Environmental Product Declaration

In accordance with ISO 14025 for:

ELECTRICITY

from

GRATI POWER GENERATION AND O&M SERVICE UNIT COMBINED-CYCLE POWER PLANT

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The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable.

Summary

Company

PT Indonesia Power is one of the subsidiaries of PT Perusahaan Listrik Negara (PLN) (Persero) which was established on October 3, 1995, under the name PT PLN Pembangkitan Jawa Bali I (PT PJB I). On October 8, 2000, PT PJB I was renamed Indonesia Power as an affirmation of the Company's goal to become a pure, business-oriented, independent power company. The Company's main business activities are focusing on a provider of electricity through power generation and provider of operations and maintenance of power plants that operate plants spread across Indonesia. In addition to managing Generating Units, Indonesia Power has 5 Subsidiaries, 2 Joint Venture Companies, 1 Associate Company, and 3 Grandson Companies (Affiliates of Subsidiaries) to support the company's business strategy and processes. Located on a 70-hectare site at Pasuruan, East Java province, Grati Power Generation and O&M Service Unit (POMU) combined-cycle power plant is one of the Power Generation Units (PGU) owned and operated by PT Indonesia Power.

Declared Product

Commissioned in 1997, on a 70-hectare site at Pasuruan, East Java province. The Grati POMU combined-cycle power plant is a combined-cycle power plant with an installed total capacity of 1460 MW that is generated by 3 blocks. Block I consists of 3 gas turbines (100,75 MW for each unit) and 1 steam turbine with 159,58 MW. Block II consists of 3 gas turbines (100,75 MW for each unit) and 1 steam turbine with 195 MW. Block III consists of 2 gas turbines (153 MW for each unit) and 1 steam turbine with 195 MW. The result presented in this EPD is not the average result of impact from the 3 blocks but represents the total 3 blocks as a whole system.

The Grati POMU combined-cycle power plant is playing an increasingly important role in supporting the Java-Bali Electrical System. The declared product is 1 kWh net electricity generated in Grati POMU combined-cycle power plant, thereafter distributed to the customer (Java-Bali electricity grid) during the reference year of 2020.

The International EPD® System

The International EPD® System, managed by EPD International AB, is a Type III environmental declaration programme according to ISO 14025. The relevant governing documents in hierarchical order are Product Category Rules for the product groups electricity, steam, and hot/cold water generation (UNCPC groups 171 and 173), General Programme Instructions for Environmental Product Declaration (EPD), ISO 14025, and ISO 14044.

Verification of the Results Presented

The complete material presented in this EPD® has been reviewed and certified by an independent third-party verifier (approved individual verifier by the International EPD System).

Environmental Impact of Electricity Generation in Grati POMU Combined-Cycle Power Plant

The life cycle assessment methodology has been applied to quantify the environmental impact. It comprises the full life cycle and associated processes, such as the construction and transportation phase. The main results of the life cycle impact assessment are summarized in the table below. Further results, including raw material consumption and emissions to the environment, are shown in the EPD®.

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – fossil fuels	kg CO_2 eq/kWh	9.37E-02	3.29E-01	1.14E-03	4.24E-01
Global warming potential – biogenic	kg CO_2 eq/kWh	1.34E-04	2.26E-05	-4.60E-06	1.52E-04
Global warming potential – land use change and land use change (Luluc)	kg CO_2 eq/kWh	2.16E-05	5.54E-07	1.84E-06	2.40E-05
Global warming potential - total	kg CO_2 eq/kWh	9.39E-02	3.29E-01	1.14E-03	4.24E-01
Acidification Potential (AP)	mol H+ eq/kWh	5.46E-04	3.74E-03	1.69E-05	4.31E-03
Eutrophication potential, aquatic freshwater	kg P eq/kWh	3.94E-06	4.46E-07	3.96E-06	8.35E-06
Eutrophication potential, aquatic marine	kg N eq/kWh	3.15E-05	1.85E-03	2.85E-06	1.89E-03
Eutrophication potential, terrestrial	mol N eq/kWh	2.90E-04	2.03E-02	3.79E-05	2.06E-02
Photochemical Oxidant Formation Potential (POFP)	kg NMVOC eq/kWh	3.65E-04	4.78E-03	8.50E-06	5.15E-03
Ozone Depletion Potential (ODP)	kg CFC^{-11} eq/kWh	5.49E-09	6.12E-11	8.26E-11	5.64E-09
Abiotic depletion potential – elements	kg Sb eq/kWh	2.03E-08	7.02E-08	1.15E-06	1.24E-06
Abiotic depletion potential – fossil fuels	MJ,*net calorific value*/kWh	1.17E+01	1.09E-02	1.48E-02	1.17E+01
Water Scarcity Footprint (WSF)	m^3 world eq. deprived/kWh	3.46E-03	2.45E-04	9.29E-04	4.64E-03

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1. Introduction

1.1 The Environmental Product Declaration and The International EPD® System

The primary purpose of the International EPD® System is to support companies in the assessment and publication of the environmental performance of their products and services so that they will be credible and understandable. To this end it:

- offers a complete Type III environmental declaration programme for any interested organization in any country to develop and communicate EPDs® according to ISO 14025,
- supports other EPD® programmes (i.e., national, sectoral, etc.) in seeking cooperation and harmonization as well as helping organizations to advantageously broaden the use of their EPDs® on the international market.

This Environmental Product Declaration conforms to the standards of the International EPD® Programme www.environdec.com. EPD® is a system for the international application of Type III environmental declarations conforming to ISO 14025 standards. The International EPD® System and its applications are described in the general programme instructions. The principal documents for the EPD® System in order of hierarchical importance, are:

- Product Category Rules, UN-CPC 171 and 173, (Product Category Rules for Preparing an Environmental Product Declaration for Electrical Energy), Version 4.2
- General Programme Instructions for Environmental Product Declarations, EPD®, Version 4.0
- ISO 14025 on Type III environmental declarations
- ISO 14040 and ISO 14044 on Life Cycle Assessment (LCA)

This EPD® contains an environmental performance declaration based on a life cycle assessment. Additional environmental information is presented following the PCR:

- Information on biodiversity
- Information on environmental risks
- Information on noise
- Information on electromagnetic fields
- Information on land use

1.2 PT Indonesia Power, LCA and EPD®

There are many reasons to declare the environmental impact of electricity production. For PT Indonesia Power, the decisive reasons are:

- Electricity generation is a fundamental component of modern society, as electricity is required to produce most goods and deliver almost all services. Therefore, as one of the largest electricity producers in Indonesia, PT Indonesia Power wants to take the initiative in communicating clearly and reliably.
- The scientific assessment and rigorous minimization of environmental impact are core pillars of PT Indonesia Power's sustainability strategy. Our main goal is to minimize greenhouse gas production throughout the total life cycle. An EPD® environmental declaration is a reliable foundation for the quantitative presentation of environmental impact, using several environmental indicators and considering the total production cycle.

For questions concerning this EPD®, please contact:

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For additional information, please visit our websites: https://www.indonesiapower.co.id/,

2. Manufacturer and Product

2.1 PT Indonesia Power and Grati POMU Combined-cycle Power Plant

PT Indonesia Power is one of the subsidiaries of PT PLN (Persero), which was established on October 3, 1995, under the name PT PLN Pembangkitan Jawa Bali I (PT PJB I). On October 8, 2000, PT PJB I was renamed Indonesia Power as an affirmation of the company's goal to become a pure, business-oriented, independent power company. The company's main business activities are focused on being a provider of electricity through power generation and a provider of operations and maintenance of power plants that operate plants spread across Indonesia. In addition to managing generating units, Indonesia Power has five subsidiaries, two joint venture companies, one associate company, and three grandsons companies (affiliates of subsidiaries) to support the company's business strategy and processes.

The Grati Power Generation and O&M Services Unit (POMU) combined-cycle power plant is located on a 70-hectare site in Pasuruan, East Java Province. The site has been developed in three phases. The construction began in 1997 with the installation of three 100.75 MW dual-fuel (natural gas and high-speed diesel) gas turbines and a single 159.58 MW steam turbine, which came into service as Block I. The generating capacity was increased in 2002 with Block II, consisting of three 100.75 MW dual-fuel (natural gas and high-speed diesel) gas turbines and a single 195 MW steam turbine. Furthermore, additional combined cycle blocks (Block III) constructed in 2018 consist of two 153 MW gas turbines and a single 195 MW steam turbine.

2.2 Management System

Grati POMU combined-cycle power plant has implemented an environmental and quality management system, certified, and registered according to ISO 14001:2015 and 9001:2015. The implementation of the environmental management system is an evident sign of Grati POMU combined-cycle power plant's environmental policy, which sets out the continual improvement of "environmental performance" regarding its working operations, its dialogue with the authorities, and the active participation of the staff members.

2.3 Product Information

This document constitutes the certified Environmental Product Declaration EPD® of the Electricity from Grati Power Generation and O&M Service Unit (POMU) combined-cycle power plant as the product name. The plant is operated by Grati POMU, a wholly-owned unit of PT Indonesia Power.

2.3.1 Product Description

The Grati POMU combined-cycle power plant is playing an increasingly important role in supporting the Java-Bali electricity grid. The Grati POMU combined-cycle power plant is a combined-cycle power plant with an installed total capacity of 1460 MW that is generated by 3 blocks. Block I consists of 3 gas turbines (100.75 MW for each unit) and 1 steam turbine with 159.58 MW. Block II consists of 3 gas turbines (100.75 MW for each unit) and 1 steam turbine with 195 MW, and Block III consists of 2 gas turbines (153 MW for each unit) and 1 steam turbine with 195 MW. The environmental performance result of the electricity product presented in this EPD is not the average result of the impact from the 3 blocks but represents the total 3 blocks as a whole system.

In principle, a combined-cycle power plant system is incorporated between a gas power plant and a steam power plant. A combined-cycle power plant changes thermal energy results from fuel and air combustion to rotate the gas turbine. The rotation of the generator's axle will generate electric power. In more detail, the exhausted leftover gas from the turbine gas is recycled and regulated by the selector valve to be channeled to the heat recovery steam generators (HRSG) that employ a drum. The generated steam is then utilized to rotate the turbine to drive the generator in electricity production. The exhaust steam from the turbine is later condensed into the condenser. The condensate is afterward pumped by the condensate pump to be channeled to the deaerator and by the feedwater pump, it is pumped back to the drum for re-steaming.

2.3.2 UN CPC Code

UN CPC 171 Electrical Energy.

2.3.3 Geographical Scope

The manufacturing site of the Grati POMU combined-cycle power plant is located in Pasuruan, East Java Province, Indonesia. The electricity produced is then thereafter distributed to the Java-Bali electricity grid as the geographical scope of the customer.

3. LCA Information

3.1 The Life Cycle Assessment Methodology

The International EPD® System uses an approach where all attributional processes from "cradle to grave" should be included using the principle of "limited loss of information at the final product". This is especially important in the case of business-to-consumer communication. According to the ISO 14025 standard, the life cycle assessment (LCA) methodology was applied to quantify the environmental impact of the electricity generation in the Grati POMU combined-cycle power plant and the subsequent distribution.

LCA is a structured framework, based on international standards ISO 14040 and ISO 14044, that facilitates the quantification and assessment of emissions to the environment and resource use along the entire electricity production chain. The LCA allows for comprehensive findings on overall energy, mass, and emission flows, key processes that are involved, and the quantification of important environmental impacts, such as greenhouse gas emissions. However, despite these advantages, there are also some issues beyond the scope of an LCA. For example, the LCA study only focuses on the normal operation of processes. Unusual process conditions or even accidents are not included. Additionally, due to the investigation of the full process chain, local effects on the environment may not be considered, such as the impact on flora and fauna near the power plant. Finally, an LCA study only quantifies environmental impacts; no economic, social, or ethical aspects are included.

The LCA study for the electricity from Grati POMU combined-cycle power plant has been carried out according to the Product Category Rules (PCR) Electricity, Steam, and Hot Water Generation and Distribution, 2007:08, Version 4.2 and UN CPC 171, 173 (valid until 2024-03-16). The PCR provides specific rules, requirements, and guidelines for developing an EPD for a specific product category.

3.1.1 Functional Unit

The functional unit is 1 kWh of net electricity generated in the Grati Power Generation and O&M Services Unit (POMU) combined-cycle power plant and thereafter distributed to the Java-Bali electricity grid (customer). The reference flow is according to the electricity production in the year 2020, taking into account the transmission and distribution losses, with a total of 2,358,706,350 kWh of electricity.

3.1.2 Reference Service Life

The reference service life of the Grati Power Generation and O&M Services Unit (POMU) combined-cycle power plant was assumed according to the expected technical service life for the combined-cycle power plant, which is 40 years. The lifetime capacity according to the expected reference service life is 99,272,152,760 kWh (corresponding to 40 years * 2,481,803,819 kWh). Then this value has been used to calculate the reference unit for the infrastructure product.

3.1.3 Time Representativeness

The data used in this study is data for 1 year from 1 January 2020 until 31 December 2020.

3.1.4 Database(s) and LCA Software Used

Selected generic data was taken from the commercial Ecoinvent database 3.7.1 (2020) Allocation, cut-off, EN15804. The OpenLCA software version 1.11 has been used for modeling the product system and impact calculation. An additional EN15804 add-on for OpenLCA has been added to help calculate the environmental impact in accordance with the International EPD® System.

3.1.5 Assumptions

There are several assumptions made in this LCA study:

- The lifetime of plant operation was assumed to be approximately 40 years according to the information from Grati POMU combined-cycle power plant and the typical technical service life from PCR.
- According to the dataset taken from the Ecoinvent 3.7.1 database, typical transmission and distribution losses in power networks used for electricity delivery were assumed to be 1% for transmission and 4% for distribution.
- The treatment of waste lubricating oil was assumed as "treatment of waste mineral oil, hazardous waste incineration" taken from Ecoinvent 3.7.1 database.
- The treatment for other hazardous waste generated (aggregated) was assumed to be "treatment of hazardous waste, hazardous waste incineration" taken from the Ecoinvent 3.7.1 database.

3.1.6 Cut-off rules

The cut-off rules in this LCA are followed according to the Product Category Rules (PCR) Electricity, Steam, and Hot Water Generation and Distribution, 2007:08, Version 4.2 and UN CPC 171, 173 where the data for elementary flow to and from product systems contributing to a minimum of 99% of the declared environmental impact has been included.

3.1.7 Data quality

This LCA has followed the data quality requirements according to the Product Category Rules (PCR) Electricity, Steam, and Hot Water Generation and Distribution, 2007:08, Version 4.2 and UN CPC 171, 173 where specific data shall always be used. All specific data used for the core process was gathered from the actual manufacturing plant (Grati POMU combined-cycle power plant) where product-specific processes are carried out, except for the core infrastructure data, which was gathered from the commercial Ecoinvent 3.7.1 database due to unavailable data. For the upstream, downstream processes and infrastructure, selected generic data has been used because specific data was not available. Data quality assessment has been carried out according to the Guidance of Data Quality Assessment for Life Cycle Inventory Data from the U.S Environmental Protection Agency, which uses the Pedigree Matrix from the Ecoinvent Data Quality System.

3.1.8 Allocations

This LCA has followed the allocation rules according to the Product Category Rules (PCR) Electricity, Steam, and Hot Water Generation and Distribution, 2007:08, Version 4.2 and UN CPC 171, 173. The principle applied to this LCA is that all allocation cases follow the 100% product rule so that the total impact generated for all products from each process is equal to the output load for each process. The Grati POMU combined-cycle power plant only produces electricity products, so there is no co-product allocation.

Allocation for reuse, recycling, and recovery of waste has followed the Polluter Pays Principle (PPP). The impact of the hazardous waste incineration process (i.e., waste lubricating oil) has been calculated and allocated to the waste generator. The principle of mass allocation was used for waste treatment.

3.2 System Boundaries and Data Sources

The life cycle assessment comprises the full plant life cycle and associated processes from “cradle to grave”. The reference period is from 1 January 2020 to 31 December 2020—one business year of the Grati POMU combined-cycle power plant. Figure 1 shows a simplified process chain with system boundaries for the LCA of electricity from the Grati POMU combined-cycle power plant. For different data quality rules and the presentation of results, the life cycle of products is divided into three different life cycle stages named upstream processes (from cradle to gate), core processes (from gate to gate), and downstream processes (from gate to grave).

Data for product-specific processes in the core processes chain was gathered from technical and environmental reports, management systems, or provided directly by the operating personnel of the Grati POMU combined-cycle power plant also referred to as primary data or site-specific data. Due to the lack of specific data on the upstream processes, downstream processes, and infrastructure, the selected generic data from the commercial Ecoinvent 3.7.1 database has been used. These data provide a reliable basis for an LCA study. For the calculation of the LCA results, all available data was used without using a cut-off for supposedly unimportant data. Data on the production of fuel supply, building material supply (e.g., steel, and concrete production), and transport services as well as on waste treatment processes (e.g., hazardous waste incineration) connected to the investigated process chain were taken from the ecoinvent 3.7.1 database. The ecoinvent database is a joint initiative of institutes and departments of the Swiss Federal Institute of Technology and provides consistent, transparent, and quality-assured life cycle inventory (LCI) data.

3.2.1 Upstream Processes

The upstream processes include cradle-to-gate stages starting with raw material extraction, production, and transportation of fuel and auxiliary substances (e.g., chemicals) that are inputs to the electricity generation process. It also includes upstream infrastructures and the production of materials needed for the core infrastructures. The process which is part of the upstream, such as natural gas production, diesel production, and chemical production (e.g., lubricating oil, hydrazine, ammonia, hydrochloric acid, etc.), Data describing the production of the auxiliary inputs were taken from the ecoinvent 3.7.1 database and linked to electricity production in Grati POMU combined-cycle power plant.

3.2.2 Core Processes

The core processes consist of core operations and core infrastructure. The core operation comprises gate-to-gate environmental information on the operation stage of the energy conversion plant (system) until the delivery point to the high-voltage transmission network system. Operational inputs in the reference year cover all processes and sub-processes involved in power generation, including natural gas and diesel fuel consumption, water and steam consumption, lubricating oil consumption, and chemical consumption. Operational outputs mainly consist of elementary flows, such as direct emissions into the air. Data from management systems (e.g., CO_2 and NOx emissions) were measured.

Construction in the core process consists of a series of processes from cornerstone laying until the plant reaches its lifetime, in which the lifetime is determined based on the dataset used for power plant construction. Detailed data on material consumption used in the construction of the power plant was not provided by the manufacturer of the plant. Data on the construction of

the power plant is calculated based on reference values taken from the Ecoinvent 3.7.1 database. For the core infrastructures, an expected service lifetime of approximately 40 years was assumed according to the PCR. An activity "gas power plant construction, combined-cycle, 400 MW" has the reference product "gas power plant, combined-cycle" expressed by the infrastructure lifetime with a property capacity of 400 MW. So, the reference value of the infrastructure product can be expressed in the dimensionless "1 unit" with the property "lifetime capacity" of 9.93E10 kWh (corresponding to 40 years * 2,481,803,819 kWh). Finally, the electricity production from the Grati POMU combined-cycle power plant with a capacity utilization of 0.96 will require 1 kWh/(0.96*9.93E10) = 1.0493E-11 unit of this input to produce 1 kWh of electricity.

3.2.3 Downstream Processes

The downstream processes comprise the distribution of the products to the customers. The processes after the power plant transformation process to the electricity grid are included and thereafter distributed to consumers by another company, PT PLN. The connection of the Grati POMU combined-cycle power plant to the national electricity grid is favorable, with the plant being directly connected to the electricity transmission station using long overhead connections that run inside the area of the plant itself.

According to the requirements stated in the PCR, downstream processes comprise the electricity distribution to high voltage transmission to the National Electricity Company (PLN) and thereafter distributed to consumer-connected low-level voltage grids by PLN. Indonesian-specific data on the operation and construction of the high-voltage, medium-voltage, and low-voltage grids was taken from the Ecoinvent 3.7.1 database, which includes 1% transmission losses and 4% distribution losses during voltage transformation. Construction in downstream processes includes the construction of the transmission and distribution network. Due to the lack of specific data, data on the input and output of the transmission and distribution network is calculated based on reference values taken from the ecoinvent 3.7.1 database.

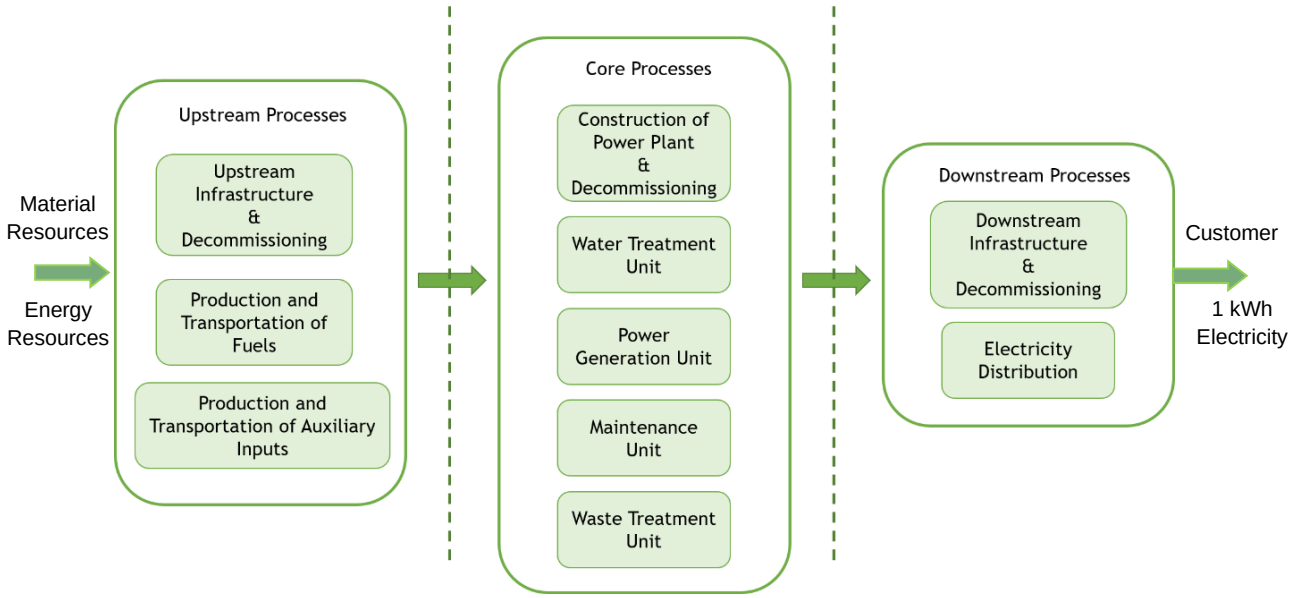

Figure 1. System diagram illustrating the processes that are included in the product system, divided into upstream, core, and downstream processes.

4. Environmental Performance

4.1 Potential environmental impact

The indicators related to the potential environmental impact of electricity products from Grati POMU combined-cycle power plant are declared per functional unit and per life cycle stage as listed in Table 1. The latest update of the default impact category list was made on 2022-03-29, referred to as Version 2.0. This version is an adapted version of the core environmental impact indicators of EN 15804:2012+A2:2019/AC:2021 as mandatory indicators.

Table 1. Potential environmental impact of electricity product from Grati POMU combined-cycle power plant

Impact category		Unit	LCIA Method	Impact Potential Value			
				Upstream	Core	Downstream	Total
Global Warming Potential (GWP)	Global warming potential – fossil fuels	kg CO_2 eq	EN 15804	9.37E-02	3.29E-01	1.14E-03	4.24E-01
	Global warming potential – biogenic	kg CO_2 eq	EN 15804	1.34E-04	2.26E-05	-4.60E-06	1.52E-04
	Global warming potential – land use change and land use change (Luluc)	kg CO_2 eq	EN 15804	2.16E-05	5.54E-07	1.84E-06	2.40E-05
	Global warming potential - total	kg CO_2 eq	EN 15804	9.39E-02	3.29E-01	1.14E-03	4.24E-01
Acidification Potential (AP)		mol H+ eq	EN 15804	5.46E-04	3.74E-03	1.69E-05	4.31E-03
Eutrophication Potential (EP)	Eutrophication potential, aquatic freshwater	kg P eq	EN 15804	3.94E-06	4.46E-07	3.96E-06	8.35E-06
	Eutrophication potential, aquatic marine	kg N eq	EN 15804	3.15E-05	1.85E-03	2.85E-06	1.89E-03
	Eutrophication potential, terrestrial	mol N eq	EN 15804	2.90E-04	2.03E-02	3.79E-05	2.06E-02
Photochemical Oxidant Formation Potential (POFP)		Kg NMVOC eq	EN 15804	3.65E-04	4.78E-03	8.50E-06	5.15E-03
Ozone Depletion Potential (ODP)		kg CFC 11 eq	EN 15804	5.49E-09	6.12E-11	8.26E-11	5.64E-09
Abiotic Depletion Potential (ADP)	Abiotic depletion potential – elements	kg Sb eq	EN 15804	2.03E-08	7.02E-08	1.15E-06	1.24E-06
	Abiotic depletion potential – fossil fuels	MJ,*net calorific value*	EN 15804	1.17E+01	1.09E-02	1.48E-02	1.17E+01
Water Scarcity Footprint (WSF)		m^3 world eq. deprived	EN 15804	3.46E-03	2.45E-04	9.29E-04	4.64E-03

4.2 Use of resources

The indicators for resource use based on the life cycle inventory (LCI) listed in Table 2 are declared per functional unit (kWh electricity), and per life cycle stage.

Table 2. Indicators describing the use of primary and secondary resources of Grati POMU combined-cycle power plant.

Parameter		Unit	LCIA Method	Impact Potential Value			
				Upstream	Core	Downstream	Total
Primary energy resource-Renewable energy	Use as the energy carrier	MJ, net calorific value	EN 15804	1.25E-02	8.78E-04	3.48E-03	1.69E-02
	Used as raw material	MJ, net calorific value	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total	MJ, net calorific value	EN 15804	1.25E-02	8.78E-04	3.48E-03	1.69E-02
Primary energy resource-Non renewable energy	Use as the energy carrier	MJ, net calorific value	EN 15804	1.17E+01	1.09E-02	1.48E-02	1.17E+01
	Used as raw material	MJ, net calorific value	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total	MJ, net calorific value	EN 15804	1.17E+01	1.09E-02	1.48E-02	1.17E+01
Secondary material		kg	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels		MJ, net calorific value	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels		MJ, net calorific value	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water		m^3	EN 15804	8.18E-05	5.82E-06	2.21E-05	1.10E-04

4.3 Waste production

Table 3. Indicators describing waste production of Grati POMU combined-cycle power plant.

Parameter	unit	LCIA Method	Impact Potential Value			
			Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	EN 15804	1.59E-05	1.18E-05	1.17E-05	3.95E-05
Non-hazardous waste disposed	kg	EN 15804	9.53E-05	0.00E+00	4.01E-04	4.96E-04
Radioactive waste disposed	kg	EN 15804	0.00E+00	0.00E+00	0,00E+00	0,00E+00

4.4 Output flows

Table 4. Indicators describing output flows.

Parameter	unit	LCIA Method	Impact Potential Value			
			Upstream	Core	Downstream	Total
Component for reuse	kg	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	EN 15804	0.00E+00	0.00E+00	0.00E+00	0.00E+00

4.5 Process Impact Contribution

The distribution of cradle-to-grave impact contribution at PT Indonesia Power Grati Power Generation and O&M Services Unit (POMU) combined-cycle power plant can be seen in Figure 2. In the upstream process, the potential impact of ADP-fossil fuels has the most dominant impact, with a value of 99.78%. This impact is caused by the extraction of natural gas resources from the ground. In the core process, the power generation unit has a 77.60% impact on the GWP-total and this is mostly caused by the emissions (CO_2, CH_4, etc.) generated by the fuel combustion. Other than that, the core process also gives dominant impact to acidification potential, eutrophication, and photochemical oxidation, mostly caused by the emissions of SO_2, NOx, etc. released to the environment. While in the downstream process, the impact of abiotic (non-fossil) depletion potential elements has a dominant impact with a value of 92.71%, mostly caused by the construction of transmission and distribution networks.

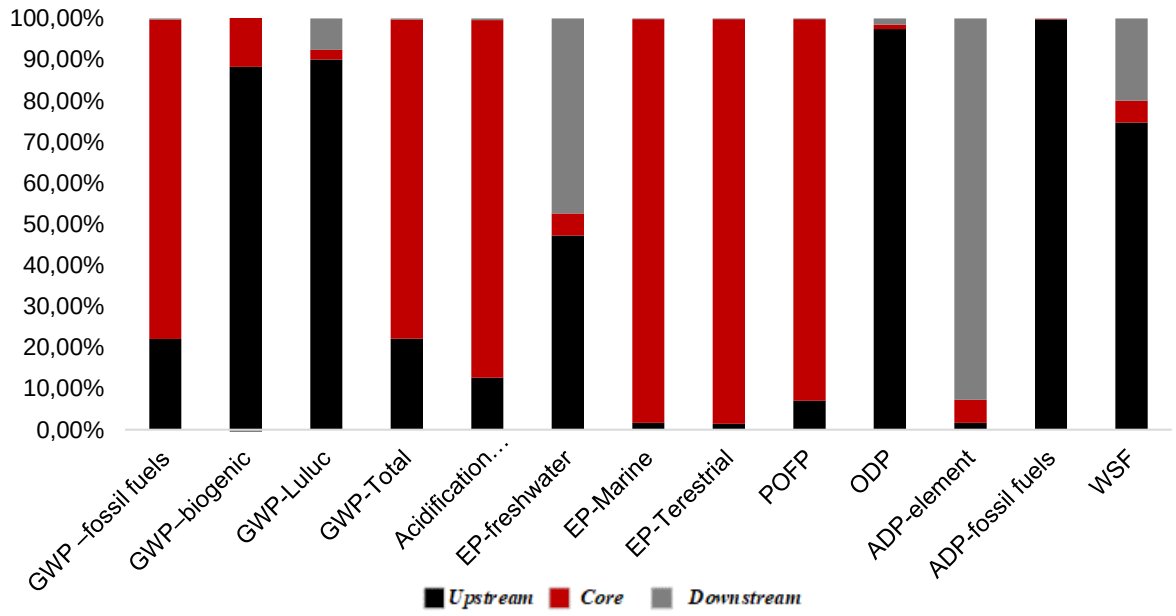

Figure 2. The distribution of the Cradle-to-Grave impact contribution.

5. Additional Environmental Information

5.1 Biodiversity Conservation Development

The development of biodiversity conservation is carried out by the Grati POMU combined-cycle power plant through in-situ and ex-situ conservation. In-situ conservation is carried out through:

1. Jombang District Government and Badan Pengelola Lingkungan Hidup Daerah (BPLHD) Jombang, for the development of the Jombang Wonosalam Diversity Park;
2. Cooperation with the Dusun Nangger community in planting Sea Pine as a coastal green belt to prevent abrasion;

The biodiversity conservation area developed by the generating units is located in the area of the national park or the area that has been determined by the local government, by entering into a cooperation agreement with the related parties. The extent of conservation areas and the types of flora and fauna developed are also jointly stipulated in the cooperation agreement with the national park area or the local government. The success of the biodiversity conservation program is reflected in the increase in the biodiversity index. Therefore, Indonesia Power conducts periodic measurements in collaboration with accredited external institutions or laboratories with a biodiversity index measurement methodology adjusted to external laboratories that perform the measurements. One of the Company's biodiversity conservation programs, i.e., the Indonesia Power Biodiversity Park Development Program, in collaboration with the Jombang Regency Environmental Service Office, obtained the award as the Outstanding Kehati Ex-Situ Park from the Ministry of Environment and Forestry.

The collaboration commitment with Dinas Lingkungan Hidup (DLH) Jombang succeeded in increasing the Shannon Wienner biodiversity index of bird species from 2,558 (baseline in 2016) to 3,015 (2021), preserving around 123 plant species endemic to East Java, bringing in 3 endemic Indonesian bird species and 2 legally national protected bird species, and create new springs in the Wonosalam Jombang Biodiversity Park Area in 2021. Ex-situ conservation is carried out through the breeding of Timor deer, which is one of the wild animals protected by Law No. 5 of 1990, Government Regulation No. 7 of 1999, and Ministerial Regulation No. 106 of 2018. Activities located within the Grati POMU combined-cycle power plant area have succeeded in increasing the number of animals from 2 to 11 individuals. In a coastal area, sea pine is periodically planted by Grati POMU combined-cycle power plant in cooperation with Dusun Nagger in order to help reduce erosion. The sea pine will act as a coastal green belt to prevent abrasion.

5.2 Environmental Risks

Indonesia Power manages environmental risks with indicators used as analysis, i.e, energy, emissions, water resources, waste, and biodiversity. Indonesia Power consistently manages and monitors every environmental and social aspect, in accordance with the matrix of Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL) in every activity, starting from the pre-construction, construction, and operation, to the post-operation.

Indonesia Power Grati POMU combined-cycle power plant has managed the environmental impact through the identification of significant risks to the environment caused by the Company's operations along with mitigation actions. The potential risks are identified as air pollution, water pollution, and waste pollution. One of the actions is the utilization of low NOx burner technology in order to reduce NOx emission from the gas turbine. Several programs to reduce environmental impact are continuous emission monitoring alongside optimization of parameters in gas turbine control with the goal to reduce the emission. Applied 3R (Reduce, Reuse, Recycle) in water and waste water treatment units for efficient usage of water and electricity.

In the ISO 14001 standard, the environmental management system has been implemented by Grati POMU combined-cycle power plant in an integrated manner since 2013, continuously identifying aspects of environmental impact (IADL) that give rise to environmental management programs to maintain and improve the environment related to the use of natural resources.

5.3 Noise

The noise produced by a power plant comes from the running machines such as turbines, pumps, fans, etc. This can easily be reduced by conventional techniques such as installing the "silencer" at the power plant building.

5.4 Electromagnetic Field

According to Indonesian law, there is no restriction on electromagnetic fields (EMF) and no data available from the power plant.

5.5 Land Use

The Grati POMU combined-cycle power plant has an area of 700,000 m^2, with 350,000 m^2 on the north side being reclaimed land. The 350,000 m^2 of land has been occupied since 1995 for the power plant area. It has been 25 years of the area being occupied since the first operation of Block I in 1997. When the follow-up project started in 2016, the reclaimed land was used as a location for laying down project equipment and materials as well as a temporary warehouse for the project, which is currently completed.

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