A.E.S Engineering Ltd. Product Avoidance

Product Emissions Avoidance Report

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1 Introduction

A.E.S Engineering Ltd., through conducting a full GHG inventory inclusive of Scope 3 emissions is aware of the wider impact outside of what would often be considered when assessing the emissions a company is responsible for. When considering the wider impact a single organisation may have on emissions it is also possible to consider the emissions impact the products or services sold by that company may have. This is itself reflected within the GHG protocol in Scope 3, Category 11. Further to this is the consideration of the emissions that the sale of products may avoid for other companies, groups and users through use of these products.

A.E.S takes pride in providing products which are beneficial to the environment, both the local environment and often on a global scale as well. A.E.S products are mechanical and passive in nature, with only a small few products consuming any energy in use. As sealing products, they ensure that a customers process does not leak fluids or gases into the environment that may potentially be hazardous or harmful. Furthermore, these products have the potential to reduce consumption of scarce resources such as energy or water. This may be taken further still to consider even the long-term benefits of increased reliability, such as preventing the unnecessary replacement of metallic components, or minimising the need for inefficient shutdown and startup procedures for maintenance or replacement. It is acknowledged that some of these benefits are very hard to quantify with a reasonable degree of accuracy, especially across a large business and range of product lines.

This report contains calculations made relating to a selected range of A.E.S products, and the associated GHG emissions that have been avoided through their use. Note that this report does not contain an assessment of the emissions associated with production, as this is covered within the separate GHG inventory report of A.E.S Engineering Ltd..

2 Methodology

Calculation of avoided emissions is done on a lifecycle basis. This means that the total avoided emissions over the entire lifecycle of a product sold may be included within the reporting timeframe of which it was sold. This would be opposed to attempting to calculate the continued impact in any given timeframe of products sold in the past. This approach is in line with the guidance and methodology of Scope 3, Category 11 – Use of Sold Products as observed in the GHG protocol.

2.1 Product Inclusions & Exclusions

This report does not consider the entirety of the products sold by A.E.S, considered within this report are seal support systems (in conjunction with mechanical seals), and the STS™ mechanical seal. The use of seal support systems has been further split between the industrial process in which they are used.

Not included are the sales solely of mechanical seals themselves, this is despite these items still carrying an emissions avoidance in relation to the use of traditional gland packing. Mechanical seals will offer reduced friction in relation to packing and will therefore reduce a customers' energy use from the driving action of the pump, turbine or machinery in question. This may result in reduced emissions through reduced electricity use or reduced consumption of fuel should another method of power be in use. Furthermore, gland packing also requires leakage in operation to prevent overheating which is reduced (but not eliminated) through use of a mechanical seal, this will result in avoided emissions from a reduction in water use or the supply of other working fluids. For this reporting period, these have not been considered due to the difficulty in attempting to calculate avoided emissions of these products. Sufficiently accurate data on the products being replaced and processes they are sold into is not available to make an assessment without a large degree of uncertainty and error.

Note that all products that may result in emissions from their use are considered within the accompanying GHG inventory report of A.E.S Engineering Ltd..

3 Water Saving Systems

Whilst mechanical seals do offer energy and water saving benefits over traditional gland packing, they still necessitate some fluid flow for their use. In many applications this is done in a quench-to-drain arrangement where significant quantities of water are consumed and subsequently dumped straight to drain.

A.E.S offers seal support systems that significantly mitigate the quantities of water lost. The water management system is a closed-loop design, where water is recirculated through a thermosiphon action, this action circulates water through the seal and re-uses it without any energy requirements. Traditional quench-to-drain and flush arrangements may use up to *6.3 million litres* of water per seal per year, water management systems are able to reduce this to as low as *32 litres* per seal per year.

3.1 Avoidance Calculation

Calculation of avoided emissions relating to the use of these products is in relation to the supply and treatment of water. An assessment is made of the total water savings of a single product, this is then multiplied by the DEFRA emissions factors for water treatment and supply to convert to a CO_2e figure. This is then multiplied by the total amount of units sold within the reporting period.

During the use of these products water savings figures can range from *4 litres* per minute to upwards of *20 litres* per minute. It is noted that Ofwat state that an external stop tap should deliver at least *9 litres* per minute as per their DG2 service level standard. Yorkshire water state that should a downstairs tap deliver less than *12 litres* per minute they will investigate the supply pipework free of charge. For the purposes of this calculation a conservative figure of *8 litres* per minute was selected, equating to *4,204,800 litres* over a year.

Parameter	Value	Units
Systems Sold	3,081	Systems
Water Savings	4,204,800	Ltrs
Water Savings	4,205	m^3
Supply Emissions	0.1767	kg CO_2e
Treatment Emissions	0.2013	kg CO_2e
Combined Emissions	0.3780	kg CO_2e
GHG Saving per application	1,589	kg CO_2e
GHG Saving per application	1.6	Tonnes CO_2e

Total GHG Savings Yr 1	4,897,023	kg CO_2e
Total GHG Savings Yr 1	4,897	Tonnes CO_2e
Total GHG LCA Savings (10 Yr)	48,970.23	Tonnes CO_2e

Table 1: GHG Savings per water saving application.

Please see the below section on evaporative processes for information relating to the life cycle of these systems.

4 Steam Turbine Seals

The STS™ (Steam Turbine Seal) mechanical seal is designed for use on steam turbines, and helps prevent unnecessary loss of high-pressure steam from these turbines in comparison to the use of carbon bushes.

These are of low overall contribution to the group avoidance figure relative to those of the seal support systems in both water saving and evaporative applications, this being due to much fewer sales of this product line in relation to the more wide ranging applicability of seal support systems.

4.1 Avoidance Calculation

Avoided GHG emissions are calculated on the basis of a reduction in steam loss through use of the seal, this is then multiplied by the DEFRA emissions factor for on-site steam to arrive at an emissions figure.

Comparative leakage rates between an STS seal and carbon bushes varies depending upon the age of the carbon bushes, carbon bushes degrade over time and result in an increased amount of leakage. Whilst not explicitly failing, this does eventually necessitate replacement of the worn carbon bushes. Leakage of the STS seal has been measured at < *2.25 kg per hour*, whilst carbon bushes have a leakage rate between *16 kg* and *30 kg* per hour for new and worn bushes respectively. At an average leakage rate of *23* kg per hour, this equates to *181.8 Tonnes* of steam saved per seal per annum.

Conversion	Value
kJ per kg*	2,620
kWh per kJ	0.0002778
kg CO_2e per kWh	0.17965
Tonnes per kg	0.001

*Table 2: Conversions used, * this being based on information from the European Council for energy efficient economy, from the NTB University of applied Science Technology and Ecole Polytechnique Federale De Lausanne.*

Parameter	Value
STS Leakage Rate (kg/h^{-1})	2.25
New Carbon Bush Rate (kg/h^{-1})	15.88
Worn Carbon Bush Rate (kg/h^{-1})	29.48
Average Carbon Bush Rate (kg/h^{-1})	22.68
Steam Savings (kg/h^{-1})	20.4296
Annual Steam Savings (kg)	178,963.3
Energy Savings (kJ)	468,883,835.5

Energy Savings (kWh)	130,245.5
CO_2e (kg)	23,398.2
CO_2e (Tonnes)	23.4

Table 3: Savings per STS seal.

This figure may now be multiplied by the total number of seals sold to arrive at a total avoidance figure for this product line.

Parameter	Value
CO_2e savings per application (Tonnes)	23.4
Seals sold (2022-23)	12
Total GHG Savings 1 Year (Tonnes)	280.8
Total GHG LCA Savings (Tonnes)	1965.4

Table 4: GHG savings, note that in this case the lifecycle of the seals is expected to exceed 7 years. However from available case studies planned maintenance is conducted after 7 years.

5 Evaporative Processes

Many sealing solutions are required in hot and viscous industrial processes, often in the pulp & paper or distillation industries. Within these processes there is often a necessity for purity which results in the need for any water ingressed into the system to be removed.

In the context of this report, where a mechanical seal is present on machinery within these processes, water would be ingressed into the working fluid. This water would then be required to be removed through the process of evaporation, although methods of doing so may vary this is a very energy intensive process. Energy may be required not only to change state from liquid to gas but also for heating of the cooler fluid to the temperature of the working fluid.

It is common for this evaporation to be conducted through the use of super-heated steam evaporators. Super heated water vapour generation is highly energy intensive and is leading to unnecessary large scale emissions of GHGs, in particular when a gas-fired boiler or an electrical heater used to produce the steam required.

A.E.S serves customers in industries which operate equipment as described above. Specifically, customers running operations where quenching water is injected into their process and steams is used for extraction through evaporation.

The products included have been reported as being installed in applications that otherwise would have used packing or single spring type arrangements. During their use, water is introduced to the product that then later has to be evaporated back out through a highly energy intensive processes.

The seals included in the calculation, when used with a water management system, remove the need for this wasteful consumption of energy and resultant GHG emissions.

5.1 Avoidance Calculation

The processes where evaporative savings can be witnessed are often hot and viscous processes in relation to those where only water savings are seen. For cold processes, quenching fluid is required for cooling of the seal or packing to prevent it over-heating from friction. For hot and viscous processes however, further cooling is required due to the influx of process heat, as a result of this both the pressure and flow rates in these evaporative processes are higher.

Calculation of avoided emissions will be based upon the steam savings from the use of a seal support system, this is then multiplied by the DEFRA emissions factor for on-site produced steam. Note that this last step is likely overly-conservative, in the majority of

on-site evaporative processes a more common setup would be for this energy input to be produced by a gas boiler. The emissions factor for gas is ***0.18293*** *kg CO_2e per kWh* and this is not accounting for energy losses due to boiler efficiency. In actual industrial conditions energy will likely be produced in a more carbon-intensive manner than the emissions factor of *0.17965 kg CO_2e per kWh*. In fact the US Environmental Protection Agency offers its own emissions factor for onsite steam of *0.22656 kg CO_2e per kWh* which is specifically based upon steam being produced in a gas boiler with *80%* thermal efficiency.

However due to the wide variation in individual conditions and a lack of representative data on the multiple processes into which systems are sold, the lower emissions factor has been chosen for final conversion.

Case studies show that steams savings per seal per year equate to *3961.54 klbs*, or *1,796,922.15 kg* of steam saved per annum. As discussed, methods of generating this steam may vary, however the conservative DEFRA emissions factor is a per kWh basis.

As a result a conversion of *2,620 kJ/kg* of steam is used, and the subsequent kilojoule figure converted into kWh figure for use with the DEFRA emissions factors. The conversion factors for this process, and the steps for this process are summarised in tables 5 and 6 below.

Conversion	Value
lbs per klb	1,000
lbs per kg	0.453592
kJ per kg*	2,620
kWh per kJ	0.0002778
kg CO_2e per kWh	0.17965
Tonnes per kg	0.001

*Table 5: Conversions used, * this being based on information from the European Council for energy efficient economy, from the NTB University of applied Science Technology and Ecole Polytechnique Federale De Lausanne.*

Parameter	Value
Annual steam savings (*klbs*)	3,961.54
Annual steam savings (*lbs*)	3,961,538.46
Annual steam savings (*kg*)	1,796,922.15
Annual energy savings (*kJ*)	4,707,936,041.25
Annual energy savings (*kWh*)	1,307,760.01
Annual CO_2e savings (*kg*)	223,273.87
Annual CO_2e savings (*Tonnes*)	**223.27**

Table 6: Savings per evaporative application.

This figure may now be multiplied by the total number of units sold to arrive at a total avoidance figure for the products sold into evaporative processes.

Parameter	Value
CO_2e savings per application (Tonnes)	223.3
Systems sold (2022-23)	163.0
Total GHG Savings 1 Year (Tonnes)	38,294.3
Total GHG 10 Year LCA Savings (Tonnes)	382,943.4

Table 7: Evaporative Savings only and does not take into consideration the avoidance associated with reduced water consumption.

With regards to lifecycle, the seals will work in conjunction with the system they are supplied with. The system as detailed below will not corrode and will conservatively last 10+ years.

Dr Chris Carmody has provided calculations that prove the systems would remain compliant with PED requirements for containing water at 16 bar for 14.5 years. This is based on the thickness of stainless steel used within the vessels. However, the systems are only used at 10 bar or less so would actually remain compliant for significantly longer than this.

Additional information in relation to the corrosion resistance of the product under normal conditions can be found in the evidence pack.

The seal itself, as validated by case studies will run uninterrupted for 5+ years and can then be re-lifed with minimal work at one of the AESSEAL® network of repair centres. It is noted that all emissions associated with the re-life work are calculated as part of the group scope 1, 2 and 3 emissions inventories.

6 Summary

Total avoided emissions as a result of the sale of products during the reported timeframe are assessed to be 433,879.1 tonnes. This is the total of avoided emissions over the entire lifespan of the products sold during this window.

Process	Total LCA Savings (Tonnes CO_2e)
Water Saving Systems	48,970.2
Steam Turbine Seals	1,965.4
Evaporative Processes	382,943.4
Total	**433,879.1**

Table 8: Total avoided emissions from the use of products over those products' lifecycle.

Appendix – Statement of Verification

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Verification Opinion

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Responsible party:	A.E.S. Engineering Ltd (Group of companies) Global Technology Centre, Bradmarsh Business Park Mill Close, Rotherham, South Yorkshire, S60 1BZ, United Kingdom
Type of GHG statement:	Organization (avoided emissions through the use of double mechanical seals)
Identification of GHG statement:	Product emissions avoidance report (Ref. GHGVA2223 – V1 – Public – 15/03/24)
Scope of activities:	Energy savings associated with AESSEAL® seal support systems (in conjunction with mechanical seals) and the STS™ mechanical seal.
Reporting boundary:	Indirect emissions - scope 3 (avoided emissions through the use of double mechanical seals)
Level of assurance / materiality:	Limited / 10%
Period:	1-Oct-2022 to 30-Sep-2023
GHG Emissions avoidance:	433,879.1 t CO_2e (over a 10-year product in service period)
Verification opinion:	Verified Based on the process and procedures conducted, there is no evidence that the "Product emissions avoidance report (Ref. GHGVA2223 – V1 – Public – 15/03/24) produced by A.E.S. Engineering Ltd is not materially correct and is not a fair representation of GHG data and information.

Verification activities:

Verification (documentation review & recalculations) was completed for the calculations supported by the following documents:

a) How do we manage your water supply? Paper by Yorkshire Water
b) Properties at risk of receiving low pressure. Paper by Ofwat
c) System Vessel Life Cycle – Expert Consideration (SES-Public-08/20). Paper by Dr Chris Carmody PhD, MSc BEng (Honours)
d) Applying low emissions API compliant sealing technology to mature pump machinery. Paper by Mr Richard J Smith (Director AESSEAL plc Rotherham England) & Mr APW (Machinery Engineer; Petrochemical plant, UK)
e) The mechanical seal industries contribution to energy efficiency in pumping systems. Paper by Mr Richard Smith (AESSEAL plc) & Chris Booth BA MBA (AESSEAL plc)
f) Water savings case studies provided
g) Mechanical Seal Conversion ROI (28th May 2015). Paper by Mr PL (Project Engineer, Paper Pulp Mill, Canada)

The verification activity has been carried out in accordance with ISO 14064-3:2019 and the principles of ISO 14065:2013.
The verification activities applied in a limited level of assurance verification are less extensive in nature, timing and extent than in a reasonable level of assurance verification.

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Responsibilities:	A.E.S Engineering Ltd is responsible for the preparation and presentation of the Product Emissions Avoidance Report. The data on which the GHG emissions avoided through the use of A.E.S. Engineering Ltd mechanical systems and seals is based on has been provided by A.E.S. Engineering Ltd. This data is the responsibility of A.E.S. Engineering Ltd and is historical in nature. A.E.S. Engineering Ltd is responsible for supporting documents provided for this verification. BSI is responsible for expressing an opinion on the GHG statement based on the verification.
Lead verifier:	Jose L Miguel
Signed on behalf of BSI:	Matt Page, Managing Director UK & Ireland, Assurance
Issue date	3rd April 2024

BSI Assurance UK Ltd, Kitemark Court, Davy Avenue, Milton Keynes, MK5 8PP

NOTE: BSI Assurance UK Ltd is independent to and has no financial interest in A.E.S. Engineering Ltd. This verification opinion has been prepared for A.E.S. Engineering Ltd only for the purposes of verifying its statement relating to its GHG emissions avoidance 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 UK Ltd accepts no liability to any third party who places reliance on this statement.