A.E.S Engineering Ltd. GHG Inventory

Scope 1, 2 & 3 Emissions Inventories

Contents

1 Responsible Undertaking

A.E.S Engineering Ltd. is the parent company and the highest business entity and therefore will be responsible for undertaking the completion of all requirements for the group. This will cover all subsidiary companies worldwide including those within the UK.

- **Company Registration Number:** 00392743
- **Standard Industry Classification:** 28290
- **Registered Address:** Global Technology Centre
  Bradmarsh Business Park
  Mill Close
  Rotherham
  South Yorkshire
  S60 1BZ

2 Introduction

The following document serves as an assessment of the greenhouse gas emissions of A.E.S Engineering Ltd., a UK-based manufacturing company producing mechanical seals, sealing products and seal support products for a global market.

This inventory is the third consecutive assessment of the global emissions of the A.E.S Engineering Group, consisting of many subsidiary companies across the globe under the ownership of A.E.S Engineering Ltd. These subsidiaries are primarily AESSEAL companies who serve as local and regional centres for sales, seal repairs, and in certain cases manufacturing and assembly. However, also present within the group are a number of service-oriented companies who provide conditional monitoring, pump-repair and other reliability focused operations.

For well over a decade, AESSEAL has had a strong focus on sustainability and minimising both the impact that the company itself has on the planet, and the impact that our customers and industry has as well. The vast majority of products sold by AESSEAL are passive in nature with only a few certain product lines consuming any energy during their use, and nearly all products carry an environmental benefit to some degree. This can range from simple reductions in energy consumption through increased efficiency through to the most significant and meaningful reductions associated with the use of seal support systems in hot and evaporative processes.

Although the positive impact of these products far outweigh the negative impacts associated with their production, every business should be committed to reducing its own environmental impact wherever possible. The Company runs an integrated system that encompasses environmental and energy management amongst wider elements including quality and safety. Certification to ISO 14001 was first gained for its UK subsidiary in 2003, with many operational sites around the globe following. Further to this in 2012 the head office in Rotherham gained certification to ISO 50001.

Over the past three years, the efforts and focus on sustainability that have long been in place in the UK have been expanded to global operations. The company has committed to spending £29 million by the year 2029 on environmental projects, and this commitment has lead to significant environmental projects being undertaken at key manufacturing sites outside of the UK. For more information on these projects, and the company's carbon reduction plan, please see section 11 of this report.

The information and data obtained during this inventory is core to the decision-making for the 29 by 29 commitment, and the final figures of the inventory serve as the metric for which the success of these projects are evaluated. Furthermore, the act of carrying out such an inventory involves many people across global operations, many of whom have no direct link to sustainability as part of their core job role. Through carrying out such an assessment, AESSEAL hopes to spread the focus on sustainability throughout the group by their involvement within this assessment.

AESSEAL believes that operating sustainably is not only the right thing to do, but also good for business in the long-term. As time goes on and the effects of global warming become more severe, it is inevitable that all companies will need to work towards net zero. It will only become more important for companies to be clear and transparent about their contribution towards climate change, this assessment is important to allow the company to be very open about the negative impacts that the company does have.

3 Scope

3.1 Organisational

A.E.S Engineering Ltd. is the parent company and owner of various A.E.S group companies operating across the globe, many of which (but not all) carry the AESSEAL brand name in their titles. A.E.S Engineering Ltd. maintains operational control of these subsidiaries that are covered within the confines of this GHG inventory.

3.2 Reporting Period

This inventory covers a customised 12-month reporting period from the 1st of October 2022, through to the 30th of September 203.

3.3 Base Year

This reporting period is the third full assessment of A.E.S Engineering Ltd., with comparable inventories having been conducted for the periods of October 2020 to September 2021, and October 2021 to September 2022, these inventories will be referred to as 2020-21 and 2021-22 respectively. There have been improvements made in data collection, scope and calculation methods between each of these inventories, the most significant of which took place between the first and second assessments. However, these changes are not considered to have change the reporting method significantly enough for a need to alter the baseline year. As such the baseline year for this inventory is the inventory relating to the time period of October 2020 to September 2021.

It should be noted that there has been significant growth within the business in comparison to the base year, both in terms of growth measured by turnover and the number of subsidiary companies belonging to A.E.S Engineering Ltd.

3.4 Locational

There is significant variance in the size of sites covered by this GHG inventory, ranging from large energy-intensive manufacturing sites to very small regional sales offices. Please see appendix C for a list of the sites covered by this inventory.

3.5 Inclusions

This report covers all greenhouse gas emissions attributable to A.E.S Engineering Ltd. under the defined scope above.

All Scope 1 & 2 emissions are covered within the inventory report including: direct combustion of fuels, fugitive emissions from the release of refrigerant or other global

warming gases, and the purchase of energy (predominantly electricity) generated off-site.

For the purposes of data collection and this report, Scope 1 emissions are divided between fleet emissions, supplied natural gas, other fuel consumption, and fugitive emissions. Supplied natural gas consists almost entirely of space heating, although do note that there are individual sites who do have space heating that is not covered by supplied natural gas. In these cases, the emissions as a result of this activity will be reported under either other fuel consumed (e.g., oil heating) or the relevant Scope 2 category (purchased heat for district heating systems).

Scope 2 emissions for A.E.S Engineering Ltd. consist almost entirely of purchased electricity, although there are some instances of purchased heat which are also accounted for. Emissions arising from purchased electricity will be reported as both a location-based and a market-based total. With the market-based total reflecting the use of green tariffs where they are applicable, primarily within the UK, Germany, and the USA.

All relevant Scope 3 value chains have been included within this inventory, although it is noted that not all categories are applicable to the business. The Scope 3 Category numbers 10, 13, 14, & 15 are not relevant to A.E.S Engineering Ltd. and are thus not covered within this report.

3.6 Global Warming Potentials

This report considers carbon dioxide equivalent (CO_2e), values for methane (CH_4) and nitrous oxide (N_2O) are therefore reported in terms of CO_2e. Conversion to carbon dioxide equivalent are done with factors from the Intergovernmental Panel on Climate Change fourth assessment report.

3.7 Offsets

Also covered within this report are the use of purchased offsets. Where Scope 1 & 2 emissions are present despite previous efforts at reducing emissions, offsets have been purchased to cover these emissions. In such cases, a log of purchased offsets is recorded as a separate document and is available on request.

These are purchased from verified schemes under Gold Standard or Verra VCS programs. It is understood that carbon avoidance from sold product cannot be reported

alongside GHG Scope 1 & 2 emissions. Where possible, offsets purchased will also have positive associations with other UN sustainable development goals.

4 Methods & Verification

4.1 Approach

The basis of the approach adopted for completing this inventory is that of the GHG protocol which is linked to the Paris agreement. The content of this report has been verified by a third-party, British Standards Institution. Verification is against the principles of ISO 14064 Part 1 (2018) with inventory reports prepared in accordance with this standard. Please see appendix for certification received from BSI.

Verification is to a reasonable level with anything below 1 tonne considered de-minimums, anything between 1 & 4% of the overall inventory total being of low significance, and anything of 5% or more treated as significant.

4.2 Methods

For details of how emissions from individual categories have been calculated, please see the relevant category within sections 5, 6 or 8.

Note that due to the large number of sites and data collection that is required, some scaling of Scope 3 Emissions has taken place. The largest A.E.S subsidiaries will have full Scope 3 inventories calculated, note that many of the Scope 3 categories are applicable to a specific subsidiary or entity and not a specific site.

The method of scaling used will be that of linear regression with the independent variable to be the staff headcount of that respective site. For each category, a plot of emissions against employee headcount is carried out using the calculated data points. Linear regression is then used to arrive at an equation relating emissions to headcount for that category, the headcount of the data points to be scaled will be used in conjunction with this equation to calculate emissions. Should a situation arise in which the y-intercept falls below zero, simple linear regression will be applied with a y-intercept forced to equal zero.

Note that this scaling method will also be applied for any Scope 1 or 2 categories in the event that data is unavailable for that site and category. This is primarily the case for certain new acquisitions that took place shortly before or during the reporting period.

Due to the structure of the business, with the majority of A.E.S subsidiaries tracing their supply chain to the largest single company and primary manufacturer of AESSEAL plc, this scaling method is inherently conservative. The calculated data points (including AESSEAL plc) represent the largest of the Scope 3 emissions, whilst those being scaled

will offer minimal impact in comparison, even relative to the headcount of the entity. However, no such reduction or change in scaling method is introduced to reflect this. This is in order to follow the principles of being conservative in absence of direct data confirming otherwise. For more specific details on the errors and uncertainties of this method, please see section 10.

4.3 Data Collection

For the purposes of data collection to carry out this inventory, a centralised approach to data collection was undertaken. This was done to ensure consistency of reporting across the group and minimise the impact on branch staff involved in data collection. Wherever possible, data was sourced directly by head office using shared group systems in order to minimise impact and operate as uniformly as possible between group companies. However there is significant variation between group companies as to how integrated each company is within these systems.

Shortly after the end of the reporting period in question, activity data was sought from branch heads relating to the activities required to complete the GHG inventory. Necessary delegation was then conducted by local branch heads in order to obtain all the data required.

4.4 Changes to Methodology from Previous Years

The baseline year for this inventory remains the first conducted inventory for the reporting period of the 1st of October 2020 to the 30th of September 2021. However, there have been multiple improvements to the method and approaches used in order to best reflect the true emissions figure of A.E.S Engineering Ltd.

For the purposes of transparency, improvements made to the methodology since the baseline year are as follows:

- Initially, spend-based emissions factors available from Quantis were used, which were worldwide averages based upon the WIOD. For both this inventory and the previously conducted 2021-22 inventory emissions factors have instead been used that are more specific to the location in which the goods and services were purchased. To better reflect the environmental impact of the company's value chain activities, in particular Scope 3 Category 1, nation-specific spend-based emissions factors have been used where available. These have been derived from the 2013 release of the World Input Output Database. In cases where the item has been procured from a nation where there is insufficient data to calculate

an emissions factor, a rest-of-world emissions factor will be applied. Please see the relevant categories in later sections for further detail.

- In the baseline year, A.E.S sites were broken down into three levels of operation, these being significant operational sites (level 1), repair centres (level 2), and sales offices (level 3). An approach was taken where all level 2 and a representative sample of levels 2 and 3 were directly calculated, and the remaining smaller sites calculated from those with full datasets. This approach was taken for Scope 1, 2 and 3 emissions. For both this inventory and the 2021-22 inventory, with the aim of being more complete (and also identifying further areas to improve) every site was contacted to provide a full Scope 1 and 2 dataset, thus greatly reducing the uncertainty and error on Scope 1 and 2 emissions. As discussed previously, this scaling approach will still be applied for the Scope 3 emissions of the less significant entities, albeit with no distinction made between sites in terms of levels. This change was made as the differences between repair centres and sales offices that were included previously were only relevant to Scope 1 and 2 emissions and not to Scope 3 emissions.

- As part of data collection, information upon the number and size of refrigerant units and fire suppression systems will be gathered. Initially, information was only gathered in the cases of a leak occurring that resulted in fugitive emissions. It was decided that information should be collected regardless of a leak occurring in order to provide more confidence that fugitive emissions did not occur. This change was implemented as a result of feedback from BSI during the verification of the 2020-21 inventory.

- Although not a change to the methodology in a way that could potentially alter results, it should be noted that efforts have been made for automatic categorisation of purchased goods and services for Scope 3 Category 1. This was a recommendation by BSI following the verification of the 2020-21 inventory. Where possible, primarily for companies using SAP, commonly purchased goods have been assigned a ‘GHG Category’ which corresponds to the emissions factors used by the WIOD & Quantis. Doing so substantially reduces the workload associated with Scope 3 Category 1 to allow focus of efforts on other problem areas.

- In such cases where there may be insufficient data to calculate fleet emissions, scaling will be conducted with the dependent variable being number of fleet

vehicles and not staff headcount. In the initial inventory, scaled fleet emissions were calculated using site staff numbers which did not properly reflect the true usage of fleet vehicles at that site. This change was made following a recommendation from BSI as a result of the verification of the 2020-21 inventory.

- In the first such inventory, where heating was provided by a geothermal heating system, emissions were calculated using a DEFRA published emissions factor which was based upon the use of a combined heat and power unit. For both this inventory and the 2021-22 inventory, a specific emissions factor relating to geothermal heating has instead been used that better reflects the true emissions impact of these heating systems.

4.5 Acknowledgement of Areas to Improve

A.E.S acknowledges that despite best efforts, some uncertainty and error will remain within the figures reported as part of this inventory, please see section 10 for more details on this. A.E.S intends to improve upon this process year on year to ensure accuracy and transparency in reporting emissions. Wherever improvements are identified by ourselves or others, these will be implemented if possible in future inventories.

A.E.S would like to acknowledge the following errors that have since been identified with the previous inventory, conducted for the period of October 1st 2021 to September 30th 2022:

- Scope 1: Fleet Emissions:

  In the previous inventory, fleet emissions of *127.97 Tonnes CO_2e* were reported by AESSEAL Middle East, operating out of Dubai, UAE. During the process of this inventory it was noted that there was a failure to distinguish between owned and leased vehicles in the previous data for this subsidiary.

  As a result of this error, Scope 1 emissions were over-reported by approximately *95 Tonnes CO_2e,* which should instead have been reported under Scope 3: Category 6.

5 Scope 1

5.1 Fleet Emissions

Fleet emissions are calculated in a varying manner according to the best quality of data available. The reason for this being that each subsidiary manages its own vehicle fleet and the methods of monitoring and recording activity vary between them. Calculation methods may be split between fuel-based, and distance-based. Where the fuel consumed by owned vehicles for business use is recorded, the volume of fuel is multiplied by either DEFRA emissions factor for that particular fuel. In cases where fuel consumption is not recorded, instead the distance covered by that vehicle is multiplied by the relevant local or DEFRA emissions factor for that vehicle type.

For certain companies, data is recorded and audited on a regular basis which allows for a high degree of confidence in figures, these tend to be the larger and thus more significant vehicle fleets. Data sources do also vary significantly across the group, as some subsidiaries use the services of a third-party to manage fleet use and expenses. Data quality at the lower end is based upon estimates of the distance covered by a company vehicle, for example at AES Coldweld there is a single fleet vehicle in use but distance or fuel consumption is not consistently recorded and as a result, emissions for this vehicles are based upon estimates provided by the company. Of those sites where fleet emissions were calculated on a distance-based approach, a total of 2,612,103 kilometres were covered by A.E.S owned vehicles. Whilst those sites who track fuel use from owned fleet consumed a total of 275,016 litres of petrol and diesel.

Fleet emissions across the group are a very significant source of Scope 1 & 2 emissions – contributing 33.01% to the scope 1 & 2 total, and some of the largest single sources of Scope 1 & 2 emissions are the fleet emissions of the larger AES subsidiaries.

Category	CO_2 (Tonnes)	CH_4 (Tonnes)	N_2O (Tonnes)	CO_2e (Tonnes)
Petrol Vehicles	848.82	2.07	1.58	747.91
Diesel Vehicles	779.59	0.05	7.57	691.17
Hybrid Vehicles	45.41	0.05	0.37	40.23
Total Fleet Emissions	1673.82	2.48	10.86	1687.15

5.2 Natural Gas

Natural gas is calculated primarily from data sourced from utility invoices by the utility providers, supported by meter readings where available. The consumption of the fuel, usually in kilowatt hours, is multiplied by the DEFRA emissions factor to calculate carbon dioxide equivalent emissions. In certain cases, a volume of gas is recorded as opposed to energy, where a relevant conversion is not supplied by the utility provider themselves, the corresponding volumetric emissions factor is used and a kWh equivalent also reported for internal comparative purposes between sites.

Natural gas is used exclusively for the purposes of space heating and hot water for welfare purposes for AES sites. Of those sites where information was gathered relating to natural gas use, 26 operated a gas heating system whilst 54 had no gas heating system.

With regards to scaling, any sites which have no natural gas emissions are not included as data points for the scaling of gas emissions, this is to ensure that such sites do not contribute towards an under-reporting of scaled sites. Note that in particular this category results in a likely overestimate of emissions for those sites which were not calculated but scaled. Amongst the scaled sites there have been no exclusions from this category despite the likelihood of several sites such as those in Africa not operating a space heating system. No attempt to exclude sites from this scaling were made in order to ensure that any underestimates present in the estimates (for those in the coldest climates) were sufficiently covered by the over-reporting from the warmest sites.

Natural gas use is responsible for 9.80% of the group's scope 1 & 2 emissions total, and in total A.E.S Engineering Ltd. used 2,742,565 kWh of natural gas during the reporting period.

Category	CO_2 (Tonnes)	CH_4 (Tonnes)	N_2O (Tonnes)	CO_2e (Tonnes)
Natural Gas	499.62	0.77	0.25	500.63

5.3 Other Consumed Fuels

Other consumed fuels refer to all consumption of fuels outside of natural gas use for space heating. A.E.S does not consume any fuel as part of its regular processes, however fuel is consumed at certain sites such as propane and LPG for forklifts or diesel for generators. Often for this category fuel is purchased to replenish stocks that are used on a regular basis, information about when the fuel itself was consumed is not always

available. As a result, the approach is taken that fuel purchased within the reporting period is assumed to be consumed and is therefore reported as part of this inventory. ä

Two sites, Kronau and Cork, purchase fuel oil for their heating system. It should also be noted that a third site, Jyväskylä, is leased and does not pay for heating directly but as part of rent, however it is known that the heating system for the shared building is oil.

Multiple sites operate diesel generators, in South Africa and India these are operated for the purposes of providing power to site during frequent blackouts. Of the sites contacted for emissions data 14 had emissions due to some form of fuel use outside of natural gas.

Data sources for this category are invoices and purchase orders for the respective fuels. Conversion to a carbon dioxide equivalent figure is then done through DEFRA emissions factors based on either the mass or volume of the purchased fuel. This category contributes 0.08% to the groups scope 1 & 2 emissions.

Category	CO_2 (Tonnes)	CH_4 (Tonnes)	N_2O (Tonnes)	HFC (Tonnes)	CO_2e (Tonnes)
Propane	24.14	0.02	0.01	0.00	24.18
Gases w/CO_2	0.00	0.00	0.00	0.00	0.00
Diesel	65.46	0.01	0.82	0.00	66.30
Oil	20.21	0.05	0.04	0.00	20.31
LPG	1.09	0.00	0.00	0.00	1.09
Total	110.91	0.08	0.88	0.00	111.87

5.4 Refrigerants

Across the group there were three instances of refrigerant or fugitive losses that have a carbon dioxide equivalent figure. In order of significance these were: Pune, Breda, and Lisbon. Both Lisbon and Breda were single instances of a loss of fluid or a top-up of fluid that is indicative of a loss of fluid previously. At Pune there have been multiple top-ups of fluid across multiple refrigerant units during the reporting period. It is suspected that in this specific case, top-ups may be being unnecessarily carried out as part of maintenance works and this is not truly reflective of a loss of gas. However, there is insufficient evidence to confirm this and in line with the standard methodology applied elsewhere any top-up of fluid is assumed to correspond with a loss of fluid equal in mass.

At all sites, the mass of fluid is used for conversion into carbon dioxide equivalent using the relevant global warming potential. The mass of fluid that was replaced as part of maintenance is multiplied by the global warming potential of the gas to provide a carbon dioxide equivalent figure.

In total, 16.00 *kg* of R-22 and 3.69 *kg* of R-32 were lost, resulting in the carbon dioxide equivalent of 28.16 and 2.50 *tonnes* respectively, this contributes 0.60% to the group scope 1 & 2 total.

Category	Mass (kg)	HFC Eq. (Tonnes)	CO_2e (Tonnes)
R-22	16.00	28.16	28.16
R-32	3.69	2.50	2.50
All Refrigerants	19.69	30.66	30.66

5.5 Scope 1 Summary by Source & Greenhouse Gas

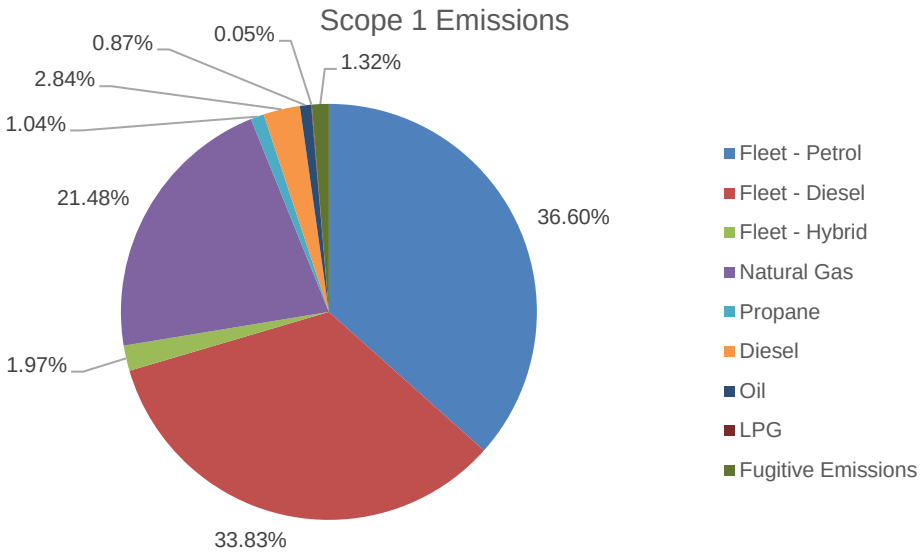
Category	CO_2 (Tonnes)	CH_4 (Tonnes)	N_2O (Tonnes)	HFC (Tonnes)	CO_2e (Tonnes)
Fleet – Petrol	848.82	2.37	1.81	0.00	852.99
Fleet – Diesel	779.59	0.05	8.63	0.00	788.28
Fleet – Hybrid	45.41	0.06	0.42	0.00	45.88
Propane	24.14	0.02	0.01	0.00	24.18
Gases w/ CO_2	0.00	0.00	0.00	0.00	0.00
Diesel	65.46	0.01	0.82	0.00	66.30
Oil	20.21	0.05	0.04	0.00	20.31
LPG	1.09	0.00	0.00	0.00	1.09
Natural Gas	499.62	0.77	0.25	0.00	500.63
R-22	0.00	0.00	0.00	28.16	28.16
R-32	0.00	0.00	0.00	2.50	2.50
Total	2284.34	3.33	12.00	30.69	2330.34

There has been a change in Scope 1 emissions of -108.73 tonnes, which represents a fall of -4.46% from the previous figure of 2,439.1 tonnes. This fall has been largely consistent across each source of emissions, with each sub-category within Scope 1 being lower than the previous inventory aside from the use of other fuels.

Relative to their previous values, fugitive emissions have seen the largest drop at -51.54%. The fall in fugitive emissions has not occurred due to any specific targeted policy by A.E.S, in the previous inventory there was a significant leak at the Rockford site which inflated figures in that period. This was an isolated incident which was subsequently addressed, furthermore the HVAC system at large in Rockford is being replaced as it was nearing its end of life, this is expected to prevent the loss of any fluid from this site in the near future.

The consumption of other fuels has remained largely similar to the previous inventory, some reductions have occurred within South Africa as there has been an alteration of the load-shedding to prioritise industrial areas. It is expected that the follow inventory will see a significant reduction in this category. At Pune, the installation of a PV system and UPS battery has largely eliminated the need for diesel generators. However, this system began operating only shortly after the end of the reporting period considered within this report. It is expected that within the next inventory, diesel consumption at the Pune site will only consist of a small amount of use for the purposes of testing and maintaining the generator. This combined PV and UPS system is also expected to have a significant improvement in Scope 2 emissions in the subsequent inventory, having only become fully operational in December of 2023, outside the scope of this report.

Fleet emissions have reduced by -4.08% on the previous inventory, largely due to a move across the group towards more fuel-efficient vehicles. This is best represented by the vehicle fleet of AESSEAL plc, where there has been a drop in emissions despite an overall increase in the distance covered by the fleet. The introduction of electric and hybrid vehicles as replacements for the aging vehicles has resulted in a quarter of distance being covered by electric vehicles, and another quarter covered by hybrids. The success of this policy has resulted in emissions relative to turnover at AESSEAL plc being halved in just a five-year period.



The proportion of emissions between each sub-category remains similar to the previous inventories, with fleet emissions dominating Scope 1 at of 72.40% the total and natural gas use providing 21.48% of the total. This distribution is as expected, A.E.S does not use any fuels in any production processes or operations outside of a small use of Propane and LPG for forklift trucks. Energy associated with production and operation is therefore largely covered under Scope 2. Fleet emissions are associated with sales and service to customers, whilst natural gas is associated purely with the welfare purposes of hot water and heating. Sites which do see consumption of other fuels fall into one of two categories: those which use some other fuel (as opposed to natural gas) for heating and hot water, and those which use some other fuel for continuity of operations during grid blackouts.

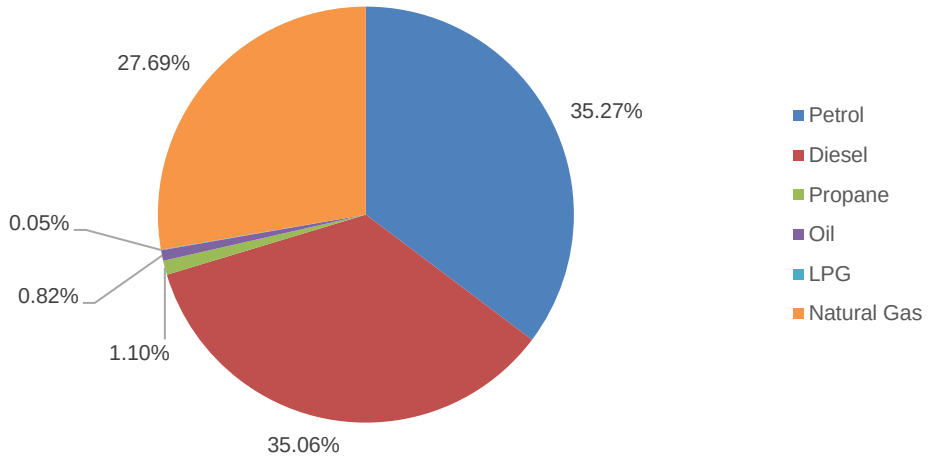
As part of gathering data on Scope 1 emissions, it is also possible to obtain a breakdown in energy use across the group that contributes to Scope 1 emissions. Data for this breakdown is dependent upon the sub-category being measured. For natural gas use, most invoices provide an energy figure directly in kWh or Gigajoules, where a volumetric figure is reported the DEFRA figures for energy content of fuels are used to convert to kWh. For any other fuels, these same DEFRA figures are consulted to convert the mass or volume of fuel into an energy figure. Finally, for the case of fleet emissions which have been calculated on a distance-based method, DEFRA also publish energy figures on a per km basis (for the purposes of SECR reporting within the United Kingdom) that may be used to obtain an estimate on the energy use of the fleet.

The breakdown of energy and associated emissions by fuel is listed in the table below, with no distinction made between diesel used in owned vehicles and diesel used for on-

site generators. Note that the table below does not consider any fugitive emissions from the loss of refrigerant gases.

Category	Energy (kWh)	% of Total by Energy	CO_2e (Tonnes)	% of Total by CO_2e (Non-Fugitive)
Petrol	3,493,274	35.27%	852.99	37.09%
Diesel	3,471,730	35.06%	900.46	39.16%
Propane	108,968	1.10%	24.18	1.05%
Oil	81,341	0.82%	20.31	0.88%
LPG	5,096	0.05%	1.09	0.05%
Natural Gas	2,742,565	27.69%	500.63	21.77%

Scope 1 Approximate Energy Mix



It is expected that there will be a further reduction in the next inventory to be conducted, as projects to eliminate diesel use at Pune and natural gas use in the UK take full effect. It is also expected that the fall in emissions from fleet vehicles will continue.

However, it is acknowledged that long-term, the emissions from the vehicle fleet pose the most significant challenge for decarbonisation of the A.E.S Engineering group of companies. Although within the UK there has been some success in the use of hybrid

and electric vehicles to minimise the emissions from the fleet (even in the face of increased usage), such efforts are much harder to implement across the group. There are significant fleet emissions from A.E.S subsidiaries based in the United States, South Africa, and Australia. In such locations, the distances covered are larger and the electric vehicle charging infrastructure is not as widespread as the United Kingdom. Such limitations mean that de-carbonisation policies effective in the United Kingdom are not practical in these regions, and A.E.S is unfortunately dependent upon action by local and national governments within these regions to make significant improvements.

Furthermore, it should be noted that in certain regions such as South Africa a move from conventional internal combustion engine vehicles to electric vehicles may have a counter-intuitive effect on emissions. The grid in South Africa is very carbon-intensive, and using an increased amount of electricity to charge electric vehicles will actually increase the Scope 2 emissions of the company by a greater amount than the corresponding reduction in Scope 1 emissions.

6 Scope 2

6.1 Purchased Electricity

Emissions from purchased electricity form the vast majority of Scope 2 emissions for A.E.S Engineering Ltd.

Data gathering was conducted with the assistance of local branch staff who advised on the purchase and consumption of electricity at the site. The primary source of evidence and data for this category is invoices from the utilities provider at the site, in certain cases meter readings from the start and end of the reporting period were also provided. In a similar case to that of natural gas use, certain invoices do not provide a meter reading and only a monthly consumption figure, whilst in other cases a single invoice displays an annual consumption of electricity.

Consumption is recorded in kWh and a relevant local emissions factor is used to convert to a carbon dioxide equivalent figure. This category in particular is where a large amount of different emissions factors are used to reflect the localised grids and networks from which different sites source their electricity. Where available, emissions factors published by a relevant national or regional government body are used. Should these not be available, emissions factors are primarily sourced from the most recent statistical profiles from the International Renewable Energy Agency. Please see the appendix for the full list of emissions factors used within this report.

As a result of the huge amount of variation in emissions factors, certain sites provide a disproportionately large amount of emissions to the overall figure within this category. Sites in South Africa and India for example have a very high emissions factor due to a very carbon-intensive local grid, and thus produce high emissions figures relative to their electricity use.

Note that both a location-based and a market-based total are provided, a number of sites purchase electricity on green tariffs. These sites being the UK sites belonging to AESSEAL plc, Warrington, Gloucester, Kronau, and Sauerlach. In addition the site of Rockford also purchases electricity, 90% of which is sourced from green sources. As these sites are some of the largest electricity users within the group, particularly the head office of Mill Close, approximately 58.94% of the group's electricity is sourced on a green tariff which is up from 57.9% in the previous inventory. Purchased electricity accounts for 54.33% of the total scope 1 and 2 emissions on a location-basis.

Note that both a location-based and market-based figure are reported below.

Sub-Category	Energy (kWh)	Market-Based CO_2e (Tonnes)	Location-based CO_2e (Tonnes)
On Green Tariff	4,988,190.18	0.00	1,242.17
Standard	3,474,965.39	1,534.44	1,534.44
Total	8,463,155.56	1,534.44	2,776.61

6.2 Purchased Heat

There are two sites across the group which purchase heat through the use of a district heating system, these being Sauerlach in Germany and Benelux (Breda) in the Netherlands. Sauerlach utilises heat from local geothermal sources, the usage in kWh has been multiplied by an emissions factor sourced from research into the life-cycle emissions of geothermal heating. Benelux is heated through waste heat from a local power station, the provider in this case offers a customs emissions factor specific to this grid.

The entire group purchased 223,148.42 *kWh* of heat energy during the reporting period, in total these sources result in emissions of 3.60 *tonnes* CO_2e which corresponds to 0.07% of the scope 1 and 2 total.

Category	Energy (kWh)	CO_2e (Tonnes)
Purchased Heat	223,148.42	3.60

6.3 Other

There are no other forms of purchased energy to report within A.E.S Engineering Ltd. during the reporting period.

6.4 Scope 2 Summary

Scope 2 Emissions for A.E.S Engineering Ltd. are comprised almost entirely of emissions due to purchased electricity, with the exception of just 3.60 tonnes due to energy sourced from district heating systems.

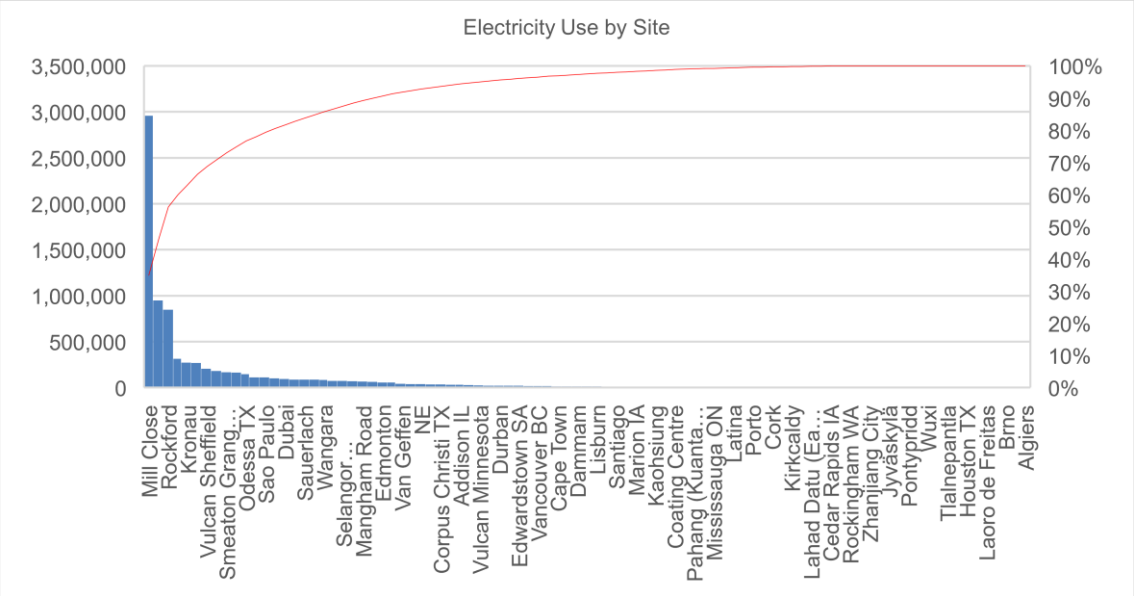
In comparison with the previously conducted inventory, scope 2 emissions have changed by -10.38% on a location-basis and by -22.88% on a market basis.

Total group electricity use (that falls within Scope 2) is mostly unchanged at -0.44% down from a figure of 8,500,175 kWh during the previous inventory. Numerous projects at the highest energy using sites in the UK, & India have come on-line during this reporting period and have acted to reduce the electricity consumption at these sites. This however has been mitigated by a further year of overall growth for the company, including further acquisitions in Canada & the United States.

Electricity purchased on a green tariff is up from the previous inventory and stands at 4,988,190.18 kWh, over half of which is attributed to the head office of Mill Close, Rotherham. Other significant electricity users on green or mostly green tariffs include the key manufacturing sites of Bradford and Rockford. As a result, the location-based equivalent of the group's green energy (and also the difference between overall market & location based figures) stands at 1,242.17 tonnes, an increase from 1,107.94 tonnes in the 2021-22 inventory. This is partly due to an increase in electricity use at existing green sites in the UK and partly due to this being the first inventory where Rockford was on a 90% green tariff for the entire duration of the reporting period.

There has been an increase of 21.58% in the use of purchased heat energy by the group. It should be noted however that this refers to only two sites in Germany and the Netherlands, and the increase in emissions as a result of this change is less than a tonne. Due to the very low contribution of purchased heat to both Scope 2 and overall Scope 1 & 2 emissions, there are no specific policies in place for reducing the energy from purchased heat at this time.

Electricity use (and thus Scope 2 emissions) are heavily skewed towards just a handful of the larger sites which handle manufacturing duties, with just three sites (Mill Close, Bradford & Rockford) accounting for roughly half of group electricity use:



The head office of Mill Close, Rotherham accounts for roughly a third of group electricity use at 34.95% of the group electricity total. In terms of environmental work, this centralised approach to manufacturing benefits the group for multiple reasons. Although not truly reflected within the figures, the products purchased by the multiple subsidiaries and sites are primarily manufactured at Mill Close where energy is purchased on a green tariff. Furthermore, the concentration of energy use amongst a select few sites means that concentrating resources on environmental projects at these sites allows a significant benefit from only a relatively small number of projects.

Category	Energy (kWh)	Market-Based CO_2e (Tonnes)	Location-based CO_2e (Tonnes)
Electricity On Green Tariff	4,988,190.18	0.00	1,242.17
Standard Electricity	3,474,965.39	1,534.44	1,534.44
Purchased Heat	223,148.42	3.60	3.60
Total	8,686,304	1,538.04	2,780.21

7 Scope 1 & 2 Summary

Emissions for Scope 1 & 2 are summarised below, Scope 2 emissions are shown purely on a location-basis.

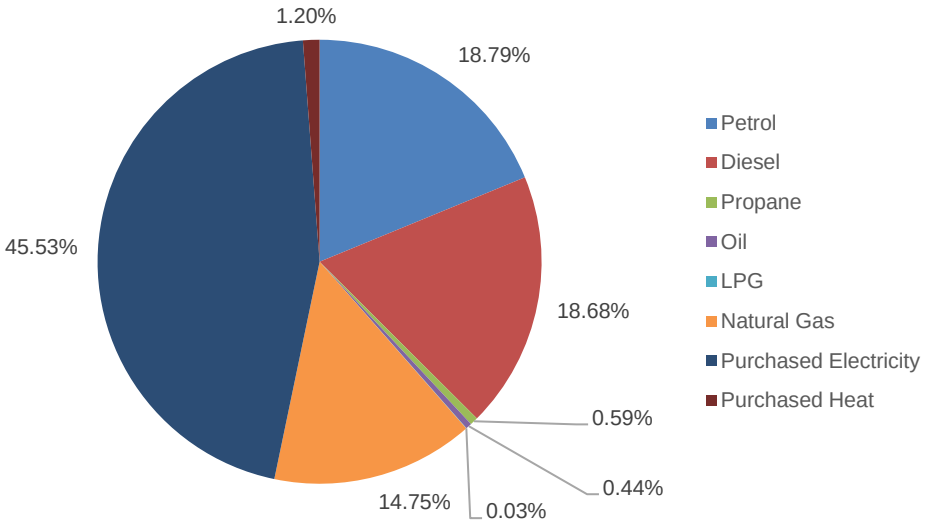
Category	Energy (kWh)	CO_2e (Tonnes)
Fleet – Petrol	3,493,274	852.99
Fleet – Diesel	3,025,007	788.28
Fleet – Hybrid	186,736	45.88
Natural Gas	2,742,565	500.63
Propane	108,968	24.18
Diesel	259,987	66.30
Oil	81,341	20.31
LPG	5,096	1.09
Fugitive Emissions	0.00	30.66
Purchased Electricity	8,463,156	2,776.61
Purchased Heat	223,148	3.60
Total	**18,589,279**	**5,110.55**

Scope 1 & 2 emissions are dominated by purchased electricity, fleet emissions, and natural gas use. Together these three sources account for 97.14% of Scope 1 and 2 emissions. Encouragingly, all three of these categories have seen a reduction from the previous inventory despite an increase in the size of the company.

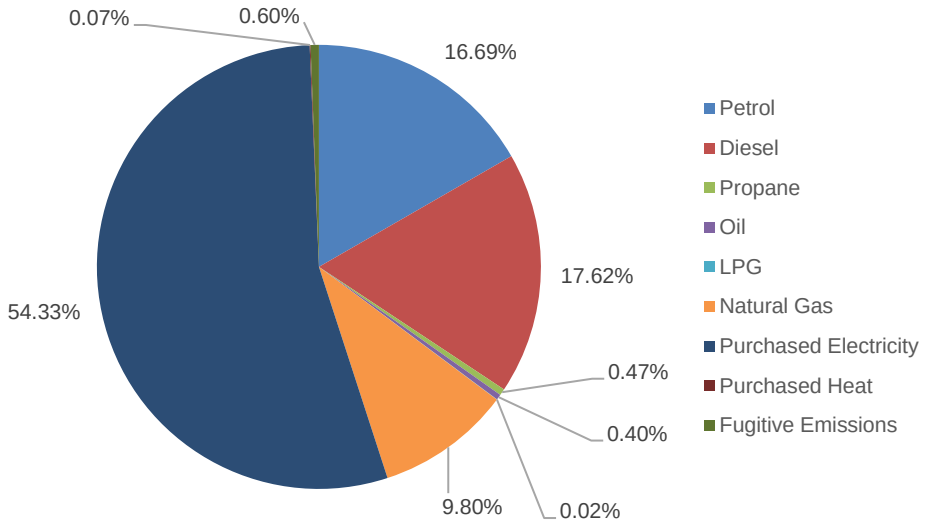
Category	Previous	Current	Change
Fleet	1,758.96	1,687.15	-4.08%
Natural Gas	515.14	500.63	-2.82%
Purchased Electricity (Location-based)	3,099.36	2,776.61	-10.41%

It is also possible to demonstrate the overall energy mix of A.E.S Engineering Ltd. associated with Scope 1 & 2 emissions, note that in the below graphs, energy and emissions associated with hybrid vehicles falls under 'diesel'.

Scope 1 & 2 Approximate Energy Mix



Scope 1 & 2 Emissions by Source



As can be observed, Scope 2 emissions for the group are more carbon intensive than Scope 1. Scope 2 accounts for 46.73% of group energy use, but accounts for 54.40% of emissions. The average intensity of Scope 1 and 2 emissions are 0.2353 and 0.3201 kg CO_2e / kWh respectively.

8 Scope 3

8.1 Category 1: Purchased Goods and Services

Category 1 is the single largest source of emissions for A.E.S Engineering Ltd. Calculation of this category has been undertaken on a spend-based approach, there is insufficient data available from the many suppliers and products involved that a supplier-specific approach is not practical to undertake.

As a result, a spend-based approach is used, utilising emissions factors from the World Input Output Database released in 2013. Please see the appendix for further details on this approach.

Use of these emissions factors requires conversion both from the local currency to US dollars and from present prices to those of the emissions factors as per the GHG protocol. Conversion to US dollars is done on an average exchange rate representing the reporting period from *01-10-2022* to *30-09-2023*. Values for major currency exchange rates are published by the IMF and are available at https://www.imf.org/external/np/fin/data/param_rms_mth.aspx. The average of all available data points falling during the reporting period will be taken for each respective currency.

Once converted to USD, inflation will be accounted for between September 2012 (the prices used in the release of the WIOD) and April 2023, the mid-point of the reporting year. Inflation data is sourced from the US Bureau of Labor Statistics, available at https://www.bls.gov/data/inflation_calculator.htm.

Data sources for this category are the ERP systems through which the various AESSEAL companies operate. Many companies across the group use SAP, although data has been sourced from other systems where they are in use.

Purchased goods and services are assigned to a relevant category within the WIOD database. A significant proportion of line items had already been assigned to categories following the previous inventory, although a large amount of line items were manually assigned to a category for the purposes of this report.

This category is very significant for AESSEAL plc, due to the business model of the company many of the smaller subsidiaries purchase items from AESSEAL plc and thus do not see as significant a Category 1 figure. This business model does create additional complexities when considering a single entity or subsidiary within the A.E.S Engineering Group as an isolated case. As mentioned above, there is frequent purchasing of goods between A.E.S companies, primarily (but not exclusively) regional A.E.S subsidiaries

purchasing from AESSEAL plc. In order to correctly calculate emissions, emissions are calculated when goods or services first 'enter' the group of companies when they are purchased from an external source. Failure to do so would result in significant double-counting of emissions if an item such as an O-ring is purchased by AESSEAL plc and then subsequently purchased from AESSEAL plc by a subsidiary. Note that this method does mean that single subsidiaries in isolation may be misleading, as the supply chain emissions of that entity are being covered by another A.E.S company.

Category 1 remains the most significant of all scope 3 emissions and contributes 63.15% to the overall scope 3 total.

Category	2012 USD Value
Agriculture, Hunting, Forestry and Fishing	$119,401.92
Mining and Quarrying	$173,316.95
Food, Beverages and Tobacco	$189,982.56
Textiles and Textile Products	$334,986.76
Leather, Leather and Footwear	$12,131.56
Wood and Products of Wood and Cork	$325,779.10
Pulp, Paper, Paper , Printing and Publishing	$1,980,587.66
Coke, Refined Petroleum and Nuclear Fuel	$53.42
Chemicals and Chemical Products	$1,760,525.25
Rubber and Plastics	$7,816,030.28
Other Non-Metallic Mineral	$7,963,712.30
Basic Metals and Fabricated Metal	$18,448,551.12
Machinery, Nec	$1,765,811.93
Electrical and Optical Equipment	$1,703,819.96
Manufacturing, Nec; Recycling	$19,136,828.37
Electricity, Gas and Water Supply	$1,464.66
Construction	$811,909.91

Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	$318,562.08
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	$3,873,304.06
Hotels and Restaurants	$364,004.59
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	$2,365.64
Post and Telecommunications	$244,227.43
Financial Intermediation	$34,549.23
Health and Social Work	$32,209.42
Total	$67,414,116.13

Category	CO_2e (Tonnes)
Category 1	81,972.29

8.2 Category 2: Capital Goods

Calculation methods for category 2 are identical to those of category 1, as per the GHG protocol however a distinction is made for capital expenditure. Data sources for this category gain vary depending upon how integrated the entity is within group systems. Companies using SAP will log capital purchases within regular purchasing data as assets, whilst certain entities report this data for the purposes of the inventory on an ad-hoc basis.

Category 2 is a particularly significant source of emissions for the largest subsidiary AESSEAL plc, note that the spend by A.E.S Engineering Ltd. itself is also allocated to the head office at Mill Close and thus is reported alongside capital expenditure of AESSEAL plc. During the reporting period there has been significant capital expenditure both by A.E.S Engineering Ltd. and AESSEAL plc. The head office of Mill Close has seen a significant expansion in an ambitious construction project, this began during the previous inventory and continued throughout the duration of this inventory. Furthermore, the 29 by 29 environmental commitment consists of spending by A.E.S Engineering Ltd. and as discussed within section 11 of this report, there have been multiple large spend environmental projects during this reporting period. Furthermore, in general it is common

practice for assets to be purchased by AESSEAL plc and purchased from AESSEAL plc if needed by other group companies.

As a result of this, there has been a significant increase of 24.17% from the previous figure of 6,783.44 seen in the previous inventory. Category 2 now stands at 8,423.21 tonnes of carbon dioxide equivalent, contributing 6.49% of the group's total scope 3 emissions.

Category	CO_2e (Tonnes)
Category 2	8,423.21

8.3 Category 3: Fuel and Energy-Related Activities Not Included in Scope 1 or Scope 2

Category 3 consists of the additional fuel and energy related activities that are not directly calculated within Scopes 1 & 2. This refers to cases such as the emissions due to losses of transmission and distribution in electricity grids, as well as the well-to-tank emissions of combustible fuels.

The data sources for this category are therefore the same as those seen within Scope 1 & 2. The category 3 emissions from Scope 1 are calculated using DEFRA emissions factors. DEFRA publish well-to-tank emissions factors for combustible fuels, and well-to-tank distance-based emissions factors for vehicles. DEFRA also publish emissions factors for the well-to-tank emissions of electricity grids, transmission and distribution losses prior to sites are calculated using local emissions factors or from the reported gross grid loss of the respective grid using the same methodology by which the United States Environmental Protection Agency recommends calculating transmission & distribution emissions.

This category is broadly proportional to the Scope 1 & 2 emissions of a site, with some variation due to the varying gross grid loss and carbon intensity of the different electrical grids. This category contributes 1.16% to the overall Scope 3 total.

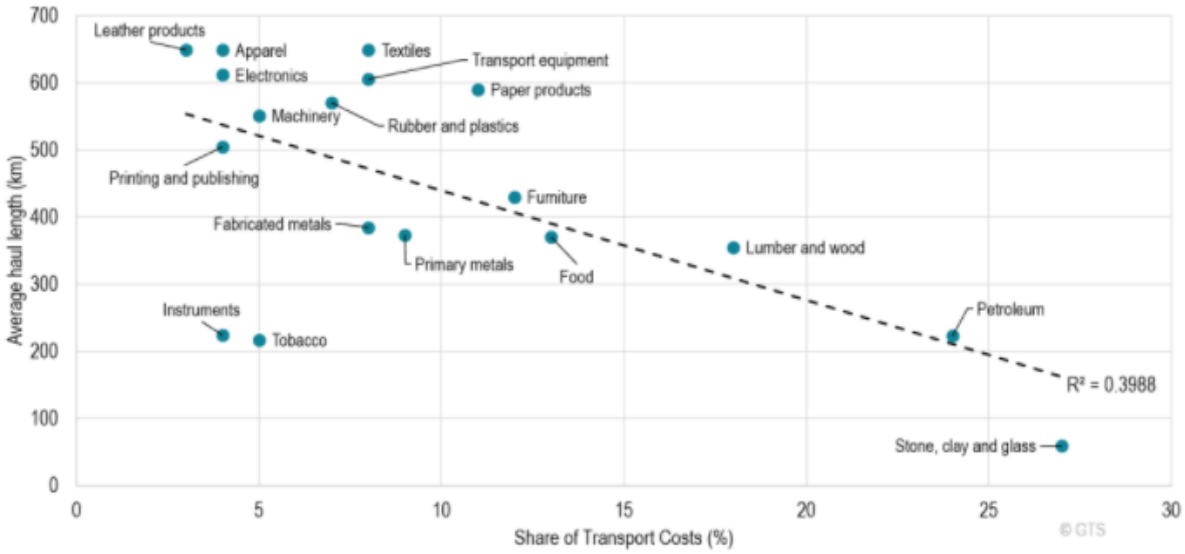
Category	CO_2e (Tonnes)
Category 3	1,508.23

8.4 Category 4: Upstream Transportation and Distribution

Category 4 emissions are to be calculated using the purchase orders of group companies within the reporting period. At present, there is insufficient data available on fuel consumption during shipping, or enough information to accurately assess the mass, and distance that items have travelled. Efforts are ongoing in future to record and tabulate weights of components and items within SAP which would allow a more accurate distance-based calculation to be carried out. However, at present this data is not available outside a limited proportion of the purchases made by AESSEAL plc.

As per the GHG protocol, a spend-based method will be used instead. Available data consists of supplying company, receiving company, item description and purchase order value. In order to make a spend-based calculation, a flat-rate proportion of the purchase order value is assumed to go towards the transport and distribution of that order. This value will then be used with Environmentally Extended Input-Output emissions factors for Inland transport, Air, and Water transport from the WIOD 2009 database. These are the same emissions factors used for spend-based calculations by the Quantis Scope 3 calculator.

When assessing the proportion of purchase order data that goes towards transport, a flat rate of *15%* has been chosen. This figure has been taken from data compiled on the transport of goods within the United States. [*The Geography of Transport Systems, FIFTH EDITION. Jean-Paul Rodrigue. New York: Routledge. ISBN 978-0-367-36463-2. 2020*].



% Share of transport costs for various types of good.

Using the data sourced for category 1 from SAP, just under half of purchased items by AESSEAL plc fall into the category of *Rubber and plastics* or *Basic metals and fabricated metal*.

AESSEAL plc (2022-2023 Data)	No. of orders	% Share
Rubber and plastics	12,120.00	25.2%
Basic metals and fabricated metal	11,281.00	23.5%
Remaining	24,659.00	51.3%
Total PO Orders	48,060.00	100.0%

The majority of purchased items for plc have a % share of transport costs below *10%*, (Rubber & plastics ≈ 7%, primary metals ≈ 9%, fabricated metals ≈ 8%, machinery ≈ 5%). It is likely that in assigning a flat rate to all purchase orders, this figure would be less than *10%* given the make-up of purchase orders. To be overly-conservative as a result of the assumptions that have been made, a higher figure of *15%* has been implemented. As this higher figure does not represent a benefit in any other capacity, it is justifiable through representing an over-estimate of emissions from these categories.

Calculated separately from the above are the cases where AES companies have utilised the services of third-party couriers such as UPS or DHL for transport of components and products to other AES companies or customers. Note that there is significant variation amongst the group companies as to the proportion of items that go to either internal or external companies due to the structure of the business. AESSEAL plc manufactures and supplies products which are then sold and distributed to smaller AESSEAL subsidiaries for onwards sale. As a result of this, a significant proportion of the deliveries that AESSEAL plc pays for are to other AES companies. For these smaller companies however, the vast majority of deliveries are to end-users, with only some shipment to other AES locations.

For the most significant and some representative sites, data has been collected on the use of third-party logistics couriers to make a calculation of emissions. This calculation is ideally based upon weight, distance, and mode of transport though some assumptions have been made where all the above data is not available.

Logistics of both inbound and outbound goods falls under the Scope 3 categories 4 & 9, depending upon the subsidiary that is paying for this shipment to take place. Although ultimately all contributing to the same grand total for A.E.S Engineering Ltd., due to the integrated supply chain of the business there is difficulty and lack of clarity in distributing these emissions between the various AES companies.

Categories 4 and 9 refer to upstream and downstream transportation and distribution logistics respectively. However, it should be noted that an important distinction is that when logistics services have been paid for by the company, these are considered upstream as they are a purchased service. Category 4 thus refers to logistics paid for by

the company and emissions from the transport of products into the company regardless of who has paid this cost. Category 9 refers to downstream logistics, these being cases where a customer or third-party has covered the cost of shipping from an AES site.

As such, where emissions are calculated using the flat-rate method from company purchases, these emissions will be assigned to category 4. This will remain the case even when these purchases are from another AES company, due to the transport of these goods being covered (the majority of the time) by the receiving company. These datasets will be used to scale the entities where such a calculation was not carried out as per standard practice for this inventory.

Where emissions have been calculated from data provided by logistics companies, this will again fall under category 4. This being deemed as upstream as it is a purchased service by the purchasing company.

Category 4 thus ends up being one of the most significant categories of emissions for the entire group at 23.82% of the scope 3 total, behind only the emissions from purchased goods and services within Category 1.

Category	CO_2e (Tonnes)
Category 4	30,926.55

8.5 Category 5: Waste Generated in Operations

Category 5 concerns emissions due to waste produced from A.E.S Engineering sites. The business has run environmental management systems for many years with the majority of operational sites maintaining certification to ISO 14001. The largest entity within the group AESSEAL plc first gained ISO 14001 in 2003. This has driven down the amounts of waste generated. That which is generated is diverted away from landfill where possible using the hierarchy of reduce, reuse, recycle and recover. For non-operational sites the levels of waste generated are generally very low, as a result this category is a relatively low contributor to the overall value chain emissions.

For this category it was not always possible to determine with a high level of confidence the means of disposal across the entire group. It is acknowledged that this category is one of the areas for which data quality is lowest, and uncertainty is highest. In cases where it could not be determined with a reasonable level of confidence that the waste was recycled or reused, it was assumed that landfill was the default method of disposal.

Data on waste disposal is primarily obtained from receipts and invoices documenting either the mass, or volume of waste collected and disposed of. The majority of invoices do not provide a mass of waste collected or disposed of, it is common only for invoices to provide the container volume or class of container that was collected from site. In such cases it is assumed that any container collected was full to its' maximum capacity at the time of collection.

The mass of waste was then used in conjunction with DEFRA emissions factors to provide a carbon dioxide equivalent figure. Category 5 contributes only 0.16% to the overall scope 3 figure.

Category	CO_2e (Tonnes)
Category 5	207.88

8.6 Category 6: Business Travel

Data for business travel for all group companies was collected from local accounts records. The data included business travel from flights (both long haul and short haul), trains, taxis, hire cars, grey fleet and hotel stays.

Data collection for this category was again highly dependent upon the assistance of local branch heads for gathering data. Methods for data collection varied significantly across group subsidiaries and sites, the primary source of data for this category was accounting and financial records relating to expensed travel.

Calculation methods varied significantly across this category depending upon the particular form of travel being accounted for. Business flight emissions are calculated on a passenger kilometre basis using DEFRA emissions factors, specific emissions factors are chosen on the basis of flight distance as distinction is made between short, medium or long-haul flights. Distance for flights were calculated from the straight line distance between the origin and destination.

Transport via train and taxi was calculated in a similar manner to that of flights using the origin and destination (if available) to estimate distance. DEFRA emissions factors were applied for conversion to CO_2e, note that for taxi journeys an average petrol car was used as a default emissions factor in absence of information on the vehicle used.

In specific cases where it was not possible to determine a journey and an origin or destination was not available, the standard approach in such cases was to use the cost-distance ratio of the remaining data points (or that of AESSEAL plc as the largest source of data) and apply this to the expensed entry cost.

Also included in this category are emissions from hired vehicles, note that in certain cases a leased vehicle fleet was used in a similar manner to an owned vehicle fleet. Calculation methods in this case were the same as those of an owned vehicle fleet, however emissions were allocated to category 6 instead of scope 1.

Hotel stays are also accounted for where appropriate, DEFRA emissions factors for hotel stays are the only source of emissions factors for this particular category and subset. Hotel stays are broken down by nights stay and country, source of data for this category and subset are again expense records from accounting departments.

Category	CO_2e (Tonnes)
Grey Fleet	911.36
Air Travel	1,232.71
Taxis	14.58
Trains	6.02
Hotels	138.43
Other	144.16
Total	2,447.25

Air travel is one of the largest sub-categories within category 6, and the emissions from air travel may be further broken down as shown.

Category	CO_2e (Tonnes)
Domestic, to/from UK	73.28
Short-haul, to/from UK	61.82
Long-haul, to/from UK	597.37

International, to/from non-UK	500.24
Total	1,232.71

This table shows the emissions due to air travel broken down by the emissions factor by which they were calculated, these correspond to the DEFRA emissions factors used for the calculation of carbon dioxide equivalent emissions. In total category 6 contributes 1.89% to the overall scope 3 total.

Category	CO_2e (Tonnes)
Category 6	2,447.25

8.7 Category 7: Employee Commuting

Category 7 is an area where calculation method may vary in order to fit the form of data that is available for each particular site. Some sites were able to provide a detailed breakdown of distance commuted, alongside mode of transport or even vehicle used. Others are only able to provide a breakdown by mode of transport or rough estimates on distance travelled. Ultimately in all cases, this category is a distance-based calculation using emissions factors from DEFRA. This category contributes 1.92% to the overall scope 3 total.

Category	CO_2e (Tonnes)
Category 7	2,497.12

8.8 Category 8: Upstream Leased Assets

This category refers to specific cases relating to leased/rented properties. In certain cases, a rented site may use electricity or gas but is neither billed for consumption nor is it possible to properly assign electricity or gas use to this site. This is particularly common for sites which consist of a single rented unit within a larger commercial premises. Such sites may not have their own specific gas or electric meter, but instead use electricity and gas that is common to the building and is included as part of rent payments. In such cases, emissions arising from the use of these utilities fall under Scope 3, Category 8 instead of Scope 1 or 2.

By the very nature of the category, emissions within this category are entirely scaled. The data gathered for Scope 1 and 2 is used to estimate the utility usage for these rented sites, in the same method and manner as described previously for any gaps in Scope 1 and 2 data.

In total, there are 13 cases of sites having some shared use of a utility for which they are not directly billed. All of these sites are either electricity or natural gas with the exception of Jyväskylä, Finland, where the A.E.S site in question is part of a larger building which has a communal electricity supply and a communal oil heating system. In total, category 8 contributes 0.23% to the scope 3 total.

Category	CO_2e (Tonnes)
Category 8	295.54

8.9 Category 9: Downstream Transportation and Distribution

For details on the calculation of this category, please see the previous section on Category 4 for details.

Category	CO_2e (Tonnes)
Category 9	911.57

8.10 Category 10: Processing of Sold Products

Category 10 does not hold any relevance to A.E.S Engineering Ltd. All manufacturing and production work of A.E.S products are carried out at A.E.S manufacturing sites or repair centres.

8.11 Category 11: Use of Sold Products

The vast majority of products sold are passive in nature, there is no consumption of electricity or fuels in use. There are however three products sold that operate with an electrical input, these being the PumpPac, FDU, and FDSC systems sold by AESSEAL plc.

A worst-case scenario is assumed where the system is assumed to be operating continuously over the entire life cycle of the product. This total time in use is multiplied

by the maximum power draw of the product to result in a total lifetime energy use for that system.

This total energy use is multiplied by a custom emissions factor of 0.5668 *kg CO_2e/kWh*, which is an average of the UK, USA, China, India, South Africa, and Australia. This is used to represent a worldwide average emissions factor into which these products are sold.

In total these 19 systems sold are estimated to consume 915,420 *kWh* throughout their entire lifespan, in total this results in 518.83 *Tonnes CO_2e* and contributes 0.40% to the overall scope 3 total.

Category	CO_2e (Tonnes)
Category 11	518.83

8.12 Category 12: End-of-Life Treatment of Sold Products

Category 12 refers to the end-of-life disposal of sold products during the reporting period. The business model of A.E.S Engineering Ltd. does allow for frequent re-working and 're-lifing' of products, however all products sold must eventually be disposed of.

Almost all the construction materials can be recycled or recovered due to metals making up the vast majority by mass of sold products, and it being cost effective and logical to recycle metal. Subsequent emissions from this disposal are assessed using DEFRA emissions factors for landfill and metal recycling alongside an estimate of the total mass of products sold during the reporting period. A conservative estimate of 90% being recycled and 10% going to landfill is made for the primary products sold by AESSEAL companies.

Mass of product sold is unfortunately not recorded across the A.E.S group, as a result two methods are used to estimate the mass of product sold for the manufacturing sites. Where sufficient quality data allows, data from logistics companies such as DHL or UPS is used to record the mass of packages leaving the site as an estimate for the mass of the products sold. This is likely an overestimate of the total mass of products, as there will be a portion of these package journeys that are transfer of components and products between A.E.S sites and not sold products. Should logistics data not be available, the waste metal of the manufacturing sites is taken as a starting point. This is combined with an assessment conducted of the % of purchased metal by weight that goes into final

product to calculate the mass of product sold. The DEFRA emissions factors for landfill and recycling are used to arrive at a total CO_2e figure.

Conducted slightly differently is the category 12 figure for ProPack AG, a subsidiary of A.E.S Engineering Ltd. based in Germany. The primary product sold by ProPack is gland packing, which is subject to fouling and heating through its' use and is therefore assumed to not be recyclable at end of life. The sales data of ProPack is consulted to arrive at a mass of packing sold during the reporting period, this mass is used with the DEFRA emissions factor for landfill to provide an emissions figure.

Those manufacturing sites involved in mechanical seals and support systems result in the emissions of 78.97 Tonnes CO_2e, whilst ProPack is responsible for a further 24.14 *Tonnes CO_2e.* Category 12 contributions to the overall scope 3 total stands at 0.08%.

Category	CO_2e (Tonnes)
Category 12	103.11

8.13 Scope 3 Summary

Overall Scope 3 emissions stand at 129,811.59 tonnes, a small increase of 0.90% on the previous figure of 128,655 tonnes. The increase in Scope 3 emissions has been driven by increases in emissions from categories 2, 4 and 6 with each category seeing increases of 24.17%, -25.14%, and 37.58% respectively.

It was expected that these categories would see increases due to the expansion of the group of companies from the previous year. Expansion of the group has likely resulted in increased inter-company and to customer logistics as well as increased business travel. There were numerous acquisitions during the previous inventory, these businesses have seen repeated visits from upper management and local A.E.S subsidiaries as part of their integration which has contributed to an increase in business travel. This is unfortunately expected to continue into the following inventory.

Emissions from Category 2 are those associated with capital investment, this was again expected due to the increased expenditure as a result of numerous projects being undertaken throughout the group. The expansion of the head office of Mill Close, Rotherham continued throughout this reporting period as did the construction of a new head office for AESSEAL Australia in Brisbane. Furthermore, expenditure as part of the

29 by 29 program of environmental spending although acting to reduce the groups Scope 1 and 2 emissions also has an initial negative impact associated with its capex.

As with the previously conducted inventory, Scope 3 emissions are dominated by Categories 1 & 4 at 63.15% and 23.82% of the Scope 3 total respectively. Both of these categories are strongly linked to the supply chain of the company and its' performance in general, A.E.S unfortunately exercises little control with which to reduce the largest categories of Scope 3 emissions.

Category	CO_2e (Tonnes)
1	81,972.29
2	8,423.21
3	1,508.23
4	30,926.55
5	207.88
6	2,447.25
7	2,497.12
8	295.54
9	911.57
10	0.00
11	518.83
12	103.11
Total	129,811.59

9 Summary

Scope	Category	CO_2e (Tonnes)
1	Fleet Emissions	1,687.15
1	Natural Gas	500.63
1	Other Consumed Fuels	111.87
1	Fugitive Emissions	30.69
1	**Scope 1 Total**	**2,330.34**
2	Purchased Electricity (Location-based)	2,776.61
	Purchased Electricity (Market-based)	1,534.44
2	Purchased Heat	3.60
2	**Scope 2 Total (Location-based)**	**2,780.21**
2	**Scope 2 Total (Market-based)**	**1,538.04**
3	Category 1: Purchased Goods and Services	81,972.29
3	Category 2: Capital Goods	8,423.21
3	Category 3: Fuel and Energy-Related Activities Not Included in Scope 1 or Scope 2	1,508.23
3	Category 4: Upstream Transportation and Distribution	30,926.55
3	Category 5: Waste Generated in Operations	207.88
3	Category 6: Business Travel	2,447.25
3	Category 7: Employee Commuting	2,497.12
3	Category 8: Upstream Leased Assets	295.54
3	Category 9: Downstream Transportation and Distribution	911.57
3	Category 10: Processing of Sold Products	0.00
3	Category 11: Use of Sold Products	518.83
3	Category 12: End-of-Life Treatment of Sold Products	103.11
3	**Scope 3 Total**	**129,811.59**

Scope	Category	CO_2e (Tonnes)
1 and 2	**Scope 1 and 2 Total (Location-based)**	5,110.55
	Scope 1 and 2 Total (Market-based)	3,868.38
3	**Scope 3 Total**	129,811.59
All	**All Scopes Total (Location-based)**	134,922.13
	All Scopes Total (Market-based)	133,679.96

10 Uncertainty & Estimates

A.E.S acknowledges that although every care has been taken to be as diligent as possible, for an undertaking of this size across the group there is always a degree of uncertainty. This section aims to quantify this uncertainty for the purposes of transparency and further improvement.

Throughout this inventory, efforts have been undertaken as per the ISO 14064 standard, to be conservative in cases of incomplete or unclear data. This means taking a worst-case scenario to over-estimate emissions should sufficient data be unavailable to prove otherwise.

Quantified uncertainty is the result of activity error, emissions factor error, and the scaling error. The activity error is the estimated uncertainty on the activity data figures with which emissions are calculated. The emissions factor error is the uncertainty on the accuracy of the emissions factors themselves, these are not published and are thus estimated at one percentage point per year since the factors were published. The scaling error, any uncertainty within the scaled figures as a result of the scaling approach.

10.1 Scaling

As mentioned previously, an approach was taken where certain data points are calculated and others are scaled. This varies between scope, with the vast majority of Scope 1 & 2 emissions sources being directly calculated whilst those it was not possible or reasonably practical to obtain were scaled. As focus was aimed at the largest and most significant sites, those sites which are scaled are the smaller subsidiary or satellite sites of regional head offices. For Scope 3, the most significant and also a sample of representative entities have had full datasets calculated whilst the smaller entities have their Scope 3 emissions scaled. Due to the business model of A.E.S Engineering Ltd, this introduces an inherent overestimation as the entities which are most emissions intensive are used as data points to scale the least emissions intensive data points.

To recap the scaling method, linear regression or single regressor models are used to scale emissions. Each data point is an emissions figure for a particular category for a particular site, e.g. fleet emissions for Mill Close is a single data point. Every data point which has been directly calculated is plotted on a graph with emissions on the *y-axis* and the headcount of the site as the *x-axis*. The only exceptions to this being fleet emissions, where the *x-axis* is the number of vehicles for that site, and purchased electricity where the *y-axis* is electricity consumption in kWh. These two cases are to better represent estimated fleet distance and to allow for the high degree of variation in grid emissions factors respectively. Once this graph is plotted, a linear regression model is used to

calculate the relationship between the measured data points and the independent variable. In cases where the *y-intercept* falls below zero, a single regressor model is used. The equation for this relationship is then used to calculate the scaled data points using the headcount of number of vehicles for all the data points that need scaling.

In certain cases, calculated data points have been excluded from the regression models but still carried towards the final total. This is the case for data points which are not representative of the other sites or may be considered outliers to the overall trend for that particular category.

Scaling is aimed to be kept to a minimum in order to reduce the uncertainty on the final figure. A key measure of the uncertainty on any scaled figures is from how many data points the regression model has been calculated, a regression model based on a greater number of calculated data points can be considered to be more reliable. Similarly there will be scaling error on any scaled data point, and reducing the number of data points that require scaling thus reduces the total error for that category.

By Number of Data Points	Calculated %	Scaled %	Total %
Scope 1	92.81%	7.19%	100.00%
Scope 2	94.12%	5.88%	100.00%
Scope 3	67.53%	32.47%	100.00%
Total	78.36%	21.64%	100.00%

Note however that it all the larger and more energy-intensive manufacturing sites are calculated whilst the scaled data points are made up of smaller less significant sites. Thus observing purely on the number of data points is not a true representation as a single ‘data point’ such as purchased electricity – Mill Close, will be substantially greater than the combined purchased electricity emissions of many of the smaller sites. As a result, the % of emissions data that is scaled is less than that of the number of data points themselves.

By Emissions	Calculated %	Scaled %	Total %
Scope 1	88.02%	11.98%	100.00%
Scope 2	85.93%	14.07%	100.00%
Scope 3	85.51%	14.49%	100.00%

Total	85.56%	14.44%	100.00%

To give a true representation of the level of data that has been directly calculated to that which has been scaled from the calculated data, it is necessary to 'weight' each data point as to its significance towards the overall total. To do this, each data point may be multiplied by the independent variable to give it a value that reflects its significance. The calculated versus scaled totals for the inventory are shown below.

By Emissions	Calculated %	Scaled %	Total %
Fleet	92.58%	7.42%	100.00%
Natural Gas	98.54%	1.46%	100.00%
Other Fuels	99.80%	0.20%	100.00%
Purchased Electricity	97.35%	2.65%	100.00%
Category 1	97.99%	2.01%	100.00%
Category 2	97.75%	2.25%	100.00%
Category 4	97.63%	2.37%	100.00%
Category 5	94.18%	5.82%	100.00%
Category 6	96.90%	3.10%	100.00%
Category 7	92.17%	7.83%	100.00%
Category 9	0.00%	100.00%	100.00%

Note that due to the methods by which logistics emissions are reported, Category 9 will always consist of fully scaled data points. This is because those sites/entities for which data was available are those who provided data from paid courier services which under the GHG protocol would fall under Category 4 and not Category 9.

Another determining factor of the uncertainty on the final figure with regards to scaling is the quality of the regression from the calculated data sets. A clear relationship between emissions and headcount leads to a higher degree of confidence in this relationship holding for those sites which are scaled using headcount as a measure. The quality of this relationship is measured by the coefficient of determination, denoted by R^2.

Category	R^2

Fleet	0.8167
Natural Gas	0.8109
Other Fuels	0.0179
Electricity	0.8797
1	0.9529
2	0.8218
Inbound Logistics	0.5289
5	0.2400
6	0.7750
7	0.9947
Outbound Logistics	0.7991

Do note however in the above table that inbound and outbound logistics are listed, as due to the distinctions of the GHG protocol some outbound logistics are later reassigned to category 4.

Coefficients of determination are encouragingly high for the majority of categories where scaling is necessary. There are two exceptions to this, these being Other Fuels and Category 5. Fortunately, both of these categories contribute a small amount in terms of carbon emissions relative to the overall totals. The error on the scaled values, although high relative to the category is therefore low relative to the overall totals in Scopes 1, 2, and 3.

Note that with the scaling of Natural Gas emissions, it is necessary to exclude a large number of calculated data points from the scaling method in order to not underestimate emissions. Sites in general may be divided between those that operate a space heating system (primarily natural gas) and those that do not due to their location and climate. Any ‘calculated’ data points which consist of sites which have no natural gas use are excluded from the scaling for this category. This is done so in order to not artificially skew the scaling of natural gas sites by including sites which report zero emissions within this category.

Category 5 refers to emissions from waste produced by group sites, it is acknowledged that this category is an area where data quality is poor. Accurate data on waste has been

found to be hard to source at many sites, few sites keep records on the mass of waste produced aside from scrap metal collections. Accordingly, in many cases the mass of waste is therefore estimated from the volume of waste collections from the site, which itself has a high amount of variation as a metric. Volumes are assumed to be the maximum volume of the container collected as a worst-case scenario in absence of any detailed data. Furthermore, the poor correlation of this category is somewhat attributed to natural high variation between emissions of this category between sites, and some artificial variation which is introduced into the emissions figures from the lack of detail and availability of emissions factors.

Considering first the natural variation, emissions from the disposal of waste produced are highly dependent upon the means of disposal. The means of disposal are themselves highly dependent upon local conditions, legislation, and availability of recycling services in proximity to the site. Sites which produce similar volumes of waste may therefore see significant differences in resultant emissions as a result of local services. For example, in Germany all landfill waste has been eliminated, whilst elsewhere a similar site may see much higher emissions as a result of landfill being the standard method of disposal within that country or region. Secondly, emissions factors for the disposal of waste are not available outside the published emissions factors by the UK DEFRA figures. These figures do not properly distinguish between emissions from the recycling of different waste streams, only distinguishing between the emissions of landfilling different waste streams. As a result, even a small amount of landfilled waste may inflate a sites Category 5 emissions relative to another site which produces a larger volume of recycled waste.

Coefficients of determination are encouragingly high for the majority of categories where scaling has taken place. Categories with weaker correlations such as category 2 and 5, are also less significant to the overall total in terms of the impact of this poor correlation. Category 2 has few entities to be scaled whilst Category 5 contributes very little to overall emissions totals.

There are however difficulties concerning the use of bottled gases and other fuels at the smaller scaled sites which were not contacted for data collection for the inventory. Fortunately this only concerns a very small number of sites and consequently a very small number of associated emissions. Problems arise with developing a strong correlation in this category due to the different uses of other fuels at the sites which consume them. For example, the single largest site of Mill Close which has the largest number of employees has only a very small amount of associated emissions due to the use of a single forklift. Whilst a much smaller site, such as Cork, has higher emissions

due to its use of other fuels for the purposes of heating. As with natural gas, sites which have zero emissions from other fuels are excluded from the scaling in order to not under report emissions.

10.2 Fleet Emissions

Concerning fleet vehicles, calculations for fleet emissions have been predominantly made using a distance-based method from the mileage of company vehicles during the reporting period. In certain cases, a more accurate fuel-based method has been used as data on fuel consumption is recorded for these entities. In general however, the accuracy of these figures is dependent upon the accuracy of which the mileage of these vehicles is recorded. As this is data that is tracked and recorded by the vehicle as in use, accuracy in terms of measurement of the distance covered is assumed to be high.

However, methods with which to verify and corroborate odometer mileage varies significantly across group companies due to the difference in management of fleet vehicles. In some cases such as AESSEAL plc, personal and business miles may be compared to records on the odometer to ensure accuracy, whilst elsewhere only the mileage of the vehicles is recorded without any supporting data collection to verify the mileage is a true representation of company use. As a result of these limitations, activity data on fleet mileage is assumed to be only 95% accurate.

10.3 Natural Gas

Activity data for natural gas use is collected predominantly from invoices provided by suppliers on gas consumption. This has been assumed to have a high level of accuracy as this is data supported by meter readings and energy companies have an inherent interest to assess consumption in order to facilitate payment. Accuracy for this category has been assessed at 99%.

10.4 Other Consumed Fuels

Fuels within this category are diesel, oil, and bottled gases. However, in all cases the data sources are purchasing records and invoices displaying the amount of purchased fuel. Depending on the fuel in question, these receipts and invoices display either a volume or mass of gas supplied. Accuracy of these invoices with respect to keeping records of the containers supplied is considered very high. Uncertainty for this category will thus depend upon the level of accuracy for which the receipts may be relied upon for recording the amount of gas within these containers. Accuracy for this category has been assessed at 95%.

10.5 Refrigerants

Refrigerants and fugitive emissions are the result of leaks or top-ups highlighted in maintenance reports. In each case, the mass of refrigerant has been sourced from a maintenance log which show the amount of refrigerant that was required to replace lost amounts. It is hard to assess however, the accuracy of which the fluid replaced was measured by the maintenance personnel conducting the required work and the tools they had available to record the refrigerant supplied. As a result of these limitations the accuracy of activity data for this category has been assessed at 75%.

10.6 Purchased Electricity

Activity data for purchased electricity is predominantly sourced from invoices for utilities provided by utility companies. As with natural gas, it is assumed that this carries a high level of accuracy due to the availability of accompanying meter readings with which to corroborate this data and the necessity of the utility companies to ensure correct payment. As with natural gas, accuracy of this category is assessed at 99%.

10.7 Purchased Heat

Purchased heat only holds relevance for two sites across the group. In both cases, invoices are the source of activity data. Accuracy of activity data is again assessed to be 99% as with natural gas.

10.8 Categories 1 & 2

Category 1 and 2 data is sourced from ERP systems in use by group companies. Accuracy of financial data is assumed to be high and reliable due its necessity to operations and preventing any fraudulent or dishonest practices. As a result of this, accuracy has been assessed at 99%.

10.9 Category 3

Category 3 emissions are derived from the same activity data as seen in Scopes 1 and 2. For some categories such as purchased electricity and consumed gas, the activity data for category 3 is simply consumption and the accuracy as such is the same as the categories for which this data was collected. Elsewhere however well-to-tank emissions are also the result of distance-based calculations for fleet use where some uncertainty does lie. As a result of this, accuracy of this category is assessed at only 95%.

10.10 Categories 4 & 9

The processes where evaporative savings can be witnessed are often hot and viscous processes in

As mentioned previously, categories 4 & 9 are the areas for which sufficient data was not available to make an accurate assessment as was hoped. Accordingly, a spend-based method was used using the category 1 and 2 data provided. Although the accuracy of this source data is high, uncertainty will be introduced through making an assessment of the proportion of orders spent upon logistics. It is recognised that this is an assessment that will vary considerably across materials, products, and location.

Also included within this category are emissions calculated using a distance-based approach from logistics data. This will carry a higher degree of accuracy but there are still some assumptions made in absence of detailed data on exact routes and distances taken.

As a result of this, activity date for both categories 4 & 9 are assessed to be only 85%.

10.11 Category 5

Category 5 data is again predominantly sourced from invoices, in this case invoices provided by waste disposal services relating to the volume or mass collected from each site. Whilst these invoices may be considered accurate in terms of the collections and containers removed, they often do not make any assessment of the mass of waste itself. Frequently throughout this category an on-going assumption has been made that the container volume collected was entirely full when collected, previously assessed densities of each waste have been used to then convert this volume into a mass for use in emissions calculations.

This method has been selected as an overestimate; however, it is still an estimate, and it is difficult to say across the entire group how close this estimate will be to the true mass of waste disposed. As a result of this, accuracy for this category has been assessed at only 80%.

10.12 Category 6

Business travel emissions itself has been sourced from various means within this category. Emissions due to hotel stays are discrete and usually tied to expense reporting and can thus be considered very accurate. Other sources such as flights and hire cars are less accurate, this category is usually recorded by companies in the form of cost and expense from an accounting perspective. Distances covered in hire cars or exact routes on flights are thus not reliably and accurately recorded, even if the expense data from which they are derived is.

Due to the difficulties in determining the exact measurable quantities needed, accuracy for this category has been assessed at 80%.

10.13 Category 7

It is recognised that there are significant estimates that have been made with respect to employee commuting. It is not feasible for the exact route and distance for which employee travels to work to be assessed across the company. Data quality across sites thus varies significantly, some sites have provided a mode of transport and approximate distance for each employee, and other sites were not able to provide any information relating to this category at all. Accordingly, a reasonable proportion of these sites were assessed using the breakdown of transport mode and distances observed in the most detailed assessment available, the transport report conducted for the head office of Mill Close, Rotherham.

It is recognised that there will be significant differences between some sites and the head office. In general however, for those sites where this estimate has been applied it is likely that levels of employees travelling by private car are likely to be lower and this may thus be considered an overestimate. However due to these estimates, accuracy for this category has been assessed at only 75%.

10.14 Category 8

Category 8 refers to scaled figures for utilities which fall under the Scope 3, the error and uncertainty in this case is thus comprised of only the scaling error and emissions factor error.

10.15 Category 11

As with other categories, when estimates have been made for this category they have been conducted by assuming a significant overestimate in order to ensure that no under-reporting occurs.

In this case, this refers to the complex systems sold being assumed to run continuously at all hours of the day for their entire lifecycle. A situation which would almost certainly never occur. Due to the length of time involve in making an assessment of use over a product's entire lifecycle, accuracy of this category is assumed to only be 80%.

10.16 Category 12

Category 12 emissions calculated are based upon the mass of products sold and thus eventually disposed of. For most cases (unless a spend-based approach was used) the source of data used was the weight carried by logistics carriers outbound from the site. Accuracy for the weight measured by this approach is considered high. In some cases an alternative approach was used, a detailed assessment of material yield was conducted which may be considered accurate. This assessment was conducted at the

head office at Mill Close using a representative range of products. It is recognised that this category include both uncertainty with this assessment and the uncertainty of category 5 from which metal scrap data is sourced. Accordingly, accuracy for this category is assessed at only 75%.

10.17 Emissions Factor Uncertainty

The final component of uncertainty is any error on the emissions factors themselves used to calculate emissions from activity data. Very rarely is any assessment of error provided alongside publications of emissions factors. As a result, an approach has been taken to apply a percentage point of error for every year that has passed since the emissions factors were published.

10.18 Summary of Uncertainty

Scope	Total CO_2e (Tonnes)	± (Tonnes)	% Error
Scope 1	2,330.3	165.2	7.1%
Scope 2	2,780.2	89.5	3.2%
Scope 3	129,811.6	19,612.1	15.1%

11 Carbon Reduction Plan

The primary aim of carrying out this inventory is to drive down emissions, by carrying out such an assessment it is possible to identify the areas that the company is able to target for emissions reductions. The data gathered for this inventory is used to assess the viability and feasibility of environmental projects, and to measure their success should they be carried out.

As previously mentioned, A.E.S has committed to spending £29 million by the year 2029 on investments and projects with environmental benefits. At the start of 2024, the company had invested over eleven million GBP as part of this commitment. Throughout the reporting period, multiple projects were initiated or ongoing as part of this commitment and in general to reduce the Scope 1 & 2 emissions of the A.E.S group of companies.

The most significant of these projects in terms of resources have logically been focused on some of the most significant sites of Mill Close, Rockford, and Pune.

The head office of Mill Close, Rotherham is the primary manufacturing site for A.E.S products and is responsible for approximately a third of the entire group's electricity use. Accordingly, efforts throughout the reporting period have been focused upon maximising the full potential of the site for renewable generation in order to generate as much energy on-site as possible. Prior to the reporting period, there had been extensive investment and effort in order to install *908 kWp* of PV capacity on the roof of the site. In order to complement the PV array, there exists a *1.2 MWh* battery storage system on site. This storage system allows for the capture and subsequent release of excess solar generation during the summer months to maximise the use of renewables. Furthermore, when not needed for excess solar generation, the battery is able to provide multiple other benefits (although these may not always result in a reportable CO_2e reduction to the group). These benefits include nighttime harvesting, the battery is able to take in from the grid at night and release to the site during the day. Doing so provides both a cost saving to the company and an environmental benefit, as the proportion of generation from renewables is highest at night. The unit is also able to offer additional benefits to the local grid in terms of grid-balancing, by charging or discharging in times of need when there is excess or scarce power supply.

Throughout this reporting period, there has been further investment at Mill Close to maximise energy generation further still. This has consisted of the install of a *407 kWp* PV array covering the new extension of the site, which is to be connected directly into another battery storage system. This new battery storage system carries *1 MWh* of

storage capacity and is capable of outputting to the site at *100 kW*. This combined DC PV and battery system will allow for further reduction of the sites reliance on the grid, and to fully maximise the proportion of the sites energy use that is generated from completely carbon free sources. Once all elements of the projects on the site have been completed, it is expected that as much as *35%* of the site's electricity needs can be provided by on-site generation. A.E.S has undertaken these investments despite the head office already being on a green-tariff, and thus on a market basis these provide no reduction in terms of CO_2e to the group.

The Pune site in Maharashtra, India is one of the largest CO_2e emitters of the group, largely due to electricity usage at the site. The site provides manufacturing capability for the group and therefore has high energy use and the Indian grid is relatively high in terms of carbon intensity. A project was therefore initiated during the previous reporting period for the install of a *355 kWp* PV array and a supporting *250 kWh* battery storage system. The combined system is expected to remove the vast majority of the sites reliance upon the grid for energy, and thus save almost *300 Tonnes CO_2e* in the process. Furthermore, the battery is also able to act as an uninterrupted power supply for the site, allowing for further reductions in *CO_2e* from the elimination of diesel usage at the site for generators. Although there were multiple complications identified during the install, the combined system was fully operational from December of 2023.

A similar system is also in place at the site of Rockford, TN, which also acts as a manufacturing site for the group of companies. Installed during the previous reporting period was a *552.2 kWp* PV array capable of producing an expected *778,100 kWh* of clean energy for the site on an annual basis. This is to be complemented by a *500 kWh* battery storage system which allows for the full generation of the site to be utilised. Once fully operational, the combined system is expected to result in a reduction of almost *300 tonnes CO_2e* on a location-basis and *30 tonnes* on a market-basis.

Elsewhere within the UK there have been further works aimed at reducing the location-based emissions of the group. At the smaller site of Mangham Road, Rotherham, this has consisted of an install of a *39 kWp* thin-film PV array capable of generating an approximate *37,000 kWh* of clean energy a year and thus reducing emissions by *7 tonnes CO_2e*. Elsewhere at Bradford, efforts have been complicated by the site's electrical infrastructure and the local grid limiting allowed connection. A *402 kWp* PV array has been installed on the roof during the reporting period with efforts underway of connecting this in conjunction with a further battery storage system.

Towards the end of this reporting period, installation of a *39 kWp* PV array took place at the A.E.S site of Mazańcowice in Poland. This installation is expected to generate just under *30,000 kWh* of clean energy, this renewable generation is expected to reduce the sites Scope 2 emissions by *8 tonnes* and also to provide an environmental benefit to the Polish grid at large through the export of surplus energy to grid. As part of the 29 by 29 investment programme, A.E.S has now installed solar arrays at the sites of Mill Close, Mangham Road, Bradford, Rockford, Pune, Tarragona, and Mazańcowice, with a further re-installation at Kronau underway after complications arose during the initial install.

A.E.S Engineering Ltd. also wishes to reduce its Scope 3 emissions, however (particularly for the largest sources) exercises very little influence and direct control over the value chain in which to reduce emissions. The most significant categories of Scope 3 and closely related to the size of the business itself and are very difficult to target with any specific policy. Attempts have been made during this reporting period at soft targets, with engagement with key suppliers and stakeholders to spread information and awareness of sustainability initiatives.

12 Offsets

Whilst emissions reduction efforts are undergoing, A.E.S Engineering Ltd. is still responsible for the production of Scope 1 & 2 emissions. Although the ongoing focus is the reduction of emissions, whilst this is taking place A.E.S will continue to offset its emissions through verified Gold Standard or VERRA Projects. Projects are purchased with the assistance of Carbon Footprint Ltd:

Carbon Footprint Ltd
Belvedere House
Basing View
Basingstoke
Hampshire
RG21 4HG
Company Number 04532520 / SIC 74901

The details of the selected projects where offsetting credits were purchased are shown in the table below:

In the unfortunate event that any errors or missing data is identified following the production of this report, A.E.S will purchase further offsets to cover these emissions to ensure an overall balance of zero is maintained.

Aligning to the reporting period of 1st October 2022 to 30th of September 2023, a total of *5000* tonnes of offset credits were purchased with which to cover the groups residual Scope 1 & 2 emissions of 3,868.38 Tonnes on a market basis or 5,110.55 on a location basis. A further *7* tonnes were also purchased as part of a tree-buddy scheme to accompany a small number of trees planted at the Mill Close site.

Credits	Projects	Project Reference	Verification
2500	Offset via improved cookstoves in Nigeria	GS7312	Gold Standard
2500	Offset via reforestation of degraded land in India	VCS 2404	VERRA
7	Offset via reduced deforestation in Cambodia	VCS 1748	VERRA

carbon footprint™

This certificate acknowledges that

AES Engineering Ltd

offset

5,000 Tonnes of Carbon Dioxide

29 September 2023

by supporting the following projects:

Improved cookstove distribution projects in Nigeria (2,500 tCO_2e)
Reforestation of degraded land in India (2,500 tCO_2e)

John Buckley, Director
Carbon Footprint Ltd

www.carbonfootprint.com

Offsetting carbon emissions
helping to combat climate change
sustaining the environment for future generations

Appendix – A: Statement of Verification

bsi.

Verification Opinion

Verified as Satisfactory	
Based on the process and procedures conducted, the GHG statement contained in the GHG Report "A.E.S Engineering Ltd. GHG Inventory (GHGINV2223 V1 Public 03/01/24)" produced by A.E.S Engineering Ltd.:	• Is materially correct and is a fair representation of GHG data and information. • Has been prepared in accordance with ISO14064-1:2018 and its principles.
Lead Verifier	Jose L Miguel
Independent Reviewer	Catherine Williams
Signed on behalf of BSI	Matt Page, Managing Director UK & Ireland, BSI Assurance UK Ltd
Issue Date	3rd April 2024
BSI Assurance UK Ltd, Kitemark Court, Davy Avenue, Milton Keynes, MK5 8PP, UK)	
NOTE: BSI Assurance UK Ltd is independent to and has no financial interest in A.E.S Engineering Ltd. This 3rd party Verification Opinion has been prepared for A.E.S Engineering Ltd only for the purposes of verifying its statement relating to its GHG emissions more particularly described in the scope above. It was not prepared for any other purpose. In making this Statement, BSI Assurance UK Ltd has assumed that all information provided to it by A.E.S Engineering Ltd is true, accurate and complete. BSI Assurance Ltd accepts no liability to any third party who places reliance on this statement.	

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UKAS VALIDATION & VERIFICATION 0003

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Verification Report

Verification Engagement

Organization	A.E.S Engineering Ltd
Responsible party	A.E.S Engineering Ltd
Verification Objectives	To express an opinion on whether the organizational GHG Statement which is historical in nature: • Is accurate, materially correct and is a fair representation of GHG data and information • Has been prepared in accordance with ISO14064-1:2018, the criteria used by BSI to verify the GHG Organizational Statement
Materiality Level	5%
Level of Assurance	Reasonable
Verification evidence gathering procedures	• Evaluation of the monitoring and controls systems through interviewing employees observation & inquiry • Verification of the data through sampling recalculation, retracing, cross checking and reconciliation
Verification Standards	The verification was carried out in accordance with ISO 14064-3: 2019 and ISO 14065: 2013
Note: AES Engineering Ltd. is responsible for the preparation and fair presentation of the GHG statement and report in accordance with the agreed criteria. BSI is responsible for expressing an opinion on the GHG statement based on the verification.	

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Verification Report

Organizational GHG Statement

Organization		A.E.S Engineering Ltd.
Organizations GHG Report containing GHG Statement		A.E.S Engineering Ltd. GHG Inventory (GHGINV2223 V1 Public 03/01/24)
Organizational Boundary		Operational control
Locations included in the Organizational Boundary		See Appendix A
Scope of activities:		Manufacturing, sales and technical service for mechanical seals and support systems.
Reporting Boundary:	Direct GHG Emissions (Scope 1)	Stationary combustion, mobile combustion & refrigerants
	Indirect GHG Emissions from imported energy (Scope 2)	Electricity & heat
	Indirect GHG emissions from transportation (Scope 3)	Upstream & downstream transportation of goods (including WTT of electricity & fuels) Commuting & business travel
	Indirect GHG emissions from products used by organization (Scope 3)	Purchased goods & services Capital goods
	Indirect GHG emissions associated with the use of products from the organization (Scope 3)	Use stage & end of life
Criteria for developing the organizational GHG Inventory:		ISO14064-1:2018
Reporting Period		1st October 2022 to 30th September 2023

Quantification of emissions

Scope	Location Based (t CO2e)	Market Based (t CO2e)
Direct (scope 1)	2,330.34	2,330.34
Indirect from imported energy (scope 2)	2,780.21	1,538.04
Indirect other (scope 3)	129,811.6	129,811.6
Total	**134,922.13**	**133,679.96**

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Verification Report

Note: A.E.S Engineering Ltd. purchases and retirement of 5,000t of CO_2e was verified:

Projects	t CO2e	Verified at
Reforestation of degraded land by MTPL in India (VCS 2404)	2,500	Verra
Promoting improved cooking practices in Nigeria (GS7312)	2,500	Gold Standard
Total	**5,000**	

Appendix – B: Conversion Factors

The following section lists all emissions factors used within this GHG report alongside their source, all emissions factors are listed in kg of CO_2e per unit unless stated otherwise.

Scope 1

The following tables cover all Scope 1 emission sources that have been used within this GHG inventory.

DEFRA - 2023 - United Kingdom

Factor	kg CO_2e	Per Unit
Natural Gas	2.03839	Cubic metre
Natural Gas	0.18293	kWh
Propane	2997.63	Tonne
Propane	1.54358	Litre
Propane	0.21410	kWh
LPG	2939.36	Tonne
LPG	1.55713	Litre
LPG	0.21450	kWh
Diesel	3203.91	Tonne
Diesel	2.65937	Litre
Diesel	0.25193	kWh
Petrol	3154.08	Tonne
Petrol	2.34503	Litre
Petrol	0.24171	kWh
Fuel Oil	3228.89	Tonne
Fuel Oil	3.17492	Litre
Fuel Oil	0.26813	kWh
R32 - Difluoromethane	677	kg
R22 - Chlorodifluoromethane	1760	kg
Diesel Small car	0.13931	km
Diesel Medium car	0.16716	km
Diesel Large car	0.20859	km
Diesel Average car	0.16983	km
Petrol Small car	0.14080	km
Petrol Medium car	0.17819	km
Petrol Large car	0.27224	km
Petrol Average car	0.16391	km
Hybrid Small car	0.10150	km
Hybrid Medium car	0.10904	km
Hybrid Large car	0.15244	km
Hybrid Average car	0.11898	km

Van - Class I (up to 1.305 tonnes)	0.14212	km
Van - Class II (1.305 to 1.74 tonnes)	0.17405	km
Van - Class III (1.74 to 3.5 tonnes)	0.25346	km
Van - Average (up to 3.5 tonnes)	0.23128	km
Electric	0.00000	km

Scope 2

The following tables cover all Scope 2 emission sources that are relevant to A.E.S Engineering group company, all values are listed as kg CO_2e per kWh unless otherwise stated.

Purchased Electricity

Site (Shorthand)	kg CO_2e per kWh	Source
Mill Close	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Derby	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Bradford	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Mangham Road	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
NE	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
SE	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Pontypridd	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Lisburn	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Cork	0.33200	Energy in Ireland 2023, SEAI, (December 2023)
Warrington	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Kirkcaldy	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
JaTech	0.02800	2023 National Inventory Report, Governmnent of Canada, (2023)
Gloucester	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Grangemouth	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Vulcan Sheffield	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Vulcan Minnesota	0.71771	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Eastern Seals	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Coating Centre	0.20707	UK Government GHG Conversion Factors for Company Reporting, DEFRA, (2023)
Rockford	0.42531	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)

Kingsport TN	0.42531	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Marion IA	0.45493	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Fairfield ME	0.24470	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Longview WA	0.28959	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Odessa TX	0.37074	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Addison IL	0.47747	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Corpus Christi TX	0.37074	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Mississauga ON	0.02800	2023 National Inventory Report, Governmnent of Canada, (2023)
Vancouver BC	0.01400	2023 National Inventory Report, Governmnent of Canada, (2023)
Buenos Aires	0.29600	Energy Profile Argentina, International Renewable Energy Agency, (2023)
Montevideo	0.01200	Energy Profile Uruguay, International Renewable Energy Agency, (2023)
Sao Paulo	0.11000	Energy Profile Brazil, International Renewable Energy Agency, (2023)
Belo Oriente	0.11000	Energy Profile Brazil, International Renewable Energy Agency, (2023)
Laoro de Freitas	0.11000	Energy Profile Brazil, International Renewable Energy Agency, (2023)
Bogota	0.14800	Energy Profile Colombia, International Renewable Energy Agency, (2023)
Santiago	0.37500	Energy Profile Chile, International Renewable Energy Agency, (2023)
Tampico	0.29200	Energy Profile Mexico, International Renewable Energy Agency, (2023)
Tlalnepantla	0.29200	Energy Profile Mexico, International Renewable Energy Agency, (2023)
Coaztacoalcos	0.29200	Energy Profile Mexico, International Renewable Energy Agency, (2023)
Atizapan	0.29200	Energy Profile Mexico, International Renewable Energy Agency, (2023)
Coldweld	0.71135	CO_2 Baseline Database, Central Electricity Authority, (2022)
Pune	0.71135	CO_2 Baseline Database, Central Electricity Authority, (2022)
Ningbo	0.55300	Energy Profile China, International Renewable Energy Agency, (2023)
Wuxi	0.55300	Energy Profile China, International Renewable Energy Agency, (2023)
Dalian	0.55300	Energy Profile China, International Renewable Energy Agency, (2023)
Zhanjiang City	0.55300	Energy Profile China, International Renewable Energy Agency, (2023)
Johannesburg	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Durban	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Cape Town	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Richards Bay	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Sasolburg	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Kuruman	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Secunda	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Breda (Benelux)	0.31400	Energy Profile Netherlands, International Renewable Energy Agency, (2022)
Brno	0.37500	Energy Profile Czechia, International Renewable Energy Agency, (2023)
Køge	0.10900	Energy Profile Denmark, International Renewable Energy Agency, (2023)
Oberösterreich	0.13500	Energy Profile Denmark, International Renewable Energy Agency, (2023)

Kronau	0.32500	Energy Profile Germany, International Renewable Energy Agency, (2023)
Jyväskylä	0.10700	Energy Profile Finland, International Renewable Energy Agency, (2023)
Nieppe	0.05800	Energy Profile France, International Renewable Energy Agency, (2023)
Tarragona	0.27100	Naturgy Iberia S.A, Miteco, (2023)
Gallarate	0.26700	Energy Profile Italy, International Renewable Energy Agency, (2023)
Latina	0.26700	Energy Profile Italy, International Renewable Energy Agency, (2023)
Mazancowice	0.53200	Energy Profile Poland, International Renewable Energy Agency, (2023)
Stockholm	0.03500	Energy Profile Sweden, International Renewable Energy Agency, (2023)
Istanbul	0.40200	Energy Profile Turkey, International Renewable Energy Agency, (2023)
Lisbon	0.16500	Energy Profile Portugal, International Renewable Energy Agency, (2023)
Porto	0.16500	Energy Profile Portugal, International Renewable Energy Agency, (2023)
Sauerlach	0.32500	Energy Profile Germany, International Renewable Energy Agency, (2023)
Selangor (Puchong)	0.66600	Energy Profile Malaysia, International Renewable Energy Agency, (2023)
Pahang (Kuantan - Gebeng Area)	0.66600	Energy Profile Malaysia, International Renewable Energy Agency, (2023)
Johor (Masai)	0.66600	Energy Profile Malaysia, International Renewable Energy Agency, (2023)
Lahad Datu (East Malaysia)	0.66600	Energy Profile Malaysia, International Renewable Energy Agency, (2023)
Pulau Pinang (Butterworth)	0.66600	Energy Profile Malaysia, International Renewable Energy Agency, (2023)
Dammam	0.59200	Energy Profile Saudi Arabia, International Renewable Energy Agency, (2023)
Dubai	0.40350	Sustainability Report 2022, DEWA, (2023)
Brisbane QLD	0.73000	National Greenhouse Accounts Factors, DISER, (2023)
Rockingham WA	0.53000	National Greenhouse Accounts Factors, DISER, (2023)
Edwardstown SA	0.25000	National Greenhouse Accounts Factors, DISER, (2023)
Algiers	0.46800	Energy Profile Algeria, International Renewable Energy Agency, (2023)
Kaohsiung	0.55400	Bureau of Energy, Taiwan, (2017)
Swakopmund	0.87000	Grid Emissions Factors, IGES, (2022)
Orapa	1.49300	Energy Profile Botswana, International Renewable Energy Agency, (2023)
Smeaton Grange (Stevco & AES&S)	0.68000	National Greenhouse Accounts Factors, DISER, (2023)
Houston TX	0.37074	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Edmonton	0.51000	2023 National Inventory Report, Government of Canada, (2023)
Van Geffen	0.31400	Energy Profile Netherlands, International Renewable Energy Agency, (2023)
East London	1.01400	Energy Profile South Africa, International Renewable Energy Agency, (2023)
Wangara	0.53000	National Greenhouse Accounts Factors, DISER, (2023)
Fort Lauderdale	0.37782	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)
Cedar Rapids IA	0.45493	Emissions Factors for Greenhouse Gas Inventories, EPA, (2023)

Purchased Heat

Site	kg CO_2e per kWh	Source
ProPack	0.01400	McCay, Feliks & Roberts (2019)
Benelux	0.05616	Ennatuurlijk, (2023)

Scope 3

Categories 1, 2 and 4: - Background:

Emissions associated with the supply chain are particularly difficult to assess, one of the most significant categories of Scope 3 emissions is category 1, purchased goods and services. These are the emissions that you are responsible for as a purchaser and consumer of these items.

However, tools and methods for calculating the impact from scope 3 category 1 are not widely available and are often out of date or poorly put together. Emissions factors for fuel use or electricity use are easy to grasp, however calculating the environmental impact of purchasing an item is much more complex.

Working out the environmental impact of purchasing an item takes data from two sources, the total emissions of industry sectors, and an input-output table for an economy. This second source is where complexity is introduced.

If an industry simply produced goods and sold these to customers, we could simply take the industries emissions and divide them by the value of the goods sold. By doing so we could then work out how much emissions a customer is responsible for due to purchasing goods from this industry.

However, the world is not this simple and industries will supply to each other, to other businesses in the same industry, to industries in other countries, all before goods end up arriving to the end user. As a result of this, we need to consider all the different ‘layers’ that occur before a product ends up being purchased by the consumer. This data is recorded in the input-output table.

As the input-output table is a huge amount of data to gather, regular published databases are not available. The World Input-Output Database (WIOD) compiled this data up until 2011 and was released in April of 2013. To go alongside this information, the European Union published a set of environmental accounts which records the emissions of various sectors in different countries that matches those seen in the WIOD, however this information was only collected up until 2009.

The process of assigning these emissions to the end product of these industries is called Environmentally Extended Input-Output (*An Introduction to Environmentally-Extended*

Input-Output Analysis. Kitzes, J. Energy and Resources Group, University of California, 2013.).

The input-output tables take the form of a square matrix with the sectors as the rows and columns, the inputs to each sector are in the columns and the outputs to each sector are in the rows.

The WIOD tables display this information for *35* sectors in *41* regions to produce a core square matrix of *2464 x 2464*. Accompanying this are the environmental accounts, this displays the CO_2e emissions of the same industry sectors and regions as seen in the WIOD report.

The first step is to simply perform an element-wise division of the total emissions [E] of a sector by its total output [O] :

$$f = [E]/[O]$$

This involves dividing each single value in the column vector containing the total sector emissions by the corresponding value in the total output column.

What is needed next is to calculate the technical coefficient matrix, *A.* This shows the amount of input a given sector must receive from others to create a single unit of output. This matrix may be derived by again performing an element-wise division of each column of the input-output table by the total output of that sector.

```
For each column in WIOD:
  For each row in WIOD:
    A(row, column) = WIOD(row, column)/Output(row)
  End
End
```

This means dividing each value in the first column of the WIOD table by the corresponding value in the total output column, and then repeating this process for every column within the WIOD table. The end product is another matrix, *A,* which is the same size as the WIOD matrix.

Finally, what is needed is the Total Intensity Vector, F. This is the sum of each intensity vector for every 'layer' of supply:

$$F = F_1 + F_2 + F_3 \ldots.$$

$$F = f[I + A + A^2 + \cdots]$$

These brackets form a geometric series whose sum may be expressed as $(I - A)^{-1}$, where *I* is the identity matrix. The identity matrix being a matrix made up of zeros with

the exception of the leading diagonal, whose elements are all equal to one. This is then referred to as *L,* the *Leontief inverse matrix*:

$$F = fL = f(I - A)^{-1}$$

The end result is a column vector displaying the CO_2e emissions per unit dollar of output for that sector and region.

In terms of calculating this, what is first needed is to perform a subtraction of *A* from the identity matrix of the same size. The resultant matrix may then be inversed to produce the *Leontief inverse matrix, L:*

$$L = \left[\begin{bmatrix} 1 & 0 & \dots \\ 0 & 1 & \dots \\ \dots & \dots & \dots \end{bmatrix} - \begin{bmatrix} A_{11} & A_{12} & \dots \\ A_{21} & A_{22} & \dots \\ \dots & \dots & \dots \end{bmatrix}\right]^{-1}$$

This may finally be multiplied by the earlier derived vector, *f*.

$$F = fL$$

This final result is a column vector displaying the CO_2e emissions per unit dollar of output for that sector and region. The calculations discussed above have been conducted within *MATLAB*.

These factors may be applied to the dollar spend in each respective sector and region to calculate the emissions impact of the purchased amount of goods.

References	
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3	*Corsatea T.D., Lindner S., Arto, I., Román, M.V., Rueda-Cantuche J.M., Velázquez Afonso A., Amores A.F., Neuwahl F.; World Input-Output Database Environmental Accounts. Update 2000-2016, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-79-64439-9, doi:10.2791/947252, JRC116234. https://joint-research-centre.ec.europa.eu/scientific-activities/economic-environmental-and-social-effects-globalisation_en*
4	*Kitzes, J., An Introduction to Environmentally-Extended Input-Output Analysis, (2013), Energy and Resourcces Group, University of California, Berkeley, 310 Barrows Hall, Berkeley, CA 94720-3050, USA, https://doi.org/10.3390/resources2040489*
5	*International Standard Industrial Classification of All Economic Activities Revision 4, Series M: Miscellaneous Statistical Papers, No. 4 Rev. 4, 2007, New York: United Nations. ST/ESA/STAT/SER.M/4/REV.4*

Categories 1, 2 and 4: - Emissions Factors:

All emissions factors listed below are sourced from the WIOD database (2013).

Country	Sector	CO_2e kg/$/yr
Australia	Food, Beverages and Tobacco	1.050
Australia	Textiles and Textile Products	0.685
Australia	Wood and Products of Wood and Cork	0.657
Australia	Pulp, Paper, Paper , Printing and Publishing	0.441
Australia	Chemicals and Chemical Products	1.034
Australia	Rubber and Plastics	0.561
Australia	Other Non-Metallic Mineral	1.599
Australia	Basic Metals and Fabricated Metal	1.083
Australia	Machinery, Nec	0.587
Australia	Electrical and Optical Equipment	0.465
Australia	Transport Equipment	0.484
Australia	Manufacturing, Nec; Recycling	0.554
Australia	Electricity, Gas and Water Supply	5.660
Australia	Construction	0.454
Australia	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.321
Australia	Hotels and Restaurants	0.496
Australia	Inland Transport	0.639
Australia	Water Transport	2.330
Australia	Air Transport	1.699
Australia	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.473
Australia	Post and Telecommunications	0.374
Australia	Health and Social Work	0.166
Brazil	Food, Beverages and Tobacco	1.863
Brazil	Textiles and Textile Products	0.446
Brazil	Wood and Products of Wood and Cork	0.850
Brazil	Pulp, Paper, Paper , Printing and Publishing	0.652
Brazil	Chemicals and Chemical Products	0.612
Brazil	Rubber and Plastics	0.426
Brazil	Other Non-Metallic Mineral	1.296
Brazil	Basic Metals and Fabricated Metal	0.704
Brazil	Machinery, Nec	0.364
Brazil	Electrical and Optical Equipment	0.374
Brazil	Transport Equipment	0.330
Brazil	Manufacturing, Nec; Recycling	0.375
Brazil	Electricity, Gas and Water Supply	0.432
Brazil	Construction	0.359
Brazil	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.124

Brazil	Hotels and Restaurants	0.754
Brazil	Inland Transport	0.656
Brazil	Water Transport	1.834
Brazil	Air Transport	0.711
Brazil	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.316
Brazil	Post and Telecommunications	0.286
Brazil	Health and Social Work	0.227
Canada	Food, Beverages and Tobacco	0.731
Canada	Textiles and Textile Products	0.456
Canada	Wood and Products of Wood and Cork	0.852
Canada	Pulp, Paper, Paper , Printing and Publishing	0.460
Canada	Chemicals and Chemical Products	0.957
Canada	Rubber and Plastics	0.519
Canada	Other Non-Metallic Mineral	1.180
Canada	Basic Metals and Fabricated Metal	0.822
Canada	Machinery, Nec	0.411
Canada	Electrical and Optical Equipment	0.418
Canada	Transport Equipment	0.382
Canada	Manufacturing, Nec; Recycling	0.455
Canada	Electricity, Gas and Water Supply	2.550
Canada	Construction	0.471
Canada	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.265
Canada	Hotels and Restaurants	0.384
Canada	Inland Transport	0.851
Canada	Water Transport	2.465
Canada	Air Transport	2.255
Canada	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.318
Canada	Post and Telecommunications	0.364
Canada	Health and Social Work	0.231
China	Food, Beverages and Tobacco	1.649
China	Textiles and Textile Products	1.518
China	Wood and Products of Wood and Cork	1.652
China	Pulp, Paper, Paper , Printing and Publishing	1.753
China	Chemicals and Chemical Products	2.549
China	Rubber and Plastics	1.903
China	Other Non-Metallic Mineral	4.158
China	Basic Metals and Fabricated Metal	2.726
China	Machinery, Nec	1.682
China	Electrical and Optical Equipment	1.404
China	Transport Equipment	1.419
China	Manufacturing, Nec; Recycling	1.302
China	Electricity, Gas and Water Supply	11.148
China	Construction	2.015

China	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.598
China	Hotels and Restaurants	1.309
China	Inland Transport	1.313
China	Water Transport	1.974
China	Air Transport	3.193
China	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	1.320
China	Post and Telecommunications	0.662
China	Health and Social Work	1.471
France	Food, Beverages and Tobacco	0.563
France	Textiles and Textile Products	0.218
France	Wood and Products of Wood and Cork	0.510
France	Pulp, Paper, Paper , Printing and Publishing	0.234
France	Chemicals and Chemical Products	0.430
France	Rubber and Plastics	0.301
France	Other Non-Metallic Mineral	0.856
France	Basic Metals and Fabricated Metal	0.385
France	Machinery, Nec	0.216
France	Electrical and Optical Equipment	0.251
France	Transport Equipment	0.254
France	Manufacturing, Nec; Recycling	0.369
France	Electricity, Gas and Water Supply	0.656
France	Construction	0.193
France	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.122
France	Hotels and Restaurants	0.206
France	Inland Transport	0.389
France	Water Transport	0.436
France	Air Transport	1.491
France	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.104
France	Post and Telecommunications	0.080
France	Health and Social Work	0.063
Spain	Food, Beverages and Tobacco	0.507
Spain	Textiles and Textile Products	0.383
Spain	Wood and Products of Wood and Cork	0.375
Spain	Pulp, Paper, Paper , Printing and Publishing	0.342
Spain	Chemicals and Chemical Products	0.483
Spain	Rubber and Plastics	0.351
Spain	Other Non-Metallic Mineral	1.341
Spain	Basic Metals and Fabricated Metal	0.452
Spain	Machinery, Nec	0.277
Spain	Electrical and Optical Equipment	0.311
Spain	Transport Equipment	0.307
Spain	Manufacturing, Nec; Recycling	0.289

Spain	Electricity, Gas and Water Supply	1.277
Spain	Construction	0.247
Spain	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.170
Spain	Hotels and Restaurants	0.165
Spain	Inland Transport	0.535
Spain	Water Transport	0.952
Spain	Air Transport	1.092
Spain	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.274
Spain	Post and Telecommunications	0.157
Spain	Health and Social Work	0.132
United States of America (the)	Food, Beverages and Tobacco	1.011
United States of America (the)	Textiles and Textile Products	0.624
United States of America (the)	Wood and Products of Wood and Cork	0.994
United States of America (the)	Pulp, Paper, Paper , Printing and Publishing	0.532
United States of America (the)	Chemicals and Chemical Products	0.827
United States of America (the)	Rubber and Plastics	0.600
United States of America (the)	Other Non-Metallic Mineral	1.924
United States of America (the)	Basic Metals and Fabricated Metal	0.762
United States of America (the)	Machinery, Nec	0.412
United States of America (the)	Electrical and Optical Equipment	0.259
United States of America (the)	Transport Equipment	0.437
United States of America (the)	Manufacturing, Nec; Recycling	0.397
United States of America (the)	Electricity, Gas and Water Supply	5.639
United States of America (the)	Construction	0.375
United States of America (the)	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.105
United States of America (the)	Hotels and Restaurants	0.389
United States of America (the)	Inland Transport	1.010
United States of America (the)	Water Transport	2.073
United States of America (the)	Air Transport	1.508
United States of America (the)	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.473
United States of America (the)	Post and Telecommunications	0.216
United States of America (the)	Health and Social Work	0.192
India	Food, Beverages and Tobacco	2.567
India	Textiles and Textile Products	1.854
India	Wood and Products of Wood and Cork	2.720
India	Pulp, Paper, Paper , Printing and Publishing	2.241
India	Chemicals and Chemical Products	2.261
India	Rubber and Plastics	2.029
India	Other Non-Metallic Mineral	4.937
India	Basic Metals and Fabricated Metal	3.279
India	Machinery, Nec	1.663
India	Electrical and Optical Equipment	1.457

India	Transport Equipment	1.840
India	Manufacturing, Nec; Recycling	1.095
India	Electricity, Gas and Water Supply	16.896
India	Construction	1.680
India	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.157
India	Hotels and Restaurants	1.977
India	Inland Transport	1.429
India	Water Transport	2.649
India	Air Transport	1.669
India	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	1.716
India	Post and Telecommunications	0.913
India	Health and Social Work	0.631
Rest Of World	Food, Beverages and Tobacco	1.405
Rest Of World	Textiles and Textile Products	0.945
Rest Of World	Wood and Products of Wood and Cork	0.991
Rest Of World	Pulp, Paper, Paper , Printing and Publishing	0.705
Rest Of World	Chemicals and Chemical Products	1.640
Rest Of World	Rubber and Plastics	3.168
Rest Of World	Other Non-Metallic Mineral	2.728
Rest Of World	Basic Metals and Fabricated Metal	1.143
Rest Of World	Machinery, Nec	0.728
Rest Of World	Electrical and Optical Equipment	0.774
Rest Of World	Transport Equipment	0.586
Rest Of World	Manufacturing, Nec; Recycling	1.844
Rest Of World	Electricity, Gas and Water Supply	4.687
Rest Of World	Construction	0.816
Rest Of World	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.386
Rest Of World	Hotels and Restaurants	0.999
Rest Of World	Inland Transport	0.980
Rest Of World	Water Transport	3.164
Rest Of World	Air Transport	2.848
Rest Of World	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.865
Rest Of World	Post and Telecommunications	0.438
Rest Of World	Health and Social Work	0.685
United Kingdom	Food, Beverages and Tobacco	0.530
United Kingdom	Textiles and Textile Products	0.375
United Kingdom	Wood and Products of Wood and Cork	0.407
United Kingdom	Pulp, Paper, Paper , Printing and Publishing	0.276
United Kingdom	Chemicals and Chemical Products	0.481
United Kingdom	Rubber and Plastics	0.405
United Kingdom	Other Non-Metallic Mineral	0.974
United Kingdom	Basic Metals and Fabricated Metal	0.717

United Kingdom	Machinery, Nec	0.332
United Kingdom	Electrical and Optical Equipment	0.290
United Kingdom	Transport Equipment	0.340
United Kingdom	Manufacturing, Nec; Recycling	0.361
United Kingdom	Electricity, Gas and Water Supply	2.032
United Kingdom	Construction	0.216
United Kingdom	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.158
United Kingdom	Hotels and Restaurants	0.236
United Kingdom	Inland Transport	0.455
United Kingdom	Water Transport	1.648
United Kingdom	Air Transport	3.329
United Kingdom	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.124
United Kingdom	Post and Telecommunications	0.174
United Kingdom	Health and Social Work	0.184
Worldwide Average	Food, Beverages and Tobacco	1.116
Worldwide Average	Textiles and Textile Products	1.096
Worldwide Average	Wood and Products of Wood and Cork	1.059
Worldwide Average	Pulp, Paper, Paper , Printing and Publishing	0.698
Worldwide Average	Chemicals and Chemical Products	1.321
Worldwide Average	Rubber and Plastics	1.235
Worldwide Average	Other Non-Metallic Mineral	2.805
Worldwide Average	Basic Metals and Fabricated Metal	1.532
Worldwide Average	Machinery, Nec	0.816
Worldwide Average	Electrical and Optical Equipment	0.807
Worldwide Average	Transport Equipment	0.610
Worldwide Average	Manufacturing, Nec; Recycling	0.775
Worldwide Average	Electricity, Gas and Water Supply	5.099
Worldwide Average	Construction	0.790
Worldwide Average	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.275
Worldwide Average	Hotels and Restaurants	0.548
Worldwide Average	Inland Transport	0.920
Worldwide Average	Water Transport	1.998
Worldwide Average	Air Transport	1.914
Worldwide Average	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.522
Worldwide Average	Post and Telecommunications	0.297
Worldwide Average	Health and Social Work	0.298
Poland	Food, Beverages and Tobacco	1.107
Poland	Textiles and Textile Products	0.587
Poland	Wood and Products of Wood and Cork	0.938
Poland	Pulp, Paper, Paper , Printing and Publishing	0.634
Poland	Chemicals and Chemical Products	1.751
Poland	Rubber and Plastics	0.716

Poland	Other Non-Metallic Mineral	2.072
Poland	Basic Metals and Fabricated Metal	1.168
Poland	Machinery, Nec	0.558
Poland	Electrical and Optical Equipment	0.575
Poland	Transport Equipment	0.549
Poland	Manufacturing, Nec; Recycling	0.621
Poland	Electricity, Gas and Water Supply	5.242
Poland	Construction	0.547
Poland	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.386
Poland	Hotels and Restaurants	0.581
Poland	Inland Transport	1.118
Poland	Water Transport	0.594
Poland	Air Transport	2.185
Poland	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.623
Poland	Post and Telecommunications	0.275
Poland	Health and Social Work	0.431
Germany	Food, Beverages and Tobacco	0.637
Germany	Textiles and Textile Products	0.409
Germany	Wood and Products of Wood and Cork	0.503
Germany	Pulp, Paper, Paper , Printing and Publishing	0.338
Germany	Chemicals and Chemical Products	0.565
Germany	Rubber and Plastics	0.365
Germany	Other Non-Metallic Mineral	1.164
Germany	Basic Metals and Fabricated Metal	0.621
Germany	Machinery, Nec	0.285
Germany	Electrical and Optical Equipment	0.286
Germany	Transport Equipment	0.325
Germany	Manufacturing, Nec; Recycling	0.309
Germany	Electricity, Gas and Water Supply	2.383
Germany	Construction	0.278
Germany	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.158
Germany	Hotels and Restaurants	0.241
Germany	Inland Transport	0.312
Germany	Water Transport	0.352
Germany	Air Transport	1.257
Germany	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.305
Germany	Post and Telecommunications	0.205
Germany	Health and Social Work	0.136

Category 3: DEFRA - 2023 - United Kingdom:

Factor	Well-to-tank kg CO_2e	Per Unit

Natural Gas	0.33660	Cubic metre
Natural Gas	0.03021	kWh
Propane	352.670	Tonne
Propane	0.18046	Litre
Propane	0.02519	kWh
LPG	349.293	Tonne
LPG	0.18551	Litre
LPG	0.02548	kWh
Diesel	733.644	Tonne
Diesel	0.61101	Litre
Diesel	0.05816	kWh
Petrol	815.935	Tonne
Petrol	0.60664	Litre
Petrol	0.06253	kWh
Fuel Oil	714.865	Tonne
Fuel Oil	0.69539	Litre
Fuel Oil	0.05913	kWh
Diesel Small car	0.03392	km
Diesel Medium car	0.04079	km
Diesel Large car	0.05100	km
Diesel Average car	0.04145	km
Petrol Small car	0.03907	km
Petrol Medium car	0.04949	km
Petrol Large car	0.07572	km
Petrol Average car	0.04551	km
Hybrid Small car	0.02703	km
Hybrid Medium car	0.02831	km
Hybrid Large car	0.03884	km
Hybrid Average car	0.03109	km
Van - Class I (up to 1.305 tonnes)	0.03463	km
Van - Class II (1.305 to 1.74 tonnes)	0.04250	km
Van - Class III (1.74 to 3.5 tonnes)	0.06207	km
Van - Average (up to 3.5 tonnes)	0.05660	km
Electric	0.00000	km

Category 3: Purchased Electricity:

Country	kg CO_2e per kWh	Unit	Source
United Kingdom	0.01792	Transmission & Distribution	DEFRA, (2023)
United Kingdom	0.04590	Well-to-tank Generation	DEFRA, (2023)
United Kingdom	0.00397	Well-to-tank Transmission & Distribution	DEFRA, (2023)
Australia	0.17557	Well-to-tank Generation	DEFRA, (2022)

Austria	0.04869	Well-to-tank Generation	DEFRA, (2022)
Brazil	0.01322	Well-to-tank Generation	DEFRA, (2022)
Canada	0.03268	Well-to-tank Generation	DEFRA, (2022)
Czech Republic	0.12477	Well-to-tank Generation	DEFRA, (2022)
Denmark	0.05307	Well-to-tank Generation	DEFRA, (2022)
Finland	0.03719	Well-to-tank Generation	DEFRA, (2022)
France	0.00765	Well-to-tank Generation	DEFRA, (2022)
Germany	0.10427	Well-to-tank Generation	DEFRA, (2022)
India	0.16748	Well-to-tank Generation	DEFRA, (2022)
Ireland	0.07267	Well-to-tank Generation	DEFRA, (2022)
Italy	0.08745	Well-to-tank Generation	DEFRA, (2022)
Malaysia	0.15407	Well-to-tank Generation	DEFRA, (2022)
Mexico	0.09889	Well-to-tank Generation	DEFRA, (2022)
Netherlands	0.07870	Well-to-tank Generation	DEFRA, (2022)
People's Rep. of China	0.16387	Well-to-tank Generation	DEFRA, (2022)
Poland	0.17082	Well-to-tank Generation	DEFRA, (2022)
Portugal	0.05198	Well-to-tank Generation	DEFRA, (2022)
Saudi Arabia	0.17160	Well-to-tank Generation	DEFRA, (2022)
South Africa	0.17814	Well-to-tank Generation	DEFRA, (2022)
Spain	0.06070	Well-to-tank Generation	DEFRA, (2022)
Sweden	0.00246	Well-to-tank Generation	DEFRA, (2022)
Turkey	0.10266	Well-to-tank Generation	DEFRA, (2022)
United States	0.10657	Well-to-tank Generation	DEFRA, (2022)
Non-OECD Europe and Eurasia (average)	0.10279	Well-to-tank Generation	DEFRA, (2022)
Australia	0.01104	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Austria	0.00267	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Brazil	0.00255	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Canada	0.00213	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Czech Republic	0.00918	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Denmark	0.00376	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Finland	0.00136	Well-to-tank Transmission & Distribution	DEFRA, (2022)
France	0.00067	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Germany	0.00542	Well-to-tank Transmission & Distribution	DEFRA, (2022)
India	0.03763	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Ireland	0.00598	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Italy	0.00537	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Malaysia	0.01184	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Mexico	0.01638	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Netherlands	0.00389	Well-to-tank Transmission & Distribution	DEFRA, (2022)
People's Rep. of China	0.00912	Well-to-tank Transmission & Distribution	DEFRA, (2022)

Poland	0.01082	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Portugal	0.00548	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Saudi Arabia	0.01843	Well-to-tank Transmission & Distribution	DEFRA, (2022)
South Africa	0.01972	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Spain	0.00647	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Sweden	0.00020	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Turkey	0.01274	Well-to-tank Transmission & Distribution	DEFRA, (2022)
United States	0.00577	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Non-OECD Europe and Eurasia (average)	0.01359	Well-to-tank Transmission & Distribution	DEFRA, (2022)
Australia	0.15000	Transmission & Distribution	DISER, (2023)
Netherlands	5.00%	Gross Grid Loss	World Bank
Canada – Ontario	0.002	Transmission & Distribution	National Inventory Report, Canada, (2023)
Canada – British Columbia	0.001	Transmission & Distribution	National Inventory Report, Canada, (2023)
China	5.00%	Gross Grid Loss	World Bank
India	19.00%	Gross Grid Loss	World Bank
Colombia	11.00%	Gross Grid Loss	World Bank
Denmark	6.00%	Gross Grid Loss	World Bank
France	6.00%	Gross Grid Loss	World Bank
Germany	4.50%	Gross Grid Loss	World Bank
Spain	9.60%	Gross Grid Loss	World Bank
America - Eastern	5.40%	Gross Grid Loss	EPA
America - Western	5.30%	Gross Grid Loss	EPA
Ireland	4.50%	Gross Grid Loss	World Bank
Italy	4.50%	Gross Grid Loss	World Bank
Mexico	14.00%	Gross Grid Loss	World Bank
UAE	3.30%	Gross Grid Loss	World Bank
Sweden	5.00%	Gross Grid Loss	World Bank
Poland	6.00%	Gross Grid Loss	World Bank
South Africa	8.00%	Gross Grid Loss	World Bank
Taiwan	3.53%	Gross Grid Loss	Taiwan Power Company
Turkey	15.00%	Gross Grid Loss	World Bank
Portugal	10.00%	Gross Grid Loss	World Bank

Category 5:

This section concerns emissions factors used within this report for the purposes of calculating emissions due to produced waste, all emissions factors are in kg CO_2e per metric tonne unless otherwise stated.

Factor	kg CO_2e	Source

Wood - Recycling	21.2808	DEFRA, (2023)
Metal: scrap metal - Recycling	21.2808	DEFRA, (2023)
WEEE - mixed - Recycling	21.2808	DEFRA, (2023)
Paper and board: mixed - Recycling	21.2808	DEFRA, (2023)
Household residual waste - Landfill	497.045	DEFRA, (2023)
Commercial and industrial waste - Landfill	520.335	DEFRA, (2023)
Commercial and industrial waste - Recycling	21.2808	DEFRA, (2023)
Wood - Landfill	925.245	DEFRA, (2023)
Metal: scrap metal - Landfill	8.88413	DEFRA, (2023)
WEEE - mixed - Landfill	8.88413	DEFRA, (2023)
Paper and board: mixed - Landfill	1164.39	DEFRA, (2023)

Category 6:

This section concerns emissions factors used within this report for the purposes of calculating emissions due to business travel. Do note that some emissions factors from Scope 1 for vehicles have also been used for calculation of category 6 emissions, those listed below are additional.

DEFRA - 2023 - United Kingdom

Factor	kg CO_2e	Per Unit
Domestic, to/from UK	0.27258	passenger.km
Short-haul, to/from UK	0.18592	passenger.km
Long-haul, to/from UK	0.26128	passenger.km
International, to/from non-UK	0.17580	passenger.km
Regular taxi	0.14861	passenger.km
Black Cab	0.20402	passenger.km
National rail	0.03546	passenger.km
International rail	0.00446	passenger.km
Light rail and tram	0.02860	passenger.km
London Underground	0.02780	passenger.km
Hotel stay - UK	10.4	Room per night
Hotel stay - UK (London)	11.5	Room per night
Hotel stay - Australia	35	Room per night
Hotel stay - Belgium	12.2	Room per night
Hotel stay - Brazil	8.7	Room per night
Hotel stay - Canada	7.4	Room per night
Hotel stay - Chile	27.6	Room per night
Hotel stay - China	53.5	Room per night
Hotel stay - Colombia	14.7	Room per night
Hotel stay - Costa Rica	4.7	Room per night
Hotel stay - Egypt	44.2	Room per night

Hotel stay - France	6.7	Room per night
Hotel stay - Germany	13.2	Room per night
Hotel stay - Hong Kong, China	51.5	Room per night
Hotel stay - India	58.9	Room per night
Hotel stay - Indonesia	62.7	Room per night
Hotel stay - Italy	14.3	Room per night
Hotel stay - Japan	39	Room per night
Hotel stay - Jordan	68.9	Room per night
Hotel stay - Korea	55.8	Room per night
Hotel stay - Malaysia	61.5	Room per night
Hotel stay - Maldives	152.2	Room per night
Hotel stay - Mexico	19.3	Room per night
Hotel stay - Netherlands	14.8	Room per night
Hotel stay - Oman	90.3	Room per night
Hotel stay - Philippines	54.3	Room per night
Hotel stay - Portugal	19	Room per night
Hotel stay - Qatar	86.2	Room per night
Hotel stay - Russian Federation	24.2	Room per night
Hotel stay - Saudi Arabia	106.4	Room per night
Hotel stay - Singapore	24.5	Room per night
Hotel stay - South Africa	51.4	Room per night
Hotel stay - Spain	7	Room per night
Hotel stay - Switzerland	6.6	Room per night
Hotel stay - Thailand	43.4	Room per night
Hotel stay - Turkey	32.1	Room per night
Hotel stay - United Arab Emirates	63.8	Room per night
Hotel stay - United States	16.1	Room per night
Hotel stay - Vietnam	38.5	Room per night

EPA – 2022 - United States of America

Factor	kg CO_2e	Per Unit
Air Travel - Short Haul (< 482.8 km)	0.12995	passenger-km
Air Travel - Medium Haul (>= 482.8 km, < 3701.5 km)	0.08093	passenger-km
Air Travel - Long Haul (>= 3701.5 km)	0.10226	passenger-km

Category 7:

This section concerns emissions factors used within this report for the purposes of calculating emissions due to employee commuting. Note that emissions factors listed previously for distance-based travel are frequently used for calculations within this category, those factors listed below are additional.

Factor	kg CO_2e per passenger.km	Source
Motorbike - Average	0.11367	DEFRA, (2023)
Local bus (not London)	0.11836	DEFRA, (2022)
Local London bus	0.07832	DEFRA, (2022)
Average local bus	0.10215	DEFRA, (2022)
Coach	0.02718	DEFRA, (2022)

Categories 4 and 9:

This section concerns emissions factors used within this report for the purposes of distance and weight based calculations for purchased logistics.

Factor	kg CO_2e per tonne.km	Source
Rigid (>3.5 - 7.5 tonnes)	0.51228	DEFRA, (2023)
Rigid (>7.5 tonnes-17 tonnes)	0.35412	DEFRA, (2023)
Rigid (>17 tonnes)	0.15375	DEFRA, (2023)
All rigids	0.17819	DEFRA, (2023)
Articulated (>3.5 - 33t)	0.11578	DEFRA, (2023)
Articulated (>33t)	0.07421	DEFRA, (2023)
All artics	0.07518	DEFRA, (2023)
All HGVs	0.09696	DEFRA, (2023)
Freight flights - Domestic, to/from UK	4.67340	DEFRA, (2023)
Freight flights - Short-haul, to/from UK	1.66816	DEFRA, (2023)
Freight flights - Long-haul, to/from UK	1.09903	DEFRA, (2023)
Freight flights - Freight Flight, International, to/from non-UK	1.09903	DEFRA, (2023)
Container ship - 8000+ TEU	0.01266	DEFRA, (2023)
Container ship - 5000–7999 TEU	0.01681	DEFRA, (2023)
Container ship - 3000–4999 TEU	0.01681	DEFRA, (2023)
Container ship - 2000–2999 TEU	0.02025	DEFRA, (2023)
Container ship - 1000–1999 TEU	0.03250	DEFRA, (2023)
Container ship - 0–999 TEU	0.03675	DEFRA, (2023)
Container ship - Average (Container Ship)	0.01612	DEFRA, (2023)

Category 11:

This section concerns emissions factors used within this report for the purposes of calculating emissions from sold product, note that this is a ‘custom’ emissions factors comprised of an average of selected emissions factors from within scope 2.

Factor	kg CO_2e per kWh	Source
Electricity Generation	0.56677	Custom

Category 12:

This section concerns emissions factors used within this report for the purposes of calculating emissions due to produced waste, all emissions factors are in kg CO_2e per tonne unless otherwise stated.

Factor	kg CO_2e	Source
Metal: scrap metal - Recycling	21.2808	DEFRA, (2023)
Commercial and industrial waste - Landfill	520.335	DEFRA, (2023)

Appendix – C: Site Locations

The following site locations are included within this report and the primary entity which operates there, do note that there are certain sites out of which multiple entities operate, or employees from multiple entities are based at.

Entity	Site (Shorthand)	Address
AESSEAL plc (02101607)	Mill Close	Rotherham - Mill Close, Bradmarsh Business Park, Rotherham, S60 1BZ
AESSEAL plc (02101607)	Derby	Derby - Wetherby Road, Osmaston Park Ind Est, Derby, DE24 8HL
AESSEAL plc (02101607)	Bradford	Bradford - Unit 1 and Unit 2 Venlo Ind Est, Knowles Street, Bradford, BD4 6HE
AESSEAL plc (02101607)	Mangham Road	Mangham Road, Barbot Hall Ind Est, Rotherham, S61 4RJ
AESSEAL plc (02101607)	NE	Middlesborough - Trident House, 1st Floor RHS Falcon Court, Preston Farm Business Park, Stockton-on-Tees, TS18 3TX
AESSEAL plc (02101607)	SE	Essex - 11 Saxon House, Upminster Trading Park, Warley Street,Upminster, Essex RM14 3PJ
AESSEAL plc (02101607)	Pontypridd	Abercynon - CF45 4SN Abercynon , Rhondda Cynon Taff
AESSEAL (MCK) LTD. (NI017307)	Lisburn	Lisburn - 139A Hillsborough Old Rd, Lisburn, County Antrim BT27 5QE
AESSEAL IRELAND LTD (NI065308)	Cork	Cork - Unit 14, Knockgriffin Ind. Park, Midleton, County Cork, P25 AR23
AVT RELIABILITY LTD (01829338)	Warrington	Warrington - Unit 2 Easter Court, Europa Boulevard, Warrington, WA5 7ZB
AVT RELIABILITY LTD (01829338)	Kirkcaldy	Evans John Smith Business Park, Kirkcaldy, KY2 6HD
JaTech	JaTech	JaTech Services - 801 Upper Canada Dr, Sarnia, ON N7W 1A3, Canada
AVTPUMP LIMITED (03336919)	Gloucester	Gloucester - Unit 5, Centurion Industrial Estate, Empire Way, Gloucester , GL2 5HY
AVTPUMP LIMITED (03336919)	Grangemouth	Grangemouth - Central England Workshop, North Site, Earls Road, Grangemouth, FK3 8XG
VULCAN ENGINEERING LIMITED (02422728)	Vulcan Sheffield	Southwest Centre, The South West Centre, Unit 3 Troutbeck Rd, Sheffield S8 0JR
VULCAN ENGINEERING LIMITED (02422728)	Vulcan Minnesota	Vulcan Seals Inc., 11401-11481 Rupp Drive, Burnsville, Minnesota, MN 55337
VULCAN ENGINEERING LIMITED (02422728)	Eastern Seals	Unit 3, Sovereign Business Park, Jubilee Industrial Estate, Ashington NE63 8UG
VULCAN ENGINEERING	Coating Centre	Unit 10 Eastover Farm, Abbotts Ann, Andover, UK, SP11 7BT

LIMITED (02422728)		
AESSEAL Inc.	Rockford	Rockford TN - 355 Dunavant Drive, Rockford Tennessee 37853
AESSEAL Inc.	Kingsport TN	Kingsport TN - Building 226 Dr 6, Eastman Road, Kingsport, Tennessee 37662 (AES employees on Eastman Site)
AESSEAL Inc.	Marion IA	Marion IA - 5055 8th Avenue Marion, Iowa 52302
AESSEAL Inc.	Fairfield ME	Fairfield ME - 11 Evergreen Drive, Fairfield, Maine, 04937
AESSEAL Inc.	Longview WA	Longview WA - Suite #8, 960 Industrial Way, Longview, WA 98632
Mechanical Seal & Service Inc.	Odessa TX	Odessa - 3500 N County Road W, Odessa, TX, 79764
AVT Sealing Solutions Inc.	Addison IL	Addison - 1070 N Garfield Street Lombard, IL 60418
AESSEAL Sealing Products of Corpus Christie, LLP	Corpus Christi TX	Corpus Christi - 433 Sunbelt Drive, Suite A, Corpus Christi, TX 78408
AESSEAL Canada Inc	Mississauga ON	Mississauga - Unit 2, 445 Admiral Boulevard, Mississauga, Ontario, L5T 2N1
AESSEAL Canada Inc	Vancouver BC	British Columbia - #304 19292- 60th Avenue, Surrey, B.C Canada, V3S 3M2
AESSEAL (SEALTEC PLC SA)	Buenos Aires	Vicente Lopez, Buenos Aires - Sebastian Gaboto 4950, B1605BH- Munro, Buenos Aires, Argentina.
AESSEAL (SEALTEC PLC SA)	Montevideo	Montevideo - Asuncion 1476 Aguada , Montevideo
AESSEAL Brazil Ltda	Sao Paulo	Sau Paulo (Main Office) - Av. Guido Caloi No 1985, Galpao 3, Santo Amaro, CEP No. 0582-140, Sao Paulo SP
AESSEAL Brazil Ltda	Belo Oriente	Belo Oriente (Branch) - Rodovia BR 381, KM 172, Perpetuo Socorro, CEP No. 35196-000, Belo Oriente, MG
AESSEAL Brazil Ltda	Laoro de Freitas	Lauro de Freitas (Branch) - Av Luiz Tarquino, 2580, Ed Villa Empresarial I, sala 311 - Pitangueiras, CEP No 42700-000, Lauro de Freitas, BA
AESSEAL Colombia SA	Bogota	Bogota - Calle 25g No. 85B-65: Barrio Santa Cecilia de Modelia
AESSEAL Chile SA	Santiago	Providencia, Santiago. - Avenida El Retiro 1275. Bodega A05 RENCA- Santiago, Chile
AESSEAL MEXICO S. DE R.L. DE C.V.	Tampico	Tampico Tamaulipas - Carretera Tampico, Mante #2005 Local D Planta Alta y Baja , Colonia del Bosque, Tampico Tamaulipas CP 89318
AESSEAL MEXICO S. DE R.L. DE C.V.	Tlalnepantla	Tlalnepantla - El Encanto #8, Col. Electra, Tlalnepantla de Baz, 54060, Edo. Mexico.
AESSEAL MEXICO S. DE R.L. DE C.V.	Coaztacoalcos	Coaztacoalcos - Nuevo Leon No. 713 Colonia Petrolera, Coatzacoalcos, Veracruz, 96400
AESSEAL MEXICO S. DE R.L. DE C.V.	Atizapan	Gardenia 14, Tulipan y Azucena, HDA De La Luz, C.P. 52929, Atizapan De Zaragoza, Mex.
AESSEAL Coldweld Pvt. Ltd,	Coldweld	Vasai East Mumbai - Gala No A Cold Weld Estate, 22-23 Gokhivare Village, Sativali Road, Vasai East, Dist Palghar, Maharashtra, India, Pin Code 401208
AESSEAL India Pvt. Ltd	Pune	Pune - Gat No. 85, At Post Varve, Khed Shivapur, Taluka Bhor, Dist. Pune, 412 205.

AESSEAL China Ltd	Ningbo	Ningbo - No. 65 1-2, Lane 777, Qingfeng Road, Ci Cheng Town, Jiang bei District, Ningbo, Zhejiang Province, China
AESSEAL China Ltd	Wuxi	Wuxi - 21F Coast Center, No. 41 Guanshundao Coast City, Taihu New Town, Binhu District, Wuxi City
AESSEAL China Ltd	Dalian	18th floor, Dalian Ping An Building, 24 Renmin Road, Zhongshan District, Dalian
AESSEAL China Ltd	Zhanjiang City	Room 806, No 9, Zone 4, Lucun Road, Xiashan district, Zhanjiang City
AESSEAL Pty Ltd	Johannesburg	Johannesburg - 67 Loper Avenue, Spartan Extension 2, Johannesburg, Gauteng
AESSEAL Pty Ltd	Durban	Durban Durban Belzona - 454 Kingsway Road, Amanzimtoti, KZN, South Africa
AESSEAL Pty Ltd	Cape Town	Cape Town - 10 Killarney Avenue, Killarney Gardens, Milnerton, Cape Town, 7441.
AESSEAL Pty Ltd	Richards Bay	Richards Bay - Unit 4, Dolphin Park, 72 Ceramic Curve, Alton, Richards Bay
AESSEAL Pty Ltd	Sasolburg	Sasolburg - 3 Oxygen Street, Sasolburg Eco Industrial Park, Vaalpark, 1947
AESSEAL Pty Ltd	Kuruman	10 Schoeman Street, Kuruman, Northern Cape, 8460
AESSEAL Pty Ltd	Secunda	Secunda - 14 Kingfisher Street, Secunda, Mpumalanga
AESSEAL Benelux BV	Breda (Benelux)	Breda - Nikkelstraat 27, 4823 AE, Breda.
AESSEAL Czech s.r.o.	Brno	Brno - Turanka 115, 627 00 Brno
AESSEAL Denmark A-S	Køge	Koege - Koebenhavnsvej 222, DK-4600 Koege
AESSEAL Austria GmbH	Oberösterreich	Obere Dorfstraße - Obere Dorfstraße 39, 4616 Weißkirchen an der Traun , Oberösterreich
AESSEAL Deutschland GmbH	Kronau	Kronau - Heidigstrasse 9, Kronau, D - 76709
AESSEAL Finland OY	Jyväskylä	Jyväskylä - Sorastajantie 1a lt. 2, 40340 Jyväskylä, Lansi-Suomen laani
AESSEAL France SARL	Nieppe	Nieppe - ZA De L'Epinette, 161 rue de Bruxelles, 59850 Nieppe France
AESSEAL Ibérica SL	Tarragona	Tarragona (Delivery Address) - Pol Ind Riu Clar, Plata 7, Tarragona, 43006
AESSEAL Italia SRL	Gallarate	Gallarate - Via Varese 17/B - 21013 Gallarate (Va)
AESSEAL Italia SRL	Latina	Latina - Via Gioberti, 11 - 04100 Latina (Lt)
AESSEAL Polska Sp. z o.o.	Mazancowice	Mazańcowice - Mazańcowice 999, 43-391 Mazańcowice
AESSEAL Nordic AB	Stockholm	Jordbro, Stockholm - Jordbro Park, Rörvägen 57, 136 50 Jordbro
AESSEAL Sızdırmazlık Tic.Ltd.	Istanbul	Istanbul - Tekstilkent Is Merkezi, A15 Blok, No.13 Esenler - Istanbul 34235
AESSEAL Univeda Unipessoal LDA	Lisbon	QUELUZ de BAIXO - Barcarena - Estrada Consiglieri Pedroso, 71 Edificio E - Fracção Q4 - 2730-055 Queluz de Baixo
AESSEAL Univeda Unipessoal LDA	Porto	Stª Maria da Feira - Porto - Rua Centro Empresarial do Cavaco, Pav. 04 - Escritório 06, 4520-061 S. João De Ver

Propack Dichtungen und Packungen AG	Sauerlach	Rudolf-Diesel-Ring 28, D 82054 Sauerlach
AESSEAL (M) Sdn Bhd	Selangor (Puchong)	Selangor (Puchong) - No.9, Jalan MJ 13, Taman Industri Meranti Jaya, 47120 Puchong, Selangor Darul Ehsan
AESSEAL (M) Sdn Bhd	Pahang (Kuantan - Gebeng Area)	Pahang (Kuantan - Gebeng Area) - A-25. Ground Floor, Jalan Gebeng 2/6, Kawasan Industri Gebeng, 26080 Kuantan, Pahang Darul Makmur, Pahang.
AESSEAL (M) Sdn Bhd	Johor (Masai)	Johor (Masai) - No. 31 Jalan Bukit 9 , Bandar Seri Alam , 81750 Masai, Johor.
AESSEAL (M) Sdn Bhd	Lahad Datu (East Malaysia)	Lahad Datu (East Malaysia) - MDLD 7635, Lot 3, Block B, Layung Industries, Jalan Tengah Nipah, 91100 Lahad Datu,
AESSEAL (M) Sdn Bhd	Pulau Pinang (Butterworth)	Pulau Pinang (Butterworth) - No. 52, Lengkok Kapal, Jalan Chain Ferry, 12100 Butterworth, Pulau Pinang
AESSEAL Saudi Arabia Co. Ltd.	Dammam	DAMMAM - DAMMAM 2ND INDUSTRIAL CITY - SAUDI INDUSTRIAL PROPERTY AUTHORIYT - MODON - Building No 6770 Unit No. 3 - PO BOX 6770 - 3341 Dammam 34334 KSA
AESSEAL Middle East FZE	Dubai	Dubai - Showroom No. S3B5SR08, Jebel Ali Free Zone, Jebel Ali, Dubai, UAE
AESSEAL Australia Pty Ltd	Brisbane QLD	QLD - 12 Counihan Road, Seventeen Mile Rocks, Queensland, 4073
AESSEAL Australia Pty Ltd	Rockingham WA	WA - Unit 6, 5 Nasmyth Road, Rockingham WA 6168
AESSEAL Australia Pty Ltd	Edwardstown SA	SA - 25 Weaver Street, Edwardstown SA 5039
AESSEAL COJ	Algiers	Algiers - Lot No 5 Zone d'activite Ain Benian-Alger, Algeria
AESSEAL Taiwan Co., Ltd	Kaohsiung	Kaohsiung City - No.124 Zhumen Ln., RenWu Dist., Kaohsiung City 81448, Taiwan (R.O.C.)
AESSEAL Namibia (Pty) Ltd	Swakopmund	Swakopmund - Unit 9, Einstein Business Park, Einstein Street, Swakopmund (moving Aug 19 to Winghoek)
AESSEAL Botswana (Pty) Ltd	Orapa	Orapa - Office Unit 3, Plot 1056, Industrial Site Orapa, Botswana
AESSEAL NSW Pty Ltd	Smeaton Grange (Stevco & AES&S)	11 Samantha Place Smeaton Grange, NSW, 2567
VULCAN ENGINEERING LIMITED (02422728)	Houston TX	7221 N. Gessner Rd, Houston, TX, 77040
AES Edmonton	Edmonton	3104/3108 - 121 Avenue N.E, Edmonton, Alberta
Van Geffen AMS	Van Geffen	Uilenwaard 7, 5236 WB 's-Hertogenbosch, Netherlands
AESSEAL Pty Ltd	East London	Mecedes Benz SA (PTY) LTD, 7 Settlers Way, Gately Industrial Township, Building B-Plant, Machine Shop, East London, 5200
AESSEAL WA	Wangara	Unit 1, 41 Paramount Drive, 6065 Wangara , Western Australia
DATUM RMS	Fort Lauderdale	2040 Tigertail Blvd., Building 5, Suite E, Dania Beach, FL
AESSEAL Inc.	Cedar Rapids IA	616 12th Ave. SW, Warehouse, Cedar Rapids IA 52404