EPD® THE INTERNATIONAL EPD® SYSTEM

SOUTHEAST ASIA EPD THE INTERNATIONAL EPD SYSTEM

Environmental Product Declaration
In Accordance with ISO 14025:2006 for:

Electricity

From

PT PLN Indonesia Power Semarang PGU

PLN Indonesia Power

Programme
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EPD Southeast Asia,
www.epd-southeasia.com

Programme Operator
EPD International AB

Regional centers
EPD Southeast Asia

EPD Registration Number
EPD-IES-0006273 (S-P-06273)

Publication Date
2024-06-19

Valid Until
2029-01-11

The EPD should provide up-to-date information and may be updated if conditions change. Therefore, the declared validity is subject to registration and continued publication in the www.environdec.com

PLN Indonesia Power

Program Information

Programme	The International EPD® System
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Accountability for PCR, LCA, and Independent Third-Party Verification
Product Category Rules (PCR)
Product Category Rules (PCR): Electricity, steam and hot water generation and distribution. PCR 2007:08**,** version 4.2, UN CPC 171 173 (valid until 2024-03-16)
The PCR review was conducted by: The Technical Committee of the International EPD® System. See **www.environdec.com/TC** for a list of members. **Review chair: Claudia A. Peña, Addere Consultores (ADDERE Research and Technology).** The review panel may be contacted via the Secretariat www.environdec.com/contact
Life Cycle Assessment (LCA)
LCA Accountability: PT ITS Tekno Sains
Third-Party Verification
Independent third-party verification of declarations and data according to ISO 14025:2006, through: ☒ EPD verification by individual verifiers Third-party verifier: Gloria FJ Kartikasari, PT Life Cycle Indonesia Approved by: The International EPD® System
The data follow-up procedure during EPD validity involves third-party verifiers: ☐ Yes ☒ No

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PLN Indonesia Power

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Contents

PLN Indonesia Power

Company Information

Company Description

PT PLN Indonesia Power is a subsidiary of PT PLN Persero which is engaged in power generation. PT PLN Indonesia Power Semarang PGU – Tambak Lorok is located in the city of Semarang, precisely in the Tanjung Emas Port area with an area of 400,000 m^2. This location was chosen because of the need for large amounts of fuel transported by tankers. PT PLN Indonesia Power Semarang PGU operates Gas and Steam Power Plants (PLTGU), Gas Power Plants (PLTG), and Steam Power Plants (PLTU) with a total capacity of 1,409 MW playing an important role in maintaining the reliability and quality of the electricity system in the Java and Bali transmission areas, especially the Central Java area, which contributes 16%. PT PLN Indonesia Power Semarang PGU consist of 2 unit, there are 3 GTG/HRSG and 1 STG in unit 1 and 3 GTG/HRSG and 1 STG in unit 2. PT PLN Indonesia Power Semarang PGU supports the government's program in reducing fuel use. The embodiment of the program is to carry out a fuel oil conversion program and replace it with gas fuel. Not only operating using gas fuel which is proven to be more efficient than fuel oil, PT PLN Indonesia Power Semarang PGU has CNG that can store gas when oversupply with low operating load conditions, resulting an increase in efficiency from fuel use.

Certification

PT PLN Indonesia Power Semarang PGU has several certification related to the production, such as:

- ISO 9001:2015
- ISO 14001:2015
- ISO 45001:2018
- ISO 50001:2018

Location

Tanjung Emas Port Area, Semarang, Central Java, Indonesia.

PLN Indonesia Power

Product Information

Product Name

Electricity.

Product Description

The function of electricity is used as an energy source to support activities both in the community and industrial activities. The LCA study of PT PLN Indonesia Power Semarang PGU has included its main product, that is electricity.

UN CPC Code

UN CPC 171

Geographical Coverage

The location of the entire process studied is in Indonesia with the following details:

- The location of natural gas suppliers is in Semarang and Cepu City.
- The location of the plant is in Semarang, Central Java.
- The electricity distribution location is in Central Java Province.

PLN Indonesia Power

LCA Information

Functional Units

1 kWh of net electricity generated and thereafter distributed to the customer.

Database

The database used in this EPD is Ecoinvent 3.8. Such databases are used in the calculation of the impact of upstream, core, and downstream processes.

Time Coverage

The data period used is 1 year (January 1-December 2020) and the generic data range from 2018-2020.

LCA Software

The LCA study was conducted using SimaPro 9.3 software.

Reference Service Life

PT PLN Indonesia Power Semarang PGU is assumed to operate for 40 years.

Cut-off Rules

Life cycle assessment study for PT PLN Indonesia Power Semarang PGU in 2021 from upstream to downstream starts from natural gas production (upstream) to the impact of electricity distribution (downstream). The cut-off rules in PT PLN Indonesia Power Semarang PGU LCA study report use the principles of mass, energy and environmental criteria. Where all input and output data related to mass, energy and the environment for each process in the electricity production system is 99% considered to have a direct impact on the environment, or in other words the cut-off used is at the 1% level.

Assumptions in The LCA Study

Some of the assumptions used in this LCA study are as follows:

- The length of natural gas transportation by transmission pipes using a path length approach based on Google Maps.
- Emmission parameters such as SO_2 and NO_2 are calculated based on fuel consumption conversion, while other emmissions are obtained from direct measurements.
- Calculation of potential impact from decommissioning process is using Ecoinvent database with the amount of waste adjusted to the plant construction stage.
- Electricity losses is calculated 1% from the amount of electricity transmitted and distributed.
- The length of transmission areas using a path length approach based on Google Maps.
- Calculation of the impact of electricity distributed to the customer using a distance approach of 100 km, 500 km, and 1000 km.

System Boundary

The boundary of the LCA study of PT PLN Indonesia Power Semarang PGU in 2021 are upstream to downstream in accordance with PCR Electricity, Steam, and Hot/Cold Water Generation and Distribution, 8:2007 Version 4.2 UN CPC 171, 173. The production system starts from the upstream stage which consists of the natural gas drilling and processing process, natural gas delivery, production and transportation of high speed diesel (HSD), production and transportation of other fuels, production and transportation of lubricating oil, as well as the production and transportation of chemicals used by PT PLN Indonesia Power Semarang PGU. The construction and decommissioning process at the upstream stage was not included in this study. The main process (core) in this system consists of infrastructure (construction and decommissioning) of PLTGU, the process of burning fuel (natural gas and HSD) with air, the conversion of thermal energy into electricity, as well

as other additional processes such as the fuel preparation process, maintenance process, use of backup power, and on-site transportation. Then the downstream stage consists of infrastructure (construction and decommissioning) transmission, electricity transmission process, and electricity distribution process to the community. Meanwhile, activities that are not related to the main process of electricity production such as personnel activities in office units are not included in this study. Inputs or inputs used to produce electricity in the form of make up water, natural gas and HSD fuel, electricity, and chemicals.

The reason for choosing the system boundaries is in accordance with the agreement on the association and the Product Category Rules (PCR). Data that can be collected and available at PT PLN Indonesia Power Semarang PGU can include the limitations of upstream to downstream study systems. A diagram of the production process flow along with the limitations of the company's 2021 LCA system as a whole can be seen in Figure 1 below.

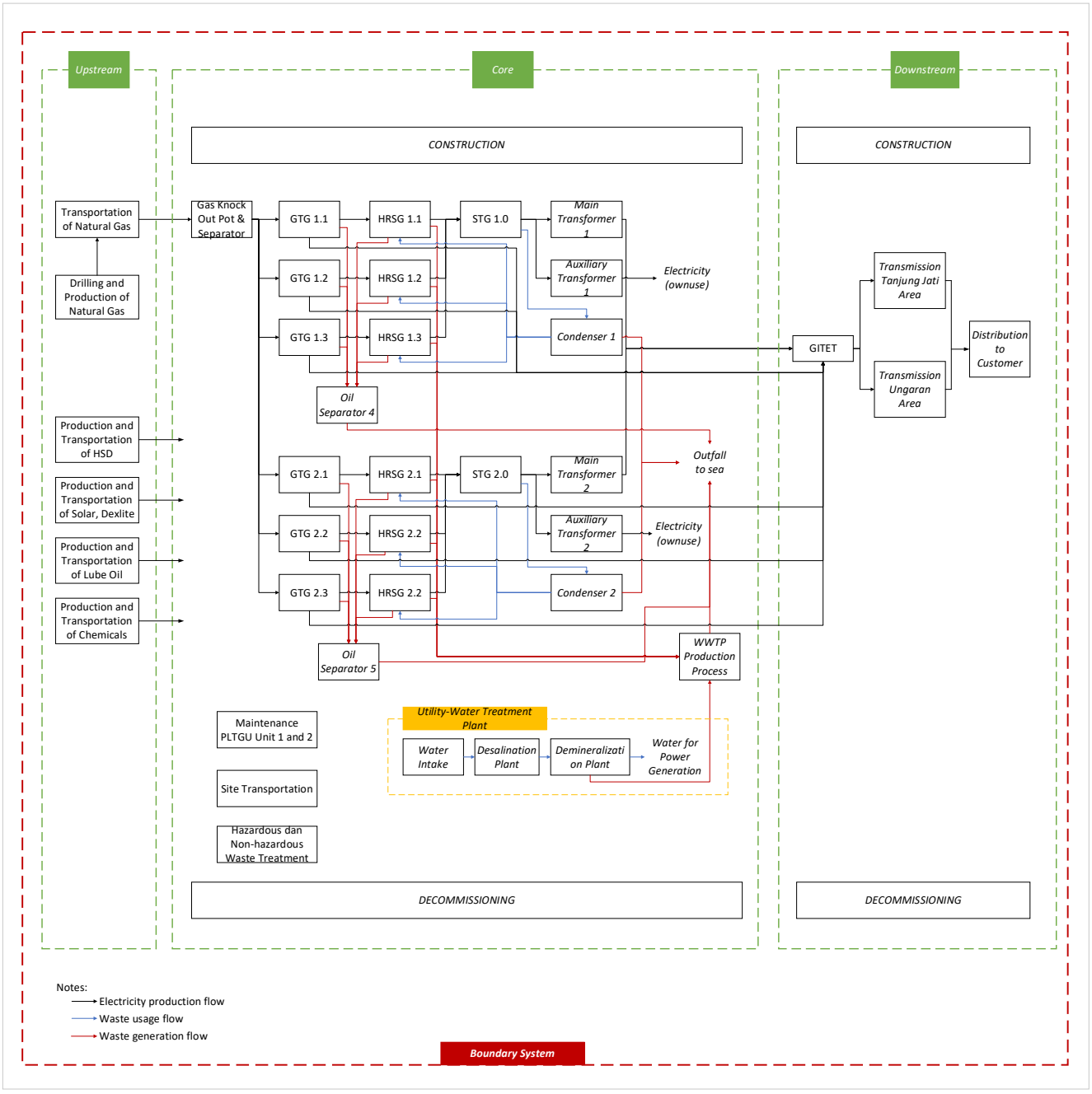


Figure 1. Electricity Production System PT PLN Indonesia Power Semarang PGU and System Boundaries of the Study

Data Collection Procedures

PT PLN Indonesia Power Semarang PGU collects data on each process unit covered by the system boundary including data on raw materials, fuel, electrical energy use, emissions into the air, emissions to water, emissions to the ground, land use data, and product data in 2020. The data collected is grouped into 2 types of data, namely primary data and secondary data in accordance with what has been determined at the National Electricity Environment Association (ALLIN) related to the LCA Implementation Plan for Power Plant Activities in the 2021 PROPER assessment and Product Category Rules (PCR): Electricity, Steam And Hot/Cold Water Generation And Distribution, 8:2007 Version 4.2 UN CPC 171, 173. The definitions of primary data and secondary data are:

a. Primary data: data obtained either by measuring or calculating according to the company's monitoring results.
b. Secondary data: data derived from literature studies or journals relating to the required calculations.

The details of the inventory data from core process used in this LCA study are as follows:

- Input

a. Material : Feed water, air, flue gas
b. Fuel/energy : Natural gas, Electricity, HSD, dexlite
c. Chemicals : Nitrites, detergents, ammonia, hydrazine, flocculant, coagulant, HCl, NaOH, anti scale, anti foam
d. Water use : Seawater
e. Other uses : Land area

- Output

a. Emissions into the air : SO_2, NO_x, CO_2
b. Emissions to water : Fat oil, TOC, Fe, Cu, Cr, Zn, PO_4, residual chlorine, TSS
c. B3 waste : Used lubricants, used majun, B3 used packaging, Laboratory waste, oil sludge
d. Non B3 Waste : Wood, metal waste
e. Main product : Electrical
f. Byproduct : -

Impact Assessment Methods

The impact indicators or categories to be analyzed in this LCA study are adjusted to the Product Category Rules (PCR): Electricity, Steam And Hot/Cold Water Generation And Distribution, 8:2007 Version 4.2 UN CPC 171, 173. Based on the PCR, the impact categories studied include Global Warming Potential (*GWP)*, Acidification Potential (AP), Eutrophication Potential (EP), Photochemical Ozone Creation Potential (POCP), Ozone Depletion Potential, Abiotic Depletion Potential NonFossil Fuels, Abiotic Depletion Potential Fossil Fuels and Water Deprivation Potential.

To analyze the above impact categories, this LCA study was carried out using the impact assessment method, namely EN 15804. The method has reviewed the required impact categories according to the impact points contained in the https://environdec.com/resources/indicators and has conversion factors that are diverse enough to analyze the various substances

causing the impact to appear. The general explanation of the method is as follows.

The development of the EN 15804 method began in 2016, during the EF trial phase, the European Commission mandated CEN to change the EN 15804 standard to better align with PEF requirements. The mandate includes a request to align the impact assessment model, indicator units and characterization factors used in EN 15804 with the appropriate developed in the EF method. Furthermore, the mandate requests that the standard use the nomenclature and format of the lifecycle inventory as in the ILCD. Both points are applied in the revised EN 15804. Compared to the EF reference package in force at the time of the relevant amendment, the revised EN 15804 differs for characterization factors (CF) of biogenic CO_2 removals and emissions, which are defined in the same standard as "-1" (CO_2 absorption) and "+1" (CO_2 release). A different CF option for biogenic CO_2 implies that a separate version of the EF reference package, specific to the EN 15804 standard, has been shipped.

Potential Environmental Impact

The indicators related to the potential environment impact of the elecricity generated by PT PLN Indonesia Power Semarang PGU are expressed per functional unit with the following details:

- For upstream, core, core-infrastructure, and total generated, impacts are expressed per 1 kWh of net electricity generated.
- For downstream, downstream-infrastructure, and total distributed, the impact is expressed per 1 kWh of electricity distributed to the customer. Electricity losses is calculated 1% from the elecricity generated.

Table 1. Potential Environmental Impact of Electricity Produced by PT PLN Indonesia Power Semarang PGU

No	Impact Categories	Unit	Method	*Upstream*	*Core*	*Core-infra structure*	*Total Generated*	*Downstream*	*Downstream-infrastructure*	*Total Distributed*
1	***Global Warming Potential* (GWP)**									
	a. GWP Fossil	kg CO_2 eq/kWh	EN 15804	9.00E-02	3.36E-01	8.34E-03	4.35E-01	4.39E-03	6.16E-02	5.01E-01
	b. GWP Biogenic	kg CO_2 eq/kWh	EN 15804	6.75E-05	4.68E-10	2.46E-04	3.14E-04	1.16E-06	1.06E-03	1.38E-03
	c. GWP Luluc	kg CO_2 eq/kWh	EN 15804	1.36E-04	1.37E-10	6.48E-06	1.43E-04	1.44E-06	1.06E-04	2.50E-04
	d. GWP Total	kg CO_2 eq/kWh	EN 15804	9.02E-02	3.36E-01	8.61E-03	4.35E-01	4.39E-03	6.28E-02	5.02E-01
2	***Acidification Potential* (AP)**	mol H^+ eq/kWh	EN 15804	5.51E-04	1.25E-03	7.93E-05	1.88E-03	1.89E-05	2.27E-03	4.17E-03
3	**Eutrophication Potential (EP)**									
	a. *Aquatic freshwater*	kg P eq /kWh	EN 15804	8.67E-06	4.92E-11	4.24E-06	1.29E-05	1.30E-07	1.75E-04	1.88E-04
	b. *Aquatic marine*	kg N eq /kWh	EN 15804	5.54E-05	5.68E-04	1.54E-05	6.39E-04	6.45E-06	1.40E-04	7.84E-04
	c. *Terrestrial*	mol N eq /kWh	EN 15804	5.46E-04	6.22E-03	1.60E-04	6.93E-03	7.00E-05	1.82E-03	8.82E-03
4	***Photochemical Ozone Creation Potential (POCP)***	kg NMVOC eq/kWh	EN 15804	3.98E-04	1.47E-03	4.96E-05	1.92E-03	1.94E-05	5.31E-04	2.47E-03
5	***Ozone Depletion Potential* (ODP)**	kg CFC-11 eq/kWh	EN 15804	6.14E-09	9.70E-14	5.69E-10	6.71E-09	6.77E-11	5.29E-09	1.20E-08
6	***Abiotic Depletion Potential* (ADP)**									
	a. for minerals and metals (non-fossil resources)	kg Sb eq /kWh	EN 15804	4.85E-07	8.42E-13	6.80E-07	1.17E-06	1.18E-08	5.14E-05	5.25E-05
	b. for fossil resources	MJ/kWh	EN 15804	8.56E+00	1.07E-05	9.21E-02	8.65E+00	8.74E-02	7.04E-01	9.44E+00
7	***Water Deprivation Potential* (WDP)**	m^3 world eq deprived /kWh	EN 15804	7.55E-03	1.60E-06	2.10E-03	9.65E-03	9.75E-05	4.33E-02	5.31E-02

Use of Resources

The indicators related to the use of resources from the elecricity generated by PT PLN Indonesia Power Semarang PGU are expressed per functional unit and per life cycle stage as listed in Table 2 below.

Table 2. Indicators Describing by The Use of Resources of Electricity Produced by PT PLN Indonesia Power Semarang PGU

Parameters		Unit	Upstream	Core	Core-infra structure	Total Generated	Downstream	Downstream-infrastructure	Total Distributed
Primary energy resources - Renewable	*Use as energy carrier*	MJ/kWh	2.39E-02	1.18E-07	8.34E-03	3.22E-02	3.22E-04	1.47E-01	1.79E-01
	Use as raw material		0	0	0	0	0	0	0
	TOTAL		2.39E-02	1.18E-07	8.34E-03	3.22E-02	3.22E-04	1.47E-01	1.79E-01
Primary energy resources – Non renewable	*Use as energy carrier*	MJ/kWh	9.45E+00	1.16E-05	9.39E-02	9.55E+00	9.55E-02	6.98E-01	1.03E+01
	Use as raw material		0	0	0	0	0	0	0
	TOTAL		9.45E+00	1.16E-05	9.39E-02	9.55E+00	9.55E-02	6.98E-01	1.03E+01
Secondary material		Kg/kWh	4.57E-03	2.12E-08	1.43E-03	6.01E-03	6.01E-05	1.38E-02	1.98E-02
Renewable secondary fuels		MJ/kWh	0	0	0	0	0	0	0
Non-renewable secondary fuels		MJ/kWh	0	0	0	0	0	0	0
Net use of fresh water		m^3/kWh	9.20E-04	2.39E-07	4.57E-05	9.66E-04	9.66E-06	1.05E-03	2.03E-03

Waste Production

The indicators related to the waste production of electricity produced by PT PLN Indonesia Power Semarang PGU are expressed per functional unit and per life cycle stage as listed in Table 3 below.

Table 3. Indicators Describing The Production of Waste of Electricity Produced by PT PLN Indonesia Power Semarang PGU

Parameters	Unit	Upstream	Core	Core-infra structure	Total Generated	Downstream	Downstream-infrastructure	Total Distributed
Hazardous waste disposed	Kg/kWh	1.92E-05	5.51E-05	0	7.43E-05	7.43E-07	2.07E-01	2.07E-01
Non-hazardous waste disposed	Kg/kWh	7.42E-05	4.22E-05	1,26E-03	1.38E-04	1.38E-06	1.31E-02	1.45E-02
Radioactive waste disposed	Kg/kWh	0	0	0	0	0	0	0

Output Flow

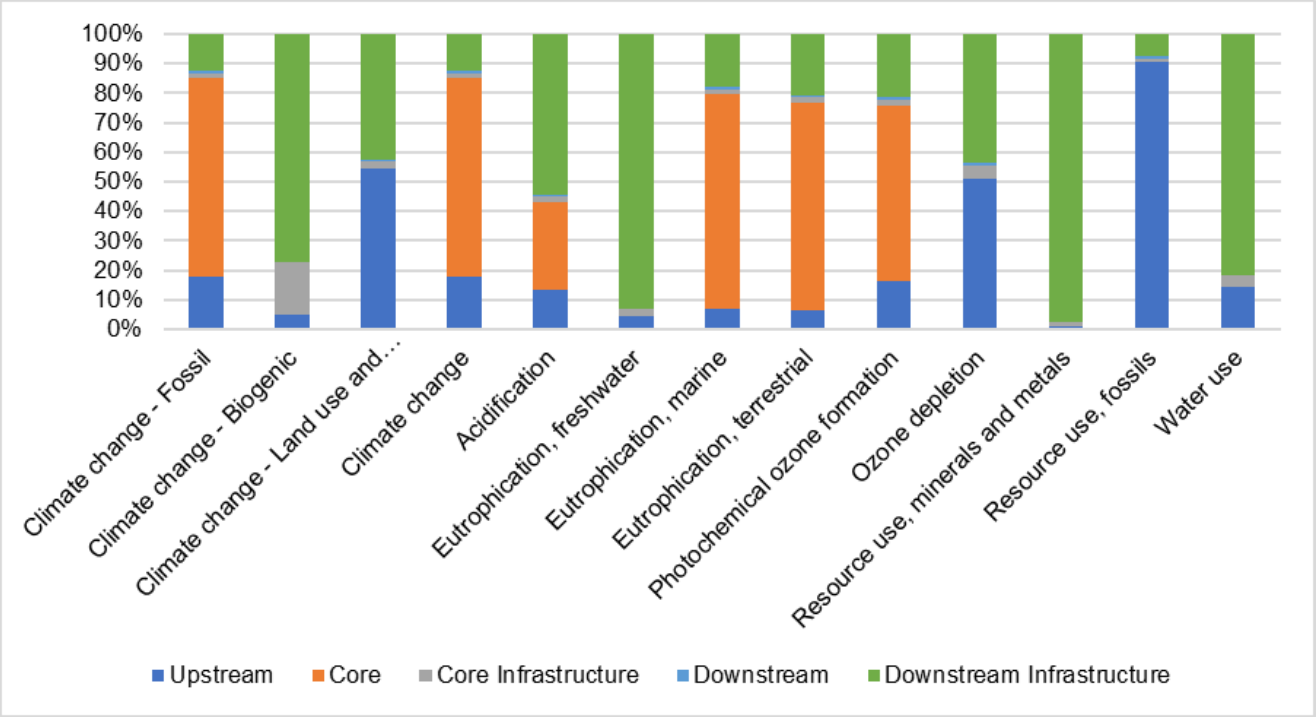
The indicators related to the output flow of electricity produced by PT PLN Indonesia Power Semarang PGU are expressed per functional unit and per life cycle stage as listed in Table 4 below.

Table 4. Indicators Describing The Output Flow of Electricity Produced by PT PLN Indonesia Power Semarang PGU

Parameters	Unit	Upstream	Core	Core-infra structure	Total Generated	Downstream	Downstream-infrastructure	Total Distributed
Component for reuse	Kg/kWh	0	0	0	0	0	0	0
Material for recycling	Kg/kWh	0	0	0	0	0	0	0
Material for energy recovery	Kg/kWh	0	0	0	0	0	0	0
Exported energy, electricity	MJ/kWh	0	0	0	0	0	0	0
Exported energy, thermal	MJ/kWh	0	0	0	0	0	0	0

Impact Contribution

The impact contribution resulting from the upstream - downstream process of PT PLN Indonesia Power Semarang PGU can be seen in the graph below. In the upstream process, the biggest impact contributor is the natural gas production and transportation process. This impact is caused by the use of natural gas, oil and other fossil resources needed in the process of extracting and transporting raw materials. In the core process, the potential impact comes from the core-infrastructure and main core units such as the Gas Turbine Generator (GTG), Heat Recovery Steam Generator (HRSG), as well as hazardous and non-hazardous waste processing units. The impact on the core process is caused by emissions released from the main electricity production process. Whereas in the downstream process, the potential impact comes from downstream-infrastructure and downstream processes in the form of electricity transmission and distribution. This impact is greatest due to the use of natural gas, oil and other fossil resources needed for the process of electricity transmission and distribution infrastructure.



Additional Information

Biodiversity Conservation Development

1. Mangrove Conservation on the North Coastline
   Mangrove planting on the north coast aims to protect Mangunharjo Village from the impact of abrasion, besides that maghrove is also processed into mangrove coffee products by the local community. Mangrove conservation exists on an area of 0.6 ha with 5,800 mangroves or there is an increase in the number of mangroves by 18% from the previous year.
2. Flora Conservation in the Generating Area
   Conservation of flora in the form of bottle palm (*Hyophorbe lagenicaulis*) in the generating area to support the existence of avifauna is protected by the government. With conservation land of 1.1 Ha, H' flora reaches 3.66 and H' avifauna 2.36.
3. Endemic Orchid Conservation of Mount Ungaran
   Orchid conservation is carried out by involving the surrounding community with the results of cultivation, some of which are released into nature and some of the orchid cultivation products are used for community empowerment. The conservation land area is 167.5 ha with the number of trees 150 and H' orchids 1.8661.
4. Conservation of Mount Ungaran Area through Sekolah Alam Hijaunesia Power
   Cultivating and preserving local plants of Mount Ungaran as an effort to reforestation in critical lands and restore the ecosystem of Mount Ungaran. An understanding of social-ecopreneurship is also given so that it can increase community awareness and capacity in conserving the forest resources of Mount Ungaran to be used as a community business. Conservation sustainability is realized by forming a community of natural resources and Kehati conservationists around the Mount Ungaran Area. The level of knowledge of the community has increased by 20% with at least 500 seeds from 5 types of local plants that have been cultivated.

Environmental Risks

PT PLN Indonesia Power Semarang PGU has consistently managed the environmental risks that occur due to its production process through the identification of significant risks to the environment. This activity is carried out through identification of environmental impacts, by carrying out a life cycle assessment. The potential risks are identified as energy, water, wastewater, air, hazardous waste and non-hazardous waste pollutions. The environmental management performance is calculated annually and reported through a verification report to the Ministry of Environment and Forestry of the Republic of Indonesia. Some of the environmental risk control programmes carried out by PT PLN Indonesia Power Semarang PGU can be seen in the table below.

Tabel 5. Environmental Risk Management Programmes of PT PLN Indonesia Power Semarang PGU

Aspect	Program
Energy	• Water wash gas turbine compressors • Re-sequence of operasi blower fan cooling (88FC) operation based on lube oil temperature • Retrofit pf debris filter and ball cleaning system
Air pollution	• Gasification PLTGU unit 1 • Gasification PLTGU unit 2 • Modification of blocking plate HRSG 2.2
Water and wastewater	• Utilization of hydrostatic test residual water PLTGU • Shorting time fast rinse in mixbed regeneration

Aspect	Program
	• Dry conservation PLTU #1 dan #2
Hazardous waste	• Purification of lube oil • Sludge oil separation • Water wash
Non-hazardous waste	• Rewinding motor water cooling 88WC • WoodSign reuse • WorkOrder Application (DigimonX)

Noise

Generally, the noise generated by a power plant comes from machines that are in operation such as boilers, pumps, turbines, etc. and can be reduced by installing sound absorbers in the generator building.

Electromagnetic Field

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

Land Use

PT PLN Indonesia Power Semarang PGU consist of 2 unit, unit 1 (3 GTG/HRSG and 1 STG) and unit 2 (3GTG/HRSG and 1 STG) power plants. The total land used by PT PLN Indonesia Power Semarang PGU equal to 788,838 m^2, where the power plant itself occupies an area of 440,913 m^2. According to Corine Land Cover Classes, the land was used to be an open-spaces with little or no vegetation (class 3.3) dan now became and industrial area (class 1.2). The area of PT PLN Indonesia Power Semarang PGU consist of main processing units and supporting facilities, among others are gas knock out pot & separator, gas turbine generator, heat recovery steam generator, steam turbine generator, condensor, trafo, oil separator, water intake, desalination plant, demineralization plant, WWTP, etc.

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