

TOXIC TWENTY

UNMASKING INDONESIA'S
MOST TOXIC COAL FIRED
POWER PLANTS

**TOXIC
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INDONESIA**

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TOXIC TWENTY; UNMASKING INDONESIA'S MOST TOXIC COAL FIRED POWER PLANTS

Publication:

November 2025

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Acknowledgements:

We extend our gratitude to all parties who have provided information, data, insights, and constructive feedback that strengthened the arguments and deepened the analysis in this study. Special thanks are directed to Rhizoma Indonesia, Sajogyo Institute, Greenpeace Indonesia, Yayasan Indonesia Cerah, YLBHI-LBH Padang, YLBHI-LBH Jakarta, YLBHI-LBH Bali, YLBHI-LBH Bandung, YLBHI-LBH Semarang, YLBHI-LBH Surabaya, YLBHI-LBH Yogyakarta, Walhi Jawa Barat, Walhi Jawa Tengah, Walhi Jawa Timur, Walhi Jakarta, Walhi Yogyakarta, and Sumatera Terang untuk Energi Bersih.

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The full report can be accessed on the website <https://toxic20.org/>

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LIST of CFPP





KEY FINDINGS

- Indonesia President; Prabowo Subianto has repeatedly expressed his commitment to achieving 100% renewable energy within the next decade, yet the operation of coal-fired power plants (CFPPs) continues. But in many cases, their early retirement is being delayed. The gap between commitment and realization of Indonesia's energy independence ambitions remains significant.
- Health impact calculations from Indonesia's 20 most toxic CFPPs, known as the "Toxic Twenty", indicate at least 156,000 premature deaths from air pollution and economic losses due to health impacts amounting to USD 109 billion (approximately IDR 1,813 trillion) projected between 2026 and 2050—the period covering their remaining operational years.
- The health impacts linked to CFPPs pollution include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.
- The annual economic loss caused by these "Toxic Twenty" reaches IDR 52.4 trillion, with aggregate reductions in household income estimated at IDR 48.4 trillion.
- Furthermore, an estimated 1.45 million jobs are lost due to the operation of these plants, most of them in agriculture, plantation, and fisheries sectors, which are directly affected by environmental degradation.
- In coastal areas, CFPP-related impacts have driven a shift in livelihoods. Many fishers and farmers are forced to become migrant workers as their traditional sources of income deteriorate. This transformation has placed local communities in an even more vulnerable socioeconomic position.
- The list of the 20 most toxic CFPPs in this study should serve as a basis for the government and PLN to initiate the timely phase-out or decommissioning of their operations. It's a crucial step to reduce economic, health, and environmental losses.

GLOSARIUM

1. **Aggregate income** is the total income received by all factors of production in an economy during a certain period of time.
2. **Ambient air** is the natural air in the open environment that surrounds living things, and is usually the focus of air quality measurements.
3. **JETP (Just Energy Transition Partnership)** is an international funding scheme to help developing countries, including Indonesia, in accelerating the transition from fossil fuels (coal) to renewable energy in a fair manner.
4. **Low weight birth** is a birth that occurs before 37 weeks of gestation. Premature babies usually require special medical care.
5. **Underweight birth** is the birth of a baby weighing less than 2,500 grams (2.5 kg), regardless of gestational age.
6. **Asthma-related emergency room visits** is a visit to a hospital's Emergency Department (ER) due to an asthma attack or worsening symptoms that require immediate treatment.
7. **New childhood asthma cases** is the number of children newly diagnosed with asthma (a chronic respiratory disorder) in a given time period.
8. **Years lived with disability (COPD)** is the number of years a person spends with a disability (limited function) due to Chronic Obstructive Pulmonary Disease (COPD).
9. **Years lived with disability (diabetes)** is the number of years a person spends in a state of disability (functional limitation) due to complications from diabetes mellitus.
10. **Years lived with disability (stroke)** is the number of years a person spends with a disability (limited function) as a result of a stroke.
11. **Premature death** is death that occurs before the average age of death in a given population.
12. **A lender** is a party that provides loans or distributes funds to other parties (borrowers) with the hope that the funds will be returned with interest or returns.
13. **A lender fraction or portion** is a part or portion of the total loan or funding provided by one lending entity (lender) in a syndicate or joint lending project.
14. **Gross generating capacity** is the maximum amount of power (in MW) that can be generated by a unit or the entire power plant. This value is measured at the generator terminals before deducting for internal plant use.
15. **Gross thermal efficiency** is a measure of the operational performance of a power plant, indicating the percentage of the fuel's thermal energy (calories) that is converted into useful energy (electricity or work) before being reduced for internal use.
16. **Lower heating value** is the amount of heat energy released when burning a certain amount of fuel, measured assuming that the water produced from the combustion remains in the form of steam (not condensed).
17. **Capacity factor** is the ratio between the actual electrical energy produced by a power plant during a given period, compared to the maximum total energy that can be produced at full capacity during the same period.

18. **Heat rate** is the rate at which thermal energy (heat) is used to produce work energy (e.g., electricity), often measured in units of energy per unit power (e.g., kJ/kWh or Btu/kWh), which is the inverse of thermal efficiency.
19. **Commercial Operation Date (COD)** is the official date for the start of commercial operations of a power plant, which means the power plant is ready to supply electricity to the PLN network.
20. **Emission factor** is the average amount of greenhouse gases or other pollutants released into the atmosphere per unit of activity or consumption (e.g., per ton of coal burned or per kWh of electricity generated).
21. **Lower heating value (NKB/LHV)** is the amount of heat energy released when burning a certain amount of fuel, measured assuming that the water produced from the combustion remains in the form of steam (not condensed).
22. **Concentration-response functions (CRF)** is a mathematical model that determines the quantitative relationship between various concentration levels of air pollutants (namely PM2.5, SO₂, and NO_x) and the resulting health impacts (outlined in tabulations of air pollution-related health impacts, ranging from increased risk of death to hospitalization), thus allowing researchers to predict how many cases of disease could be prevented if pollution were reduced. The Concentration-Response Function is built and tested using epidemiological data, obtained from observational and research efforts collected from human populations about the patterns of disease distribution and risk factors (including pollution exposure) that actually occur in the community.
23. **Confidence interval** is a range of values used in statistics to estimate a parameter of an unknown sample population of data, such as the mean or proportion, based on the sample data taken (generally 95% or 90%)
24. **Co-firing** is a method of burning two different types of fuel simultaneously in one boiler, usually mixing coal with biomass (for example, rice husks or palm kernel shells) in a coal-fired power plant.
25. **Best available technology for air pollution control** is the most advanced and effective technology commercially available to reduce or eliminate air pollutant emissions (such as SO_x, NO_x, and particulates) from industrial sources, such as coal-fired power plants.
26. **Combustion technology** is a method or type of boiler design used to burn fuel (e.g. coal) in power plants, classified based on the pressure and temperature of the steam produced.
- **Subcritical Technology** is a term for combustion technology (in coal-fired power plants), where the boiler operates at steam pressure and temperature below the critical point of water.
 - **Supercritical Technology** is a term for combustion technology (in coal-fired power plants), where the boiler operates at a steam pressure above the critical point of water, which increases thermal efficiency compared to subcritical.
 - **Ultra-supercritical technology** is a term for combustion technology (in coal-fired power plants), where the boiler operates at steam pressures and temperatures much higher than supercritical, resulting in the highest thermal efficiency (most fuel efficient).

27. Types of coal and their sources

- **Bituminous** is a type of high quality coal (medium to high carbon content), which is commonly used as the main fuel for steam power plants (PLTU) and coke production.
- **Sub-bituminous** adalah jenis batubara dengan kualitas di bawah bituminous (tingkat karbon lebih rendah, kandungan air lebih tinggi), sering digunakan sebagai bahan bakar di PLTU karena biaya yang relatif murah.
- **Bioenergi** adalah energi yang berasal dari bahan organik (biomassa), seperti limbah pertanian, limbah hutan, atau tanaman yang ditanam khusus untuk tujuan energi.

28. The BRICS Summit is a meeting of the heads of state of the BRICS member states: Brazil, Russia, India, China, South Africa, Egypt, Ethiopia, Iran, the United Arab Emirates, and Indonesia. Indonesia officially joined BRICS on January 6, 2025.

29. Carbon neutrality is a condition where the amount of carbon emissions released into the atmosphere is balanced and the carbon is reabsorbed by nature.

30. Gross economic output is the total value of all goods and services produced within a country's borders during a specific time period, usually a year or a quarter, also known as Gross Domestic Product (GDP).

31. The 1.5-degree scenario pathway is a global climate change mitigation pathway or trajectory that limits the increase in global average temperatures to a maximum of 1.5 degrees Celsius, above pre-industrial levels, in line with the goals of the Paris Agreement.

CONTEXT

Early Retirement of Coal-Fired Power Plants: Between Climate Urgency and Government Commitment

The closure of coal-fired power plants (CFPPs) is a crucial step in the energy transition process. Beyond aligning with global decarbonization efforts, CFPPs in Indonesia have proven to be major contributors to the economic burden on communities and the state, to public health problems, and to deepening social inequality in affected regions. Yet, amid the urgency of the climate crisis, Indonesia's government policies continue to show inconsistency and hesitation in implementing a phased and just retirement of CFPP operations.

Although Presidential Regulation No. 112 of 2022 and the Minister of Energy and Mineral Resources' regulation on the energy transition roadmap have been issued, early CFPP retirement measures remain optional—contingent on available financing and not grounded in climate responsibility. The development of this roadmap also lacks transparency and public participation, with PT. PLN (the state-owned utility and majority owner of CFPPs) plays a dominant role that risks extending the lifetime of coal plants under the pretext of efficiency and energy security.

The national development vision, which remains fixated on economic growth and fossil-fuel-based industrialization, further prolongs the utilization of coal.

The development of industrial zones, downstreaming projects, and PSN (National Strategic Projects) expansion continues to rely heavily on electricity from CFPPs. In this scheme, local communities and vulnerable groups become the first to bear the costs through air pollution, health risks, loss of livelihoods, and unequal access to clean and affordable energy.

This situation is exacerbated by the government's tendency to view early CFPP retirement as a potential state loss, whether from unpaid infrastructure investments or the fiscal burden. In fact, this flawed perspective needs to be reversed; the phase-out of coal plants should be seen as a social and ecological investment that delivers long-term benefits.

Coal-fired power plants are among the main sources of air pollution from human (anthropogenic) activities. The air pollutants of greatest concern emitted by CFPPs are fine particulate matter of $PM_{2.5}$, sulphur dioxide (SO_2), nitrogen dioxide (NO_x), mercury, and other heavy metals. Due to relatively lax air pollutant emissions standards, the majority of Indonesia's coal-fired power plants lack air pollutant control technologies for SO_2 and NO_x . These pollutants make a significant contribution to $PM_{2.5}$ pollution through the formation and release of sulphate and nitrate aerosols, a form of $PM_{2.5}$, in the atmosphere.

Fine particulate matter ($PM_{2.5}$) is well known to be highly hazardous to community health. These plants significantly degrade air quality across various regions in Indonesia and

beyond. The impact is evident not only from the combined emissions of the twenty CFPPs identified as the “Toxic Twenty,” but also from the cumulative effects of individual plants operating nationwide.

PM_{2.5} refers to extremely small particles—measuring 2.5 microns in diameter or less—that can penetrate deep into the lungs and even enter the circulatory system. Exposure to PM_{2.5} has been strongly linked to a range of short- and long-term health problems, including respiratory infections, cardiovascular diseases, stroke, and an increased risk of premature death.

Unlike larger particles that settle quickly, PM_{2.5} can remain suspended in the atmosphere for one to two weeks, allowing it to travel far from its original source. This long-range transport means pollutants from the so-called “Toxic Twenty” CFPPs can affect areas located far beyond the plant sites, thereby widening

their health impacts. As a result, air pollution exposure is not limited to communities living near CFPPs—it can reach entire provinces and even neighboring countries through the formation of secondary particles and the transboundary movement of polluted air.

As illustrated in Figure 1 of this report, the combined annual average concentration of PM_{2.5} from the “Toxic Twenty” plants reaches 1 µg/m³. While this number may seem small, considering global baseline levels and the fact that it originates from only 20 facilities, it reflects a **significant pollution burden concentrated in densely populated regions of Indonesia**. High concentrations of pollution are particularly evident on Java Island, as well as in Lampung and South Sumatra—areas where most of the “Toxic Twenty” are located. The overlap of multiple emission sources in these regions creates cumulative effects that are far more heavy than the regional average pollution levels.

Annual mean PM2.5 concentration from Toxic 20

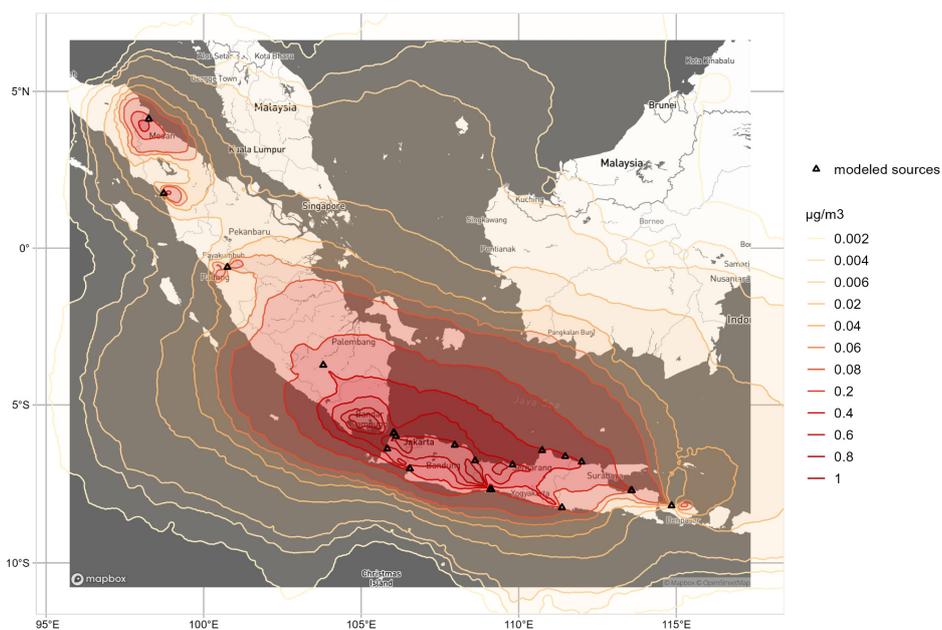


Figure 1. Contribution of the “Toxic Twenty” to the Annual Average PM2.5 Concentration in Indonesia’s Ambient Air

Figure 2 highlights the maximum 24-hour average concentrations of PM_{2.5} generated by these CFPPs, reaching levels of up to 15 µg/m³—a figure that exceeds the World Health Organization (WHO) guideline for daily exposure. The WHO’s standard sets a 24-

hour average safety threshold at 15 µg/m³, indicating that emissions from these 20 plants alone are already sufficient to pose health risks, even in the absence of other pollution sources.

Maximum 24-hour PM2.5 concentration from Toxic 20

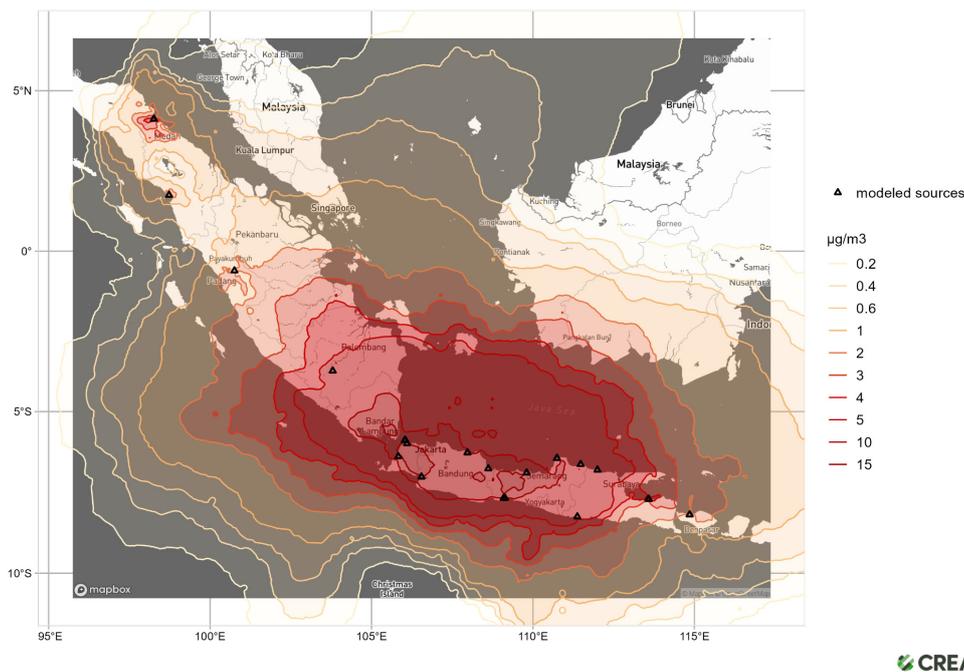


Figure 2. Contribution of the “Toxic Twenty” to the Maximum Daily Average PM2.5 Concentration in Indonesia’s Ambient Air

By preventing up to 156,000 deaths from air pollution and avoiding economic losses from health impacts amounting to USD 109 billion (approximately IDR 1,813 trillion), the early retirement of CFPPs should be recognized as a strategic step toward a just and sustainable energy system.

Indonesia now stands at a critical crossroads in its national energy trajectory. Amid the mounting threats of the global climate crisis and accelerating ecological degradation, the government has pledged to reduce dependence on fossil fuels—particularly through the early retirement of CFPPs. On

at least two international occasions—at the BRICS Summit and the United Nations General Assembly—President Prabowo reaffirmed Indonesia’s commitment to achieving 100% renewable energy within the next decade. However, a considerable gap remains between pledge and implementation, one that must be bridged through bold political action and consistent policymaking.

The Indonesian government has stated its commitment to the early retirement of CFPPs as part of its broader efforts toward an energy transition and decarbonization. Key related commitments include:

- **Net Zero Emissions (NZE) Target 2060**

The government has committed to achieving carbon neutrality by 2060 or earlier, with strong international support. One of the key steps toward this target is the early retirement of coal-fired power plants (CFPPs) to reduce emissions from the energy sector.

- **Just Energy Transition Partnership (JETP)**

Through the JETP, Indonesia receives international support to accelerate its energy transition, including financing to enable the early closure of CFPPs. This partnership also aims to ensure that the energy transition is conducted in a just manner, without disadvantaging workers or communities that depend on the coal sector.

- **Moratorium on New CFPP Construction**

In 2021, the government announced a moratorium on the development of new coal-fired power plants after 2023. This policy marks an important step toward limiting the number of CFPPs operating in the future and accelerating the shift to renewable energy.

- **Planned Phase-Out of CFPPs**

The National Electricity General Plan (RUKN) 2019 and the Electricity Supply Business Plan (RUPTL) 2021–2030 outline a roadmap for the gradual phase-out of CFPPs starting in 2030, prioritizing older or inefficient plants.

- Additionally, the Strategic Environmental Assessment Report for Indonesia's National Long-Term Development Plan 2025–2045 (KLHS RPJPN 2025–2045), published in August 2023, provides two phase-out scenarios: a *fair* scenario starting in 2040 and concluding in 2060; and an *ambitious* scenario beginning in 2030 and also

ending in 2060. The RPJPN Law 2025–2045 has adopted the ambitious scenario. As stated in the Annex of the RPJPN Law, the implementation planning for CFPP retirement begins in 2030–2034 (Phase 2).

- **Memorandum of Understanding with ADB**

The government is also collaborating with the Asian Development Bank (ADB) to implement the Energy Transition Mechanism (ETM). This mechanism is designed to accelerate early CFPP retirement and replace coal generation with cleaner sources of energy.

- **Expansion of Renewable Energy Capacity**

One form of government support for early CFPP retirement is the acceleration of renewable energy development, including solar, wind, and micro-hydro power. These renewable installations are expected to form the backbone of Indonesia's future electricity supply.

However, these commitments will mean little without concrete implementation. The government must stop viewing CFPP retirement as a fiscal burden or a risk to economic growth, and instead recognize it as a long-term investment in creating a healthier, fairer, and more sustainable future.

By reaffirming its commitments through tangible and measurable actions, Indonesia has the opportunity to lead an energy transition that prioritizes public safety and the survival of future generations. What is needed now is no longer mere goodwill, but political courage to place human safety and planetary well-being at the forefront.

Economic Impacts of the Toxic Twenty Operations

The twenty most hazardous coal-fired power plants (CFPPs) in Indonesia impose a substantial economic burden on both society and the state. According to CELIOS analysis (2025), these CFPPs lead to aggregate income losses of up to **IDR 48.4 trillion per year** and negatively affect **1.45 million workers** through declining productivity, higher illness rates, and reduced employment opportunities in surrounding areas. These losses reflect the systemic impacts of air pollution and environmental degradation, which erode household welfare and suppress local economic growth in regions with high CFPP concentration such as Java, South Sumatra, and Lampung.

Three major economic sectors are most severely affected by CFPP pollution: **agriculture, forestry, and fisheries; manufacturing; and trade.** Air pollution and water contamination from CFPP activities reduce land productivity, crop yields, and raw material quality, while worker health disruptions diminish production efficiency in the industrial sector. These cascading effects ultimately lead to reduced trade activity at both local and regional levels. In short, CFPP operations not only contribute to carbon emissions but also undermine the productive economic foundations of communities that rely on healthy ecosystems and a resilient workforce.

Table 1. Economic Impacts of the Twenty Most Toxic CFPPs on Indonesia's Economy. Source: CELIOS, 2025

Name of CFPP	Economic Output (IDR Trillion)	Gross Domestic Product (IDR Trillion)	Household Income (IDR Trillion)	Corporate Income (IDR Trillion)	Labor Income (IDR Trillion)	Net Government Tax Revenue (IDR Trillion)	Job Creation (Person)
Suralaya	(2,55)	(2,43)	(2,31)	(1,24)	(1,16)	(0,04)	(66.726)
Paiton	(14,86)	(14,75)	(13,61)	(7,37)	(6,90)	(0,48)	(410.668)
Cirebon	(1,28)	(1,30)	(1,21)	(0,61)	(0,66)	(0,03)	(27.447)
Tanjung Jati B	(9,39)	(9,35)	(8,69)	(5,90)	(3,25)	(0,19)	(289.422)
Cilacap	(4,56)	(4,53)	(4,22)	(2,86)	(1,58)	(0,09)	(140.407)
Bukit Asam	(0,27)	(0,28)	(0,26)	(0,16)	(0,11)	(0,00)	(6.664)
Pacitan	(1,96)	(1,94)	(1,79)	(0,97)	(0,91)	(0,06)	(54.104)
Pelabuhan Ratu	(2,30)	(2,33)	(2,17)	(1,10)	(1,18)	(0,05)	(49.348)
Adipala	(1,26)	(1,25)	(1,16)	(0,79)	(0,44)	(0,03)	(38.738)
Indramayu	(2,17)	(2,20)	(2,05)	(1,03)	(1,11)	(0,05)	(46.574)
Labuan	(0,27)	(0,25)	(0,24)	(0,13)	(0,12)	(0,00)	(6.956)
Jawa Tengah	(3,56)	(3,55)	(3,30)	(2,24)	(1,23)	(0,07)	(109.832)
Ombilin	(0,16)	(0,16)	(0,15)	(0,10)	(0,06)	(0,00)	(2.825)
Jawa-7	(0,69)	(0,66)	(0,63)	(0,34)	(0,32)	(0,01)	(18.202)
Celukan Bawang	(0,17)	(0,17)	(0,16)	(0,11)	(0,07)	(0,00)	(4.155)

Name of CFPP	Economic Output (IDR Trillion)	Gross Domestic Product (IDR Trillion)	Household Income (IDR Trillion)	Corporate Income (IDR Trillion)	Labor Income (IDR Trillion)	Net Government Tax Revenue (IDR Trillion)	Job Creation (Person)
Pangkalan Susu	(2,36)	(2,35)	(2,23)	(1,40)	(0,92)	(0,03)	(54.768)
Tanjung Awar-Awar	(2,17)	(2,16)	(1,99)	(1,08)	(1,01)	(0,07)	(60.038)
Rembang	(1,49)	(1,49)	(1,38)	(0,94)	(0,52)	(0,03)	(46.011)
Banten	(0,23)	(0,22)	(0,21)	(0,11)	(0,11)	(0,00)	(6.154)
Labuhan Angin	(0,72)	(0,72)	(0,68)	(0,43)	(0,28)	(0,01)	(16.742)
TOTAL	(52,44)	(52,10)	(48,47)	(28,91)	(21,93)	(1,25)	(1.455.781)

*Parentheses (...) indicate a reduction or negative value

**Economic modeling calculations exclude health-related costs, which are assessed separately

Source: CELIOS, 2025

Health Impacts of Air Pollution from the “Toxic Twenty”

For pollution originating from the “Toxic Twenty” power plants, CREA estimated its impacts on public health and the economy. The results of these calculations are presented in Table 2.

Table 2. Historical Cumulative and Projected Future Impacts of Air Pollution from the “Toxic Twenty” CFPPs on Public Health and the Economy

Health impact parameter	Historical Impacts (2000-2025)*	Projected cumulative future impacts (2026 to the final operational year in 2050 and beyond)*
Preterm births	55.000 (27.000-58.000)	63.000 (31.000-67.000)
Low-birth-weight	36.000 (11.000-63.000)	42.000 (13.000-72.000)
Asthma-related emergency room visits	100.000 (60.000-140.000)	141.000 (85.000-196.000)
New childhood asthma cases	70.000 (16.000-153.000)	84.000 (19.000-184.000)
Years lived with disability (COPD)	32.000 (12.000-59.000)	56.000 (20.000-104.000)
Years lived with disability (stroke)	12.000 (3,000-24,000)	22.000 (6.000-43.000)
Years lived with disability (diabetes)	69.000 (22,000-141,000)	121.000 (39.000-248.000)
Work absence (sick days)	41.000.000 (35.000.000-47.000.000)	64.000.000 (55.000.000-74.000.000)
Mortality	89.000 (550.000-140.000)	156.000 (97.000-245.000)
Economic cost (USD billion)	63 (39-98)	109 (67-170)
(IDR trillion)	1.050 (650-1.630)	1.810 (1.115-2.830)

*Values listed represent central estimates, and values in brackets represent low and high estimates, corresponding to the 95% confidence interval of the concentration-response functions and the epidemiological and population data.

Harmful Impacts on Birth Outcomes

The health impacts of air pollution begin even before birth. Both pregnant women and newborns are at risk of exposure to emissions generated by coal-fired power plant (CFPP) operations. Exposure to pollutants can adversely affect birth outcomes, including low birth weight, which is a risk factor for long-term health problems. Air pollution from the Toxic Twenty is estimated **to cause 63,000 (31,000–67,000) preterm births and 42,000 (13,000–72,000) low birth weight births between 2026 and the final year of operation in 2050.** These impacts not only directly affect infant health but also have long-term implications for development and well-being, placing additional strain on the healthcare system and on affected individuals.

Health Impacts Related to Asthma

Air pollution from the Toxic Twenty severely damages the respiratory system. Pollution from these plants is estimated to cause **141,000 (85,000–196,000) asthma-related emergency room visits between 2026 and 2050.**

For both affected patients and the healthcare system, these emergency visits represent a significant burden, increasing demand for medical resources such as hospital beds, oxygen therapy, and medications. The impacts extend beyond health infrastructure: repeated asthma attacks disrupt daily life—children miss school, and parents must take time off work to care for them.

This creates economic burdens as well, both at the individual level—through medical costs and lost income—and at the societal level, where rising healthcare expenditures and declining labor productivity place additional pressure on the public health system and the broader economy.

Children are the most vulnerable to air pollution, especially when it comes to respiratory health. The study estimates that pollution from the Toxic Twenty will **cause 84,000 (19,000–184,000) new cases of childhood asthma between 2026 and 2050.** The scale of these impacts underscores the urgency of implementing stricter emission standards to protect the youngest and most vulnerable members of society.

Chronic Disease and Disability

Air pollution from the Toxic Twenty contributes significantly to chronic diseases and disabilities. The study assesses the burden on people living with disabilities using *Years Lived with Disability* (YLD), a standard public health metric for non-fatal health conditions. YLD represents the number of years a person lives with a disease or health impairment, calculated by multiplying the number of affected individuals by the average duration of the condition.

The Centre for Research on Energy and Clean Air (CREA) estimates that pollution from the Toxic Twenty will result in: **56,000 (20,000–104,000) YLD due to chronic obstructive pulmonary disease (COPD), 22,000 (6,000–43,000) YLD due to disability from stroke, and 121,000 (39,000–248,000) YLD due to diabetes between 2026 and the last year of operation in 2050.**

Loss of Labor Productivity

The impacts of air pollution extend far beyond direct health outcomes, imposing substantial economic costs through reduced labor productivity. The study estimates that pollution from the Toxic Twenty will **cause 64 million (55–74 million) lost workdays between 2026 and 2050 due to pollution-related**

health problems. These absences reflect lost productivity, disrupted workflows, and reduced economic output across multiple sectors.

Premature Mortality

The study estimates that pollution from the Toxic Twenty will contribute to **156,000 (97,000–245,000) premature deaths in Indonesia between 2026 and 2050.**

This represents one of the most severe consequences of coal-related pollution. Most of these deaths are caused by exposure to PM_{2.5} and NO₂, followed by SO₂. Mortality linked to PM_{2.5} arises from lung cancer, chronic obstructive pulmonary disease (COPD), ischemic heart disease, stroke, and diabetes. Long-term exposure to PM_{2.5}, in particular, has been widely shown to significantly increase mortality risk by worsening these conditions.

Translating Health Impacts into Economic Burdens

Many of the health impacts outlined in this report translate directly into economic burdens for society. Lost workdays, for instance, reduce productivity not only for individual employers but also create ripple effects across the national economy. Increased absenteeism places additional pressure on businesses, lowers workforce efficiency, and raises operating costs. Meanwhile, healthcare expenses associated with pollution-related illnesses intensify financial strain on both the private and public sectors.

Many of these health impacts correspond to direct medical costs. For example, Brandt et al. (2012) estimate that each asthma-related emergency room visit cost approximately

USD 844 in 2010. The European Environment Agency (EEA, 2014) estimates that a single lost workday in the European Union results in an economic loss of EUR 130.

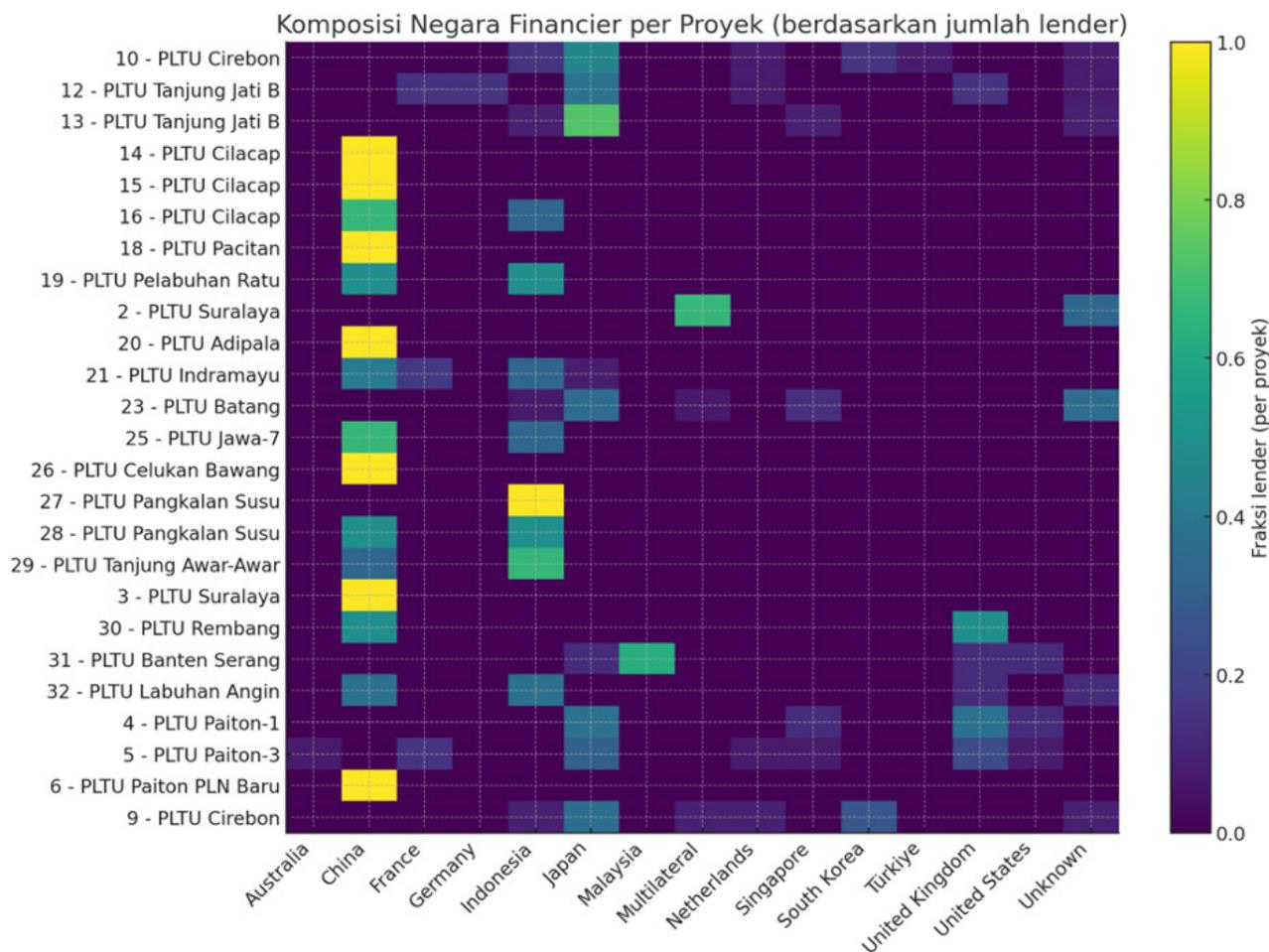
Using health cost valuations from academic literature—adjusted for spatial and temporal GDP differences—we estimate that air pollution from the Toxic Twenty will cause **USD 109 billion (USD 67–170 billion) or IDR 1,813 trillion (IDR 1,115–2,828 trillion) in air-pollution-related economic burdens between 2026 and the final year of operation in 2050.**

The majority of these costs stem from premature mortality, followed by lost productivity

Analysis of Country-Level Financing Linkages Behind Indonesia's Twenty Most Toxic CFPPs

Data from Trend Asia (2025) shows that financing for the 20 most dangerous coal-fired power plants (CFPPs) in Indonesia remains dominated by foreign institutions and countries. Japan is recorded as the largest financier, with total project capacity reaching **63,328 MW**, followed by China (**18,815 MW**), the United Kingdom (**10,325 MW**), and multilateral institutions such as the World Bank and the Asian Development Bank (ADB).

This cross-border financing involvement demonstrates that CFPP development in Indonesia is not merely a matter of domestic energy policy, but part of a broader global investment network that continues to support coal, despite global commitments to energy transition and carbon emission reductions



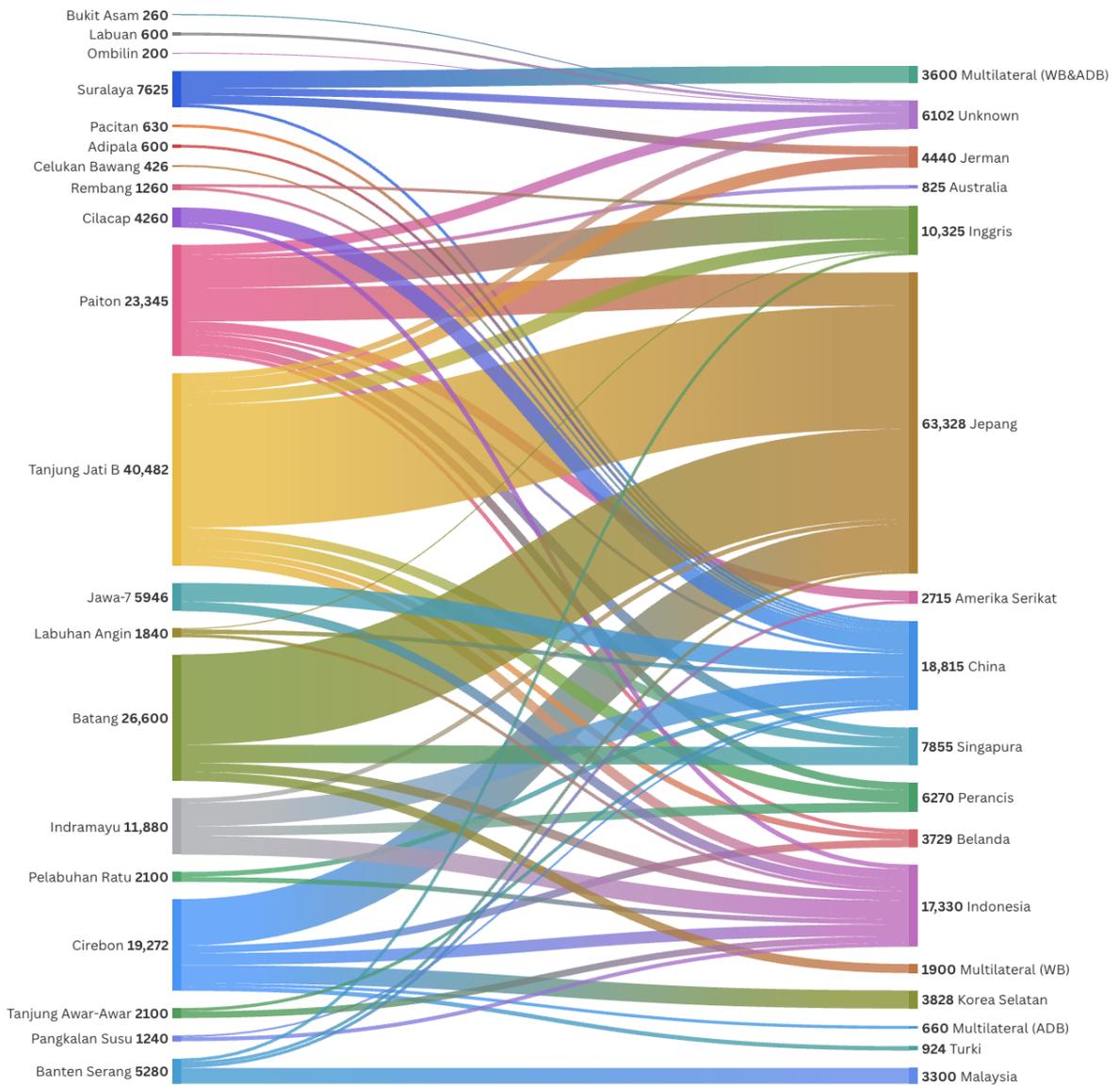
**Note: The chart shows the composition of the countries of origin of lenders financing each CFPP, based on the number of lending institutions. It illustrates the share of lenders by country for each project (the lighter the color, the larger the proportion of lenders from that country in the respective CFPP)*

Source: Trend Asia, 2025

Meanwhile, the map of lender country composition highlights Indonesia’s strong dependence on foreign financing for CFPP projects. Several major plants—such as Cirebon, Tanjung Jati B, Paiton, and Batang—are funded by a combination of banks and financial institutions from Japan, China, and the United Kingdom. The lighter shades in the chart indicate the dominance of particular

lenders in strategic projects, suggesting that much of the environmental and social risk associated with coal power plants in Indonesia is also a consequence of global investment decisions. Given this financing structure, Indonesia’s energy transition depends not only on national policy but also on the commitment of lending countries to halt capital flows into coal projects.

The Largest Financing Network Behind the 20 Most Hazardous Coal-Fired Power Plants in Indonesia
Country of Origin of Funders for Toxic Twenty CFPPs Based on Capacity (MW)



Sumber: Trend Asia (2025) • Data mengacu intensitas aliran dana negara asal pendana ke PLTU, sehingga jumlah kapasitas kawasan (MW) PLTU tampak berlipat dari jumlah asal.

* A Flourish sankey chart

Source: Trend Asia, 2025

1

Suralaya CFPP Unit 1-10, Banten (6.025 MW)



Suralaya Coal-Fired Power Plant Unit 1-10, Banten (6,025 MW)

https://www.gem.wiki/Banten_Suralaya_power_station

Located in Suralaya Village, Pulomerak District, Cilegon City, Banten Province—approximately 7 km from Merak Port—the Suralaya coal-fired power plant (CFPP) is one of the largest coal power complexes in Indonesia. The first unit of the plant was constructed in 1984, and for the past forty years it has played a major role in supplying electricity to the Java–Bali grid.

Construction of the plant began in the early 1980s, with the first unit entering operation in 1984–1985. The complex was developed progressively, eventually reaching seven units by 2011. The plant consists of four units of 400 MW each (Units 1–4), three units of 600 MW each (Units 5–7), and an additional Unit 8 with a capacity of 625 MW, bringing the total installed capacity to approximately 3,400–4,025 MW.

The ownership and financing structure of the Suralaya CFPP reflects the strong involvement of international financial institutions in

Indonesia’s coal energy sector. For Units 1–7 (Phases I–II), the plant was financed by the World Bank, which provided a loan of USD 426.6 million in 1992 with a 20-year term, supplemented by additional support from the Asian Development Bank (USD 350 million) and the German government (USD 69.7 million). Meanwhile, Unit 8, with a capacity of 625 MW, was financed by the Export–Import Bank of China through a loan worth USD 284.29 million in 2008, with a 15-year tenor and an interest rate of 4.619%.

Although various statements have been made regarding the phased retirement of coal-fired power plants and the expansion of renewable energy, implementation on the ground has progressed slowly. This half-hearted commitment is evident in the construction of Units 9 and 10 of the Suralaya CFPP, which were inaugurated in 2024.

Ownership and Investors

Suralaya Coal-Fired Power Plant Units 5-7/Phase II Units 1-3

 Capacity
3x600 MW

 Loan Date
1992

 Funding
World Bank

 Loan Tenor
20 Years

 Amount
USD 426.6 Million

 Other Loans
Asian Development Bank (USD 350 Million) and the German Government (USD 69.7 Million)

Source: World Bank¹

¹ <https://documents1.worldbank.org/curated/en/343731628595913833/pdf/Announcement-of-Indonesia-Suralaya-Thermal-Power-Project-on-July-2-1992.pdf>

PLTU Suralaya Unit 8



Capacity
625 MW



Loan Year
2008



Lending Country
China



Financing
**Export-Import
Bank of China**



Loan Tenor
15 Tahun



Amount
USD 284.288.744



Interest Rate
4,619%

Source: GEM and China AidData¹

General information

COD & power generation capacity	Unit 1 - 1984: 400 MW	Unit 6 - 1997: 600 MW
	Unit 2 - 1985: 400 MW	Unit 7 - 1997: 600 MW
	Unit 3 - 1988: 400 MW	Unit 8 - 2011: 625 MW
	Unit 4 - 1989: 400 MW	Unit 9 - Oktober 2024: 1.000 MW
	Unit 5 - 1996: 600 MW	Unit 10 - April 2025: 1.000 MW

Combustion technology	Units 1-8: Subcritical Pulverized Coal Boilers Units 9-10: Ultra-Supercritical Pulverized Coal Boilers
------------------------------	---

National targets	<ul style="list-style-type: none"> • Biomass co-firing is currently being implemented, with sawdust utilization up to 5% in Units 1-8. • Ammonia co-firing², with a feasibility study to be conducted in 2022 for Units 9-10 at 60%³, and for Units 5-7.⁴ • High-ratio biomass combustion⁵, with a feasibility study to be conducted in 2022 for Units 1-4 in 2022, up to 100%
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Coal types and sources	Units 1-8 - Coal: sub-bituminous; bioenergy: wood & other biomass (solids) [5%] Units 9-10 - Coal: sub-bituminous
-------------------------------	--

¹ <https://china.aiddata.org/projects/37864/#:~:text=On%20January%2030%2C%202008%2C%20the%20Export-Import%20Bank%20of,the%20625MW%20Banten%20Suralaya%20Power%20Plant%20Construction%20Project.>

² <https://www.mhi.com/news/220607.html>

³ <https://industri.kontan.co.id/news/pltu-9-dan-10-jadi-pembangkit-pertama-menggunakan-energi-amonia-dan-hidrogen-hijau>

⁴ <https://web.pln.co.id/cms/media/siaran-pers/2022/11/percepat-transisi-energi-pln-gandeng-mitsubishi-uji-coba-co-firing-amonia-dan-hidrogen-pada-pembangkit-listrik/>

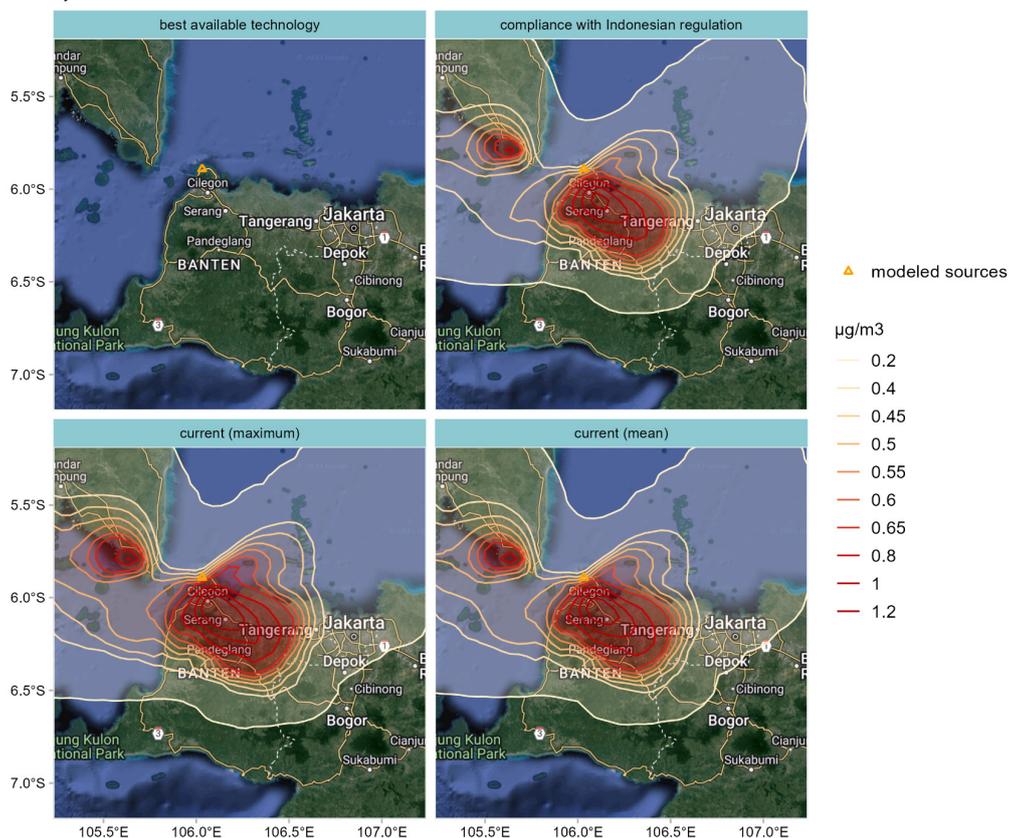
⁵ <https://web.pln.co.id/cms/media/siaran-pers/2022/11/percepat-transisi-energi-pln-gandeng-mitsubishi-uji-coba-co-firing-amonia-dan-hidrogen-pada-pembangkit-listrik/>

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Health impact assessments conducted by CREA⁶ show that the operation of this CFPP complex generates high levels of air pollution across a wide and densely populated area, including an average annual PM_{2.5} concentration of **1.0 µg/m³** in the northern part of Banten Province, home to 13 million people and encompassing Serang and Cilegon.

In addition to PM_{2.5}, the Banten–Suralaya complex contributes to simulated average annual concentrations of **1–1.4 µg/m³ of NO₂** and **0.5–2.0 µg/m³ of SO₂**. Moreover, populations in western Java and southern Sumatra are exposed not only to emissions from the Banten–Suralaya complex, but also from other power plants (Anhäuser, 2019; Myllyvirta, 2020), traffic (Pun et al., 2020), and biomass burning (Reddington et al., 2014).

Annual mean PM_{2.5} concentration from Banten Suralaya complex
by scenario

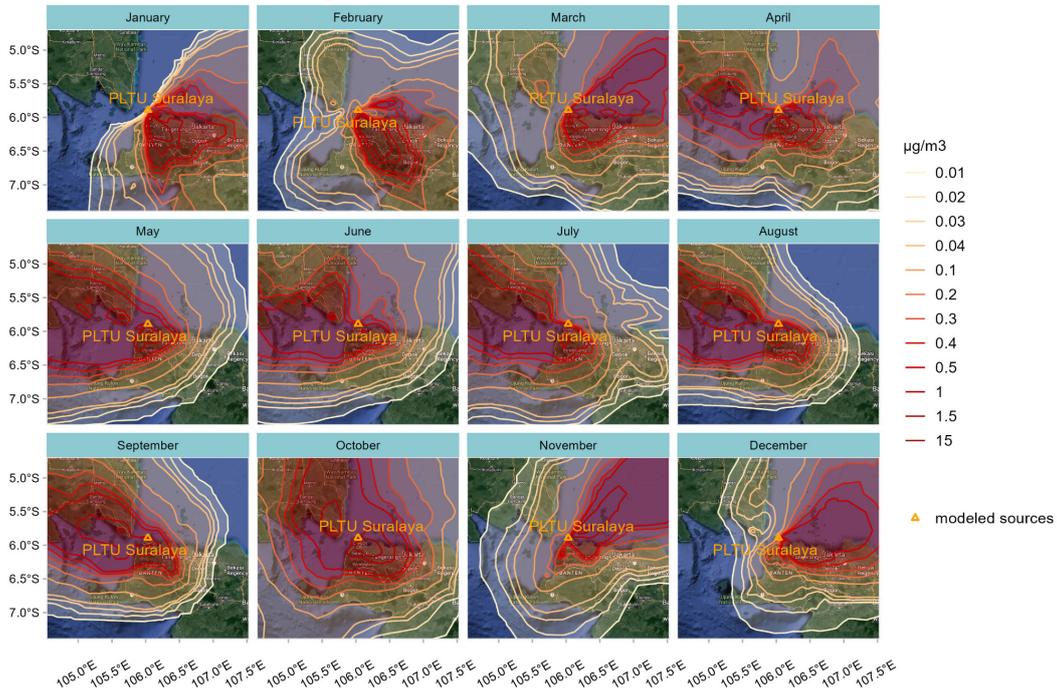


CREA

⁶ <https://energyandcleanair.org/publication/air-quality-impacts-of-the-banten-suralaya-complex/>

PM2.5 concentration from Banten-Suralaya coal power plant

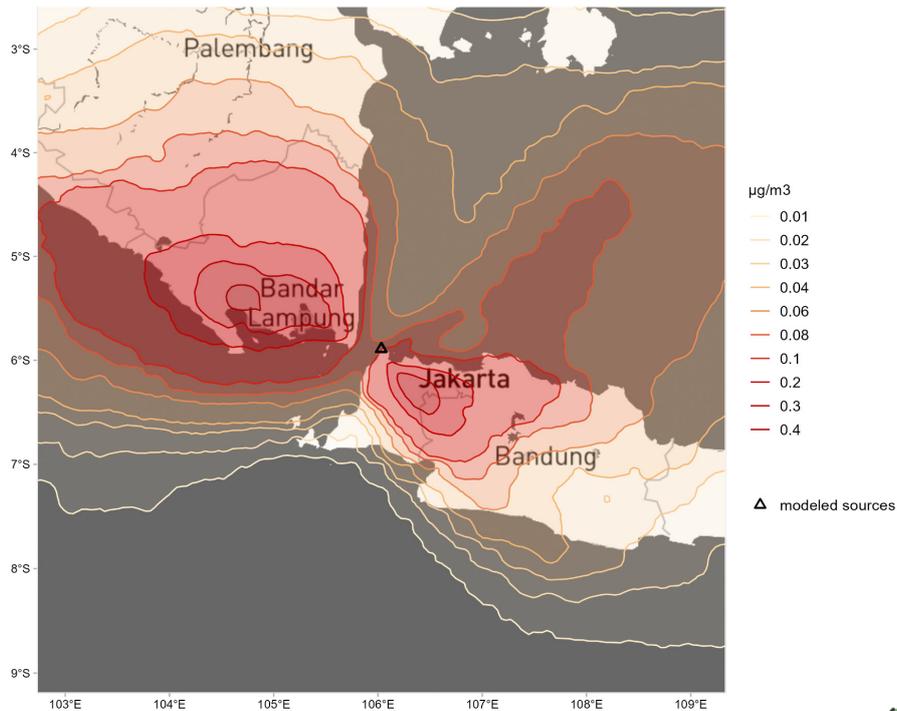
average by month



CREA

Figure 1. Map of PM2.5 Distribution from the Suralaya Coal Power Complex — under the current scenario compared to the applicable compliance standards and a scenario with the installation of Best Available Technology (BAT) for air pollution control (top), and monthly averages illustrating the influence of atmospheric conditions (bottom).

Annual mean PM2.5 concentration from Suralaya



CREA

Figure 2. Annual Average Distribution of PM2.5 from the Suralaya Coal Power Complex

Maximum 24-hour PM2.5 concentration from Suralaya

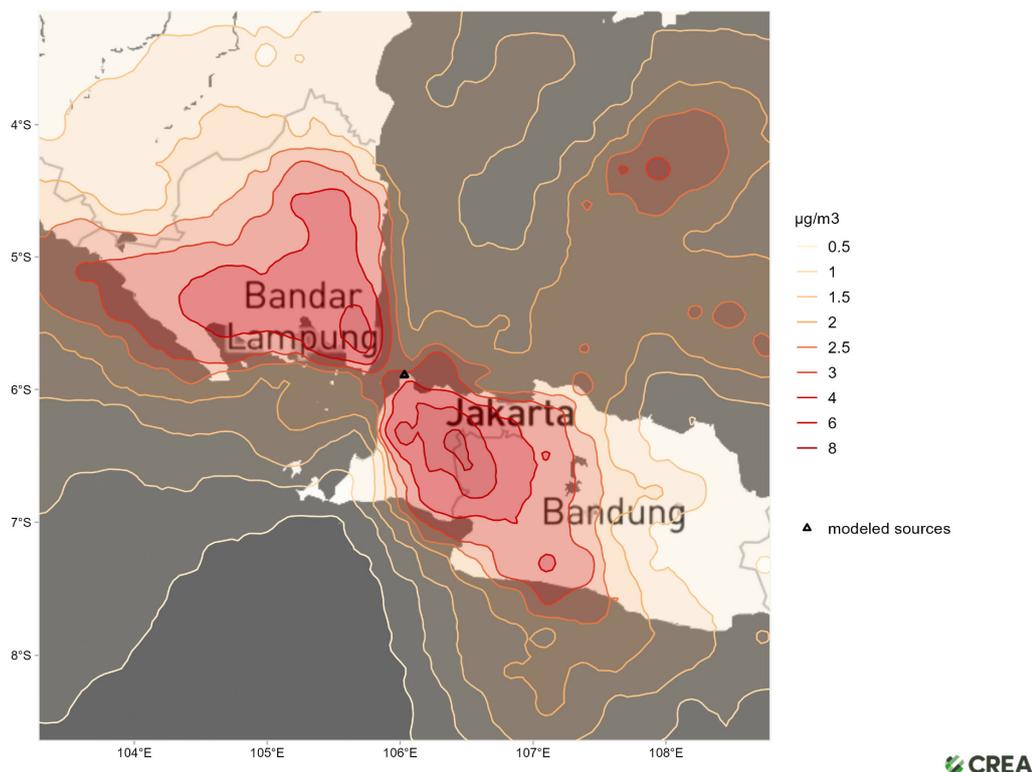


Figure 3. Maximum 24-Hour PM2.5 Concentration from the Suralaya Coal Power Complex

Exposure to harmful air pollutants increases the risk of premature death and a wide range of diseases.

For mortality related to air pollution, the operation of the Suralaya coal-fired power plant results in **1,063 premature deaths per year** among the adult population, caused by stroke (401), ischemic heart disease (365), lower respiratory infections (91), chronic obstructive pulmonary disease (86), lung cancer (72), and diabetes (16), as well as **8 deaths among children under five** due to lower respiratory infections.

In terms of morbidity, air pollutant emissions from the Suralaya plant lead to significant increases in respiratory diseases, including

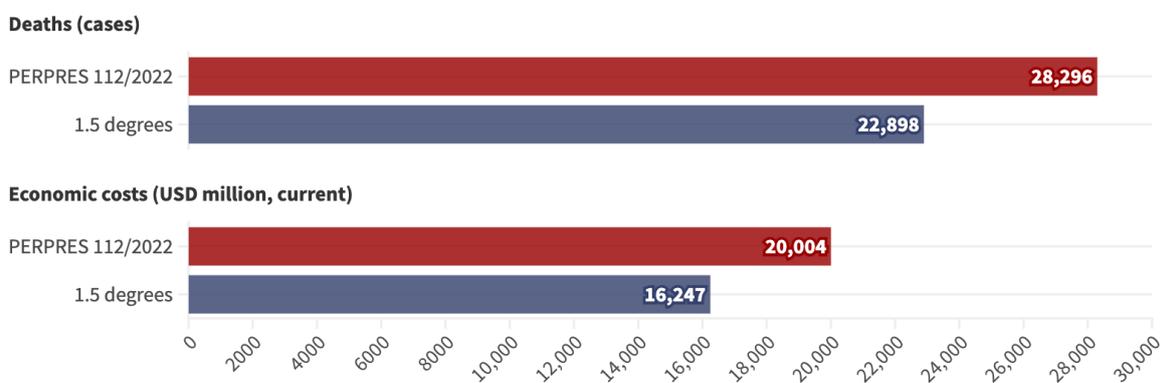
1,790 (1,070–2,500) asthma-related emergency room visits and **1,010 (230–2,190) new asthma cases**. Negative impacts on infants and unborn children include **936 (454–993) preterm births** and **612 (190–1,060) low birth weight cases**. Additionally, pollution-related illness and disability cause **742,000 (631,000–852,000) lost workdays** every year due to absenteeism.

The economic burden on Indonesia resulting from health impacts linked to air pollution from the Suralaya power complex amounts to **USD 1.04 billion (0.65–1.60 billion) per year**, equivalent to **IDR 14.2 trillion (8.8–21.8 trillion)**. This substantial economic cost is driven largely by mortality, but also includes hospital-related expenditures for morbidity and productivity losses due to work absences.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis shows that aligning with the 1.5-degree pathway would avoid 5,400 cumulative deaths and reduce the national economic burden by USD 3.76 billion, equivalent to IDR 60 trillion.

To realize these benefits, the Suralaya power complex must retire **Units 1–2 in 2026, Units 5–6 in 2027, Unit 7 in 2028, and Units 3–4 and Unit 8 in 2029**, ahead of Indonesia’s emissions peak in 2035, followed by the retirement of **Units 9–10 by the end of 2040**.

Cumulative air pollution-related deaths and economic costs attributed to Banten Suralaya coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 4. Future projections of the impact of air pollution on mortality and economic costs of the Banten Suralaya PLTU complex.

b. Impact on the Surrounding Community

One of the most immediate problems experienced by communities around the Suralaya power complex is air pollution, particularly the thick dust that frequently disperses into residential areas. Analyses show that this complex is a significant contributor to transboundary air pollution from Banten to the Greater Jakarta (Jabodetabek) region.

The plant has previously been the subject of a dispute before the Central Information Commission, following a request for disclosure of emissions data from the Suralaya and Ombilin coal plants—information that PLN refused to release. Yet transparency in emissions data from these facilities is crucial for managing their impacts on public health.⁷

This power plant is included in the list of facilities implementing fuel blending, or co-firing, using approximately **30 tons of**

⁷ <https://trendasia.org/pln-tertutup-terkait-data-perizinan-dan-polusi-pltu-kesehatan-masyarakat-bergantung-pada-putusan-komisi-informasi-publik/>

solid waste per day from the Bagendeung⁸ landfill, with the total biomass requirement for Suralaya projected to reach **328,407 tons in 2024**⁹. Although the RUPTL document indicates that Units 1–4 of the Suralaya plant are planned to use rice husk biomass, the current implementation involves a different mix of feedstock.

Suralaya CFPP also plans to establish partnerships with local governments and communities to develop “energy plantations” to supply wood-based biomass from species such as *lamtoro* and *kaliandra*. However, energy plantation programs elsewhere have faced numerous issues, including the dispossession of community living spaces and the deforestation of natural forests.

Moreover, in several areas designated as sites for these energy plantations, communities

have not been meaningfully involved in the planning or implementation of the program. At the same time, the co-firing initiative functions as a maneuver to prolong the operational life of aging coal-fired units—such as those at the Suralaya plant¹⁰.

c. Impact on Local and National Economy

Instead of generating positive economic contributions, the Suralaya CFPP is recorded as producing a **negative economic output of IDR 2.55 trillion per year**. This is further reflected in a **decline in the Regional Gross Domestic Product (RGDP) of IDR 2.43 trillion per year**, indicating that the plant does not provide added value to regional economic growth. From the business perspective, the plant also shows a **negative business surplus of IDR 1.24 trillion per year**.

Operating costs	USD 16,99 million
Annual CO ₂ emissions	28,3 kiloton
Impact on annual economic output (gross domestic product)	- Rp2,55 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp2,43 trillion
Impact on annual business surplus	- Rp1,24 trillion
Impact on annual labor compensation	- Rp1,16 trillion
Impact on annual employment absorption	- 66.726 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp1,89 trillion
Sectoral impacts on health services and social activities	- Rp2,9 miliar

*negative sign (-) indicates a decrease in the indicator

⁸ <https://www.liputan6.com/regional/read/5000418/pln-gandeng-pemkot-cilegon-olah-sampah-jadi-bahan-bakar-co-firing-di-pltu-suralaya?page=3>

⁹ <https://news.detik.com/berita/d-7615277/usaha-ini-ubah-limbah-untuk-co-firing-demi-energi-bersih-pltu-di-banten>

¹⁰ <https://betahita.id/news/detail/6735/menyoal-pltu-co-firing-batu-bara-biomassa-di-indonesia.html.html>

Minimal Fiscal Contribution and Weak Employment Impact

The fiscal contribution of the Suralaya CFPP to state revenue is insufficient to offset the tax losses generated in the affected sectors. Modeling conducted by the authors shows that the plant's aggregate net tax contribution is **negative IDR 40 million per year**. The impact on employment is equally striking, with a **reduction of 66,726 jobs per year** and a **negative labor compensation effect of IDR 1.16 trillion per year**. This indicates that the presence of the Suralaya plant contributes to a decline in employment opportunities across various economic sectors, particularly agriculture and fisheries.

High Social and Environmental Costs

In addition to its direct economic impacts, the operation of the Suralaya CFPP generates

28.3 kilotons of CO₂ emissions per year, further increasing social and public health burdens and exacerbating the climate crisis. Its operating costs are also substantial, amounting to **IDR 1.7 trillion per year**.

Sectoral Impacts of the Power Plant's Operations

Beyond its negative macroeconomic effects, the Suralaya plant also inflicts economic losses on strategic sectors that support community livelihoods. The agriculture, forestry, and fisheries sector experiences a **decline in value of IDR 1.89 trillion**, reflecting disruptions to productivity and the sustainability of natural resources due to pollution and environmental degradation. Meanwhile, the health services and social activities sector incurs **losses of IDR 2.9 billion per year**, indicating rising social burdens and potential declines in service quality as a result of pollution-related health impacts.

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.892.462)
Mining and Quarrying	(20.142)
Manufacturing	(262.955)
Electricity and Gas Supply	(15.153)
Water Supply; Waste Management, Wastewater, and Recycling	(321)
Construction	(10.512)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(124.551)
Transportation and Warehousing	(41.731)
Accommodation and Food Service Activities	(3.948)
Information and Communication	(12.235)
Financial and Insurance Activities	(18.939)
Real Estate Activities	(5.863)
Business Activities	(11.425)
Public Administration, Defence, and Compulsory Social Security	(1.294)
Education Services	(556)
Human Health and Social Work Activities	(2.900)
Other Services	(7.519)
TOTAL	(2.432.506)

Tabel. Dampak Operasional PLTU Suralaya Terhadap PDB Menurut 17 SECTOR (dalam Rp million)

2

**Paiton CFPP,
East Java
(4.835 MW)**



Paiton Coal-Fired Power Complex, East Java (4,835 MW)

Paiton-1; Paiton-2; Paiton-3; PLN Paiton; PLN New Paiton

The Paiton coal-fired power plant (CFPP) is located in Binor Village, Paiton Subdistrict, Probolinggo Regency, East Java, and constitutes one of the largest CFPP complexes in Southeast Asia. Operated by a consortium that includes PT PJB, Jawa Power, and Paiton Energy, the complex consists of **eight generating units** with a total installed capacity of **4,835 MW**, supplying approximately **20–22 percent** of the electricity demand of the Java–Madura–Bali (Jamali) grid. The units were constructed in stages beginning in 1994, employing a range of technologies from older subcritical units to newer ultra-supercritical units.

As the plant ages, the operational efficiency of the Paiton CFPP has continued to decline, while its carbon emissions remain high. The combustion process at the plant generates approximately **400 tons of coal combustion waste per day**, amounting to an estimated **110,000 tons of waste annually**¹. Biomass co-firing initiatives implemented in recent years have drawn criticism from civil society groups, as they may increase pollution burdens and risk shifting environmental pressures to other sectors rather than delivering genuine emissions reductions.

Ownership and Investors

PLTU Paiton-1 Unit 7-8



Capacity
1.230 MW



Year of Financing
2017



Lenders
Barclays, Citibank, DBS Bank, HSBC, Mizuho Financial Group, Shinsei Bank, Standard Chartered Bank, Sumitomo Mitsui Banking Corporation



Total Loans
USD 1.378.385.000



Lender Countries
Inggris, Australia, Prancis, Amerika Serikat, Singapura, Belanda, Jepang



Type of Financing
Loans and Bonds

Source: Global Energy Monitor (GEM)

PLTU Paiton-3



Capacity
825 MW



Lender Countries
Inggris, Australia, Prancis, Amerika Serikat, Singapura, Belanda, Jepang



Total Loans
USD 2.897.365.000



Lenders
Barclays, BHP Billiton, BNP Paribas, Citibank, Credit Agricole Group, DBS Bank, HSBC, ING Group, International Power, Japan Bank for International Cooperation, Mitsui & Co., Mizuho Financial Group, MUFG Bank

Source: Global Energy Monitor (GEM)

1 <https://projectmultatuli.org/kisah-orang-orang-desa-bhinor-menanggung-nestapa-akibat-pltu-paiton/>

PLTU Paiton-1 Unit 9



Capacity
660 MW



Type of Financing
Loan



Total Loan
USD 330.825.515



Year of Financing
2008



Lender
Export-Import Bank of China



Lender Country
China

Sumber: GEM

PLTU Paiton PLN Baru Unit 9



Capacity
660 MW



Type of Financing
Buyer's Credit Loan



Lender Country
China



Total Loan
USD 330.825.515



Year of Financing
2008



Lender
China Eximbank



Loan Tenor
15 years (with a 3-year grace period)

Sources: Global Energy Monitor (GEM)² Website, China AidData³

General Info

Commercial Operation Date (COD) and Power Generation Capacity

PLN Paiton Unit 2 - 1993: 400 MW
 PLN Paiton Unit 1 - 1994: 400 MW
 Paiton-1 Unit 7 - 1999 : 615 MW
 Paiton-1 Unit 8 - 1999 : 615 MW
 Paiton-2 Unit 1 - 2000: 660 MW
 Paiton-2 Unit 2 - 2000: 660 MW
 PLN Paiton Baru Unit 09 - 2012: 660 MW
 Paiton-3 - 2012: 825 MW

Combustion Technology

Subcritical, except for Paiton-3, supercritical

National Targets

Biomass co-firing implemented for **Paiton-1 and Paiton 2, and PLN Paiton**, use of 5% sawdust

Types of Coal and Their Sources

Paiton-1 & Paiton 2 - Coal: Subbituminous, bioenergy: wood & other biomass (solids), bioenergy: refuse (municipal and industrial wastes) [5%]
PLN Paiton - Coal: subbituminous, bioenergy: wood & other biomass (solids) [5%]
PLN Paiton Baru - Coal: subbituminous
Paiton-3 - Coal: subbituminous

² https://www.gem.wiki/PLN_Paiton_Baru_power_station

³ <https://china.aiddata.org/projects/38604/>

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases. In terms of air pollution-related mortality, the operation of the Paiton coal-fired power plant complex is associated with an estimated **612 total deaths per year**

among the adult population, as well as **two deaths annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.

Annual mean PM_{2.5} concentration from Paiton

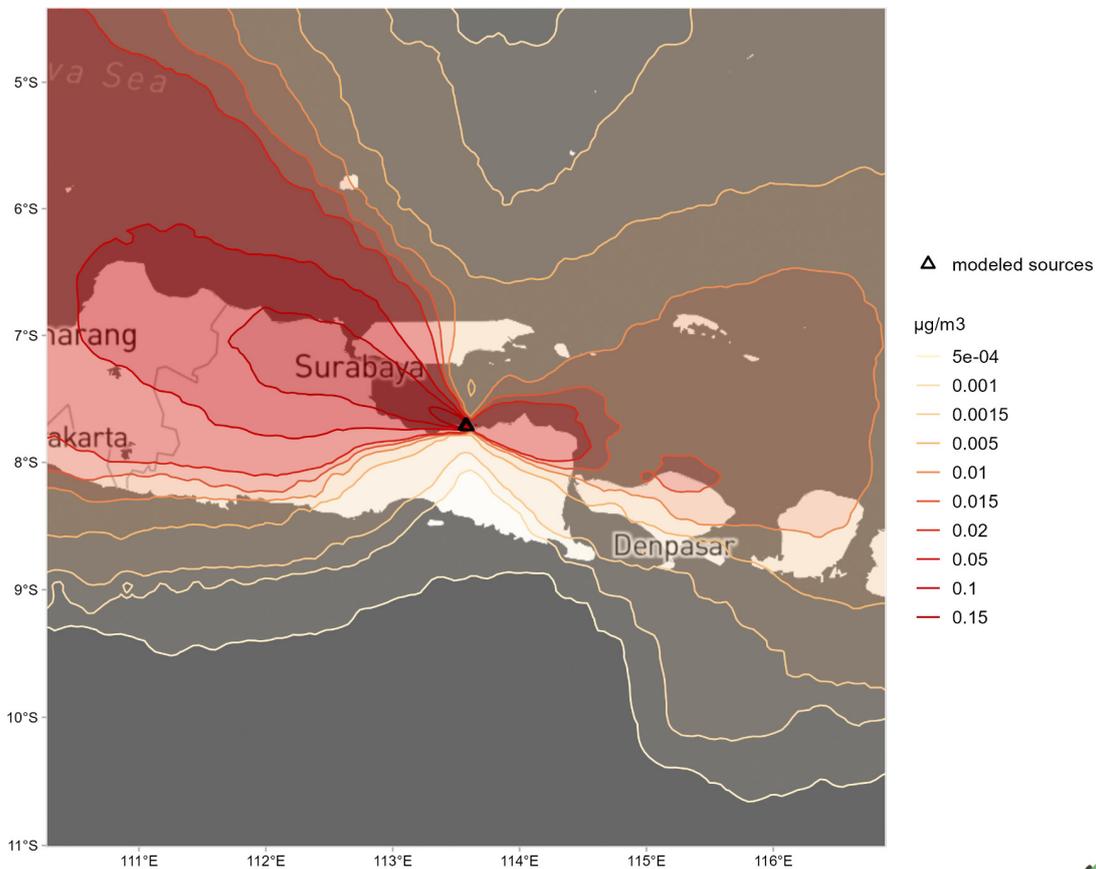


Figure 1. Annual average dispersion of PM_{2.5} from the Paiton Coal Power Plant Complex

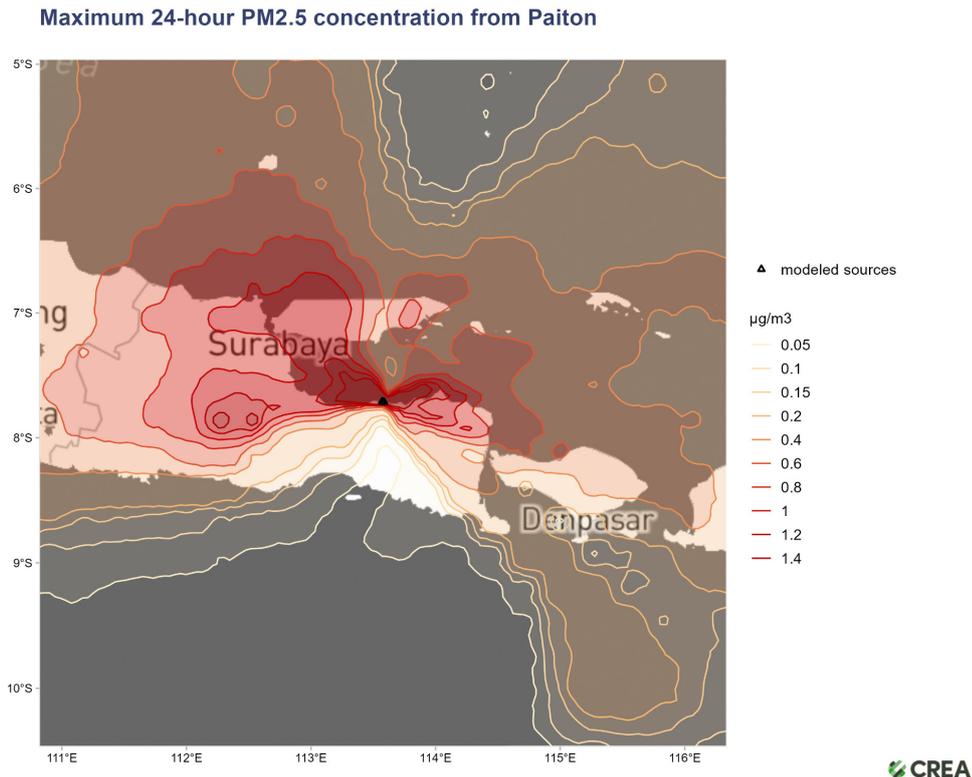


Figure 2. Maximum 24-hour PM2.5 concentration from the Paiton Coal Power Plant Complex

In terms of morbidity, air pollutant emissions from the Paiton CFPP complex lead to increased risks and incidences of respiratory diseases,

including **412 (247–576) asthma-related emergency room visits** and **3,662 (978–7,434) new asthma cases**. Adverse impacts on children and unborn infants include **200 (97–213) preterm births** and **134 (42–232) cases of low birth weight**. In addition, pollution-related illness and disability result in productivity losses of **180,000 (153,000–206,000) lost workdays per year**, directly affecting economic activity.

The economic burden on Indonesia arising from health impacts associated with air pollution from the Paiton CFPP amounts to

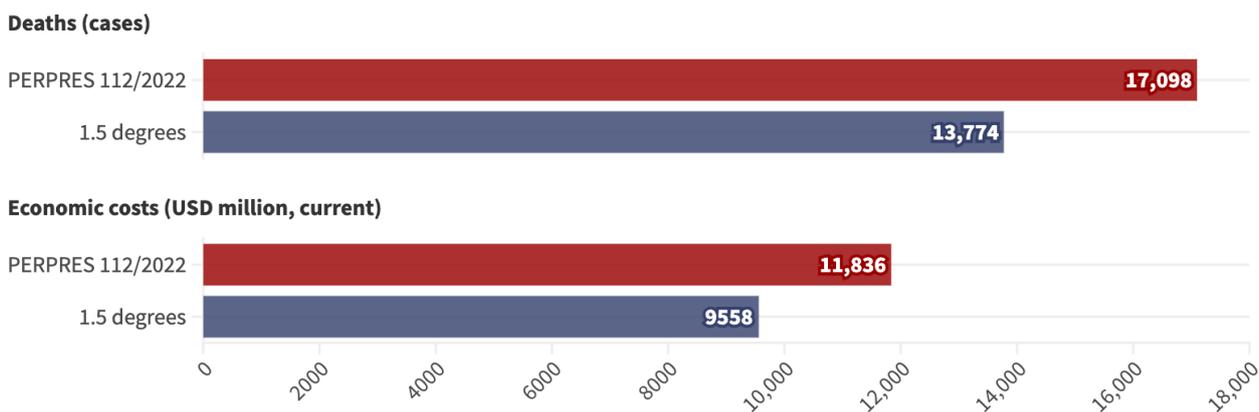
USD 408 million per year, equivalent to **IDR 6.22 trillion**. This substantial economic cost is driven primarily by premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 3,324 cumulative deaths and reduce the national economic burden by USD 2.28 billion, equivalent to IDR 36 trillion.

To realize these benefits, the Paiton CFPP complex must retire **PLN Paiton Unit 2 in 2026, PLN Paiton Baru Unit 09 in 2028, Paiton-1 Units 7 and 8 in 2030, PLN Paiton**

Unit 1 and Paiton-2 Unit 1 in 2034, and Paiton-3 and Paiton-2 Unit 2 in 2035, prior to Indonesia's emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Paiton coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of air pollution impacts on mortality and economic costs from the Paiton Coal Power Plant Complex

b. Impact on Surrounding Community

Binor Village, Probolinggo Regency, East Java, is the site of the Paiton coal-fired power plant, which has a total capacity of approximately **4,600 MW** and occupies an area of **400 hectares**.⁴ The construction and operation of the plant have resulted in the loss of livelihoods for local communities, many of whom were previously engaged as seaweed farmers, hook-and-line and net fishers, and small-scale farmers.

Fishing communities in Binor Village have increasingly struggled to secure adequate catches, as most local fishing vessels are small—typically **2–3 gross tons (GT)**, locally known as *jukung*—while fish stocks now

require traveling farther offshore. According to community accounts, prior to the establishment of the power plant, coral reef conditions were relatively healthy and fish catches were abundant, particularly reef fish and skipjack tuna.

Farmers, especially those reliant on tobacco and coconut cultivation, have experienced similar impacts, with declining yields and product quality reportedly linked to airborne ash and dust from coal combustion. In addition, the presence of the power plant is suspected to be a contributing factor to the degradation of ecosystems and the loss of habitat for several bird species, including the **Javan white-eye (*Zosterops flavus*)**, the **Javan coucal (*Centropus nigrorufus*)**, and the **Java sparrow (*Padda oryzivora*)**.

⁴ <https://www.tempo.co/ekonomi/mengenal-pltu-paiton-salah-satu-pembangkit-listrik-terbesar-di-indonesia-134731>

As traditional livelihoods declined, some community members have shifted to alternative sources of income, including small-scale livestock farming, renting out their boats for transportation and logistics services for coal barges, operating small roadside shops, or seeking work outside the region. Among those employed at the power plant, most are hired as **daily laborers or on fixed-term contracts (PKWT)**, with employment rotated among villages under short contracts of **three to six months** and wages **below the regional minimum wage**.

The land acquisition process for the power plant was reportedly carried out through intimidation and repression involving the military under the former regime, with landowners who refused to relinquish their land subjected to negative stigmatization. Another significant impact of the plant's operation is the deterioration of public health. Community monitoring indicates that approximately **100 residents suffer from acute respiratory infections (ARI/ISPA)** each year and frequently report persistent coughing. Even plant workers themselves experience shortness of breath due to continuous exposure to smoke and black dust emitted by the facility.

Since 2022, the Paiton plant has implemented a **co-firing program**, with biomass accounting for **6 percent** of the fuel mix and a stated target of increasing this share to **30 percent**⁵. The program is applied to Units **1, 2, and 9**, with a target capacity of **800 MW**, using **sawdust** supplied by wood-processing industries in Probolinggo and surrounding areas, including Situbondo, Lumajang, Pasuruan, and Gresik. One supplier, **PT Raja Muda Gemilang** from Situbondo, is alleged to have engaged in fraudulent practices by spraying water onto sawdust⁶ while it was still

on transport trucks prior to delivery to the Paiton plant, in order to artificially increase its weight. This practice highlights weak oversight within the biomass supply chain.

Amid these **false claims of a “green” solution**, **Perhutani** has signed a cooperation agreement with **PLN** to supply biomass—particularly in the form of wood pellets—through the development of **Energy Plantation Forests (Hutan Tanaman Energi/HTE)**. Furthermore, **PT Paiton Energy** and Perhutani have initiated collaboration with **Social Forestry Business Groups (Kelompok Usaha Perhutanan Sosial/KUPS)** in Probolinggo under a **Corporate Social Responsibility (CSR)** scheme to develop **750 hectares** of HTE in the regency⁷. In practice, however, biomass supply remains dominated by waste from the wood-processing industry, while the HTE program risks expanding pressure on community living spaces and forest lands. Co-firing at the Paiton plant thus functions as a form of **greenwashing**, prolonging the lifespan of coal-fired power generation and diverting attention away from a genuine energy transition.

c. Impact on Local and National Economy

With an annual decline in economic output of **IDR 14.86 trillion** and the loss of approximately **410,668 jobs per year**, the plant's continued operation reflects a tangible economic burden resulting from pollution and dependence on fossil fuels. These figures indicate that the operational activities of the Suralaya CFPP not only suppress national productivity but also exacerbate welfare inequalities in surrounding communities.

⁵ <https://web.pln.co.id/cms/media/siaran-pers/2022/07/pltu-paiton-sukses-terapkan-co-firing-6-persen-pln-siapkan-untuk-showcase-ktt-g20/>

⁶ Walhi Jatim & Trend Asia, 2025, Co-firing Biomassa di PLTU Paiton (Solusi Palsu Mengatasi Krisis Iklim).

⁷ Ibid.,

Table 1: Economic impacts of the operation of the Suralaya Coal-Fired Power Plant on the local economy

Operating costs	USD 12.77 million
Annual CO ₂ production	23.53 kilotons
Impact on annual economic output (gross domestic product)	- IDR 14.86 trillion
Impact on annual regional gross domestic product (GRDP)	- IDR 14.75 trillion
Impact on annual business surplus	- IDR 7.37 trillion
Impact on annual labor compensation	- IDR 6.90 trillion
Impact on annual employment absorption	- 410,668 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR 10.54 trillion
Sectoral impacts on health services and social activities	- IDR 18.6 billion

*The negative sign (–) indicates a decline in the indicator.

Negative Economic Contribution to the National Economy

Similar to the Suralaya CFPP, rather than generating positive contributions, the operation of the Paiton coal-fired power plant imposes substantial pressure on the national economy. Recorded losses in economic output attributable to the plant are significant, and this decline is also reflected in a reduction of **Regional Gross Domestic Product (RGDP) of up to IDR 14.75 trillion per year**. Combined with very high operating costs—amounting to **IDR 1.7 trillion** and **IDR 1.3 trillion per year**—the Paiton CFPP represents a fiscal burden disproportionate to its contribution to national economic growth.

Business Sector and Employment Losses

The impacts of Paiton’s operations are also strongly felt in the business and labor sectors. Business surplus declines substantially

by **IDR 7.37 trillion per year**, while labor compensation decreases by **IDR 6.9 trillion per year**. In addition, employment absorption is severely affected, with an estimated loss of **410,668 potential jobs per year**.

Rising Social and Environmental Burdens

From an environmental perspective, the Paiton CFPP generates **23.53 kilotons of CO₂ emissions per year**, a very high level that directly contributes to the climate crisis and public health burdens. These social costs are further compounded by sectoral losses in **agriculture, forestry, and fisheries amounting to IDR 10.54 trillion per year**. Meanwhile, the **health services and social activities sector** incurs losses of **IDR 18.6 billion**, reflecting increasing burdens arising from the environmental and health impacts of the plant’s operations.

Table 2: Impacts on GDP by 17 Sectors (in million IDR)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(10.536.854)
Mining and Quarrying	(210.251)
Manufacturing	(1.920.728)
Electricity and Gas Supply	(198.332)
Water Supply; Waste Management, Wastewater, and Recycling	(3.081)
Construction	(44.002)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(750.898)
Transportation and Warehousing	(386.760)
Accommodation and Food Service Activities	(51.696)
Information and Communication	(102.853)
Financial and Insurance Activities	(242.495)
Real Estate Activities	(63.130)
Business Activities	(139.600)
Public Administration, Defence, and Compulsory Social Security	(9.509)
Education Services	(4.441)
Human Health and Social Work Activities	(18.608)
Other Services	(70.738)
TOTAL	(14.753.976)

3

Cirebon CFPP Units 1 and 2, West Java (1,584 MW)



Cirebon Coal-Fired Power Plant Units 1 and 2, West Java (1,584 MW)

Cirebon-1 and Cirebon-2, West Java

The Cirebon coal-fired power plant consists of two generating units: Cirebon CFPP Unit 1, with a capacity of 660 MW, which began operations in 2012, and Cirebon CFPP Unit 2, with a capacity of 924 MW, which officially commenced operations in May 2023. Both plants are located in Cirebon Regency, West Java, and make a substantial contribution to electricity supply within the Java–Bali power system.

Within the framework of the Just Energy Transition Partnership (JETP), the early retirement of Cirebon CFPP Unit 1 (660 MW) was announced by the Minister of Energy and Mineral Resources on 3 February 2025. Under this plan, the plant is to be retired in

2035, seven years earlier than its originally scheduled retirement in 2042. However, no concrete follow-up actions have been taken to date. In contrast, Cirebon CFPP Unit 2 has only recently begun operations and is contractually scheduled to operate until 2047.

Although the Cirebon CFPP supplies a large volume of electricity, its environmental impacts are also significant. Local communities have reported health disturbances resulting from exposure to coal ash and air pollution emitted by the plant. Studies indicate that the early retirement of Cirebon CFPP Unit 1 could prevent approximately 6,400 premature deaths attributable to air pollution.¹

Ownership and Investors

Cirebon Coal-Fired Power Plant (PLTU Cirebon) Unit 1

 Capacity 660 MW	 Year of financing 2010	 Lender countries South Korea, Japan, Turkey, the Netherlands, and Indonesia
 Total loan USD 850.010.000	 Lenders Asian Development Bank, Korea Export-Import Bank, ING Group, Japan Bank for International Cooperation, KEPCO, Marubeni, Mizuho Financial Group, MUFG Bank, PT Tripatra Engineers & Constructors, ST International, and Sumitomo Mitsui Banking Corporation	
 Type of financing Loans and equity		

Cirebon Coal-Fired Power Plant (PLTU Cirebon) Unit 2 (new)

 Capacity 924 MW	 Year of financing 2017	 Lender countries South Korea, Japan, Turkey, the Netherlands, and Indonesia
 Total loan USD 2.138.600.000	 Lenders KEPCO, Chubu Electric Power, Marubeni, PT Imeco Inter Sarana, PT Indika Energy Tbk, Sabancı Holding, Tokyo Electric Power Company (TEPCO), Export-Import Bank of Korea, Japan Bank for International Cooperation, ING Group, Mizuho Bank, MUFG Bank, and Sumitomo Mitsui Banking Corporation	
 Type of financing Loans and equity		

¹ <https://energyandcleanair.org/publication/health-and-economic-benefits-from-early-phase-out-of-indonesias-first-jetp-coal/>

General information

COD & power generation capacity	Cirebon-1 - 2012: 660 MW Cirebon-2 - 2023: 924 MW
Combustion technology	Unit 1, supercritical; Unit 2, ultra-supercritical
National target	Cirebon-1, pilot project for IPP-owned early retirement under Just Energy Transition Partnership, Asian Development Bank's Energy Transition Mechanism (JETP ADB ETM), to be retired in 2035 (23 year of operation)
Types of coal and their sources	Coal: unknown

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases. In terms of air pollution-related mortality, the operation of **Cirebon Units 1 and 2 (hereafter referred to as the Cirebon CFPP)** is associated with an estimated

1,109 total deaths per year among the adult population, as well as **four deaths annually among children under the age of five.**

These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.

Annual mean PM_{2.5} concentration from Cirebon

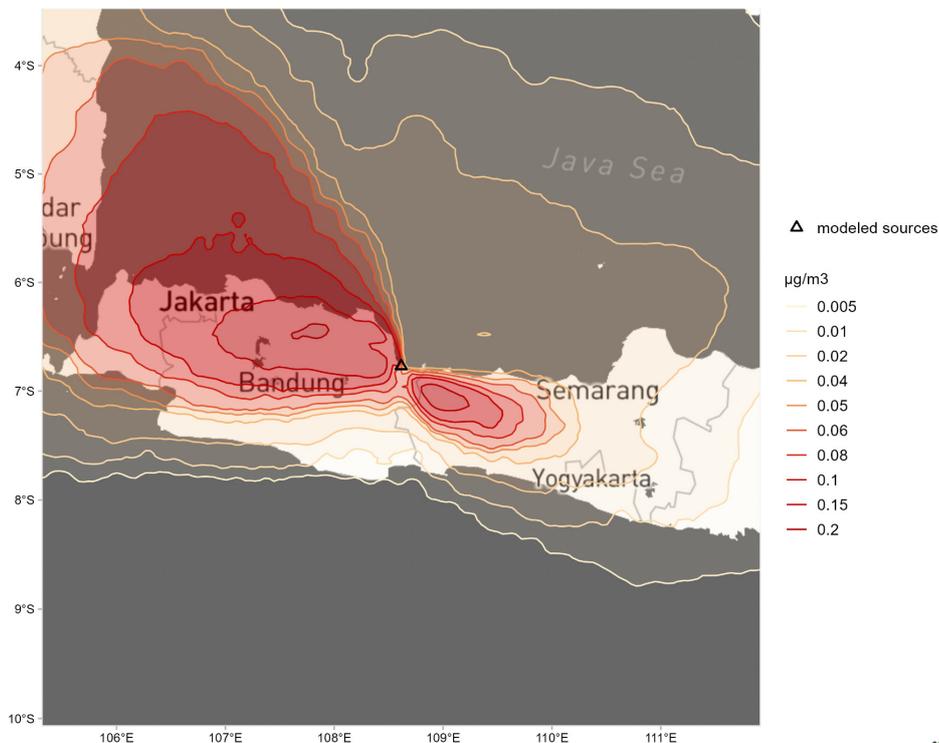


Figure 1. Annual average distribution of PM_{2.5} from the Cirebon PLTU

Annual mean PM2.5 concentration

before and after commissioning of Cirebon 2 and retirement of Cirebon 1

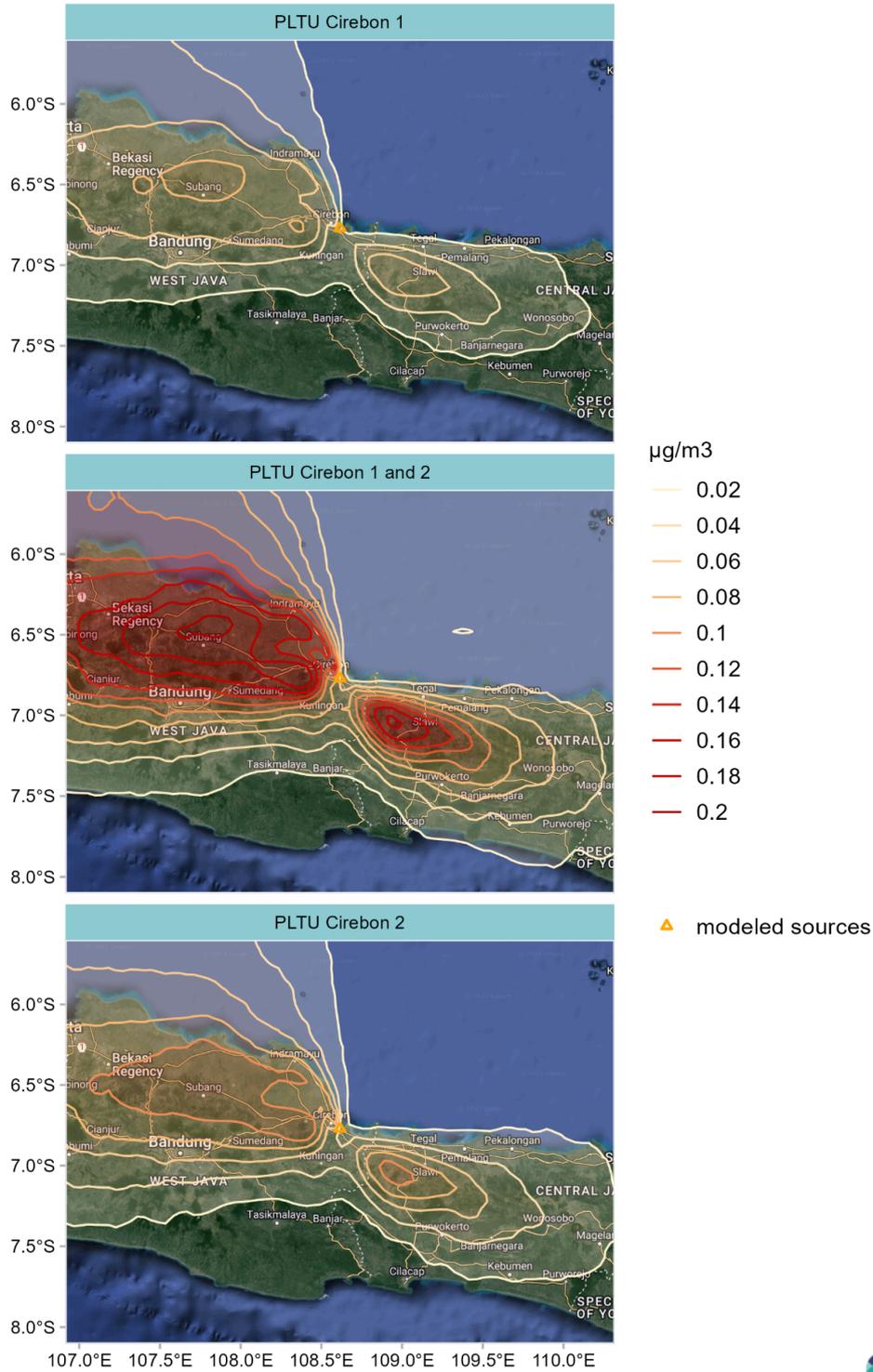
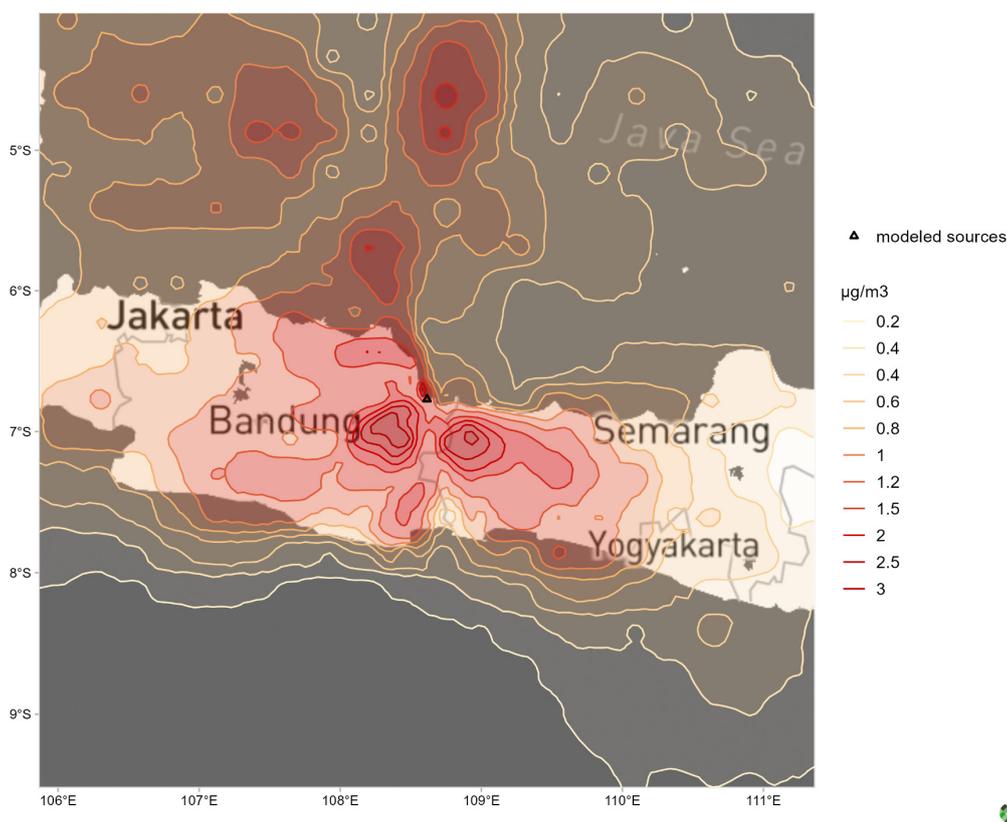


Figure 2. Average annual distribution of PM2.5 from the Cirebon PLTU, taking into account the planned early retirement of Cirebon-1 in 2035



Maximum 24-hour PM2.5 concentration from Cirebon



CREA

Figure 3. Maximum 24-hour PM2.5 concentration from Cirebon PLTU

In terms of morbidity, air pollutant emissions from the Cirebon CFPP lead to increased risks and incidences of respiratory diseases,

including **1,075 asthma-related emergency room visits** and **3,503 (936–7,112) new asthma cases²**. Adverse impacts on children and unborn infants include **528 (256–560) preterm births** and **346 (108–599) cases of low birth weight**. In addition, pollution-related illness and disability result in productivity losses of **463,000 (394,000–531,000) lost workdays per year**, directly affecting economic activity.

The economic burden on Indonesia arising from health impacts associated with air pollution from the Cirebon CFPP amounts to **USD 737 million per year**, equivalent to **IDR 11.2 trillion**. This substantial economic cost is driven primarily by

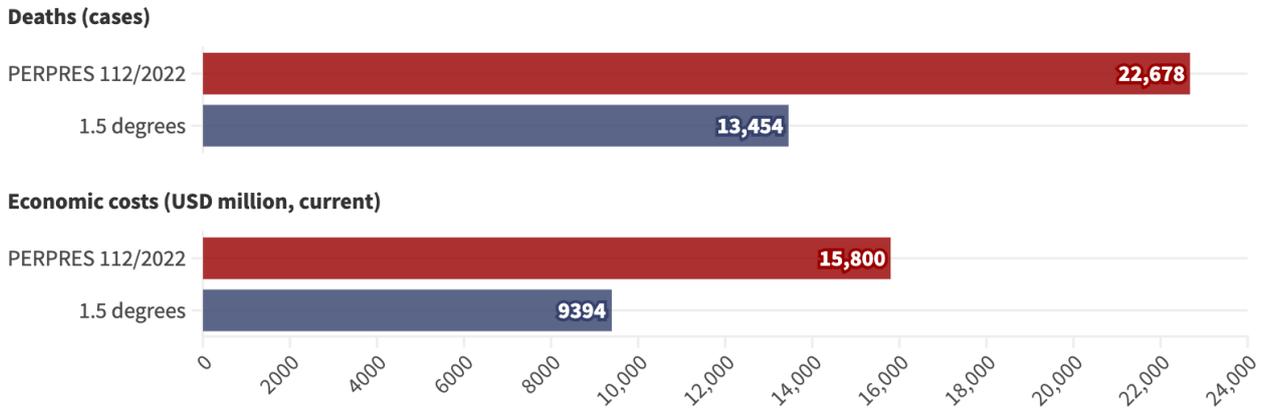
premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 9,224 cumulative deaths and reduce the national economic burden by USD 6.41 billion, equivalent to IDR 101 trillion.

To realize these benefits, the Cirebon power complex must retire **Cirebon Units 1 and 2 by 2031**, prior to Indonesia’s emissions peak in 2035.

2 A range of 645–1,500 asthma emergency room visits

Cumulative air pollution-related deaths and economic costs attributed to Cirebon coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 4. Future projections of the impact of air pollution on mortality and economic costs from the Cirebon Coal-Fired Power Plant

b. Impact on Surrounding Community

This power plant is privately owned and operated as an **Independent Power Producer (IPP)**.³ Since its establishment, the plant has posed serious threats to the livelihoods of surrounding communities, ranging from problematic land acquisition processes and public health impacts to environmental degradation, job losses, and household indebtedness.

The land acquisition process was conducted in a highly problematic manner. Local residents reported being intimidated and manipulated into selling their land without meaningful price negotiations. Although the purchase prices offered by the project developer were relatively high in nominal terms, community members argued that these amounts were not commensurate with the long-term income they had previously generated from managing and cultivating

their land, which had provided more sustainable and substantial livelihoods.

One resident, referred to here as **Mr. S**, recounted that since the construction of the power plant, ambient temperatures have felt significantly hotter—particularly during the windy and dry seasons—and residents have experienced skin irritation, fever, and respiratory problems. Interviews conducted by the **Independen.id** team indicate that **80 percent of residents in Waruduwur Village** have suffered from **acute respiratory infections (ARI/ISPA)**, with children and infants being the most affected. As a result of these conditions, **two toddlers were reportedly deceased**, following symptoms of severe shortness of breath. Health center (puskesmas) data further show that between **2019 and 2022**, there were **3,562 cases of ARI** and **10,698 cases of acute nasopharyngitis**, underscoring the severity of the public health burden associated with the plant's operation.⁴

³ https://www.gem.wiki/Cirebon_power_station

⁴ <https://independen.id/read/khusus/1322/pltu-1-dan-2-cirebon-timbulkan-dampak-kesehatan-maupun-lingkungan/>

The operation of the coal-fired power plant has resulted in the loss of multiple local livelihoods, including the disappearance of community-owned aquaculture activities such as salt ponds, shrimp ponds, fish ponds, and green mussel cultivation areas at sea, which have been converted into jetties and port infrastructure for the power plant. Residents of **Waruduwur** and **Citemu** villages—where the majority of households rely on capture fisheries, particularly commodities such as blue swimming crab (*Portunus pelagicus*)—have been among those most severely affected by the impacts of the plant’s development.

Coastal women have experienced similar losses. Their livelihoods in nearshore and shallow coastal areas—such as collecting various types of shellfish and shrimp—have disappeared following the construction of the power plant and the discharge of liquid waste, which has led to declining shellfish populations and increasing scarcity. Fisherfolk have also reported growing difficulties in catching fish species such as *ukon*, *embet*, *ingser*, *rebon*, other small pelagic fish, and blue swimming crab.

Local residents were at one point promised employment opportunities at the power plant; however, most were unable to meet the required skill qualifications, as the majority had backgrounds as fishers. Some were employed only during the construction phase, primarily as security guards or construction workers under short-term contracts and outsourcing arrangements. The power plant allocated approximately **100 jobs** across the affected villages—**Mundu, Citemu, Waruduwur, Kanci Wetan, and Kanci Kulon**—during this phase. Many residents were also reluctant to take up project-based employment, citing a mismatch with their skills, the perception

that marine-based livelihoods offered more reliable income, and a lack of transparency in recruitment processes.

The loss of primary livelihoods, combined with limited access to employment at the power plant due to unmet qualifications, has forced many households into debt. Borrowing has been used to finance longer fishing trips farther offshore, meet daily household needs, secure work on larger fishing vessels outside the region, or even cover the costs of migration abroad. For women who no longer had viable livelihood options locally, many ultimately chose to leave their villages to work as crab meat peelers or as migrant workers overseas.

Historically, much of the coastal area where the power plant is located was covered by **mangrove forests**. Since the plant was constructed on former mangrove land, tidal flooding (*rob*) has intensified and expanded into community aquaculture ponds and agricultural fields, resulting in repeated crop failures. Beyond this, the loss of mangrove ecosystems has eliminated natural wave barriers and critical fish nursery habitats, further undermining coastal resilience and local fisheries.

c. Impact on Local and National Economy

The operation of the Cirebon CFPP results in tangible economic losses, most notably reflected in an annual decline in economic output of **IDR 1.28 trillion** and the loss of approximately **27,447 jobs per year**. Despite operating costs amounting to **USD 140.9 million**, the negative impacts on productivity and the welfare of communities surrounding the plant far outweigh its economic contributions.

Operating costs	USD 140,9 million
Annual CO ₂ emissions	2,87 kiloton
Impact on annual economic output (gross domestic product)	- Rp1,28 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp1,30 trillion
Impact on annual business surplus	- Rp0,61 trillion
Impact on annual labor compensation	- Rp0,66 trillion
Impact on annual employment absorption	- 27.447 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp0,94 trillion
Sectoral impacts on health services and social activities	- Rp2,29 miliar

*negative sign (-) indicates a decrease in the indicator

Minimal Economic Contribution Carbon Emissions and Social Burdens

The operation of **Cirebon CFPP Units 1 and 2** entails exceptionally high operating costs, amounting to **IDR 14.09 trillion per year**. However, rather than generating added value for economic growth, the presence of the plant has resulted in a **decline in Regional Gross Domestic Product (RGDP) of IDR 1.30 trillion per year**. This indicates that the Cirebon CFPP is not only economically inefficient but also constitutes a burden that erodes the region's growth potential.

Business Sector and Employment Losses

The impacts on the business sector and employment are equally pronounced. Annual business surplus losses reach **IDR 0.61 trillion**, accompanied by a **decline in labor compensation of IDR 0.66 trillion**. In addition, the Cirebon CFPP leads to a reduction in potential employment absorption of approximately **27,447 jobs per year**. Workers in the **fisheries and food crop sectors** are the most adversely affected by the plant's operations.

From an environmental perspective, **Cirebon CFPP Units 1 and 2** contribute **2.87 kilotons of CO₂ emissions annually**, exacerbating the climate crisis and increasing social burdens, particularly with respect to public health. This is reflected in losses within the **health services and social activities sector**, which amount to **IDR 2.29 billion per year**. These figures demonstrate that air pollution and waste generated by the plant have direct impacts on the quality of life of surrounding communities, especially vulnerable groups such as children and the elderly.

Beyond macroeconomic losses, the Cirebon CFPP also inflicts negative impacts on strategic livelihood-supporting sectors, including **agriculture, forestry, and fisheries**. Losses in these sectors reach **IDR 0.94 trillion per year**, indicating serious disruptions to local ecosystems caused by air pollution, water contamination, and declining land productivity.

Impact on GDP by 17 Sectors in IDR Million

SECTORS	RESULTS
Agriculture, Forestry, and Fisheries	(942.390)
Mining and Quarrying	(14.717)
Manufacturing	(162.202)
Electricity and Gas Supply	(10.693)
Water Supply; Waste Management, Wastewater, and Recycling	(1.281)
Construction	(16.515)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(66.157)
Transportation and Warehousing	(25.047)
Accommodation and Food Service Activities	(2.224)
Information and Communication	(9.436)
Financial and Insurance Activities	(17.864)
Real Estate Activities	(3.332)
Business Activities	(12.480)
Public Administration, Defence, and Compulsory Social Security	(584)
Education Services	(964)
Human Health and Social Work Activities	(2.296)
Other Services	(7.677)
TOTAL	(1.295.859)



4

**Tanjung Jati B CFPP,
Central Java
(4640 MW)**



Tanjung Jati B Coal-Fired Power Plant, Central Java (4,640 MW)

https://www.gem.wiki/Tanjung_Jati_B_power_station

The Tanjung Jati B coal-fired power plant (CFPP) is a large-scale coal-based power complex with an installed capacity of 4 × 660 MW (Units 1–4) and 2 × 1,000 MW (Units 5 and 6), resulting in a total capacity of 4,640 MW. Located in Jepara, Central Java, the plant has been operating in two phases since 2006–2012. It is one of the largest electricity suppliers to the Java–Bali power system, providing approximately 12–15 percent of the region’s electricity demand. During its operation, the plant consumes up to 24,000 tons of coal per day.¹

In 2022, Units 5 and 6 commenced operations in close proximity to the four existing units. These new units are projected to supply

electricity to PLN for 25 years from the start of operation. The project is estimated to have required an investment of up to USD 4.2 billion.²

In November 2022, Sumitomo announced plans to retire its four units at the Tanjung Jati B complex and shift its focus toward the development of the Kayan hydropower project.³ However, to date, this plan has not been implemented. This was followed by the government’s postponement of the early retirement of the Tanjung Jati B CFPP, citing concerns over potential electricity supply shortages and the lack of readiness of replacement renewable energy infrastructure.

Ownership and Investors

Tanjung Jati B Coal-Fired Power Plant (PLTU Tanjung Jati B) Units 1–2

 Capacity
2x661 MW

 Total loan
Data not publicly available

Tanjung Jati B Coal-Fired Power Plant (PLTU Tanjung Jati B) Units 3–4

 Capacity
2x660 MW

 Year of financing
2003

 Lender countries
Japan, Singapore

 Total loan
USD 1.5 billion

 Type of financing
Loans

 Lenders
Japan Bank for International Cooperation, Sumitomo Mitsui Banking Corporation, BNP Paribas, MUFG Bank, Shinsei Bank, ING Group, Deutsche Bank, Société Générale, Mizuho Financial Group, HSBC, Mitsubishi UFJ Financial Group, WestLB, and Standard Chartered Bank

Source: GEM Website, GEM Database

1 <https://globalenergi.co/2022/11/25/sumitomo-lepas-aset-pltu-tanjung-jati-b/>

2 [https://www.cnbcindonesia.com/news/2022111080712-4-386933/ini-taipan-pemilik-2-pltu-raksasa-yang-diam-diam-beroperasi#:~:text=Sementara%20PLTU%20Jawa%204%20Tanjung,.%20Inc.%20\(25%25\).](https://www.cnbcindonesia.com/news/2022111080712-4-386933/ini-taipan-pemilik-2-pltu-raksasa-yang-diam-diam-beroperasi#:~:text=Sementara%20PLTU%20Jawa%204%20Tanjung,.%20Inc.%20(25%25).)

3 <https://www.cnbcindonesia.com/news/20221124164325-4-390977/sumitomo-lepas-aset-pltu-tanjung-jati-b-bakal-pensiun-dini>

Tanjung Jati B Coal-Fired Power Plant (PLTU Tanjung Jati B) Units 5–6



Capacity
2x1000 MW



Year of financing
2017



Total loan
USD 4.194.030.000



Lender countries
apan, Singapore, Indonesia



Type of financing
USD3,355 million in loans and USD838.81 million in equity



Lenders
Japan Bank for International Cooperation, Kansai Electric Power, Mitsubishi UFJ Financial Group, Mizuho Bank, MUFG Bank, Norinchukin Bank, Oversea Chinese Banking Corporation (OCBC), PT United Tractors, Sumitomo Corporation, Sumitomo Mitsui Banking Corporation, Sumitomo Mitsui Trust Holdings

Source: GEM Website, GEM Database

General information

COD & power generation capacity	Unit 1 - 2006: 660 MW Unit 2 - 2006: 660 MW Unit 3 - 2011: 660 MW Unit 4 - 2012: 660 MW Unit 5 - 2022: 1000 MW Unit 6 - 2022: 1000 MW
Combustion technology	Unit 1-4, subkritis; Unit 5-6, ultra-superkritis
National target	Biomass co-firing testing in Unit 1-4, use of sawdust in 2021, but not implemented yet⁴ due to feedstock issue
Types of coal and their sources	Unit 1-4 - Coal: bituminous Unit 5-6 - Coal: subbituminous

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution-related mortality, the operation of the **Tanjung Jati B coal-fired**

power plant is associated with an estimated **470 total deaths per year** among the adult population, as well as **two deaths annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.

⁴ <https://katadata.co.id/ekonomi-hijau/energi-baru/62c2c8261844c/tak-terapkan-co-firing-pltu-tanjung-jati-terkendala-masalah-teknologi>

Annual mean PM2.5 concentration from Tanjung Jati B

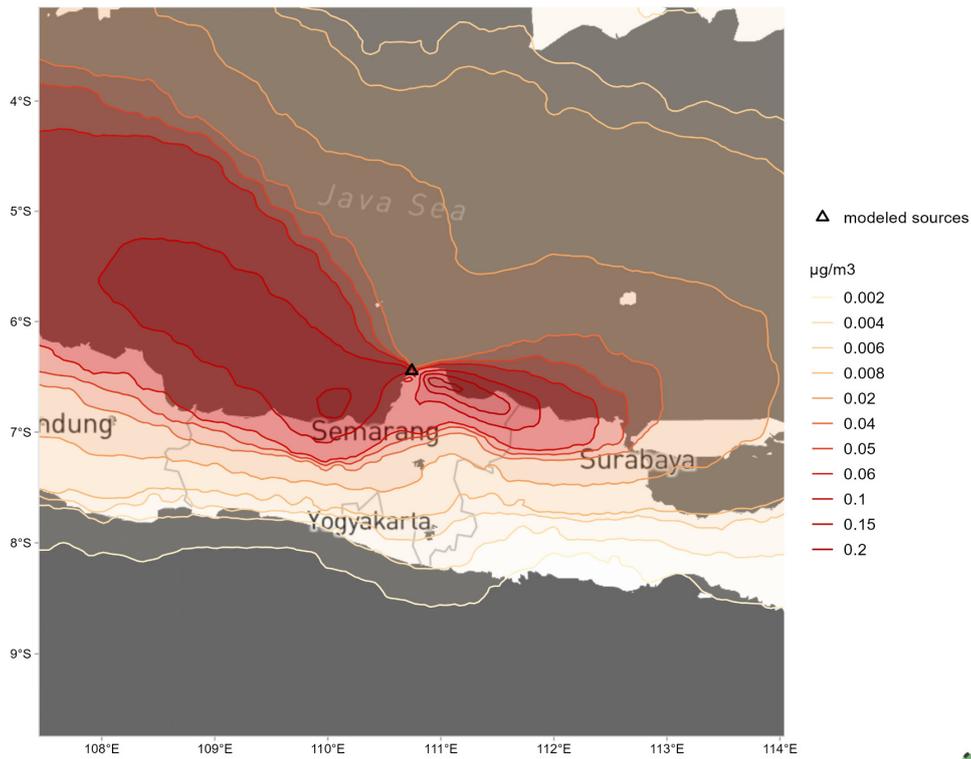


Figure 1. Annual average dispersion of PM2.5 from Tanjung Jati B

Maximum 24-hour PM2.5 concentration from Tanjung Jati B

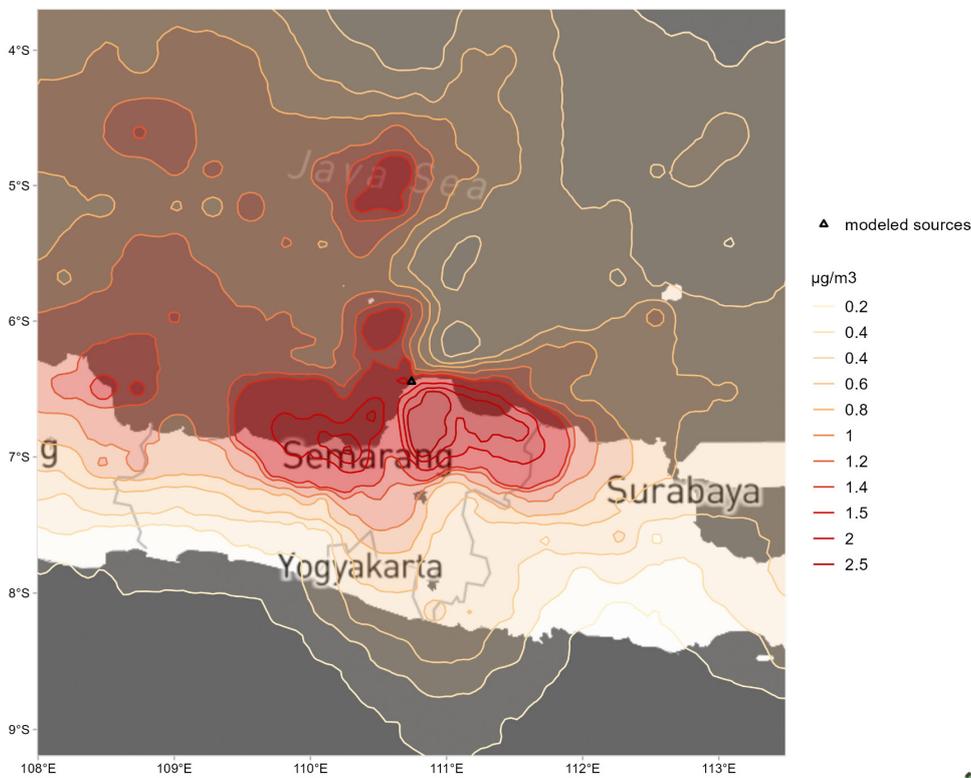


Figure 2. Maximum 24-hour PM2.5 concentration from Tanjung Jati B

In terms of morbidity, air pollutant emissions from the **Tanjung Jati B coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **543 (326–758) asthma-related emergency room visits** and **1,253 (335–2,545) new asthma cases**. Adverse impacts on children and unborn infants include **266 (129–282) preterm births** and **176 (55–304) cases of low birth weight**. In addition, pollution-related illness and disability result in productivity losses of **235,000 (200,000–270,000) lost workdays per year**, directly affecting economic activity.

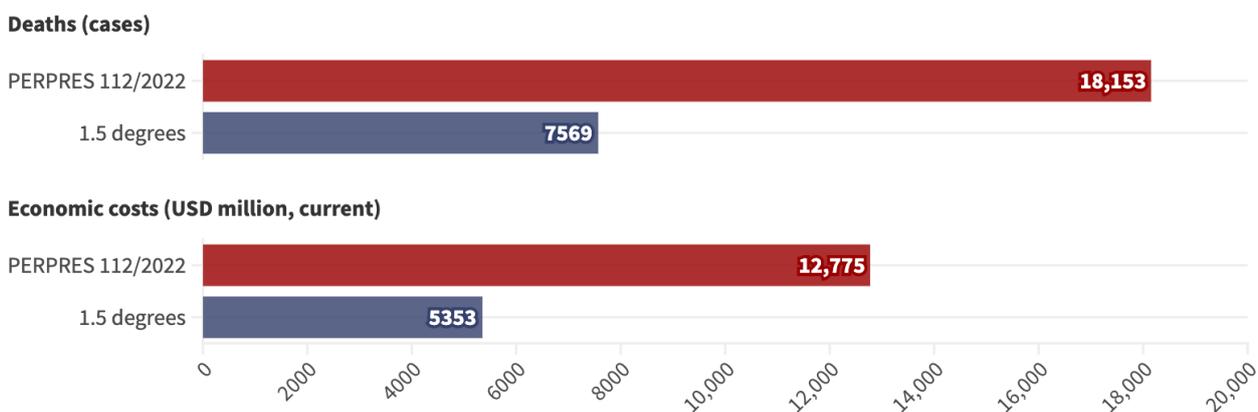
The economic burden on Indonesia arising from health impacts associated with air pollution from the Tanjung Jati B CFPP amounts to **USD 314 million per year**, equivalent to **IDR 4.8 trillion**. This substantial economic cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 10,584 cumulative deaths and reduce the national economic burden by USD 7.42 billion, equivalent to IDR 118 trillion.

To realize these benefits, the Tanjung Jati B power complex must retire **Units 1–2 in 2037** and **Units 3–4 in 2039**, prior to Indonesia's emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Tanjung Jati B coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs in Tanjung Jati B

b. Impact on Surrounding Community

The coal-fired power plant complex, which has been operating since **2006**, has profoundly altered the lives of local communities. Agricultural land has been converted into project sites, while marine ecosystems have been degraded by wastewater discharges from production processes and the constant movement of coal barges. Coastal abrasion has reportedly reached **up to one meter per year** since the establishment of the Jepara power plant.

Fishing communities have come under increasing pressure due to declining fish availability. Fisherfolk are now forced to travel much farther offshore—sometimes as far as **Kendal**—to secure adequate catches, resulting in sharply rising fuel costs. During earlier periods of relative abundance, fishermen reported that a **1-kilogram catch of shrimp required only around 10 individual shrimp**. In contrast, current conditions require **50–80 shrimp to reach the same weight**, reflecting a severe decline in stock size and quality. Over the past two years, an increasing number of fishermen have either changed occupations or ceased fishing altogether; in **Bandungharjo**, for example, approximately **30 percent of fishermen** have reportedly exited the sector.

Employment at the power plant itself is also difficult to access. Prospective workers reportedly must pay **IDR 3–5 million per contract** to intermediaries such as NGOs or mass organizations, with contract durations ranging from **six months to one year**. As a result, some community members have been compelled to seek employment as

migrant workers or factory laborers, where possible, provided they meet the required qualifications.

For households without stable income, economic pressures have disproportionately affected coastal women, many of whom have been forced to borrow from informal and predatory lenders locally referred to as *“bank setan”* (loan sharks). Individual debts can reach **IDR 5 million**, often incurred to finance fishing activities or meet daily household needs. Economic hardship has also been associated with rising levels of domestic violence. Men who remain unemployed and spend more time at home may respond with physical or verbal abuse when wives request money for basic necessities. Under such coercive conditions, many coastal women ultimately choose to migrate for work abroad in order to support household finances and repay accumulated debts.

Public health concerns represent another major grievance. Residents report persistent deposition of coal dust inside homes and small shops throughout the area, underscoring continuous exposure to airborne pollution.

The **Tanjung Jati B CFPP** is also among the coal power plants implementing a **co-firing program**. In **2021**, the plant conducted a co-firing trial using **40 tons of so-called bio-coal (BBN)**, which was claimed to generate **75 MW of electricity**. This biomass fuel was derived from wood waste supplied by wood-processing industries in Jepara. However, reports indicate that co-firing has yet to be fully operational at the plant, due to constraints related to the availability and quality of the required technology.⁵

5 <https://katadata.co.id/ekonomi-hijau/energi-baru/62c2c8261844c/tak-terapkan-co-firing-pltu-tanjung-jati-terkendala-masalah-teknologi>

c. Impact on Local and National Economy

The operation of the **Tanjung Jati B coal-fired power plant** results in substantial economic

losses, with the potential loss of approximately **289,422 jobs per year**. This significant impact indicates that the social and economic costs arising from emissions and pollution associated with the plant far exceed its operational costs.

Operating costs	USD 7,71 million
Annual CO ₂ emissions	19,5 kilotons
Impact on annual economic output (gross domestic product)	- IDR9,39 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR9,35 trillion
Impact on annual business surplus	- IDR5,9 trillion
Impact on annual labor compensation	- IDR3,25 trillion
Impact on annual employment absorption	- 289.422 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR6,08 trillion
Sectoral impacts on health services and social activities	- IDR16,92 billion

*tanda negatif (-) menunjukkan adanya penurunan terhadap indikator

Impacts on Regional Economic Growth and Business Surplus

The operational impact of the Tanjung Jati B CFPP on **Gross Domestic Product (GDP)**—amounting to **IDR 9.39 trillion per year**—indicates that the plant’s operation reduces national economic output rather than contributing to it. A similar pattern is observed at the regional level, where **Regional Gross Domestic Product (RGDP)** declines by **IDR 9.35 trillion per year**. This suggests that the presence of the Tanjung Jati B CFPP does not generate net economic benefits for regional growth. In addition, the business sector is adversely affected, with a **decline in business surplus of IDR 5.9 trillion per year**, which may undermine the competitiveness of local enterprises.

Declining Labor Compensation and Economic Activity

From a labor perspective, the plant’s operations lead to a **reduction in labor compensation of IDR 3.25 trillion per year** and a contraction in employment absorption. This implies that the CFPP hampers job creation and suppresses worker incomes across related sectors. The **agriculture, forestry, and fisheries sectors** are the most severely affected, incurring losses of **IDR 6.08 trillion per year**, indicating that pollution and environmental degradation from the power plant disrupt productivity in these vital sectors. Meanwhile, the **health services and social activities sector** experiences losses of **IDR 16.92 billion per year**, reflecting additional burdens on the healthcare system arising from air pollution impacts.

Impact on GDP by 17 Sectors (in million IDR)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(6.087.928)
Mining and Quarrying	(132.718)
Manufacturing	(1.716.443)
Electricity and Gas Supply	(57.512)
Water Supply; Waste Management, Wastewater, and Recycling	(1.554)
Construction	(118.337)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(565.520)
Transportation and Warehousing	(168.686)
Accommodation and Food Service Activities	(26.632)
Information and Communication	(100.045)
Financial and Insurance Activities	(174.749)
Real Estate Activities	(25.490)
Business Activities	(83.906)
Public Administration, Defence, and Compulsory Social Security	(19.205)
Education Services	(4.643)
Human Health and Social Work Activities	(16.923)
Other Services	(47.087)
TOTAL	(9.347.378)



5

Cilacap CFPP, Central Java (2260 MW)



Cilacap Coal-Fired Power Plant, Central Java (2,260 MW)

https://www.gem.wiki/Cilacap_Sumber_power_station

The Cilacap coal-fired power plant (CFPP) is located in Karangkandri, Kesugihan Subdistrict, Cilacap Regency, Central Java, and has a minimum installed capacity of 2,260 MW. The plant consists of several generating units: two 300 MW units (Phase I) that began operations in 2006, one 660 MW unit (Phase II) commissioned in 2016, and one 1,000 MW unit (Phase III) that commenced operations in 2019.

The Cilacap CFPP is designated as a National Strategic Project, with investment led by PT PJB and financing support from domestic financial institutions.¹ The project is owned by PT Sumber Segara Primadaya (100 percent) as the project company, with a shareholding structure comprising 51 percent owned by

PT Sumberenergi Sakti Prima and 49 percent by PT PLN (Persero) through its subsidiary. The expansion of the larger units has also been supported by international financing, including a USD 700 million loan from the China Development Bank for the construction of Unit 3.

From an environmental perspective, the Cilacap CFPP has drawn sustained public attention due to reported health disturbances among surrounding communities and its contribution to regional air pollution. In addition, residents living near the project have experienced saltwater intrusion and well water depletion linked to the plant's operations since 2016, highlighting the broader environmental and social impacts associated with the facility.²

Ownership and Investors

Cilacap Coal-Fired Power Plant (PLTU Cilacap) Units 1–2

 Capacity 2x300 MW	 Loan type Loan	 Lender Bank of China
 Total loan USD 993.91 million	 Year of financing 2006	 Lender country China

Source: GEM Database, China AidData

Cilacap Coal-Fired Power Plant (PLTU Cilacap) Unit 3

 Capacity 660 MW	 Loan type Pinjaman	 Lender country China
 Total loan USD 700.000.000	 Year of financing 2016	 Lender China Development Bank

Source: GEM Database

¹ <https://www.esdm.go.id/id/media-center/arsip-berita/presiden-resmikan-pltu-cilacap-2-x-300-mw#:~:text=Pembangunan%20PLTU%20Cilacap%20telah%20digagas,PT%20PJB%20dan%2051%25%20PT>

² <https://mongabay.co.id/2018/09/06/derita-warga-cilacap-hidup-bersama-pembangkit-batubara/>

Cilacap Coal-Fired Power Plant (PLTU Cilacap) Unit4

 Capacity
1.0000 MW

 Loan type
Loan

 Loan tenor
11 years

 Total loan amount
USD 1,398,000,000

 Year of financing
2013

 Lender countries
Cina, Indonesia

 Lenders
Bank of China, China Development Bank (CDB), Bank Rakyat Indonesia (BRI)

Source: Kompas, 4 April 2013, GEM Database

General information

COD & power generation capacity

Tahap I Unit 1 - 2006: 300 MW
Tahap I Unit 2 - 2006: 300 MW
Tahap II Unit 3 - 2016 : 660 MW
Tahap III Unit 4 - 2019 : 1000 MW

Combustion technology

Phase I Unit 1-2, subcritical
Phase II Unit 3, supercritical
Phase III Unit 4, ultra-supercritical

National target

None

Types of coal and their sources

Coal: subbituminous

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Cilacap coal-fired power plant** is associated with an estimated **1,435 total deaths per year** among the adult population, as well as **six deaths annually among children under the age of five** due to lower respiratory infections. These estimates

are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Cilacap

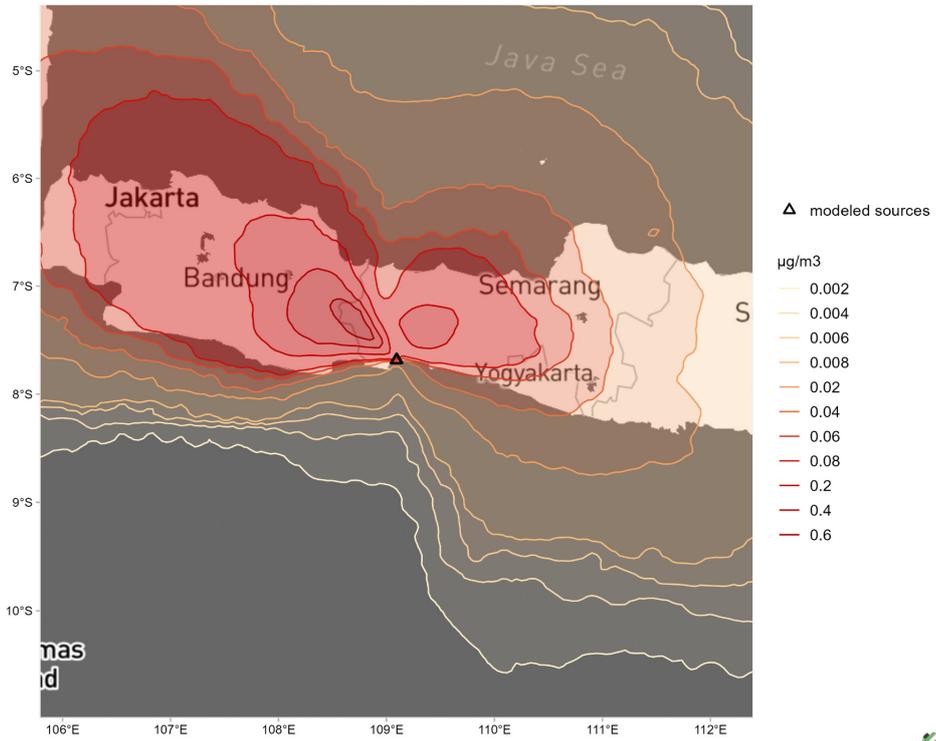


Figure 1. Annual average dispersion of PM2.5 from the Cilacap Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Cilacap

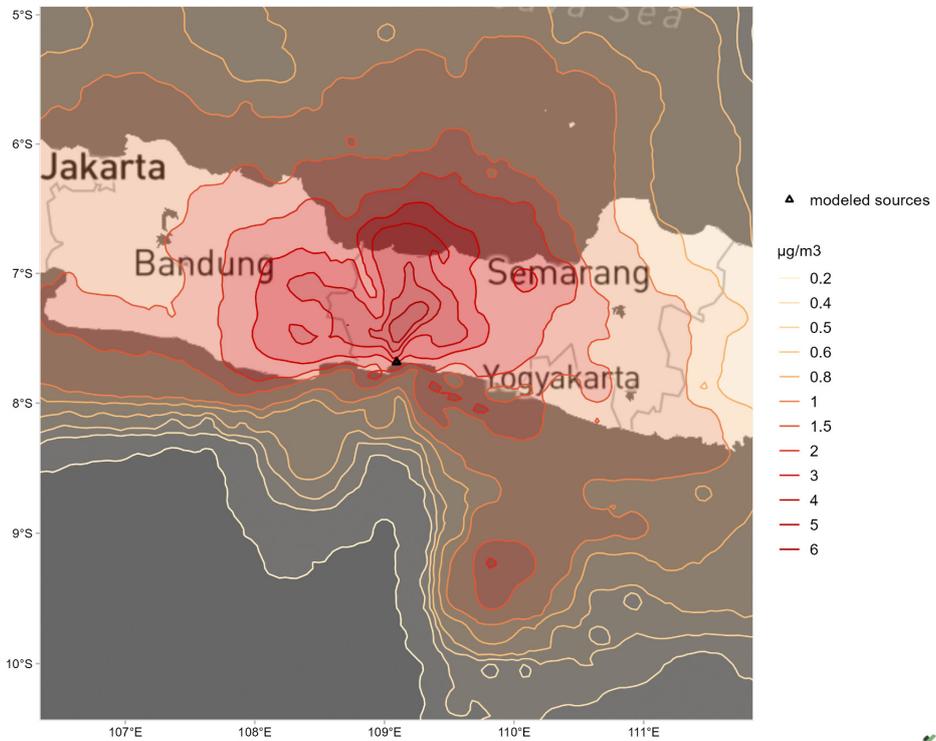


Figure 2. Maximum 24-hour PM2.5 concentration from the Cilacap Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Cilacap coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **1,632 (979–2,278) asthma-related emergency room visits** and **3,700 (989–7,512) new asthma cases**. Adverse impacts on children and unborn infants are also evident, with **801 (389–850) preterm births** and **525 (163–909) cases of low birth weight**. In addition, pollution-related illness and disability result in substantial productivity losses, amounting to **702,000 (597,000–806,000) lost workdays per year**, directly affecting economic activity and labor productivity.

The economic burden on Indonesia arising from health impacts associated with air pollution from the Cilacap CFPP amounts to **USD 953 million per year**, equivalent to **IDR 14.53 trillion**. This substantial economic cost is driven primarily by premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

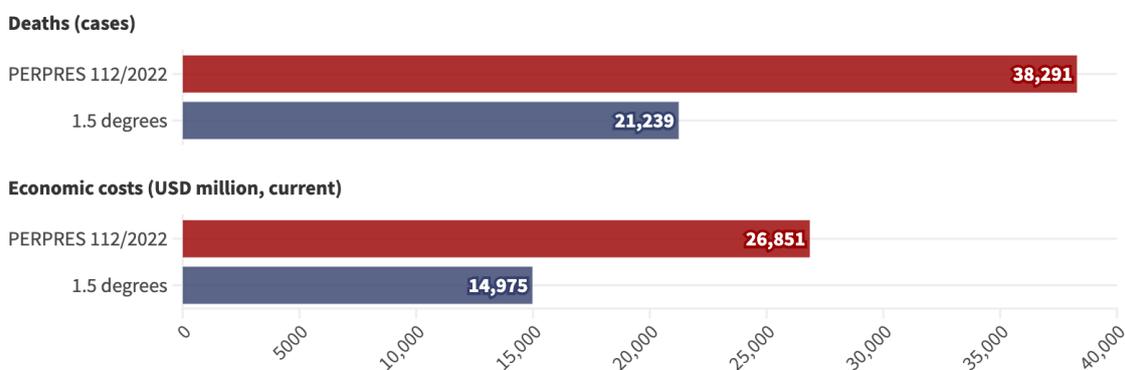
In future projections developed based on retirement schedules

and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 17,052 cumulative deaths and reduce the national economic burden by approximately USD 12 billion, equivalent to IDR 188 trillion.

To realize these benefits, the Cilacap power complex must retire **Units 1–2 in 2030**, **Unit 4 in 2031**, and **Unit 3 in 2032**, prior to Indonesia’s emissions peak in 2035.

According to media reports, the impacts experienced by local communities include **seawater intrusion into agricultural land and household wells**, water scarcity, the infiltration of coal ash into homes, and a high prevalence of **acute respiratory infections (ARI/ISPA)**, particularly among residents of **Winong Hamlet**. The hamlet is located directly behind the power plant complex, where approximately **35 out of 877 residents** have reportedly suffered from **bronchitis**, affecting both **children and women**.

Cumulative air pollution-related deaths and economic costs attributed to Cilacap coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs at the Cilacap Coal-Fired Power Plant

b. Impacts on Surrounding Community

Media reports indicate that the impacts felt by residents include **seawater entering agricultural areas and wells, drought, ash entering homes, and a high incidence of respiratory infections (ARI)**, including those suffered by many residents of Winong Hamlet. They live directly behind the coal-fired power plant. **Approximately 35 of the 877 residents, including both children and women, have contracted bronchitis.**³

Some residents of these villages have shifted their livelihoods from farming and fishing to working as construction laborers at the power plant, while others have turned to sand mining or migrated to urban areas in search of work. When the plant began operations, only a limited number of local residents were employed, mostly in positions such as security guards or as daily laborers.

The land acquisition process was further marred by the involvement of land mafias, resulting in compensation prices that did not correspond to community demands.

Not all land was acquired explicitly for the construction of the power plant and its facilities. Some parcels were reportedly acquired under the pretext of being designated as green or reforestation areas—such as land north of the access road to Winong Hamlet—but were in fact later filled and incorporated into the power plant site.

Moreover, the power plant is located within a **water recharge zone and agricultural area** spanning three villages—**Karangkandri, Slarang, and Menganti**. This situation was reinforced following revisions to the district

spatial plan (RTRW), which reclassified the area as an industrial zone. In **Kuwasen Hamlet**, several parcels of farmland were purchased at low prices on the grounds that the rice fields were considered unproductive.

The plant also plans to use biomass derived from **gamal** (*Gliricidia sepium*) and **kaliandra** (*Calliandra calothyrsus*) as co-firing feedstock, with an estimated demand of **42,000 tons per year**. To meet this requirement, the plant has partnered with village-owned enterprises (**BumDes**) in a pilot project involving **100 hectares of plantations** across three subdistricts in Cilacap—**Kawunganten, Jeruklegi, and Kesugihan**.⁴ However, the implementation of **Energy Plantation Forests (HTE)** to supply biomass has triggered conflicts over access to and control of livelihood resources with surrounding communities.⁵ **Co-firing with biomass is not a solution, but rather a new way to extend the lifespan of coal-fired power plants that should already be retired.** Under the guise of an energy transition, this project actually perpetuates dependence on dirty energy while sacrificing people's living space.

c. Impact on Local and National Economy

With an annual decline in economic output amounting to **IDR 4.56 trillion**, despite operating costs of **USD 62.95 million**, the socio-economic impacts generated by the **Cilacap coal-fired power plant** are substantially greater. Air pollution and environmental contamination from the plant have suppressed productivity in key sectors such as **agriculture, forestry, and fisheries**, while also exacerbating public health conditions in surrounding communities.

³ <https://regional.kompas.com/read/2019/10/16/14543881/limbah-batubara-pltu-cilacap-ganggu-kesehatan-warga-mengeluh>

⁴ <https://kumparan.com/kumparanbisnis/kurangi-batu-bara-pln-indonesia-power-bikin-ekosistem-biomassa-di-pltu-cilacap-22SnaDoQDnP/full>

⁵ Sajogyo Institute, dkk. 2024. Hegemoni Politik Kebun Energi: Mengulang Kisah Lama Ekstraksi Sumber Agraria Pedesaan. Bogor: Sajogyo Institute.

Operating costs	USD 62,95 million
Annual CO ₂ emissions	9,46 kilotons
Impact on annual economic output (gross domestic product)	- IDR4,56 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR44,53 trillion
Impact on annual business surplus	- IDR42,86 trillion
Impact on annual labor compensation	- IDR41,58 trillion
Impact on annual employment absorption	- 147.407 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR42,95 trillion
Sectoral impacts on health services and social activities	- IDR48,21 billion

Negative Economic Contribution at the Regional Level

Despite operating at high annual costs of **IDR 6.3 trillion**, the Cilacap CFPP fails to generate added value for the regional economy. Instead, its presence results in a **decline in Regional Gross Domestic Product (RGDP) of IDR 4.53 trillion per year**. From a business perspective, recorded **business surplus losses amount to IDR 2.86 trillion**, indicating that economic activities associated with the plant are financially unproductive.

Pressure on Employment and Community Income

The impacts of the Cilacap CFPP are also strongly felt in the labor sector. **Worker compensation declines by IDR 1.58 trillion per year**, while employment absorption drops sharply, with the loss of **147,407 jobs annually**. This demonstrates that the plant does not deliver long-term economic benefits for local communities and instead exacerbates social inequality.

Environmental Degradation and Impacts on Strategic Sectors

From an environmental standpoint, the Cilacap CFPP generates **9.46 kilotons of CO₂ emissions per year**, contributing significantly to the climate crisis and local air pollution. These impacts extend to strategic sectors, including **agriculture, forestry, and fisheries**, which incur losses of up to **IDR 2.95 trillion per year**, as well as the **health and social services sector**, which suffers losses of **IDR 8.21 billion per year**. These data indicate that the plant's operations not only undermine economic performance but also degrade ecosystem integrity and the quality of life of surrounding communities.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(2.953.425)
Mining and Quarrying	(64.385)
Manufacturing	(832.695)
Electricity and Gas Supply	(27.901)
Water Supply; Waste Management, Wastewater, and Recycling	(754)
Construction	(57.409)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(274.350)
Transportation and Warehousing	(81.834)
Accommodation and Food Service Activities	(12.920)
Information and Communication	(48.535)
Financial and Insurance Activities	(84.775)
Real Estate Activities	(12.366)
Business Activities	(40.705)
Public Administration, Defence, and Compulsory Social Security	(9.317)
Education Services	(2.252)
Human Health and Social Work Activities	(8.210)
Other Services	(22.843)
TOTAL	(4.534.676)



6

Bukit Asam Muara Enim CFPP, South Sumatra (260 MW)



Bukit Asam Muara Enim Coal-Fired Power Plant, South Sumatra (260 MW)

https://www.gem.wiki/Bukit_Asam_Muara_Enim_power_station

The Bukit Asam Muara Enim coal-fired power plant (CFPP) is located in Tanjung Enim Village, Lawang Kidul Subdistrict, Muara Enim Regency, South Sumatra, and has a minimum installed capacity of 260 MW, consisting of four units of 65 MW each that began operations between 1987 and 1994. All units are 100 percent owned and operated by PT PLN (Persero).

As a subcritical coal-fired power plant that has been operating for several decades, this facility is included in proposals for early retirement based on technical and economic considerations, as well as environmental assessments indicating that these units

represent “*low-hanging fruit*” within transition scenarios aligned with the 1.5°C target.

During 2023–2024, the plant came under public scrutiny due to plans to conduct biomass co-firing trials as part of Indonesia’s energy transition efforts. In addition, in 2025, a corruption scandal related to the retrofit project at the Bukit Asam Muara Enim CFPP was revealed.¹ The project, which was originally intended to improve plant efficiency, is currently under investigation by the Corruption Eradication Commission (KPK) following allegations of price mark-ups and bribery in the procurement process.

Ownership and Investors

Bukit Asam Muara Enim Coal-Fired Power Plant (PLTU Bukit Asam Muara Enim)



Capacity
4x65 MW



Loan amount
Data not publicly available

Note: Data related to the financing of this coal-fired power plant—including total financing amounts, lenders, loan tenors, financing instruments, and other relevant details—are not publicly disclosed and remain fragmented across various information sources. The authors submitted formal requests for information disclosure through the Public Information and Documentation Officer (PPID) to **PLN** and **PT Bukit Asam Tbk**

(PTBA) in **May and June 2025**. Unfortunately, these requests did not result in satisfactory responses. PLN stated that the requested information falls under the authority and management of its power generation sub-holding company. However, when the same request was submitted to PTBA, the company responded that the power plant is neither an asset nor part of **PT Bukit Asam Tbk**, but instead belongs to **PT PLN (Persero)**.

¹ <https://www.citrasumsel.com/hukrim/601005120/sidang-korupsi-retrofit-pltu-bukit-asam-mantan-karyawan-pt-hjm-ungkap-kantor-hjm-jadi-tempat-pembahasan-proyek-retrofit>

These responses indicate that the two institutions are effectively deflecting responsibility for the provision of public information. This situation is regrettable,

as it prevents the public from accessing information that should, by principle, be available, transparent, and easily accessible.

General information	
COD & power generation capacity	Unit 1 - 1987: 65 MW Unit 2 - 1987: 65 MW Unit 3 - 1994: 65 MW Unit 4 - 1994: 65 MW
Combustion technology	Subcritical
National target	Biomass co-firing implemented, beginning 2021 with proportion to be raised from 5% to 10% in 2024
Types of coal and their sources	Coal: subbituminous, bioenergy: wood & other biomass (solids)

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution-related mortality, the operation of the **Bukit Asam Muara Enim coal-fired power plant** is associated with an estimated **35 total deaths per year** among the adult population. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Bukit Asam

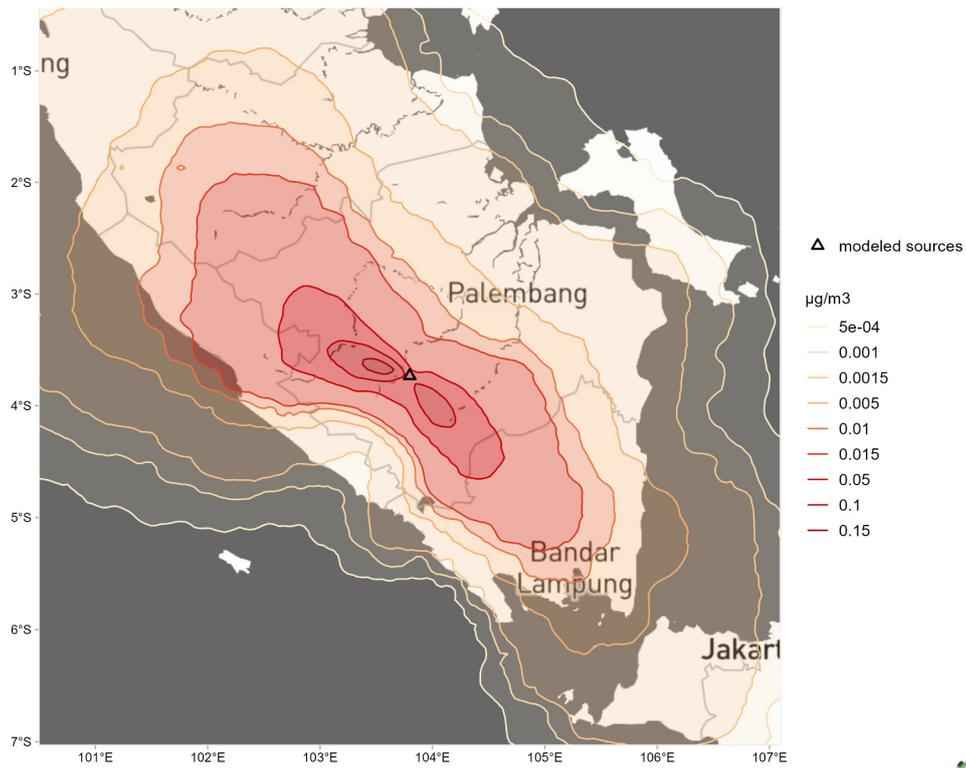


Figure 1. Annual average dispersion of PM2.5 from the Bukit Asam Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Bukit Asam

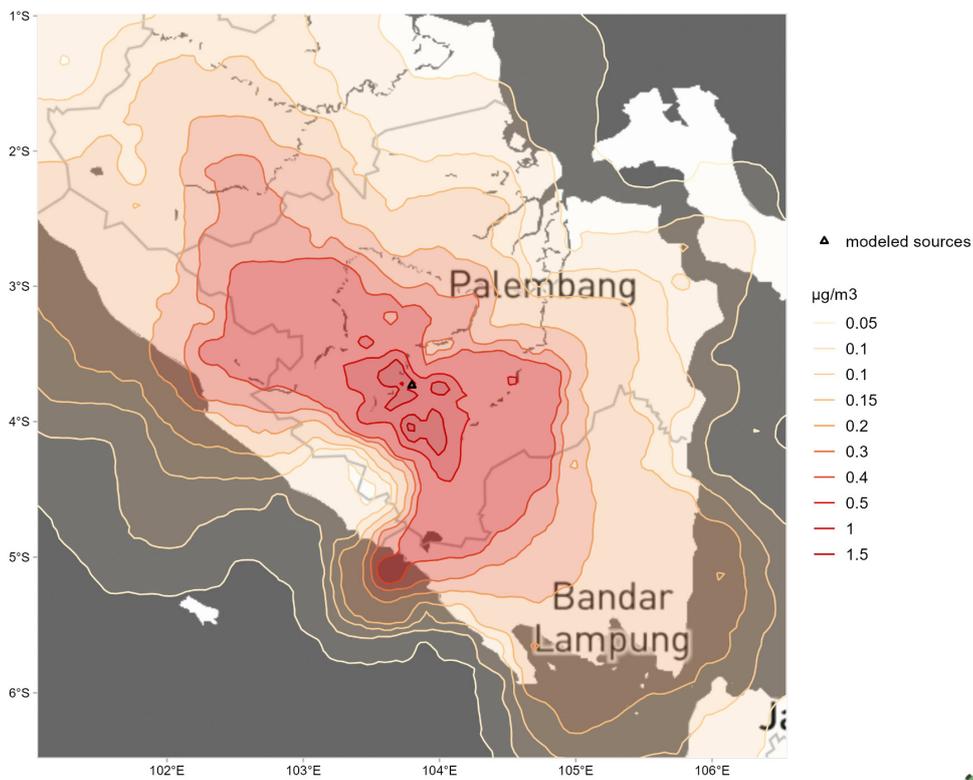


Figure 2. Maximum 24-hour PM2.5 concentration from the Bukit Asam Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Bukit Asam Muara Enim coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **49 (30–69) asthma-related emergency room visits** and **52 (14–105) new asthma cases**. Adverse impacts on children and unborn infants are also observed, with **24 (12–26) preterm births** and **16 (5–28) cases of low birth weight**.

In addition, pollution-related illness and disability result in productivity losses, reflected in **21,000 (18,000–24,000) lost workdays per year**, which directly affect economic activity.

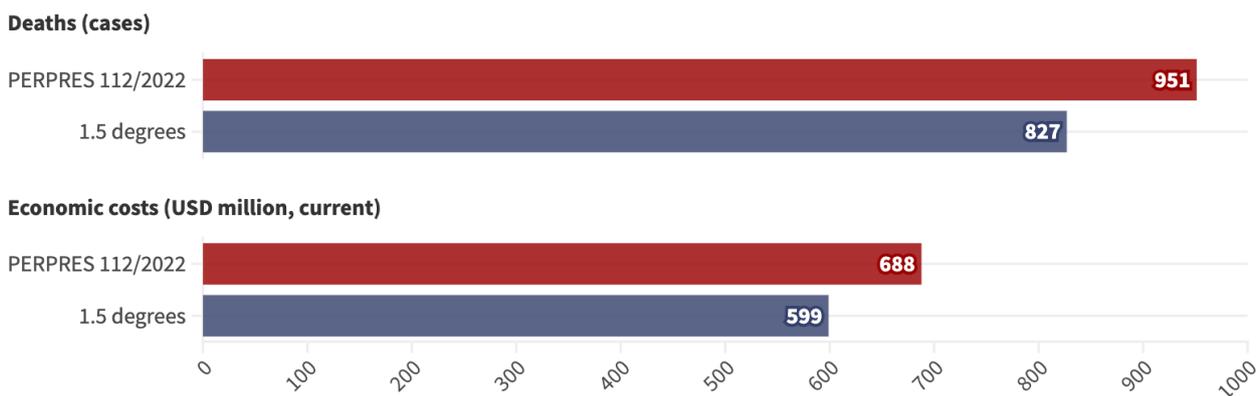
The economic burden on Indonesia arising from health impacts associated with air pollution from the Bukit Asam CFPP amounts to **USD 23 million per year**, equivalent to **IDR 357 billion**. This substantial economic cost is

driven primarily by premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 124 cumulative deaths and reduce the national economic burden by USD 89 million, equivalent to IDR 1.41 trillion.

To realize these benefits, the Bukit Asam power complex must retire **Units 1–2 in 2026** and **Units 3–4 in 2033**, prior to Indonesia's emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Muara Enim coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Bukit Asam Coal-Fired Power Plant

b. Impact on Surrounding Community

Limited information is available in open sources regarding the impacts of this power plant's presence. Nevertheless, the absence of publicly documented data does not imply the absence of environmental degradation or health impacts experienced by surrounding communities. As observed in other areas where residents live in close proximity to coal-fired power plants, communities commonly report health problems such as acute respiratory infections (ARI/ISPA), persistent coughing, skin irritation, homes constantly covered in dust, and other related ailments. Similar conditions are likely experienced by communities residing near this facility.

At the same time, this power plant falls under the category of mine-mouth coal-fired power plants, meaning that its coal supply is sourced from mining sites located in close proximity

to the plant. The open-pit mining operations conducted by PT Bukit Asam Tbk (PTBA) have dramatically altered the landscape.

Thousands of hectares of forest in Lawang Kidul Subdistrict have been lost due to mining activities, resulting in deforestation and the removal of vegetation that plays a critical role in flood prevention and landslide mitigation.²

c. Impact on Local and National Economy

The operation of the **Bukit Asam Muara Enim coal-fired power plant** generates considerable economic impacts, as reflected in an annual decline in economic output of **IDR 0.27 trillion**. Despite operating costs of approximately **USD 13.62 million**, the resulting social and economic impacts on surrounding communities are far more extensive, particularly affecting productive sectors such as **agriculture, forestry, and fisheries**.

Operating costs	USD 13,62 million
Annual CO ₂ emissions	1,54 kilotons
Impact on annual economic output (gross domestic product)	- IDR0,27 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR0,28 trillion
Impact on annual business surplus	- IDR0,16 trillion
Impact on annual labor compensation	- IDR0,11 trillion
Impact on annual employment absorption	- 6.664 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR0,9 trillion
Sectoral impacts on health services and social activities	- IDR0,3 billion

² <https://mongabay.co.id/2021/04/22/setop-bangun-pembangkit-batubara-saatnya-ramah-bumi-dengan-energi-terbarukan/>

Negative Contribution to Economic Growth

The operation of this coal-fired power plant exerts a counterproductive impact on the regional economy, reflected in an annual decline in **Regional Gross Domestic Product (RGDP) of IDR 0.28 trillion**. Rather than serving as a driver of economic growth, the plant instead constrains the region's development potential.

Adverse Impacts on Business Activity and Employment

Business surplus records a deficit of up to **IDR 0.16 trillion per year**, indicating that economic activities directly or indirectly linked to the plant fail to generate meaningful profits. Employment absorption declines by approximately **6,664 jobs per year**,

accompanied by a loss of **IDR 0.11 trillion per year in labor compensation**—a significant blow to the socio-economic stability of local communities.

Environmental and Social Pressures amid High Operating Costs

With annual emissions reaching **1.54 kilotons of CO₂**, the plant further degrades air quality and accelerates climate deterioration. Ecological losses are particularly evident in the **agriculture, forestry, and fisheries sectors**, which suffer economic losses of up to **IDR 0.9 trillion per year**, as well as in the **health and social services sector**, which incurs losses of **IDR 0.3 billion per year**. All of these impacts occur despite operating costs amounting to **IDR 1.4 trillion per year**, a figure that is clearly disproportionate to the benefits delivered by the plant.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(187.473)
Mining and Quarrying	(10.102)
Manufacturing	(34.221)
Electricity and Gas Supply	(2.067)
Water Supply; Waste Management, Wastewater, and Recycling	(64)
Construction	(9.834)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(12.319)
Transportation and Warehousing	(3.926)
Accommodation and Food Service Activities	(787)
Information and Communication	(2.661)
Financial and Insurance Activities	(8.422)
Real Estate Activities	(868)
Business Activities	(3.477)
Public Administration, Defence, and Compulsory Social Security	(1.041)
Education Services	(102)
Human Health and Social Work Activities	(299)
Other Services	(2.079)
TOTAL	(279.742)

7

**Pacitan CFPP,
East Java
(630 MW)**



Pacitan Coal-Fired Power Plant, East Java (630 MW)

https://www.gem.wiki/Pacitan_power_station

The Pacitan coal-fired power plant (CFPP) is located in Pacitan Regency, East Java, and consists of two generating units with a capacity of 315 MW each, which began commercial operation in 2011. All units are 100 percent owned and operated by PT Perusahaan Listrik Negara (Persero) (PLN).

The construction of the Pacitan CFPP was financed through foreign loans, including USD 293 million from the Export-Import Bank of China to support an Engineering, Procurement, and Construction (EPC) project valued at USD 345 million¹. The plant has also been identified as a potential candidate

under integrated transition financing (blended finance) schemes for early retirement within Indonesia's clean energy transition roadmap.

From an environmental and social perspective, the Pacitan CFPP has drawn criticism from local communities due to coal dust exposure, air pollution, and declining fish catches among coastal fishers along the southern coast of Java. These impacts indicate that, beyond its relatively large generation capacity, the plant's operations have substantial environmental and local economic implications—factors that contribute to its inclusion on the list of power plants being considered for early retirement.

Ownership and Investors

Pacitan Coal-Fired Power Plant (PLTU Pacitan) Units 1–2

 Capacity
2x315 MW

 Loan Type
Loan

 Loan Tenor
15 years

 Total Loan
USD 293,000,000

 Loan Year
2009

 Commercial Operation
2013

 Lender
**Export-Import
Bank of China**

 Lender Country
China

Source: China AidData²

¹ [https://finance.detik.com/energi/d-3081610/investor-hong-kong-bangun-pltu-di-bengkulu-rp-4-9-t#:~:text=Proyek%20PLTU%20\(%20Pembangkit%20Listrik%20Tenaga%20Uap,ekuitas%20PT%20TLB%20dan%20pinjaman%20luar%20negeri.](https://finance.detik.com/energi/d-3081610/investor-hong-kong-bangun-pltu-di-bengkulu-rp-4-9-t#:~:text=Proyek%20PLTU%20(%20Pembangkit%20Listrik%20Tenaga%20Uap,ekuitas%20PT%20TLB%20dan%20pinjaman%20luar%20negeri.)

² <https://china.aiddata.org/projects/38610/>

General information

COD & power generation capacity	Unit 1 - 2011: 315 MW Unit 2 - 2011: 315 MW
Combustion technology	Subcritical
National target	Biomass co-firing implemented, use sawdust at 3% share as of 2023
Types of coal and their sources	Coal: subbituminous, bioenergy: wood & other biomass (solids) [3%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Pacitan coal-fired**

power plant is associated with an estimated **388 total deaths per year** among the adult population, as well as **two deaths annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Pacitan

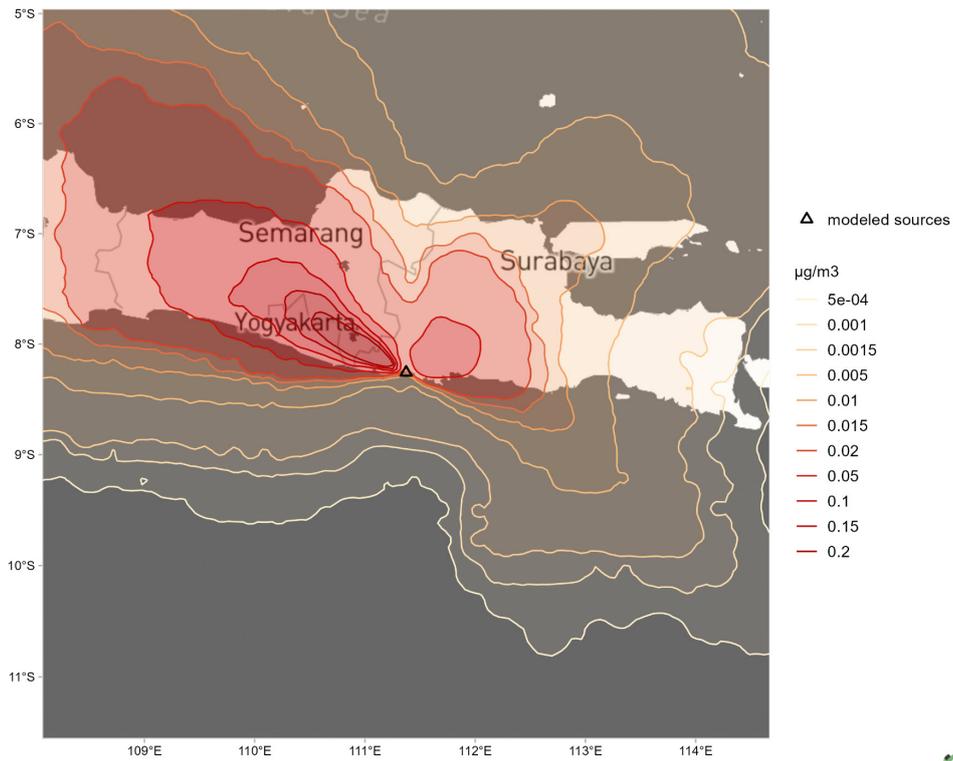


Figure 1. Annual average dispersion of PM2.5 from the Pacitan Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Pacitan

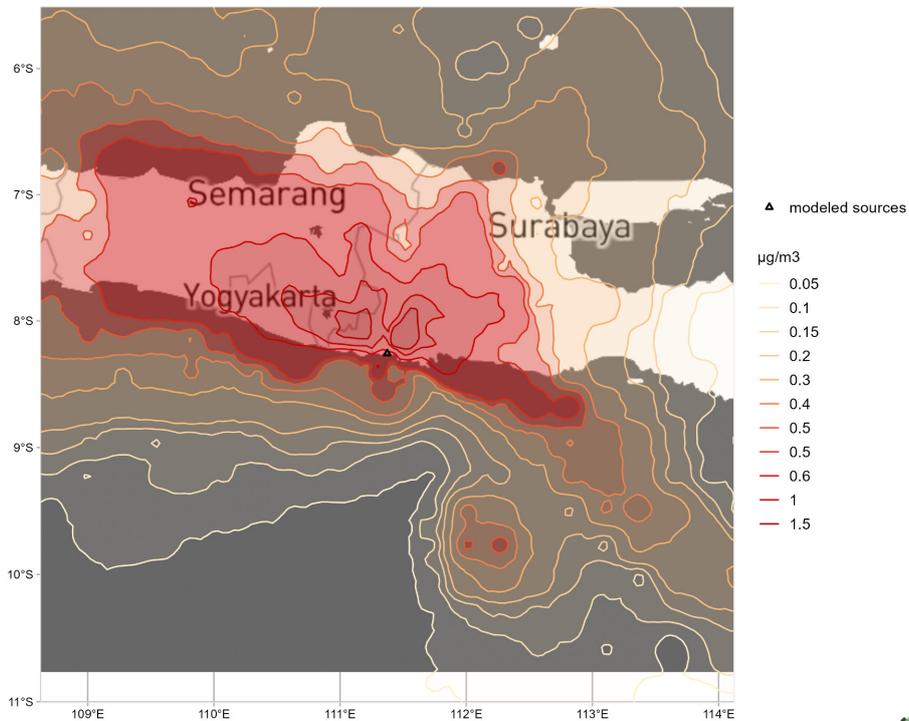


Figure 2. Maximum 24-hour PM2.5 concentration from the Pacitan Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Pacitan coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **432 (259–603) asthma-related emergency room visits** and **408 (109–829) new asthma cases**. Adverse impacts on children and unborn infants include **212 (103–225) preterm births** and **139 (43–241) cases of low birth weight**. In addition, pollution-related illness and disability result in productivity losses of **186,000 (158,000–213,000) lost workdays per year**, directly affecting economic activity.

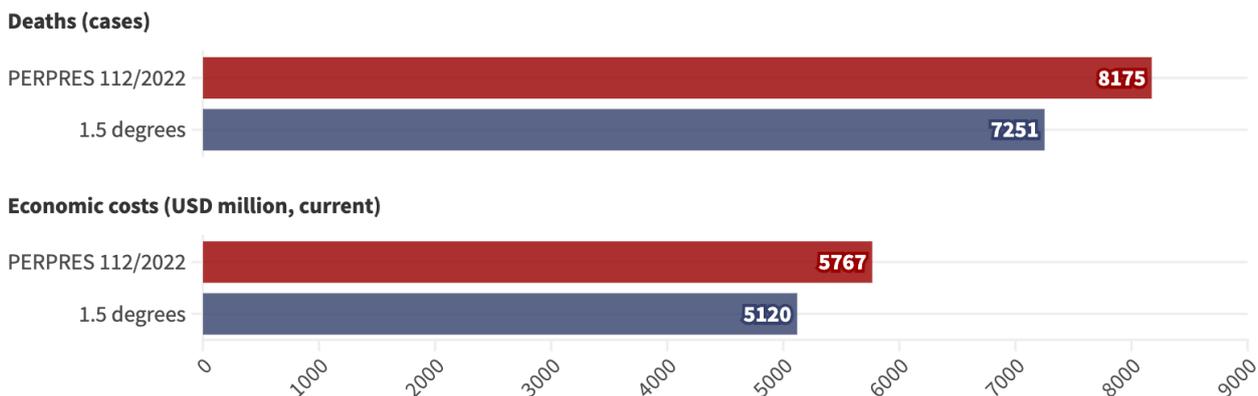
The economic burden on Indonesia arising from health impacts associated with air pollution from the Pacitan CFPP amounts to **USD 258 million per year**, equivalent to **IDR 3.93 trillion**. This substantial economic cost is

driven primarily by premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 924 cumulative deaths and reduce the national economic burden by USD 647 million, equivalent to IDR 10 trillion.

To realize these benefits, the Pacitan CFPP must retire **Units 1–2 by 2032**, prior to Indonesia’s emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Pacitan coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs from the Pacitan Coal-Fired Power Plant

b. Impact on Surrounding Community

The operation of the **Pacitan coal-fired power plant**, also known as **Sudimoro CFPP**, has generated significant environmental impacts on surrounding communities. The power plant complex is located within a **karst landscape**, along the coastal area of **Kondang Beach** and the **Bawur River**, and has encroached upon ecosystems that previously supported water-retaining vegetation, livestock grazing areas, and local livelihoods such as *impun* harvesting.

At present, many residents are no longer able to fish in the river, as waterways flowing into the coastal estuary have been contaminated by **thermal wastewater discharges** from the power plant. Buffalo herders have been forced to sell their entire livestock herds following the loss of grazing land, which has been converted into power plant infrastructure.

Marine and wildlife conservation ecosystems—particularly **sea turtle conservation areas** along the Pacitan coastline (Taman Ria Beach) extending to **Trenggalek (Taman Kili-Kili Beach)**—have also been disrupted by frequent coal barge traffic and coal spills. As a result, the number of turtles coming ashore to nest has declined significantly.

Health data from local **community health centers (puskesmas)** indicate that over a decade (**2010–2020**), cases of **acute respiratory infections (ARI/ISPA)** increased substantially in villages located near the power plant, particularly among women. In addition, residents have reported cases of eye disorders, including cataracts, following incidents of eye irritation experienced while working in agricultural fields

during rainfall—suspected to be linked to **acid rain** resulting from airborne **fly ash** emissions. Household well water traditionally used for daily needs has also reportedly turned yellow, raising concerns over water quality.

Promises that the presence of the power plant would improve local welfare have largely remained rhetorical. Residents report that their livelihoods were more secure prior to the plant's construction. Clove, coconut, and other plantations have experienced widespread crop failure, as leaves have blackened after being covered by coal dust emissions from the facility.

The presence of the power plant has also generated **intergenerational tensions** within the community. For residents aged **50 years and above**, the plant is perceived as having eroded traditional sources of income. Conversely, among younger residents aged **18 and above**, the plant is often viewed as a source of new employment opportunities, with many youths working as **security personnel or cleaning service staff**.

Since **November 2023**, the Pacitan CFPP has begun implementing **biomass co-firing**, using **sawdust** sourced from nearby wood-processing industries at a rate of approximately **3–5 percent** of the fuel mix. The plant's estimated biomass demand is projected to reach **15,000 tons per month**.³ PLN has also signed a **Memorandum of Understanding (MoU)** with the **Special Region Government of Yogyakarta** and the **Ngayogyakarta Hadiningrat Palace** to develop the cultivation of biomass crops—including **gamal, gmelina, indigofera**, and **red calliandra**—in **Gunung Kidul**, intended to supplement the biomass supply required for the power plant.⁴

3 <https://radarmadiun.jawapos.com/advertorial/801205863/upaya-pjb-pltu-pacitan-terapkan-metode-cofiring>

4 <https://www.mongabay.co.id/2024/04/15/ambisi-tanaman-energi-untuk-co-firing-pltu-pacitan/>

c. Impact on Local and National Economy

With an annual decline in economic output amounting to **IDR 1.96 trillion**, the plant's **operating costs of USD 61.16 million** are clearly disproportionate to the negative

impacts it imposes on the local economy and community welfare. Air pollution and environmental contamination from the power plant have reduced productivity in key sectors such as **agriculture, forestry, and fisheries**, while also adversely affecting the health of coastal communities.

Operating costs	USD 61,16 million
Annual CO ₂ emissions	3,1 kiloton
Impact on annual economic output (gross domestic product)	- Rp1,96 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp1,94 trillion
Impact on annual business surplus	- Rp0,97 trillion
Impact on annual labor compensation	- Rp0,91 trillion
Impact on annual employment absorption	- 54.104 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp1,38 trillion
Sectoral impacts on health services and social activities	- Rp2,45 miliar

Negative Economic Contribution to the Regional Economy

Rather than stimulating growth, the operation of this coal-fired power plant exerts downward pressure on the regional economy. Each year, **Regional Gross Domestic Product (RGDP)** declines by up to **IDR 1.94 trillion**. These figures indicate that the presence of the plant erodes economic value rather than strengthening regional productivity.

Losses in the Business Sector and Employment

Business surplus is recorded as negative, amounting to **IDR 0.97 trillion per year**, signaling the limited profitability of economic activities associated with the plant. The impacts on employment are also severe,

with a reduction in job absorption reaching **54,104 positions per year**. In addition, **labor compensation declines by IDR 0.91 trillion per year**, implying reduced household incomes and heightened economic vulnerability among local communities.

Social, Environmental, and Operational Cost Burdens

Annually, the plant generates **3.1 kilotons of CO₂ emissions**, contributing to air pollution, adverse health outcomes, and the acceleration of the climate crisis. These environmental burdens are compounded by very high operating costs, totaling **IDR 6.1 trillion per year**. Sectoral impacts are likewise significant, with losses in the **agriculture, forestry, and fisheries sectors** reaching **IDR 1.38 trillion per year**, alongside losses of **IDR 2.45 billion per year** in the **health services and social activities sector**.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.388.196)
Mining and Quarrying	(27.700)
Manufacturing	(253.050)
Electricity and Gas Supply	(26.130)
Water Supply; Waste Management, Wastewater, and Recycling	(406)
Construction	(5.797)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(98.928)
Transportation and Warehousing	(50.954)
Accommodation and Food Service Activities	(6.811)
Information and Communication	(13.551)
Financial and Insurance Activities	(31.948)
Real Estate Activities	(8.317)
Business Activities	(18.392)
Public Administration, Defence, and Compulsory Social Security	(1.253)
Education Services	(585)
Human Health and Social Work Activities	(2.451)
Other Services	(9.319)
TOTAL	(1.943.788)



8

Pelabuhan Ratu CFPP, West Java (1050 MW)



Pelabuhan Ratu Coal-Fired Power Plant, West Java (1,050 MW)

https://www.gem.wiki/Pelabuhan_Ratu_power_station

The power plant is located in Pelabuhan Ratu, Sukabumi Regency, West Java, with an installed capacity of approximately 1,050 MW, consisting of three generating units of 350 MW each (Units 1–3) that began commercial operation in 2013. All units are owned by PT PLN (Persero) through its subsidiary, PT Indonesia Power. The construction of the Pelabuhan Ratu CFPP was financed through substantial foreign loans, including USD 481 million from the Export–Import Bank of China and USD 175.59 million from Bank Mega, positioning the plant as part of Indonesia’s large-scale coal investment portfolio.

In October 2022, PLN, together with PT Bukit Asam Tbk (PTBA), signed a Principal Framework Agreement to pursue the early retirement of the Pelabuhan Ratu CFPP and replace it with clean energy alternatives. Early closure is projected to reduce CO₂ emissions by up to 51 million tons and potentially avert

economic burdens arising from air pollution impacts amounting to billions of rupiah. However, the success of this plan depends heavily on the availability of direct financing mechanisms and effective coordination among PLN, the government, and investors.

To date, despite being designated as one of the two JETP pilot coal-fired power plants (alongside Cirebon CFPP Unit 1), the early retirement of the Pelabuhan Ratu CFPP has not yet been implemented. In April 2023, PLN stated that the target for operational cessation could be realized by 2037, contingent upon the readiness of Energy Transition Mechanism (ETM) financing and supportive regulatory frameworks.² Meanwhile, media reports indicate that technical cooperation between PLN and PT Bukit Asam Tbk (PTBA) remains under discussion, with the aim of ensuring supply continuity while supporting Indonesia’s national energy transition targets.³

Ownership and Investors

Pelabuhan Ratu Coal-Fired Power Plant (PLTU Pelabuhan Ratu) Units 1–3

 Capacity
3x350 MW

 Loan Type
Loan

 Loan Tenor
15 years

 Total Loan
USD 656,590,000

 Loan Year
2009

 Commercial Operation
2013

 Lenders
The Export-Import Bank of China, Bank Mega

Source: China AidData, GEM Database¹, GEM Database

¹ <https://china.aiddata.org/projects/38600/>

² https://ekonomi.bisnis.com/read/20230329/44/1641725/pln-targetkan-pensiun-dini-pltu-pelabuhan-ratu-pada-2037#goog_rewarded

³ [https://www.cnnindonesia.com/longform/ekonomi/20250630/longform-jeritan-batang-pltu-dan-jalan-panas-ri-ke-energi-terbarukan/index.html#:~:text=%E2%80%9CPLN%20akan%20memastikan%20langkah%20ini%20\(pensiun%20dini\),bagi%20masyarakat%2C%E2%80%9D%20ujar%20Gregorius%20melalui%20pesanan%20singkatnya.](https://www.cnnindonesia.com/longform/ekonomi/20250630/longform-jeritan-batang-pltu-dan-jalan-panas-ri-ke-energi-terbarukan/index.html#:~:text=%E2%80%9CPLN%20akan%20memastikan%20langkah%20ini%20(pensiun%20dini),bagi%20masyarakat%2C%E2%80%9D%20ujar%20Gregorius%20melalui%20pesanan%20singkatnya.)

General information

COD & power generation capacity	Unit 1 - 2013: 350 MW Unit 2 - 2013: 350 MW Unit 3 - 2013: 350 MW
Combustion technology	Subcritical
National target	Biomass co-firing implemented at 5% ratio, use of sawdust since 2021
Types of coal and their sources	Coal: unknown, bioenergy: wood & other biomass (solids) [5%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Pelabuhan Ratu coal-fired**

power plant is associated with an estimated **481 total deaths per year** among the adult population, as well as **two deaths annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Pelabuhan Ratu

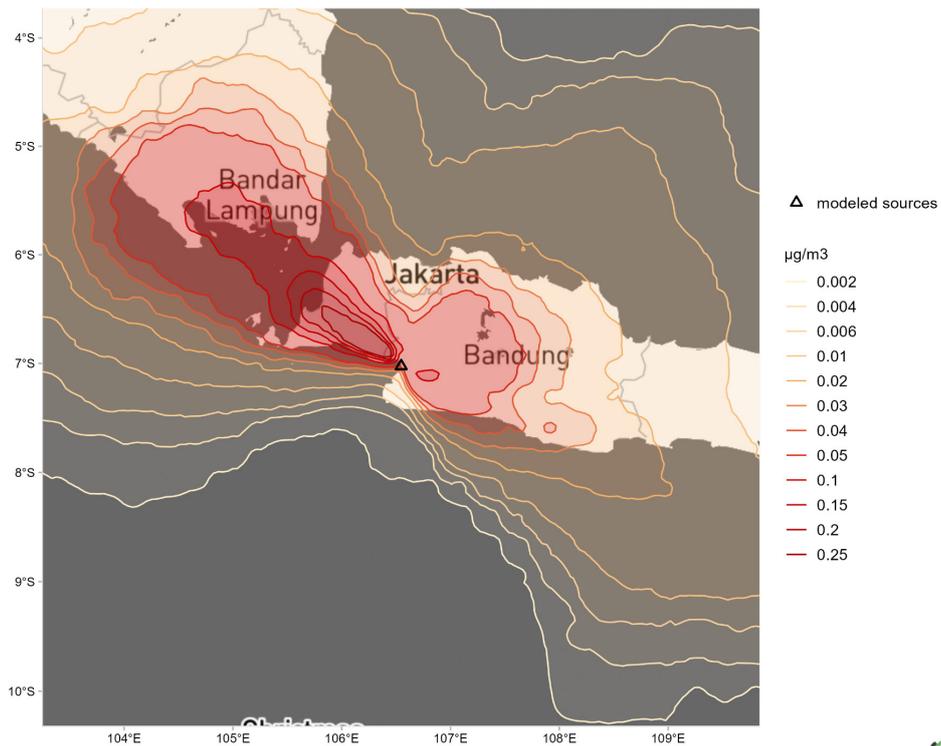


Figure 1. Annual average dispersion of PM2.5 from the Pelabuhan Ratu Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Pelabuhan Ratu

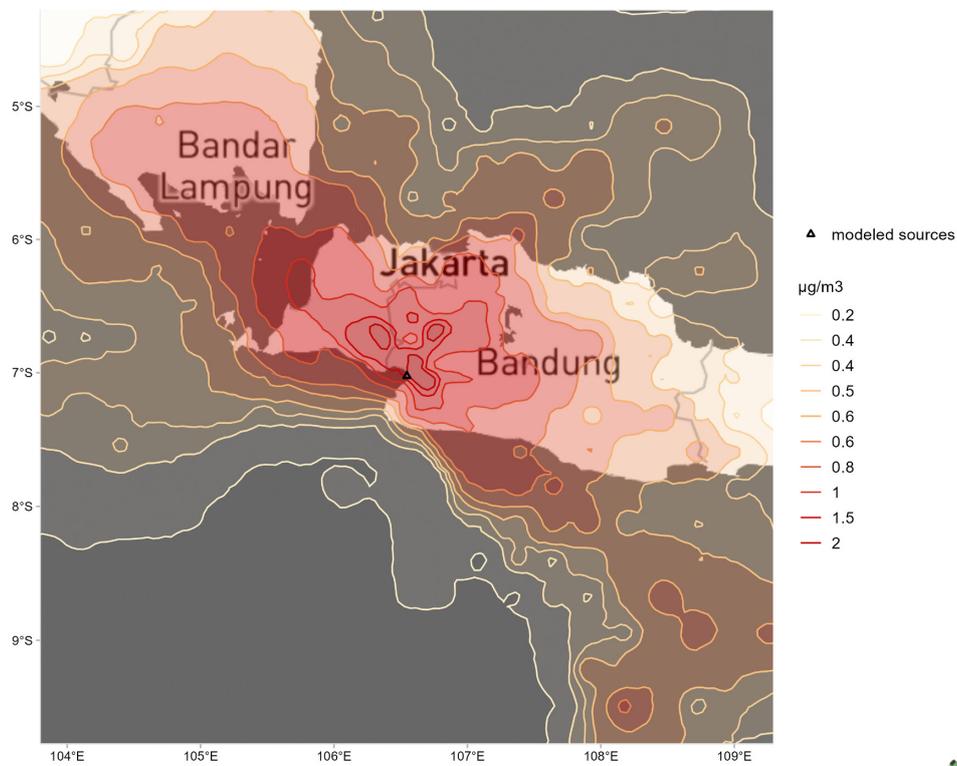


Figure 2. Maximum 24-hour PM2.5 concentration from the Pelabuhan Ratu Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the Pelabuhan Ratu coal-fired power plant lead to an increased risk and incidence of respiratory diseases, amounting to an **estimated 435 (261–607) asthma-related emergency room visits and 1,426 (381–2,896) new asthma cases**. Adverse impacts are also observed among children and unborn infants, with an **estimated 213 (104–226) cases of preterm birth and 140 (44–242) cases of low birth weight**. In addition, productivity losses due to illness and disability reach **approximately 187 (159–215) thousand workdays lost each year, directly affecting economic activity**.

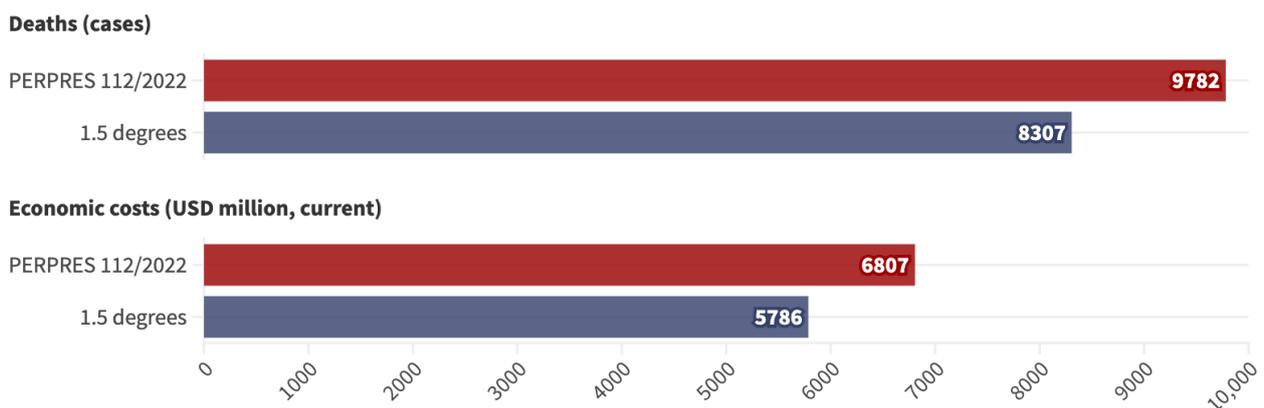
The economic burden on Indonesia’s economy from health impacts associated with air pollution from the Pelabuhan Ratu coal-fired power plant amounts to USD 320 million annually, equivalent to IDR 4.87 trillion. This substantial economic burden is largely driven

by premature mortality, while also accounting for hospital costs related to morbidity and the economic costs of work absenteeism.

Under future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5-degree pathway would avert an estimated 1,475 cumulative deaths and reduce the national economic burden by USD 1.02 billion, equivalent to IDR 16.2 trillion.

To realize these benefits, Units 1–3 of the Pelabuhan Ratu coal-fired power plant must cease operations by 2032, prior to Indonesia’s emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Pelabuhan Ratu coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs from the Pelabuhan Ratu coal-fired power plant

b. Impact on Surrounding Community

This **PLN-owned coal-fired power plant**, which is financed through debt from foreign investors,⁴ has generated profound adverse consequences for surrounding communities, including the loss of livelihoods among farmers and fishers. Residents who continue to work as fishers face increasing difficulties due to declining catches, as traditional fishing grounds have become progressively restricted.

At the outset of the project, the plant operator claimed that the development would improve local welfare and employ up to **80 percent of the surrounding community**. In practice, however, this promise has not materialized. Local residents who were employed were largely confined to positions as **security personnel** or **casual daily laborers**, hired under weekly or monthly work arrangements with limited job security.

The plant's coal demand is estimated to reach approximately **4.5 million tons per year**, or around **67.5 million tons over its 15-year operational period**.⁵ These conditions have inevitably led to adverse health impacts among local communities, including persistent coughing and skin irritation or scabies. Environmental quality has also deteriorated, as evidenced by increased air pollution and the dispersion of fine particulate matter from coal combustion residues.

This power plant is included in **PLN's co-firing program**, utilizing approximately **10 percent**

sawdust as a biomass blend, which has been implemented since **2020**.⁶ **Perhutani** has also planned to supply biomass for the plant through **Energy Plantation Forest (HTE)** projects developed in **KPH Sukabumi**. Since **2023**, **Perhutani KPH Sukabumi** has further expanded its involvement by developing a **wood-processing facility** on a **three-hectare site** located in **Compartment 97, Hanjuang Barat, Waluran Subdistrict**.⁷ According to **Perhutani's West Java Regional Division**, the annual biomass requirement for the Pelabuhan Ratu CFPP amounts to **223,735 tons**.⁸

Perhutani claims that the HTE program is implemented on *degraded land*. In practice, however, these lands have long served as critical sources of livelihood for local communities. Rather than restoring the environment, the project has restricted community access to agricultural land and failed to meaningfully involve residents in its planning and governance. Local people are largely mobilized as **low-wage laborers**, tasked with nursery work, maintenance, and harvesting of biomass crops under precarious employment conditions. Moreover, the **monoculture planting system** promoted under the HTE scheme poses significant risks to environmental sustainability, exacerbating **water scarcity and food insecurity**.⁹

There is growing concern that the adoption of co-firing at this power plant—originally designed with a **15-year operational lifespan**—is being used as a strategic maneuver to **extend its operation**, under the misleading claim that it has become a low-emissions facility.

4 https://www.gem.wiki/Pelabuhan_Ratu_power_station

5 <https://www.ptba.co.id/berita/pln-dan-ptba-kerja-sama-pensiun-dini-pltu-pelabuhan-ratu-1546>

6 <https://independen.id/petaka-pltu-pelabuhan-ratu-mundur-kena-co-firing-maju-kena-pensiun-dini>

7 <https://independen.id/petaka-pltu-pelabuhan-ratu-mundur-kena-co-firing-maju-kena-pensiun-dini>

8 LBH Bandung, Walhi Jabar, dan Trend Asia, 2023, Kertas Posisi: Jawa Barat Dalam Ancaman Solusi Palsu Energi Baru Terbarukan.

9 Sajogyo Institute, dkk. 2024. Hegemoni Politik Kebun Energi: Mengulang Kisah Lama Ekstraksi Sumber Agraria Pedesaan. Bogor: Sajogyo Institute.

c. Impact on Local and National Economy

The operation of the **Pelabuhan Ratu coal-fired power plant** results in significant economic losses, as reflected in an annual decline in economic output of **IDR 2.30 trillion**. With operating costs reaching **IDR 4.5**

trillion, the adverse impacts on productivity and community welfare far outweigh any economic benefits generated by the plant. Air pollution and environmental degradation from its operations further suppress key sectors such as **agriculture, forestry, and fisheries**, which together incur economic losses of up to **IDR 1.7 trillion per year**.

Operating costs	Rp 4,5 trillion
Annual CO ₂ emissions	5,16 kiloton
Impact on annual economic output (gross domestic product)	- Rp2,30 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp2,33 trillion
Impact on annual business surplus	- Rp1,10 trillion
Impact on annual labor compensation	- Rp1,18 trillion
Impact on annual employment absorption	- 49.348 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp1,7 trillion
Sectoral impacts on health services and social activities	- Rp4,13 miliar

Negative Economic Contribution to the Regional Economy

Rather than acting as a driver of growth, the operation of this coal-fired power plant exerts a substantial negative impact on the regional economy, with an annual decline in **Regional Gross Domestic Product (RGDP) of IDR 2.33 trillion**. This figure indicates that the plant erodes economic value rather than stimulating productive economic activity in the region.

Losses in the Business Sector and Employment

From the perspective of business actors, the plant records a **negative business surplus of IDR 1.10 trillion per year**. The impacts on employment are equally concerning, with **job absorption declining by approximately**

49,348 positions per year. In addition, **labor compensation decreases by IDR 1.18 trillion annually**, translating into lost household income and increased economic vulnerability among local communities.

Social, Environmental, and Operational Cost Burdens

The plant generates **5.16 kilotons of CO₂ emissions per year**, contributing to air pollution and climate change while adversely affecting public health. These environmental burdens are accompanied by high operating costs, amounting to **IDR 4.5 trillion per year**, which are disproportionate to the plant's economic contribution. Sectoral impacts are also pronounced, with losses in the **agriculture, forestry, and fisheries sectors** reaching **IDR 1.7 trillion per year**, alongside losses of **IDR 4.13 billion per year** in the **health services and social activities sector**.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.694.331)
Mining and Quarrying	(26.460)
Manufacturing	(291.624)
Electricity and Gas Supply	(19.225)
Water Supply; Waste Management, Wastewater, and Recycling	(2.303)
Construction	(29.693)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(118.944)
Transportation and Warehousing	(45.032)
Accommodation and Food Service Activities	(3.998)
Information and Communication	(16.965)
Financial and Insurance Activities	(32.117)
Real Estate Activities	(5.990)
Business Activities	(22.438)
Public Administration, Defence, and Compulsory Social Security	(1.050)
Education Services	(1.733)
Human Health and Social Work Activities	(4.128)
Other Services	(13.802)
TOTAL	(2.329.833)



9

**Adipala CFPP,
Central Java
(660 MW)**



Adipala Coal-Fired Power Plant, Central Java (660 MW)

https://www.gem.wiki/Adipala_power_station

The Adipala coal-fired power plant (CFPP) is located in Bunton Village, Adipala Subdistrict, Cilacap Regency, Central Java. The plant has an installed capacity of 660 MW, was constructed using supercritical technology between 2013 and 2015, and commenced commercial operation in March 2015 as part of efforts to strengthen the Java–Bali electricity system. As part of PLN Indonesia Power, the plant is managed under the Central Java Generation Business Unit 2. The facility is equipped with Flue Gas Desulfurization (FGD) systems as a standard emission mitigation measure, making it comparatively less polluting than many conventional coal-fired power plants.

The construction of the Adipala CFPP involved investment financing of USD 625 million, provided through a loan from the China Development Bank in late 2009. The project was developed by China National Technical Import and Export Corporation (CNTIC) and has been fully operated by PLN since it began operations in 2015.

Since 2023, the Adipala CFPP has implemented a biomass co-firing scheme, utilizing wood pellets, sawdust, and even waste banknotes, with the biomass share gradually increasing to approximately 3–5 percent. In relation to this practice, surrounding communities have reported increased coal dust exposure, respiratory health disturbances, and inadequate compensation from the plant operator.

Ownership and Investors

Adipala Coal-Fired Power Plant (PLTU Adipala) Unit 1

 Capacity
600 MW

 Loan Type
Loan

 Loan Tenor
13 years, with a 3-year grace period

 Total Loan
USD 625,000,000

 Loan Year
2009

 Lender
China Development Bank

 Commercial Operation
2015

Source: GEM Database, GEM Website, China AidData¹, China AidData²

¹ https://www.gem.wiki/Adipala_power_station

² <https://china.aiddata.org/projects/67236/>

General information

COD & power generation capacity	Unit 1 - 2015: 660 MW
Combustion technology	Supercritical
National target	Biomass co-firing implemented, use of 5% sawdust since 2021
Types of coal and their sources	Coal: subbituminous, bioenergy: wood & other biomass (solids) [5%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Adipala coal-fired**

power plant is associated with an estimated **405 total deaths per year** among the adult population, as well as **two deaths annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks linked to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Adipala

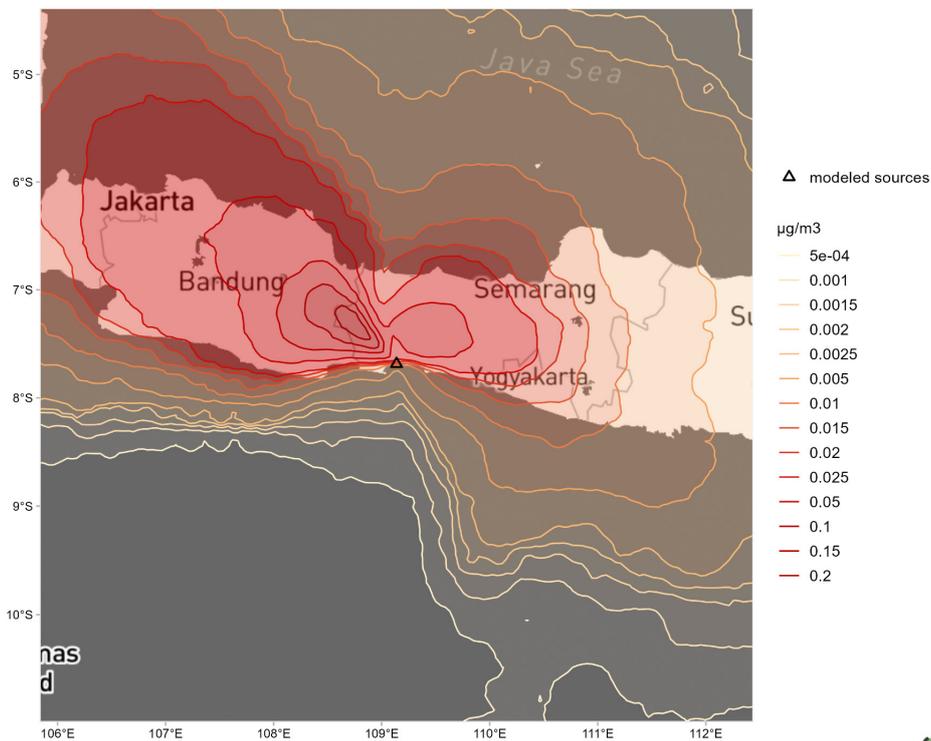


Figure 1. Annual average distribution of PM2.5 from the Adipala PLTU

Maximum 24-hour PM2.5 concentration from Adipala

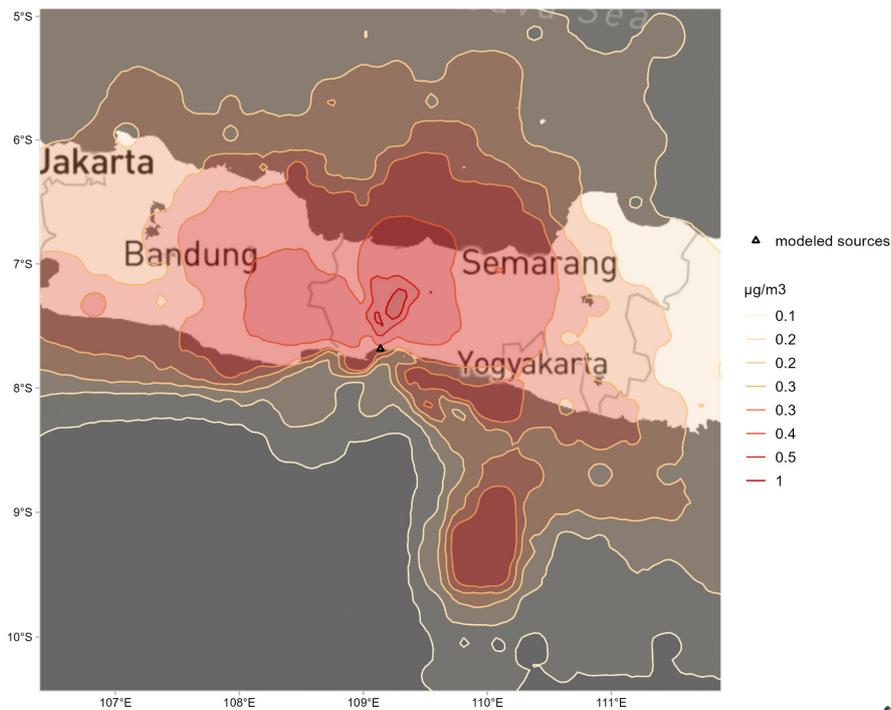


Figure 2. Maximum 24-hour PM2.5 concentration from Adipala PLTU

In terms of morbidity, air pollutant emissions from the **Adipala coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **483 (289–674) asthma-related emergency room visits** and **860 (230–1,746) new asthma cases**. Adverse impacts on children and unborn infants are also evident, with **237 (115–251) preterm births** and **155 (48–269) cases of low birth weight**. In addition, pollution-related illness and disability result in substantial productivity losses, amounting to **208,000 (177,000–238,000) lost workdays per year**, directly affecting economic activity.

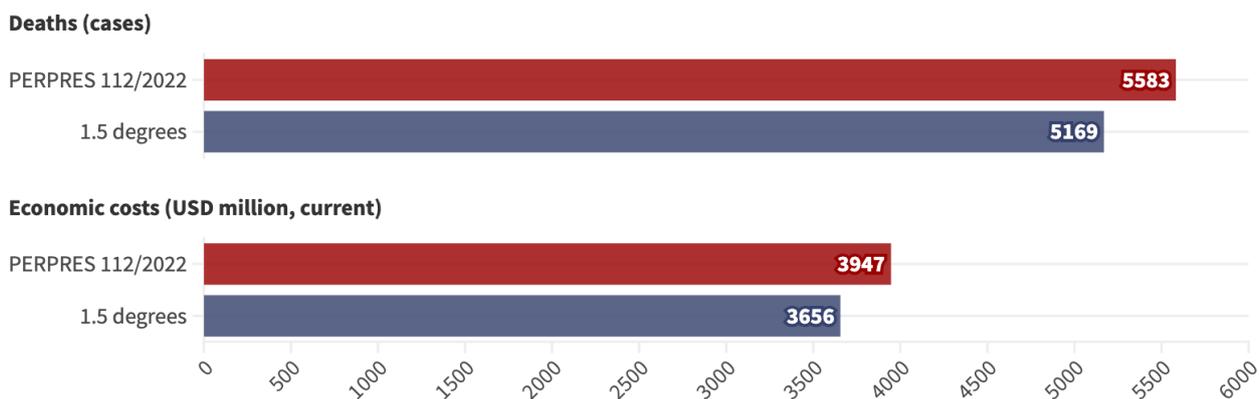
The economic burden on Indonesia arising from health impacts associated with air pollution from the Adipala CFPP amounts to **USD 269 million per year**, equivalent to **IDR 4.10 trillion**. This considerable economic

cost is driven primarily by premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 414 cumulative deaths and reduce the national economic burden by USD 291 million, equivalent to IDR 4.62 trillion.

To realize these benefits, the **Adipala CFPP must be retired by 2029**, prior to Indonesia's emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Adipala coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs of the Adipala PLTU

b. Impact on Surrounding Community

The location of this power plant lies directly opposite the **Cilacap coal-fired power plant**, separated only by the **Serayu River**, placing the two facilities in close proximity. Local communities have reported significant **coal dust pollution** resulting from combustion activities. Several residents have stated that they frequently experience **shortness of breath, respiratory disorders**, and persistent exposure to **airborne dust particles** that disperse into residential areas.³

Although only limited community testimonies have been documented, this does not imply the absence of grievances regarding the impacts of the power plant's presence. On the contrary, the existence of **two large-scale coal-fired power plants in the Adipala area** has evidently generated significant impacts on local communities, spanning from the **pre-construction phase through to ongoing operations**.

This power plant is also included in the list of facilities implementing **biomass co-firing**, with an initial target of **five percent biomass utilization**, and with policy direction indicating a continued push toward increasing biomass use—potentially up to **100 percent substitution**.⁴ The biomass used in the co-firing process at this power plant consists of **sawdust and processed waste from paper banknotes**.⁵

c. Impact on Local and National Economy

The operation of the **Adipala coal-fired power plant** generates tangible economic losses at both the regional and national levels, with an annual decline in economic output of **IDR 1.26 trillion**. Despite operating costs reaching **USD 60.94 million**, the adverse impacts on the local economy and community welfare are substantially greater. Pollution and emissions from the plant have reduced productivity in key sectors such as **agriculture, forestry, and fisheries**, while also undermining regional economic competitiveness.

Operating costs	USD 60,94 million
Annual CO ₂ emissions	2,61 kiloton
Impact on annual economic output (gross domestic product)	- Rp1,26 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp1,25 trillion
Impact on annual business surplus	- Rp0,79 trillion
Impact on annual labor compensation	- Rp0,44 trillion
Impact on annual employment absorption	- 38.738 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp0,8 trillion
Sectoral impacts on health services and social activities	- Rp2,26 miliar

³ https://www.gem.wiki/Adipala_power_station

⁴ <https://finance.detik.com/energi/d-7186797/tak-pakai-batu-bara-pltu-adipala-gunakan-limbah-kayu-hingga-uang-kertas>

⁵ <https://www.dunia-energi.com/terus-berinovasi-pln-indonesia-power-genjot-cofiring-pltu/>

Negative Economic Contribution to the Regional Economy

The operation of this coal-fired power plant has been shown to exert detrimental economic effects on the regional economy. With a decline in **Regional Gross Domestic Product (RGDP) of IDR 1.25 trillion**, the plant—rather than serving as an engine of economic growth—erodes the added value that should otherwise accrue to local communities and the region.

Losses in the Business Sector and Employment

The business sector incurs substantial losses, with a **negative business surplus of IDR 0.79 trillion per year**. The impacts on employment are equally significant, with a reduction in labor absorption reaching **38,738 jobs per year**.

In addition, **labor compensation declines by IDR 0.44 trillion per year**, indicating the loss of income sources and a deterioration in household welfare in affected areas.

Social, Environmental, and Operational Cost Burdens

Although the plant generates carbon emissions that are described as *relatively small* compared to larger coal-fired power plants—amounting to **2.61 kilotons of CO₂ per year**—its impacts on public health and the environment remain substantial. These burdens are compounded by very high operating costs, totaling **IDR 6.1 trillion per year**, which are disproportionate to the economic benefits produced. Sectoral impacts are also evident, with losses of **IDR 0.8 trillion per year** in the **agriculture, forestry, and fisheries sectors**, and losses of up to **IDR 2.26 billion per year** in the **health services and social activities sector**.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(814.846)
Mining and Quarrying	(17.764)
Manufacturing	(229.739)
Electricity and Gas Supply	(7.698)
Water Supply; Waste Management, Wastewater, and Recycling	(208)
Construction	(15.839)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(75.693)
Transportation and Warehousing	(22.578)
Accommodation and Food Service Activities	(3.565)
Information and Communication	(13.391)
Financial and Insurance Activities	(23.389)
Real Estate Activities	(3.412)
Business Activities	(11.230)
Public Administration, Defence, and Compulsory Social Security	(2.571)
Education Services	(621)
Human Health and Social Work Activities	(2.265)
Other Services	(6.302)
TOTAL	(1.251.111)

10

**Indramayu CFPP,
West Java
(990 MW)**



**CO-FIRING
IS
FALSE
SOLUTION**

**KIAMAT
SUDAH
DEKATI!
MASA
BAKAR
HUTAN
DIBILANG
HIJAU? 🌍**

**STOP ENERGY
COTOR,
BERANI BERSIH
ITU BAIK!**

**STOP ENERGY
COTOR,
BERANI BERSIH
ITU BAIK!**

Indramayu Coal-Fired Power Plant, West Java (990 MW)

https://www.gem.wiki/Indramayu_power_station

The Indramayu coal-fired power plant is located in West Java Province and consists of three coal-fired generating units with a total installed capacity of approximately 990 MW. All units are owned by PT Perusahaan Listrik Negara (Persero) (PLN) as the sole project operator. The financing of the plant's construction involved USD 129 million in equity from PLN and USD 730 million in loans from international banks, provided by a consortium that includes banks from China and Europe, as well as domestic banks such as Bank Mandiri and Bank Negara Indonesia (BNI), following Japan's withdrawal from the project's financing in 2022.¹

Although it is a large-scale power generation facility supporting the Java electricity system, the Indramayu coal-fired power plant faces environmental and financing challenges related to new projects, including delays in expansion permits and concerns over emission impacts on surrounding areas. Plans for the Indramayu II expansion (2 × 1,000 MW) have been challenged through legal action by local residents and WALHI over environmental permits, citing potential pollution and public health risks. Communities living near the site have reported deteriorating air quality since the introduction of biomass co-firing.

Ownership and Investors

Indramayu Coal-Fired Power Plant (PLTU Indramayu) Units 1–3

 Capacity
3x330 MW

 Loan Year
2008

 Lender Countries
Indonesia, China, France, Japan

 Total Loan
USD 946.990.000

 Loan Type
Loans and equity

 Loan Tenor
**3-year grace period,
13-year maturity**

 Commercial Operation
**2010 (unit 1)
2011 (unit 2-3)**

 Lenders
Bank Mandiri, Bank Negara Indonesia, Bank of China, Bank Rakyat Indonesia, BNP Paribas, China CITIC Bank, China Construction Bank, China Development Bank, Industrial and Commercial Bank of China (ICBC), PLN, Société Générale, Japan International Cooperation Agency

Source: China AidData, GEM Database

¹ <https://www.bbc.com/indonesia/indonesia-61985277>

General information

COD & power generation capacity	Unit 1 - 2010: 330 MW Unit 2 - 2011: 330 MW Unit 3 - 2011: 330 MW
Combustion technology	Subcritical
National target	Biomass co-firing implemented, use of 5% wood pellets since 2021
Types of coal and their sources	Coal: subbituminous, bioenergy: wood & other biomass (solids) [5%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

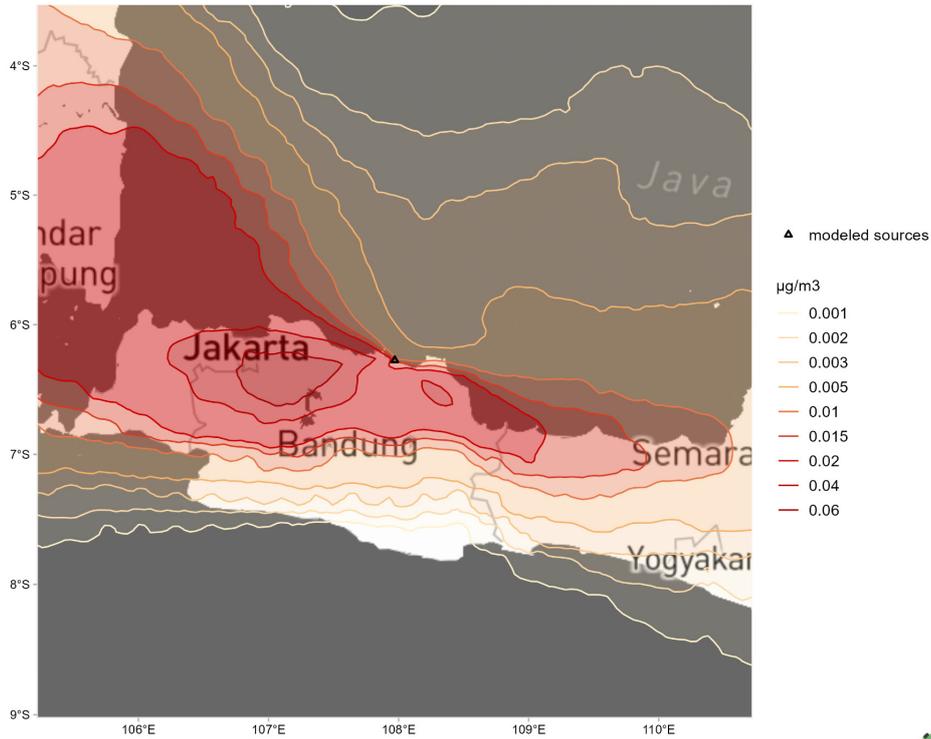
Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Indramayu coal-fired power**

plant can be associated with an estimated **336 total deaths per year among the adult population**, as well as **at least one death annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



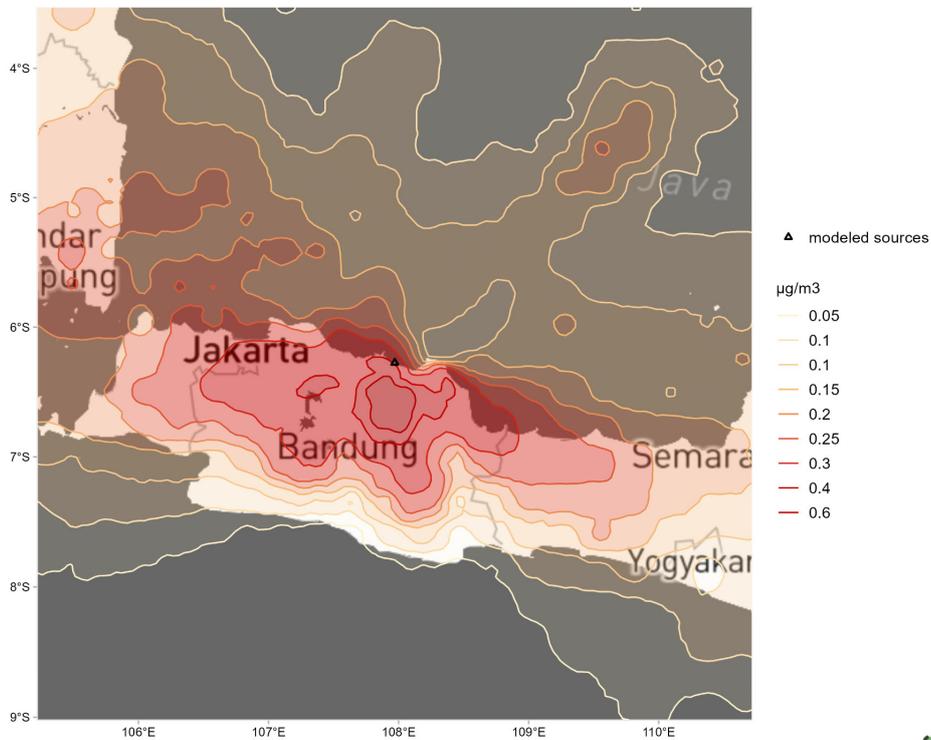
Annual mean PM2.5 concentration from Indramayu



CREA

Figure 1. Annual average PM2.5 dispersion from the Indramayu coal-fired power plant

Maximum 24-hour PM2.5 concentration from Indramayu



CREA

Figure 2. Maximum 24-hour PM2.5 concentration from the Indramayu coal-fired power plant

In terms of morbidity, air pollutant emissions from the **Indramayu coal-fired power plant** result in increased risks and incidences of respiratory diseases, including **327 (196–456) asthma-related emergency room visits** and **1,265 (338–2,567) new asthma cases**, as well as adverse impacts on children and unborn infants, comprising **160 (78–170) preterm births** and **105 (33–182) cases of low birth weight**. In addition, pollution-related illness and disability lead to productivity losses of **141,000 (120,000–161,000) lost workdays per year**, directly affecting economic activity.

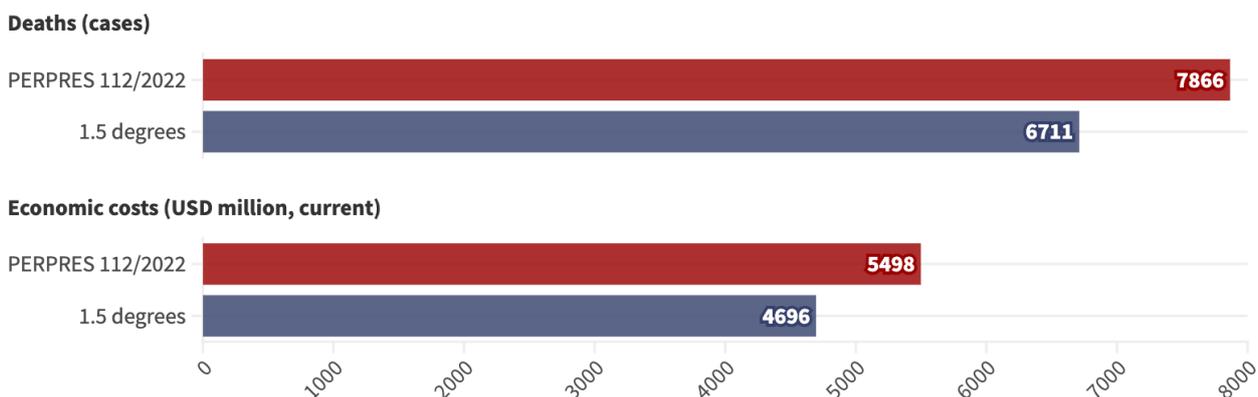
The economic burden on Indonesia arising from health impacts associated with air pollution from the Indramayu coal-fired power plant amounts to **USD 224 million per year**, equivalent to **IDR 3.41 trillion**. This substantial economic cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 1,155 cumulative deaths and reduce the national economic burden by USD 802 million, equivalent to IDR 12.7 trillion.

To realize these benefits, the **Indramayu coal-fired power plant must retire Units 1–3 by 2033**, prior to Indonesia’s emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Indramayu coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Indramayu coal-fired power plant

b. Impact on Surrounding Community

A dark story has haunted **Sumuradem Village** since the construction of this coal-fired power plant began. Previously, villagers earned their livelihoods as milkfish fry collectors, fishers, farmers, and salt producers. These occupations have become increasingly threatened and, in many cases, have disappeared **since Unit 1 began operating in 2010, forcing many residents to change professions—becoming construction laborers, ship workers, migrant workers, or falling into unemployment.** Even those who manage to work at the power plant are mostly employed as **security guards or cleaning staff.**

Thermal wastewater discharged from the power plant into the sea has destroyed milkfish fry habitats and narrowed fishing grounds, particularly for rebon shrimp fishers, as marine ecosystems continue to decline. Fishermen's nets are frequently damaged by coal barge anchoring activities, salt quality has deteriorated, and farmers increasingly experience crop failures.

These impacts have intertwined with other social problems. Some residents have been forced to take on additional debt to finance farming activities and to cover rising medical costs for illnesses suspected to be caused by smoke and coal dust emissions from the power plant. Monitoring conducted by **WALHI West Java** since **2015** shows an upward trend in **acute respiratory infections (ARI/ISPA).** This is further reinforced by data from the **Indramayu Health Office (2019–2021),** which recorded an increase in ARI cases—particularly among infants—in the village where the power plant is located.²

This power plant is included on **PLN's list of facilities conducting co-firing trials,** using **2 percent wood pellets,** equivalent to **240 tons per day,** which have been implemented since **2021.**³ However, to date, the biomass used has consisted solely of **sawdust,** sourced from various areas across **West Java,** including **Subang, Kuningan, Bandung, and even Tasikmalaya.** The required supply reaches **12,000 tons per month.** Unfortunately, fraudulent practices have been identified, in which suppliers deliberately **spray water onto sawdust loads on trucks** to artificially increase their weight by up to **40 percent,** a practice suspected of causing financial losses to the power plant of **more than IDR 1 billion per month.**⁴

Selain dari industri gergajian, Perhutani juga menandatangani MoU dengan PLN untuk memasok kebutuhan biomassa bagi *co-firing* PLTU, yang realisasinya mandek. Di balik semua ini, *co-firing* justru menjadi kedok untuk menunda pensiun PLTU tua seperti PLTU Indramayu.

c. Impact on Local and National Economy

The operation of the **Indramayu coal-fired power plant** has resulted in substantial economic losses, reflected in an annual decline in economic output of **IDR 2.17 trillion.** Despite relatively modest operating costs of approximately **USD 33.38 million,** the negative impacts on the broader economy are far more significant. Pollution and emissions generated by the plant have contributed to declining productivity in key economic sectors and have undermined the welfare of communities living in the surrounding areas.

2 <https://www.mongabay.co.id/2024/01/30/polusi-udara-dari-pltu-co-firing-indramayu-balita-rawan-terserang-isp-a-1/>

3 <https://www.mongabay.co.id/2024/01/30/polusi-udara-dari-pltu-co-firing-indramayu-balita-rawan-terserang-isp-a-1/>

4 <https://fwi.or.id/praktik-culas-pemasok-biomassa-di-pltu-indramayu/>

Operating costs	USD 33,38 million
Annual CO ₂ emissions	4,87 kiloton
Impact on annual economic output (gross domestic product)	- Rp2,17 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp2,20 trillion
Impact on annual business surplus	- Rp1,03 trillion
Impact on annual labor compensation	- Rp1,11 trillion
Impact on annual employment absorption	- 46.574 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp1,6 trillion
Sectoral impacts on health services and social activities	- Rp3,89 miliar

Negative Economic Contribution to the Regional Economy

The operation of this coal-fired power plant instead makes a negative contribution to the regional economy. Data show that the operation of the **Indramayu coal-fired power plant** causes an annual decline in **Regional Gross Domestic Product (RGDP)** of **IDR 2.20 trillion**. This figure indicates that the plant does not generate meaningful added value and instead erodes economic growth in the surrounding region.

Losses in the Business Sector and Employment

From a business perspective, the plant records a **negative business surplus of IDR 1.03 trillion per year**. The impacts on employment are also substantial, with a reduction in labor absorption of up to **46,574 jobs annually**. In addition, **labor compensation declines by IDR 1.11 trillion per year**, reflecting reduced purchasing power and weakening household economic stability in affected communities.

Social, Environmental, and Operational Burdens

The plant produces **4.87 kilotons of CO₂ emissions per year**, posing serious risks to public health and further exacerbating the climate crisis. At the same time, operating costs reach **IDR 3.3 trillion per year**, a considerable figure that is disproportionate to its economic benefits. Sectoral losses are also widespread, with the **agriculture, forestry, and fisheries sectors** experiencing annual value losses of **IDR 1.6 trillion**, while the **health services and social activities sector** incurs losses of up to **IDR 3.89 billion per year**.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.599.107)
Mining and Quarrying	(24.973)
Manufacturing	(275.234)
Electricity and Gas Supply	(18.145)
Water Supply; Waste Management, Wastewater, and Recycling	(2.174)
Construction	(28.024)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(112.259)
Transportation and Warehousing	(42.501)
Accommodation and Food Service Activities	(3.774)
Information and Communication	(16.012)
Financial and Insurance Activities	(30.312)
Real Estate Activities	(5.654)
Business Activities	(21.177)
Public Administration, Defence, and Compulsory Social Security	(991)
Education Services	(1.636)
Human Health and Social Work Activities	(3.896)
Other Services	(13.026)
TOTAL	(2.198.895)



11

**Labuan CFPP
(Banten 2),
Banten (600 MW)**



Labuan Coal-Fired Power Plant (Banten 2), Banten (600 MW)

https://www.gem.wiki/Banten_Labuan_power_station

The **Labuan coal-fired power plant (Banten 2 CFPP)** is located in **Sukamaju Village, Labuan Subdistrict, Pandeglang Regency, Banten**, and is operated by the **Banten 2 Labuan Generation Business Unit (PGU)**, a subsidiary of **PT PLN Indonesia Power (IP)**. The plant consists of **two generating units of 300 MW each**, with a total installed capacity of **600 MW** under IP's ownership. **Unit I** was first synchronized with the **Java–Bali grid** in **July 2009** and was officially inaugurated by **President Susilo Bambang Yudhoyono** on **28 January 2010**, while **Unit II** subsequently entered the testing phase and commenced commercial operation in **March 2010**.

The development of the Labuan CFPP was anchored in the **10,000 MW Power Acceleration Program** (Presidential Regulation No. 71/2006). Project groundbreaking took place around **April 2007**, with **Chengda Engineering (China)** serving as the main EPC contractor. The total investment value reached approximately **IDR 4–4.5 trillion**. The plant was constructed on **coastal land**, equipped with a **dedicated jetty and coal yard** to support coal logistics, and directly interconnected to the **Java–Bali grid via a 500 kV transmission network**.

Ownership and Investors

Labuan Coal-Fired Power Plant Units 1–2



Capacity
2x300 MW



Total Loans
Data not publicly available

Note: Data related to the financing of this coal-fired power plant—including total financing amounts, lenders, loan tenors, financing instruments, and other details—are not publicly disclosed and remain scattered across various information sources. The authors submitted a formal request for information disclosure through the **Public Information and Documentation Officer (PPID)** to **PLN** in **May**. Unfortunately, the response was unsatisfactory. PLN stated that the requested information falls under the authority and

management of its power generation sub-holding companies.

Subsequently, the authors submitted the same request to **PT Indonesia Power (IP)** via email in **June 2025**, as the company's website does not provide a PPID feature. However, as of the writing of this report, no response has been received. This situation is deeply regrettable, as it prevents the public from accessing information that should be available, transparent, and easily accessible.

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2009: 300 MW Unit 2 - 2010: 300 MW
Combustion Technology	Subcritical
National Targets	Biomass co-firing, use of solid refuse-derived fuel
Types of Coal and Their Sources	Coal: unknown, bioenergy: agricultural residues (solid)

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

In terms of air pollution–related mortality, the operation of the **Labuan coal-fired power**

plant can be associated with an estimated **241 total deaths per year among the adult population**, as well as **at least one death annually among children under the age of five** due to lower respiratory infections. These estimates are derived from measured health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated health outcomes include stroke, ischemic heart disease, lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.



Annual mean PM2.5 concentration from Labuan

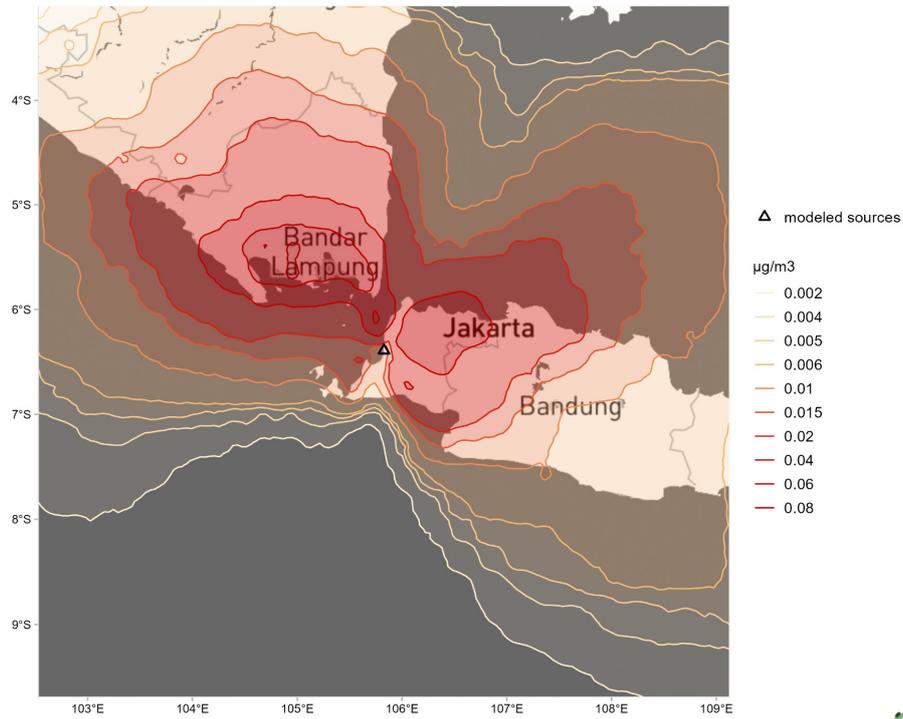


Figure 1. Annual average dispersion of PM2.5 from the Labuan Banten coal-fired power plant

Maximum 24-hour PM2.5 concentration from Labuan

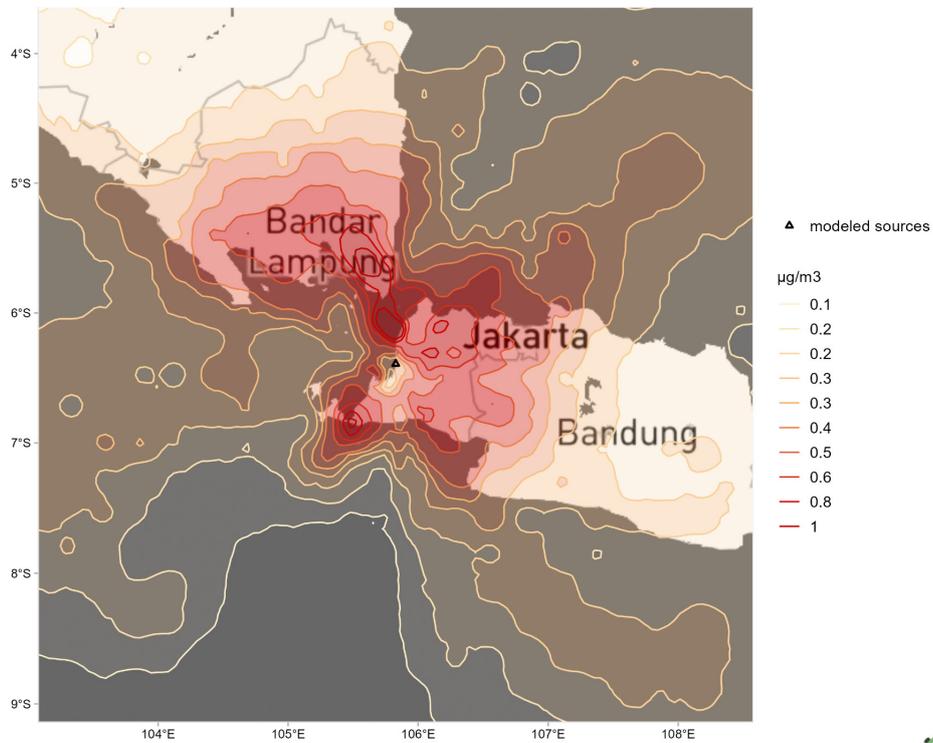


Figure 2. Maximum 24-hour PM2.5 concentration from the Labuan Banten coal-fired power plant

In terms of morbidity, air pollutant emissions from the **Labuan coal-fired power plant** lead to increased risks and incidences of respiratory diseases, including **261 (156–364) asthma-related emergency room visits** and **623 (166–1,264) new asthma cases**, as well as adverse impacts on children and unborn infants, comprising **128 (62–136) preterm births** and **84 (26–145) cases of low birth weight**. In addition, pollution-related illness and disability result in productivity losses of **112,000 (95,000–129,000) lost workdays per year**, directly affecting economic activity.

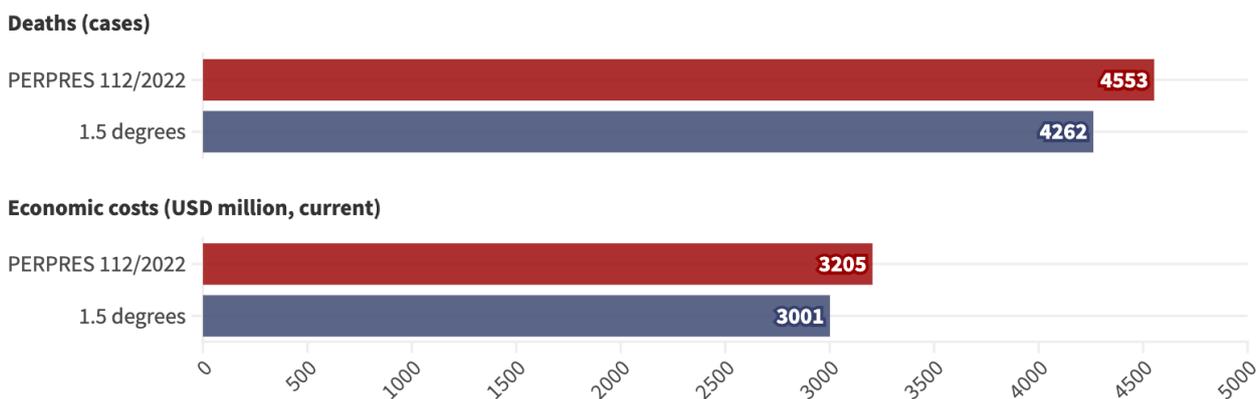
The economic burden on Indonesia arising from health impacts associated with air pollution from the Labuan coal-fired power plant amounts to **USD 160 million per year**, equivalent to **IDR 2.40 trillion**. This substantial economic cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and productivity losses due to work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avoid 291 cumulative deaths and reduce the national economic burden by USD 204 million, equivalent to IDR 3.24 trillion.

To realize these benefits, the **Labuan coal-fired power plant must retire Units 1–2 by 2030**, prior to Indonesia’s emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Labuan coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Labuan coal-fired power plant

b. Impact on Surrounding Community

The operation of this coal-fired power plant has caused environmental impacts on surrounding communities, further exacerbating existing environmental degradation in the Banten region. In **December 2024**, a **coal spill from a barge** occurred near the plant area, polluting local waters and threatening **coral reef ecosystems**. For fishers, the incident resulted in direct losses, as the spill occurred in one of their primary fishing grounds. Similar incidents have occurred repeatedly, generating growing concern among local communities over the ongoing risks posed by the plant's operations to marine ecosystems and coastal livelihoods.¹

Since **2023**, this power plant has implemented **biomass co-firing** using **agricultural waste**. As of **November 2024**, approximately **80,000 tons of biomass** have been burned, including **energy crops cultivated by local farmers**.² This power plant has also become a **pilot project for green ammonia co-firing**, involving a trial of a **three percent ammonia blend** conducted over **three hours**, requiring **50 tons of fuel**, as part of a collaboration

between **PLN Indonesia Power, Pupuk Kujang**, and **IHI Corporation**.³

Rather than advancing a just energy transition, **biomass and ammonia co-firing** have instead become strategies to **extend the operational lifespan of coal-fired power plants that should already be retired**. Behind the green narrative, what is unfolding is a diversion away from real solutions: **ending coal use, protecting the environment, and restoring community rights**.

c. Impact on Local and National Economy

The operation of the **Labuan coal-fired power plant** results in significant economic losses, reflected in an annual decline in economic output of **IDR 2.17 trillion**. Although its operating costs are recorded at approximately **USD 39.66 million**, the resulting economic losses far exceed this figure. Emissions and pollution from the plant's activities have reduced community productivity and constrained the growth of key economic sectors in surrounding areas, driven in part by annual **CO₂ emissions reaching 2.95 kilotons**.

Operating costs	USD 39,66 million
Annual CO ₂ emissions	2,95 kiloton
Impact on annual economic output (gross domestic product)	- Rp2,17 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- Rp2,20 trillion
Impact on annual business surplus	- Rp1,03 trillion
Impact on annual labor compensation	- Rp1,11 trillion
Impact on annual employment absorption	- 46.574 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	- Rp1,6 trillion
Sectoral impacts on health services and social activities	- Rp3,89 miliar

¹ <https://www.beritasatu.com/banten/2861580/tongkang-batu-bara-kandas-di-perairan-labuan-pandeglang>

² https://www.gem.wiki/Banten_Labuan_power_station

³ <https://www.metrotvnews.com/read/KYVC4gY4-tekan-emisi-karbon-pln-ip-uji-coba-penggunaan-green-am>

Implications for the Regional Economy

To keep it operating, the **Labuan (Banten) coal-fired power plant** incurs operating costs of **IDR 3.3 trillion per TWh of electricity produced**. Based on the analysis, this capital-intensive operation has instead generated negative implications for the regional economy. Rather than creating added value, the Labuan CFPP has exerted downward pressure on **Regional Gross Domestic Product (RGDP)**, resulting in a contraction of **IDR 2.20 trillion**. Moreover, net business gains have also been eroded, with **business surplus declining by IDR 1.03 trillion per year**.

Contraction of the Employment Sector

These economic burdens extend into the labor market. **Labor compensation** has declined significantly, amounting to **IDR 1.11 trillion per year**. This pressure is directly associated with shrinking employment opportunities, with **46,574 jobs lost** that could otherwise have been created had the regional economy been directed toward more productive

and sustainable sectors. In other words, the presence and continued operation of the Labuan (Banten) CFPP in **Pandeglang Regency** not only drains financial resources but also narrows the living space and prospects of workers.

Implications for the Environment and Other Strategic Sectors

The plant's negative impacts extend to strategic sectors that underpin economic sustainability and community well-being. The operation of the Labuan Banten CFPP imposes the largest economic burden on the **agriculture, forestry, and fisheries sectors**, with losses reaching **IDR 197.27 billion per year**. Two other sectors are also significantly affected: **manufacturing**, which incurs losses of approximately **IDR 27.41 billion**, and **wholesale and retail trade**, which loses up to **IDR 12.98 billion per year**. These three highest loss figures indicate that the Labuan Banten CFPP primarily weakens productive sectors that are highly dependent on environmental quality and public health.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(197.271)
Mining and Quarrying	(2.100)
Manufacturing	(27.411)
Electricity and Gas Supply	(1.580)
Water Supply; Waste Management, Wastewater, and Recycling	(33)
Construction	(1.096)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(12.983)
Transportation and Warehousing	(4.350)
Accommodation and Food Service Activities	(412)
Information and Communication	(1.275)
Financial and Insurance Activities	(1.974)
Real Estate Activities	(611)
Business Activities	(1.191)
Public Administration, Defence, and Compulsory Social Security	(135)
Education Services	(58)
Human Health and Social Work Activities	(302)
Other Services	(784)
TOTAL	(253.566)

12

**Batang CFPP,
Central Java
(1.900 MW)**



Batang Coal-Fired Power Plant, Central Java (1,900 MW)

https://www.gem.wiki/Central_Java_Power_Project

The **Batang coal-fired power plant**, commonly known as **CJPP (Central Java Power Plant)**, is a coal-based power facility located in **Ujungnegoro and Ponowareng Villages, Kandeman Subdistrict, Batang Regency, Central Java**. The plant has an installed capacity of **2 × 1,000 MW**, with a net capacity of approximately **1,982 MW**, making it one of the largest coal-fired power plants in Southeast Asia constructed in a single phase.

The Batang CFPP was developed and is operated by **PT Bhimasena Power Indonesia (BPI)**, a consortium comprising Indonesian and Japanese companies: **Adaro Power (34%)**, **J-Power (34%)**, and **Itochu Corporation (32%)**, under a **Build–Operate–Transfer (BOT)** scheme for a period of **25 years** before being transferred to **PLN**. The total project investment amounts to approximately **USD 4.2 billion**, with major financing provided by the **Japan Bank for International Cooperation (JBIC)** and **Sumitomo Mitsui Banking Corporation**.

Unit 1 commenced commercial operation (**Commercial Operation Date/COD**) on **20 August 2022**, followed by **Unit 2** on **17 October 2022**, according to official reports from **PLN** and **Bhimasena Power Indonesia**. The power plant occupies an area of more than **226 hectares** and is connected to the **Java–Bali 500 kV transmission network** through the **Tuntang substation**. Electricity generated by the plant is intended to strengthen power supply in **Central Java and surrounding regions**.

However, from the planning phase through construction, the Batang CFPP faced strong resistance from local communities and civil society groups. Opposition emerged primarily because the project site is located near the **Ujungnegoro–Roban marine conservation area**, a coastal zone known for its high biodiversity and as a vital livelihood area for **traditional fishers**.

Ownership and Investors

Batang Coal-Fired Power Plant Units 1–2

 Capacity
2x950 MW

 Type of Financing
Loans, government guarantees, equity

 Lender Countries
World Bank, Japan, Indonesia

 Total Financing
USD 4,31 billion

 Commercial Operation Date
2022

 Lenders
World Bank, Japan Bank for International Cooperation (JBIC), MUFG Bank, Mizuho Financial Group, Mitsubishi UFJ Trust and Banking, Norinchukin Bank, Shinsei Bank, Sumitomo Mitsui Trust Holdings, Sumitomo Mitsui Banking Corporation, DBS Bank, Oversea-Chinese Banking Corporation, Adaro Energy, Itochu, J-Power

Source: GEM¹ Website

¹ https://www.gem.wiki/Central_Java_Power_Project

General Info

Commercial Operation Date (COD) and Power Generation Capacity Unit 1 - 2022: 950 MW
Unit 2 - 2022: 950 MW

Combustion Technology Ultra-supercritical

National Targets None

Types of Coal and Their Sources Coal: sub-bituminous

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to hazardous air pollutants increases the risk of premature mortality and a wide range of diseases.

With regard to air-pollution-related mortality, the operation of the Batang coal-fired power plant in

Central Java can be associated with an estimated **899 deaths per year among the adult population**, as well as **four deaths among children under the age of five** due to lower respiratory tract infections. These estimates are derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated disease burden includes **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes**.



Annual mean PM2.5 concentration from Jawa Tengah

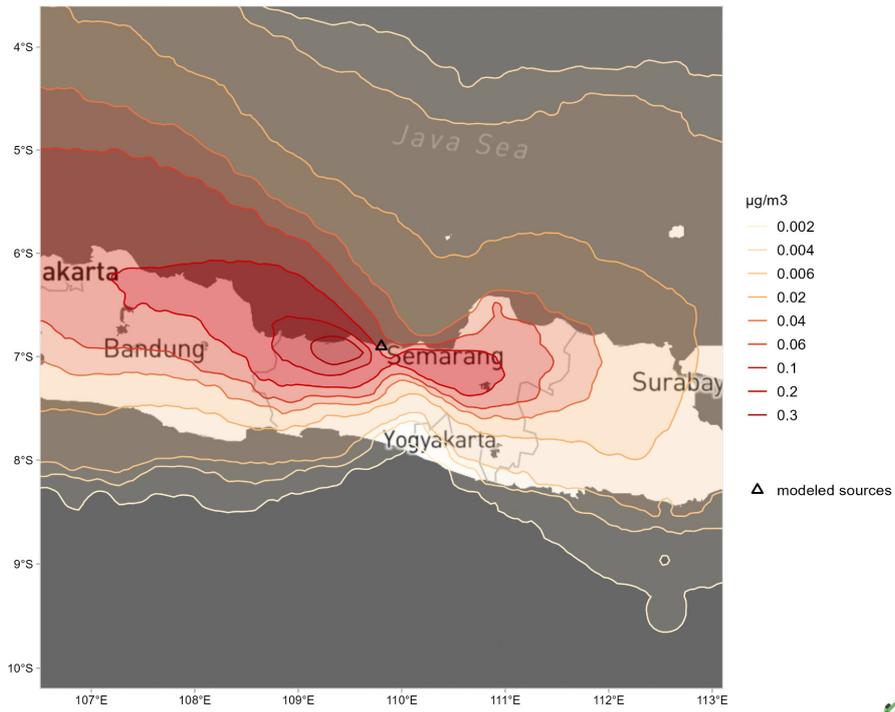


Figure 1. Annual average PM2.5 dispersion from the Batang Coal-Fired Power Plant

Annual mean PM2.5 concentration from Jawa Tengah

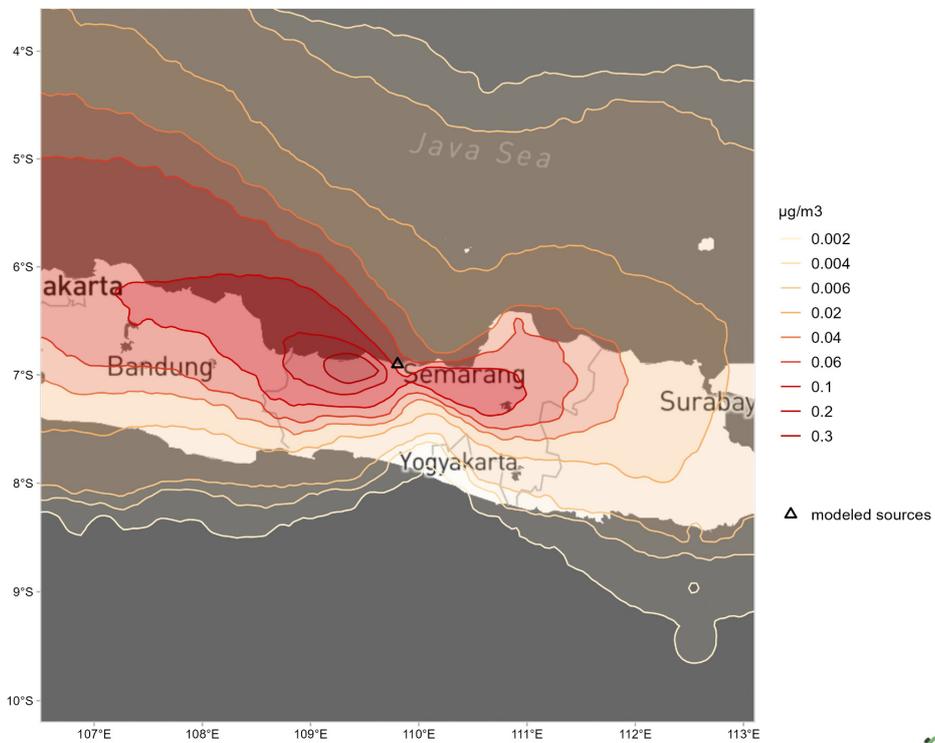


Figure 2. Maximum 24-hour PM2.5 concentration from the Batang Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the Batang coal-fired power plant are associated with increased risks and incidences of respiratory diseases, including an estimated 982 (589–1,370) asthma-related emergency room visits and 2,229 (595–4,524) new asthma cases. Adverse impacts on children and unborn infants are also observed, with 482 (234–511) cases of preterm birth and 316 (98–547) cases of low birth weight. In addition, productivity losses due to illness and disability amount to an estimated 423 (360–485) thousand workdays lost annually, directly affecting economic activity.

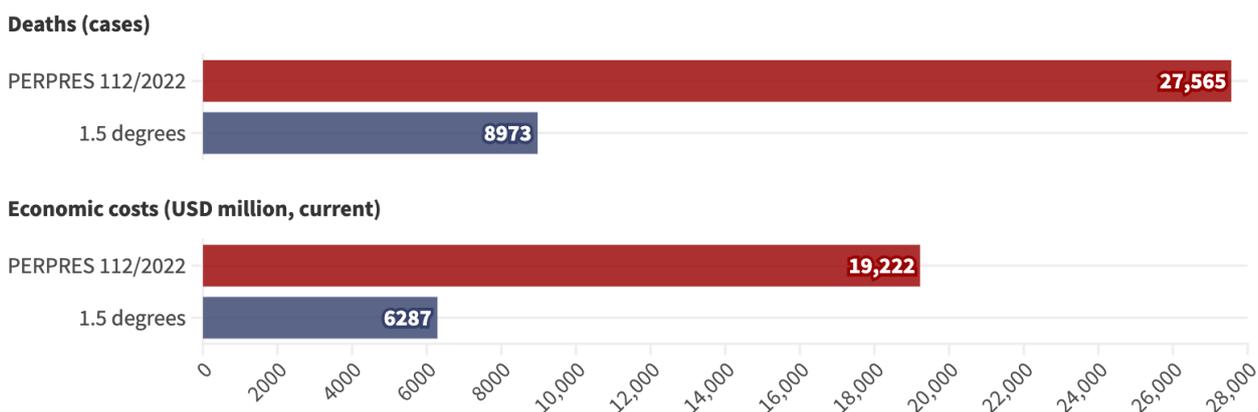
The economic burden on Indonesia arising from health impacts associated with air pollution from the Batang power plant is estimated at USD 598 million per year, equivalent to IDR 9.11 trillion. This substantial economic burden is primarily driven by

premature mortality, while also accounting for hospital costs related to morbidity and the costs of work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5-degree pathway would avert a cumulative total of 18,592 deaths and reduce the national economic burden by USD 13 billion, equivalent to IDR 205 trillion.

To realize these benefits, the Batang coal-fired power plant would need to cease operation of Unit 2 in 2032 and Unit 1 in 2033, prior to Indonesia’s emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Batang coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Proyeksi masa depan dampak polusi udara terhadap kematian dan biaya ekonomi dari PLTU Batang

b. Impact on Surrounding Community

The majority of residents in Karanggeneng Hamlet, Ponowareng, and Ujungnegoro work as tenant farmers cultivating rice fields and jasmine flowers. It was these tenant farmers who were among the most affected by job losses following the conversion of agricultural land into the coal-fired power plant site. Many landowners also ceased farming, as the compensation they received was insufficient to purchase replacement land elsewhere. Those who continued farming found their land far less productive than before—previously yielding up to three harvests per year—due to the destruction and disappearance of irrigation rivers as a result of the power plant’s construction. As a consequence, many residents have shifted to irregular day labor and construction work.

Fisherfolk have faced a double burden. Fishing gear has frequently been damaged after becoming entangled in construction debris from the jetty and pipeline infrastructure, while declining fish stocks have forced them to travel farther offshore to secure a viable catch. This situation has led to rising household debt, particularly in East Roban Hamlet, where fishers reportedly incur debts of approximately IDR 1.5–2 million per fishing gear set for repairs.

The area where the jetty was built was previously designated as a Regional Marine Conservation Area (Kawasan Konservasi Laut Daerah, KKLD) by the Ministry of Marine Affairs, known for large coral formations

such as Preketek and Sebangang that served as breeding grounds for marine life. The conservation area has since been shifted westward, and the coral reefs were destroyed—an outcome that fishers say has eliminated one of the most productive fishing grounds in the area.

Some local residents who found employment at the power plant were hired only as unskilled or construction laborers. In several cases, residents reportedly had to pay intermediaries or third parties in order to secure employment at the facility.

From the early stages of development, the Batang coal-fired power plant faced strong resistance from local communities. Many landowners, including women, experienced intimidation and even physical violence from hired thugs as well as state security apparatus such as the police and military. Approximately seven residents were criminalized and imprisoned on charges of committing violence, despite not being present at the scene at the time of the alleged incidents.

The land acquisition process was also deeply problematic. Parcels purchased during the initial phase were priced cheaply, in some cases even below the official taxable land value (NJOP) at the time. Several landowners who had consistently opposed the power plant have refused to collect the compensation funds deposited at the Batang District Court, arguing that the amount offered does not reflect the long-term economic benefits they previously derived from their land.

c. Impact on Local and National Economy

The operation of the Bangka coal-fired power plant imposes a substantial economic burden, as reflected in a decline in economic output of up to **IDR 3.56 trillion per year**. With operating costs of approximately **USD 47.97**

million, the scale of these losses indicates a clear imbalance between the energy benefits produced and the economic damage incurred. Annual carbon emissions of **7.4 kilotons** further exacerbate environmental degradation and place additional pressure on economic activities in productive sectors that sustain local communities.

Operating costs	USD47,97 million
Annual CO ₂ emissions	7,4 kilotons
Impact on annual economic output (gross domestic product)	-Rp3,56 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-Rp3,55trillion
Impact on annual business surplus	-Rp2,24 trillion
Impact on annual labor compensation	-Rp1,23 trillion
Impact on annual employment absorption	-109.832 people
Sectoral impacts on agriculture, forestry, and fisheries	-Rp2.3 trillion
Sectoral impacts on health services and social activities	-Rp6.4 billion

Implications for the Regional Economy

With operating costs of **USD 47.97 million per TWh of electricity produced** (equivalent to **IDR 782.28 billion** at an exchange rate of IDR 16,299/USD), the Batang coal-fired power plant absorbs substantial financial resources while exerting downward pressure on regional economic activity. The data indicate that economic output declines by up to **IDR 3.56 trillion per year**, accompanied by a contraction in **Gross Regional Domestic Product (GRDP)** of **IDR 3.55 trillion**. These losses are directly borne by business actors, as reflected in a reduction of business surplus amounting to **IDR 2.24 trillion**. In effect, not only are public funds drained, but the region's economic potential—

resources that could otherwise be mobilized to support productive sectors—becomes locked into an unsustainable energy model.

Contraction of the Labor Sector

These economic losses have a parallel social dimension: the erosion of workers' welfare. Labor compensation declines sharply by **IDR 1.23 trillion per year**. Moreover, **109,832 individuals** either lose employment opportunities or never obtain jobs that could have been created had financial resources and energy investments been redirected toward sectors with higher productivity and greater labor absorption. This represents a dual loss: the disappearance of livelihoods and the erosion of household purchasing power.

Implications for the Environment and Other Strategic Sectors

The damage caused by the Batang coal-fired power plant also extends to strategic sectors that underpin food security and public health. The

agriculture, forestry, and fisheries sectors incur losses amounting to **IDR 2.3 trillion per year**, reflecting the degradation of natural resources and life-supporting ecosystems. Health services and social activities are likewise affected, with losses of **IDR 6.4 billion**, adding further strain to already limited public service capacities.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(2.310.291)
Mining and Quarrying	(50.365)
Manufacturing	(651.368)
Electricity and Gas Supply	(21.825)
Water Supply; Waste Management, Wastewater, and Recycling	(590)
Construction	(44.907)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(214.608)
Transportation and Warehousing	(64.014)
Accommodation and Food Service Activities	(10.107)
Information and Communication	(37.966)
Financial and Insurance Activities	(66.315)
Real Estate Activities	(9.673)
Business Activities	(31.841)
Public Administration, Defence, and Compulsory Social Security	(7.288)
Education Services	(1.762)
Human Health and Social Work Activities	(6.422)
Other Services	(17.869)
TOTAL	(3.547.211)

13

**Ombilin CFPP,
West Sumatra
(200 MW)**



Ombilin Coal-Fired Power Plant, West Sumatra (200 MW)

https://www.gem.wiki/Ombilin_power_station

The Ombilin Coal-Fired Power Plant is located in Sijantang Koto Village, Talawi District, Sawahlunto City, West Sumatra. This coal-fired facility consists of two generating units with a total installed capacity of 200 MW—each unit rated at 100 MW—which commenced commercial operation on 26 August 1996 (Unit 1) and 15 November 1996 (Unit 2). The plant employs aging subcritical technology, with an average thermal efficiency of approximately 33–37%. Its coal supply is sourced directly from the nearby Ombilin coal mine, forming an integrated local system of power generation and fuel distribution.

In terms of infrastructure, the plant is equipped with coal combustion residual (FABA) handling facilities at several locations surrounding the power station. However, these facilities have become a source of dispute due to the accumulation of waste and associated pollution. For emissions monitoring, the Ombilin Power Plant is required to operate a Continuous

Emission Monitoring System (CEMS), although its effectiveness has been questioned following the discovery of a damaged stack filter in June 2018.¹

Civil society organizations have urged that the power plant be shut down, or at a minimum that its environmental governance and public health management be substantially improved. This demand stems, among other factors, from violations committed by the plant, including the accumulation of hazardous coal ash (classified as B3 waste) at unlicensed sites and damage to the smokestack, which resulted in administrative sanctions imposed by the Ministry of Environment and Forestry (KLHK) in August 2018. However, subsequent legal efforts—such as a lawsuit filed against KLHK at the Jakarta State Administrative Court (PTUN) in January 2025—were rejected. To date, KLHK has not revoked the plant’s operating permit, even as affected residents continue to pursue legal accountability for repeated violations.

Ownership and Investors

Ombilin Coal-Fired Power Plant Units 1–2



Capacity
2x100 MW



Commercial Operation Date
1996 (unit 1) 1997 (unit 2)



Total Loans
The Ombilin power plant was constructed at an estimated cost of approximately USD 200 million. Project financing was sourced from foreign loans and internal funds of PT PLN (Persero), the state-owned electricity company.



Lenders
Information regarding the financing syndication for this power plant is not available in open sources.

¹ <https://trendasia.org/media-briefing-mengapa-izin-pltu-ombilin-layak-untuk-dicabut/>

General Info

Commercial Operation Date (COD) and Power Generation Capacity

Unit 1 - 1996: 100 MW
Unit 2 - 1997: 100 MW

Combustion Technology

Subcritical

National Targets

Biomass co-firing, estimated to use 5% sawdust in 2025

Types of Coal and Their Sources

Coal: sub-bituminous from Sawahlunto; bioenergy: wood and other solid biomass [5%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that endanger health increases the risk of premature mortality and a wide range of diseases.

In terms of mortality attributable to air pollution, the operation of the Ombilin coal-fired power plant can be associated with 21 total deaths per year among the adult population. This estimate is derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to NO₂, SO₂, and PM_{2.5}. These diseases include stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes.



Annual mean PM2.5 concentration from Ombilin

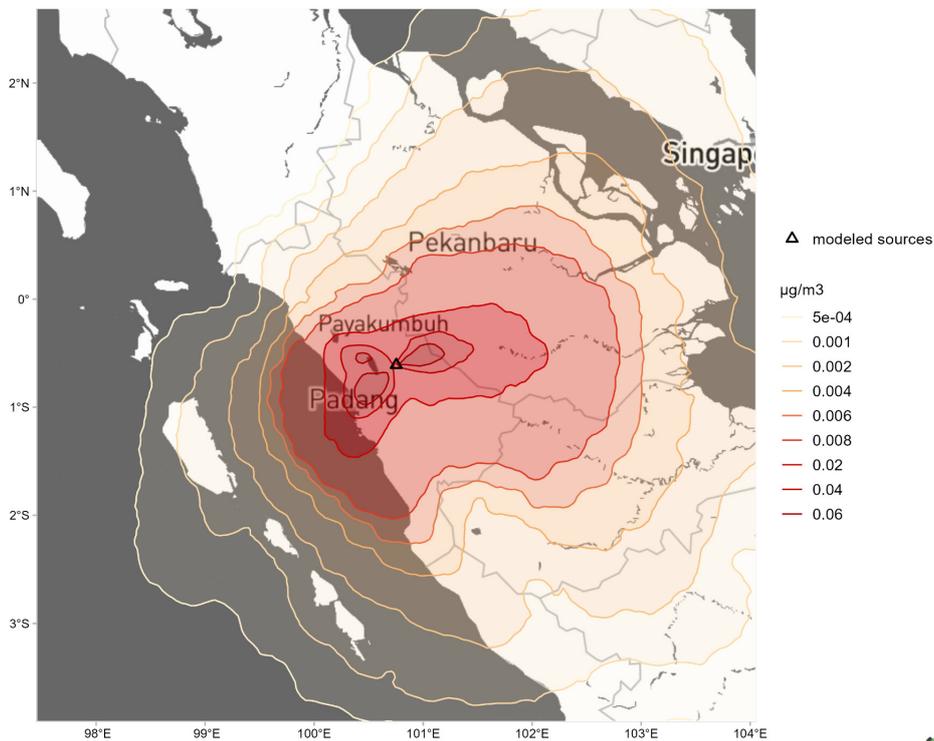


Figure 1. Annual average dispersion of PM2.5 from the Ombilin coal-fired power plant

Maximum 24-hour PM2.5 concentration from Ombilin

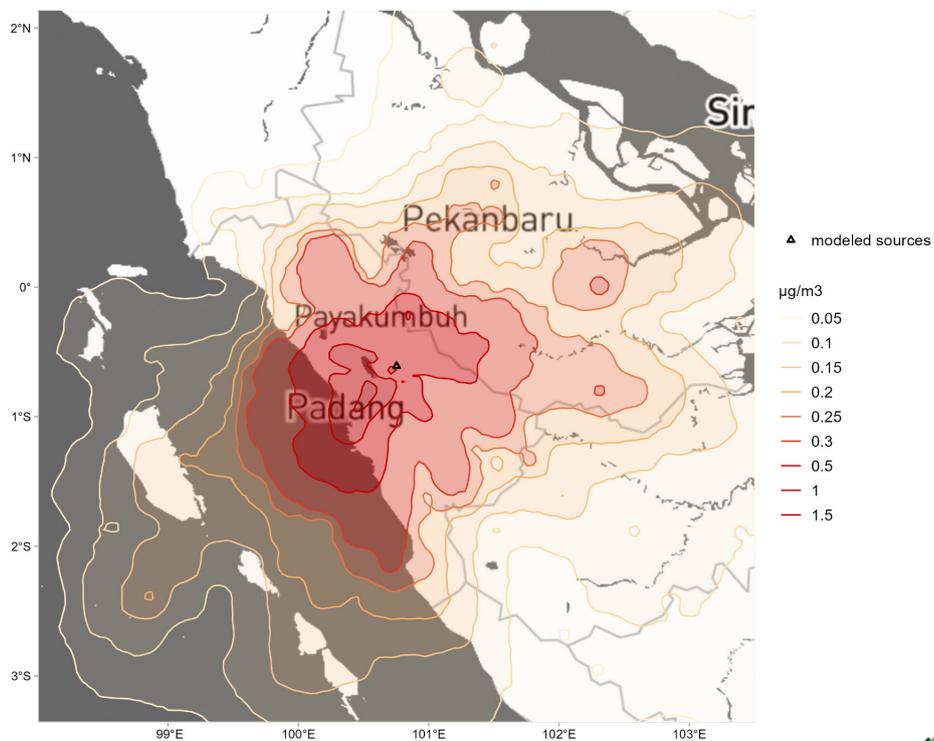


Figure 2. Maximum 24-hour PM2.5 concentration from the Ombilin coal-fired power plant

In terms of morbidity, air pollutant emissions from the Ombilin coal-fired power plant lead to increased risks and incidences of respiratory diseases, including an estimated **25 (15–35) asthma-related emergency room visits** and **27 (7–55) new asthma cases** annually. Adverse impacts are also observed among children and unborn infants, with **13 (6–13) cases of preterm birth** and **8 (3–14) cases of low birth weight** attributed to air pollution exposure. In addition, productivity losses resulting from illness and disability amount to approximately **11 (9–13) thousand workdays lost per year**, directly affecting economic activity.

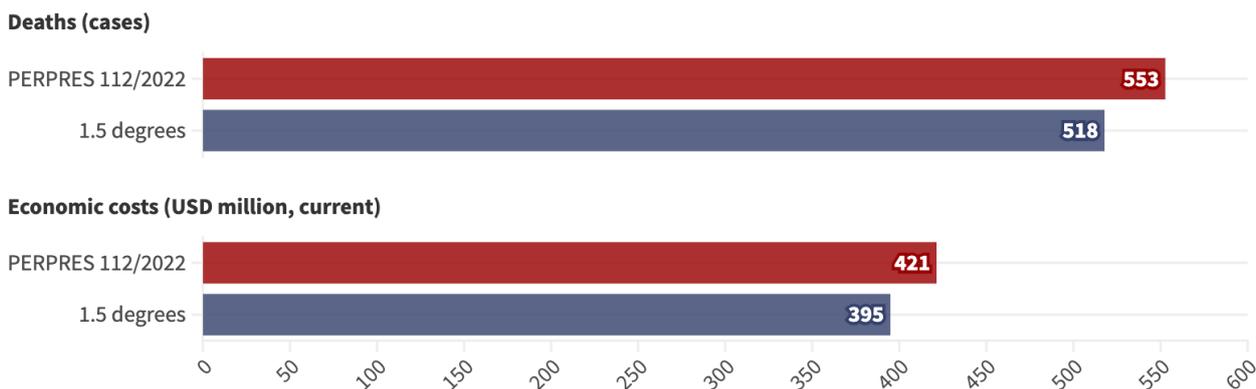
The economic burden on Indonesia associated with health impacts from air pollution attributable to the Ombilin power plant is estimated at **USD 15 million per year**, equivalent to **IDR 0.22 trillion**. The majority of this economic burden is driven by premature

mortality, while hospital treatment costs for morbidity and losses due to work absenteeism also contribute significantly.

Under future projections developed based on retirement schedules and the implementation of air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would prevent 35 cumulative premature deaths and reduce the national economic burden by USD 26 million, equivalent to IDR 413 billion.

To realize these benefits, the Ombilin coal-fired power plant would need to be decommissioned by **2032**, prior to Indonesia's projected emissions peak in **2035**.

Cumulative air pollution-related deaths and economic costs attributed to Ombilin coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Ombilin coal-fired power plant

b. Impact on Community Sekitar

The Ombilin Coal-Fired Power Plant is one of the oldest coal power plants in Sumatra, having been in operation since 1996 with a total capacity of 200 MW. It is located in Sijantang Koto Village, approximately 15 km from the center of Sawahlunto City, West Sumatra.²

In the village where the Ombilin power plant is located, two rounds of health examinations were conducted among students of SD 19 Sijantang Koto between December 2016 and January 2017. The findings revealed that by January, more than 50 students in grades III and IV were experiencing impaired lung function. Approximately 34 students (76%) were diagnosed with mild obstruction, while others were found to suffer from chronic bronchitis and pulmonary tuberculosis (TB).

The examinations also identified a correlation between reduced lung function and abnormalities in chest X-ray results with residential proximity to the plant, particularly among children living within a distance of 1 km. Subsequently, during another health screening conducted in December 2017 involving 53 students from grades IV and V, 40 children were found to be in normal physical condition, while 10 children exhibited abnormal physical conditions. Analysis of the chest X-ray results indicated that **66% of the elementary school students had already developed respiratory disorders**, including chronic bronchitis and pulmonary TB.

Publications by Statistics Indonesia (BPS) also show that, among the ten most commonly recorded diseases, **acute respiratory infections (ARI/ISPA)** consistently ranked highest across all community health centers (puskesmas) in Sawahlunto City throughout the period **2011–2022**.³

This aging coal-fired power plant has also been subjected to sanctions by the Ministry of Environment and Forestry (KLHK) in **2017** for serious violations. These included coal ash (bottom ash) contamination across several areas and damage to the plant's emission stacks, which resulted in the release of fly ash—at that time still classified as hazardous and toxic waste (B3).⁴

Legal action was subsequently pursued by **LBH Padang**, challenging KLHK's failure to follow up on the sanctions by freezing or revoking the environmental permit of the Ombilin power plant. However, the lawsuit was dismissed by the Jakarta Administrative Court (PTUN Jakarta) on the grounds that LBH Padang lacked legal standing. In doing so, the court disregarded factual evidence of fly ash and bottom ash (FABA) pollution that has forced nearby residents to inhale polluted air on a daily basis.⁵

The Ombilin power plant is also included in PLN's co-firing pilot program, utilizing **5% sawdust biomass**. Such measures function merely as a technical pretext to extend the operational lifespan of the plant, which is currently scheduled to be retired only in **2060**, or four decades from now⁶—despite the extensive environmental, health, and social harms that have already been documented.

2 https://www.gem.wiki/Ombilin_power_station

3 https://trendasia.org/wp-content/uploads/2024/11/Briefing-Paper-Mengapa-Izin-PLTU-Ombilin-Layak-untuk-Dicabut_.pdf, hal. 3

4 Idem footnote 19, hal.1

5 <https://trendasia.org/gugatan-lingkungan-lbh-padang-tidak-diterima-ptun-jakarta-abaikan-fakta-pencemaran-limbah-beracun-pltu-ombilin/>

6 <https://industri.kontan.co.id/news/co-firing-pltu-ombilin-kerek-perekonomian-masyarakat>

c. Impact on Local and National Economy

The operation of the Ombilin coal-fired power plant generates adverse economic impacts, as reflected in an annual decline in economic output of approximately **IDR 0.16 trillion**.

With a carbon footprint of **1.15 kilotons of CO₂ per year**, this facility remains a source of emissions that contributes to the climate crisis. Although its scale is smaller than that of larger coal-fired power plants, the cumulative impact of facilities such as Ombilin remains significant when assessed at the national level.

Operating costs	USD 10,98 million
Annual CO ₂ emissions	1,15 kiloton
Impact on annual economic output (gross domestic product)	-Rp0,16 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-Rp0,16 trillion
Impact on annual business surplus	-Rp0,10 trillion
Impact on annual labor compensation	-Rp0,06 trillion
Impact on annual employment absorption	-2.825 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	-Rp0,107 trillion
Sectoral impacts on health services and social activities	-Rp0,35 miliar

Implications for the Regional Economy

Operating the Ombilin coal-fired power plant entails substantial costs—amounting to **IDR 179.15 billion (USD 10.98 million) per TWh** of electricity generated—yet the economic benefits fall far short of these expenditures. Instead, available data indicate a contraction in regional economic output, reflected in a decline in **Gross Regional Domestic Product (GRDP) of IDR 0.16 trillion per year**. Business surplus has also shrunk by **IDR 0.10 trillion**, signaling that private sector actors likewise bear economic losses. Rather than functioning as an engine of growth, the Ombilin power plant in West Sumatra increasingly resembles a structural burden that constrains fiscal space and erodes value added at the regional level.

Contraction in Employment

The adverse impacts are clearly felt in the labor market. Each year, worker compensation declines by **IDR 0.06 trillion**, representing a reduction in household welfare in communities surrounding the plant's operations. Moreover, the loss of **2,825 employment opportunities** demonstrates that the Ombilin power plant does not serve as a significant source of job creation; on the contrary, it displaces potential employment that could otherwise be generated in sectors with higher productivity and greater long-term sustainability.

Implications for the Environment and Other Strategic Sectors

At the sectoral level, the operation of the Ombilin power plant inflicts its greatest economic losses on **agriculture, forestry, and fisheries**, with a combined decline in value of **IDR 107.05 billion per year**, making these

sectors the most severely affected. Significant losses are also observed in the **manufacturing sector**, estimated at **IDR 15.45 billion**, as well as in **wholesale and retail trade**, which loses up to **IDR 8.59 billion annually**. The **health services and social activities sector** likewise bears economic losses of **IDR 0.35 billion per year**, further intensifying pressure on already constrained public service facilities.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(107.046)
Mining and Quarrying	(1.572)
Manufacturing	(15.447)
Electricity and Gas Supply	(1.118)
Water Supply; Waste Management, Wastewater, and Recycling	(43)
Construction	(1.929)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(8.587)
Transportation and Warehousing	(6.020)
Accommodation and Food Service Activities	(313)
Information and Communication	(1.931)
Financial and Insurance Activities	(8.519)
Real Estate Activities	(971)
Business Activities	(2.350)
Public Administration, Defence, and Compulsory Social Security	(491)
Education Services	(131)
Human Health and Social Work Activities	(353)
Other Services	(550)
TOTAL	(157.371)

14

Jawa-7 CFPP,
Banten
(1.982(?) MW)



Jawa-7 Coal-Fired Power Plant, Banten (1,982 MW)

https://www.gem.wiki/Jawa-7_power_station

Jawa 7 Coal-Fired Power Plant is one of the largest coal power plants in Indonesia, with a total installed capacity of **2 × 1,000 MW (2,000 MW)**. It employs **ultra-supercritical (USC) technology** to achieve high thermal efficiency, along with a **seawater flue gas desulfurization (SWFGD)** system to reduce sulfur and nitrogen oxide emissions. The project was inaugurated with a groundbreaking ceremony on **5 August 2017** by the President of Indonesia and entered early construction stages in **April 2016**, although financial close was only achieved on **29 September 2016**. The total investment value reached **USD 1.8 billion**, developed through a partnership between **China Shenhua Energy (70%)** and **PT PJB Investasi (30%)**, forming **PT Shenhua Guohua PJB (PT SGPJB)**.

Unit 1 officially underwent the **Reliability Run Test** and targeted its **Commercial Operation Date (COD) in October 2019**, followed by **Unit 2 in April 2020**. Supporting infrastructure includes a **4-kilometer coal terminal** and a coal unloading jetty inaugurated in **July 2019**. Electricity generated by the plant is transmitted through the **500 kV Suralaya–Balaraja interconnection**, thereby strengthening the reliability of the Java–Bali power system.

Project financing was largely provided through loans from the **China Development Bank**. The project site covers approximately **170 hectares**, and the plant has a **net capacity of around 1,982 MW**.

Ownership and Investors

PLTU Jawa-7 Unit 1–2

 Capacity
2x991 MW

 Loan Year
2016

 Borrowing Countries
Cina, Indonesia

 Total Loans
USD 1,800,000,000

 Commercial Operation Date
**2019 (unit 1)
2020 (unit 2)**

 Type of Financing
**Approximately
17-year loan tenor**

 Loan Maturity
1 September 2033

 Lenders
**China Development Bank, China Shenhua Energy,
Perusahaan Listrik Negara**

Source: China AidData, GEM Database¹, GEM Database

¹ <https://china.aiddata.org/projects/62069/>

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2019: 991 MW Unit 2 - 2020: 991 MW
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Combustion Technology	Ultra-supercritical
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National Targets	None
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Types of Coal and Their Sources	Coal: unknown
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a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that are harmful to human health increases the risk of premature mortality and a wide range of diseases.

With respect to air pollution–related mortality, the operation of the **Jawa-7 coal-fired power**

plant can be associated with an estimated **608 total deaths per year among the adult population**, as well as **two deaths annually among children under five years of age** due to lower respiratory tract infections.

These estimates are derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated disease burden includes **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes**.



Annual mean PM2.5 concentration from Jawa-7

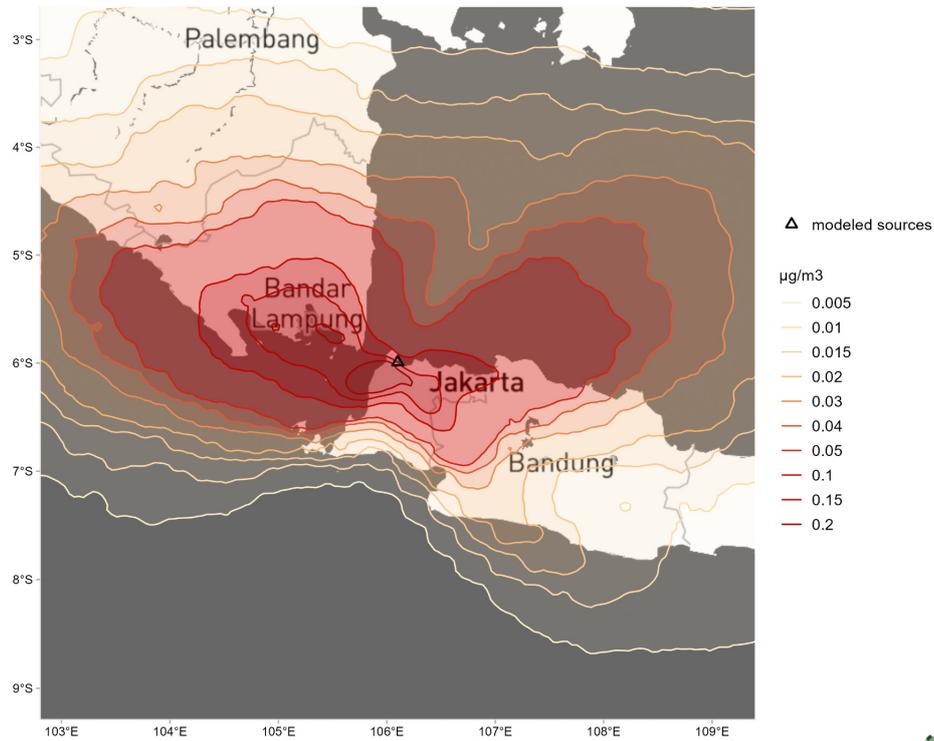


Figure 1. Annual average PM2.5 dispersion from the Jawa-7 Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Jawa-7

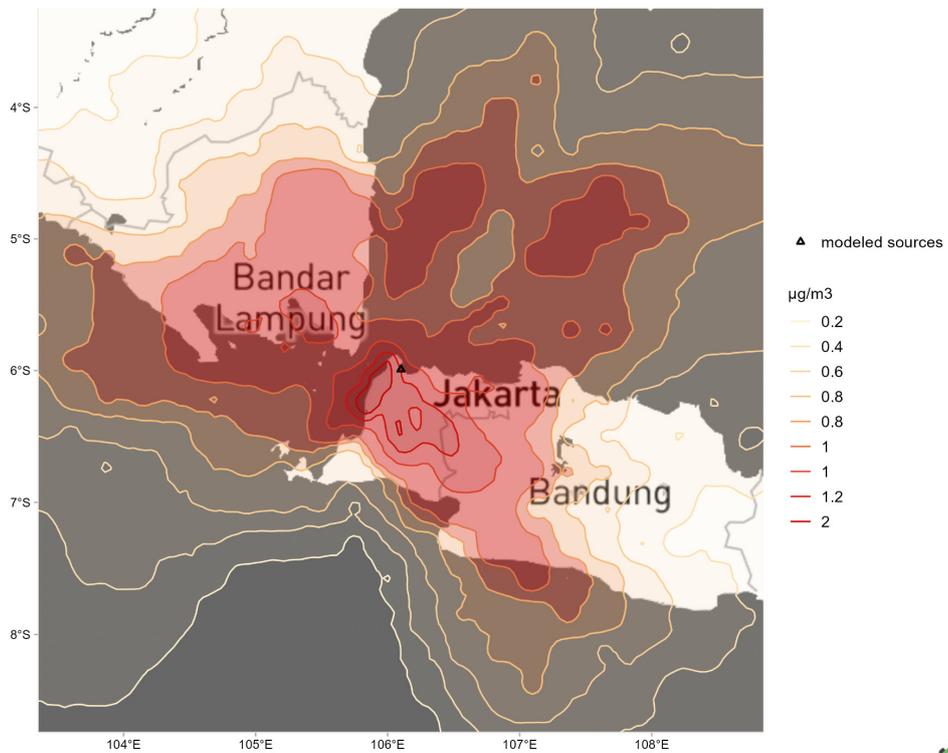


Figure 2. Maximum 24-hour PM2.5 concentrations from the Jawa-7 Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Jawa-7 coal-fired power plant** increase the risk and incidence of respiratory diseases, resulting in an estimated **637 (382–890) asthma-related emergency room visits** and **1,788 (478–3,630) new asthma cases**. Adverse impacts on children and unborn infants are also observed, including **313 (152–332) preterm births** and **205 (64–355) cases of low birth weight**. In addition, productivity losses due to illness and disability amount to **274 (233–315) thousand workdays lost per year**, directly affecting economic activity.

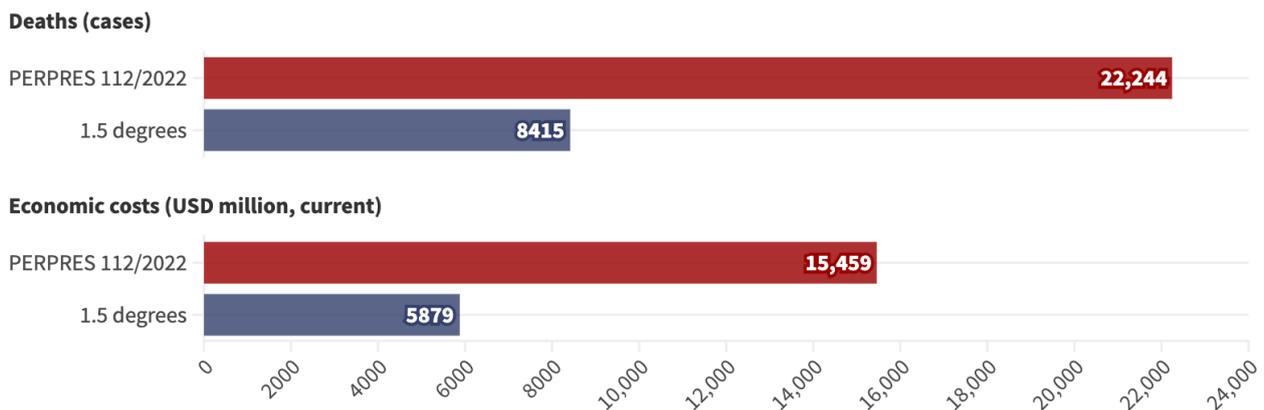
The economic burden on Indonesia arising from health impacts associated with air pollution from the Jawa-7 power plant is estimated at **USD 404 million annually**, equivalent to **IDR 6.2 trillion**. This substantial economic cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and losses due to work absenteeism.

Under future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avert 14,100 cumulative deaths and reduce the national economic burden by USD 9.58 billion, equivalent to IDR 152 trillion.

To realize these benefits, the **Jawa-7 power plant** would need to cease operations of **Unit 2 in 2033** and **Unit 1 in 2034**, prior to Indonesia’s projected emissions peak in **2035**.

Cumulative air pollution-related deaths and economic costs attributed to Jawa-7 coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs from the Jawa-7 Coal-Fired Power Plant

b. Impact on Surrounding Community

The operation of this power plant has long been protested by hundreds of fishers from Terate Village, who feared it would damage the marine ecosystem. These concerns have since materialized. Since the plant began operating in 2019, fishing grounds have narrowed significantly, and fishers' catches have dropped sharply—from previously around 20 kilograms per trip to only about 5 kilograms. According to fishers' accounts, the liquid waste discharged into the sea is often hot, foamy, sometimes brown in color, and emits a foul odor.²

Since the plant commenced operations, its negative impacts have increasingly been felt by nearby residents. Villagers complain of air pollution and black dust that settles on their homes and surrounding environment. The assistance provided has been minimal

and disproportionate to the impacts they experience. Residents have also demanded that the company conduct regular monitoring of local air quality, given the proximity of the plant—only about 1 km from residential areas—which raises serious concerns about long-term health risks.³

c. Impact on Local and National Economy

The operation of the **Jawa-7 coal-fired power plant** results in significant economic losses, reflected in an annual decline in economic output of approximately **IDR 0.69 trillion**, despite operational costs amounting to **USD 30.23 million**. With carbon emissions reaching **7.72 kilotons per year**, the plant's activities contribute to reduced economic productivity while simultaneously exacerbating environmental degradation in surrounding areas.

Operating costs	USD 30,23 million
Annual CO ₂ emissions	7,72 kiloton
Impact on annual economic output (gross domestic product)	-Rp0,69 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-Rp0,66 trillion
Impact on annual business surplus	-Rp0,34 trillion
Impact on annual labor compensation	-Rp0,32 trillion
Impact on annual employment absorption	-18.202 jiwa
Sectoral impacts on agriculture, forestry, and fisheries	-Rp0,51 miliar
Sectoral impacts on health services and social activities	-Rp0,8 miliar

² <https://jaring.id/suam-suam-bahaya-di-teluk-banten/>

³ <https://www.bantenraya.com/daerah/12712721244/warga-desa-terate-kramatwatu-keluhkan-polusi-udara-dari-pltu-jawa-7-agung-permana-harus-diselesaikan>

Implications for the Regional Economy

The operation of the **Jawa-7 coal-fired power plant** requires expenditures of approximately **IDR 492.39 billion (USD 30.23 million) per TWh** of electricity generated. However, its performance runs counter to local economic growth, as evidenced by a contraction in **Gross Regional Domestic Product (GRDP) of IDR 0.66 trillion per year**. The business sector is also adversely affected, with **business surplus declining by IDR 0.34 trillion**. These figures indicate that the power plant does not provide a net contribution to the regional economy; instead, it absorbs resources that could otherwise be allocated to more productive and resilient sectors.

Contraction in Employment

These economic losses have direct consequences for the labor market. Each year, **IDR 0.32 trillion** is lost from total worker compensation, reducing household purchasing power. Moreover, the loss of **18,202 employment opportunities**

reflects the plant's failure to generate jobs commensurate with its operational costs. Local workers consequently lose opportunities to participate in sectors capable of delivering longer-term economic benefits.

Implications for the Environment and Other Strategic Sectors

The impacts of the Jawa-7 power plant extend beyond the economy. **Agriculture, forestry, and fisheries** incur losses amounting to **IDR 0.51 trillion per year** due to ecosystem degradation. **Health services and social activities** are also affected, with losses estimated at **IDR 0.8 billion**, further straining already limited public service systems. On a sectoral basis, the largest losses attributable to the operation of the Jawa-7 plant occur in **agriculture, forestry, and fisheries**, with a decline in value reaching **IDR 516.25 billion per year**. Two other sectors experiencing significant impacts are **manufacturing**, which incurs losses of approximately **IDR 71.73 billion**, and **wholesale and retail trade**, which loses economic value of up to **IDR 33.98 billion per year**.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(516.248)
Mining and Quarrying	(5.495)
Manufacturing	(71.732)
Electricity and Gas Supply	(4.133)
Water Supply; Waste Management, Wastewater, and Recycling	(88)
Construction	(2.868)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(33.977)
Transportation and Warehousing	(11.384)
Accommodation and Food Service Activities	(1.077)
Information and Communication	(3.338)
Financial and Insurance Activities	(5.166)
Real Estate Activities	(1.599)
Business Activities	(3.117)
Public Administration, Defence, and Compulsory Social Security	(353)
Education Services	(152)
Human Health and Social Work Activities	(791)
Other Services	(2.051)
TOTAL	(663.569)

15

**Celukan Bawang CFPP,
Bali
(380 MW)**



Celukan Bawang Coal-Fired Power Plant, Bali (380 MW)

https://www.gem.wiki/Celukan_Bawang_power_station

The **Celukan Bawang Coal-Fired Power Plant** is located in **Celukan Bawang Village, Tejakula Subdistrict, Buleleng Regency, Bali**. The plant operates using **subcritical coal technology**, with an estimated thermal efficiency of approximately **38%**. Managed by a subsidiary of **PT PLN (Persero)**, the facility supplies electricity to the **Java–Bali power system** and has previously been promoted as utilizing a so-called *double combustion* technology, which was claimed to be “cleaner.”

Units 1–3 have a combined installed capacity of **3 × 142 MW** and were financed entirely through overseas loans from the **China Development Bank (CDB)**. According to data from **Global Energy Monitor (GEM)**, the total value of the project loan reached **USD 880 million**, while **China AidData** reports a lower figure of **USD 533.56 million**. Detailed information on the financing structure remains unclear. The loan agreement was concluded in **2016**, with no

explicit disclosure of the loan tenor, and the plant began commercial operations in **2015**.

Plans for a **Phase II expansion (2 × 330 MW)** sparked significant controversy, as the project was not included in PLN’s **Electricity Supply Business Plan (RUPTL)** and was opposed by local residents, **Greenpeace**, and **LBH Bali**, who filed a lawsuit with the **Denpasar Administrative Court (PTUN)** in **2018** on the grounds of environmental violations and inadequate public consultation. Although the lawsuit was rejected at all judicial levels, demands for improved governance and meaningful community participation have persisted.

As of **May 2025**, PLN has reportedly been assessing a follow-up project at Celukan Bawang involving **LNG- and hydrogen-fired generation (~900 MW)** under the **RUPTL 2025–2034**. However, this proposal remains at the feasibility study stage and has yet to receive final approval.

Ownership and Investors

Celukan Bawang Coal-Fired Power Plant Units 1–3

 Capacity
3x142 MW

 Loan Year
2016

 Lender Country
China

 Loan Tenor
Unknown

 Commercial Operation Date
2015

 Lender
China Development Bank

 Total Loans
**USD 880 million (according to the GEM Database)/
USD 533.56 million (according to China AidData¹)**

 Type of Financing
Not explicitly specified, but likely project finance loans

Source: China AidData², GEM³ Website

1 <https://china.aiddata.org/projects/49810/>

2 <https://china.aiddata.org/projects/49810/>

3 <https://docs.google.com/spreadsheets/d/1TaHWGOJ0O6iND7VEQ6cQyDYKLYF4bAOpM1m-c366E9k/edit?gid=937423972#gid=937423972>

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2015: 142 MW Unit 2 - 2015: 142 MW Unit 3 - 2015: 142 MW
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Combustion Technology	Subcritical
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National Targets	None
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Types of Coal and Their Sources	Coal: unknown
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a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that are harmful to human health increases the risk of premature mortality and a wide range of diseases.

With respect to air pollution–related mortality, the operation of the **Celukan Bawang coal-**

fired power plant can be associated with an estimated **184 total deaths per year among the adult population**, as well as **at least one death annually among children under five years of age** due to lower respiratory tract infections. These estimates are derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated disease burden includes **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes.**



Annual mean PM2.5 concentration from Celukan Bawang

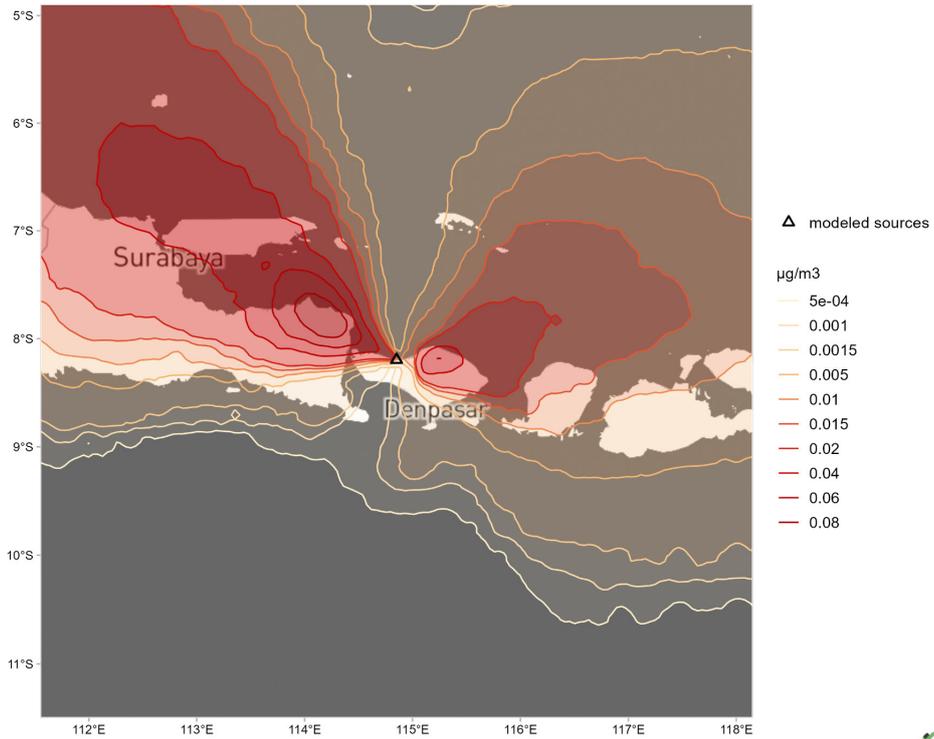


Figure 3. Annual average dispersion of PM2.5 from the Celukan Bawang Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Celukan Bawang

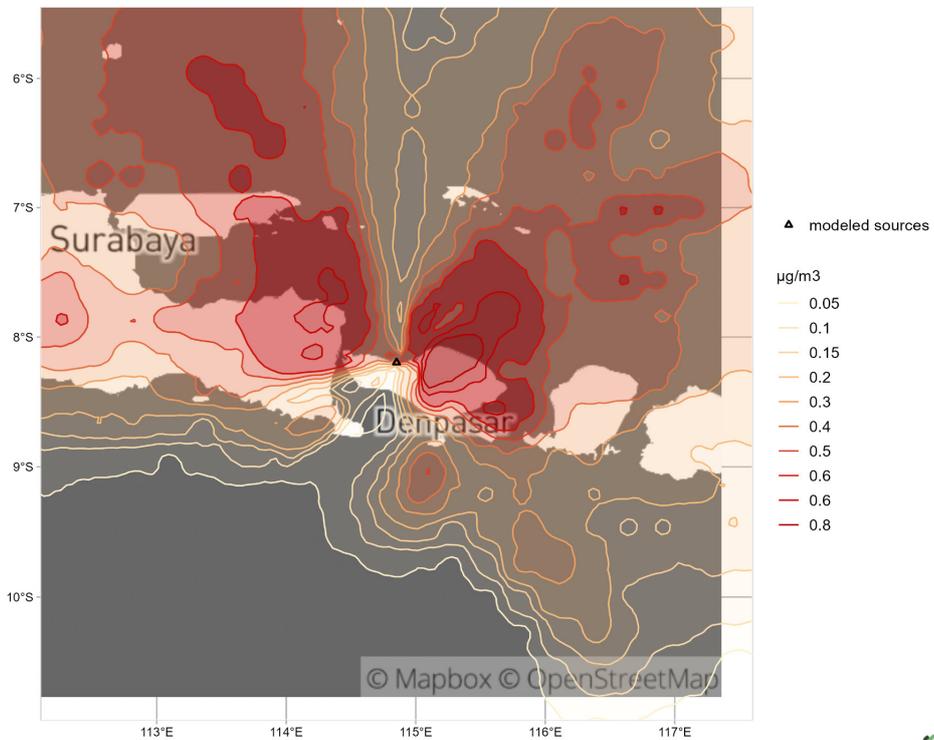


Figure 4. Maximum 24-hour PM2.5 concentration from the Celukan Bawang Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Celukan Bawang coal-fired power plant** increase the risk and incidence of respiratory diseases, resulting in an estimated **173 (104–241) asthma-related emergency room visits** and **387 (103–786) new asthma cases**. Adverse impacts on children and unborn infants are also evident, including **81 (39–86) preterm births** and **56 (17–97) cases of low birth weight**. In addition, productivity losses due to illness and disability amount to **75 (64–87) thousand workdays lost per year**, directly affecting economic activity.

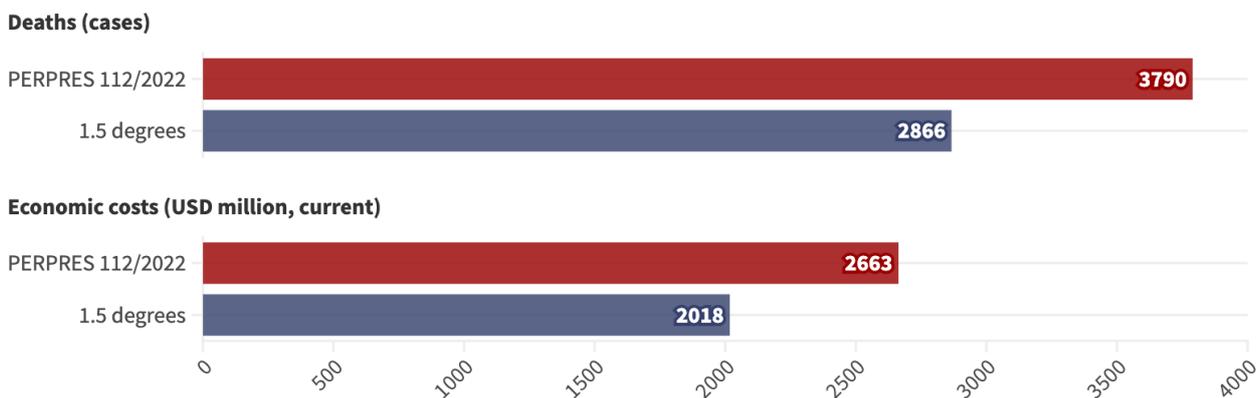
The economic burden on Indonesia arising from health impacts associated with air pollution from the Celukan Bawang power plant is estimated at **USD 123 million annually**, equivalent to **IDR 1.87 trillion**. This substantial cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and losses due to work absenteeism.

Under future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avert 924 cumulative deaths and reduce the national economic burden by USD 646 million, equivalent to IDR 10.2 trillion.

To realize these benefits, **Units 1–3 of the Celukan Bawang power plant** would need to cease operations in **2032**, prior to Indonesia’s projected emissions peak in **2035**.

Cumulative air pollution-related deaths and economic costs attributed to Celukan Bawang coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 5. Future projections of the impacts of air pollution on mortality and economic costs from the Celukan Bawang Coal-Fired Power Plant

b. Impact on Surrounding Community

Since the power plant began operations in 2015, fishers have complained of increasing difficulty in catching fish due to damage to coral reef ecosystems and seawater that has turned dark as a result of wastewater discharges from the plant. Prior to the plant's operation, such conditions had never been observed; fishers were reportedly able to harvest up to 300 buckets of fish in a single fishing trip. The fishers' wives would then circulate through the village each morning, selling baskets full of fish. Those who remain in the fishing profession are now forced to venture into offshore waters, significantly increasing operational costs.

In addition to fishers, coconut farmers have also been adversely affected by the plant's operations. One coconut farmer recounted that previously, a single harvest could yield up to 3,000 coconuts, sold at prices ranging from IDR 6,000 to 8,000 per fruit. Following the establishment of the power plant, yields have declined to approximately 1,000 coconuts per harvest, with selling prices falling to around IDR 1,000 per fruit. This decline is suspected to be linked to increasingly dry and infertile soil conditions resulting from deteriorating water quality.

For those with limited alternatives, occupational shifts have become unavoidable. Some residents have taken jobs at the power plant; however, they report discriminatory wage practices, with lower pay for workers

from villages surrounding the plant compared to those recruited from outside the area. Local workers at the Celukan Bawang power plant have also experienced unhealthy labor practices, including forced resignations followed by reapplication to avoid severance pay obligations, sudden overtime demands, inadequate personal protective equipment, and intimidation during attempts to form labor unions.

At the same time, the presence of the power plant has generated health problems that increase household expenditures for medical treatment. Residents frequently complain about layers of dust settling on household furniture, clothes hung out to dry, and persistent health issues such as coughing, shortness of breath, and eye irritation due to continuous exposure. This dust not only disrupts daily comfort but also poses long-term health risks, particularly for children, older adults, and individuals with pre-existing respiratory conditions.

Based on field interviews, there remain at least two residents whose land was acquired for the construction of a PLN electrical substation but who have yet to receive compensation from the power plant. From the outset, the land acquisition process lacked meaningful participation and transparency, as intermediaries were used to purchase land. Residents reported feeling deceived, as they were initially informed that the land would be used to build a soy sauce factory; in reality, it was later developed into a coal-fired power plant.

c. Impact on Local and National Economy

With operational costs amounting to **IDR 782.94 billion (USD 48.01 million) per TWh** of electricity generated, the Celukan Bawang coal-fired power plant instead produces negative impacts on the local economy. Economic output declines by approximately **IDR 0.17**

trillion per year, accompanied by a contraction in **Gross Regional Domestic Product (GRDP)**. The business sector is also adversely affected, with **business surplus decreasing by IDR 0.11 trillion annually**. These figures demonstrate that the substantial costs incurred do not translate into commensurate economic benefits; rather, they constrain the growth of productive economic activities in the region.

Operating costs	USD 48,01 million
Annual CO ₂ emissions	2,09 kilotons
Impact on annual economic output (gross domestic product)	- IDR0,17 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR0,17 trillion
Impact on annual business surplus	- IDR0,11 trillion
Impact on annual labor compensation	- IDR0,07 trillion
Impact on annual employment absorption	- 4.155 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR0,11 billion
Sectoral impacts on health services and social activities	- IDR0,43 billion

Contraction in Employment

The economic losses generated by the Celukan Bawang coal-fired power plant directly affect workers. Each year, **worker compensation declines by IDR 0.07 trillion**, indicating reduced incomes that undermine household purchasing power. Moreover, **4,155 job opportunities are lost** from the local labor market—positions that could otherwise have been created in sectors with stronger long-term prospects. As such, the plant functions not only as a financial burden but also as a constraint on community participation in the regional economy.

per year, while **health services and social activities** forgo potential value of **IDR 0.43 billion**. Although these figures may appear modest compared to those associated with larger coal-fired power plants, they remain significant for local communities that depend heavily on these sectors.

Implications for the Environment and Other Strategic Sectors

Beyond its economic impacts, the Celukan Bawang power plant also undermines strategic sectors. **Agriculture, forestry, and fisheries** incur losses of approximately **IDR 0.11 billion**

The plant's annual carbon footprint reaches **2.09 kilotons of CO₂**. Given the negative impacts spanning the economy, labor market, and ecosystems, retiring the Celukan Bawang power plant could serve as a strategy to reduce cross-sectoral losses that have long been borne by communities in northern Bali. Indeed, the largest losses attributable to the plant's operation occur in **agriculture, forestry, and fisheries**, with a decline in value of **IDR 113.79 billion per year**, making this the most severely affected sector. The next largest losses are observed in **manufacturing**, estimated at **IDR 24.68 billion**, followed by **wholesale and retail trade**, which loses up to **IDR 11.65 billion annually**.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(113.788)
Mining and Quarrying	(3.571)
Manufacturing	(24.678)
Electricity and Gas Supply	(5.205)
Water Supply; Waste Management, Wastewater, and Recycling	(30)
Construction	(666)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(11.652)
Transportation and Warehousing	(3.649)
Accommodation and Food Service Activities	(830)
Information and Communication	(1.873)
Financial and Insurance Activities	(2.842)
Real Estate Activities	(1.026)
Business Activities	(1.770)
Public Administration, Defence, and Compulsory Social Security	(186)
Education Services	(63)
Human Health and Social Work Activities	(426)
Other Services	(898)
TOTAL	(173.153)

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**Pangkalan Susu CFPP,
North Sumatra
(840 MW)**



Pangkalan Susu Coal-Fired Power Plant, North Sumatra (840 MW)

https://www.gem.wiki/Pangkalan_Susu_power_station

The **Pangkalan Susu Coal-Fired Power Plant** is a coal-based power facility developed under the **Fast Track Program Phase II (FTP II)**. **Unit 1** officially commenced power generation on **2 April 2015**, followed by **Unit 2** on **27 March 2015**. Both units are connected to the **Binjai substation** via approximately **70 km of 275 kV transmission lines**. Located in **Tanjung Pasir Village**, the plant occupies an area of **105 hectares** and was designed to strengthen the electricity system reliability of **Northern Sumatra**, particularly the **Langkat and Medan** regions.

Subsequently, **Units 3 and 4**, each with a capacity of **210 MW**, were added and began operations between **June and September 2019**, bringing the total installed capacity to **approximately 800 MW**. These units

utilize **low-rank coal (~4,200 kcal/kg)** and incorporate **biomass co-firing technology**. Supporting infrastructure includes **coal storage facilities**, a **coal unloading jetty**, and a **Continuous Emissions Monitoring System (CEMS)** for real-time emissions monitoring.

Negative impacts from the plant's operations have been reported since **Units 1–4** became operational. These include increased incidences of **acute respiratory infections (ARI/ISPA)**, **skin diseases**, and declines in **fish catches and agricultural yields**—such as **vannamei shrimp and grouper**—in affected areas. Local health centers have reported **thousands of acute respiratory cases within a period of several months**, indicating significant public health concerns associated with the plant's operations.

Ownership and Investors

Pangkalan Susu Coal-Fired Power Plant Units1–2

 Capacity
2x220 MW

 Loan Year
2016

 Lender Country
Indonesia

 Total Loan Amount
USD 381,689,125

 Lenders
Bank Mega

Source: Basis Data PERMATA

Pangkalan Susu Coal-Fired Power Plant Units3–4

 Capacity
2x200 MW

 Loan Type
Loans and equity

 Lender Country
China

 Total Loan Amount
USD 438.560.532

 Loan Year
2014

 Loan Tenor
15years(with5-year grace period)

 Lenders
China Exim bank, Government of Indonesia

Source: Basis Data GEM

General Info

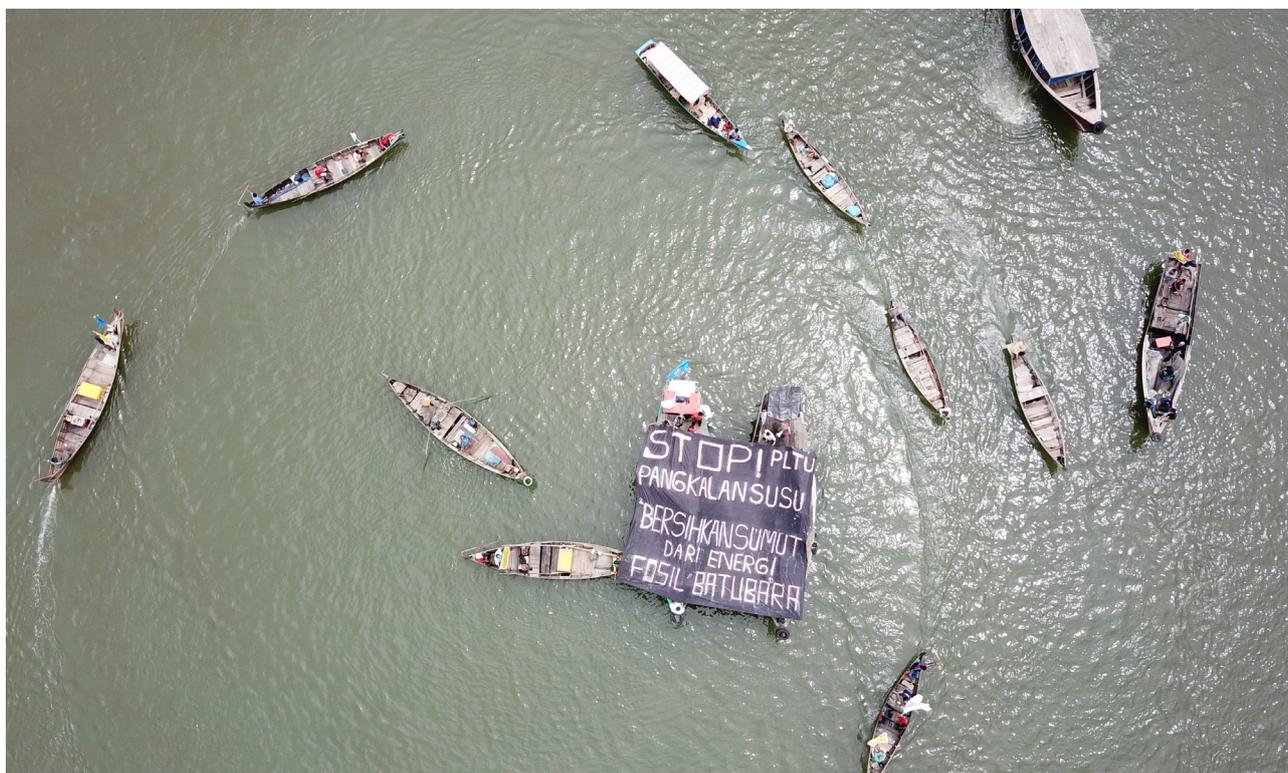
Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2015: 220 MW Unit 2 - 2014: 220 MW Unit 3 - 2019: 200 MW Unit 4 - 2019: 200 MW
Combustion Technology	Subcritical
National Targets	<i>Biomass co-firing, use of solid waste-derived fuel at 3% starting in 2024</i>
Types of Coal and Their Sources	Coal: unknown, bioenergy: waste (municipal and industrial solid waste) [3%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that are harmful to human health increases the risk of premature mortality and a wide range of diseases.

With respect to air pollution-related mortality, the operation of the **Pangkalan Susu** coal-

fired power plant can be associated with an estimated **205 total deaths per year among the adult population**, as well as **at least one death annually among children under five years of age** due to lower respiratory tract infections. These estimates are derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The associated disease burden includes **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease (COPD), lung cancer, and diabetes**.



Annual mean PM2.5 concentration from Pangkalan Susu

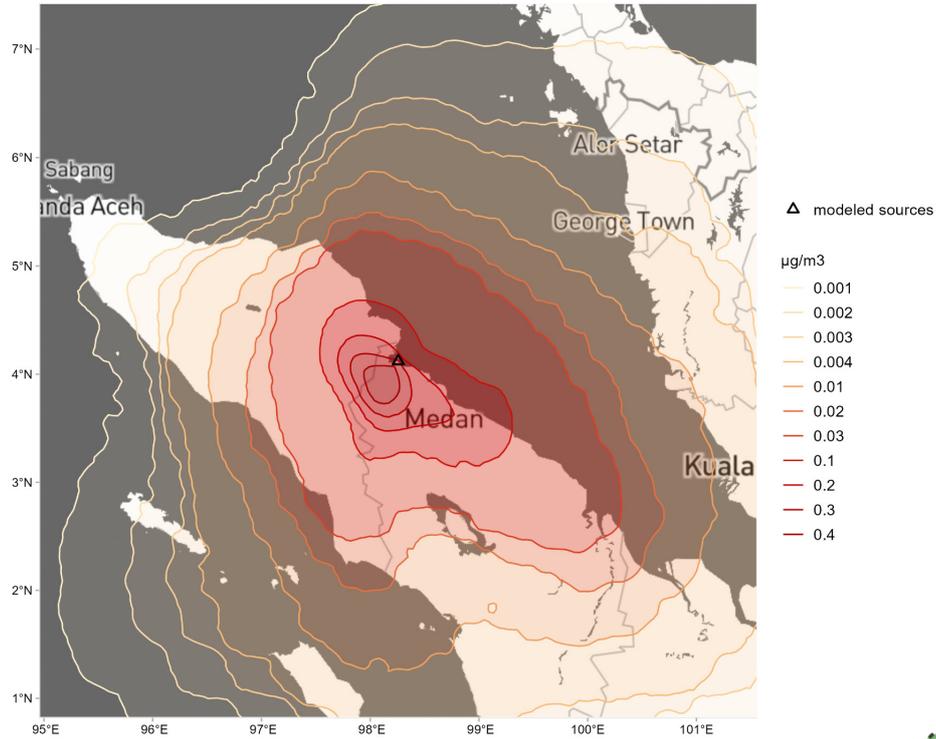


Figure 1. Annual average dispersion of PM2.5 from the Pangkalan Susu Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Pangkalan Susu

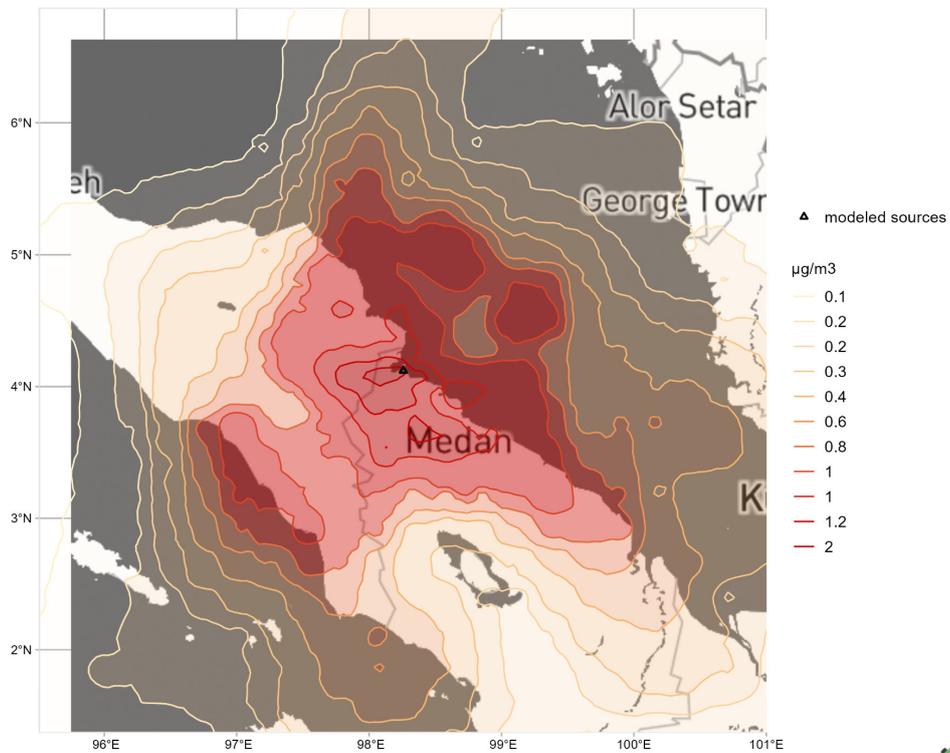


Figure 2. Maximum 24-hour PM2.5 concentration from the Pangkalan Susu Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Pangkalan Susu coal-fired power plant** increase the risk and incidence of respiratory diseases, resulting in an estimated **177 (106–247) asthma-related emergency room visits** and **434 (116–883) new asthma cases**. Adverse impacts on children and unborn infants are also observed, including **82 (40–87) preterm births** and **59 (18–103) cases of low birth weight**. In addition, productivity losses due to illness and disability amount to **79 (68–91) thousand workdays lost per year**, directly affecting economic activity.

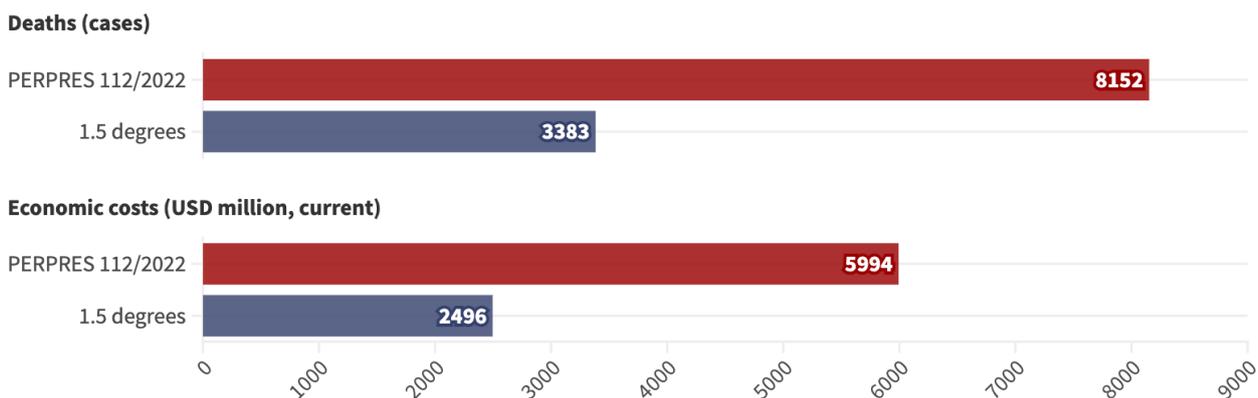
The economic burden on Indonesia arising from health impacts associated with air pollution from the Pangkalan Susu power plant is estimated at **USD 144 million annually**, equivalent to **IDR 2.19 trillion**. This substantial cost is driven primarily by

premature mortality, while also accounting for hospital expenditures related to morbidity and losses due to work absenteeism.

Under future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5°C pathway would avert 4,769 cumulative deaths and reduce the national economic burden by USD 3.50 million, equivalent to IDR 55 trillion.

To realize these benefits, **Units 1–4 of the Pangkalan Susu power plant** would need to retire in **2034**, prior to Indonesia’s projected emissions peak in **2035**.

Cumulative air pollution-related deaths and economic costs attributed to Pangkalan Susu coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Pangkalan Susu Coal-Fired Power Plant

b. Impact on Surrounding Community

Residents have complained of significant changes in environmental conditions since the operation of the power plant began. Rice fields that previously allowed two harvests per year can no longer be cultivated properly, forcing farmers to stop farming rather than continue to incur losses and to shift to other livelihoods.¹ This situation is believed to be linked to ash emissions from the plant's smokestacks, which are carried by the wind onto nearby agricultural land.

The quality of the marine ecosystem has also deteriorated due to the plant's activities along the coastal area. Fisherfolk report steadily declining catches, fish farmers describe mass fish deaths in floating cages before they reach harvest age, and mangrove forests have disappeared. Many residents have been compelled to sell their boats to repay debts and change occupations simply to sustain their families.²

An investigation conducted by the Srikandi Foundation in 2022 across the villages of Pintu Air, Lubuk Kertang, Pulau Sembilan, Beras Basa, and Tanjung Pasir found that the most common illnesses affecting residents were skin diseases, followed by coughing or shortness of breath (acute respiratory infections/ARI), hypertension, black lung disease, and thyroid disorders.³ A total of 98 children aged 1–9 years and 253 adults aged 20–75 years were affected by illnesses linked to the power plant. Reported cases included 243 instances of skin disease, 42 cases of cough, shortness of breath, and ARI, followed by 4 cases of black lung disease, 4 cases of thyroid disorders,

and 39 cases of hypertension. Acute skin conditions affected 60 children across five villages, forcing them to take medication to prevent recurrence. These children also faced difficulties writing due to itching and festering wounds on their hands, and struggled to play for fear of transmitting the condition to their peers. Data from the Beras Basa Community Health Center further show that between 2019 and 2022, ARI was the most prevalent disease, followed by gastric illnesses.⁴

This power plant has been included in the list of facilities reported to the Ministry of Environment (KLH) for alleged environmental crimes, particularly due to uncovered coal stockpiles that have polluted vegetation, degraded air quality, and caused sedimentation that disrupts community activities.⁵

c. Impact on Local and National Economy

The operation of the Pangkalan Susu coal-fired power plant requires annual operational expenditures of Rp423.09 billion per TWh. However, this substantial outlay does not generate positive contributions to the local economy. On the contrary, economic output has declined by as much as Rp2.36 trillion per year, accompanied by a contraction in Gross Regional Domestic Product (GRDP) of Rp2.35 trillion. These impacts also extend to the business sector, with business surplus reduced by Rp1.40 trillion. Taken together, these figures indicate that maintaining the operation of this power plant effectively allows the regional economy to continue losing its potential for productive growth.

1 https://wacana.org/pilu-di-balik-pltu-pangkalan-susu/?utm_source=chatgpt.com

2 <https://beritasumut.id/hilangnya-laut-nelayan-di-pangkalan-susu/>

3 <https://www.mongabay.co.id/2022/12/13/penyakit-warga-sekitar-pltu-pangkalan-susu-dari-gatal-gatal-sampai-paru-paru-hitam/>

4 <https://indonesiaclimatereaction.com/dampak-pltu-batu-bara-pangkalan-susu-terhadap/>

5 <https://p2lh.org/koalisi-stueb-laporkan-15-kejahatan-lingkungan-8-pltu-batu-bara-di-sumatera-ke-kementerian-lingkungan-hidup-untuk-ditindak/>

Operating costs	USD 25,93 million
Annual CO ₂ emissions	4,22 kilotons
Impact on annual economic output (gross domestic product)	-IDR2,36 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-IDR2,35 trillion
Impact on annual business surplus	-IDR1,40 trillion
Impact on annual labor compensation	-IDR0,92 trillion
Impact on annual employment absorption	-54.768 people
Sectoral impacts on agriculture, forestry, and fisheries	-IDR1,64 trillion
Sectoral impacts on health services and social activities	-IDR4,21 billion

Contraction of the Employment Sector

The economic losses have triggered a domino effect in the labor market. Each year, Rp0.92 trillion is lost from total labor compensation. The disappearance of 54,768 employment opportunities further underscores that this coal-fired power plant is not an efficient absorber of labor. Human resources that could otherwise be absorbed by the renewable energy sector or green industries are instead displaced by a coal-based energy model that contracts employment opportunities.

Implications for the Environment and Other Strategic Sectors

The damage caused by the Pangkalan Susu coal-fired power plant extends to sectors that sustain livelihoods. Agriculture, forestry, and fisheries lose economic value amounting to

Rp1.64 trillion per year, threatening regional food security and ecosystem sustainability. Health services and social activities are also affected, incurring losses of Rp4.21 billion annually—an additional burden borne by communities and local governments.

With annual emissions of 4.22 kilotons of CO₂, this power plant accelerates the climate crisis, leading to increased frequency of hydrometeorological disasters, declining agricultural yields, and escalating health-related costs. The operation of the Pangkalan Susu coal-fired power plant generates the greatest economic losses in the agriculture, forestry, and fisheries sector, with a reduction in value reaching Rp1.63 trillion per year, making it the most severely affected sector. Other sectors under significant pressure include manufacturing, which incurs losses of approximately Rp247.86 billion, and wholesale and retail trade, which suffers losses of around Rp139.74 billion.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.635.155)
Mining and Quarrying	(22.066)
Manufacturing	(247.860)
Electricity and Gas Supply	(35.452)
Water Supply; Waste Management, Wastewater, and Recycling	(1.762)
Construction	(9.840)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(139.742)
Transportation and Warehousing	(101.997)
Accommodation and Food Service Activities	(14.897)
Information and Communication	(17.590)
Financial and Insurance Activities	(60.461)
Real Estate Activities	(15.100)
Business Activities	(31.299)
Public Administration, Defence, and Compulsory Social Security	(4.496)
Education Services	(1.401)
Human Health and Social Work Activities	(4.205)
Other Services	(8.049)
TOTAL	(2.351.372)



17

Tanjung Awar-Awar CFPP, East Java (700 MW)



Tanjung Awar-Awar Coal-Fired Power Plant, East Java (700 MW)

Tanjung_Awar-Awar_power_station

The **Tanjung Awar-Awar Coal-Fired Power Plant**, located in **Wadung Village, Jenu Subdistrict, Tuban Regency**, is operated by **PT Pembangunan Jawa Bali (PJB Nusantara Power, UBJOM unit)**. The plant has a total installed capacity of **2 × 350 MW (700 MW)** and uses **sub-bituminous coal** as its primary fuel. More recently, the plant has adopted a **biomass co-firing program**, utilizing materials such as **wood sawdust and agricultural residues, including waste and corn cobs**, as fuel blends.

Unit 1 commenced operation on **24 January 2014**, followed by **Unit 2** on **18 July 2016**, on a site covering approximately **80 hectares**.

Electricity generated by the Tanjung Awar-Awar power plant is transmitted to the **Tuban substation** and supports the **Java-Bali power system** through the **500 kV transmission network**, supplying substations in **Gresik, Lamongan, Bojonegoro**, and extending to **Central and West Java**.

The project forms part of the **35,000 MW non-state budget (non-APBN) electricity program**, with total investment estimated at around **Rp 6 trillion (approximately USD 588 million)** for the EPC contract carried out by the **Sinomech-CNEEC consortium**. The **80-hectare site** includes the main plant area, **coal yard**, and **fly ash and bottom ash (FABA) storage facilities**.

Ownership and Investors

Tanjung Awar-Awar Coal-Fired Power Plant Unit 1-2



Capacity
2x350 MW



Type of Financing
Loan



Commercial Operation Date
2014



Total Loan
USD 472,785,000



Year of Financing
2009



Loan Tenor
13 years (with a 3-year grace period)



Lenders
Bank of China (BOC), Bank Negara Indonesia, Bank Rakyat Indonesia



Location
Wadung Village, Jenu Subdistrict, Tuban Regency, East Java.

Source: PERMATA Database, China AidData¹, GEM Website²

¹ <https://china.aiddata.org/projects/38611/>

² https://www.gem.wiki/Tanjung_Awar-Awar_power_station

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2012: 350 MW Unit 2 - 2013: 350 MW
Combustion Technology	Subcritical
National Targets	Biomass co-firing, using 3% sawdust in 2021, with pilot trials of solid refuse-derived fuel and corn cobs
Types of Coal and Their Sources	Coal: sub-bituminous, bioenergy: wood and other biomass (solid) [3%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that are harmful to health increases the risk of premature mortality and various diseases.

With respect to deaths attributable to air pollution, the operation of the Tanjung

Awar-Awar coal-fired power plant can be associated with **121 total deaths per year among the adult population**, as well as **at least one death of a child under the age of five** due to lower respiratory tract infections. These estimates are derived from measured health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The diseases include **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes**.



Annual mean PM2.5 concentration from Tanjung Awar-Awar

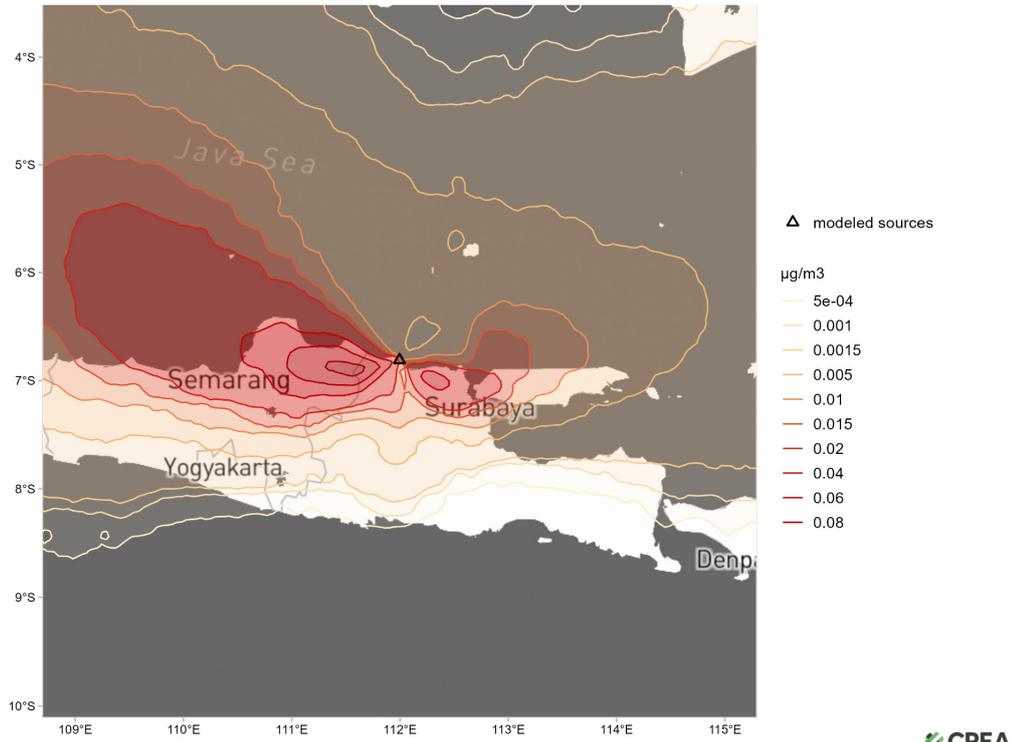


Figure 1. Annual average PM2.5 dispersion from the Tanjung Awar-Awar Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Tanjung Awar-Awar

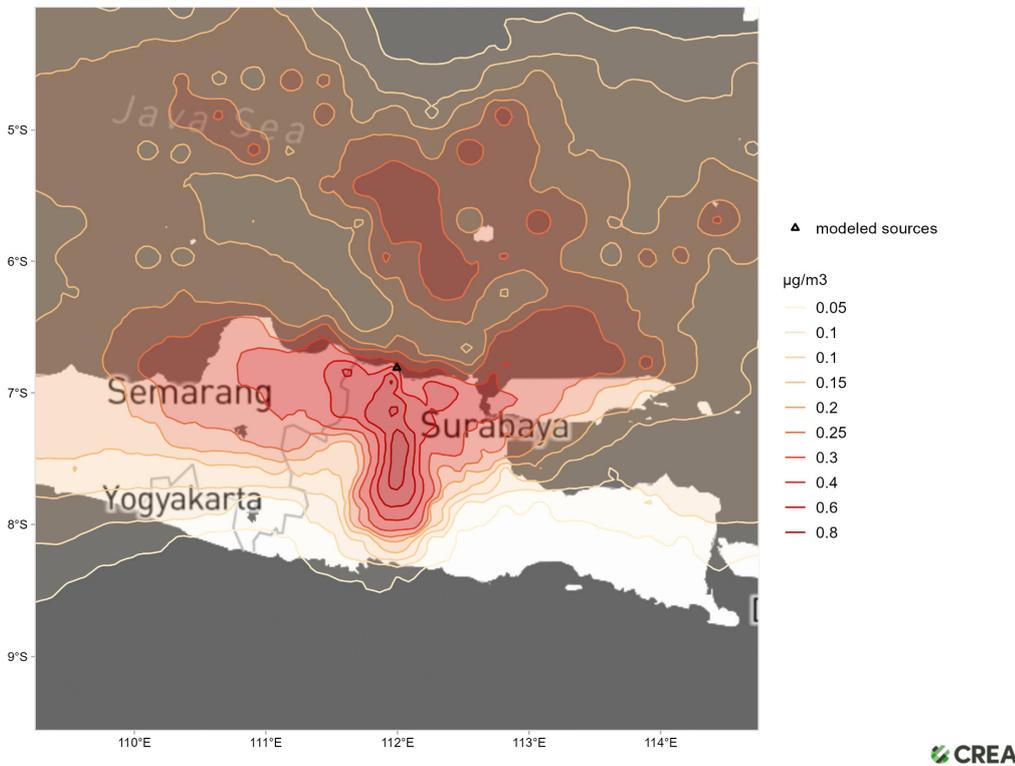


Figure 2. Maximum 24-hour PM2.5 concentration from the Tanjung Awar-Awar Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the Tanjung Awar-Awar coal-fired power plant lead to an increased risk and incidence of respiratory diseases. These include **137 (82–192) emergency room visits for asthma** and **281 (75–571) new cases of asthma**, as well as adverse impacts on children and unborn infants. There are **67 (33–71) cases of preterm birth** and **44 (14–77) cases of low birth weight**. In addition, productivity losses due to illness and disability are observed. The total loss of community productivity reaches **59 (51–68) thousand workdays lost per year**, directly affecting economic activity.

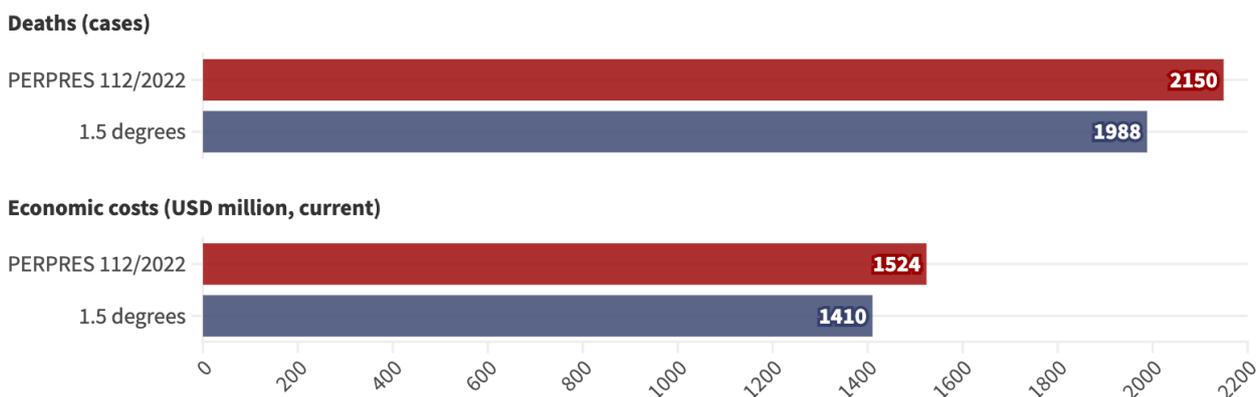
The economic burden on Indonesia resulting from health impacts associated with air pollution from the Tanjung Awar-Awar coal-fired power plant amounts to **USD 81 million annually**, equivalent to **Rp1.23 trillion**.

This substantial economic burden is largely attributable to mortality, while also accounting for hospital costs related to morbidity and the costs of work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5-degree pathway would avoid 162 cumulative deaths and alleviate USD 114 million in national economic burden, equivalent to Rp1.81 trillion.

To realize these benefits, **Tanjung Awar-Awar Units 1 and 2 must be retired in 2031**, prior to Indonesia's emissions peak in **2035**.

Cumulative air pollution-related deaths and economic costs attributed to Tanjung Awar-Awar coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Tanjung Awar-Awar Coal-Fired Power Plant

b. Impact on Surrounding Community

Local residents have expressed concerns regarding the environmental impacts arising from the operation of the Tanjung Awar-Awar coal-fired power plant. The most commonly reported impacts relate to health effects from air pollution and the deterioration of water quality resulting from power plant activities. These concerns also include issues related to the limited employment opportunities provided by the plant for local communities.³

This power plant is included in the list of facilities implementing biomass co-firing. In July 2023, the plant received shipments of sawdust via sea transport from Bulukumba, South Sulawesi, to meet a biomass requirement of 49.7 thousand tons.⁴ In 2022, the biomass share was only 0.6 percent and is targeted to increase to 10 percent by 2030.⁵ The plant has also previously conducted co-firing trials using processed waste from Sidoarjo Regency through cooperation with the Sidoarjo Environmental Agency (DLH).⁶

Behind the transition narrative, co-firing instead serves as a justification to maintain the operation of the Tanjung Awar-Awar coal-fired power plant, which could otherwise be retired much earlier. This scheme does not address the root causes of environmental damage resulting from fossil energy use; rather, it merely prolongs the lifespan of a polluting power plant under a green guise.

c. Impact on Local and National Economy

With operational costs reaching Rp280.34 billion (USD 17.2 million) per TWh, the Tanjung Awar-Awar coal-fired power plant does not stimulate economic activity but instead suppresses regional economic output. Gross Domestic Product (GDP) declines by up to Rp2.17 trillion per year, while regional Gross Domestic Product (GRDP) decreases by Rp2.16 trillion. Business surplus, which serves as an indicator of the health of the business sector, is eroded by Rp1.08 trillion. This indicates that every rupiah spent to sustain the operation of this power plant generates a negative multiplier effect on the local economy.

Operating costs	USD17,2 million
Annual CO ₂ emissions	3,44 kilotons
Impact on annual economic output (gross domestic product)	-IDR2,17 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-IDR2,16 trillion
Impact on annual business surplus	-IDR1,08 trillion
Impact on annual labor compensation	-IDR1,01 trillion
Impact on annual employment absorption	-60.038 people
Sectoral impacts on agriculture, forestry, and fisheries	-IDR1,54 trillion
Sectoral impacts on health services and social activities	-IDR2,72 billion

3 <https://ejatlas.org/conflict/tanjung-awar-awar-coal-fired-power-plant-indonesia>

4 <https://kominfo.jatimprov.go.id/berita/pln-np-pln-epi-tingkatkan-kolaborasi-cofiring-pltu-tanjung-awar-awar>

5 <https://ronggo.id/pltu-tanjung-awar-awar-tuban-mulai-gunakan-biomassa-dari-limbah-kayu/>

6 <https://www.kompas.tv/regional/309393/sampah-diolah-jadi-co-firing-pengganti-batu-bara-pltu>

Contraction of the Employment Sector

Employment generated within the economic chain of the Tanjung Awar-Awar coal-fired power plant is not accompanied by commensurate welfare gains. Labor compensation declines by up to Rp1.01 trillion per year, while employment absorption is reduced by as many as 60,038 workers. For regions that rely on job creation, these figures constitute a counterproductive signal to claims that coal-fired power plants generate employment. This illustrates that the presence of the power plant no longer serves as a source of economic security, but rather poses a threat to job sustainability.

Implications for the Environment and Other Strategic Sectors

Economic losses also extend into strategic sectors. Agriculture, forestry, and fisheries experience losses equivalent to Rp1.54 trillion per year, undermining the foundations of food security and ecosystem sustainability. Health services and social activities are likewise affected, incurring losses of Rp2.72 billion per year in line with the increasing burden of pollution-related diseases. Carbon dioxide (CO₂) emissions reaching 3.44 kilotons per year further underscore the urgency of accelerating the retirement of this coal-fired power plant.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(1.540.450)
Mining and Quarrying	(30.738)
Manufacturing	(280.803)
Electricity and Gas Supply	(28.995)
Water Supply; Waste Management, Wastewater, and Recycling	(450)
Construction	(6.433)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(109.779)
Transportation and Warehousing	(56.543)
Accommodation and Food Service Activities	(7.558)
Information and Communication	(15.037)
Financial and Insurance Activities	(35.452)
Real Estate Activities	(9.229)
Business Activities	(20.409)
Public Administration, Defence, and Compulsory Social Security	(1.390)
Education Services	(649)
Human Health and Social Work Activities	(2.720)
Other Services	(10.342)
TOTAL	(2.156.977)

18

**Rembang CFPP,
Central Java
(630 MW)**



Rembang Coal-Fired Power Plant, Central Java (630 MW)

https://www.gem.wiki/Rembang_power_station

The Rembang Coal-Fired Power Plant is located in Leran Village and Trahan Village, Sluke Subdistrict, Rembang Regency, with a total capacity of 2 × 315 MW fueled by low-calorific coal. The project is part of Fast Track Program Phase 1 (FTP-1) under the acceleration of electricity development in the Java–Bali system. Construction commenced on 20 September 2007, with Unit I targeted for completion in September 2009 and Unit II in December 2009.

The Rembang Power Plant was developed by the Zelan–Priamanaya–Tronoh consortium and is operated by PT PJB UBJ O&M PLTU Rembang, a subsidiary of PT PLN (Persero). The site covers an area of approximately 54–55 ha, located about 137 km east of Semarang, near the northern coastal corridor of Central Java. The electricity generated is transmitted via 150 kV high-voltage overhead lines to the Rembang Substation (22 km) and the Pati Substation (60 km).

Total project investment reached approximately USD 338.8 million (around Rp6.8 trillion), with 15 % financed by PT PLN and 85 % through loans from international banks—including those from China. Annual coal consumption is estimated at 1.9–2.16 million tons. The project was projected to reduce fuel oil imports by approximately Rp4 trillion per year.

From a social perspective, labor-related conflicts emerged. Residents of Leran and Trahan Villages staged protests over recruitment processes that did not prioritize local communities surrounding the power plant site. Conflicts also arose during the land acquisition process. The National Commission on Human Rights (Komnas HAM) recorded indications of human rights violations, noting that community land was taken without proper procedures—local objections were disregarded, compensation prices were not mutually agreed upon, and crops were damaged when project activities began.

Ownership and Investors

Rembang Coal-Fired Power Plant Unit 1–2

 Capacity
2x315 MW

 Type of Loan
Syndicated Loan

 Lender Countries
China, United Kingdom

 Total Loan
USD 262.000.000

 Loan Year
2008

 Loan Tenor
13 years (with a 3-year grace period)

 Lenders
China Development Bank (CDB), Barclays

 Commercial Operation Date
2011

Source: GEM Website¹, GEM Database

¹ https://www.gem.wiki/Rembang_power_station

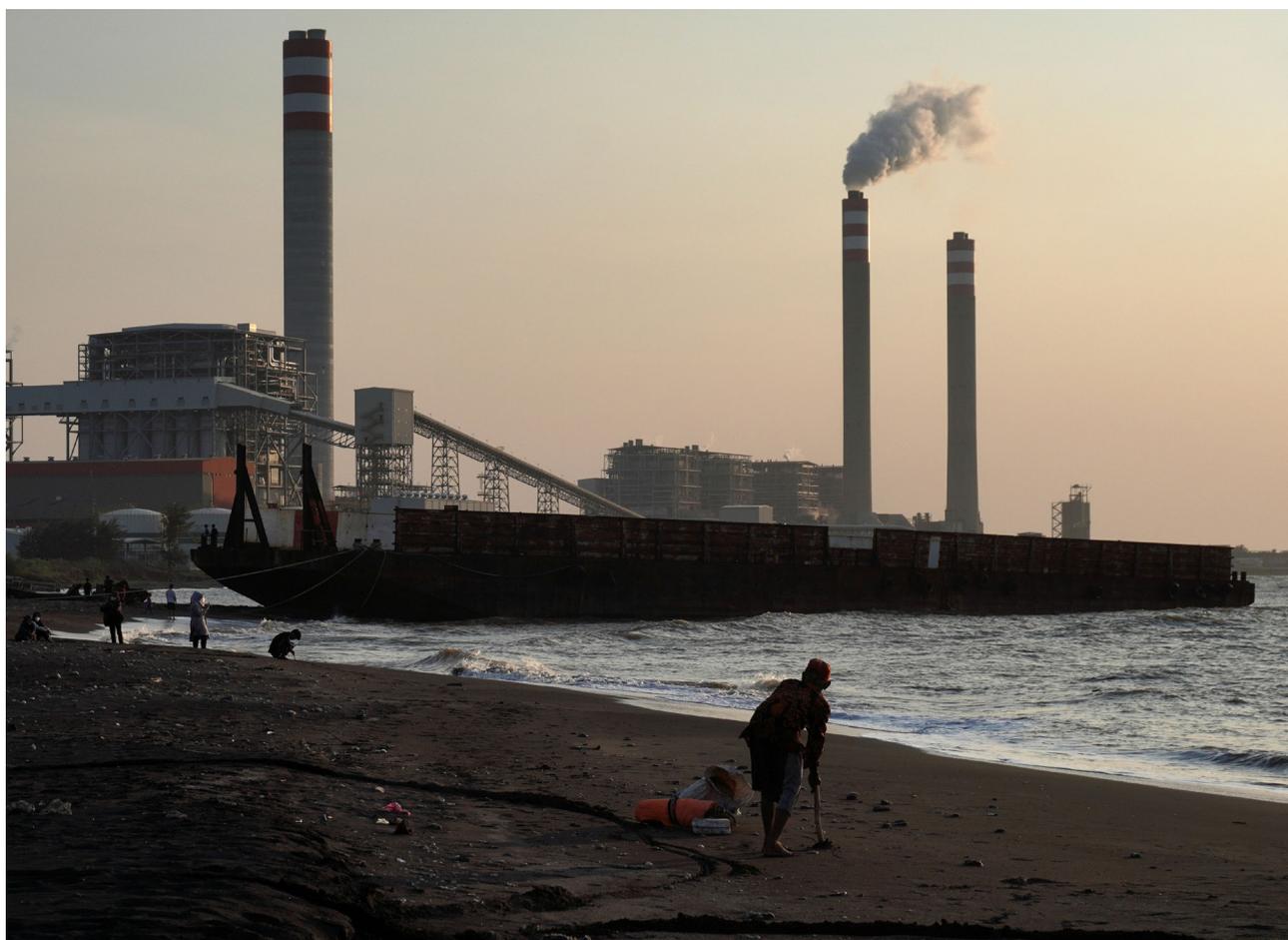
General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2011: 315 MW Unit 2 - 2011: 315 MW
Combustion Technology	Subcritical
National Targets	<i>Biomass co-firing, use of 5% wood pellets starting in 2021</i>
Types of Coal and Their Sources	Coal: sub-bituminous; bioenergy: wood and other biomass (solid) [5%]

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that are hazardous to health increases the risk of premature mortality and various diseases.

With regard to mortality attributable to air pollution, the operation of the Rembang Coal-Fired Power Plant can be associated with an estimated 86 total deaths per year among the adult population. This estimate is derived from measured health risks related to the development or exacerbation of underlying diseases resulting from exposure to NO₂, SO₂, and PM_{2.5}. These diseases include stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes.



Annual mean PM2.5 concentration from Rembang

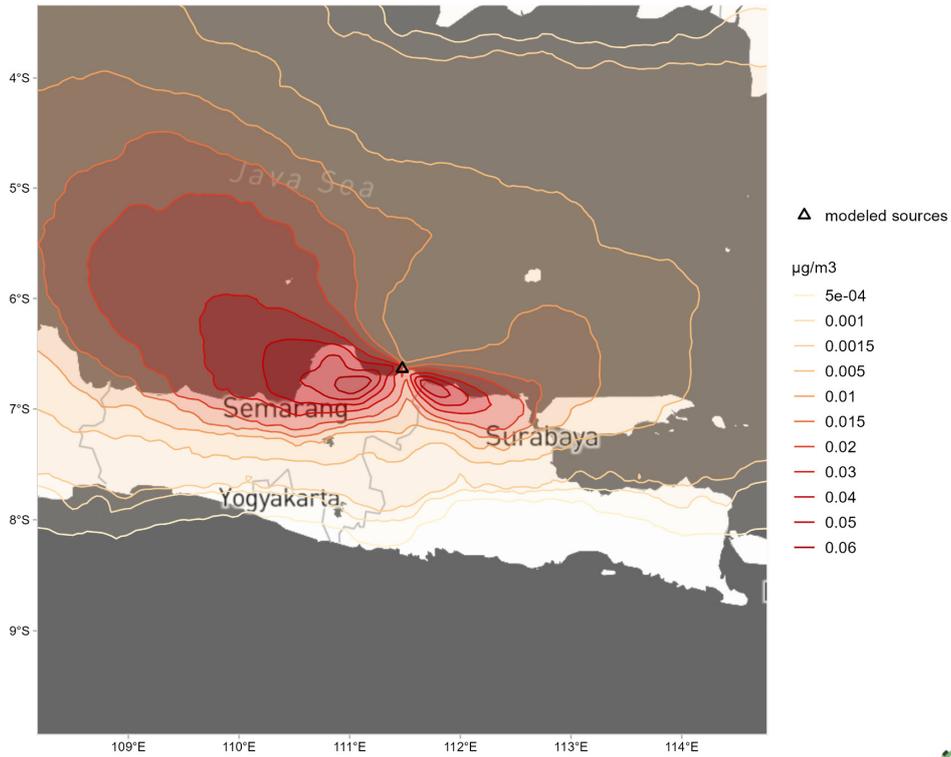


Figure 1. Annual average dispersion of PM2.5 from the Rembang Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Rembang

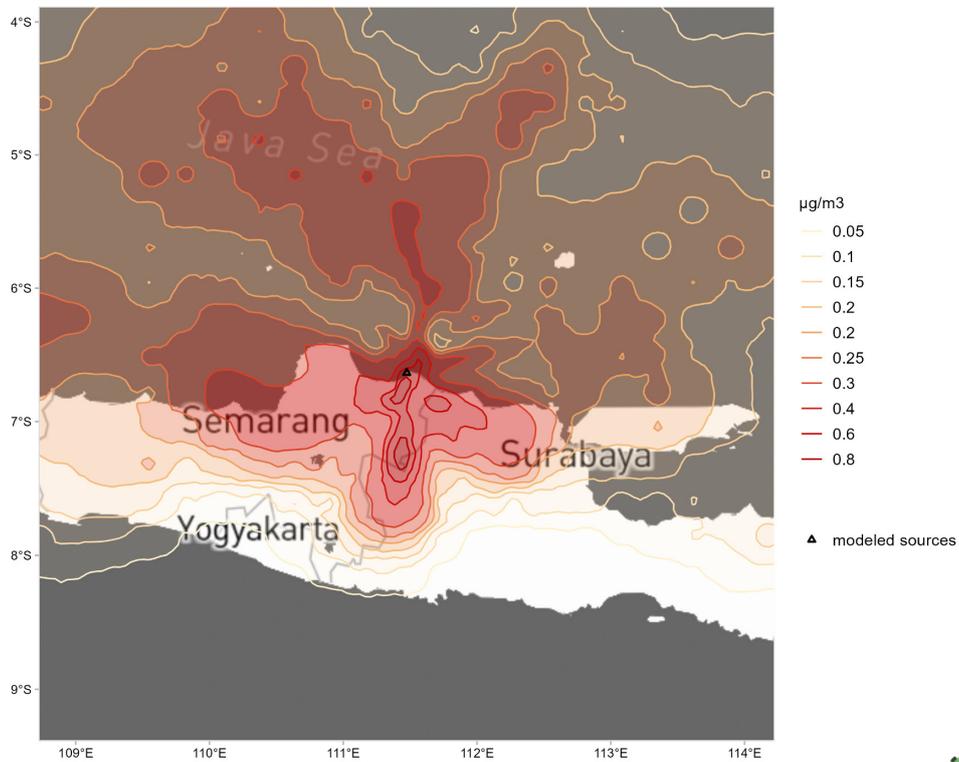


Figure 2. Maximum 24-hour PM2.5 concentration from the Rembang Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the Rembang Coal-Fired Power Plant increase the risk and incidence of respiratory diseases. It is estimated that these emissions result in 108 (65–151) asthma-related emergency department visits and 108 (29–220) new asthma cases, as well as adverse impacts on children and unborn infants. Other health effects include 53 (26–56) cases of preterm birth and 35 (11–61) cases of low birth weight. In addition, productivity losses due to illness and disability are substantial, amounting to 47 (40–54) thousand lost workdays each year, which directly affect economic activity.

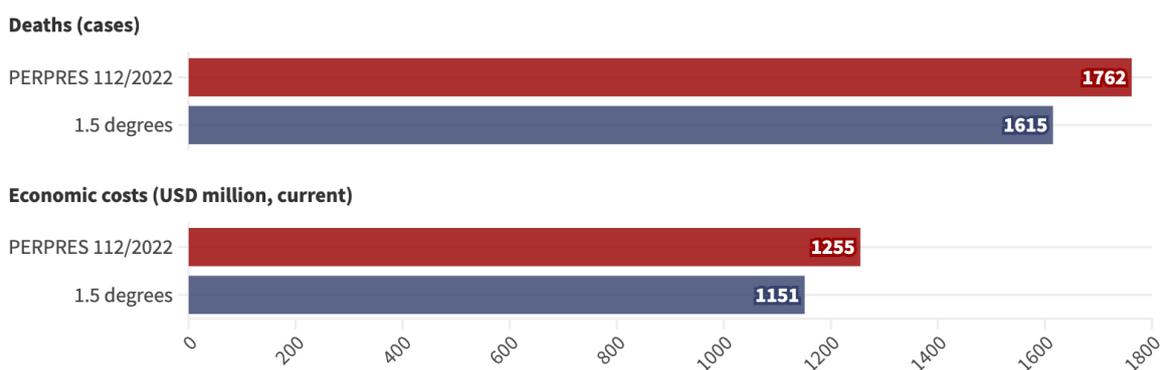
The economic burden on Indonesia arising from health impacts associated with air pollution from the Rembang Coal-Fired Power Plant amounts to USD 58 million per year, equivalent to IDR 0.88 trillion. This

considerable economic burden is largely driven by mortality, while also accounting for hospital costs related to morbidity and the costs of work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5-degree pathway would avert 147 cumulative deaths and reduce the national economic burden by USD 104 million, equivalent to IDR 1.65 trillion.

To realize these benefits, the Rembang Coal-Fired Power Plant must cease operations by 2032, prior to Indonesia’s emissions peaking in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Rembang coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Rembang Coal-Fired Power Plant

b. Impact on Surrounding Community

In November 2023, this power plant became the subject of an investigation related to alleged corruption in the procurement and purchase of coal that did not meet the required calorific specifications.² Allegations of corruption within coal-fired power plants are not unprecedented; this case further underscores the importance of transparency and accountability in power plant operations, particularly when the facility is state-owned.

This power plant is included in PLN's list of facilities implementing biomass co-firing, with a target of blending 14,300 tons of wood pellets derived from *kaliandra* and *gamal* annually. The biomass supply is to be provided by Perhutani in cooperation with PT Sang Hyang Seri.³ However, the development of energy plantation forests (HTE) in this area has once again generated conflict.

In Grobogan, Central Java, the development of HTE by Perhutani in the KPH Sedayu area has triggered the eviction of residents from their cultivated land. Land that had long been used to grow secondary food crops (*palawija*) has been designated for biomass cultivation of *gamal*.⁴ This program is also alleged to have obstructed the process of land redistribution to local residents,

despite their possession of legal documentation in the form of village SPPT records.⁵

Rather than accelerating the retirement of this coal-fired power plant, co-firing instead perpetuates dependence on coal and exacerbates agrarian inequality. A just energy transition cannot be constructed on the basis of land dispossession and the marginalization of community rights. The power plant must be retired now, not sustained under the guise of a superficial "green" narrative.

c. Impact on Local and National Economy

With annual operational costs reaching Rp223.53 billion (USD 13.72 million) per TWh of electricity produced, PLTU Rembang absorbs substantial economic resources. However, rather than stimulating growth, its operations instead trigger an economic contraction of Rp1.49 trillion per year, reflected both in overall economic output and in the regional Gross Domestic Product (GRDP). This decline is further transmitted to the business sector, with operating surplus reduced by up to Rp0.94 trillion. These figures indicate that the presence of the power plant not only restrains growth but also deepens structural losses that are directly experienced by economic actors in the surrounding area.

Operating costs	USD13,72 million
Annual CO ₂ emissions	3,1 kilotons
Impact on annual economic output (gross domestic product)	-IDR1,49 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	-IDR1,49 trillion
Impact on annual business surplus	-IDR0,94 trillion
Impact on annual labor compensation	-IDR0,52 trillion
Impact on annual employment absorption	-46.011 people
Sectoral impacts on agriculture, forestry, and fisheries	-IDR0,97 trillion
Sectoral impacts on health services and social activities	-IDR2,69 billion

2 <https://www.rmolsumsel.id/usut-dugaan-korupsi-pengadaan-batu-bara-kejaksaaan-geledah-kantor-kementerian-esdm>

3 <https://ekonomi.bisnis.com/read/20220302/44/1506224/penggunaan-biomassa-untuk-co-firing-pltu-dorong-perekonomian-masyarakat>

4 Sajogyo Institute, dkk. 2024. Hegemoni Politik Kebun Energi: Mengulang Kisah Lama Ekstraksi Sumber Agraria Pedesaan. Bogor: Sajogyo Institute.

5 Ibid.,

Contraction of the Employment Sector

The contribution to employment likewise demonstrates a negative trend. Labor compensation declines by up to Rp0.52 trillion annually, indicating a loss of household income among those dependent on affected sectors. Moreover, employment absorption contracts sharply, with the loss of approximately 46,011 jobs. This reduction in employment opportunities not only harms individuals but also erodes community purchasing power and widens local socioeconomic disparities.

Implications for the Environment and Other Strategic Sectors

Strategic sectors such as agriculture, forestry, and fisheries lose economic potential of up to Rp0.97 trillion per year due to environmental degradation triggered by PLTU Rembang. Meanwhile, the health services and social activities sector incurs losses of Rp2.69 billion annually, reflecting additional burdens on the healthcare system arising from pollution and declining environmental quality. With annual carbon emissions reaching 3.1 kilotons of CO₂, the power plant constitutes a significant source of pollution that exacerbates the climate crisis and undermines the foundations of regional sustainability.

Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(967.824)
Mining and Quarrying	(21.099)
Manufacturing	(272.870)
Electricity and Gas Supply	(9.143)
Water Supply; Waste Management, Wastewater, and Recycling	(247)
Construction	(18.813)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(89.903)
Transportation and Warehousing	(26.817)
Accommodation and Food Service Activities	(4.234)
Information and Communication	(15.905)
Financial and Insurance Activities	(27.781)
Real Estate Activities	(4.052)
Business Activities	(13.339)
Public Administration, Defence, and Compulsory Social Security	(3.053)
Education Services	(738)
Human Health and Social Work Activities	(2.690)
Other Services	(7.486)
TOTAL	(1.485.994)

19

Banten Serang CFPP, Banten (660 MW)



Serang Banten Coal-Fired Power Plant, Banten (660 MW)

https://www.gem.wiki/Banten_Serang_power_station

The **Banten Coal-Fired Power Plant (PLTU Banten)** is a steam-based coal power facility with a capacity of **1x660 MW**, operated by the private company **PT Lestari Banten Energi** (a subsidiary of the Genting Group) and located in **Salira Village, Pulo Ampel Subdistrict, Serang Regency, Banten Province**. The project was implemented under a **Build, Own, Transfer (BOT)** scheme, with a **25-year Power Purchase Agreement (PPA)** signed with **PT Perusahaan Listrik Negara (PLN)** on **10 July 2012**.

Commercialization of the plant began with a trial operation phase in early 2017, and it officially achieved **Commercial Operation Date (COD)** in **May 2017**. Of the total installed

capacity of **660 MW, 600 MW** is supplied to PLN, while the remaining **60 MW** is allocated for internal use by Lestari Banten Energi.

The plant utilizes **supercritical boiler technology**, with a total investment value of approximately **USD 1 billion**. It was the **first Independent Power Producer (IPP)** project under Indonesia's **35,000 MW program** to successfully reach COD. In addition, the project was supported by the issuance of **USD 775 million in global bonds** in **January 2019**, released by Lestari Banten Energi for refinancing purposes. These bonds mature in **2039** and were assigned **investment-grade ratings of Baa3 and BBB-** by **Moody's** and **Fitch**, respectively.

Ownership and Investors

Serang Banten Coal-Fired Power Plant



Capacity
2x660 MW



Commercial Operation Date
20xx



Total Loans
USD 1.973.000.000



Year of Financing
2013



Lender Countries
Malaysia, United States, United Kingdom, Japan



Lenders
Citigroup, EXIM Bank of Malaysia, CIMB, Maybank, RHB Bank, Barclays, CIMB Group, Sumitomo Mitsui Banking Corporation



Location
Salira, Puloampel, Serang, Banten



Type of Financing
USD 730 million (initial loan financing) + USD 775 million (refinancing through bond issuance)

Source: GEM Website, GEM Database

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2017: 660 MW
Combustion Technology	Supercritical
National Targets	None
Types of Coal and Their Sources	Coal: unknown

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that pose risks to human health increases the likelihood of premature mortality and a wide range of diseases.

With regard to deaths attributable to air pollution, the operation of the **Banten**

Serang Coal-Fired Power Plant (PLTU Banten Serang) can be associated with **204 total deaths per year among the adult population**, as well as **at least one death of a child under the age of five** due to lower respiratory tract infections. These estimates are derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to **NO₂, SO₂, and PM_{2.5}**. The diseases included in this assessment comprise **stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes**.



Annual mean PM2.5 concentration from Banten

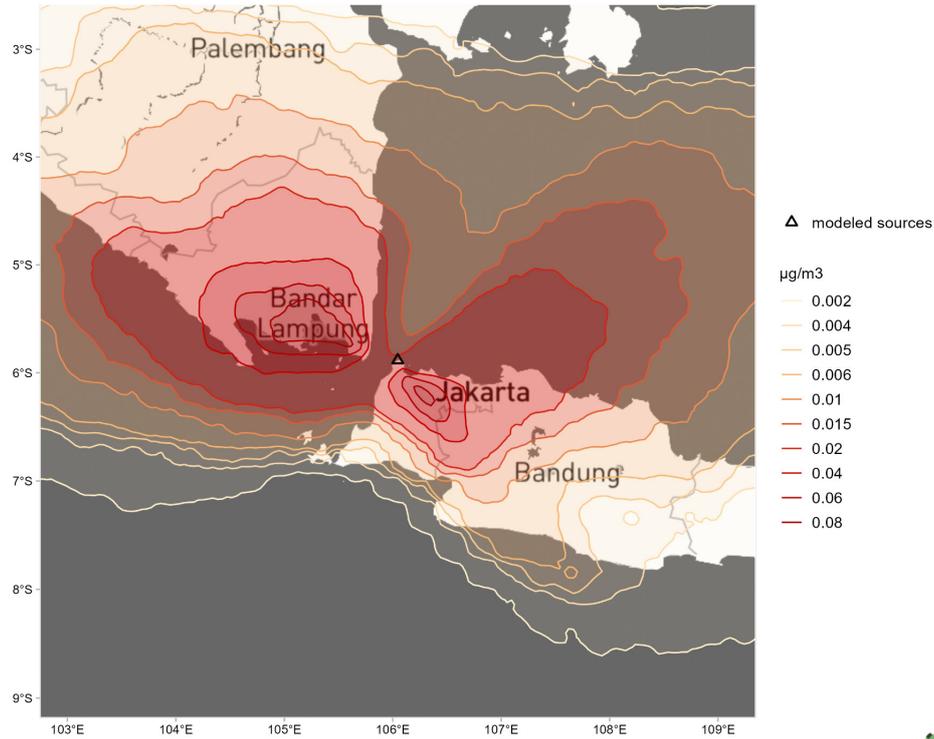


Figure 1. Annual average dispersion of PM2.5 from the Banten Serang Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Banten

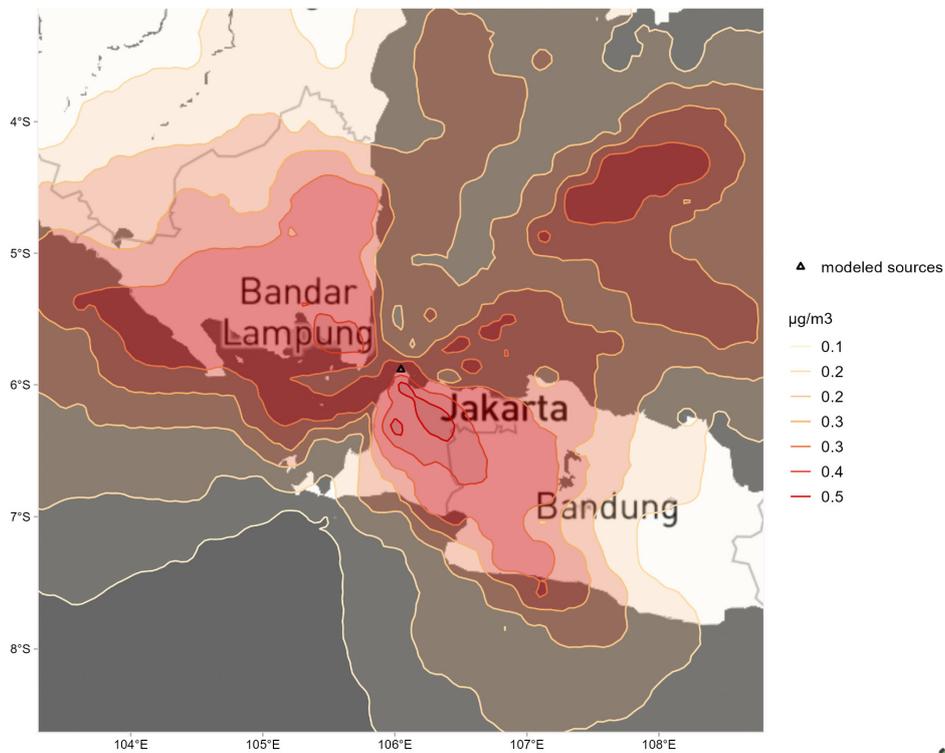


Figure 2. Maximum 24-hour PM2.5 concentration from the Banten Serang Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the **Banten Serang Coal-Fired Power Plant (PLTU Banten Serang)** lead to increased risks and incidences of respiratory diseases, including **237 (142–331) emergency department visits for asthma** and **552 (147–1,120) new asthma cases**, as well as adverse impacts on children and unborn infants, comprising **116 (56–123) cases of preterm birth** and **76 (24–132) cases of low birth weight**. In addition, productivity losses due to illness and disability amount to **102 (87–117) thousand workdays lost each year**, directly affecting economic activity.

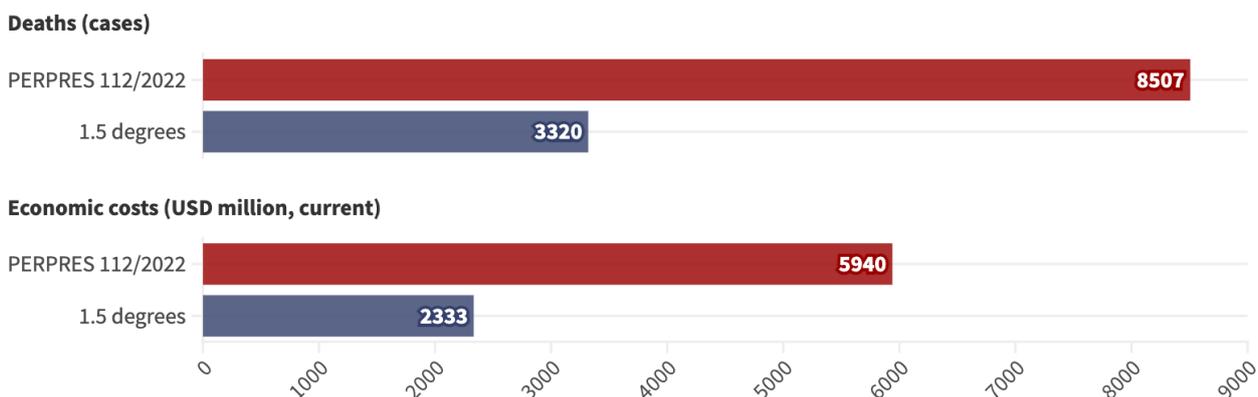
The economic burden on Indonesia arising from health impacts associated with air pollution from PLTU Banten Serang is estimated at **USD 136 million annually**, equivalent to **IDR 2.07 trillion**. This substantial economic burden is largely

attributable to mortality, while also accounting for hospital costs related to morbidity and costs associated with work absenteeism.

In future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with the 1.5-degree scenario pathway would avert 5,187 cumulative deaths and reduce the national economic burden by USD 3.61 billion, equivalent to IDR 57 trillion.

To realize these benefits, **PLTU Banten Serang must cease operations by 2034**, prior to Indonesia’s projected emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Banten Serang coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impact of air pollution on mortality and economic costs from the Banten Serang Coal-Fired Power Plant

b. Impact on Surrounding Community

Since commencing operations in 2017, this coal-fired power plant has also become part of a process that has further exacerbated pre-existing environmental degradation in the Banten region. The concentration of dozens of coal-fired power plants in this area has increasingly deteriorated air quality, with impacts extending to the Greater Jakarta (Jabodetabek) region, thereby undermining public health conditions.

Data from the Cilegon City Health Office indicate that between 2018 and May 2020 there were 118,184 cases of acute respiratory infections (ISPA) among residents of Cilegon City, including children under five years of age.¹ These illnesses are strongly suspected to be closely associated with the release of fine particulate matter resulting from coal combustion emitted by the numerous coal-fired power plants surrounding Cilegon. Nevertheless, comprehensive research is still required to conclusively confirm this correlation.

Local communities also frequently experience episodes of “dust rain” from combustion residues that settle on houses and coat plant leaves.² In addition, coal spills that contaminate Banten’s marine environment occur repeatedly. In 2019, approximately **7,000 tons of coal** were spilled in the southern waters of Java Island while being transported to the Suralaya coal-fired power plant.³ Once again, local communities are compelled to bear the consequences of reliance on dirty energy sources.

c. Impact on Local and National Economy

Operasional PLTU ini memerlukan biaya mencapai Rp3,11 triliun per tahun, disertai emisi karbon sebesar 2,61 kiloton CO₂ setiap tahunnya. Angka ini menunjukkan tingginya beban ekonomi dan lingkungan yang diRESULTkan, sementara kontribusinya terhadap pembangunan berkelaanmillionn justru minim.

Operating costs	USD 30,71 million
Annual CO ₂ emissions	2,61 kilotons
Impact on annual economic output (gross domestic product)	- IDR0,23 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR0,22 trillion
Impact on annual business surplus	- IDR0,11 trillion
Impact on annual labor compensation	- IDR0,11 trillion
Impact on annual employment absorption	- 6.154 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR0,17 trillion
Sectoral impacts on health services and social activities	- IDR0,27 billion

1 <https://faktabanten.co.id/cilegon/2ratusan-ribu-kasus-penyakit-ispa-di-cilegon-pltu-jadi-salah-satu-penyebabnya/>

2 <https://trendasia.org/wp-content/uploads/2020/09/FA-LAPORAN-BANTEN-PLTU-JAWA-9-10.pdf>, hal.7

3 <https://trendasia.org/wp-content/uploads/2020/09/FA-LAPORAN-BANTEN-PLTU-JAWA-9-10.pdf>, hal 20

Negative Economic Contribution

At the macroeconomic level, the operation of this coal-fired power plant results in an annual economic output loss of **Rp 0.23 trillion**, accompanied by a decline in **Gross Regional Domestic Product (GRDP)** of **Rp 0.22 trillion**. These figures underscore that the plant fails to function as a driver of regional economic growth and instead constitutes an economic burden.

Business Losses and Employment Impacts

Business surplus associated with activities linked to the plant records a negative balance

of **Rp 0.11 trillion per year**. The impact on employment is also substantial, with an estimated loss of **Rp 0.11 trillion** in labor compensation and a reduction in employment absorption of up to **6,154 workers per year**, directly affecting household incomes.

Impacts on Vital Sectors

Key sectors such as agriculture, forestry, and fisheries experience annual economic losses of **Rp 0.17 trillion** due to pollution and environmental degradation generated by the plant's operations. Meanwhile, the health services and social activities sector incurs losses of up to **Rp 0.27 billion per year**, reflecting the increased public health burden on communities surrounding the plant's operational area.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(174.534)
Mining and Quarrying	(1.858)
Manufacturing	(24.251)
Electricity and Gas Supply	(1.397)
Water Supply; Waste Management, Wastewater, and Recycling	(30)
Construction	(969)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(11.487)
Transportation and Warehousing	(3.849)
Accommodation and Food Service Activities	(364)
Information and Communication	(1.128)
Financial and Insurance Activities	(1.747)
Real Estate Activities	(541)
Business Activities	(1.054)
Public Administration, Defence, and Compulsory Social Security	(119)
Education Services	(51)
Human Health and Social Work Activities	(267)
Other Services	(693)
TOTAL	(224.339)

20

Labuhan Angin CFPP,
North Sumatra
(230 MW)



Labuhan Angin Coal-Fired Power Plant, North Sumatra (230 MW)

https://www.gem.wiki/Labuhan_Angin_power_station

The **Labuhan Angin Coal-Fired Power Plant** is a coal-based power generation facility with a capacity of 2×115 MW, located in Tapian Nauli I Village, Tapian Nauli Subdistrict, Central Tapanuli Regency, North Sumatra. Each unit officially commenced commercial operation on 21 April 2009 and 7 November 2009, respectively, and the project was inaugurated by President Susilo Bambang Yudhoyono on 28 January 2010. The Labuhan Angin Power Plant is managed by PT PLN Indonesia Power Services, a subsidiary of the subholding PT PLN Indonesia Power under PT PLN (Persero).

The construction of the Labuhan Angin Power Plant was undertaken by CMEC (China National Machinery & Equipment Import & Export Corporation), with financing sourced from a combination of loans from China and PLN's internal funds amounting to approximately

USD 208.7 million plus IDR 232.4 billion. The electricity generated is transmitted via a ± 29 km 150 kV overhead transmission line to the Sibolga Substation, strengthening the stability of electricity supply in Northern Sumatra. In the course of its operation, the plant has also adopted a biomass co-firing program as a supplementary fuel to reduce coal consumption.

In terms of conflict and health-related issues, there was a reported case involving a cooling water pump (CWP) operator who suffered poisoning in the hazardous chemical storage pond area. Local media reported turbid water conditions and fish mortality at the site. Although PLN denied these claims and stated that the worker's death was caused by a stroke, the incident prompted criticism regarding occupational health and safety oversight and internal transparency.

Ownership and Investors

PLTU Labuhan Angin Unit 1-2



Capacity
2x115 MW



Loan Year
2003



Commercial Operation Date
2008



Loan Tenor
15 years (with a 7-year grace period)



Lender Countries
China, United Kingdom, Indonesia



Total Loan
USD 183,544,240.26 (USD 477.4 million adjusted to 2021 USD value for inflation)



Type of Financing
Loans, Preferential Buyer's Credit (PBC)



Lenders
China Exim Bank, Bank of China, Commercial Development Bank, Barclays, ICBC Bank, and domestic banks including Bank BRI, Bank BNI, and Regional Development Banks

Source: China AidData¹

¹ <https://china.aiddata.org/projects/61681/>

General Info

Commercial Operation Date (COD) and Power Generation Capacity	Unit 1 - 2008: 115 MW Unit 2 - 2008: 115 MW
Combustion Technology	Subcritical
National Targets	Biomass co-firing, utilization of waste banknotes
Types of Coal and Their Sources	Coal: lignite

a. Distribution of Pollution and its Health Impact on the Surrounding Community

Exposure to air pollutants that pose risks to human health increases the likelihood of premature mortality and a range of diseases.

In terms of deaths attributable to air pollution, the operation of the Labuhan Angin coal-fired power plant can be associated with an estimated 21 total deaths per year among the adult population. This estimate is derived from quantified health risks related to the development or exacerbation of underlying diseases resulting from exposure to NO₂, SO₂, and PM_{2.5}. These diseases include stroke, ischemic heart disease, lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, and diabetes.



Annual mean PM2.5 concentration from Labuhan Angin

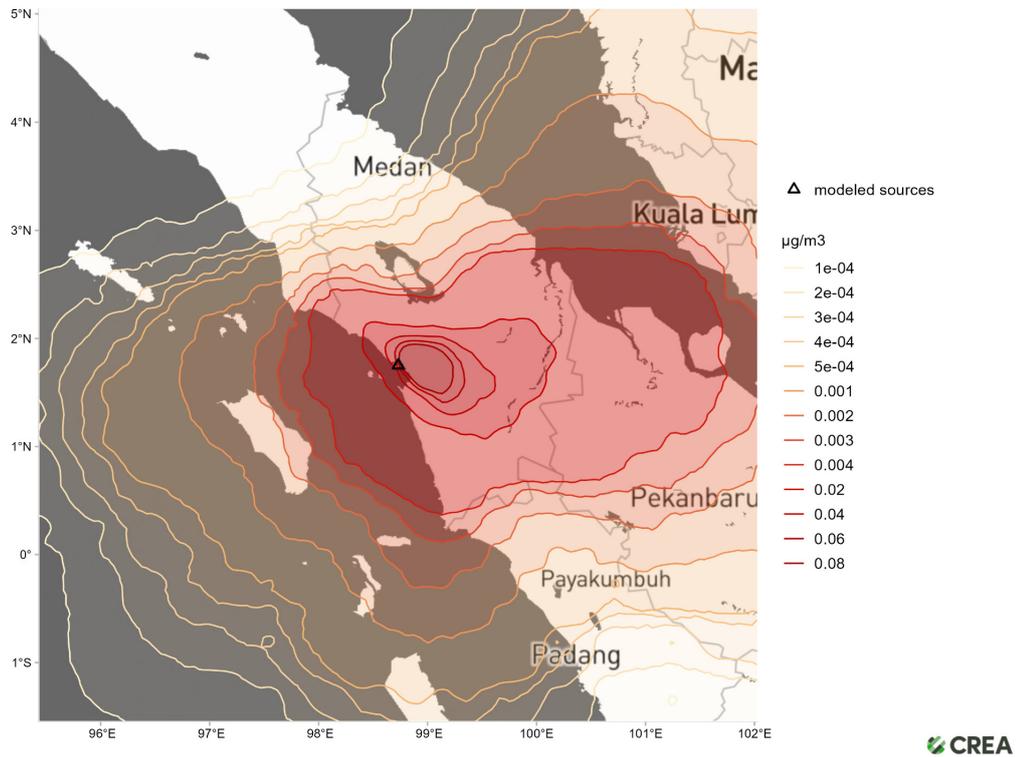


Figure 1. Annual average dispersion of PM2.5 from the Labuhan Angin Coal-Fired Power Plant

Maximum 24-hour PM2.5 concentration from Labuhan Angin

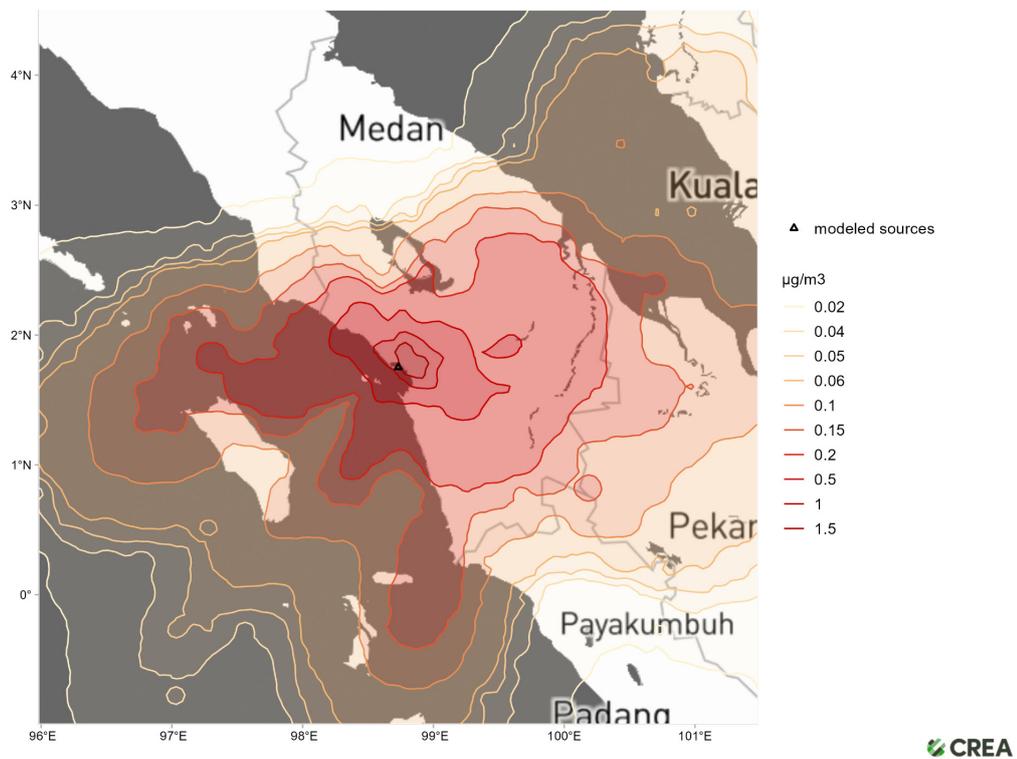


Figure 2. Maximum 24-hour PM2.5 concentration from the Labuhan Angin Coal-Fired Power Plant

In terms of morbidity, air pollutant emissions from the Labuhan Angin coal-fired power plant lead to increased risks and incidences of respiratory diseases, including an estimated 19 (11–26) asthma-related emergency room visits and 60 (16–122) new asthma cases. Adverse impacts are also observed among children and unborn infants, with 10 (5–10) cases of preterm birth and 6 (2–11) cases of low birth weight. In addition, productivity losses due to illness and disability amount to an estimated 9 (7–10) thousand workdays lost each year, directly affecting economic activity.

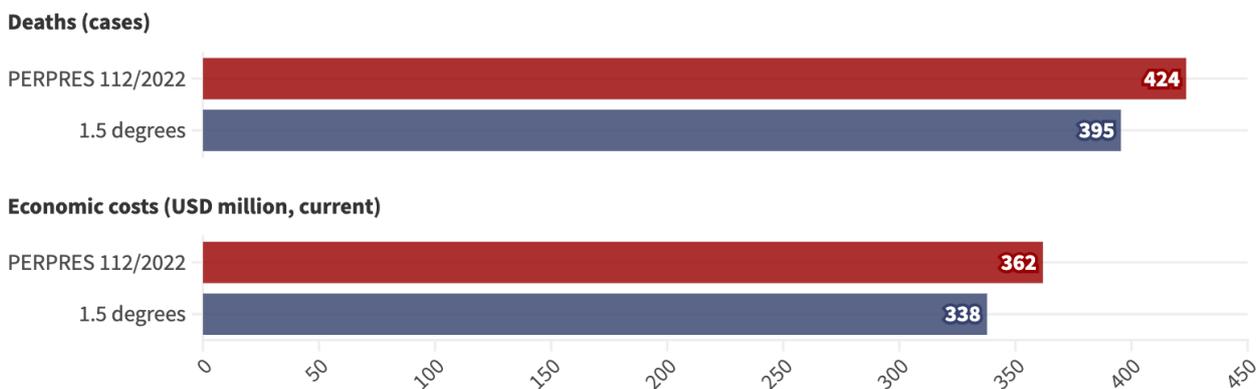
The economic burden on Indonesia arising from health impacts associated with air pollution from the Labuhan Angin coal-fired power plant is estimated at USD 17 million annually, equivalent to Rp0.26 trillion. This substantial economic burden is largely driven by premature mortality,

while also accounting for hospital costs related to morbidity and the costs of work absenteeism.

Under future projections developed based on retirement schedules and air pollution control technologies, the analysis indicates that alignment with a 1.5-degree pathway would avert 29 cumulative deaths and reduce the national economic burden by USD 24 million, equivalent to Rp380 billion.

To realize these benefits, the Labuhan Angin power plant must cease operation of Unit 2 in 2031 and Unit 1 in 2030, prior to Indonesia's projected emissions peak in 2035.

Cumulative air pollution-related deaths and economic costs attributed to Labuhan Angin coal power plant



Source: CREA analysis, "Health benefits of Just Energy Transition and coal phase-out in Indonesia" • Refer to Methodology for specific assumptions



Figure 3. Future projections of the impacts of air pollution on mortality and economic costs from the Labuhan Angin Coal-Fired Power Plant

b. Impact on Community

Since commencing operations in 2009, this coal-fired power plant has been suspected of contributing to public health problems among surrounding communities. Numerous residents—particularly children—have reportedly fallen ill, suffering from acute respiratory infections (ARI) and persistent coughing as a result of inhaling polluted air emitted from the plant’s smokestacks. Community incomes have also declined, as reflected in complaints from fishers whose livelihoods have been affected by the degradation of marine ecosystems.

On 8 May 2025, Unit 1 of the plant experienced a fire, reportedly triggered by a high-intensity lightning strike that caused a localized fire in part of the unit’s facilities. The Ministry of Energy and Mineral Resources (ESDM) stated that there were no casualties and that electricity supply to consumers remained secure. However, the extent of state losses resulting from the incident has not yet been disclosed.

Infrastructure damage resulting from negligence or inadequate risk mitigation systems should not be treated lightly. The

financial losses arising from such incidents must be calculated and publicly disclosed as a form of transparency and accountability for state-owned assets. Moreover, this incident serves as a reminder that maintaining coal-fired power plants not only generates environmental and health impacts, but also poses the risk of significant financial losses for the state.

Such incidents should constitute a compelling justification for the immediate retirement of the Labuhan Angin coal-fired power plant. Funds that would otherwise be allocated for repairing damages should instead be redirected toward investments in cleaner and more sustainable renewable energy sources.

c. Impact on Local and National Economy

This power plant incurs annual operational costs of USD 11.09 million, while its carbon emissions reach 1.29 kilotons of CO₂ per year. These expenditures are disproportionate to the economic benefits generated, particularly when considering the environmental impacts arising from air pollution and the potential degradation of surrounding ecosystems.

Operating costs	USD 11,09 million
Annual CO ₂ emissions	1,29 kilotons
Impact on annual economic output (gross domestic product)	- IDR0,72 trillion
Impact on annual Gross Regional Domestic Product (GRDP)	- IDR0,72 trillion
Impact on annual business surplus	- IDR0,43 trillion
Impact on annual labor compensation	- IDR0,28 trillion
Impact on annual employment absorption	- 16.742 people
Sectoral impacts on agriculture, forestry, and fisheries	- IDR0,49 trillion
Sectoral impacts on health services and social activities	- IDR1,28 billion

Negative Contributions to the Economy

Rather than providing a positive stimulus to the economy, this power plant instead generates economic losses, as reflected in a decline in economic output of IDR 0.72 trillion per year. This figure is consistent with the contraction of Gross Regional Domestic Product (GRDP), which also amounts to negative IDR 0.72 trillion, indicating that the plant's presence fails to generate added value for regional economic growth.

Business Losses and Impacts on Employment

From the business perspective, the plant results in annual losses in business surplus totaling IDR 0.43 trillion. Its impact on

labor is also substantial, with a reduction in labor compensation of IDR 0.28 trillion and the loss of employment opportunities for approximately 16,742 workers per year, which in turn undermines the welfare of local households and communities.

Losses in Strategic Sectors

The operation of the Labuhan Angin Coal-Fired Power Plant causes the greatest losses in the agriculture, forestry, and fisheries sectors, with a decline in value reaching IDR 499.85 billion per year, making these sectors the most severely affected. Two other sectors experiencing significant losses are manufacturing, which incurs losses of approximately IDR 75.77 billion, and wholesale and retail trade, which loses economic value of up to IDR 42.72 billion per year.



Impact on GDP by 17 Sectors (in IDR million)

SECTOR	RESULT
Agriculture, Forestry, and Fisheries	(499.846)
Mining and Quarrying	(6.745)
Manufacturing	(75.768)
Electricity and Gas Supply	(10.837)
Water Supply; Waste Management, Wastewater, and Recycling	(539)
Construction	(3.008)
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	(42.717)
Transportation and Warehousing	(31.179)
Accommodation and Food Service Activities	(4.554)
Information and Communication	(5.377)
Financial and Insurance Activities	(18.482)
Real Estate Activities	(4.616)
Business Activities	(9.568)
Public Administration, Defence, and Compulsory Social Security	(1.374)
Education Services	(428)
Human Health and Social Work Activities	(1.285)
Other Services	(2.461)
TOTAL	(718.784)

Analysis of Coal-Fired Power Plant Retirement Using the Analytical Hierarchy Process (AHP) Method

A. Stages Toward the Early Retirement of Coal-Fired Power Plants under Minister of Energy and Mineral Resources Regulation (Permen ESDM) Number 10 of 2025

Tahapan Transisi Energi	Deskripsi	Masalah yang Dihadapi
Penerapan CCS/CCUS dan Pembatasan Pembangunan PLTU	Teknologi CCS/CCUS masih mahal dan belum terbukti secara luas di Indonesia. Pembatasan pembangunan PLTU tidak cukup mengurangi ketergantungan pada PLTU yang ada.	Biaya penerapan CCS/CCUS yang tinggi. Keterbatasan teknis dan finansial dalam implementasi. Pembatasan pembangunan PLTU belum cukup agresif dalam pengurangan emisi.
Natural Retirement PLTU dengan Teknologi CCS/CCUS	Natural retirement PLTU yang bergantung pada CCS/ CCUS cenderung lambat dan tidak cukup cepat dalam mengurangi emisi.	Mengandalkan teknologi yang mahal dan belum terbukti secara luas. Proses transisi yang tidak cukup cepat.
Melanjutkan Natural Retirement PLTU	Proses penghentian PLTU yang terlalu bertahap tidak cukup efektif mengurangi emisi secara cepat.	Tidak ada batas waktu yang jelas untuk penghentian PLTU. Ketergantungan yang terus berlanjut pada pembangkit berbasis fosil.
Perluasan Retirement PLTU	Perluasan retirement PLTU terlalu lambat dan tidak agresif dalam mengatasi perubahan iklim.	Tidak cukup mendesak untuk menghadapi krisis iklim yang semakin parah. Masih memberi ruang untuk keberlanjutan PLTU yang menghasilkan emisi tinggi.

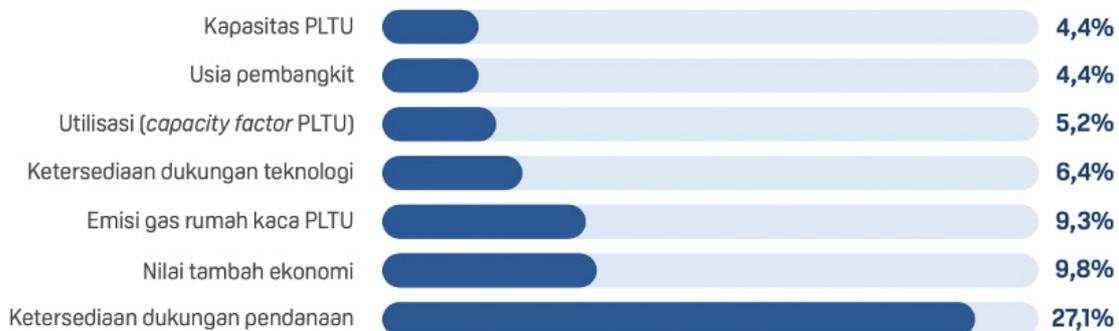
The stages outlined in the Energy Transition Roadmap for the electricity sector provide considerable leeway for coal-fired power plants to continue operating for extended periods, while also opening opportunities for the adoption of costly and unproven technologies such as CCS/CCUS (Carbon Capture and Storage/Carbon Capture, Utilization, and Storage) to prolong their operational lifespans. Instead, Indonesia should redirect its focus toward more concrete measures for the phase-out of coal-fired power plants that are not obscured by

narratives of false transition. This position is also explicitly stated in the roadmap document, which notes that *“the National Electricity General Plan (Rencana Umum Ketenagalistrikan Nasional, RUKN) stipulates that the acceleration of the early termination of coal-fired power plant operations is conditional, taking into account international support, the basic cost of electricity supply, and the reliability of the power system. In cases where replacement power plants are required, their capacity must fall outside the projections already established in the RUKN.”*

B. Critique of the Use of the Analytical Hierarchy Process (AHP) Method for the Analysis of Early Retirement of Coal-Fired Power Plants

Tabel.
Kriteria dan Metodologi yang digunakan untuk Pemilihan PLTU

Sesuai Perpres Nomor 112 Tahun 2022



Tambahan dalam Peta Jalan



Sumber: (Lampiran Permen ESDM No 10 Tahun 2025)

The use of the Analytical Hierarchy Process (AHP) method to compare and assign weights to technical, economic, environmental, and social aspects is considered problematic because it assumes that all aspects are equivalent and mutually substitutable. In reality, studies by CREA and IESR (2023) [1] show that emissions from coal-fired power plants in Indonesia in 2022 caused approximately 10,500 deaths and imposed an economic burden of up to IDR 170 trillion. If the energy transition were accelerated, up to 182,000 lives could be saved and health-related costs amounting to IDR 2,900 trillion could be avoided. Notably, no specific health component is included in the AHP framework as stipulated in the Minister of Energy and Mineral Resources Regulation.

In the Minister of Energy and Mineral Resources regulation, environmental aspects—such as greenhouse gas emissions and the energy transition—are assigned weights of only 9.3 percent and 10.1 percent, respectively, far below the 27.1 percent weight allocated to financing factors. This weighting scheme reflects a policy inclination that downplays the urgency of environmental protection in the coal power plant retirement process. Such a quantitative approach is not only morally problematic, as it equates the value of human life and environmental sustainability with technical or economic considerations, but it is also methodologically flawed.

Moreover, the Just Energy Transition aspect, assigned a weight of 10.1 percent, is not accompanied by a clear explanation of its constituent components. Incorporating Just Energy Transition criteria without detailed descriptions or clear definitions creates a risk that no coal-fired power plant would fail to meet the

Ministry of Energy and Mineral Resources' and PLN's version of "Just Energy Transition." This lack of transparency in the criteria governing coal plant phase-out is fundamentally detrimental to credible and accountable policymaking.

The consequences of this flawed weighting are substantial. An excessive focus on financing may lead the government to retire only those coal-fired power plants that already have secured financial support, while the most environmentally destructive plants continue to operate. Poorly managed plants or those located in less strategic areas also risk being overlooked.

Furthermore, the government may invoke limited funding as a justification for the slow pace of coal power plant retirements, constructing a narrative that frames this failure as the result of insufficient international donor support. In reality, the primary responsibility for accelerating the energy transition and protecting communities and the environment rests with the state itself, rather than being contingent upon third parties.

Questioning Expert Competence

The regulation in question bases its policy on expert assessments, yet it does not publicly disclose who these experts are, their academic backgrounds, professional experience, or institutional affiliations. This lack of clarity violates fundamental principles of scientific research that require transparency and accountability. In the absence of information regarding the number of experts involved and data validation methods such as triangulation, the validity of the study's findings is open to question. If conflicts of interest were present in this process, the results would be highly susceptible to bias, potentially shaping the overall direction of energy transition policy.

Methodological Weaknesses of AHP under Inaccurate Indexation

The study used in formulating the regulation relies on a Likert scale of 1–5 within the AHP method, yet the basis for assigning each score is not explained. This lack of explanation creates room for bias, as each expert may interpret the relative importance of an indicator—such as energy transition—differently. Such differences in perception lead to inconsistencies in assessment, which ultimately risk producing erroneous conclusions in policy formulation.

Inappropriateness of the AHP Method for Coal Power Plant Retirement

In the context of coal-fired power plant retirement, the AHP approach is less appropriate because it does not position

environmental considerations as a primary prerequisite. A more suitable approach is a sequential filtering model, as developed in studies by Peter Henderson[2], Achmed Edianto[3], and N. Mayfield[4]. This approach identifies and selects coal-fired power plants based first on their environmental impacts, using measurable indicators such as emissions, pollution, health impacts, land use, and plant age. If a plant exceeds certain environmental thresholds, it is immediately categorized as a candidate for retirement. Subsequent stages then assess social and economic aspects in a stepwise manner, enabling decision-making that is more equitable and scientifically grounded.

[1] Center for Research on Energy and Clean Air (CREA) & Institute for Essential Services Reform (IESR), *Health Benefits of Just Energy Transition and Coal Phase-out in Indonesia*, Juli 2023. Akses: <https://energyandcleanair.org/publication/health-benefits-of-just-energy-transition-and-coal-phase-out-in-indonesia/>

[2] Peter Henderson, Ben Chugg, Brandon Anderson, dan Daniel E. Ho. 2022. *Beyond Ads: Sequential Decision-Making Algorithms in Law and Public Policy*. In Proceedings of the 2022 Symposium on Computer Science and Law (CSLAW '22), November 1–2, 2022, Washington, DC, USA. ACM, New York, NY, USA. <https://doi.org/10.1145/3511265.3550439>

[3] Edianto, Gregory Trencher, dkk, Forecasting coal power plant retirement ages and lock-in with random forest regression. *Patterns*, Volume 4, Issue 7, 14 July 2023. Doi: <https://doi.org/10.1016/j.patter.2023.100776>

[4] Erin N Mayfield, Phasing out coal power plants based on cumulative air pollution impact and equity objectives in net zero energy system transitions. *Environ. Res.: Infrastruct. Sustain.* 2 (2022) 021004 <https://doi.org/10.1088/2634-4505/ac70f6>

Methodology

I. Economic Modeling

The Interregional Input–Output (IRIO) model is employed to analyze and estimate the economic impacts of coal-fired power plants across 20 locations. Although the IRIO and conventional Input–Output (I–O) methods share many similarities, the IRIO approach is better suited to conducting detailed analyses of both interregional and intraregional impacts, including spillover effects and feedback effects.

Through the IRIO framework, it is possible to observe how electricity generation activities in one region affect other regions. An IRIO

table consists of multiple regional input–output tables that are interconnected through interregional trade transactions. These tables represent flows of goods and services between regions and can be interpreted as interregional trade relationships.

In general, IRIO analysis is illustrated in Table 1, which depicts the process by which economic transactions as inputs generate outputs. In producing output, primary production sectors generate inputs not only for themselves but also for other sectors (secondary and tertiary), which are then combined with final demand in each province.

Table 1. Metode IRIO

Provinsi	Sector	D			J			Other		
		1	...	16	1	...	16	1	...	16
D	1	Z_{11}^{DD}	...	Z_{116}^{DD}	Z_{11}^{DJ}	...	Z_{116}^{DJ}	Z_{11}^{DL}	...	Z_{116}^{DL}
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	16	Z_{161}^{DD}	...	Z_{1616}^{DD}	Z_{161}^{DJ}	...	Z_{1616}^{DJ}	Z_{161}^{DL}	...	Z_{1616}^{DL}
J	1	Z_{11}^{JD}	...	Z_{116}^{JD}	Z_{11}^{JJ}	...	Z_{116}^{JJ}	Z_{11}^{JL}	...	Z_{116}^{JL}
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	16	Z_{161}^{JD}	...	Z_{1616}^{JD}	Z_{161}^{JJ}	...	Z_{1616}^{JJ}	Z_{161}^{JL}	...	Z_{1616}^{JL}
Lain-lain	1	Z_{11}^{LD}	...	Z_{116}^{LD}	Z_{11}^{LJ}	...	Z_{116}^{LJ}	Z_{11}^{LL}	...	Z_{116}^{LL}
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	16	Z_{161}^{LD}	...	Z_{1616}^{LD}	Z_{161}^{LJ}	...	Z_{1616}^{LJ}	Z_{161}^{LL}	...	Z_{1616}^{LL}

- The diagonal matrix **Z** represents intersectoral transaction matrices within the same region. For example, **ZDD** denotes the matrix of intersectoral transactions within the PLTU Indramayu location. In contrast, the off-diagonal **Z** matrices represent intersectoral transactions between one region and another. For instance, the **ZJD** matrix represents transactions between sectors in the PLTU Indramayu location and those in the PLTU Jeparu location. As an additional note, these off-diagonal matrices are not necessarily square matrices, as the number of sectors in one region may differ from that in another region.
- In addition to analyzing intersectoral linkages, this study also examines the impacts of policy interventions on economic output and employment absorption. These policy impacts refer to changes in the values of several components of final demand, such as household consumption (C), government consumption (G), investment (I), changes in inventories (I), and exports (E). This approach is consistent with the Keynesian multiplier framework, in which changes in exogenous variables of final demand can influence output expansion across all sectors. For example, economic policies such as investment can be allocated across all sectors or targeted to specific sectors. Even if the magnitude of investment is identical, the resulting impacts will differ due to variations in the strength and interconnections of each sector. This study calculates the impacts on economic output and employment absorption.

II. Ranking of the Toxic Twenty

The ranking of Indonesia's most polluting coal-fired power plants is based on a composite index that evaluates three equally weighted parameters. This analysis includes 38 power

plants and complexes owned by PLN and IPPs. The final ranking of the top twenty is determined by summing the values of these three weighted parameters for each plant.

The first parameter is the extent of air pollution-related burden in terms of economic value rated for the unit of electricity generation, representing both health impacts on the population and the corresponding economic burden and losses directly attributed to the air pollution released from the power generation activity. The approach undertaken to quantify total air pollution-related economic burden is detailed in the section for "Methodology - Health Impact Assessment (HIA)", which is also described in CREA's publication titled "Health benefits of Just Energy Transition and coal phase-out in Indonesia". Electricity generation (in TWh) is calculated based on the gross electric generation capacity (in MW), the gross thermal efficiency on the basis of Lower Heating Value (in MJ/kg), and the capacity factor. A higher value on this parameter indicates a greater economic and health burden on the population.

The second is the annual carbon emissions from coal-fired power generation, representing the primary greenhouse gas of interest that is most deeply linked to climate change. Coal-fired power is the most carbon-intensive form of electricity generation, releasing a significant amount of carbon dioxide (CO₂). Annual CO₂ emissions data, sourced from the Global Energy Monitor's Global Coal Plant Tracker database, are estimated based on the plant's power generation capacity, capacity factor, heating rate, and the specific emission factor of the type of coal used (lignite, subbituminous, bituminous, or anthracite), including its origin when available.

The third is the operating age of the plant unit and the complex, from commercial operation date (COD) to the current reference year of 2025, representing the extent of cumulative release by operating years to present. Coal power plants or complexes with multiple units and differing COD years

are assigned with a representative year that is weighted based on the power generation capacity.

Table X summarises the aforementioned values and parameters, as well as the weighting indices.

Rank	Plant/complex name	Province	Capacity (MW)	Parameter 1 Weighted air pollution-related burden (USD million per TWh)	Parameter 2 Operating age in 2025 (years)	Parameter 3 Annual CO2 emission (MTCO2)	Index 1	Index 2	Index 3	Index final
1	Suralaya	Banten	6025	17.0	19	28.30	0.02	0.05	0.17	0.24
2	Paiton	Jawa Timur	4735	12.8	22	23.53	0.01	0.06	0.14	0.21
3	Cirebon	Jawa Barat	1584	140.9	6	2.87	0.15	0.02	0.02	0.18
4	Tanjung Jati B	Jawa Tengah	4640	7.7	10	19.50	0.01	0.03	0.12	0.15
5	Cilacap	Jawa Tengah	2260	63.0	5	9.46	0.07	0.01	0.06	0.14
6	Bukit Asam	Sumatera Selatan	260	13.6	37	1.54	0.01	0.10	0.01	0.13
7	Pacitan	Jawa Timur	630	61.2	13	3.10	0.06	0.04	0.02	0.12
8	Pelabuhan Ratu	Jawa Barat	1050	44.8	11	5.16	0.05	0.03	0.03	0.11
9	Adipala	Jawa Tengah	660	60.9	9	2.61	0.06	0.02	0.02	0.10
10	Indramayu	Jawa Barat	990	33.4	14	4.87	0.03	0.04	0.03	0.10
11	Labuan	Banten	600	39.7	15	2.95	0.04	0.04	0.02	0.10
12	Batang/Jawa Tengah	Jawa Tengah	1900	48.0	2	7.40	0.05	0.01	0.04	0.10
13	Ombilin	Sumatera Barat	200	11.0	28	1.15	0.01	0.08	0.01	0.10
14	Jawa-7	Banten	1982	30.2	5	7.72	0.03	0.01	0.05	0.09
15	Celukan Bawang	Bali	380	48.0	9	2.09	0.05	0.02	0.01	0.09
16	Pangkalan Susu	Sumatera Utara	840	25.9	9	4.22	0.03	0.02	0.03	0.08
17	Tanjung Awar-Awar	Jawa Timur	700	17.2	12	3.44	0.02	0.03	0.02	0.07
18	Rembang	Jawa Tengah	630	13.7	13	3.10	0.01	0.04	0.02	0.07
19	Banten	Banten	660	30.7	7	2.61	0.03	0.02	0.02	0.07
20	Labuhan Angin	Sumatera Utara	230	11.1	16	1.29	0.01	0.04	0.01	0.06

Rank	Plant/complex name	Province	Capacity (MW)	Parameter 1 Weighted air pollution-related burden (USD million per TWh)	Parameter 2 Operating age in 2025 (years)	Parameter 3 Annual CO2 emission (MTCO2)	Index 1	Index 2	Index 3	Index final
21	Sumut-1	Sumatera Utara	300	56.4	-2	1.47	0.06	-0.01	0.01	0.06
22	Tarahan	Lampung	200	8.1	16	1.07	0.01	0.04	0.01	0.06
23	Simpang Belimbing	Sumatera Selatan	227	9.6	11	1.68	0.01	0.03	0.01	0.05
24	Teluk Sirih	Sumatera Barat	224	12.3	11	1.19	0.01	0.03	0.01	0.05
25	Sumsel-8	Sumatera Selatan	1200	10.5	1	5.35	0.01	0.00	0.03	0.05
26	Sebalang	Lampung	200	12.4	9	0.97	0.01	0.02	0.01	0.04
27	Tanjung Kasam	Kepulauan Riau	110	4.8	12	0.69	0.00	0.03	0.00	0.04
28	Keban Agung	Sumatera Selatan	225	9.2	9	1.33	0.01	0.02	0.01	0.04
29	Banjarsari	Sumatera Selatan	270	8.8	9	1.08	0.01	0.02	0.01	0.04
30	Tenayan	Riau	220	10.9	8	1.08	0.01	0.02	0.01	0.04
31	Sumsel-5	Sumatera Selatan	300	6.8	8	1.47	0.01	0.02	0.01	0.04
32	Air Anyir	Bangka Belitung	60	4.2	10	0.32	0.00	0.03	0.00	0.03
33	Jambi-2	Jambi	600	18.6	-2	3.15	0.02	-0.01	0.02	0.03
34	Sumsel-1	Sumatera Selatan	600	13.4	0	2.70	0.01	0.00	0.02	0.03
35	Nagan Raya	Aceh	620	7.6	1	3.14	0.01	0.00	0.02	0.03
36	Jambi-1	Jambi	600	18.0	-3	2.70	0.02	-0.01	0.02	0.03
37	Sumbagsel-1	Lampung	300	19.8	-2	1.46	0.02	-0.01	0.01	0.02
38	Bengkulu	Bengkulu	200	1.7	5	0.98	0.00	0.01	0.01	0.02

Table X. List of 38 coal-fired power plants (PLTU) and power plant complexes owned and operated by PLN and Independent Power Producers (IPP) within the Java–Bali and Sumatra power systems, encompassing all units that are currently in operation as well as units under construction, as analyzed in this report.

I. Health Impact Assessment (HIA)

The health impacts assessment (HIA) was carried out in the following four steps:

- 1. estimating annual emissions released from the stack**, assuming thermal efficiency and specific flue gas volume for each coal power plant (corrected at 7% oxygen, to the average of Indonesian coal samples in the US Geological Survey 2019 World Coal Quality Inventory);
- 2. simulating pollution dispersion** using the CALPUFF v7 model (Exponent, 2015), supplemented with background concentrations of oxidants from the

Geos-Chem model with a nested grid for Southeast Asia (Kopplitz et al., 2017), and 2021 meteorological data from the Weather Research Forecasting model v.4.2.2. (Skamarock et al., 2008);

- 3. quantifying health impacts caused by changes in air pollutant concentrations** using a compilation of exposure-response functions cited in relevant peer-reviewed literatures; and
- 4. valuing health impacts in monetary terms using economic costs per outcomes**, adjusted for Indonesia's Gross Domestic Product or Gross National Income (GDP/GNI) per capita.

Emissions calculation

Emissions inventory was developed based on the collected information on combustion and generation technologies, power generation capacity and plant location, and pollutant

flue gas concentrations. In addition to this, stack characteristics, namely stack height and diameter, flue gas release velocity, and temperature were also collected to model plume release height and the thermal rise of pollutants.

Emissions concentration as enforced in the Ministerial Decree of Environment and Forestry No. P.15/MENLHK/SETJEN/KUM.1/4/2019 on Emission Quality Standards for Thermal Power Plants

Air pollutant	Pre-2019	Post-2019
NO _x (NO ₂)	550 mg/Nm ³	200 mg/Nm ³
SO ₂	550 mg/Nm ³	200 mg/Nm ³
PM	100 mg/Nm ³	50 mg/Nm ³
Merkurius	0,03 mg/Nm ³	0,03 mg/Nm ³

Atmospheric modelling

CREA simulated air pollutant concentrations using the CALPUFF air dispersion model, version 7 (Exponent, 2015). CALPUFF is a widely-used industry standard model for long-range air quality impacts of point sources. The model has been evaluated extensively by the US Environmental Protection Agency, is open-source, and fully documented. CALPUFF calculates the atmospheric transport, dispersion, chemical transformation, deposition of the pollutants, and the resulting incremental ground-level concentrations attributed to the studied emissions sources.

Chemical transformations of NO to NO₂ as well as SO₂ and NO₂ to PM_{2.5} are calculated using the ISORROPIA chemistry module in CALPUFF. Background concentrations of oxidants (ozone, ammonia, hydrogen peroxide) are taken from simulations using the Geos-Chem global atmospheric model with a nested grid for Southeast Asia (Kopplitz et al., 2017). Meteorological input data

for the year 2021 are generated from the Weather Research Forecasting (WRF) model (Skamarock et al., 2008), version 4.2.2.

Health and economic impacts assessment

CREA refers to a globally implementable health impact assessment framework based on the latest science to estimate the impacts of air pollution on public health. This framework includes as complete a set of health outcomes as possible without obvious overlaps. The emphasis is on outcomes for which incidence data are available at the national level from global datasets and outcomes that have high relevance for healthcare costs and labour productivity. These health endpoints were selected and quantified in a way that enables economic valuation, adjusted by levels of economic output and income in different jurisdictions. Further information on the assessment is provided in the CREA-IESR study titled “Health Benefits of Just Energy Transition and Coal Phase-out in Indonesia”.

Air pollution increases the risk of developing respiratory and cardiovascular diseases and complications related to them, significantly lowering the quality of life and economic productivity of people affected while increasing healthcare costs. Economic losses as a result of air pollution were calculated using the methods outlined in Myllyvirta (2020) (see Table A2 for the breakdown of the valuations).

Risks and incidences of respiratory diseases

Air pollution is a well-studied cause for increased incidence of symptomatic asthma, lower respiratory tract infections, and exacerbations of chronic cardiopulmonary or other diseases. Particulate matter less than 2.5 micrometres in diameter (PM_{2.5}) can penetrate deeply into the lungs, irritate and corrode alveolar walls. Similarly, nitrous dioxide (NO₂) causes cellular injuries and irritates the epithelial lining. Our assessment specifies two outcomes – asthma emergency room visits linked to PM_{2.5} and new cases of paediatric asthma linked to NO₂ – to be valued in economic terms based on Brandt et al. (2012), which assessed the direct and indirect costs per year of childhood asthma, including medical costs and loss of income to the child’s caregiver, estimating a cost of USD 3800 and USD 4000 in two communities in California, United States.

Lost productivity due to illness and disabilities

Millions of people around the world are living with diabetes and chronic respiratory diseases, as well as disabilities caused by stroke. Exposure to air pollution increases the risk of developing these diseases and their complications. For years lived with disability, the valuation is referenced from Birchby et al. (2019), which provides the costs of different illnesses based on the disability weights quantified in the Global Burden of Disease project, as used by the United Kingdom's environmental regulator, DEFRA. Acute health incidences that lead to restricted activities and workday losses are valued based on the WHO HRAPIE recommendations (2013). The economic cost of these sick leaves was evaluated at EUR 130 per day (USD 160 at 2005 exchange rate) in the European Union, according to the European Environment Agency (2014).

Mortality and impacts on children and unborn babies

Globally each year, exposure to air pollution leads to 7 million excess deaths per year. Impacts on maternal and children's health are reported at 6 million preterm births, 3 million underweight births, and 2 million paediatric asthma. Over the years, studies tend to report higher numbers, since health impacts of exposure are found to be higher than previously thought.

Deaths linked to NO₂, SO₂, and PM_{2.5} — which are the most health-harming air pollutants — are valued based on Viscusi and Masterman (2017), which refers to a meta-analysis of the value of statistical life (VSL) derived from labour market data. The data is based on the observed wage differentials between professions with different mortality risks. For instance, the value was set at USD 9,631,000 in the United States in 2015. Aligning with the recommendations outlined by the OECD (2012), **deaths of children under 5 years old** are valued at twice the value of adult deaths. PM_{2.5} exposure in pregnant women increases the likelihood of **preterm birth and low birth weight**, which consequently increases the risk of many health and development issues throughout the baby's life. Trasande et al. (2016) estimated the economic costs of preterm birth, due to lower economic productivity and increased health costs at USD 300,000 per birth.

Projection of impacts, based on future scenarios

As part of CREA's analysis titled "Health benefits of Just Energy Transition and coal phase-out in Indonesia", there are scenarios set to evaluate the projection of health and economic impacts. The scenario pathways were developed based on applicable retirement schedules, as well as the installation of effective Air Pollution Control (APC) technology.

The **PERPRES 112/2022** scenario represents Government's current commitment to energy transition that is reflected in the Presidential

Regulation No. 112 Year 2022, which mandates that a total capacity of 14 GW of PLN and IPP coal plants is to be retired by 2035, and the remaining plants to be retired by 2050. Each of the analysed coal power plants is assumed to follow a retirement pathway, retiring when it reaches 25-35 years of operation with utilisation assumed to steadily increase to optimal utilisation.

In the **1.5 degree** scenario, coal transition commitment is assumed to be aligned with the commitment outlined in the Paris Agreement where the coal power plant would be retired before Indonesia's emission peak in 2035. Utilisation is assumed to remain at set values.

Table A1. Input parameters and data used in estimating physical health impacts

Age group	Effect	Pollutant	Conc.-response function	Conc. change	No-risk threshold	Reference	Incidence data
1-18	New asthma cases	NO ₂	1.26 (1.10 – 1.37)	10 ppb	2 ppb	Khreis et al. (2017)	Achakulwisut et al. (2019)
0-17	Asthma emergency room visits	PM _{2.5}	1.025 (1.013 – 1.037)	10 µg/m ³	6 µg/m ³	Zheng et al. (2015)	Anenberg et al. (2018)
18-99	Asthma emergency room visits	PM _{2.5}	1.023 (1.015 – 1.031)	10 µg/m ³	6 µg/m ³	Zheng et al. (2015)	Anenberg et al. (2018)
New Born	Preterm birth	PM _{2.5}	1.15 (1.07 – 1.16)	10 µg/m ³	8,8 µg/m ³	Sapkota et al. (2012)	Chawanpaiboon et al. (2018)
20-65	Work absence	PM _{2.5}	1.046 (1.039 – 1.053)	10 µg/m ³	T/A	WHO (2013)	EEA (2014)
0-4	Deaths from lower respiratory infections	PM _{2.5}	IHME (2020)		5,8 µg/m ³	IHME (2020)	IHME (2020)
25-99	Deaths from noncommunicable diseases, disaggregated by cause, and from lower respiratory infections	PM _{2.5}	Burnett dkk. (2018)		2,4 µg/m ³	Burnett et al. (2018)	IHME (2020)
25-99	Disability caused by diabetes, stroke and chronic respiratory disease	PM _{2.5}	IHME (2020)		2,4 µg/m ³	Burnett et al. (2018)	IHME (2020)
25-99	Premature deaths	NO ₂	1.02 (1.01 – 1.04)	10 µg/m ³	4,5 µg/m ³	Huangfu & Atkinson (2020); NRT from Stieb et al. (2021)	IHME (2020)
25-99	Premature deaths	SO ₂	1.02 (1.01-1.03)	5 ppb	0,02 ppb	Krewski et al. (2009)	IHME (2020)

Note: Numeric values in the column “Concentration-response function” refer to odds ratio 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.

Table A2. Input parameters and data used to estimate the economic costs of health impacts

Outcome	Valuation at world average GDP/GNI per capita (2017 int. USD)	Valuation in Indonesia		Referensi
		(current USD)	(current IDR)	
Work absence (sick leave days)	85	22	335.300	EEA (2014)
Number of children suffering from asthma due to pollution exposure (increased prevalence)	1.077	274	4.228.000	Brandt et al. (2012)
Deaths	2.637.000	663.900	10.260.000.000	Viscusi & Masterman (2017)
Deaths of children under 5	5.273.000	1.328.000	20.510.000.000	OECD (2012)
Asthma emergency room visits	232	59	911.800	Brandt et al. (2012)
Preterm births	107.700	27.370	422.800.000	Trasande et al. (2016)
Years lived with disability	28.480	7.171	110.800.000	Birchby et al. (2019)

Interviews and Surveys

Information on *Impact on Community* was collected using a questionnaire-based method encompassing a range of variables, including economic conditions, public health, employment, gender, land acquisition, migration, human rights, as well as habitat and biodiversity. The questionnaire was distributed

to networks of civil society organizations engaged in solidarity with affected communities, including those accompanying, assisting, or monitoring the impacts of power plant development. In addition, supplementary and supporting information was gathered from open sources, including online media and other publications.

