

# Health & Economic Impacts of the Lae, Papua New Guinea Coal Power Plant

June 2022



CREA is an independent research organisation focused on revealing the trends, causes, and health impacts, as well as the solutions to air pollution.

## Key Messages

The Lae Enviro Energy Park (EEP) coal-fired power plant is a proposed 52 megawatt (MW) project in Papua New Guinea backed by Australia-based Mayur Resources with plans to eventually expand the project to 200 MW. It would be the first coal-fired power plant and coal mine in Papua New Guinea if built. Such a move would tie the country to coal for a minimum of 30 years, as the rest of the world seeks to reduce and completely phase out the fuel's use to meet the Paris Agreement Climate targets. In addition, coal combustion emits a significant amount of air pollutants and toxic gases that harm the local population.

The Centre for Research on Energy and Clean Air (CREA) modelled the Lae EEP plant's air pollutant emissions and estimated the health and economic impact on populations exposed to the plant's emissions under the two potential capacity scenarios. We found:

- Under a 52 MW scenario, Lae EEP would emit approximately 210 tons of Sulfur Dioxide (SO<sub>2</sub>), 460 tons of Nitrogen Oxides (NO<sub>x</sub>), and 90 tons of particulate matter (PM) every year. If capacity is 200 MW, annual emissions would increase to 850 tons of SO<sub>2</sub>, 1,840 tons of NO<sub>x</sub>, and 340 tons of PM.
- Assuming the plant operates for the average 30-year operating life of coal plants in the region, air pollution from a 52-MW Lae EEP plant would result in a cumulative 30 premature deaths, 25 new cases of asthma in children, 890 years of life lost, and 5,900 work absences taken due to sickness. With the additional 3 units, the cumulative impacts significantly increase to 115 premature deaths, 100 new cases of asthma in children, 3,500 years of lives lost, and 23,500 sick leaves.
- An area of approximately 3.1 km<sup>2</sup> with a population of 3,200 would be affected by potentially dangerous mercury deposition above a 125mg/ha/year threshold. Increasing the capacity to 200 MW would subject much more: 12,100 people and 24.6 km<sup>2</sup> of forests, waterways, and farmland would be exposed to dangerous mercury deposition every year. This does not include intentional discharges, possible leakage or accidental discharge into water from coal ash ponds, coal ash landfills, and coal storage.
- Economic damages of air pollution from a 52MW Lae EEP, in the form of increased healthcare spending and loss of economic productivity, is estimated at USD 7.5 million over 30 years. The cumulative economic cost of a 200 MW expanded complex totals USD 30 million — more than Papua New Guinea's entire GDP in 2020.

All of these impacts could be avoided if the plant is not built.

## Contents

<b>Key Messages</b>	<b>1</b>
<b>About CREA</b>	<b>2</b>
<b>Introduction</b>	<b>4</b>
Air Pollution from Coal	5
<b>Shortcomings of the Environmental Impact Assessment</b>	<b>6</b>
<b>Results: Toxic Deposition</b>	<b>9</b>
<b>Results: Cumulative Health &amp; Economic Impacts</b>	<b>11</b>
<b>Appendix</b>	<b>13</b>
<b>References</b>	<b>15</b>

### About CREA

The **Centre for Research on Energy and Clean Air (CREA)** is an independent research organisation focused on understanding the trends, causes, health impacts and solutions to air pollution.

CREA uses scientific data, research and evidence to support the efforts of governments, companies and organizations worldwide in their efforts to move towards clean energy and clean air, believing that effective research and communication are the keys to successful policies, investment decisions and advocacy efforts. CREA was founded in December 2019 in Helsinki and has staff in several Asian and European countries.

Cover Photo by Ok Tedi Mine CMCA Review, <https://commons.wikimedia.org/w/index.php?curid=10315371>

## Introduction

The Lae Enviro Energy Park (EEP) coal-fired power plant is a proposed 52 megawatt (MW) project in Papua New Guinea, prioritized by the Government's Development Strategic Plan to increase its current 13% electrification rate to a mandated target of 70% by 2030. The Australia-based Mayur Resources plans to eventually expand the project into a 200MW plant to power their Enviro Energy Park in the industrial hub of Lae, Morobe province.

If the project is built, it would mark the first coal-fired power plant and coal mine in the country, tying the country to coal for over 30 years as the rest of the world seeks to reduce its dependence on the fuel and ultimately phase out its generation between 2030 and 2040 to meet the Paris Agreement Climate targets.

Thus far, the Lae EEP has already been granted an environmental permit and received bids for the construction and equipment procurement of the power station. However, the Centre for Research on Energy and Clean Air (CREA) found major gaps in the assessment of the potential air pollution and emissions impacts from the plant, which was a document used to secure the permit. Furthermore, no official assessment has been made by the developers of the increased impact of the 200 MW expansion.

Air Pollution has serious impacts on human health that cannot be neglected in the planning and construction of a major infrastructure project. It is the leading environmental cause of human mortality and morbidity, causing and worsening a range of medical conditions such as asthma, stroke, heart attack, and cancer. Pollutants also irritate and inflame the lungs leading to chronic lung disease, and restricted lung growth in children.

To address this gap, CREA modelled the potential health and economic impacts of the plant's air pollutant emissions using the CALPUFF modelling system, which factors in the chemical transformation and transport of emissions. We also estimated the increased risk of death and other negative health outcomes for populations exposed to the plant's emissions under the Lae EEP's proposed expansion scenario.

A Power Purchasing Agreement (PPA) has not been signed by the national electricity provider, PNG Power, and only a conditional commitment has been received from the financiers of the project. While the Lae EEP is 'construction ready' but has yet to break ground, developers and the Papua New Guinea government should look into the need for such a project given rapidly falling prices for alternative, renewable technologies. There is the potential to convert the project to renewable energy to avoid a tie into coal, as well as the negative impacts on the health and livelihood of the population and the natural environment as a result of carbon and pollutant emissions from the proposed plant.

---

## Air Pollution from Coal

Coal releases a range of air pollutants when burned, including sulphur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), toxic volatile organic compounds (VOCs), heavy metals like mercury, and particulate matter (PM).

Coal burning is the dominant source of SO<sub>2</sub> emissions in most countries with significant coal use, and an important contributor to NO<sub>x</sub> emissions. These pollutants can be reduced by using pollution control techniques such as Flue Gas Desulfurization (FGD) and Selective Catalytic Reduction of nitrogen oxides (SCR). However, these techniques are not used in the Lae EEP power plant.

Nitrogen dioxide (NO<sub>2</sub>) irritates and corrodes skin and the respiratory tract. Inhalation of high concentrations of this pollutant for a short period may lead to pulmonary oedema. Prolonged exposure can affect the immune system and lungs, weakening resistance to infections and causing irreversible changes in the lung tissue.

Sulfur dioxide (SO<sub>2</sub>) is irritating and toxic, mainly affecting the mucus and lungs. Exposure to high concentrations for short periods of time can irritate the respiratory tract, and cause bronchitis, asthmatic reactions, respiratory arrest and congestion in the bronchial tubes. Along with NO<sub>2</sub>, SO<sub>2</sub> is a precursor to the formation of fine particulate matter (PM<sub>2.5</sub>) and ozone (O<sub>3</sub>).

PM<sub>10</sub> are particles with an aerodynamic diameter of ≤10 μm. They are made up of inorganic compounds such as silicates, aluminates, and heavy metals, as well as organic material associated with carbon particles. Prolonged or repetitive exposure can cause harmful effects on the respiratory system.

PM<sub>2.5</sub> or particles with an aerodynamic diameter of ≤2.5 μm is commonly known as fine particulate matter and is considered the most dangerous pollutant to human health. They are mainly made up of secondary particles formed in the atmosphere from chemical reactions of precursor gases – particularly NO<sub>x</sub>, SO<sub>2</sub>, VOC, and NH<sub>3</sub>. They penetrate the nose and the throat, reaching the lungs and penetrating into the bloodstream. They may cause respiratory morbidity, damage to lung function and lung cancer, and increase the risk of cardiovascular diseases such as stroke and ischemic heart disease.

---

## Shortcomings of the Environmental Impact Assessment

A review of the official Lae EEP power plant EIA obtained by CREA presented some gaps and inconsistencies in the information presented.

The proposed plant is said to reduce the sulfur dioxide and nitrogen oxide by 16 and 11 times respectively compared to the current reliance upon liquid fuel but no references are provided to back this statement. Emissions control technologies such as flue-gas desulfurization (FGD) are not guaranteed for the initial 52 MW plant, nor its 200 MW expanded form.

In addition, the EIA completely neglects to mention pollution from heavy metals such as mercury. Consequently, the emissions of mercury and other toxic metals are not disclosed and none of the potential impacts is assessed. Coal-fired power plants are one of the largest sources of mercury emissions into the environment globally (AMAP&UNEP 2019), and seriously affects the health and development of children. Exposing children to methylmercury while they are in the womb can have impacts on their cognitive thinking, memory, attention, language, fine motor skills, and visual-spatial skills (U.S. EPA; Bose-O'Reilly et al, 2010). In adults, exposure to mercury increases the risk of cardiovascular diseases (Spadaro & Rabl, 2008).

Lastly, EIA also fails to present any quantified assessment of the health impacts from all relevant pollutants, even though the tools and methods to do so are well-established, and standard practice for coal plant assessments worldwide. The description of the health impacts of PM<sub>2.5</sub> and PM<sub>10</sub> is highly incomplete, failing to include serious chronic health impacts associated with air pollution. Particulate matter pollution is a major environmental health risk globally and in the country. In 2019, air pollution was responsible for an estimated 1,180 deaths in Papua New Guinea, according to the prestigious Global Burden of Disease study.

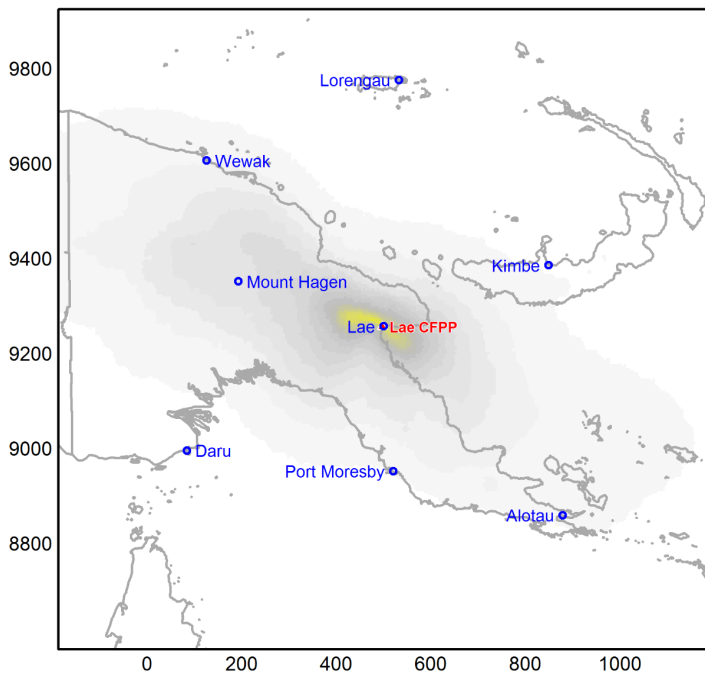


## Results: Air Pollution

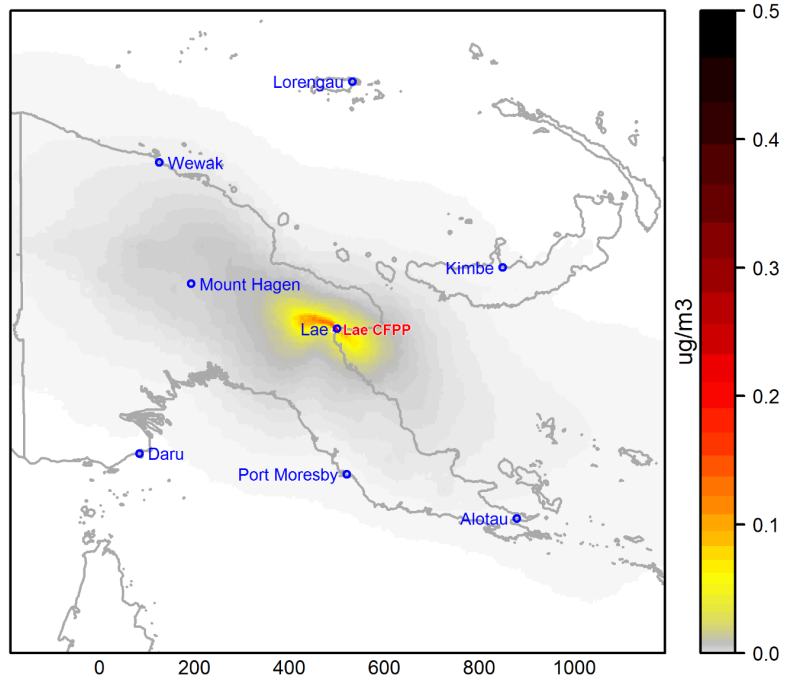
Using the CALPUFF modelling system, we modelled the chemical transformation and transport of emissions from the plant under 2019 meteorological conditions.

Under a 52 MW scenario, the plant would emit approximately 210 tons of SO<sub>2</sub>, 460 tons of Nitrogen Oxides (NO<sub>x</sub>), and 90 tons of particulate matter every year. If capacity is increased to 200 MW, annual emissions would increase to 850 tons of SO<sub>2</sub>, 1,840 tons of NO<sub>x</sub>, and 340 tons of particulate matter every year.

Annual mean PM<sub>2.5</sub> Concentrations  
from a 52 MW Lae EEP

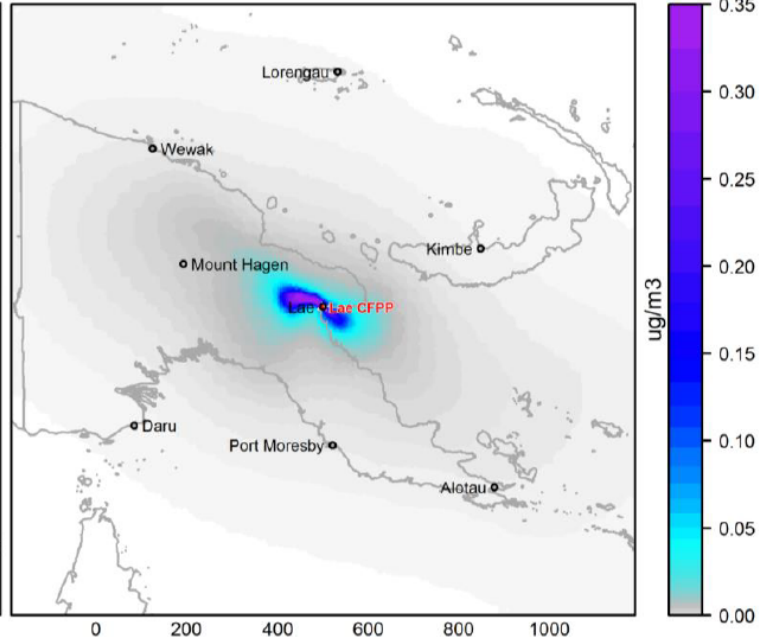
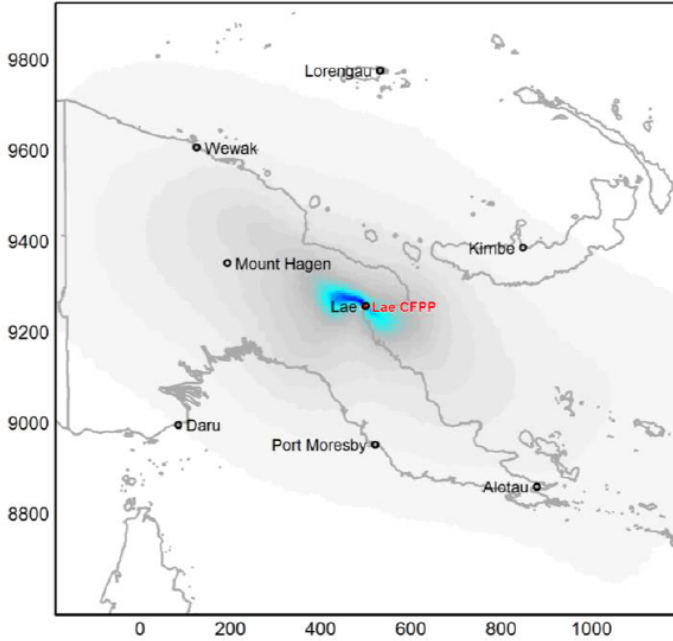


Annual mean PM<sub>2.5</sub> Concentrations  
from a 200 MW Lae EEP



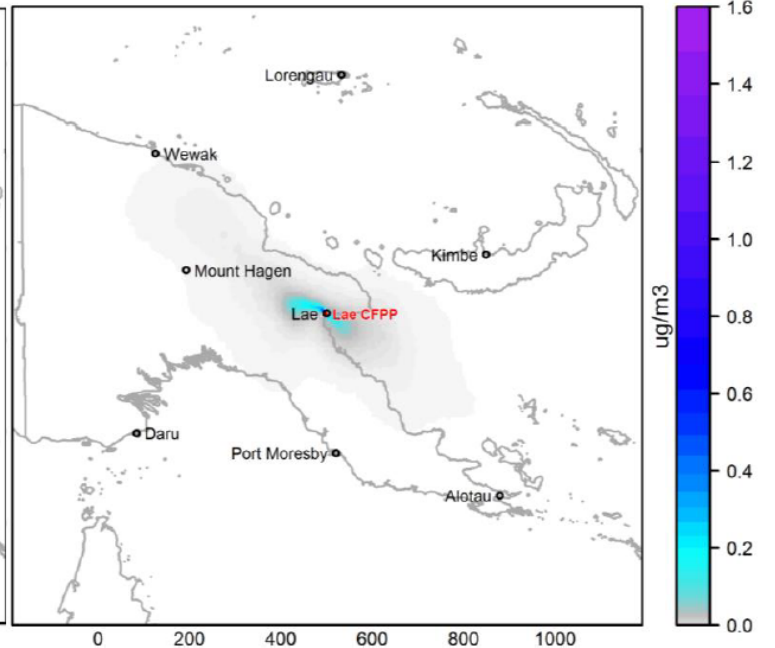
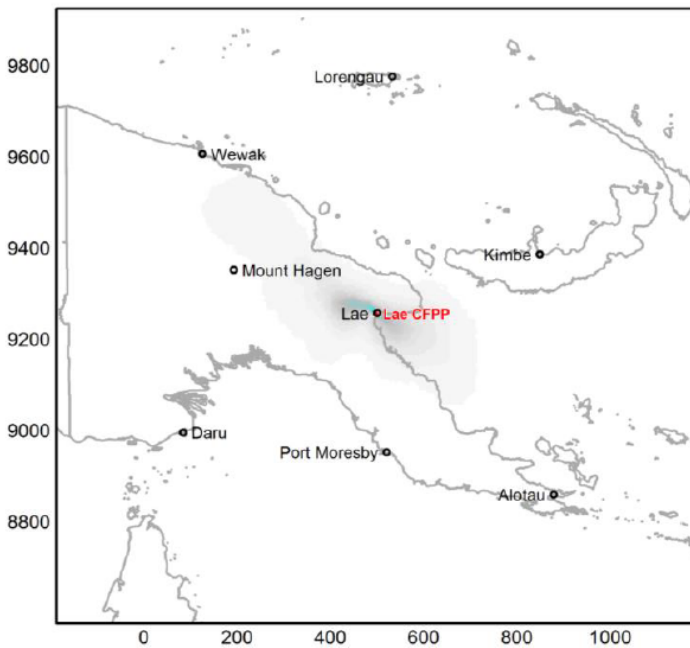
Annual mean NO<sub>2</sub> Concentrations from  
a 52 MW Lae EEP

Annual mean NO<sub>2</sub> Concentrations from  
a 200 MW Lae EEP



Annual mean SO<sub>2</sub> Concentrations from  
a 52 MW Lae EEP

Annual mean SO<sub>2</sub> Concentrations from  
a 200 MW Lae EEP





## Results: Toxic Deposition

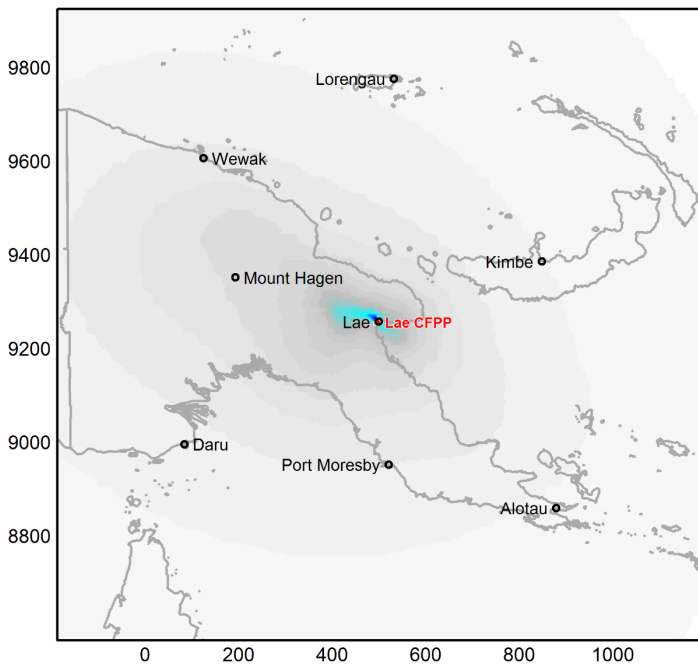
The studied power plants would emit an estimated 5.2 kg per year of mercury into the atmosphere at a 52 MW capacity. Accounting for the expansion plan, mercury emissions from the plant would quadruple to 20.7 kg per year. This is partly due to the lack of meaningful regulations or control requirements for mercury in Papua New Guinea.

Mercury deposition rates as low as 125mg/ha/year can lead to the accumulation of unsafe levels of mercury in fish (Swain et al 1992). We project that an area of approximately 3.1 km<sup>2</sup>, with a population of 3,200, would be affected by potentially dangerous mercury deposition above this threshold.

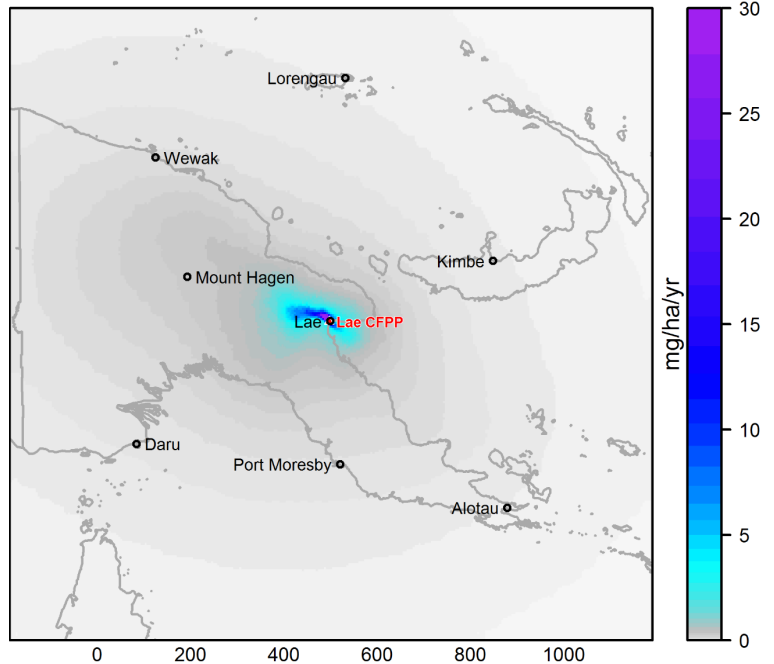
Increasing the capacity of the plant to 200 MW would subject a total of 12,100 people and 24.6 km<sup>2</sup> of forests, waterways, and farmland to dangerous mercury deposition per year.

The air emissions do not include intentional discharges or possible leakage or accidental discharge into water from coal ash ponds, coal ash landfills, coal storage and other sources. Such releases are hard to project ahead of time but could add significantly to the heavy metal load into the environment.

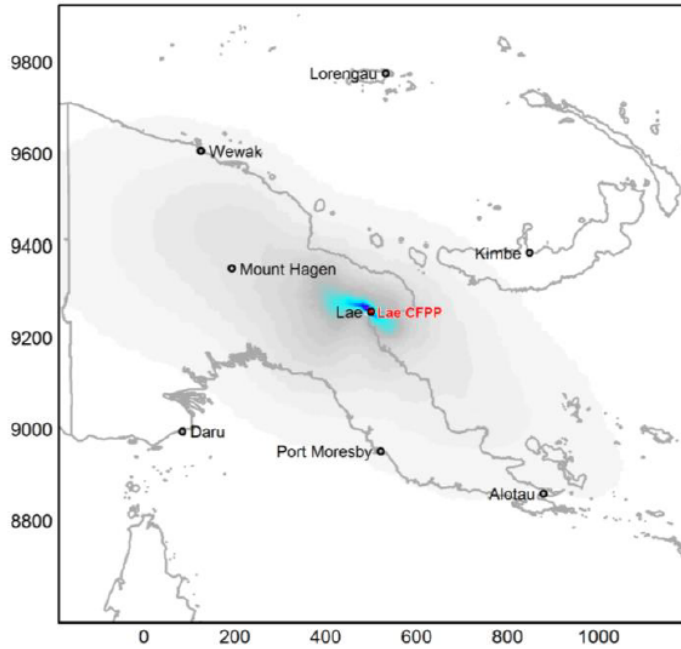
Annual total mercury deposition from a 52 MW Lae EEP



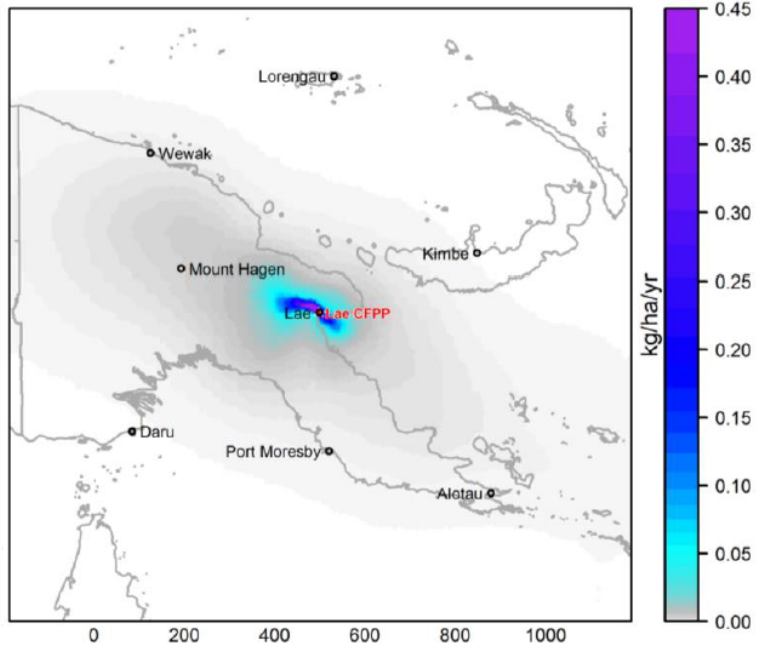
Annual total mercury deposition from a 200 MW Lae EEP



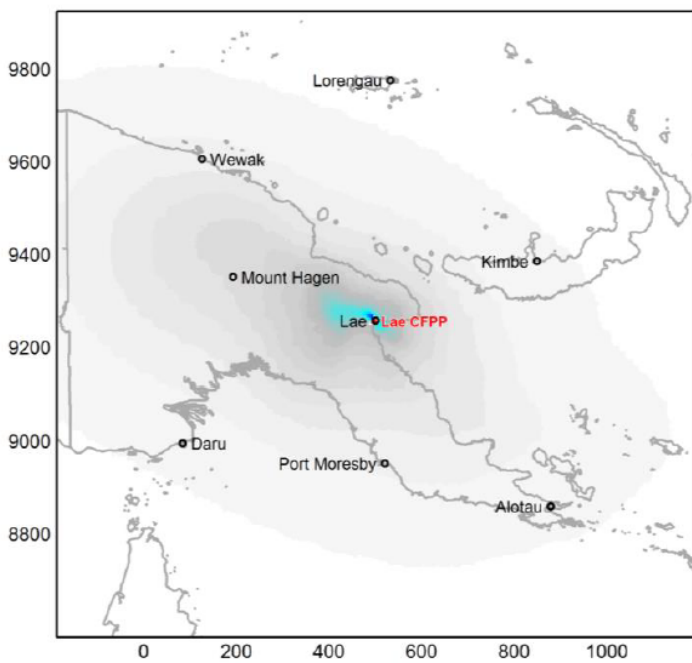
Annual total fly ash deposition from a 52 MW Lae EEP



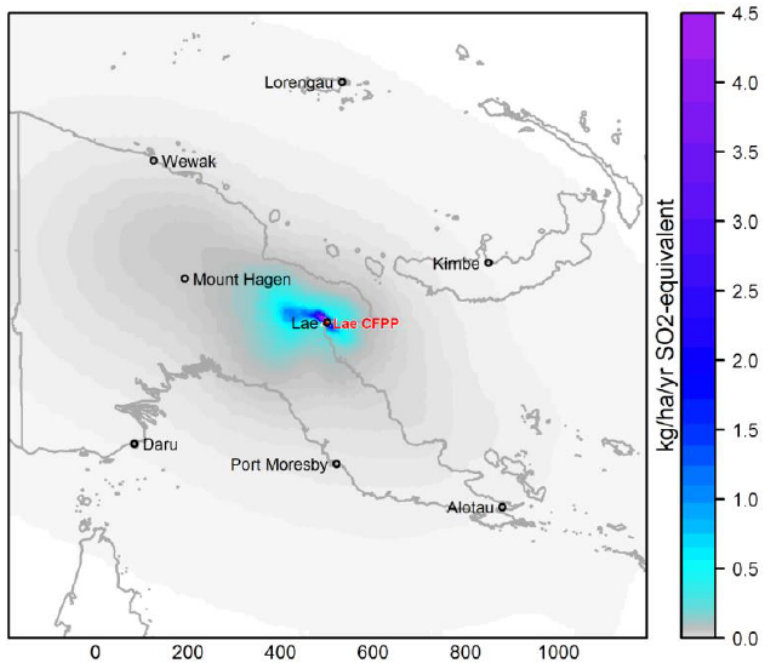
Annual total fly ash deposition from a 200 MW Lae EEP



Annual total acid deposition from a 52 MW Lae EEP



Annual total acid deposition from a 200 MW Lae EEP



## Results: Cumulative Health & Economic Impacts

Our analysis of the health and economic impacts of the Lae EEPC Plant follows the methodology in the CREA study “Quantifying the Economic Costs of Air Pollution from Fossil Fuels” (Myllyvirta 2020).

Coal-fired plants are long-lived assets with power purchase agreements (PPA) given to operate for 30 to 40 years.<sup>1</sup> If the plant is built, the EIA estimates that it would likely operate for a minimum of 30 years — the average operating life of coal plants in the region. This will have significant cumulative impacts for the local population, as a result of long-term exposure to air pollution.

Our estimates found that air pollutant emissions from the proposed 52-MW Lae EEP coal power plant over a 30-year operating life would result in approximately 30 premature deaths, 25 new cases of asthma in children, and 890 years of life lost, and 5,900 work absences taken due to sickness.

With the additional 3 proposed units, health impacts significantly increase. Approximately 115 premature deaths, 100 new cases of asthma in children, 3,500 years of lives lost, as well as 23,500 sick leaves could be attributed to pollution from a 200 MW complex.

These health impacts have corresponding economic damages in the form of increased healthcare spending and loss of economic productivity. Over 30 years, the cost of air pollution from a 52 MW Lae EEP is estimated at USD 7.5 million. The cumulative economic cost of a 200 MW Lae EEP plant expanded complex totals USD 30 million — more than the Papua New Guinea’s entire GDP in 2020.<sup>2</sup>

**Table 1.** Estimated 30 Year Cumulative Premature Deaths due to pollution from the Lae Plant

Cause	50 MW Scenario	200 MW Scenario
chronic obstructive pulmonary disease	2.4 (0.8 - 5.1)	9.6 (3.0 - 20.4)
diabetes	4.1 (0.4 - 29.4)	16.5 (1.6 - 116.3)
ischaemic heart disease	10.8 (6.6 - 17.0)	42.7 (26.1 - 67.3)
lower respiratory infections	1.0 (0.3 - 2.9)	4.0 (1.2 - 11.4)
lower respiratory infections in children	0.8 (0.1 - 3.7)	3.1 (0.6 - 14.7)

<sup>1</sup> see full annual health impacts in the Appendix.

<sup>2</sup> According to the World Bank, Papua New Guinea’s GDP was 23.59 billion USD in 2020.

lung cancer	0.6 (0.2 - 1.3)	2.2 (0.8 - 5.1)
stroke	2.2 (0.7 - 5.0)	8.9 (2.6 - 19.9)
<b>Total</b>	<b>28.8 (17.9 - 46.7)</b>	<b>114.5 (71.1 - 185.5)</b>

**Table 2.** 30 Year Cumulative Impacts and Cost of the Lae Plant

Cause	50 MW Scenario		200 MW Scenario	
	Impacts	Cost in USD million	Impacts	Cost in USD million
<b>asthma emergency room visits</b>	3.0 (1.7 - 4.2)	NA	12.3 (7.3 - 17.4)	NA
<b>low birthweight births</b>	2.2 (0.7 - 3.8)	0.01 (0.002 - 0.01)	8.7 (2.7 - 15.1)	0.03 (0.01 - 0.04)
<b>new cases of asthma in children</b>	24.4 (6.3 - 49.2)	NA	98.9 (25.5 - 198.9)	NA
<b>children suffering from asthma due to pollution exposure (increased prevalence)</b>	100.8 (29.8 - 187.7)	0.02 (0.01 - 0.04)	407.8 (120.5 - 759.4)	0.09 (0.03 - 0.16)
<b>work absence (sick leave days)</b>	5,933 (5,047 - 6,812)	0.09 (0.08 - 0.1)	23,525 (20,013 - 27,014)	0.36 (0.30 - 0.41)
<b>years lived with disability</b>	59.2 (9.2 - 354.5)	0.33 (0.05 - 1.97)	235.1 (37 - 1404.3)	1.31 (0.21 - 7.8)
<i>COPD</i>	6.9 (2.6 - 12.6)	0.04 (0.01 - 0.07)	27.5 (10.2 - 50.0)	0.15 (0.06 - 0.28)
<i>diabetes</i>	44.3 (4.0 - 326.2)	0.25 (0.02 - 1.81)	176 (16.3 - 1,292)	0.98 (0.09 - 7.17)
<i>stroke</i>	7.9 (2.6 - 15.7)	0.04 (0.01 - 0.09)	31.6 (10.5 - 62.4)	0.18 (0.06 - 0.35)
<b>years of life lost</b>	886.8 (514.7 - 1611.3)	7.09 (4.12 - 12.89)	3523.3 (2045.2 - 6414.3)	28.18 (16.36 - 51.30)
<i>non-communicable disease and LRI</i>	817.3 (502.3 - 1289.1)	6.54 (4.02 - 10.31)	3247.1 (1995.4 - 5122)	25.97 (15.96 - 40.97)
<i>LRI in children</i>	69.5 (12.3 - 322.2)	0.56 (0.10 - 2.58)	276.2 (49.9 - 1292.3)	2.21 (0.4 - 10.33)
<b>Total Economic Cost</b>		<b>7.54 (4.25 - 15.01)</b>		<b>29.95 (16.90 - 59.71)</b>

All of these health and economic impacts could be completely avoided if Lae EEP is not built. **Official cancellation of the Lae EEP coal project, and a comprehensive policy to ensure only zero-carbon technologies are pursued for Papua New Guinea's development are recommended.**

## Appendix

**Table A-1: CALPUFF Input Data used to**

Unit	Emissions										Stack characteristics			
	Consu Capacity	Thermal mption	efficiency	NOx	SO	PM	NOx	SOx	PM	Hg	Exit temp	diameter	height	Exit velocity
	MW	tons		mg/Nm3			tons per annum			kg/yr	C	meter		m/s
Unit 1	52	200000	37%	320	190	60	459.5	272.8	86.2	5.2	140	2.53	150	12
Unit 2	50	200000	37%	320	190	60	459.5	213.5	86.2	5.2				
Unit 3	50	200000	37%	320	190	60	459.5	213.5	86.2	5.2				
Unit 4	50	200000	37%	320	190	60	459.5	213.5	86.2	5.2				

**Table A-2: Papua, Indonesia Basin Coal Properties**

	Unit	Value
Sample number	NA	185029
Sulphur content	%	0.61
Mercury content - DRY	ppm	0.17
Mercury content	ppm	0.16
Ash content	%	3.54
Moisture	%	5.23
NCV (Net Calorific Value)	MJ/kg	31.41

SOURCE: World Coal Quality Inventory

**Table A-3: Annual Health Impacts of the Lae Plant**

	52 MW Scenario	200 MW Scenario
<b>work absence (sick leave days)</b>	141.63 (120.5 - 162.6)	561.6 (477.8 - 644.9)
<b>new cases of asthma in children</b>	0.6 (0.2 - 1.2)	2.4 (0.6 - 4.7)
<b>number of children suffering from asthma due to pollution exposure (increased prevalence)</b>	2.4 (0.7 - 4.5)	9.7 (2.9 - 18.1)
<b>premature deaths, of which:</b>	0.6 (0.4 - 1.0)	2.5 (1.6 - 3.8)
<i>Chronic obstructive pulmonary disease</i>	0.05 (0.02 - 0.1)	0.2 (0.07 - 0.5)
<i>Diabetes</i>	0.09 (0.01 - 0.7)	0.4 (0.04 - 2.6)
<i>Ischemic heart disease</i>	0.2 (0.15 - 0.4)	1.0 (0.6 - 1.5)
<i>Lung Cancer</i>	0.01 (0.0 - 0.03)	0.05 (0.02 - 0.1)

<i>Lower respiratory infections (LRI)</i>	0.02 (0.01 - 0.06)	0.1 (0.03 - 0.3)
<i>Lower respiratory infections in children</i>	0.03 (0.01 - 0.2)	0.1 (0.02 - 0.6)
<i>Stroke</i>	0.05 (0.01 - 0.1)	0.2 (0.05 - 0.4)
<b>asthma emergency room visits</b>	0.07 (0.04 - 0.1)	0.3 (0.2 - 0.4)
<b>low birthweight births</b>	0.07 (0.02 - 0.1)	0.3 (0.1 - 0.5)
<b>years lived with disability, of which:</b>	1.3 (0.2 - 7.9)	5.6 (0.8 - 31.4)
<i>COPD</i>	0.3 (0.06 - 0.3)	0.6 (0.2 - 1.1)
<i>diabetes</i>	1.0 (0.09 - 7.3)	3.9 (0.4 - 28.9)
<i>stroke</i>	0.2 (0.06 - 0.4)	0.7 (0.2 - 1.4)
<b>years of life lost, of which:</b>	21.2 (11.8 - 42.8)	84.3 (46.7 - 169.3)
<i>LRI in children</i>	2.9 (0.5 - 13.7)	11.7 (2.1 - 54.8)
<i>Non-communicable disease and LRI</i>	18.3 (11.2 - 28.8)	72.6 (44.6 - 114.5)



---

## References

- Burnett, R., et al. 2018. Global estimates of mortality associated with long-term exposure to outdoor fine particulate matter. *Proceedings of the National Academy of Sciences* 115(38): 9592-9597. <https://doi.org/10.1073/pnas.1803222115>
- Center for International Earth Science Information Network (CIESIN) - Columbia University 2018: Gridded Population of the World, Version 4 (GPWv4): Population Density Adjusted to Match 2015 Revision UN WPP Country Totals, Revision 11. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/H4F47M65>.
- European Environment Agency (EEA) 2014: Costs of air pollution from European industrial facilities 2008–2012 — an updated assessment. EEA Technical report No 20/2014. <https://www.eea.europa.eu/publications/costs-of-air-pollution-2008-2012>.
- Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2020 (GBD 2020) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2020. <http://ghdx.healthdata.org/gbd-results-tool>.
- Mehta et al 2011: Ambient particulate air pollution and acute lower respiratory infections: a systematic review and implications for estimating the global burden of disease. *Air Qual Atmos Health*. DOI 10.1007/s11869-011-0146-3.
- Myllyvirta, L. 2020. Quantifying the Economic Costs of Air Pollution from Fossil Fuels. Centre for Research on Energy and Clean Air. <https://energyandcleanair.org/wp/wp-content/uploads/2020/02/Cost-of-fossil-fuels-briefing.pdf>
- OECD 2012: Mortality Risk Valuation in Environment, Health and Transport Policies. <https://doi.org/10.1787/9789264130807-en>.
- United Nations Population Division (UNPD) 2019: World Population Prospects 2019. <https://population.un.org/wpp/>
- UNEP, 2017. Toolkit for Identification and Quantification of Mercury Releases. UN Environment Chemicals Branch, Geneva, Switzerland.
- World Bank (undated): World Bank Open Data. <https://data.worldbank.org/>
- World Health Organization (WHO) 2013: Health risks of air pollution in Europe-HRAPIE project. [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0006/238956/Health\\_risks\\_air\\_pollution\\_HRAPIE\\_project.pdf?ua=1](http://www.euro.who.int/__data/assets/pdf_file/0006/238956/Health_risks_air_pollution_HRAPIE_project.pdf?ua=1)