DUKES, NAEI, Distribution Network Operator Data, EA SPR Registry <p>MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, NAEI, EA SPR Registry, EA Bespoke Registry 	<p>NAEI – Purpose can be inferred with EPC information.</p> <p>Other datasets can infer the use of each plant through other data (e.g., operating hours, annual energy output).</p> <p>Renewable Heat Incentive doesn't include information on purpose per technology level.</p>
Size/Capacity of plant and any variation by sector/ purpose	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, DUKES, EA SPR Registry, , Renewable Heat Incentive <p>MCP Regs (1-5 MWth)</p> <ul style="list-style-type: none"> • DUKES, Impact assessment for 2018 EPR, GLA Study, EA SPR Registry, Renewable Heat Incentive <p>MCP Regs (5-20 MWth)</p> <ul style="list-style-type: none"> • DUKES, Impact assessment for 2018 EPR, GLA Study, EA Bespoke Registry, EA SPR Registry <p>MCP Regs / Part B (20-50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES, Impact assessment for 2018 EPR, GLA Study, EA Bespoke Registry <p>IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPQA/CHPSTATS, DUKES 	<p>RESTATS contains data for CHP only, no SG.</p> <p>NAEI can determine size of plant using employee statistics (IDBR) by sector. There is restricted license of use at site level.</p> <p>Ranges of sizes are known for some datasets (DUKES, Trade Association).</p> <p>Renewable Heat Incentive has data on total installed capacity of applications per technology type or ranges of size classifications (Small (<200kW), Medium (200-1000kW) and Large (>1MW)).</p>
Type of fuel used and volume used	<p>Ecodesign (<0.5Mwth)</p> <ul style="list-style-type: none"> • RESTATS, CHPSTATS, NAEI, ETS <p>MCP Regs (1-5 MWth), MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) and IED BAT (>50 MWth)</p> <ul style="list-style-type: none"> • CHPSTATS/CHPQA, NAEI, ETS <p>See other data gap charts on fuel type in Appendix A for a comprehensive summary.</p>	<p>Data available from Landfill Gas Dataset (2019-2021) for biogas, (but size of plant unknown).</p> <p>RESTATS, DUKES, can calculate fuel consumption based on power generation.</p> <p>EA MCP/SG installations public register (for all of UK) – types of fuel are provided, but fuel is not provided.</p> <p>GLA gives type of fuel, fuel consumption given infrequently.</p> <p>Renewable Heat Incentive data gives type of fuel (biomass or biogas), but no volume.</p>
Annual operating hours/ annual fuel use	<p>Ecodesign (<0.5Mwth);</p> <ul style="list-style-type: none"> • EA SPR Registry <p>MCP Regs (1-5 MWth); MCP Regs (5-20 MWth);</p> <ul style="list-style-type: none"> • EA Bespoke Registry, EA SPR Registry 	<p>GLA/COLC data are inferred/estimated for most plant.</p> <p>CHPQA / RESTATS / DUKES can estimate operation hours based on heat generation, capacity, type of fuel used etc.</p>

Type of information	Applicable datasets	Known gaps
	MCP Regs / Part B (20-50 MWth); IED BAT (>50 MWth) <ul style="list-style-type: none"> EA Bespoke Registry 	Annual operating hours provided only EA registry data (permitted operating hours), annual fuel use not available.
Type of abatement installed & abatement potential	All plant sizes Only source for UK-wide is from the impact assessment for the 2018 amendments to the EPR, or through consultation through trade associations, though it is highly uncertain whether this information can be determined. EA SPR Registry states if plant has installed abatement, but no further information provided	
Any other factors relevant to emissions (e.g. age of plant)	Ecodesign (<0.5Mwth) <ul style="list-style-type: none"> RESTATS (age of plant) NAEI (EPC data) EA SPR Register (permitting date, plant manufacturer, plant model, annual load emissions) Renewable Heat Incentive (Heat generated and paid for under the scheme (GWh)) MCP Regs (1-5 MWth), <ul style="list-style-type: none"> EA Bespoke Register (NOx ELVs, Stack Height) Renewable Heat Incentive (Heat generated and paid for under the scheme (GWh)) EA SPR Register (permitting date, plant manufacturer, plant model, annual load emissions) MCP Regs (5-20 MWth), MCP Regs / Part B (20-50 MWth) <ul style="list-style-type: none"> CHPQA (age of plant) EA Bespoke Register (NOx ELVs, Stack Height) 	ELVs for permitted MCP/SG plant for England, NI and Wales (size of plant unknown) from Local Authority permit data. No additional relevant factors for IED BAT (>50 MWth).
Historical data to inform analysis of trends	Ecodesign (<0.5Mwth), MCP Regs (1-5 MWth), <ul style="list-style-type: none"> Renewable Heat Incentive (from 2011-2023) All plant sizes (where data are available) <ul style="list-style-type: none"> RESTATS, CHPQA/CHPSTATS, DUKES, NAEI 	No other datasets have historic data, such that any gaps in the datasets listed left cannot be filled without further consultation.
Locations of plant to inform trends of clustering (e.g. in AQMAs, SCAs, CAZ, LEZs)	Regional level <ul style="list-style-type: none"> Renewable Heat Incentive Postcode-level <ul style="list-style-type: none"> CHPSTATS, CHPQA,RESTATS (Postcode-level), Local Authority Part B permitting Exact coordinates / GIS data <ul style="list-style-type: none"> NAEI, GLA study, COLC study, EA Bespoke Register, EA SPR Register 	GLA Combustion Study only includes London plant. COLC study only includes City of London plant.
Drivers of market behaviours and operational trends and predicted likely changes to these trends	All plant sizes Drivers of operational trends can be inferred from historic NAEI and CHPQA data from 2000 onwards for all size of plants. Market behaviours may be determined from Trade Associations and Industrial & Commercial Heating Equipment Association consultation. Heating panel may also provide insight. Unknown plant size	

Type of information	Applicable datasets	Known gaps
	Hy4Heat study draws correlation between project valuation/deal sizes and TRL of hydrogen heating before and after Hy4Heat scheme	

Figure 2 summarises the availability and certainty of data for WP2 in line with the available datasets and constraints considered in the above table. Individual radar plots for each range of plant size are presented in Appendix B.

Figure 2 - summary of availability & certainty of data for WP2 (heat –boilers, district heating, heat pumps) for each power rating



Rating	Rating description
0	No available data
1	Data available, with major gaps/uncertainty
2	Data available, with minor gaps/uncertainty
3	Comprehensive

Data coverage is summarised as follows:

- Historical data to inform on analysis of trends was the most complete set of data, however, there are still minor data gaps for plant sizes: 1-5MWth; 5-20MWth; 20-50MWth: and >50MWth.
- The data for purpose of plant and quantity of plant are similarly available for all plant sizes, with only minor gaps being found across the datasets. Some further research may need to be conducted for their complete analysis.
- Minor gaps in available data for capacity of plant and location of plant were found for the majority of plant sizes, with major gaps being found in the data for plants of size >50MWth. Further investigation into data in these areas may need to be conducted for complete analysis in this project.

- Data on type of plant and type of fuel used have little data available, with major gaps identified for all plant sizes except those that are <1MWth, where only minor gaps in data was found.
- The data available on operating hours was mixed, with major data gaps found for plants of size <1MWth, 20-50MWth and >50MWth, while minor data gaps were found for plants within the 1-5MWth and 5-20MWth categories.
- There is limited data available on other factors that are relevant to emissions for most plant types. There was no data found in this area relating to plants of size >50MWth. Major gaps were identified for plants of size <1MWth, 1-5MWth, and 5-20MWth. For plants of size 20-50MWth, there were only minor data gaps found. For analysis of these other factors, further research may need to be conducted.
- Data on the drivers of market behaviours, operational trends and any predicted changes is limited, with major gaps for plants of all sizes.
- There are no identified datasets that provide information on abatement installations and potential, for plants of any size. Further investigation will need to be conducted to allow for analysis in this project.
- Overall, the data available to support WP2 is less comprehensive than that for WP1.

4. CONCLUSIONS

In this report, we have provided an overview of the existing datasets available for the quantitative analysis stage of this project for work packages relating to power (including CHPs) and heat. This includes focusing on what data are available, the constraints to the use of these data and considers any areas where there are gaps in the available data.

From the gap analysis, historical data is comprehensive and will require no further research for WP1, and little further research for WP2. Overall, across both WP1 and WP2, data on the quantity of plant, location of plant and purpose of plant are relatively comprehensive and will only require some further research and consultation. The remaining areas will be a priority for gap filling, with WP2 requiring more particular attention as it has less comprehensive data across all aspects for all plant sizes. The areas with the most significant need for additional data are the abatement of plant and drivers of trends, for both WP1 and WP2, across all plant sizes.

Using the current collated data, Ricardo will request access to datasets listed as requiring permissions (e.g., DESNZ for CHPQA, CHPSTATS and RESTATS) and conduct research into data gap areas, then begin building a standardised database.

In order to fill in the data gaps, where possible, Ricardo will work with Defra to carry out consultations with stakeholders, including the stakeholder panel which will include operators, suppliers and other interested parties. Ricardo will also contribute to a steering group, including Defra, DESNZ and the EA. Where data is not available at individual plant level, aggregate data using extrapolation and industry knowledge can be used to fill these gaps, acknowledging the limitations of such estimations.

APPENDIX A – FUEL GAP & PLANT SIZE GAP ANALYSIS

The below figures show the coverage of most useable known data across fuel type and plant size for WP1 and WP2. The lighter/hatched cells indicate where data is incomplete or where there is high uncertainty. Note that for WP1, coverage applies to both CHP and generators (unless otherwise stated).

Figure 3 - data coverage of known datasets (WP1 - power)

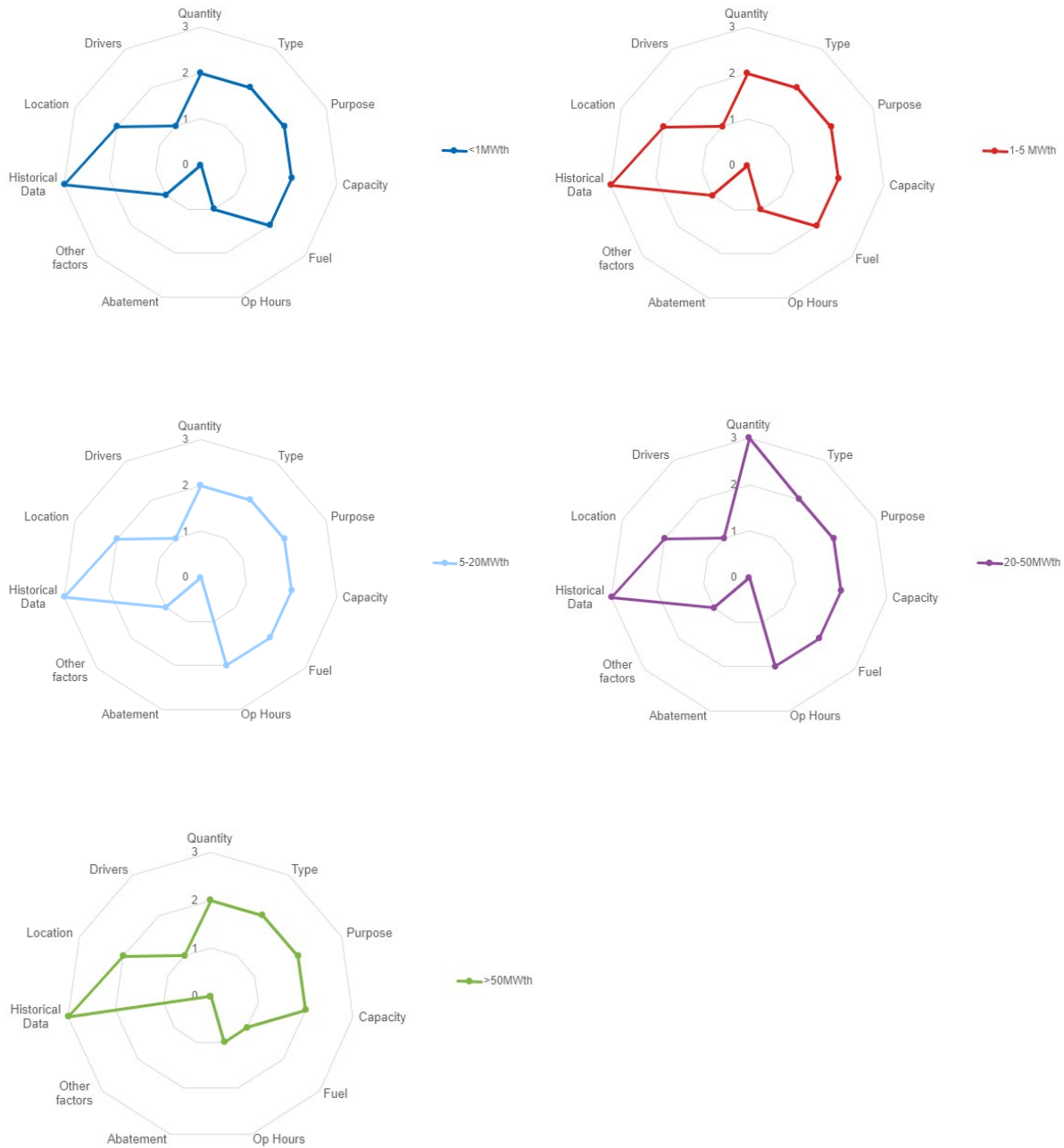
	<0.5 MW	0.5 – 1 MW	1 – 5 MW	5 – 20 MW	20 – 50 MW	50+ MW
Natural gas	CHPQA (contains all data for limited range of plant: registered CHP only)					
	CHPSTATS (CHP)					
				2018 Amendments to EPR		
	Environment Agency SRP Registry					
Biogas	Landfill gas dataset (contains all data for limited range of plant: landfill gas CHP)					
	RESTATS (CHP only)					
Biomass	Renewable Heat Incentive Data (OFGEM)					
				Environment Agency Bespoke Registry	NAEI (aggregated, data for Part B regulated plant)	NAEI (full data for Part A regulated plant)
Diesel	NAEI (aggregated, approximate data for smaller plant)		EA register of permitted MCP and SG (full data: under development)			
Solid fuel	GLA Study of Combustion Plants (London only)		EA & Devolved Administrations' MCP/SG Installations public register (incomplete, limited information)			
	Capacity Market Register					
Other fuel	Distribution Network Operator Data					

Figure 4 - Data coverage of known datasets (WP2 - heating)

	<0.5 MW	0.5 – 1 MW	1 – 5 MW	5 – 20 MW	20 – 50 MW	50+ MW
Natural gas	CHPQA (contains all data for limited range of non-CHP heating plant)					
	RESTATS (contains all data for limited range of plant)					
	CHPSTATS (contains all data for limited range of plant)					
	GLA Study of Combustion Plants (London only)					
	Environment Agency SRP Registry					
Biogas	Landfill gas dataset (contains all data for limited range of plant)					
Biomass	Renewable Heating Incentive					
Oil	NAEI (aggregated, approximate data for smaller plant)		Administrations' MCP/SG Installations public register (incomplete, limited information)		Environment Agency Bespoke Registry	NAEI (aggregated data for Part B regulated plant)
Solid fuel	Capacity Market Register		EA register of permitted MCP and SG (full data, under development)		Emissions Trading Scheme (ETS)	NAEI (full data for Part A regulated plant)
Other fuel						

APPENDIX B – GAP ANALYSIS PLOTS

Figure 5 - summary of availability & certainty of data for WP1 (power – CHP, engines, backup generators) for each power rating (individual plots)



Rating	Rating description
0	No available data
1	Data available, with major gaps/uncertainty
2	Data available, with minor gaps/uncertainty
3	Comprehensive

Figure 6 - summary of availability & certainty of data for WP2 (heat –boilers, district heating, heat pumps) for each power rating (individual plots)



Rating	Rating description
0	No available data
1	Data available, with major gaps/uncertainty
2	Data available, with minor gaps/uncertainty
3	Comprehensive



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