A.E.S Engineering Ltd. GHG Avoidance

Scope 1, 2 & 3 Emissions Inventories

Introduction

Having conducted a full GHG inventory inclusive of Scope 3 emissions, AES Engineering Ltd. is aware of the wider impact of a single company's emissions, beyond those which would usually be considered. When assessing the impact of each organization, its products or services must also be taken into account. This is 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.

In addition, consideration has to be given to the emissions that may be avoided through companies' use of AES products).

AES takes pride in providing products which are beneficial to the environment, both the local environment and on a global scale. AES products are mechanical and passive in nature, with only a very few consuming any energy when in use. As sealing products, they ensure that a customer's process does not cause the leakage of potentially hazardous or harmful fluids or gases into the environment. Furthermore, these products also have the potential to reduce the consumption of scarce resources such as energy or water. In addition, there are the long-term benefits resulting from increased reliability, such as avoiding the unnecessary replacement of metallic components, for example, or minimizing the need for costly shutdown and start-up procedures for maintenance or replacement. However, it is acknowledged that some of these benefits are very hard to quantify with any reasonable degree of accuracy, especially across a large business and range of product lines.

This report contains calculations relating to a selected range of AES 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 AES Engineering Ltd which can be found on www.aesseal.com.

1 Methodology

Calculation of avoided emissions is undertaken on a life cycle basis. This means that the total avoided emissions over the entire life cycle of a product may be included, as opposed to attempting to calculate the continued impact in any given time frame 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.

1.1 Product Inclusions & Exclusions

This report does not consider the entirety of the products sold by AES. Included here are seal support systems (in conjunction with mechanical seals), and the STS™ mechanical seal. The use of seal support systems has been further divided according to the industrial processes in which they are used.

Not included are the sales solely of mechanical seals themselves. This is despite these items carrying an emissions avoidance when compared with traditional gland packing. Mechanical seals offer reduced friction compared to packing and therefore reduce the energy use associated with the driving action of the pump, turbine, or machinery in question. This may result in reduced emissions through reduced electricity use, or through a reduction in fuel consumption should another method of power be in use.

Furthermore, gland packing also requires leakage in operation to prevent overheating. This is reduced (but not eliminated) through the use of a mechanical seal, resulting in avoided emissions from a reduction in water use or 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 is not available on the products being replaced and the processes they are sold into, to make an assessment without a large degree of uncertainty and error.

Note that all products whose use may result in emissions are considered within the accompanying GHG inventory report of AES Engineering Ltd.

2 Water Saving Systems

While mechanical seals do offer energy and water saving benefits over traditional gland packing, they still require some fluid flow. 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.

AES offers seal support systems that significantly reduce 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.

2.1 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, which is then multiplied by the DEFRA emissions factor 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 can range from *four litres* per minute to upwards of *20 litres* per minute. It is noted that Ofwat states that an external stop tap should deliver at least *nine litres* per minute as per their DG2 service level standard. According to Yorkshire Water, 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 *eight litres* per minute was selected, equating to *4,204,800 litres* over a year.

Parameter	Value	Units
Systems Sold	3,058	Systems
Water Savings	4,204,800	Ltrs
Water Savings	4,205	m^3
Supply Emissions	0.149	kg CO_2e
Treatment Emissions	0.272	kg CO_2e
Combined Emissions	0.421	kg CO_2e
GHG Saving per application	1,770	kg CO_2e
GHG Saving per application	1.8	Tonnes CO_2e
Total GHG Savings Yr 1	5,413,335	kg CO_2e
Total GHG Savings Yr 1	5,413	Tonnes CO_2e

Total GHG LCA Savings (10 Yr)	**54,133.35**	**Tonnes CO_2e**

Table 1: GHG Savings per water saving application.

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

3 Steam Turbine Seals

The STS™ (Steam Turbine Seal) mechanical seal is designed for use on steam turbines. It helps prevent unnecessary loss of high-pressure steam from these turbines and provides better results when compared with the use of carbon bushes.

These (carbon bushes) 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 is due to significantly fewer sales of this product line in comparison to the more wide-ranging applicability of seal support systems.

3.1 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 vary depending on the age of the carbon bushes. These degrade over time, resulting in an increased amount of leakage. Even when not completely failing, these worn bushes do eventually have to be replaced. Leakage of the STS seal has been measured at *< 2.25 kg per hour*, while 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	0.17073
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})	16
Worn Carbon Bush Rate (kg/h^{-1})	30
Average Carbon Bush Rate (kg/h^{-1})	23
Steam Savings (kg/h^{-1})	20.75
Annual Steam Savings (kg)	181,770.0
Energy Savings (kJ)	476,237,400.0
Energy Savings (kWh)	132,288.2
CO_2e (kg)	22,585.6
CO_2e (Tonnes)	**22.6**

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)	22.6
Seals sold (2021-22)	10
Total GHG Savings 1 Year (Tonnes)	225.9
Total GHG LCA Savings (Tonnes)	**1581.0**

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

4 Evaporative Processes

Many sealing solutions are required to operate 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 entering the system to be removed.

In the context of this report, where a mechanical seal is present on machinery within these processes, water would enter into the working fluid. This water would then have 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 to heat 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

leads to unnecessary large-scale emissions of GHGs, in particular when a gas-fired boiler or an electrical heater is used to produce the steam required.

AES serves customers in industries which operate equipment as described above. Specifically, customers running operations where quenching water is injected into the process and where steam 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 later has to be evaporated back out through a highly energy-intensive process.

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.

4.1 Avoidance Calculation

The processes where evaporative savings can be achieved are often hot and viscous processes, compared with 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 on 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 *0.18254 kg CO_2e per kWh* and this does not account 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 *0.17073 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 on 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 steam 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 on 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 summarized 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	0.17073
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 (2021-22)	151.0
Total GHG Savings 1 Year (Tonnes)	33,714.4
Total GHG 10 Year LCA Savings (Tonnes)	337,143.5

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

With regards to life cycle, 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 proving that 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 requested.

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.

5 Summary

Total avoided emissions as a result of the sale of products during the reported time frame are assessed to be 392,858 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	54,133.4
Steam Turbine Seals	1,581.0
Evaporative Processes	337,143.5
Total	392,857.9

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