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BATTLE ON EMISSION REDUCTION CLAIMS

Indonesia's State electric company (PT PLN) has claimed Energy transition to renewable energy only with replacement of 5-10 percent coal supply to biomass in coal fired power plant. Utilization of coal is not reduced, but coal power plant emission increase.

TREND ASIA

RANANG STRATEGIC

Introduction

Intergovernmental Panel on Climate change (IPPC) report, released on April 4th 2022 mentioned that in 2010-2019, average global greenhouse emission reached the highest level in human history. The report titled *Climate Change 2022: Mitigation of Climate Change* stated that greenhouse emission from human activity in 2019 reached 59 giga tones equal carbon dioxide, the biggest contributor of that emission is energy sector with 34 percent, 24 percent from industry and; 22 percent from agriculture, forest and land use change; 15 percent from transportation and 6 percent from buildings.

IPCC stated, without effort to reduce emission in all sectors intensively and immediately, the objective of Paris Agreement 2015 to limit global warming to 1.5˚ Celsius in the end of this century will not be achieved. IPPC report that to fulfill the objective, energy sector needs to conduct transformative and sustainable change. The mitigation action to be taken is to reduce massively the utilization of coal, fossil oil and natural gas; using renewable power plant and large sale electrification (IPCC, 2022).

As signatory country of Paris Agreement, Indonesia has commitment in nationally determined contribution (NDC), to reduce greenhouse emission to 29% in 2030 by national effort without intervention or 41 percent with international assistance. Indonesia projects also energy sector as biggest emission contributor with 60 percent, following by forestry sector and agriculture 27 percent, waste sector 11 percent and industrial sector 2 percent. Therefore, government focuses on mitigation action of greenhouse emission to energy sector.

State Electricity Company *(PT Perusahaan Listrik Negara*/PLN), as part of energy sector biggest contributor of emission, support government commitment. General plan of electricity supply (RUPTL) of PT PLN year 2021-2030, stated four reliable strategies to reduce greenhouse emission; prioritize new and renewable energy development, fuel transfer and exhaust gas utilization, utilization of fuel based on biomass as source of energy and utilization of low carbon and efficient technology for new power plant.

PLN considered biomass as golden opportunity to reduce greenhouse emission in power plant sub sector instantly at low cost. Without having to invest on new power plant development, PLN claimed to be able to support target achievement of mix and renewable energy to 23% in 2025. This is done through *co-firing* technology, i.e., mix burning of biomass with coal in old coal fired power plant or in the ones in planning phase.

Only by burning biomass of tenth of total fuel of coal fired power plant, PLN claimed of energy transition from unclean energy to renewable source of energy. Director General of PLN Darmawan Prasodjo stated that until May 2022, 32 power plant applied *co-firing*. This year, PLN targeted *co-firing* in 35 coal fired power plants (PLTU) with 450 thousand tones biomass needs. Next year, biomass needed will increase five times. (PLN, 2022).

As *co-firing* implementation is intensifying, PLN need massive and sustainable biomass supply. Moreover, PLN targeted implementation of *co-firing* in 52 location or 107 unit of Coal fired power plant all over Indonesia until 2025. Trend Asia counts with assumption of using biomass type of wood pellet and 10% *co-firing* level, 107 coal fired power plants with total capacity of 18.8 gigawatt will reach the need of 10.23 million tonnes per year of biomass.

This amount of biomass material can only be fulfilled from large scale wood plantation such as energy timber plantation *(Hutan Tanaman Energi*/HTE). Trend Asia estimated the need of land for HTE is at least 2.33 million hectares or 35 times larger than Jakarta Capital city. Developing extensive HTE will potentially cause deforestation.

Industrial timber plantation *(Hutan Tanaman Industri/* HTI) so far shows this kind of trend. Map Biomas Indonesia data shows that 38% of total coverage of HTI in 2019 came from natural forest opening.

PLN claim that *co-firing* will accelerate carbon emission reduction is more and more unreasonable. Math model of Trend Asia revealed that *co-firing* 10% of biomass in 107 PLTU unit potentially produce 26.48 million tonnes of Carbon dioxide equal (CO_2e) emission per year. This emission comes from deforestation, HTE utilization, to wood pellet production. Instead of reducing, mix biomass-coal will add emission from Coal fired power plants in RUPTL 2021-2030, with increasing projection 298.9 million tonnes of CO_2e in 2030.

PLN argument that woods biomass utilization will not produce emission or carbon neutral has no proof. The supporters of neutral carbon biomass argued that carbon is already absorbed during plant growth. Others argued that carbon production will be re-absorbed by substitute plants. Trend Asia calculate that natural forest carbon stock that disappear in developing HTE will not be replaceable by the whole built HTE carbon stock. There is gap of net emission around 6.8 million -11.3 million tonnes of CO_2e.

Also, biomass burning do not reduce coal utilization in Coal fired power plants. Based on PLN statistics in 2021, PLN use 282,628 tonnes biomass, increased significantly from 9,731 tonnes in 2020. Meanwhile coal utilization also increased to 68.47 million tons, from 66.68 million tonnes in 2020. This means PLN failed to implement second strategy of RUPTL PLN 2021-2030, to conduct fuel transfer in Coal fired power plants by replacing part of coal with biomass. Biomass as a substitute fuel instead becomes a complement.

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Emission Addition

Trend Asia research on Coal fired power plant *co-firing* policy with biomass in Indonesia, critically reviewed PLN choice to implement the co firing of biomass and coal. Trend Asia mapped the current condition of *co-firing* implementation through analysis of various official government and business entities documents. Other part of research project the future of utilization based on some assumptions to estimate carbon emission potential of *co-firing* in 52 coal fired power plant locations using wood pellet biomass.

This research assumed that PLN will use wood pellet to mix with coal in 52 coal fired power plant locations until 2025. Wood pellet is chosen as the continuous biomass demand will be met by energy timber plantation (HTE). Moreover, wood pellet industry had already been in operation in Indonesia although in the minor production scale. Data from production forest directorate of the ministry of environment and forestry in 2020, shows 14 companies developing energy plants and 18 others companies plan to develop it (Widjanarko, 2020).

Wood pellet is quite valuable, with 4,200 Kilo calorie per kilogram (kkal/kg), compared to average calorie

of coal 5,311 kkal/kg. Beside wood pellet, PLN also conducts *co-firing* with *wood chip, solid recovered fuel*, palm kernel shells, empty fruit bunch, sawdust and rice husks. However, various media reported stagnation in biomass supply. For example, Sintang Unit Coal fired power plant 1, 2 and 3 in west Kalimantan admitted that palm kernel shells supply cannot be fulfilled few times a year. (Betahita, 2021).

The halt of biomass supply for *co-firing* is also experienced by Jeranjang Unit 1 and 3 in Coal fired power plant in Lombok, West Nusa Tenggara that use rice husk. After one year, Jeranjang Coal fired power plant decided to stop using rice husk, due to seasonal supply and low calorie of rice husk 2,000 kkal/kg, far behind low calorie coal. Similar situation is also happened in Ropa Unit 1 and 2 Coal fired power plant in Ende, east Nusa Tenggara that used dry grass pellet (Betahita, 2021).

Counting the need of wood pellet, this research assumes average Coal fired power plant efficiency of 33%, 1 kilowatt hour equal 3,600 Kilo joule and 1 kkal/kg equal 4.1868 kilojoule per kilogram. After calculation, the need of wood pellet to produce 1 megawatt hour electricity is 620.4 kilogram. Multiplying this result with the power of Coal fired power plant, *co-firing* level and number of hours in a year, we will see the need of wood pellet for a year. The need of wood pellet for 107 Coal fired power plants with 10% *co-firing* is 10,228,679 tonnes wood pellet per year.

That large need of wood pellet cannot be fulfilled by current domestic industry that can only produce less than 1 million tonnes per year. Moreover, the majority of domestic wood pellet production are intended for export. So how will PLN meet the need of wood pellet? The biggest hope is on energy timber plantation. In the press release of PLN in March, 30th 2022, PLN stated plans to collaborate with state forest company *(Perum Perhutani)* and Nusantara Plantation Company *(PT Perkebunan Nusantara III/ PTPN Group)* to supply wood pellet in long term.

As pilot project, press release stated that Perhutani supply the need of biomass for Pelabuhan Ratu Coal fired power plant for 11,500 tonnes per year. Meanwhile, for Rembang Coal fired power plant, Perhutani supply 14,300 tonnes per year of Kaliandra Merah *(Calliandra Calothyrsus)* and Gamal *(Gliricidia Sepium)* wood chips. Through the same business scheme, Perhutani will build processing factory in Rembang, Central Java. Meanwhile PTPN Group estimate to be able to supply 500,000 tonnes of fresh empty bunch per year. It will be developed until 750 thousand tonnes per year in 2024 (PLN, 2022).

Trend Asia tried to calculate the land area to fulfil wood pellet material needed for 107 Coal fired power plant units. There are six scenarios of the based on the type of plant used by researcher. These six types of trees are referred to the Forestry Research and Development Agency of Ministry of Environment and Forestry; namely Akasia *(Acacia Mangium)*, Kaliandra Merah *(Calliandra Calothyrsus)*, Gamal *(Gliricidia Sepium)*, Eucalyptus Pelita *(Eucalyptus Pellita)*, Turi *(Sesbania Grandiflora)* and Lamtoro Gung *(Leucaena Leucocephala)*.

For the first scenario, the calculation started by dividing the need of wood pellet in each Coal fired power plant with acacia wood pellet production. The productivity assumption of acacia plant is 30.04 cubic meter/hectare/year and acacia wood pellet production of 18.54 tons/hectare/year. Therefore, total land area needed is 551,760 hectare/year. Since acacia has plant rotation of 5 years, therefore the land area will be 2,758,799 hectares. However, only 71% area can be used, therefore concession land needed for acacia is 3,885,632 hectares.

Similar calculation method is used for other five scenarios. As a result, total area for red calliandra is 1,988,984 hectares with concession area of 2,801,385 hectares, total areal plantation for gamal is 5,524,954 hectares with concession area of 7,781,626 hectares. Total areal plantation for eucaliptus pelita is 2,646,896 hectares with concession area of 3,728,023 hectares, and Turi plantation area is 2,209,982 hectares with concession area 3,112,650 hectares. Meanwhile total areal plantation of lamtoro gung is 1,657,486 hectares with concession area 2,334,488 hectares.

The large area of concession needed for HTE raise concern on the opening of natural forest or deforestation. The concern raised is reflected from the current management of industrial timber plantation. Counting deforestation potential, researcher refer to Map Biomas Indonesia's Collection 1.0 annual land cover for 2000-2019, accessed in June 18th 2022. According to Map Biomas, 38% of Industrial Forest total coverage or 1,330,236 from total 3,500,622 hectares in 2019 came from deforestation. This percentage became the basis for researcher to estimate the quantity of forest to be converted to HTE (energy wood plantation). The need of plantation area with rotation of 2,758,799 hectares, has potential of deforestation of 1,048,344 hectares.

The potential of deforestation for Red Calliandra HTE is 755,814 hectares. Gamal, with the largest area of plantation will have the highest potential of deforestation of 2,099,843 hectares. Meanwhile potential deforestation for eucalyptus pelita is 1,005,820 hectares, turi is 839,793 hectares, and the lowest is lamtoro gung; 629,845 hectares.

Deforestation has direct impact on the loss of large carbon stock in natural forest. Energy timber plantation (HTE) plants is indeed capable to absorb carbon, however carbon stock contained on built energy wood plantation (HTE) is not equal to natural forest carbon stock loss due to emission. Trend Asia analysis result shows even though total carbon stock of all energy timber plantation (HTE) that support *co-firing* in 52 Coal fired power plant locations is considered, net emission production remain positive. This means that the loss of carbon stock from natural forest cannot be compensated by total energy timber plantation (HTE) development.

Natural forest itself consist of seven classes with different emission factor values. Primary dry forest has the highest Emission Factor of 375.70 tonnes per hectare (ton/ha), followed by primary mangrove forest (309.62 ton/ha), and primary swamp forest (303.53). There are Secondary dry land forest (263.29), secondary swamp forest (249.62), secondary mangrove forest (131.59), and the lowest is timber plantation (100.4). These emission factor

values are referred to second document *"National Forest Reference Level for Deforestation, Forest Degradation and Enhancement of Forest Carbon Stock, 2022"*.

Percentage of potential deforestation in each natural forest type on HTI concession in these resources comes from 2020 data taken and processed from Web GIS of Ministry of Environment and Forestry. This number must be shift to proportional percentage to gain deforestation potential percentage in primary dry forest 10.70%; secondary dry forest 54.11%; primary swamp forest 1.81%; secondary swamp forest 32.27 %; primary mangrove forest 0.17%; and secondary mangrove forest 0.95%.

Multiplying that percentage with deforestation potential of certain HTE plant, researcher will have result on deforestation potential for each type of natural forest. For example, deforestation of primary dry forest acacia HTE is 10.7% from total acacia deforestation potential of 1.048.344 hectares, it will be 112.173 hectares. Equally for other five types of natural forest, we need to change only the percentage. The same calculation way is applied to the scenario of calliandra, gamal, eucalyptus pelita, turi and lamtoro gung.

The next phase is counting emission stock in each natural forest. By multiplying certain natural forest deforestation potential with factor mission values, carbon fraction values and conversion factor from carbon-to-carbon dioxide equivalent (CO_2e). The assumption used is carbon fraction assumed 47% and conversion factor to CO_2e is 3.67. The calculation of emission stock in each natural forest also use formula in second document *"National Forest Reference Level for Deforestation, Forest Degradation and Enhancement of Forest Carbon Stock"* (Rusolono, 2022).

After result, emission stock of each natural forest is added to get total of emission of natural forest stock of HTE. As the result, total of natural forest emission stock of gamal HTE is the highest with, 979,547,647 tonnes CO_2e. The next place is acacia with emission stock of 489,121,661 tonnes CO_2e, followed by total of emission of natural forest stock of eucalyptus pelita HTE is 469,281,849 tonnes CO_2e. total of emission of natural forest stock of Turi HTE is 391,819,059 tonnes CO_2e, total of emission of natural forest stock red calliandra is 352,657,153 tonnes CO_2e and total of emission of natural forest stock HTE lamtoro gung is 293,864,294 tonnes CO_2e.

To calculate emission stock after deforestation that is absorbed by HTE, researcher multiply HTE plant deforestation potential with timber plantation emission factor (EFj) of 100.4 carbon fraction value and conversion factor of carbon to CO_2e. the result of emission stock absorbed by acacia HTE is 181,552,089 tonnes CO_2e, Calliandra HTE 130,891,794 tonnes CO_2e, gamal HTE 363.588.316 ton CO_2e, eucalyptus HTE 174.187.951 tonnes CO_2e Turi HTE 145,435,327 tonnes CO_2e, and the lowest is lamtoro gung HTE 109,076,495 tonnes CO_2e.

The calculation of net emission from deforestation came from difference between of total natural forest emission stock and emission stock after deforestation which absorbed by certain energy timber plantation (HTE). In fact, for all those scenarios of energy timber plantation species, there is net emission of deforestation; Acacia timber plantation as much as

Emission Stock in Each Type of Forest with 10% *Co-firing* (ton CO_2e)

Type of Forest	Primary Dryland Forest	Secondary Dryland Forest	Primary Swamp Forest	Secondary Swamp Forest	Primary Mangrove Forest	Secondary Mangrove Forest	TOTAL
Acacia	72.692.986	257.619.917	9.934.539	145.661.870	951.799	2.260.550	**489.121.661**
Calliandra Calothyrsus	52.408.735	185.733.655	7.162.405	105.016.382	686.209	1.629.766	**352.637.153**
Gamal (Gliricidia Sepium)	145.579.820	515.926.820	19.895.571	291.712.172	1.906.137	4.527.127	**979.547.647**
Eucalyptus Pellita F. Mel	69.744.404	247.170.306	9.531.573	139.753.516	913.192	2.168.857	**469.281.849**
Turi	58.231.928	206.370.728	7.958.228	116.684.869	762.455	1.810.851	**391.819.059**
Vegetable Hummingbird (Lamtoro)	43.673.946	154.778.046	5.968.671	87.513.652	571.841	1.358.138	**293.864.294**

7,510 tons of coal load of MMN 2 Tanjung Pinang barge caught fire close to Java 9 and 10 steam power plants in the coast Salira Village, sub distric Puloampel, Serang district, Banten, Wednesday (21/8/2019).
Photo: Melvinas Priananda/Trend Asia.

307.569.572 tonnes CO_2e, Red Calliandra timber plantation 221.745.359 tonnes CO_2e, Gamal is the highest 615.959.330 tonnes CO_2e, Eucalyptus Pelita 295.093.898 tonnes CO_2e, Turi 246.383.732 tonnes CO_2e, and the lowest is Lamtoro gung 184.787.799 tonnes CO_2e.

Next, researcher calculate emission stock of total energy timber plantation (HTE). Total need of plantation area with rotation is multiplying with emission factor timber plantation, carbon fraction values and conversion factor with carbon to CO_2e. The value result is emission of energy timber plantation stock of total acacia timber plantation 477,768,654 tonnes CO_2e, red calliandra 344,452,089 tonnes CO_2e, gamal 956,811,359 tonnes CO_2e, eucalyptus pelita 458,389,345 tonnes CO_2e, turi 382,724,543 tonnes CO_2e, and lamtoro gung 287,043,408 tonnes CO_2e.

Finally, researcher count net emission from deforestation after subtracted by Energy timber Plantation (HTE) total stock, difference between total of natural forest emission stock with the total emission stock of energy plantation. The result of deforestation net emission after it subtracted by total emission stock for acacia, 11,353,007 tonnes CO_2e, red calliandra 8,185,064 tonnes CO_2e, gamal 22,736,288 tonnes CO_2e, eukaliptus pelita 10,892,505 tonnes CO_2e, turi 9,094,515 tonnes CO_2e, and lamtoro gung 6,820,886 tonnes CO_2e.

This is an undeniable proof that timber biomass is not carbon neutral as assumed by its supporters. Energy

Co-firing 10%	Stock of Emissions after Deforestation absorbed by HTE (tonnes CO_2e)	Net Emissions from Deforestation (tonnes CO_2e)	HTE Total Emission Stock (tonnes CO_2e)	Net Deforestation Emissions After Deducting Total HTE Stock (tonnes CO_2e)
Acacia	181.552.089	307.569.572	477.768.654	11.353.007
Calliandra Calothyrsus	130.891.794	221.745.359	344.452.089	8.185.064
Gamal	363.588.316	615.959.330	956.811.359	22.736.288
Eucalyptus Pellita	174.187.951	295.093.898	458.389.345	10.892.505
Turi	145.435.327	246.383.732	382.724.543	9.094.515
Lamtoro	109.076.495	184.787.799	287.043.408	6.820.886

timber Plantation (HTE) total emission stock is not capable to compensate lost natural forest emission stock when deforestation happen. The finding of Trend Asia is similar with Chatham House report, an established think tank institution from England entitled *Woody Biomass for Power and Heat: Impacts on the Global Climate* published in 2017. This report conclude that forest wood biomass tends to increase carbon pollution rather than reduce emission.

According to report written by Duncan Brack et. al., the harvest of all trees for energy will increase clean carbon emission substantially compared to fossil fuel. This is due to the loss of carbon absorption on the future of growing trees especially mature tree in old forest, that can have very high carbon absorption and the loss of soil carbon.

Chatham House (Royal Institute of International Affairs), in its report, also stated that wood biomass has lower energy contain compared to fossil fuel. Moreover, the water level in wood biomass is higher, which cause firing for energy produce more carbon

per unit energy than coal and fossil gas. Therefore, this report states that firing biomass is not climate solution, but make the climate change worse.

Beside emission from deforestation, Trend Asia research also count the emission for Energy Wood Plantation (HTE) management and wood pellet production. It is referred to Iswanto's research from Tropical silviculture magister study, faculty of forestry and environment, Bogor Agricultural Institute. Iswanto et. al. studied life cycle values of wood pellet production in PT Korintiga Hutani Central Borneo that produce total emission of 678.03-kilogram CO_2e. This value is multiplying with plantation area with timber plantation (HTE) rotation and divided by 1.000.

Meanwhile production of wood pellet in PT Korintiga Hutani, produce emission of 0.11-kilogram CO_2e per 100 tonnes produced wood pellet. This emission come from diesel fuel to transport wood and wood pellet as well as for power generation to make wood pellet. Therefore, emission in wood pellet production only count needed wood pellet in 107 Coal fired power plants multiplied by 0.11 and divided by 1,000 so for 10% *co-firing*, yields wood pellet production emission of 1.125 tonnes CO_2e.

Total *co-firing* biomass emission of 107 Coal fired power plant units from upstream to downstream, start from deforestation to wood pellet production is 13,224,680 tonnes CO_2e for acacia timber plantation, 9,534,770 tonnes CO_2e for red calliandra timber plantation, gamal timber plantation 26,483,498 tonnes CO_2e, eucalyptus pelita timber plantation 12,688,305 tonnes CO_2e, turi timber plantation 10,594,074 tonnes CO_2e, and lamtoro gung timber plantation 7,945,837 tonnes CO_2e. The total emission of *co-firing* 10 percent biomass with coal is around 7,9 to 26,5 million tonnes CO_2e per year. This emission score is quite high.

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52 Steam Power Stations *Co-firing* Target	Acacia	Calliandra Calothyrsus	Gamal	Eucalyptus Pellita	Turi	Lamtoro
Potential Emissions from HTE Management (tonnes CO_2e)	1,870,548	1,348,591	3,746,085	1,794,675	1,498,434	1,123,825
Total Emissions (tonnes CO_2e)	13,224,680	9,534,779	26,483,498	12,688,305	10,594,074	7,945,837

Conclusion

PLN claim on wood pellet biomass *co-firing* as proper solution to reduce greenhouse emission and energy transition is not proven.

Mathematical calculations conducted by Trend Asia found that carbon emissions are generated from upstream to downstream. The emission from energy timber plantation development with deforestation to wood pellet *co-firing* in Coal fired power plant are higher than emission stock that can be produce by all energy timber plantation.

Carbon dioxide that is released to atmosphere cannot be automatically absorbed by newly planted energy timber plantation.

Chatham House report from England in 2017 also refused argument to support forest (wood based) biomass as carbon neutral. In contrary, that research stated that forest biomass firing creates "carbon debt' or carbon excess in the atmosphere. Carbon debt duration can last for few years and even decades, depend on biomass material.

Meanwhile, carbon emission from forest biomass firing has consequence for climate immediately, carbon emission impact includes melting glacier, sea level increase, agriculture system disturbance, and human health effect. Carbon contains in atmosphere is already in critical condition. Based on the measurement by ocean and atmosphere office USA in May 2022, the contain reach 420 part per one million part (ppm). If it is not limited, the contain of CO2 in atmosphere will reach 500 ppm, or 3˚ Celsius global temperature increase. (Kompas, 2022).

The result of calculation of Trend Asia only assumes utilization of wood pellet from acacia as 10% coal substitute in 107-unit Coal fired power plants producing about 13.22 million tonnes CO_2e annually. Using wood pellet from gamal trees, will cause higher total emission; 26.48 million tonnes CO_2e per year. High greenhouse gas emission contribution from wood biomass is claimed as renewable energy sources. Moreover, if that emission is added to coal emission in projection of RUPTL PT PLN year 2021-2030. It will continue to increase to 298.9 million tonnes CO_2e in 2030.

The co firing of biomass and coal does not reduce coal utilization of coal in Coal fired power plants. The need for coal will continue to increase in year to year because Coal fired power plant is still dominant in national energy mix until 2030 (CNBC, 2022). According to RUPTL PT PLN 2021-2030, projection of the need of coal will continue to increase from 111 million tonnes in 2021 to 153 million tonnes in 2030. Biomass, glorified as coal substitute turns out to be complementary fuel for Coal fired power plant.

If policies related to *co-firing* of biomass with coal is mitigation action to resolve climate change, instead of reducing carbon emission in energy sector, in contrary it will add carbon emission in forestry sector. Meanwhile *co-firing* is only be used to extend Coal fired power plant operational age that should be ended.

The seriousness of government on energy transition must clearly consider clean and just energy resources.

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Farmer activity with background of chimney of Indramayu I steam power plant, Mekasari village Indramayu, tuesday (August, 16th 2022). This power plant had worsened farmer's and krill shrimp fisherman harvest. This power plant is included in biomass *co-firing* program.
Photo Bukbisj Chandra Ismeth. Trend Asia.

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BATTLE ON EMISSION REDUCTION CLAIMS

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