Analysis of the Achievement of Indonesia's Nationally Determined Contribution Target in 2030

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Abstract - ***Global climate diplomacy through the Paris Agreement obligates every member state to update their greenhouse gas (GHG) emission reduction commitments through the Nationally Determined Contribution (NDC) document. As a form of national implementation, the Government of Indonesia sets an emission reduction target in 2030 of 31.89% for the CM1 or unconditional scenario in the Enhanced NDC (ENDC) document. Furthermore, PT PLN (Persero) is mandated to contribute directly to GHG emission reductions by 127 Million Tons of CO2 in 2030 based on the unconditional scenario (CM1). However, along with the progress of GHG emission reduction achievements which have dynamics, there is a potential gap in achieving the GHG emission reduction target. Thus, an analysis of the fulfillment of the GHG emission reduction target by PT PLN (Persero) in 2030 is needed, as well as mapping the achievement prognosis and the challenges per mitigation activity. The use of a descriptive-analytical method based on literature study and review of regulatory documents of the Government of Indonesia and PT PLN (Persero), as well as emission reduction calculations, is carried out based on mathematical formulas that refer to the BAU scenario calculation in the ENDC. The analysis is focused on the comparison of three main data trends: the initial target of the ENDC document for the 2021–2030 period, the historical realization of emission reductions for the 2021–2025 period, and the prognosis of emission reductions for the 2026–2030 period across four main activities of PLN. The projection shows that a significant gap will occur in achieving the target of 127 million tons of CO_2 emissions, and the activity that has the largest gap is the renewable energy (EBT) development activity. Even so, PT PLN (Persero) shows a positive trend in GHG emission reduction, but the fulfillment of the NDC target, specifically the contribution from PT PLN (Persero) in 2030, faces major structural challenges.***

Keywords — Enhanced NDC, GHG emission reduction, New and Renewable Energy, Biomass Cofiring, Clean Coal Technology, Gas Power Plants.

I. Introduction

Global climate change is one of the most crucial challenges faced by humanity in the 21st century. The world has engaged in a global climate diplomacy process that has evolved from 1992 to the present day [1]. The diplomatic process began with the establishment of the UNFCCC (United Nations Framework Convention on Climate Change) at the Earth Summit in Rio de Janeiro in 1992 in order to stabilize greenhouse gas (GHG) concentrations in the Earth's atmosphere [2]. However, the UNFCCC did not establish legally binding GHG emission reduction targets, so the GHG emission reduction targets remained voluntary [3]. The reduction of GHG emissions carried out based on voluntary commitments from UNFCCC member states was deemed insufficient, hence the Kyoto Protocol was subsequently agreed upon in December 1997. The Kyoto Protocol officially entered into force on February 16, 2005, by including GHG emission reduction targets at the international level, followed by the alignment of GHG emission reduction contributions to UNFCCC member states [4]. The weakness of the Kyoto Protocol, which distinguished the GHG emission reduction contributions between developed and developing countries, caused the protocol to not run well, so during its journey several protocols were drafted, including the Bali Action Plan at COP13-2007, Copenhagen at COP15-2009, and the Doha Amendment at COP18-2012. However, none were agreed upon by all UNFCCC member states. The global climate diplomacy that is valid to this day is the Paris Agreement, which was agreed upon by 196 countries at COP21-2015 [5]. The Paris Agreement has several important agreements, specifically that each country is obligated to formulate, communicate, and update its own emission reduction targets every 5 years in an NDC (Nationally Determined Contributions) document [6]. Based on these international commitments, Indonesia has committed to GHG emission reductions that are stated and submitted to the UNFCCC in several documents, among others, the First NDC (FNDC) document in 2016 [7], the Updated NDC document in 2021 [8], the Enhanced NDC document in 2022 [9], and the Second NDC (SNDC) document in 2025 [10].

The analysis will focus on the targets stated in the ENDC with a discussion of the targets stated in the SNDC. Furthermore, the achievement of GHG emission reduction focuses on the energy sector and which constitutes the contribution of PT PLN (Persero). The Enhanced NDC (ENDC) document of Indonesia published in 2022 [9] includes several main pieces of information, among others, the GHG emission reduction target in 2030 which is divided into 5 sectors, namely: energy, waste, industrial process & product use (IPPU), agriculture, and forestry & other land use (FOLU). It includes a business-as-usual (BAU) scenario as the basis for calculating GHG emission reductions, furthermore the inclusion of the Counter-Measure-1/CM1 scenario with the definition of an unconditional mitigation scenario [11], which is decarbonization efforts carried out independently using domestic resources, and the Counter-Measure-2/CM2 scenario with the definition of a conditional mitigation scenario [12], which is decarbonization efforts that can only be achieved if

there is international assistance in the form of funding, technology transfer, and capacity building [13], [14]. Based on the information presented in the ENDC document, the contribution of PT PLN (Persero) to achieving Indonesia's GHG emission reduction target is analyzed with a focus on the 2030 target in the energy sector, particularly under the CM1 scenario [15].

The first information relates to the determination of the GHG emission reduction target, which is illustrated by the graph below.

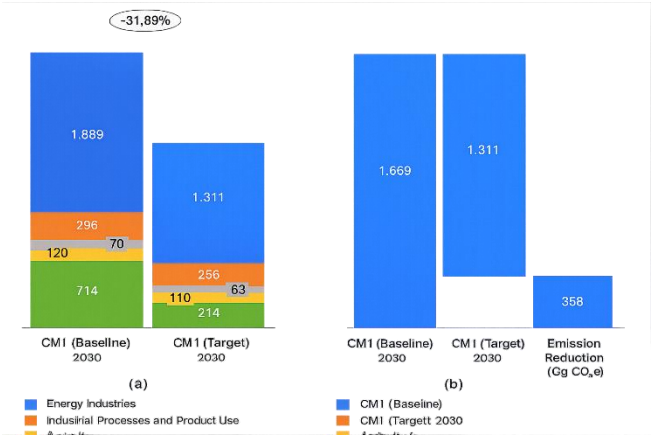

Figure 1 Visualization of Emission Reduction in the Enhanced NDC Document (adapted from [15]).

Figure 1(a) illustrates the GHG emission levels by sector under the Business-as-Usual (BAU) and CM1 target scenarios for 2030. The total GHG emission reduction target for the CM1 scenario is **31.89%**, decreasing from **2.87 billion tons of CO_2e** in the BAU scenario to **1.95 billion tons of CO_2e**. The figure also shows that the largest contribution to total emissions in both scenarios originates from the energy sector, followed by forestry and other land use, while the industrial processes, agriculture, and waste sectors contribute comparatively smaller shares.

Figure 1(b) presents the total GHG emission reduction achieved under the CM1 scenario relative to the BAU scenario. The overall reduction across all sectors amounts to approximately **1.3 billion tons of CO_2e**, with the **energy sector contributing 358 million tons of CO_2e** to the total reduction target. This value serves as the reference for evaluating the contribution of PT PLN (Persero) in achieving the national emission reduction target in the electricity sector.

The second information presented in the ENDC document provides the basis for calculating GHG emission reductions under the Business-as-Usual (BAU) scenario. Specifically, for the electricity sector, the document defines the BAU scenario as follows:

Table 1 Excerpt from Annex 1 of the Enhanced NDC Document

Mitigation Action	BAU Scenario
Additional RE in Power according to RUPTL	No additional RE PP since 2010
Solar rooftop, PV Wilus and Hydro Wilus, Off grid RE	No solar rooftop program
Biofuel	B-10 only
Cofiring	No cofiring program
Energy Efficiency Improvement of Equipment	No EE Improvement Program
Electric Vehicle (EV)	No EV Program
Clean Coal Technology	No additional implementation of Clean Coal Technology after 2010
Gas Power Plant	No additional gas power plant development after 2010

The definitions in the table 1 will be the basis for calculating the GHG emission reduction for each mitigation action that becomes the contribution of PT PLN (Persero) in 2030. The Government of Indonesia through the Ministry of Energy and Mineral Resources (ESDM) calculates the derivative of the 2030 GHG emission reduction contribution by PT PLN (Persero) [16]. The Energy Sector GHG emission reduction in 2030 is 358 Million Tons of CO2, consisting of several groups of activities including energy efficiency, renewable energy, clean energy power plants, low carbon fuels, and additional reclamation [17]. The contribution of PT PLN (Persero) for GHG emission reduction is related to 4 activities, namely Electricity Supply Business Plan (Rencana Usaha Penyediaan Tenaga Listrik, RUPTL) Renewable Energy (EBT) Power Plants, cofiring, clean coal technology, and new gas power plants. The GHG emission reduction activity per activity for PT PLN (Persero) is according to the graph below.

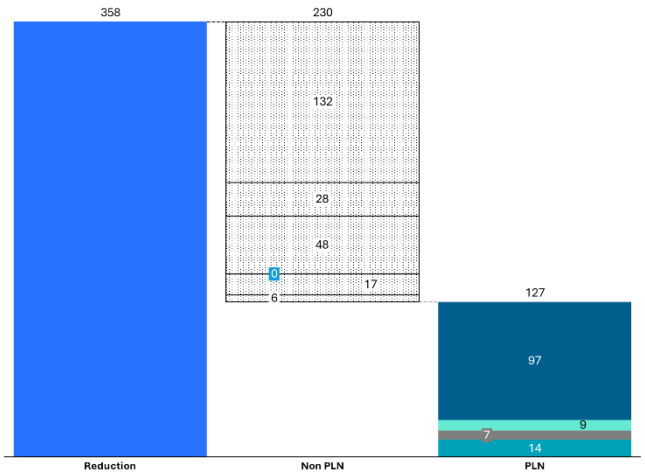

Figure 2 Visualization of Emission Reduction Alignment for PT PLN (Persero) (adapted from [15], [16]).

The GHG emission reduction target in 2030 for activities that are the contribution of PT PLN (Persero) totals 127 Million Tons of CO2, a calculation approach taking into account the development plan according to the 2021-2030 RUPTL document [18], with the division of renewable energy (EBT) power plant development at 97 Million Tons of CO2, Biomass Cofiring at 9 Million Tons of CO2, clean coal technology development at 7 Million Tons of CO2, and gas power plant development at 14 Million Tons of CO2 [19].

The Government of Indonesia has submitted the SNDC document of Indonesia in November 2025 [10] which lists the emission level targets in 2030, 2035, and 2060. Another quite significant change is the adjustment regarding the scenarios. The analysis of the conformity of the ENDC and SNDC documents is according to the figure below.

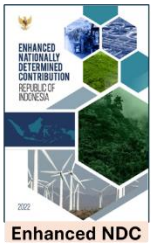

Table 1. Projected BAU and emission reduction from each sector category

Sector	GHG Emission Level 2010* (MTon CO2eq)	GHG Emission Level 2030 MTon CO_2eq			GHG Emission Reduction MTon CO_2eq		% of Total BaU		Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy*	453.2	1,669	1,311	1,223	358	446	12.5%	15.5%	6.7%	4.50%
2. Waste	88	298	256	253	40	43.5	1.4%	1.5%	6.3%	4.00%
3. IPPU	36	69.6	63	61	7	9	0.2%	0.3%	3.4%	0.10%
4. Agriculture	110.5	119.66	110	108	10	12	0.3%	0.4%	0.4%	1.30%
5. Forestry and Other Land Uses (FOLU)**	647	714	214	-15	500	729	17.4%	25.4%	0.5%	2.70%
TOTAL	1,334	2,869	1,953	1,632	915	1,240	31.89%	43.20%	3.9%	3.20%

Notes: CM1= Counter Measure 1 (unconditional mitigation scenario)
CM2= Counter Measure 2 (conditional mitigation scenario)
*) Including fugitive
**) Including emission from estate and timber plantations.

Scenario	Sector	2019	2025	2030	2035	2060
CPOS	Energy	655,568	1,032,127	1,310,969	1,419,126	1,561,764
	IPPU	63,729	74,858	79,465	93,580	109,397
	Waste	124,360	164,933	215,924	238,017	379,874
	Agriculture	79,996	79,572	79,457	79,634	83,504
	FOLU	221,384	133,675	94,635	-43,054	-247,434
	Net Emission	1,145,037	1,484,966	1,780,450	1,787,094	1,886,905

Scenario	Sector	2019	2025	2030	2035	2060
LCCP_L	Energy	655,568	909,829	1,071,841	1,109,800	129,000
	IPPU	63,729	68,042	74,147	73,115	34,243
	Waste	124,360	164,905	215,750	168,477	9,069
	Agriculture	79,996	77,843	76,193	74,738	76,503
	FOLU	221,384	-12,886	-92,224	-168,412	-329,703
	Net Emission	1,145,037	1,207,533	1,345,707	1,257,717	-80,889

Scenario	Sector	2019	2025	2030	2035	2060
LCCP_H	Energy	655,568	964,610	1,239,463	1,336,312	129,000
	IPPU	63,729	70,656	78,960	78,304	34,375
	Waste	124,360	164,540	215,928	205,695	34,705
	Agriculture	79,996	77,570	75,708	75,492	78,307
	FOLU	221,384	-25,729	-118,585	-208,897	-347,540
	Net Emission	1,145,037	1,251,648	1,491,474	1,488,866	-71,154

Figure 3 Visualization of the Comparison between the Enhanced NDC and Second NDC

The ENDC lists the GHG emission target of the CM1 scenario for the energy sector in 2030 at 1,311 MTon of CO2 and the GHG emission reduction of the CM1 scenario for the energy sector in 2030 at 358 MTon of CO2 [20]. The SNDC only lists the GHG emission level target. The GHG emission level target for the energy sector in 2030 in the CPOS scenario is the same as the GHG emission level target of the CM1 scenario for the energy sector in the ENDC document. The LCCP_L scenario in the SNDC has a more ambitious 2030 GHG emission level target, for the energy sector amounting to 1,071 MTon of CO2 [21].

II. Research Method

The calculation of GHG emission reduction for activities that constitute the contribution of PT PLN (Persero) refers to the 2021–2030 RUPTL [18].

A. Renewable Energy (EBT) Development

The EBT development activity calculates GHG emission reduction in an electricity system resulting from EBT development within that system. The EBT development included in this calculation is power plants that have achieved COD since 2011. The definition of COD since 2011 follows the BAU scenario calculation method listed in the ENDC document. GHG emissions in the electricity system use emission intensity information for each system listed in the Decree of the Minister of Energy and Mineral Resources (Kepmen ESDM) Number 163.K/HK.02/MEM.S/2021 concerning the Determination of Greenhouse Gas Emission Factors for the Electricity System.

The calculation of the GHG emission reduction target is as follows:

$$T - EBT = KapEBT \times CFEBT \times 8760 + REBT \times FESIS \quad (1)$$

Where:

T-EBT = GHG emission reduction target from EBT development activities (Million Tons CO_2)

KapEBT = planned capacity of EBT power plants in the 2021–2030 RUPTL (MW)

CFEBT = capacity factor assumption according to the EBT power plant type (%)

REBT = realization of accumulated production of EBT power plants during 2011–2020 (MWh)

FESIS = emission factor of each power system based on realization (Million Tons CO_2/MWh)

The realization calculation uses the following formula:

$$R - EBT = EEBT2011 \times FESIS \quad (2)$$

Where:

R-EBT = realization of GHG emission reduction from EBT development activities (Million Tons CO_2)

EEBT2011 = realization of electricity production from EBT power plants that achieved COD since 2011 (MWh)

FESIS = emission factor of each power system based on realization (Million Tons CO_2/MWh)

The EBT power plants included in this calculation consist of PLTP, PLTA, PLTM, PLTS, PLTB, PLTBm, PLTSa, and other EBT power plants.

B. Biomass Cofiring

The biomass cofiring activity calculates GHG emission reduction in Coal Power Plants (PLTU) through co-combustion between coal and biomass at certain composition ratios within one PLTU boiler. The biomass cofiring considered in this calculation is the biomass volume burned in Coal PLTUs. Emission factors use realization data of emission intensity per coal unit listed in APPLE GATRIK.

The target calculation formula is:

$$T - cof = TVolcof \times FEPLTU \quad (3)$$

Where:

T-cof = GHG emission reduction target from biomass cofiring activities (Million Tons CO_2)

TVolcof = target biomass fuel volume in Coal PLTU (Million Tons)
FEPLTU = emission factor of Coal PLTU based on realization (Million Tons CO_2/MWh)

The realization calculation uses the formula:

$$R - cof = RVolcof \times FEPLTU \quad (4)$$

Where:
R-cof = realization of GHG emission reduction from biomass cofiring activities (Million Tons CO_2)
RVolcof = realization of biomass fuel volume in Coal PLTU (Million Tons)
FEPLTU = emission factor of Coal PLTU based on realization (Million Tons CO_2/MWh)
The calculation of biomass fuel usage is based on the volume of biomass burned in Coal PLTUs.

C. Clean Coal Technology

The clean coal technology activity calculates GHG emission reduction resulting from the use of Coal PLTUs with clean coal technology compared with sub-critical Coal PLTUs. Emission reduction occurs because of differences in emission factors between these technologies.
Coal PLTUs included in clean coal technology are super-critical (SC) and ultra-super-critical (USC) units.
The target calculation formula is:

$$T - CCT = KapCCT \times CFCCT \times 8760 \times (FECCT - FESubC) \quad (5)$$

Where:
T-CCT = GHG emission reduction target from clean coal technology activities (Million Tons CO_2)
KapCCT = capacity of Coal PLTUs using clean coal technology (MW)
CFCCT = capacity factor assumption of Coal PLTU (%)
FECCT = clean coal technology emission factor = 0.95 Million Tons CO_2/MWh
FESubC = sub-critical Coal PLTU emission factor = 1.05 Million Tons CO_2/MWh

The realization calculation uses the following formulas:

$$R - CCT = ECCT \times (FESC - FESubC) \quad (6)$$

$$R - CCT = ECCT \times (FEUSC - FESubC) \quad (7)$$

Where:
R-CCT = realization of GHG emission reduction from clean coal technology activities (Million Tons CO_2)
ECCT = realization of electricity production from clean coal technology plants (MWh)
FESC = super-critical Coal PLTU emission factor = 0.9 Million Tons CO_2/MWh
FEUSC = ultra-super-critical Coal PLTU emission factor = 0.852 Million Tons CO_2/MWh
FESubC = sub-critical Coal PLTU emission factor = 1.05 Million Tons CO_2/MWh
Coal PLTUs with clean coal technology are considered more efficient because lower fuel consumption is required to produce the same amount of electrical energy. This efficiency leads to lower GHG emission factors.

D. Gas Power Plants

Gas power plant activities calculate GHG emission reduction in a system by comparing emissions generated by gas power plants with emissions in the electricity system. Emission reduction results from differences between emission factors of gas plants and electricity systems.
Gas power plants included in this calculation consist of PLTGU, PLTG, and PLTMG using gas fuel as primary energy sources.
The target calculation formulas are:

$$T - gas = KapGU \times CFGU \times 8760 \times (FESIS - FEGU) \quad (8)$$

$$T - gas = KapMG \times CFGU \times 8760 \times (FESIS - FEMG) \quad (9)$$

Where:
T-gas = GHG emission reduction target from gas power plant activities (Million Tons CO_2)
KapGU = PLTGU capacity in the 2021–2030 RUPTL (MW)
KapMG = capacity of PLTMG and PLTG in the 2021–2030 RUPTL (MW)
CFGU = PLTGU capacity factor assumption = 55%
CFMG = PLTMG and PLTG capacity factor assumption = 35%
FESIS = electricity system emission factor = 0.85 Million Tons CO_2/MWh
FEGU = PLTGU emission factor = 0.489 Million Tons CO_2/MWh
FEMG = PLTMG and PLTG emission factor = 0.709 Million Tons CO_2/MWh

The realization calculation uses the following formula:

$$R - gas = Egas \times (FESIS - FEgas) \quad (10)$$

Where:
R-gas = realization of GHG emission reduction from gas power plant activities (Million Tons CO_2)
Egas = realization of electricity production from gas power plants that achieved COD since 2011 (MWh)
FESIS = electricity system emission factor based on realization (Million Tons CO_2/MWh)
FEgas = gas power plant emission factor based on realization (Million Tons CO_2/MWh).

E. Analysis of the 2025–2034 RUPTL

The analysis of the 2025–2034 Electricity Supply Business Plan (RUPTL) was conducted to evaluate the updated roadmap of PT PLN (Persero) in supporting the achievement of Indonesia's 2030 GHG emission reduction target. This analysis focuses on identifying changes in emission reduction strategies, estimating the contribution of the planned programs, and assessing their alignment with the Enhanced Nationally Determined Contribution (ENDC) target. The projected emission reduction values reported in the 2025–2034 RUPTL are subsequently compared with the estimated contribution required to achieve the national target.

F. Analysis of GHG Emission Reduction Beyond PT PLN (Persero)'s NDC Contribution

In addition to the four primary mitigation activities identified in the ENDC framework, this study also evaluates other GHG emission reduction initiatives implemented by PT PLN (Persero) that are not explicitly included in its NDC contribution. These initiatives include biofuel utilization in diesel power plants, improvements in transmission and distribution efficiency, rooftop solar photovoltaic (PV) deployment, and the electric vehicle (EV) ecosystem. The purpose of this analysis is to quantify the additional emission reduction potential and assess its contribution toward narrowing the remaining gap in achieving the 2030 GHG emission reduction target.

III. Results and Discussion

The theoretical foundation and calculation method produce 3 calculations, namely the 2021-2030 GHG emission reduction target, the 2021-2025 GHG emission reduction realization, and the 2026-2030 GHG emission reduction prognosis, according to the graph of Comparison of Target, Realization, and Prognosis of GHG Emission Reduction below:

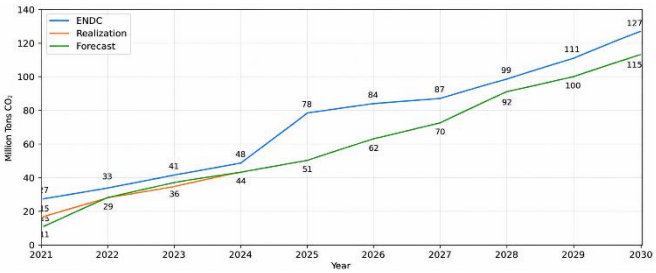

Figure 4 Comparison of Target, Realization, and Prognosis of GHG Emission Reduction

Based on the graph above, there is a substantial gap in 2025, where the basis for target setting refers to the 2021–2030 RUPTL document, which still sets a renewable energy (EBT) mix target of 23% in 2025 [22]. This target is no longer relevant because the ESDM RUKN, published in 2025, specifies the 2025 EBT mix target as 15.9%. It should also be noted that the SNDC is not included in Figure 4 because the realization and prognosis data analyzed in this study are based on the ENDC target framework. Since the available datasets and evaluation indicators were developed using the ENDC baseline, including the SNDC would not provide a consistent basis for comparison. The realization of GHG emission reductions from 2021 to 2024, although still below the target, shows a continuous upward trend, indicating that the GHG emission reduction initiatives implemented by PT PLN (Persero) have consistently improved each year. The remaining challenge, beyond maintaining this positive trajectory, is to develop effective strategies for achieving the 2030 GHG emission reduction target, which is still projected to have a considerable gap. Therefore, a detailed analysis of each GHG emission reduction activity contributing to PT PLN (Persero)'s performance is required to identify the remaining gap and formulate appropriate mitigation strategies for achieving the 2030 target.

A. Renewable Energy (EBT) Development Activity

The GHG emission reduction target in 2030 for the EBT development activity is 97 Million Tons of CO2. The realization of GHG emission reduction in 2025 for the EBT development activity is 19.9 Million Tons of CO2, and the prognosis of GHG emission reduction in 2030 for the EBT development activity is 54.4 Million Tons of CO2. The EBT development activity has a very large gap; even considering the GHG emission reduction prognosis, it still cannot be achieved. This activity uses more ambitious capacity factor and emission factor assumptions in the target calculation, making this one of the parameters causing the high gap. Furthermore, another challenge of this activity lies in the implementation of the EBT power plant plans. As comparative information, the realization of EBT power plants in PT PLN (Persero) up to 2025 is 9.4 GW, and it is estimated that EBT power plants that have achieved COD from 2011 to 2025 amount to 4.4 GW. Based on the 2021-2030 RUPTL, the planned addition of EBT power plants is 20.9 GW, and the 2025-2034 RUPTL also lists a roughly similar figure up to 2030.

B. Biomass Cofiring Activity

The GHG emission reduction target in 2030 for the cofiring activity is 8.88 Million Tons of CO2. The realization of GHG emission reduction in 2025 for the cofiring activity is 2.4 Million Tons of CO2, and the prognosis of GHG emission reduction in 2030 for the cofiring activity is a maximum of 6.9 Million Tons of CO2. The EBT development activity has a gap that can still be met with more ambitious initiatives. Based on the 2025 GHG emission reduction realization of 2.4 Million Tons of CO2, a biomass cofiring volume of 2.2 Million Tons has been implemented in 2025 across 52 Coal PLTUs owned by PLN. Thus, to meet the GHG emission reduction of 8.88 Million Tons of CO2 in 2040, an implementation of biomass cofiring volume of 8.14 Million Tons is needed in 2030, approximately 4 times the realization.

C. Clean Coal Technology Activity

The GHG emission reduction target in 2030 for the clean coal technology activity is 7.42 Million Tons of CO2. The

realization of GHG emission reduction in 2025 for the clean coal technology activity is 15 Million Tons of CO2. The clean coal technology activity has exceeded the target, which is estimated to have used unupdated capacity factor information and clean coal technology lists. However, this realization may decrease due to the coal phase down target, which is to reduce production from Coal PLTUs in order to maintain emission intensity, as well as production decreases resulting from the availability of coal fuel.

D. Gas Power Plant Activity

The GHG emission reduction target in 2030 for the gas power plant activity is 14.12 Million Tons of CO2. The realization of GHG emission reduction in 2025 for the gas power plant activity is 13.73 Million Tons of CO2, and the prognosis of GHG emission reduction in 2030 for the gas power plant activity is 26.3 Million Tons of CO2. The gas power plant activity can be fulfilled considering that gas power plants are a transition technology from the restriction of fossil power plants such as Coal PLTUs and PLTDs to EBT power plants. However, the availability of gas fuel can cause the non-fulfillment of the GHG emission reduction in 2030.

E. RUPTL 2025-2034

The 2025-2034 RUPTL states that the emission reduction in 2030 reaches 151 Million Tons of CO2 [9]. Thus, an assumption approach is needed to obtain a more accurate calculation, but the challenge of fulfilling the 2030 GHG emission reduction target to meet the contribution of PT PLN (Persero) can be addressed by implementing all activities listed in the 2025-2034 RUPTL document.

F. Beyond the NDC Contribution of PT PLN (Persero)

The GHG emission reduction activities of PT PLN (Persero) have been set to only 4 activities, but currently, there are other activities that have GHG emission reduction impacts that can be claimed by PT PLN (Persero), among others: the use of biofuel in PLTDs with an accumulation of up to 3.6 GL from 2022 to 2025, which has a GHG emission reduction impact of 2.6 Million Tons of CO2; energy efficiency on the side of transmission and distribution losses improvement by 1.72%, which has a GHG emission reduction impact of 5.62 Million Tons of CO2; the implementation of Rooftop Solar PV by PT PLN (Persero) customers up to 801 MWp in 2025, which has a GHG emission reduction impact of 0.08 Million Tons of CO2; and the EV Ecosystem by PT PLN (Persero) customers with electricity consumption for EVs amounting to 48.57 MWh in 2025, which has a GHG emission reduction impact of 0.03 Million Tons of CO2. The total impact of GHG emission reduction beyond the PLN NDC in 2025 is 7.79 Million Tons of CO2. There is a potential increase in GHG emission reduction in 2030.

IV. Conclusion

Based on the analysis conducted in this study, the following conclusions can be drawn: Based on the analysis conducted in this study, the following conclusions can be drawn:

1. Achieving Indonesia's 2030 greenhouse gas (GHG) emission reduction target under the CM1 scenario remains a significant challenge for PT PLN (Persero), particularly in renewable energy deployment, which constitutes the largest contributor to the targeted emission reductions while also exhibiting the largest implementation gap.
2. Among the four mitigation activities analyzed, renewable energy development has the greatest potential contribution to GHG emission reduction, followed by coal-fired power plant retirement, clean coal technology implementation, and gas-fired power plant development. However, each activity faces different levels of implementation challenges that influence the overall achievement of the emission reduction target.
3. The implementation of GHG emission reduction programs by PT PLN (Persero) since 2021 has demonstrated positive progress toward supporting Indonesia's decarbonization efforts. Nevertheless, additional efforts are required to close the remaining gap and achieve the projected 2030 emission reduction target.
4. Continuous monitoring and evaluation of the four mitigation activities are essential to ensure their effective implementation and to improve PT PLN (Persero)'s contribution toward achieving the national GHG emission reduction target by 2030.

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