THE HIDDEN COST OF COAL-TO-LIQUIDS IN SOUTH AFRICA:

HEALTH IMPACTS OF AIR POLLUTION FROM SASOL SECUNDA

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Health Impact Assessment

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The hidden cost of coal-to-liquids in South Africa: Health impacts of air pollution from Sasol Secunda

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The hidden cost of coal-to-liquids in South Africa: Health impacts of air pollution from Sasol Secunda

Key findings

- The Sasol Secunda facility emitted 112 kilotonnes of sulphur dioxide (SO_2) in 2024. It is also a major emitter of hydrogen sulphide (H_2S), particulate matter, and other air pollutants. The health and economic costs of this pollution are borne largely by society rather than the polluter.
- Air pollution from Sasol Secunda's emissions is estimated to contribute to approximately 1,000 deaths every year. It also contributes to reduced quality of life across exposed communities due to chronic disease, including respiratory illness and diabetes, and adverse birth outcomes.
- Children are among those most affected, with the facility's emissions increasing the burden of childhood asthma and harming health before birth through increased risks of low birthweight and preterm birth.
- The cumulative health impacts of the air pollution from Sasol Secunda are estimated to cost the South African economy approximately USD 1.0 billion, equivalent to ZAR 19 billion, each year.
- Sasol Secunda's emissions are exceptionally high in part because the facility has been granted alternative SO_2 emission limits that are less stringent than South Africa's minimum emission standards (MES). The MES were established to limit harmful industrial emissions and protect public health. These alternative limits allow Sasol Secunda to emit substantially more SO_2 than the standard limits would permit.
- Reducing emissions from Sasol Secunda to meet more stringent emission limits would deliver substantial public health and economic benefits, particularly for communities in and around the Highveld Priority Area.

Contents

Introduction

Fossil fuel combustion and the burden of air pollution

Air pollution is one of the most serious environmental risks to public health globally, contributing to millions of deaths each year and increasing the burden of respiratory disease, cardiovascular illness, lost workdays, and wider economic costs. The World Health Organization identifies particulate matter, nitrogen dioxide, sulphur dioxide, ozone, and carbon monoxide among the pollutants with the strongest evidence of public health concern, with both short- and long-term exposure linked to adverse health outcomes (World Health Organization, 2021).

The health impacts of air pollution are not distributed evenly. Communities living close to major industrial facilities, workers in heavily polluted airsheds, children, older people, and people with pre-existing health conditions are more impacted by higher concentrations of harmful pollutants and face a greater risk of adverse health outcomes. In highly industrialised regions such as South Africa's Highveld Priority Area, these exposure risks are shaped by the cumulative contribution of coal-fired power generation, petrochemical production, mining, transport, residential fuel burning, and other industrial activities (Department of Forestry, Fisheries and The Environment, 2025).

Fossil fuels are a major contributor to air pollution (Lelieveld et al., 2019; Vohra et al., 2021). Coal, gas, and liquid fuels emit a mixture of pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}) and their precursors, as well as sulphur dioxide (SO_2), nitrogen oxides (NO_x), and hydrogen sulphide (H_2S). These pollutants affect health both directly and indirectly. Primary pollutants can harm respiratory and cardiovascular systems near the source. In contrast, secondary pollutants, including fine particulate matter formed from SO_2 and NO_x in the atmosphere, can travel long distances and expose populations far beyond the immediate industrial site. This indicates that large point sources are not only local environmental concerns, but also regional public health risks (Goshua et al., 2022), as well as national, and even international, due to the transboundary nature of pollution.

Sasol Secunda and the industrial emissions burden

Sasol is a global chemicals and energy company. The Sasol Secunda facility is located near the town of Secunda in Mpumalanga Province, approximately 140 km east of Johannesburg. According to Sasol, the Sasol Secunda site is the world's largest coal-based synthetic fuels and chemicals production facility, using coal as its primary feedstock together with natural gas to produce liquid fuels and a wide range of chemical products through high-temperature gasification and Fischer-Tropsch synthesis (Sasol, 2023).

Sasol Secunda forms the core of Sasol's Southern Africa Energy and Chemicals business (Sasol, 2025b). The facility markets 8.0 to 8.5 billion litres (50-54 million barrels) of liquid fuels annually, supplying approximately 30% of South Africa's domestic fuel demand, while its Chemicals Africa business markets 3 to 4 million tonnes of chemical products each year to customers in more than 100 countries (Sasol, 2025b). Sasol operates six coal mines supplying approximately 30-35 million tonnes of thermal coal annually to Secunda and Sasolburg (Sasol, 2025b).

Although Sasol reports progress in reducing emissions and improving compliance across its operations, emissions of key toxic pollutants remain extremely high. Rather than complying with the 1,000 mg/Nm^3 minimum emission standard (MES) for SO_2 that should have applied to its 17 coal boilers starting in April 2025, the facility is operating under substantially higher alternative limits set out in its atmospheric emission licence (Gert Sibande District Municipality, 2025). Sasol has committed to reducing the steam plant's total SO_2 emissions load by 2030, but the facility continues to emit large quantities of SO_2 in the interim (Sasol, 2025c).

Ambient air quality studies conducted in Secunda and its surrounding regions have reported elevated concentrations of SO_2, NO_x, $PM_{2.5}$ and PM_{10}, and H_2S, demonstrating that emissions from the facility influence both local and regional air quality (Venter & Lourens, 2021). Hydrogen sulphide is also an important pollutant because it readily oxidises in the atmosphere to form sulphur dioxide and subsequently $PM_{2.5}$, contributing to the regional sulphur burden that also causes local odour nuisance episodes (Myllyvirta, 2022) and potential health impacts at elevated concentrations (World Health Organization 2021).

Strong sulphurous odours were reported across Johannesburg and other parts of Gauteng in January and March 2026, continuing a pattern of recurring episodes reported since at least 2021. Media coverage documented complaints from residents of headaches, burning eyes, chest tightness, fatigue, and respiratory discomfort, while also drawing attention to the more persistent air-pollution burden experienced by communities in the Highveld Priority Area (Bega, 2026; Delahunt, 2026; Maphosa, 2026; Mutsila, 2026).

In March 2026, the Department of Forestry, Fisheries and the Environment confirmed that the odour was likely caused by hydrogen sulphide. It stated that investigations in 2022 revealed that although Sasol Secunda was operating within the legal emission limits, the existing limits, ‘were not enough to properly protect public health, particularly for communities around Secunda’ (Department of Forestry, Fisheries and the Environment, 2026). Air quality monitors recorded elevated H_2S peaks in Secunda, Springs, Irene, Midstream and Buccleuch (Department of Forestry, Fisheries and the Environment, 2026). The Department also stated that it was, ‘in the process of introducing hydrogen sulphide as a criteria pollutant under the National Environmental Management: Air Quality Act. This will allow South Africa to establish national ambient air quality standards for hydrogen sulphide, aligned with international health protection guidelines’ (Department of Forestry, Fisheries and the Environment, 2026). Despite recurring episodes of this kind, South Africa still has no national ambient air quality standard for H_2S against which ambient concentrations can be formally assessed.

In August 2025, the government proposed tightening the MES for hydrogen sulphide from coal-gasification processes by requiring both new and existing facilities to meet a limit of 600 mg/Nm^3, compared with the current limit of 3,500 mg/Nm^3 for existing facilities (Government of South Africa, 2025). However, it subsequently announced that revised amendments would undergo a second round of public consultation. As of August 2026, the updated proposed amendments have still not been published, and the tighter standard therefore not taken effect (Department of Forestry, Fisheries and the Environment, 2026).

The odour episodes and their health impacts are additional to the modelled $PM_{2.5}$ and NO_2 health impacts quantified in this health impact assessment. They provide important local evidence of reported recurring pollution concerns, community exposure, and regulatory gaps around sulphur-bearing emissions.

Regulatory context and emissions scenario

South Africa’s air quality regulatory framework places obligations on listed industrial activities through the National Environmental Management: Air Quality Act and the associated MES. As is set out in the National Environmental Management: Air Quality Act: List of Activities, the MES applies to industrial activities and varies depending on processes, fuel types, plant sizes, and whether an installation is ‘new’ or ‘existing’ (Government of South Africa, 2025). Existing plants were required to comply with the existing plant MES from 1 April 2015 and with a stricter, so-called new plant MES from 1 April 2020. The legislation also makes provision for existing plants to apply to postpone compliance with the new plant MES for a maximum of five years.

Sasol Secunda is regulated under several categories because the facilities include solid-fuel combustion, gasification, petrochemical production, and chemical manufacturing (National Environment Management: Air Quality Act [No. 39 of 2004], 2004).

As a result of an SO_2 MES postponement, the 17 Secunda steam-plant coal-fired boilers were subject to the MES for existing solid-fuel combustion installations until 31 March 2025. Following the expiry of Sasol's postponement on 31 March 2025, the national SO_2 limit that would otherwise have applied to these boilers was 1,000 mg/Nm^3. Even before the less stringent facility-specific alternative limits granted to Sasol are considered, this national limit is substantially less stringent than selected limits and benchmarks for comparable large coal and solid-fuel facilities in South Korea, the European Union, and China, as shown in Figure 1. Additional information about the limits is provided in Appendix A.

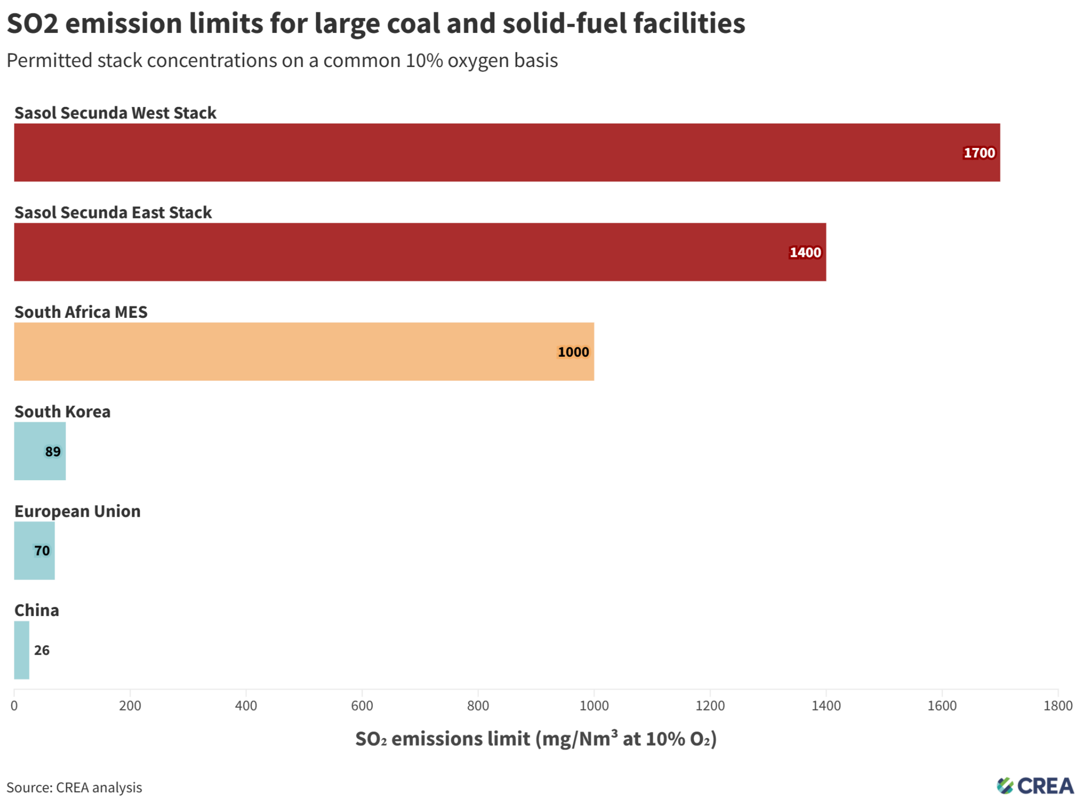

Figure 1 — Comparison of SO_2 emission limits[1] for large coal-fired and solid-fuel facilities, expressed on a common 10% oxygen basis

[1] Note: For the European Union and South Korea, bars show the midpoint of the applicable daily-average ranges.

Even though the South African emission limit is extremely lenient compared to third-country standards, Sasol has not been required to comply with the limit. In 2015, the company received a five-year postponement and suspension of the new-plant SO_2 standard for its steam-plant boilers, covering the period from 1 April 2020 to 31 March 2025. In 2022, Sasol applied to the National Air Quality Officer (NAQO) of the Department of Forestry, Fisheries and the Environment, under Paragraph 12A of the National Environmental Management: Air Quality Act: List of Activities, to replace the concentration-based standard (subject to daily averaging) with an alternative load-based limit of 503 t/d from 1 April 2025 to 31 March 2030, and 365 t/d from 1 April 2030 onwards (both with monthly averaging) (Department of Forestry, Fisheries and the Environment, 2024; Sasol South Africa Limited, 2022).

When the NAQO refused Sasol's application, pointing out that only one postponement of compliance was permitted, Sasol appealed this decision and was granted permission (Just Share, 2024a) by the Minister of Forestry, Fisheries and the Environment to measure SO_2 emissions from its steam-plant boilers using its requested load-based limit of 503 t/d from 1 April 2025 to 31 March 2030, subject to various conditions (Department of Forestry, Fisheries and the Environment, 2024). One such condition was that Sasol must continue to implement its 'integrated solution and must achieve the reductions in emissions of all pollutants as undertaken in its [12A] application and appeal'. The appeal decision also stated, as a condition, that any exceedances of the standards would require a full atmospheric dispersion assessment to determine the likelihood of health incidents.

Another condition was that such emissions should also be subject to a daily concentration limit. Following submissions on such limit (Just Share, 2024b), the Minister determined the concentration limits to accompany the load-based limit: 1,700 mg/Nm^3 for the West Stack, and 1,400 mg/Nm^3 for the East Stack (Second-Generation Highveld Priority Area Air Quality Management Plan, 2025). The resulting 2025 atmospheric emission licence applies daily average SO_2 concentration limits of 1,700 mg/Nm^3 for the West Stack and 1,400 mg/Nm^3 for the East Stack, both higher than the generally applicable MES. The two stacks are also subject to a combined monthly load-based limit of 503 tonnes of SO_2 per day. All of these values were designed not to require Sasol to reduce its emissions.

This regulatory pathway allows Sasol Secunda to continue operating under limits that are weaker than the national standard. However, the health and economic consequences of the emissions permitted under this arrangement have not been quantified in a publicly available facility-specific assessment. This study addresses that gap by estimating the air pollution, health impacts, and economic costs associated with the reported emissions of Sasol Secunda for FY 2024/2025.

Health impacts of Sasol Secunda

Table 1 shows the annual health and economic impacts of air pollution originating from Sasol Secunda. A full description of the methodology used is presented in the Methodology section of this report. Briefly, we consider emissions of NO_X, SO_2, PM, and H_2S reported from Sasol, in an air dispersion model (CALPUFF). We then quantify health outcomes by combining simulated pollutant concentrations, dose-response concentrations, and epidemiological data. Note that hereafter any references to Sasol Secunda refer to the Sasol Secunda facility in Mpumalanga and not the town of Secunda. Emissions are from stacks within the facility, and not associated activities such as transport.

Table 1 — Estimated annual health impacts from Sasol Secunda over the 2024/2025 financial year

Health outcome	Annual impacts (95% confidence interval)
Deaths	1,000 (600–1,500)
Years of life lost	23,800 (14,100–37,500)
Years lived with disability due to COPD	600 (300–1,000)
Years lived with disability due to diabetes	1,600 (600–3,000)
Years lived with disability due to stroke	400 (200–800)
Asthma emergency room visits	2,030 (1,190–2,870)
New cases of asthma in children	260 (50–620)
Number of children suffering from asthma	1,300 (300–2,800)
Low birthweight births	820 (260–1,420)
Preterm births	1,100 (500–1,100)
Work absences	468,000 (398,000–537,000)
Economic costs (billion USD)	1.0 (0.6–3.0)
Economic costs (billion ZAR)	19 (12–57)

Deaths

Air pollution from the Sasol Secunda facility is estimated to have imposed a substantial public health burden over the 2024/2025 financial year. The analysis estimates 1,000 (600–1,500) deaths attributable to $PM_{2.5}$ and NO_2 from the facility's operation. These deaths are estimated to correspond to 23,800 (14,100–37,500) years of life lost, indicating a large cumulative loss of life expectancy across the exposed population, as shown in Table 1.

The mortality burden reflects exposure to a combination of pollutants released by the facility, including fine particulate matter and nitrogen dioxide, as well as secondary particulate matter formed in the atmosphere from sulphur dioxide, hydrogen sulphide, and nitrogen oxide emissions. Long-term exposure to these pollutants is associated with increased mortality from cardiovascular and respiratory diseases, as well as other non-communicable conditions (Burnett *et al.*, 2018; Huangfu and Atkinson, 2020; World Health Organization, 2021). The results capture the wider population-level mortality burden associated with Sasol Secunda's emissions, rather than deaths occurring only in communities immediately surrounding the facility.

Chronic disease and disability

Non-fatal chronic health outcomes are also significant. Sasol Secunda's emissions are estimated to contribute to 2,600 (1,000–4,800) years lived with disability across chronic obstructive pulmonary disease, diabetes, and stroke. This includes 600 (300–1,000) years lived with disability from chronic obstructive pulmonary disease, 1,600 (600–3,000) years from diabetes, and 400 (200–800) years from stroke. These outcomes show that the burden of pollution is not limited to deaths alone. It also includes long-term illness, reduced quality of life, and the need for continued medical care.

The chronic disease burden reflects the cumulative effects of exposure to the Sasol Secunda facility-generated pollution, including primary particulate emissions and secondary particulate matter formed from SO_2 and NO_x. Air pollution is an established risk factor for respiratory, cardiovascular, and metabolic disease, and can worsen existing health conditions among exposed populations (Bowe *et al.*, 2018; World Health Organization, 2021). Years lived with disability capture the duration and severity of these non-fatal outcomes, showing how continued emissions can result in long-term health, care, and financial burdens for affected individuals and households.

Children, asthma, and birth outcomes

Children and infants bear a distinct burden from pollution from Sasol Secunda. For example, the analysis estimates 260 (50–620) new cases of asthma among children. These findings are supported by a wider body of epidemiological evidence linking combustion-related air pollution to childhood asthma. Anenberg et al. (2022) found that combustion-related NO_2 pollution remains a significant contributor to the global incidence of paediatric asthma, particularly in cities. A systematic review and meta-analysis by Khreis et al. (2017) also found statistically significant associations between childhood exposure to traffic-related air pollution indicators, including NO_2, $PM_{2.5}$, PM_{10}, and black carbon, and the development of childhood asthma.

Respiratory illness due to air pollution within Secunda and the wider Mpumalanga Highveld has already been documented before. Among 233 adolescents living in Secunda and neighbouring eMbalenhle Millar *et al.* (2022), found that 39% reported having experienced wheezing, while the odds of reporting a respiratory illness increased with the number of years lived in the area. A more recent study of 706 schoolchildren across six Highveld communities, including Secunda, found that short-term $PM_{2.5}$ exposure was significantly associated with asthma symptom scores, airway inflammation, and measures of reduced lung function, although the authors did not find a consistent dose-response relationship across all measures (Buthelezi et al., 2024). Therefore, the evidence from Secunda and the wider Highveld indicates that children are particularly vulnerable to air pollution, with exposure linked to asthma symptoms, respiratory illness, airway inflammation, and impaired lung function.

Consistent with this evidence, the results of this health impact assessment (HIA) estimate 2,000 (1,200–2,900) asthma emergency room visits over the FY 2024/2025 period, including 930 (610-1,240) visits among children aged 0 to 17. These emergency room visits represent acute episodes in which exposure to pollution contributes to severe respiratory symptoms requiring urgent medical care. This is important because asthma not only translates into immediate distress for children and families, missed school days, parental work disruption, and healthcare costs, but also long-term, chronic health impacts.

Adverse birth outcomes are also estimated. Sasol Secunda’s emissions are linked to 820 (260–1,420) low-birthweight births and 1,100 (500–1,100) preterm births over FY 2024/2025. These impacts are important because early-life health outcomes can influence development, disease vulnerability, and healthcare needs later in life.

The results show that pollution from Sasol Secunda affects children before and after birth. The estimated impacts include adverse birth outcomes, newly developed asthma, children living with asthma due to pollution exposure, and asthma emergency room visits. This indicates that the facility's emissions contribute to a health burden that begins early in life and can have consequences beyond the immediate period of exposure.

Work absences and productivity losses

Air pollution from Sasol Secunda is also estimated to cause substantial productivity losses. The analysis estimates 468,000 (398,000–537,000) sick leave days over FY 2024/2025. This reflects days when pollution-related illness prevents people from working, reducing productivity, and creating economic disruption for workers, households, and employers.

Work absence is an important indicator because it captures a more common and recurring form of pollution-related harm. While deaths, chronic disease, and emergency room visits represent severe health outcomes, sick leave days show how air pollution also affects everyday life. Exposure to pollution can worsen respiratory and cardiovascular symptoms, contribute to illness episodes, and reduce people's ability to attend work. These effects can be especially burdensome for households with limited income security and/or limited access to healthcare.

Economic costs

Air pollution from Sasol Secunda is estimated to impose substantial economic costs. The analysis estimates total health-related economic damages of USD 1.0 (0.6–3.0) billion over FY 2024/2025. This is equivalent to approximately ZAR 19 (12–57) billion, based on the average USD–ZAR exchange rate for FY 2024/2025. These costs reflect the economic value of deaths, illness, disability, healthcare use, adverse birth outcomes, and productivity losses associated with exposure to the facility's emissions.

Economic valuation is important because the costs of air pollution are distributed across affected households, workers, employers, healthcare systems, and the wider economy in the surrounding and transboundary regions, as well as the polluting facility. Families may face medical expenses, lost income, and caregiving responsibilities, while employers experience reduced productivity due to illness and workplace absences. The estimated damages therefore represent a substantial externalised cost of Sasol Secunda's operations, showing that continued emissions carry significant economic consequences alongside the direct effects on health and wellbeing.

Policy implications and recommendations

Sasol Secunda operates in the Highveld Priority Area, close to residential communities including Secunda and eMbalenhle (Gert Sibande District Municipality 2025). Monitoring around the facility shows that its emissions contribute to both local and regional pollution, particularly through SO_2, NO_x, particulate matter, and H_2S (Venter & Lourens, 2021).

The 2022 'Deadly Air' judgment in the High Court of South Africa confirmed that poor air quality in the Highveld breaches the constitutional right to an environment that is not harmful to health or wellbeing (Trustees for the Time Being of Groundwork Trust and Another v Minister of Environmental Affairs and Others, 2022). Although the Minister did not dispute this, it was confirmed on appeal that the High Court was correct that this constitutional right was breached. The Supreme Court of Appeal also confirmed (which the Minister had disputed on appeal) that the Minister had a legal duty to prescribe regulations to implement and enforce the Highveld Priority Area Air Quality Management Plan (Minister of Environmental Affairs v The Trustees for the Time Being of Groundwork Trust and Others, 2025). This makes Sasol's exemption from the MES a public health and human rights issue, not only a question of technical compliance.

Sasol's steam-plant boilers are currently regulated through alternative load-based SO_2 limits and concentration-based emission standards that are weaker than the generally applicable concentration-based MES. Sasol states that this pathway will reduce total SO_2 emissions by 30% by 2030 (Sasol, 2025a). However, compliance with an alternative licence limit does not mean that the remaining emissions are safe. The health impacts estimated in this study indicate that substantial harm will continue under the current emissions pathway. Sasol has also stated that the implementation of its 'integrated roadmap' is 'contingent on SO_2 also being regulated on a load-based limit beyond 31 March 2030 (Just Share, 2025b). In light of this open issue and the conditions of the Minister's decision, a further dispensation will likely be required as available in law, the outcome of which cannot be guaranteed.'

1. Review Sasol's alternative SO_2 limits against health outcomes

The national government and Gert Sibande District Municipality should assess Sasol's alternative compliance arrangement against its impacts on ambient air quality, population exposure, and health, rather than assessing compliance with the alternative limits alone. Under the arrangement, Sasol can comply with a load-based SO_2 limit alongside weaker concentration-based limits, rather than meeting the generally applicable MES.

The licence states that exceedances of the alternative load-based limit for SO_2, 'will require a full atmospheric dispersion assessment to determine likely health incidents' (Gert Sibande District Municipality, 2025). It also states, as per the appeal decision, that the SO_2 leniency granted to Sasol is conditional on its achievement of all of the emission reductions it has undertaken. These conditions must be monitored and enforced.

In addition, the licence should include clear triggers for stronger limits if monitoring shows that Sasol's emissions are contributing to exceedances of relevant ambient air quality standards, or if Sasol fails to meet its emission reduction milestones. These include not only the failure to meet SO_2 reduction milestones, but also failures to achieve any of the other emission reductions set out in Sasol's integrated roadmap, including, inter alia, commitments in relation to greenhouse gas emission reductions, and the integration of renewable energy. Failure to meet these milestones and other undertakings should result in the withdrawal of the alternative SO_2 compliance arrangement and require compliance with the nationally applicable new plant MES.

2. Require binding annual emissions reductions

Sasol's 30%-by-2030 SO_2 reduction target should be converted into enforceable annual milestones. The company should publish and regularly update a time-bound unit-level plan showing which boilers and process units will be upgraded, when projects will be completed, and how much pollution each measure will remove and within which timeframes.

The plan should cover SO_2, NO_x, particulate matter, and H_2S across the wider Secunda facility, not only the East and West steam plant stacks.

3. Improve emissions reporting and independent monitoring

The licence also includes various additional monitoring requirements as conditions of the SO_2 leniency. This includes the need for Sasol to send stack monitoring data, specifically emissions concentration and volumetric flow at a 10-minute resolution to the licensing authority on a weekly basis. An independent consultant appointed by Sasol is required to submit a monthly report to the NAQO which assesses compliance with emission standards. That report must also be published on Sasol's website.

In addition, Sasol should publish consistent monthly and annual data on pollutant loads, stack concentrations, exceedances, equipment failures and repair times, and monitoring gaps and plans to address these.

Ambient air quality data should be independently audited and made publicly available. H_2S monitoring should also be strengthened because of its relevance to local exposure and odour complaints.

4. Strengthen air quality regulation to protect human health and wellbeing

As set out above, the South African government has undertaken to re-publish proposed amendments to the National Environmental Management: Air Quality Act: List of Activities for comment. These include some proposals to strengthen H_2S MES. The Department of Forestry, Fisheries and the Environment has also indicated that it intends to establish national ambient air quality standards for H_2S. These are valuable interventions which should be prioritised.

However, as Just Share has pointed out in its October 2025 submissions on the proposed amendments to the National Environmental Management: Air Quality Act: List of Activities published in August 2025, when these amendments are re-published for comment, they should also:

- address and correct recent concerning interpretations of Paragraph 12A of the National Environmental Management: Air Quality Act: List of Activities and section 59 of the National Environmental Management: Air Quality Act; and
- ensure that all proposals to include weaker MES (for proposed new/amended subcategories) than the MES in comparable subcategories in the current National

Environmental Management: Air Quality Act: List of Activities are removed (Just Share, 2025a).

Rather than weakening the MES or leaving any room for further leniency or exemption from South Africa's already-weak MES, the MES should be strengthened, particularly for facilities like Sasol Secunda in air pollution priority areas.

5. Put affected communities at the centre of enforcement

Authorities should use evidence of health impacts more directly in licence reviews, enforcement decisions, appeal decisions, and Highveld air quality planning.

Communities should receive timely alerts during major pollution or odour episodes, updated access to monitoring data, and clear information on the source, health risks, and corrective actions taken.

The objects of the National Environmental Management: Air Quality Act include preventing air pollution and giving effect to the constitutional environmental right, 'in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and wellbeing of people' (National Environment Management: Air Quality Act [No. 39 of 2004], 2004). Accordingly, whether Sasol formally complies with the alternative conditions in its licence is not the central issue. The central issue should be whether the alternative compliance arrangement protects the environmental right, and delivers measurable reductions in emissions, population exposure, adverse health impacts and associated economic costs.

Conclusion

This study indicates that air pollutant emissions from Sasol Secunda are associated with a substantial public health burden in FY 2024/2025. The estimated impacts include 1,000 deaths, 23,800 years of life lost, 2,030 asthma emergency room visits, 260 new cases of asthma in children, 1,300 children suffering from asthma due to pollution exposure, 820 low birthweight births, 1,100 preterm births, 468,000 sick leave days, and 2,600 years lived with disability from chronic disease.

These findings show that the effects of Sasol Secunda's emissions are broad and multidimensional. The burden includes mortality, acute respiratory illness, chronic disease, adverse birth outcomes, child health impacts, and productivity losses. This indicates that the facility's emissions should be understood not only as an environmental compliance issue but also as a significant public health and human rights issue.

The results also have direct relevance for regulatory decision-making. In the context of South Africa's MES, postponements, suspensions, exemptions, and alternative compliance pathways, the key question is whether regulatory decisions reduce or prolong exposure to harmful pollution. The estimated health burden demonstrates that delayed or weakened emission controls can carry substantial public health costs.

Reducing emissions from Sasol Secunda would deliver significant benefits for exposed populations, particularly children, pregnant women, workers, and people already vulnerable to air pollution-related disease. As a result, the facility's air quality policy and plan should prioritise measurable, enforceable, and transparent reductions in emissions. This would help ensure that regulatory decisions align with protecting health, reducing harm in the Highveld Priority Area, and the broader public interest.

Methodology

Emissions

NO_x, SO_x, and particulate matter

Annual emissions for Sasol Secunda were taken directly from Sasol's self-reported Performance Data for the Financial Year Ended 30 June 2025. The 2024/2025 financial year was selected because it was the most recent complete 12-month reporting period for which consistent, facility-wide emissions data were available for all pollutants included in the modelling. It therefore provides the most up-to-date representation of the facility's operations while capturing seasonal and operational variations across a full year. For FY 2024/2025, Sasol estimated facility-wide emissions of 77 kilotonnes of nitrogen oxides (NO_x), 112 kilotonnes of sulphur oxides (SO_x), and 4 kilotonnes of particulate matter reported as fly ash (Sasol, 2025b).

Sasol's 2025 performance report provides annual totals for the Secunda facility but does not disaggregate these emissions by individual source. The source distribution reported in Sasol's 2022 atmospheric impact report was therefore used to allocate the facility-wide totals between the major emission sources. In particular, the report's emission ratios were applied to divide emissions between the East and West stacks, which are the principal release points for several key pollutants at the facility.

The East and West stacks were modelled separately using their respective stack locations and release characteristics. This approach retains Sasol's most recent self-reported annual emissions while using the more detailed 2022 inventory to represent how those emissions are distributed across the facility.

Sasol reports sulphur emissions as SO_x, defined as the combined emissions of sulphur dioxide and sulphur trioxide. For the atmospheric modelling, the reported SO_x emissions were treated as SO_2. Sasol's reported particulate emissions relate specifically to fly ash from coal processing and were used as the available measure of primary particulate emissions from the facility.

Hydrogen sulphide

Hydrogen sulphide emissions are not included in Sasol's 2025 facility-level performance data. The H_2S input was therefore derived from Sasol's 2014 proposal on H_2S emissions from the Secunda facility. The document identifies the East and West stacks as the two main H_2S release points and reports that combined emissions were typically between 8 and 10 tonnes per hour. It also proposed 7.5 tonnes per hour as an achievable existing-plant emission level (Sasol, 2014). The hourly rate was annualised for use in the atmospheric modelling, assuming continuous operation throughout the modelled year.

Atmospheric modelling

For this study, we simulated air pollutant concentrations using the CALPUFF air dispersion model, version 7 (Exponent, Inc., 2015; Scire et al., 2000). CALPUFF has been a widely used industry standard model for long-range air quality impacts of point sources. Due to its ability to capture complex chemical processes and atmospheric transport of pollutants, this modelling system is approved for use by regulators, such as the Maryland Department of the Environment (TRC Environmental Corporation, 2024), and in academic research (Bai et al., 2020). The model has been evaluated extensively by the US Environmental Protection Agency, is open-source, and fully documented. The CALPUFF model has been applied in many regions around the world, including the United States (Rzeszutek, 2019), Europe (Holnicki et al., 2016), Central America (Hernández-Garcés et al., 2021), South America (Arregocés & Rojano, 2023), the Middle East (Ghannam & El-Fadel, 2013), Asia (Jittra et al., 2015; Zhou et al., 2003), and Africa (Affum et al., 2016).

CALPUFF calculates the atmospheric transport, dispersion, chemical transformation, and deposition of the pollutants, and the resulting incremental ground-level concentrations, attributed to the studied emission sources. For direct emissions of SO2, NOX, and PM, gas and aqueous phase chemistry is simulated explicitly. For emissions of H_2S, atmospheric dispersion is simulated explicitly, while subsequent oxidation is represented using a simplified first-order approach with fixed atmospheric half-lives of 12 hours for H_2S oxidation to SO_2 and a further 12 hours for SO_2 oxidation to sulfate (SO_4^{2-}). Estimates of the lifetimes of H_2S oxidation range from six hours (Spedding & Cope, 1984) to over two days (Cox, 1975). Kim et al. (2013) find that the lifetime of SO_2 oxidation within pollution plumes ranges from 10 to 13 hours. Background concentrations of oxidants (ozone, ammonia, hydrogen peroxide) are taken from a global atmospheric chemistry model. Meteorological input data for the year 2021 are generated from the Weather Research Forecasting (WRF) model (Skamarock et al., 2008), version 4.2.2. WRF was set up with 33 vertical levels and two nested grids. The mother nest has a grid resolution of 15 km and the inner nest has a grid resolution of 3 km.

The mother and inner domains use a two-way nesting technique, which ensures dynamic interaction between them. WRF simulations use initial and lateral boundary conditions from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFRS) dataset of the National Oceanic and Atmospheric Administration (NOAA), producing three-dimensional, hourly meteorological data covering the full calendar year of 2021.

For assessment of annual average pollutant concentrations, emissions are assumed constant throughout the year. Emissions from each of the Sasol Secunda stacks were modelled as separate area sources. The emission sources were modelled as buoyant point sources, accounting for stack height and thermal plume rise.

Health and economic impact assessment

We calculate the corresponding public health and economic impacts by combining modelled pollutant concentrations with population, baseline health, and economic data for South Africa and surrounding countries. The analysis focuses on annual impacts in 2025 attributable to air pollution from Sasol Secunda.

CREA has developed a detailed globally implementable health impact assessment (HIA) framework based on the latest science (Myllyvirta, 2020). This framework includes as complete a set of health outcomes as possible without obvious overlaps. Health outcomes covered in this framework are those identified in the peer-reviewed academic literature from meta-studies across multiple populations, for which incidence data are available at the national level from global datasets.

For each health outcome, we use a concentration-response relationship that has been used in peer-reviewed academic literature to quantify the global health burden from air pollution. This indicates that the evidence is mature enough to be applied across varying geographies and exposure levels. We estimate the number of cases for each health outcome following a standard epidemiological calculation:

$$\Delta cases = Pop \times \sum_{age} \left[Frac_{age} \times Incidence_{age} \times \left(\frac{RR_{c,\,age}}{RR_{cbase,\,age}} - 1\right) \right],$$

Where:

Pop is the total population in the grid cell;

age is the specific age group for which the epidemiological studies have established a health risk;

$Frac_{age}$ is the fraction of the population belonging to the specific age group;

$Incidence_{age}$ is the baseline rate of occurrence of the health outcome for the population belonging to the specific age group;

c is the pollutant concentration from the baseline combined with emissions from the Sasol Secunda facility, with c_{base} referring to the baseline concentration or current ambient concentration; and,

$RR_{c,\ age}$ is the function giving the risk ratio of the health outcome at the given concentration for the given age group compared with clean air.

In the case of a log-linear, non-age-specific concentration-response function, the RR function becomes:

$$RR(c) = RR_0^{\frac{c-c_0}{\Delta c_0}} \; when\; c > c_0,\; 1\; otherwise$$

Where:

RR_0 is the risk ratio found in epidemiological research;

Δc_0 is the concentration change that RR_0 refers to; and,

c_0 is the assumed no-harm threshold concentration — in general, the lowest concentration found in the study data.

We take the disease incidence rate from the Global Burden of Disease, using the most up-to-date year available (2023). This data is accessed from the Institute for Health Metrics and Evaluation (IHME, 2026). We use Gridded Population of the World v4 (for the latest year, 2020) from the Centre for International Earth Science Information Network (CIESIN, 2025). We then scale this to 2025 using changes in population and death rates from the World Population Prospect dataset of the UN (United Nations, Department of Economic and Social Affairs, Population Division, 2019).

Table 2 shows the health outcomes included in this study and the relative risk values used for each. Adult deaths, as well as deaths of children under five years old, were estimated using the risk functions developed by Burnett *et al.* (2022). For all mortality results, cause-specific data are taken from the Global Burden of Disease project results for 2023 (IHME, 2026).

Health impact modelling projects the effects of pollutant exposure during the study year. Some health impacts are immediate, such as exacerbation of asthma symptoms and lost working days, whereas other chronic impacts may have a latency of several years. Concentration-response relationships for emergency room visits for asthma and work absences were based on studies that evaluated daily variations in pollutant concentrations and health outcomes; these relationships were applied to changes in annual average concentrations.

Table 2 — Input parameters and data used to estimate physical health impacts

Health outcome	Age group	Pollutant	Relative risk			Incidence
			Value	Threshold	Reference	
New cases of asthma	1–18	NO_2	1.26 (1.10–1.37) per 10 ppb	2 ppb	Khreis *et al.* (2017)	Achakulwisut et al. (2019)
People suffering from asthma	1–18	NO_2	1.26 (1.10–1.37) per 10 ppb	2 ppb	Khreis *et al.* (2017)	Achakulwisut *et al.* (2019)
Asthma ER visits	0–17	$PM_{2.5}$	1.025 (1.013–1.037) per 10 µg/m^3	6 µg/m^3	Zheng *et al.* (2015)	Anenberg et al. (2018)
Asthma ER visits	18–99	$PM_{2.5}$	1.023 (1.015–1.031) per 10 µg/m^3	6 µg/m^3	Zheng *et al.* (2015)	Anenberg *et al.* (2018)
Preterm birth	Infant	$PM_{2.5}$	1.15 (1.07–1.16) per 10 µg/m3	8.8 µg/m^3	Sapkota *et al.* (2012)	Chawanpaiboon *et al.* (2019)
Work absence	20–65	$PM_{2.5}$	1.046 (1.039–1.053) per 10 µg/m^3	0.0	WHO (2013)	European Environment Agency (2014)

Deaths	0–4	$PM_{2.5}$	Burnett *et al.* (2022)	0 µg/m^3	Burnett et al. (2022)	(IHME, 2026)
Deaths	25–99	$PM_{2.5}$	Burnett *et al.* (2022)	0 µg/m^3	Burnett et al. (2018)	(IHME, 2026)
Years lived with disability	25–99	$PM_{2.5}$	(IHME, 2026)	2.4 µg/m^3	Burnett *et al.* (2018)	(IHME, 2026)
Deaths	25–99	NO_2	1.02 (1.01–1.04) per 10 µg/m^3	4.5 µg/m^3	Huangfu and Atkinson (2020), Stieb *et al.* (2021)	(IHME, 2026)

Note: Numeric values in the column 'Value' refer to odds ratios (OR) corresponding to the increase in concentrations given in the column 'concentration change'. Literature references indicate the use of a non-linear concentration-response function. No-harm threshold refers to a concentration below which the health impact is not quantified, generally because the studies on which the function is based did not include people with lower exposure levels. Data on concentration-response relationships do not exist for all geographies, so a global risk model is applied to all cities. Incidence data are generally unavailable at the city level, so national averages have to be applied. $PM_{2.5}$ deaths in 25–99 year-olds are from non-communicable diseases, disaggregated by cause, and from lower respiratory infections. $PM_{2.5}$ deaths in 0–4-year-olds are due to lower respiratory infections. $PM_{2.5}$ years lived with disability are disaggregated by diabetes, stroke and chronic respiratory disease.

This study calculates the economic costs of health impacts resulting from air pollution, following a similar methodology to Myllyvirta (2020). The analysis accounts for respiratory and cardiovascular diseases, including their complications, which significantly reduce quality of life, lower economic productivity, and increase healthcare costs. The health impacts with their valuations are summarised in Table 3.

Table 3 — Health impact costs included in this study and their economic valuation			
Health outcome	**Valuation at world average GDP/GNI per capita (2017 int. USD)**	**2024 valuation adjusted for South Africa (USD)**	**Reference**
Work absence (sick leave days)	85 per day	24 per day	European Environment Agency (2014)
Number of children suffering from asthma due to pollution exposure (increased prevalence)	1,077 per case	337 per case	Brandt et al. (2012)
Deaths (adults)	2,637,000 per death	1,021,000 per death	Viscusi and Masterman (2017)
Preterm births	107,700 per birth	33,680 per birth	Trasande, Malecha and Attina (2016)
Years lived with disability	28,480 per year-lived-with-disability	30,030 per year-lived-with-disability	Birchby *et al.* (2019)
Asthma emergency room visits	232 per case	146 per case	Brandt *et al.* (2012)
Note: The deaths of young children (under 5) are valued at twice the valuation of adult deaths, following the OECD's recommendations (2012).			

The valuation for adult deaths (Viscusi & Masterman, 2017) is based on labour market data, and we multiply it by two to estimate the value for children, following the OECD's recommendation (2012). The economic cost of disability is assessed using disability valuations from the UK's Department for Environment, Food & Rural Affairs (Birchby et al., 2019). 'Disability weights' calculated by the Global Burden of Disease (GBD) allow comparison of economic costs across different illnesses. Disabilities considered include diabetes, chronic obstructive pulmonary disease (COPD), and stroke.

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Appendix

Comparison of SO_2 emission limits for large coal and solid-fuel combustion facilities.

Table A.1 compares the SO_2 limits applicable to Sasol Secunda with standards or regulatory benchmarks for large coal and solid-fuel combustion facilities in South Africa, China, the European Union, and South Korea. The limits are also converted to a common reference oxygen concentration of 10% to support comparison.

Table A.1 — Comparison of published SO_2 emission limits for Sasol Secunda and large coal or solid-fuel combustion facilities, normalised to 10% O_2

Jurisdiction or facility	Published SO_2 limit	Equivalent at 10% O_2	Compliance basis
South Africa MES	1,000 mg/Nm^3 at 10% O_2	1,000 mg/Nm^3	Daily average, applicable from 1 April 2025 (Government of South Africa, 2020)
Sasol Secunda East Stack	1,400 mg/Nm^3 at 10% O_2	1,400 mg/Nm^3	Facility-specific alternative limit, assessed as a daily average from 1 April 2025 to 31 March 2030 (Gert Sibande District Municipality, 2025; Ramandh & Goede, 2025)
Sasol Secunda West Stack	1,700 mg/Nm^3 at 10% O_2	1,700 mg/Nm^3	Facility-specific alternative limit, assessed as a daily average from 1 April 2025 to 31 March 2030 (Gert Sibande District Municipality, 2025; Ramandh & Goede, 2025)
China	35 mg/Nm^3 at 6% O_2	26 mg/Nm^3	"Ultralow" emission standards for coal power plants, steel plants and cement plants(Ministry of Ecology and Environment of the People's Republic of China, 2018)
European Union	10-130 mg/Nm^3 annual average; 25-165 mg/Nm^3 daily average	Annual average: 7–95 mg/Nm^3; daily average: 18–121 mg/Nm^3	BAT-associated emission levels for existing pulverised-coal plants, already expressed at 6% O_2. Permit limits must generally ensure that emissions under

			normal operating conditions do not exceed the applicable BAT-AELs (European Commission, 2021).
South Korea	25-60 ppm at 6% O_2 depending on installation date and category	Approximately 52–125 mg/Nm^3	National SO_2 emission limits for solid-fuel power facilities of at least 100 MW. The applicable limit varies according to the installation date (Republic of Korea Ministry of Environment, 2025).

Concentrations originally reported at 6% oxygen were converted to 10% oxygen using: $C_{10}\% = C_6\% \times (21 - 10) \div (21 - 6)$. There are other differences in air pollution regulation between the jurisdictions, e.g. regarding plant definitions, averaging periods, regulatory structures, fuel characteristics, and treatment of start-up, shutdown, and abnormal operating conditions.

The European Union values are BAT-associated emission levels for existing pulverised-coal combustion plants with a total rated thermal input of at least 300 MWth. Competent authorities must generally set permit conditions that ensure emissions under normal operating conditions do not exceed the applicable BAT-AELs, although derogations may be granted under defined and documented circumstances.

South Korea expresses its standards in parts per million. These were converted using the molecular weight of SO_2 under normal conditions and rounded to the nearest mg/Nm^3.

Sasol's Atmospheric Emission Licence also includes a combined load-based condition for the East and West stacks. This is not included in the table because a mass-emission rate cannot be compared directly with concentration limits.

China's 35 mg/Nm^3 value is the "ultra-low-emission" benchmark defined in HJ 2053-2018 for coal power plants, rather than the generally applicable limit in the existing national power-plant emission standard. The same limit is also applied to steel and cement plants that comply with the "ultralow" standard. In March 2026, China published a draft standard that would replace GB 13223-2011 and GB 13271-2014 and establish a 35 mg/m^3 SO_2 limit for larger boilers. As this draft had not been finalised at the time of writing, it is not presented as an enacted national emission limit (Ministry of Ecology and Environment of the People's Republic of China, 2026).