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CHALLENGING JAPAN'S PROMOTION OF AMMONIA CO-FIRING FOR COAL POWER GENERATION

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The Japanese government and industry are championing co-firing of ammonia in coal-fired power plants as a supposed climate mitigation solution. This approach promotes uncertain future technology options with limited feasibility, while delaying the clear-cut policy actions required now to phase out coal power plants. Ammonia co-firing in coal plants is inconsistent with pathways to keep global temperature rise below 1.5 °C, and risks undermining the clean energy transition in Japan and Southeast Asian countries.

This briefing gives an overview of the detrimental climate and economic impacts of co-firing ammonia with coal for electricity generation. It identifies the arguments used by pro-coal interests to promote the technology and provides recommendations for robust response.

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Summary

> Co-firing of ammonia in coal-fired power plants has **limited emissions reductions potential, cost competitiveness and technical feasibility**. It is highly unlikely to be deployable at sufficient scale, speed, cost, and carbon intensity to contribute materially to the decarbonisation of the power sector and limiting emissions in line with the goals of the Paris Agreement. Its active promotion by Japan **risks delaying deployment of existing commercialised and scalable zero-emissions options, including wind and solar**.

> Ammonia co-firing is **unlikely to contribute to Japan's key objective of improving its energy self-sufficiency** by reducing its heavy reliance on imported fossil fuels for power generation. Due to the high price of domestic ammonia production, Japan would still need to depend heavily on imports.

> Japan's promotion of ammonia co-firing risks delaying **increased deployment of renewables and the necessary phase-out of coal power generation.** Instead, it focuses attention on incremental emission reductions that allow incumbent private sector stakeholders to continue operating existing coal power plants, while seeking to maintain markets for legacy technology exports and service contracts.

> The focus on ammonia co-firing is **the latest stage of Japan's long-term promotion of so-called "clean coal"** technologies. This approach has repeatedly pursued pilot scale projects for technologies that will at best offer incremental reductions in emissions. These projects serve as a delaying tactic by proclaiming a potential alternative technology future instead of pursuing stringent policy requirements to reduce emissions in line with the Paris Agreement goal of limiting warming to 1.5 °C.

> Promotion of ammonia co-firing **risks extending the operational lifetime of coal plants and increasing their life cycle emissions** in Japan and Asia, especially in the absence of firm policies to impose emission reductions or close coal plants.

Headline recommendations

> **Ammonia co-firing should not be considered an effective emission abatement technology**. Definitions of abatement[1] should be maintained as interventions that substantially reduce the amount of greenhouse gas emissions emitted throughout the life cycle, such as carbon capture and storage (CCS) capturing 90% or more CO_2 emissions from power plants, as defined by the IPCC.[2]

> Given the limitations and risks of pursuing the approach, **governments should act early to rule out ammonia use in co-firing** with coal.

> If countries still pursue the approach despite its risks, strong regulatory frameworks are necessary to ensure any potential consideration of ammonia for co-firing includes an **assessment of the lifetime emissions from coal power plants and the life cycle emissions of ammonia production** from different feedstocks, as well as its transport and storage, and that these are aligned with the Paris Agreement goal of limiting warming to 1.5 °C.

> **Co-firing should be excluded from the scope of multilateral financing tools for the power sector**. Safeguards must be put in place to ensure any co-firing retrofits do not lengthen the operational lifetime of the targeted power plant or expand its life cycle emissions.

> Due to the high costs of producing green ammonia, its **use should be strategically prioritised for those sectors where it can have the greatest climate benefit**. The promotion of ammonia for co-firing creates further pressure on the ammonia supply chain and risks slowing down emissions reduction in other sectors.

> To ensure that any production and utilisation of ammonia is aligned with 1.5 °C goals, governments and international institutions should instead **work to establish robust standards, including:**

- Focusing international cooperation around green ammonia on sectors where it can provide greater proven climate benefit than in co-firing, such as to decarbonise fertiliser production and hard-to-abate sectors.
- Ensuring that robust carbon intensity standards are created for ammonia production and supply chains, incorporating full life cycle emissions.

[1] E3G, 2021, **Explained: what does 'unabated coal' mean?**

[2] IPCC, 2023, **Synthesis Report of the IPCC Sixth Assessment Report (AR6)**

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Japan's co-firing promotion: domestic context

> The **Japanese government promotes ammonia as a fuel for "zero-emission thermal power"** and a route to carbon neutrality. It subsidises technology development by domestic utilities and power plant manufacturers, many of whom have then included co-firing in their decarbonisation strategies. This has been met with **criticism from local civil society organisations and research institutions**.[3]

> Japan has long promoted **"clean coal"** technologies, such as IGCC (integrated coal gasification combined cycle), CCUS (carbon capture, use, and storage) and USC (ultra-supercritical) coal power technology. Out of these, only USC power plant technology is in wide use today. These "high efficiency" power plants emit 15–30% less CO_2 per kWh generated than a subcritical coal power plant.[4] The Japanese government and industry emphasise the supposed benefits of this increased efficiency improvement, but do not consider the lifetime emissions of CO_2 from coal power plants – the ultimate metric that matters for climate impact.

> These **technologies have not realised Japan's goals of reducing emissions from power generation**. Instead, Japan's national greenhouse gas inventories have attributed most of its emission reductions in the power sector to the deployment of renewables and nuclear power, and reduced power demand by improved energy conservation.[5]

> Coal plays a key role in Japan's **energy security policy**. Japan relies on imported fuels for 84.8% of its energy needs[6] and considers coal as having the least geopolitical risk. This belief perpetuates (despite the consequences of Russia's invasion of Ukraine for coal supply chains) and has not significantly shifted towards the need for greater domestic power generation. However, **ammonia co-firing is unlikely to support Japan's energy self-sufficiency**. Due to the **high price of domestic ammonia production**, Japan would need to depend heavily on imports, which presents energy security risks in volatile international markets.[7]

[3] Kiko Network, 2021, **Hydrogen and ammonia co-firing in the power sector: Japan is choosing to expand fossil-fuel extraction and perpetuate coal and LNG**

[4] IEA, 2020, **The role of CCUS in low-carbon power systems**.

[5] National Institute for Environmental Studies, Japan, 2022, **Japan's National Greenhouse Gas Emissions in Fiscal Year 2020 (Final Figures)**

[6] METI, 2022, **2021 – Understanding the current energy situation in Japan (Part 1)**

[7] BloombergNEF, 2022, **Japan's Costly Ammonia Coal Co-Firing Strategy**

- There is a pervading view in parts of Japan's leadership that the country has limited potential for renewables and thus will continue to need fossil fuels. However, several well-grounded studies show **Japan can replace coal with cleaner solutions** by 2030 or 2035. Notably, a recent study from Lawrence Berkeley National Laboratory demonstrates Japan can achieve **90% clean power in 2035 by focusing on renewables and nuclear** while phasing out coal.[8]

- Japan's recent **Green Transformation (GX)** Basic Policy statements on ammonia co-firing **do not currently set out regulatory frameworks** that define which ammonia feedstock will be used or how life cycle emissions will be assessed. Nor is there consideration of how ammonia co-firing will reduce emissions in line with Japan's commitment, through the G7, to achieve "a fully or predominantly decarbonised power sector by 2035", or its own net zero emissions target for 2050. It would be necessary for Japan to establish strong regulations to manage life cycle emissions of ammonia in the power sector in order to ensure climate benefits.

Japan's 2023 G7 Presidency: promotion of ammonia co-firing met with pushback from G6 governments

Japan has promoted ammonia co-firing through its G7 Presidency including seeking text in support of ammonia and hydrogen in the G7 Climate, Energy and Environment Ministers' Communiqué. During the negotiation of the text other G6 governments pushed back on this pro-ammonia promotion, particularly the UK, Canada and France.[9,10] Ultimately, this resulted in explicit caveats and restrictions regarding the potential use of ammonia in the final communiqué.

The discussion of ammonia in the communiqué starts by stating that hydrogen and ammonia should be used where "impactful as effective emission reduction tools to advance decarbonization across sectors and industries, **notably in hard-to-abate sectors in industry and transportation**." The other members of the G7 included this example to underline that they do not see ammonia co-firing as an effective use.

[8] Shiraishi, Park, Abhyankar, Paliwal, Khanna, Morotomi, Lin, Phadke, 2023, **The 2035 Japan Report: Plummeting Costs of Solar, Wind, and Batteries Can Accelerate Japan's Clean and Independent Electricity Future**

[9] Nikkei Asia, **Japan's Coal Tech for Asia Questioned by U.K. and Canada**, 2023

[10] Reuters, **G7 Ministers to Offer Cautious Backing of Japan's Climate Strategy**, 2023

The communiqué then states that countries exploring the use of "hydrogen and its derivatives" (which includes ammonia) to achieve "zero-emission thermal power generation" will only do so if "this can be aligned with a 1.5°C pathway" and the G7's "collective goal for a fully or predominantly decarbonized power sector by 2035".[11] **This places stringent requirements on any potential use of ammonia for co-firing with coal by Japan, as a member of the G7.**

Additionally, the communiqué reaffirms "the importance of developing international standards and certification including for a GHG calculation methodology for hydrogen production."

Despite these conditionalities, Japan's post-Ministerial press releases have framed the reference to ammonia for the power sector as a win for their promotion of the approach.[12,13]

The discussion of ammonia co-firing in the G7 negotiations highlights how strongly Japan is seeking to promote it as a supposed decarbonisation option, and that other governments needed to be proactive in pushing back against its misuse as a delaying tactic. Similar efforts will likely be required in other diplomatic forums.

Japan's co-firing promotion: shaping Asia's decarbonisation pathway through equipment exports

> Internationally, **Japan is actively promoting ammonia co-firing as a decarbonisation strategy for Asian countries**. It argues that the region has a large and young fleet of coal power plants that will continue to be required for reliable baseload power,[14] given perceived limitations in renewables potential and poor grid connections. However, International Renewable Energy Agency (IRENA) modelling shows that Southeast Asia has vast

[11] G7, **G7 Climate, Energy and Environment Ministers' Communiqué,** 2023

[12] Sankei Shimbun, 2023, **Coal-fired power generation, G7 adopt joint statement without specifying when to end**, 2023 (In Japanese)

[13] DW, 2023, **G7 Ministers Pledge to Speed Up Clean Energy Transition**

[14] Nikkei GX, **Interview with Chairman of the Federation of Electric Power Companies**, 2023. Note: the Chairman stated that "*Considering that we are a member of Asia, fossil fuel-based thermal power, including coal, is highly important.*"

renewable resources and that, with significantly upscaled investment and policy,[15] a majority renewables-based power system is feasible.

> Japan is supporting its industry to shape power sector decarbonisation in Asia. Through its **Asia Energy Transition Initiative (AETI)**, the government has committed 2 trillion yen ($15.2bn) to develop and export new energy technologies, including for ammonia co-firing.[16] Many public and private MoUs have been signed to study and implement ammonia co-firing in countries such as Bangladesh, Indonesia, Thailand, Viet Nam, the Philippines, Laos, Malaysia, and India. A few projects have also been started outside Asia, such as Morocco and Chile. **Japan's promotion of ammonia co-firing in Southeast Asia risks increasing fossil fuel lock-in in the region.**

> The **promotion of co-firing benefits Japanese industry interests**, such as those of boiler manufacturers Mitsubishi Heavy Industries (MHI) and IHI, by **creating a market for their co-firing equipment** and justifying the lifetime extension of existing coal power plants which use their technologies, thereby resulting in continued contracts for servicing and maintenance.

> Japan uses high-level diplomatic engagement to promote its co-firing strategy. In March 2023, Prime Minisher Kishida's **Asia Zero Emissions Community (AZEC)** initiative convened ASEAN (minus Myanmar) and Australian ministers, who released a joint statement that "hydrogen and ammonia can play a significant role in decarbonising thermal power generation", and announced 28 new MoUs between Japanese and Southeast Asian businesses on technology development, including for ammonia.[17,18]

> The promotion of co-firing aims to facilitate Japanese industry leadership in "new" technology markets, as an alternative to the renewables market where Japan has so far not established itself as a major force.[19] However, **Japan has a major opportunity to become a global leader in renewables deployment**. The Global Wind Energy Council expects the country to become

[15] IRENA & ACE, 2022, **Renewable energy outlook for ASEAN: Towards a regional energy transition** (2nd ed.), International Renewable, Energy Agency, Abu Dhabi; and ASEAN Centre for Energy, Jakarta

[16] METI, 2021, **Minister Kajiyama announced the Asia Energy Transition Initiative (AETI**)

[17] METI, 2023, **Asia Zero Emission Community Joint Statement**, 4 March 2023

[18] METI, 2023, **List of MOUs (AZEC Public Private Investment Forum)**

[19] Recent announcements show the Japanese private sector is not only looking to export expertise and equipment on the co-firing process itself, but also on the wider ammonia supply chain, including shipping, storage and production. See Mitsui O.S.K. Lines, 2023, **MOL Concludes MoU on Building Clean Hydrogen/Ammonia Value Chain in Thailand** and Splash 247, 2023, **Mitsubishi Joins the Japanese Rush to Develop Ammonia Bunker Vessels** for examples

one of the world's top markets for floating offshore wind,[20] and Japanese companies are building up expertise to deliver on renewables targets.[21] Prioritising a **positive regulatory environment for renewables would provide greater opportunities for Japanese industry as well as much greater climate benefit** for Japan than pursuing co-firing of ammonia.

> Despite joining the 2021 G7 commitment to end international finance to unabated coal power, **Japan's public financial institutions remain open to financing co-firing related projects overseas**. If this support materialises, it would run counter to Japan's G7 commitment.

Prioritising the use of green ammonia

> Ammonia production today is a highly emissions-intensive process. The current global production of 185 Mt of ammonia is responsible for 1.3% of CO_2 emissions from the energy system, as almost all of it is produced using coal or gas. Around 70% of ammonia is used for fertilisers, and the rest for industrial applications such as in plastics. The IEA Ammonia roadmap highlights that it is one of the most emissions-intensive commodities produced by industry; nearly twice as intensive as crude steel production, and four times more than cement, on a direct CO_2 emissions basis.[22] As such, the **priority for any investment in green ammonia production (produced with renewable electricity) should be replacing current fossil-based ammonia** to meet existing demand.

> Beyond decarbonising existing ammonia demand, green ammonia represents a considerably **more cost-effective pathway to emissions reductions in non-power sectors** than for use in co-firing**.** Green ammonia can replace fossil fuels in hard-to-abate sectors where electrification may be challenging, such as heavy industry like cement, steel or plastics, shipping and aviation.[23] For example, ammonia could be used in industrial furnaces, or as fuel for maritime transport.[24] Technology development for green ammonia use could be effective in these hard-to-abate sectors where other low-emission options are limited and costly.

[20] Global Wind Energy Council, 2022, **Floating Offshore Wind – A Global Opportunity**

[21] Reuters, 2023, **Japan's JERA to buy Belgium's top offshore wind company for $1.7 bln**

[22] IEA, 2021, **Ammonia Technology Roadmap Towards more sustainable nitrogen fertiliser production**

[23] TransitionZero, **Coal-de-Sac: the role of advanced coal technologies in decarbonising Japan's electricity sector**, 2022, p.16

[24] The Royal Society, 2020, **Ammonia: zero-carbon fertiliser, fuel and energy store**

- **Japan's promotion of ammonia for co-firing would lead to increased demand for ammonia**, which would make it more challenging to decarbonise existing production and prioritise its use in hard-to-abate sectors. Analysis by IGES estimates that Japan would need 20 million tons of ammonia to implement 20% ammonia co-firing in all its existing coal plants, equal to the total amount of ammonia currently traded internationally.[25]

Technology challenges of co-firing coal with ammonia

- Co-firing in power production can involve various fuel combinations, for example coal and biomass, or gas and hydrogen. Ammonia is touted as a "low-carbon fuel" because it does not result in direct carbon emissions at the point of combustion.[26]
- Co-firing 20% ammonia with 80% coal is seen as technically feasible, but current projects are **still in the demonstration phase and not yet commercially operational**. The most well-known is Japanese utility JERA's government-supported pilot project, which aims to introduce 20% ammonia co-firing in its Hekinan 4 coal power unit in 2023.[27] In the future, Japan aims to demonstrate 50% co-firing rates, and ultimately 100% ammonia power, but the economic and technical feasibility of this is questionable.
- The IEA sees negligible potential for ammonia co-firing to contribute to emission reductions from the global coal fleet. In its analysis, emissions cuts will instead be achieved by a combination of repurposing coal power plants from baseload to peaking operation; early retirements; replacement with clean energy; and to a small extent continued operations following the integration of CCS (carbon capture and storage) retrofits.[28]

[25] IGES, 2022, **Japan's Coal "Fade-out" and Decarbonisation Policy**

[26] TransitionZero, 2022, p.12

[27] JERA, 2022, **JERA and IHI Move Up the Start of Large-Volume Co-firing of Fuel Ammonia in the Demonstration Project at Hekinan Thermal Power Station**

[28] IEA, 2022, **Coal in Net Zero Transitions**, p.66

Emissions implications of ammonia co-firing

> The life cycle emissions implications of ammonia co-firing depend on:

I. the feedstock used to produce ammonia

II. the availability of abatement methods for both carbon dioxide and methane emissions (in the case of fossil-derived feedstock)

III. the co-firing ratio of coal and ammonia in the electricity generation phase

IV. the potential extension of the operational lifetime of the power plant to cover the cost of investment.

> Ammonia can be sourced from various feedstocks and processes. However, **the production process can result in significant carbon emissions**. The main production process involves combining hydrogen and nitrogen using the highly energy intensive Haber–Bosch process, where the hydrogen can derive from different feedstocks. Most ammonia currently produced is **grey ammonia**, derived from hydrogen produced from fossil gas. **Blue ammonia** is also made using gas-based hydrogen, but with integrated carbon capture and storage (CCS). **Green ammonia** is produced using hydrogen resulting from electrolysis of water powered by renewable electricity.

> Blue and green ammonia are often discussed as equivalent low-carbon fuels, however upstream methane emissions leakage from fossil gas production **may mean blue ammonia would still be responsible for significant emissions.** International standards for green and low-carbon hydrogen and ammonia do not yet exist.[29]

> The **direct emissions reductions of ammonia co-firing in electricity generation are extremely limited** compared to replacing coal with renewables, or zero emission flexibility solutions such as battery storage or smart demand response. The IEA's 2021 Net Zero scenario assumes grid emissions must be below **138** gCO_2/kWh by 2030 globally, but co-firing fails to bring emissions even close to this level. A coal plant with 20% ammonia will emit **five times** more (**693** gCO_2/kWh), and even a plant with 50% co-firing would emit three times (**434** gCO_2/kWh) the IEA NZ benchmark.[30] According to analysis by Bloomberg NEF, **a coal power plant retrofitted to**

[29] APEC, 2022, **Low-Carbon Hydrogen International Standard – Post-Workshop Report**

[30] TransitionZero, 2022, p.8

co-fire ammonia at 50% or lower blend rates still emits more CO_2 than a natural gas-fuelled combined cycle power plant.[31]

> Any potential marginal emissions reductions from ammonia co-firing are insufficient in both scale and speed to contribute to the timely pursuit of power sector decarbonisation. **Ammonia co-firing should not be considered an effective abatement option** in the absence of a regulatory framework that would guarantee sufficient emissions reductions and rule out the extension of power plant lifetimes.

> **The full life cycle emissions of ammonia co-firing must be accounted for in any plans to deploy it**. The life cycle emissions of ammonia production vary greatly depending on the feedstock used. For example, grey ammonia produced from unabated coal contains embedded emissions equivalent to double the emissions associated with the direct combustion of coal.[32] Even with the use of blue or green ammonia, the production process of ammonia and carbon-intensive maritime transport and storage could still result in further increases in life cycle emissions.[33,34] The high energy content losses involved in the different stages of the conversion process and combustion also mean any ammonia use for producing electricity is highly inefficient.[35]

> If ammonia is produced using currently common fossil-based methods, the marginal emissions reduction achieved in Japan at the point of combustion would be more than negated by increased emissions in ammonia-producing countries like Australia, constituting an export of emissions.[36]

> Decarbonising the power sector requires the **phase-out of unabated coal power in OECD countries by 2030 and globally by 2040**, and of unabated gas by 2035, bringing emissions from the power sector to net zero, to be in line with IEA's Net Zero scenario.[37] Promoting ammonia co-firing in coal plants

[31] BloombergNEF, 2022, **Japan's Costly Ammonia Coal Co-Firing Strategy'**, p.1

[32] TransitionZero, 2022, based on IEA, 2021, **The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector**

[33] The combustion of ammonia may also increase nitrogen oxide (NOx) emissions. While initial simulation studies suggest this could decrease as the ammonia share rises, above 40% co-firing unburned ammonia can produce PM2.5 when it reacts with sulphur dioxide (SO_2).

[34] TransitionZero, 2022, p.21

[35] TransitionZero, 2023, **Japan's Toxic Narrative on Ammonia**

[36] Stocks, M., Fazeli, R., Hughes, L. and Beck, F. J., 2022. **Global emissions implications from co-combusting ammonia in coal fired power stations: An analysis of the Japan-Australia supply chain**, *Journal of Cleaner Production,* Volume 336.

[37] IEA, 2021, **Net Zero by 2050: A Roadmap for the Global Energy Sector**

increases the risk these plants stay online beyond these timelines, without any regulatory requirements to reduce emissions or shut down.

> **A 20% or 50% ratio of co-firing achieves much less emission reduction than direct use of CCS in power generation**, which typically aims to remove 90% or more of the emitted CO_2.[38] The UK government has recently consulted on proposals to amend the capacity market to require gas power plants to meet an emissions level of 100g/kWh from 2034 onwards, to deliver power sector decarbonisation objectives. The UK calculates that this would be achievable with a minimum capture rate of 73%.[39] Power plants in receipt of financial incentives for CCS would aim for substantially higher levels of CO_2 capture.

> **The effective deployment of CCS at scale would be an essential pre-requisite** for developing low-carbon ammonia from the most commonly used fossil fuel feedstocks. CO_2 has been captured from ammonia production sites since the 1980s, principally for use in enhanced oil recovery.[40] However, the IEA notes that permanent storage of the CO_2 is not yet widely adopted.[41] In Japan, a recently announced project aims to pilot the production of ammonia with CCS from 2025, but would produce just 500 tonnes of ammonia a year.[42]

The poor economics of ammonia co-firing

> Recent BloombergNEF analysis found that **co-firing with high ratios of blue or green ammonia is more expensive than renewables**. Making clean ammonia co-firing at a 20% blend rate economically viable would require a carbon price of at least **$300/tCO₂** in 2030.[43] The Japanese government is planning to adopt a carbon levy for power producers from 2028 as part of its GX policy, estimated to be in the range of **$8–12/t CO₂**.[44] If Japan persists in implementing carbon pricing at such slow pace and low price level, it will not impact sufficiently on incumbent emitters to drive a change in approach.

> TransitionZero similarly found that **shifting from conventional coal power to 20% ammonia co-firing would double fuel costs**, even when using the

[38] MIT, 2021, **How efficient is carbon capture and storage?**

[39] Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy, 2023, **Capacity Market 2023: strengthening security of supply and alignment with net zero**

[40] Bellona, 2016, **Why deeply decarbonising fertiliser manufacture needs CCS**

[41] IEA, 2021, **Ammonia Technology Roadmap**

[42] Ammonia Energy Association, 2023, **Small-scale CCS ammonia in Japan**

[43] BloombergNEF, 2022, **Japan's Costly Ammonia Coal Co-Firing Strategy**, p. 11

[44] Influence Map, 2023, based on REI, 2022. **Policy overview: carbon taxes and levies**, **Diamond Online (2022**).

cheapest ammonia (grey).[45] They estimate that, overall, grey ammonia costs **four** times as much as coal, and green ammonia **15** times as much. In addition, using green electricity directly is much more efficient than converting it into hydrogen or ammonia and then back into electricity.

> Ammonia co-firing is promoted with a claim that it would only require limited retrofitting to convert existing coal units. However, differing plant configurations can change the economics of projects considerably.[46] Japanese power companies often cite the ability to use existing coal assets as a reason for pursuing co-firing,[47] which can be seen as an attempt to avoid stranded assets. However, in scenarios where the majority fuel use remains coal, there would also need to be consideration of CCS retrofit in order to achieve sufficient emission reductions. Industrial interests promoting ammonia co-firing are in part seeking to avoid the cost and complexity of CCS retrofits.

Recommendations

> **Ammonia co-firing should not be considered an effective emission abatement technology**. Definitions of abatement[48] should be maintained as interventions that substantially reduce the amount of greenhouse gas emissions emitted throughout the life cycle, such as CCS capturing 90% or more CO_2 emissions from power plants, as defined by the IPCC.[49]

> Given the limitations and risks of pursuing the approach, **governments should act early to rule out ammonia use in co-firing** with coal.

> If countries still pursue the approach despite its risks, strong regulatory frameworks are necessary to ensure any potential consideration of ammonia for co-firing includes an **assessment of the lifetime emissions from coal power plants and the life cycle emissions of ammonia** production from different feedstocks, as well as its transportation and storage, to ensure any co-firing policies are aligned with achieving the goals of the Paris of limiting warming to 1.5 °C. **Co-firing should be excluded from the scope of multilateral financing tools for the power sector**, along with other fossil fuel options. In cases where its inclusion is unavoidable, safeguards must be put

[45] TransitionZero, 2022, p.19

[46] TransitionZero, 2022, p.22

[47] JERA, 2022, **Corporate Profile**

[48] E3G, 2021, **Explained: what does 'unabated coal' mean?**

[49] IPCC, 2023, **Synthesis Report of the IPCC Sixth Assessment Report (AR6)**

in place to ensure the co-firing retrofits do not lengthen the operational lifetime of the targeted power plant or expand its life cycle emissions.

> Due to the high costs and energy intensity of producing green ammonia, its **use should be strategically prioritised for those sectors where it can have the greatest climate benefit.** These include decarbonising existing ammonia demand for fertilisers, which is currently highly emissions intensive, and decarbonising hard-to-abate sectors. The promotion of ammonia for co-firing creates further pressure on the ammonia supply chain and risks slowing down emissions reduction in other sectors.

> To ensure that any production and utilisation of ammonia is aligned with 1.5 °C goals, governments and international institutions should instead **work to establish robust standards, including:**

- Focusing international cooperation around green ammonia on sectors where it can provide greater proven climate benefit than in co-firing, such as to decarbonise fertiliser production and hard-to-abate sectors.
- Ensuring that robust carbon intensity standards are created for ammonia production and supply chains, incorporating full life cycle emissions.

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