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Why Investments in Ammonia Co-firing to Coal Power are not Consistent with the 1.5°C Climate Goal

Kae Takase Senior, Coordinator, Renewable Energy Institute

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Many of Japan's major banks, life insurance companies, and major asset management companies have joined an international initiative and pledged to take investment and lending actions consistent with limiting the global temperature increase from pre-industrial level to within 1.5°C. In addition to the net-zero goal as of 2050, financial institutions that are members of these initiatives are also required to set and meet medium-term targets.

Japan has declared its goal of becoming carbon neutral by 2050. On the other hand, the IPCC Sixth Assessment Report states that to limit the temperature increase from pre-industrial times to within 1.5°C with a probability greater than 50%, we need to reduce greenhouse gas emissions by 60% and CO_2 by 65% from 2019 levels by 2035. In other words, to achieve the 1.5°C goal, net-zero emissions by 2050 will not be sufficient, and significant reductions must be made earlier [1] .

Is the policy of co-firing ammonia with existing coal-fired power, which has been increasingly criticized internationally, consistent with the 1.5°C with respect to the 65% reduction in CO_2 emissions by 2035 indicated in the IPCC Sixth Assessment Report? The answer is clear, “NO”.

The reason why the policy of ammonia co-firing with coal-fired power is not consistent with 1.5°C is:

> The International Energy Agency's Net Zero scenario indicates that developed countries should phase out unabated coal-fired power generation by 2030; the IPCC's Sixth Assessment Report states that 90% decarbonization is the standard for abated coal-fired power generation. In other words, 20% co-firing of ammonia by 2030 is not sufficient.

The International Energy Agency's net zero by 2050 scenario [2] indicates that "unabated" coal-fired power generation in developed countries should be phased out by 2030. The IPCC Sixth Assessment Report clearly states that "abated" refers to capturing 90% or more CO_2 from power plants [3] . In the draft fossil fuel policy for the financial sector of the Science Based initiative (SBTi) also adopts "90% or higher" for its definition of "abated" coal fired power [4] .

The current Strategic Energy Plan targets only 20% co-firing of ammonia in coal-fired power plants by 2030 [5] . This is far short of the "abated" target of 90% CO_2 reduction in generation phase. Theoretically, in addition to ammonia co-firing, thermal power plants could install carbon capture and storage (CCS) systems to reduce emissions. However, the government's CCS target is to capture and store 6-12 million tons by 2030. 1 GW class coal-fired power plants emit around 5 million tons of CO_2, and there are over 50 GW capacity of coal-fired power plants in Japan. Efforts to reach the target of capturing 6-12 million tons per year have just begun, and this should includes not only thermal power generation, but also capture in various sectors such as steel, oil refining, and chemical plants. Even if the government's CCS targets are met, the contribution of reduce emissions from coal-fired power plants will be very limited.

For the target of completely phasing out "unabated" coal-fired power by 2030, neither ammonia co-firing nor CCS will be effective at all. The rational conclusion is that all existing coal-fired power plants will have to be phased out by 2030.

Figure 1 visually shows that even with 20% ammonia co-firing in coal-fired power plants, the international standard of over 90% reduction in power generation phase is not met at all; even 50% is clearly not enough. The following emission intensities from the IEA report [6] were used for the data.

- Coal combustion emissions (generation phase): 115 gCO_2-eq/MJ(LHV)
- Coal upstream emissions (production phase, median): 8.0 gCO_2-eq/MJ (LHV)
- Ammonia from natural gas emissions (production phase): 112g-CO_2 -eq/MJ(LHV)
- Ammonia from solar PV (production phase): 13gCO_2-eq/MJ(LHV)

Based on these emission intensities, the lifecycle CO_2 emissions of "coal only"-fired power or ammonia co-firing with coal were calculated for cases 1 to 7. In order to achieve the same lifecycle CO_2 emissions as in Case 2, which is described as "capturing 90% or more CO_2 from power plants" in the IPCC Sixth Assessment Report, the following conditions are required: a) When 95% or more CCS is added to ammonia produced from natural gas, the required ammonia co-firing ratio must be 88% or more (Case 6), and b) if ammonia is produced using electricity from photovoltaic power generation, the required ammonia co-firing ratio should be 93% or higher (Case 7). Only when such a high capture rate of CCS or low emission intensity in the production process, and a high co-firing ratio of more than 90% were achieved simultaneously, then it can be considered "abated". In such cases, it is hard to see the cost effectiveness of going to the trouble of co-firing.

The following section provide details of the seven cases shown in Figure 1. Again, based on the international standards or common sense presented in the IPCC Sixth Assessment Report, only cases 2, 6, and 7 are considered as "abated".

(Case 1) Lifecycle CO_2 emissions intensity per heat value when 100% coal is combusted.

(Case 2) Life cycle CO_2 emission intensity per heat value when 100% coal is combusted and 90% of CO_2 emissions during combustion for power generation are captured and stored permanently by CCS.

(Case 3) Life cycle CO_2 emission intensity per heat value when 80% coal and 20% ammonia are co-fired, but ammonia is produced from natural gas and not captured by CCS.

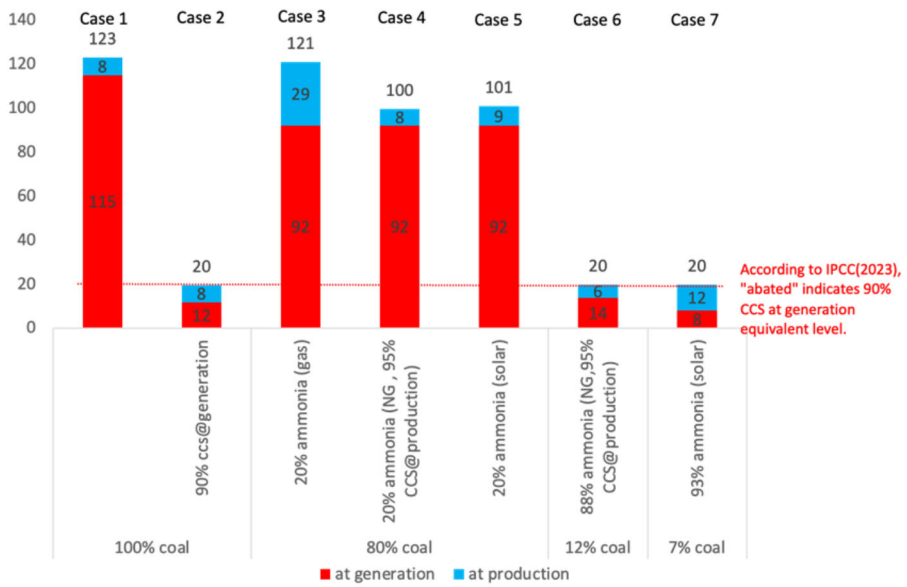
(Case 4) Life cycle CO_2 emission intensity per heat value when 80% coal and 20% ammonia are co-fired, but ammonia is produced from natural gas and 95% is captured and stored permanently by CCS.

(Case 5) Life cycle CO_2 emission intensity per heat value when 80% coal and 20% ammonia are co-fired, but ammonia is produced by electricity from solar PV power.

(Case 6) Life cycle CO_2 emissions intensity per heat value when 12% coal and 88% ammonia are co-fired, but ammonia is produced from natural gas and 95% is captured and stored permanently by CCS. (Coal ratio is caluculated to achieve "abated" level, Case 2.)

(Case 7) Life cycle CO_2 emission intensity per heat value when 7% of coal 93% of ammonia is co-fired, but ammonia is produced by electricity from solar PV. (Coal ratio is calculated to achieve "abated" level, Case 2.)

Figure 1. Comparison of lifecycle emissions from coal-fired power plants and various type of co-firing with various ammonia (unit: gCO_2-eq/MJ(LHV)) [7]



Source: Calculated by Renewable Energy institute using data from IEA(International Energy Agency), " The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector"(p.51)

PROPOSAL: USE GX (GREEN TRANSFORMATION)BOND FOR THE DOMESTIC MANAGED COAL PHASEOUT

Instead of extending the life of coal-fired power plants through co-firing, why not facilitate and fund a managed phaseout? The Glasgow Financial Alliance for Net Zero (GFANZ), which includes many international initiatives by financial institutions, has also set standards so called "managed coal phaseout" as a mainstream way to fund just transition [8], [9]. In the draft criteria for revising Science-Based Targets initiative (SBTi) for financial institutions, it is also proposed that the fossil fuel sector can be excluded from the conventional targets by engaging the fossil fuel sector to "transition" to business model in line with 1.5°C with funds in place [10]. Of course, as SBT for financial

institutions, based on IEA's Net Zero by 2050 scenario, it is a requirement that all "unabated" coal-fired power plants should be engaged to be phaseout by 2030 in middle-and high-income countries and by 2040 in all other countries, where the definition of "abated" is to emit less than 90% of their life cycle CO_2 emissions.

Ammonia co-firing in coal-fired power plants is clearly not consistent with the G7's 1.5°C pathway to decarbonize power sector fully or predominantly by 2035. Rather than investing vast sums of money in high-cost [11] and highly uncertain technologies to forcibly prolong the life of the coal-fired power plants, a realistic path forward would be to introduce a managed phaseout approach to the GX(Green Transformation) Economic Transition Bonds. In this way, financial institutions can contribute squarely to net zero without hurting the operations of companies that currently own coal-fired power, and decarbonization of Japan will greatly progress.

Japan has enormous potential for renewable energy, including offshore wind power [12] . The Renewable Energy Institute has quantitatively drawn a scenario with power sector with 80% renewables ratio by 2035 [13] . Much of the offshore wind potential is in the Hokkaido and Tohoku regions, and 80% in 2035 would certainly require more faster and larger grid enhancement among other flexibility measures, when current national plan only see 50-60% of renewable power ratio by 2050 [14] . It is necessary to set a more ambitious 2035 target as soon as possible, not expecting too much for expensive, uncertain, future dream technologies such as ammonia co-firing and major CCS, which will continue Japan's dependency on abroad. We need to revise our load map with costly, highly uncertain future, and plan for investment as soon as possible. This is where the GX Economic Transition Bonds could come into play.

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1 The revised Net Zero Roadmap report published by the International Energy Agency (IEA) in September 2023 states that in order to achieve "net zero (emissions)" to limit temperature increase to 1.5°C, greenhouse gas emissions in 2035 must be 80% lower than in 2022 for developed countries and 60% lower for emerging and developing countries. In particular, developed countries are required to reduce emissions from the power sector. (IEA, "Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach") (IEA,"Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach")

2 IEA, "Net Zero by 2050" (May 2021)

3 Climate Change 2023 Synthesis Report by IPCC includes sentences on p.92 (Section 4 'Near-Term Responses in a Changing Climate'), that" In this context, 'unabated fossil fuels' refers to fossil fuels produced and used without interventions that substantially reduce the amount of GHG emitted throughout the life cycle; for example, capturing 90% or more CO_2 from power plants, or 50 to 80% of fugitive methane emissions from energy supply."

4 According to the "Deep Dive Webinar on Fossil Fuel Finance Position Paper Consultation Draft" webinar material (p.18) held by SBTi in July 2023, the definition of "abatement" clearly states that direct and indirect emissions are reduced by 90% or more.

5 JERA Co., Inc. aims to achieve more than 50% co-firing by the mid-2030s (source: JERA website, in Japanese), but even with more than 50% co-firing, a 90% reduction will not be reached.

6 International Energy Agency(IEA), "The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector" (October 2021)

7 Note that the CO_2 emissions during fuel production phase is included in the calculation. For example, in case 3, a. CO_2 emissions during power generation (115*80%) and b. CO_2 emissions during fuel production (112*20% for ammonia and 8*80% for coal) are added together.

8 GFANZ, "The Managed Phaseout of High-emitting Assets" (June, 2022)

9 Asia-Pacific Network of the Glasgow Financial Alliance for Net Zero, "Financing the Managed Phaseout of Coal-Fired Power Plants in Asia Pacific" (June 2023)

10 SBTi, "The SBTi Fossil Fuel Finance Position Paper, consultation draft" (June, 2023)

11 BloombergNEF, "Japan's Ammonia-Coal Co-Firing Strategy a Costly Approach to Decarbonization, Renewables Present More" (September 2022). This report shows that, when compared as a decarbonization method, thermal power generation that burns 100% ammonia produced with sufficient CCS attached is expected to be more than twice as expensive as solar power generation with storage batteries, even in 2030.

12 Renewable Energy Institute, "Proposal for faster deployment of floating offshore wind" (in Japanese) (November 2023) . The report estimates the maximum potential of floating offshore wind power at 952 GW, and proposes 10 promising offshore areas from the viewpoint of availability of transmission lines and substations, ports, and business feasibility, as well as proposing a fast track for commercial-scale floating offshore wind power.

13 Renewable Energy Institute,"Proposal for the 2035 Energy Mix (First Edition) Toward Decarbonizing Electricity with Renewable Energy" (April 2023)

14 Renewable Energy Institute, "Cost benefit analysis for grid enhancement" (in Japanese) (April 2023)