Energy & Transport

Zero Carbon Analytics

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Zero emissions or fossil fuels? Tracking Japan's AZEC projects

Key points:

- The Asia Zero Emission Community (AZEC) is an initiative launched by Japan in March 2023 to advance cooperation with Asia towards carbon neutrality. Japan aims to play a pivotal role in Asia's energy transition. To date 158 Memorandums of Understanding (MoUs) have been signed as part of the AZEC initiative.
- 56 MoUs (35%) include fossil fuel technologies. These include, natural gas, LNG, ammonia co-firing with thermal power plants, ammonia and hydrogen not made by green power, CCS and e-fuels.
- 54 MoUs (34%) include renewables and electrification technologies. These include, solar PV, wind, renewable power, hydropower, geothermal, battery storage, electric vehicles, green hydrogen, green ammonia and waste management. Only 11 agreements (7%) include wind and/or solar.
- The lifecycle emissions of these fossil fuel technologies are higher than clean solutions like wind or solar. The project cost of retrofitting coal/gas plants with ammonia and/or CCS will soon be higher than solar and wind. Developing AZEC countries risk deepening coal dependence or new LNG dependence at a high cost by adopting these nascent technologies.
- Japan signed the majority (43%) of deals with Indonesia, followed by Thailand (15%) and Malaysia (11%). Most projects are in their preliminary stages with 75% of projects in pre-construction.

To what extent does AZEC promote regional decarbonisation?

Japan's Asia Zero Emission Community (AZEC) is a platform promoting "various pathways to net zero" for countries in the Asia Pacific. Japanese Prime Minister Kishida first proposed the concept in a speech in January 2022, and it was officially launched at the AZEC Ministerial Meeting in March 2023. The first AZEC leaders summit was held in December that year. As of April 2024, the 11 AZEC partner countries are Australia, Brunei, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, Vietnam and Japan.

AZEC is one lever by which Japan aims to play a pivotal role in the Asian energy transition. This has manifested in many ways, including its participation in the Japan-ASEAN Summit and the Strategic Program for ASEAN Climate and Environment, writing the Roadmap for Transition of Asian countries and launching the Asia GX (green transformation) consortium on transition finance.

Non-governmental organisations across Asia have raised concerns that AZEC promotes mainly fossil-based technologies such as liquified natural gas (LNG), ammonia co-firing with coal plants, and carbon capture and storage (CCS). Japan's push for ammonia co-firing has been criticised by the UK and Canada at the G7 in 2023.

This analysis examines the agreements that have been signed under AZEC since March 2023 and highlights which technologies the projects are funding and to which countries.

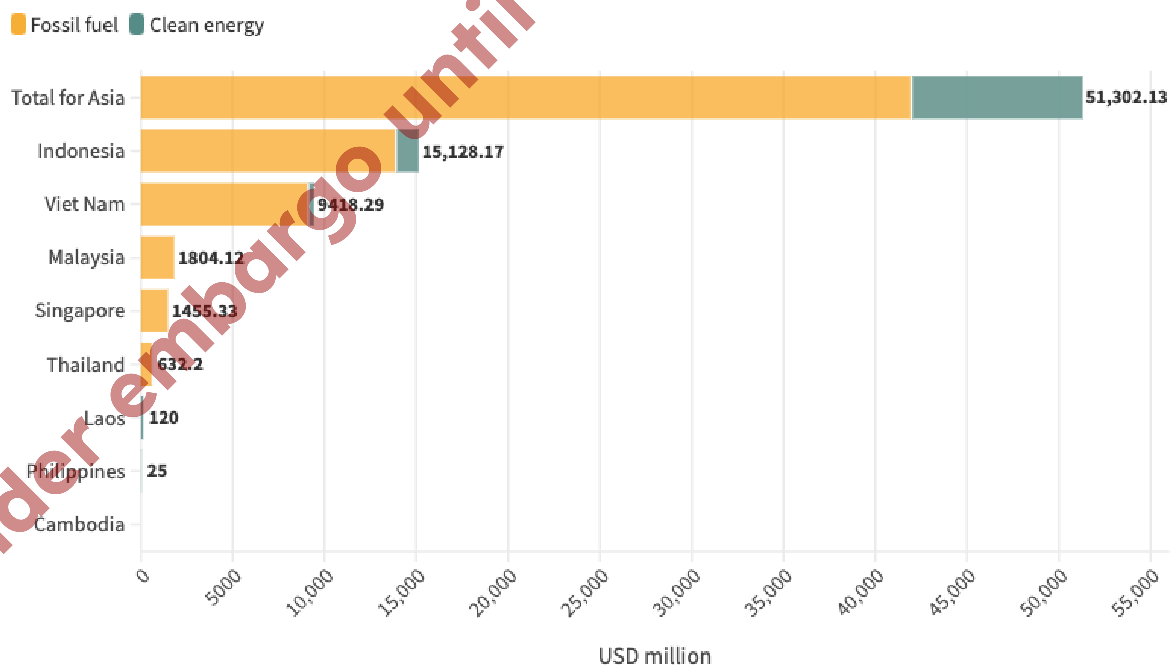
Japan's track record of regional energy investment

Historically, Japan has invested in building the LNG industry in Asia. Since the 1960s, Japan has helped to develop LNG projects in Brunei, Malaysia, Australia, Indonesia and Qatar. The largest gas utility in Japan, Tokyo Gas, stated in its 2018 annual report that its "ultimate goal for the future is to form an LNG value chain in Southeast Asia".

Japanese energy companies earned over USD 14 billion gas-related profits last year, according to Bloomberg estimates. Despite Japan being one of the world's largest LNG buyers, domestic demand has declined in the last five years due to a rise in generation from renewables and nuclear power, increased energy efficiency and demographic shifts. This has led the country to re-export surplus LNG to Southeast Asia.

Japanese public financial institutions have provided USD 93 billion for overseas oil and gas projects between 2013 and 2023. Almost half of which has been for upstream operations (production and exploration). Oil Change International has found that between 2013 and 2022, the Japanese government invested around USD 41 billion on fossil fuels in Asia, almost five times more than the USD 9 billion spent on clean energy over the same period.

Fig. 1: Japan public finance for fossil fuels vs clean energy in Asia, with breakdown byAZEC partner countries (2013-2022)



Source: OCI: Public Finance for Energy Database • Other Asian countries not part of AZEC are included in the total but are not shown individually in the graphic, which only highlights AZEC partner countries. Data was not available for Brunei.

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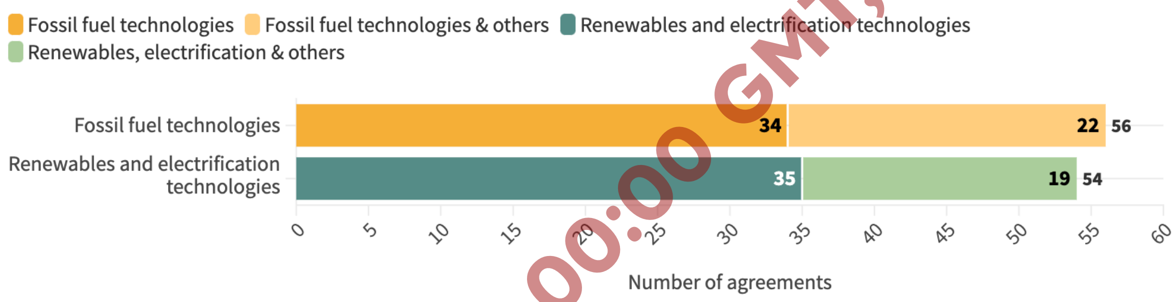
Results show AZEC is supporting prolonged fossil fuel use

Of the 158 agreements signed since the launch of AZEC, there are 22 in which ammonia and ammonia co-firing are included, 23 for CCS/CCUS, 17 for hydrogen, and 17 for LNG or natural gas.[1] By contrast, only 11 agreements (7%) involve wind and/or solar.

All together, just over a third (56) of the memorandums of understanding (MoUs) involve fossil fuel technologies.[2] Of these, 34 MoUs are dedicated solely to technologies categorised as fossil fuel technologies with a further 22 including them alongside other technologies.

Another 54 agreements involve renewables and electrification technologies. Of these, 35 MoUs are dedicated solely to renewables and electrification technologies with a further 19 including other technologies as well.

Fig. 2: Number of agreements involving fossil fuels vs renewable and electrification technologies



Source: Zero Carbon Analytics analysis of AZEC MoUs
Agreements involving both renewables and fossil fuels are included in both 'fossil fuel technologies and others' and 'renewables, electrification and others'.

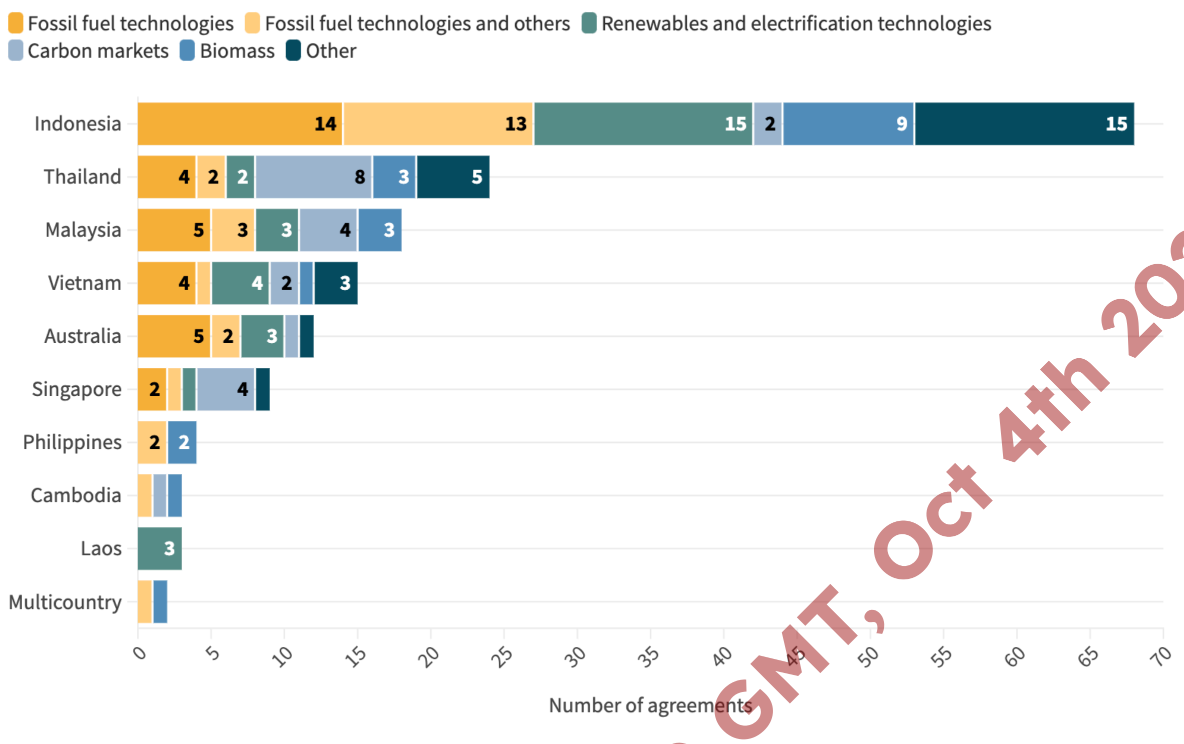
In this analysis, **fossil fuel technologies** are defined as: natural gas, LNG, ammonia co-firing, ammonia, CCS/carbon capture utilisation and storage (CCUS), hydrogen and e-fuels.[3]

Renewable and electrification technologies are defined as: solar photovoltaic (PV), wind, renewable power, green hydrogen, green ammonia, hydropower, geothermal, battery storage, electric vehicles and waste management.

A regional breakdown of the agreements Japan signed with AZEC partners shows Indonesia holds the highest by far, making up 43% of the agreements. This is followed by Thailand (15% of agreements) and Malaysia (11% of agreements).

[1] The 158 MoUs include all the official AZEC MoUs announced since its launch in March 2023. These include the 28 projects released at the start of AZEC, the MoUs from the AZEC leaders summit in December 2023 and the MoUs from the second AZEC ministerial meeting in August 2024. Duplicates or MoUs that had existed before March 2023 were excluded.
[2] Individual technologies can be counted multiple times across agreements as many agreements include a mix of technologies.
[3] Hydrogen and ammonia projects that are not explicitly stated as being green, are assumed to use fossil fuel feedstock.

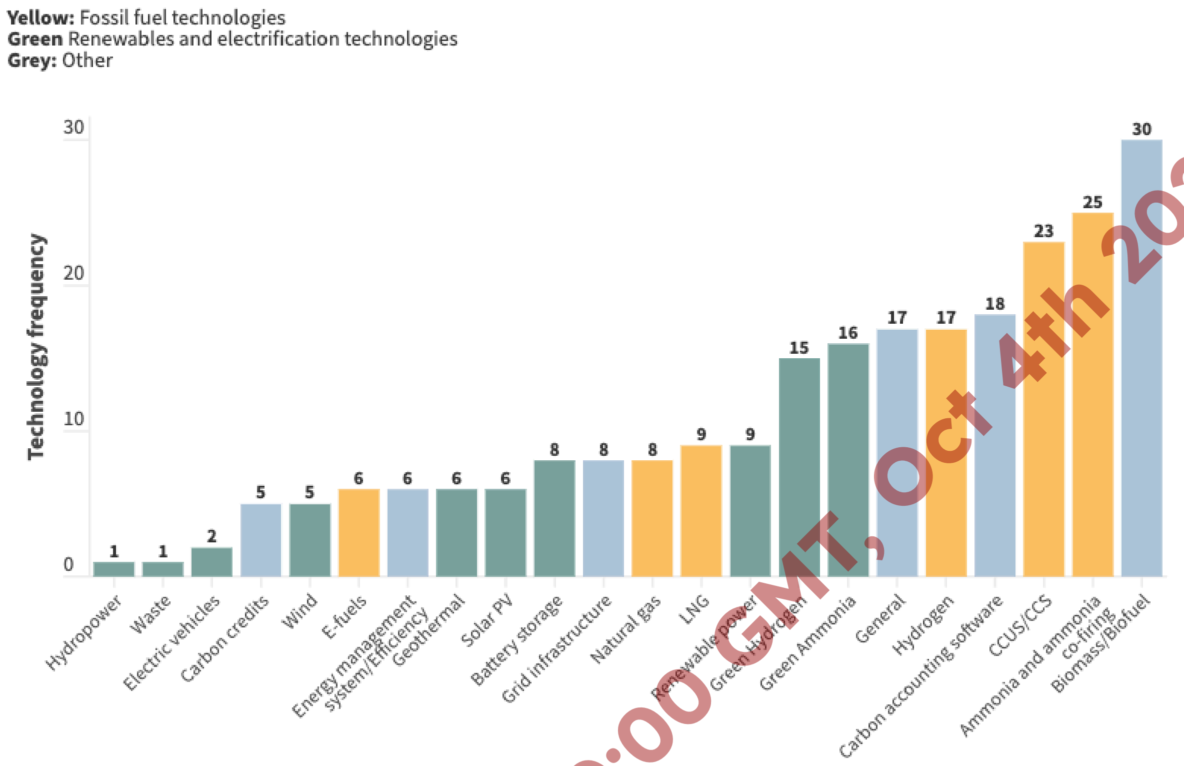
Fig. 3: Breakdown of AZEC agreements by country and technology involved



Source: Zero Carbon Analytics analysis of AZEC MoUs
"Fossil fuel technologies and others" includes agreements that have a mix of technologies including fossil fuel technologies such as CCS or ammonia co-firing.

As there were a number of agreements that involved multiple technologies, figure 4 shows how many times each technology appears in total in the AZEC MoUs since March 2023. Biomass/biofuels appeared the most (30 times), followed by ammonia and ammonia co-firing (25 times), then CCUS (23 times). Solar PV and wind combined appear 11 times.

Fig. 4: Number of times each technology appears in the AZEC MoUs since March 2023



Source: ZCA analysis of AZEC MoUs

What are the risks of fossil and fossil-based technologies for Asia?

Projects that expand the use of LNG, non-green ammonia and ammonia co-firing and CCS carry emissions, fiscal stability and affordability risks to AZEC partner countries which could derail the national power sector emissions targets set out in the International Energy Agency's 2050 net zero scenario.

Liquified natural gas

LNG is formed by purifying natural gas and super cooling it to a liquid so it can be stored and shipped. The end product is natural gas composed largely of methane, which is regasified at its destination for use in power generation.

Since 2018, LNG sales to other countries by Japanese companies have almost tripled. In South and Southeast Asia, Japan is also investing in midstream and downstream gas sectors, such as LNG-fired power plants and regasification terminals. About $220 billion of capital investments into LNG infrastructure is planned in Southeast Asia, with much of the investment led by international finance from Japanese institutions.

Emissions

Methane is the second-largest contributor to climate warming after carbon dioxide. Methane lingers in the atmosphere for less time than carbon dioxide, but traps more heat per molecule – making it 80 times more warming than carbon dioxide over the 20 years after it is released.

Even before combustion, methane can escape into the atmosphere through gas infrastructure, a process known as methane leaks. Methane leaks are notoriously hard to measure. Methane emissions released both intentionally and unintentionally by oil and gas companies contribute to the gap between reported and actual emissions. The total oil and gas methane emissions reported by countries to the UN Framework Convention on Climate Change in 2023 was around 50% lower than estimates from the International Energy Agency. A Stanford University-led study also revealed that emissions from leaks through gas operations are much higher than previously thought.

The process of producing LNG from natural gas is also energy intensive and expensive. A study of US LNG shipments found that: "The greenhouse gas (GHG) emissions from the extraction, transport, liquefaction, and re-gasification of LNG can be almost equal to the emissions produced from the actual burning of the gas, effectively doubling the climate impact of each unit of energy created from gas transported overseas."

Stability

Many South and Southeast Asian countries import LNG from overseas via the spot market. Between January 2021 and August 2024, around 32% of Southeast Asia's LNG imports were from the spot market.[4] This means that LNG is bought at the spot price – the current market price of gas at any given time for immediate delivery.

During the 2022 energy crisis, when gas prices were high, the average price of LNG in Asia was twice as high as the annual average for 2021. If LNG prices remain volatile and unaffordable, LNG infrastructure in countries like the Philippines, Vietnam, Pakistan or Bangladesh risks being underutilised or cancelled.

Affordability

Vietnam, an AZEC partner country, is shielding consumers from volatile LNG prices through an LNG price cap which does not reflect the volatility of LNG prices. LNG is more costly than coal and hydropower (the top power sources) in Vietnam. Amid falling solar and wind costs, there is an opportunity for renewable generation, as Vietnam, like much of Southeast Asia, has high renewable energy potential.

Ammonia and ammonia co-firing

Ammonia is made by reacting nitrogen and hydrogen and is a more stable form to ship and store hydrogen. The early "hydrogen hype" as a fossil fuel replacement stems from the fact that it does not include carbon in its molecular structure. However, high costs, challenges related to thermodynamics, geopolitics and other factors have led to a number of failed projects, making ammonia a less useful decarbonisation option in sectors with renewable alternatives. Currently, around 80% of ammonia is used in fertiliser production, where it has potential to help decarbonise the sector. In 2020, 99% of global ammonia production relied on fossil fuels.

[4] Zero Carbon Analytics analysis, BNEF (2024) LNG Spot-Contract Trade Flow Playbook, available via BNEF platform, accessed on 23rd September 2024.

Ammonia can be used as fuel via direct combustion, in fuel cells, as a hydrogen carrier, or through co-firing in coal combustion for power generation. In Asia, there are trials for ammonia co-firing in thermal (often coal and gas) power plants. Japan has signed agreements with AZEC partners in Thailand, Indonesia, Malaysia and the Philippines to test ammonia co-firing as part of its vision to make these coal plants "zero emission" by 2050.

Emissions

The most technically feasible co-firing rate currently being tested (20% ammonia and 80% coal) is not aligned with the 2030 power sector emissions trajectories in the International Energy Agency (IEA) 2050 net zero emission scenario for Thailand, Malaysia, Indonesia and the Philippines. An ammonia co-firing ratio below 50% will release more carbon dioxide than a gas fired power plant, negating its usefulness as an emissions reduction mechanism, according to BloombergNEF (BNEF) analysis.[5] The direct combustion of ammonia also generates high levels of polluting nitrogen oxides. Producing, transporting and storing ammonia (upstream) also results in emissions. Around 1.6 tonnes of CO_2 emissions are produced per ton of ammonia.

Stability

Pursuing ammonia co-firing in Southeast and East Asian countries will require the import of clean ammonia due to high domestic costs of production. Through this process – which requires producing renewable hydrogen, converting it to ammonia, and shipping it to a power plant where it is burned to make electricity – 77% of the original energy input could be lost. Energy transformation losses and high capital and operating expenses makes ammonia shipping expensive, and countries reliant on this method may see their competitors using cheaper, direct renewable energy sources.

Affordability

Ammonia is more expensive than coal on an energy-equivalent basis. Switching from coal to ammonia means costs will increase for the same amount of electricity generated, as ammonia has much lower volumetric density than coal.[6] Switching to ammonia will increase power prices and/or the taxpayers burden depending on how much the government decides to absorb these costs via subsidies.

Existing coal plants must be retrofitted with specific infrastructure in order to co-fire with ammonia. This increases capital expenditures by 11% for plants that co-fire at a ratio of 20%. Using ammonia at higher co-firing rates of 50% and 100%, or using green ammonia, will be more expensive than other low-emission technologies, such as solar and wind, in Japan, according to BNEF.

Carbon capture, utilisation and storage

Carbon capture refers to technologies that take carbon dioxide from power generation or industrial facilities before it is released into the atmosphere and transport it to be stored or used in other industrial processes. Carbon dioxide can be stored in geological storage sites, such as deep saline formations – essentially underground rock formations – or in depleted oil and gas wells.

[5] Zero Carbon Analytics analysis, BNEF/Bloomberg (2022) Japan's Costly Ammonia coal Co-Firing Strategy, available via BNEF/Bloomberg platform, accessed on 23rd September 2024.
[6] Zero Carbon Analytics analysis, BNEF/Bloomberg (2024) Ammonia no Magical Bullet to Cut Asia's Power Emissions, available via BNEF/Bloomberg platform, accessed on 23rd September 2024.

Review of the IEA CCS database, official AZEC documents and the Global CCS Institute, which according to Global Witness is closely linked to the hydrocarbons industry, show that there are around 50 CCUS projects in the pipeline in Southeast Asia,[7] of which 23 have an MoU signed under AZEC since March 2023. These projects are mostly still in the planning phase and are often connected to the production of gas. In addition, 16 cross-border CO2 export projects are planned in Asia.[8] The focal point is often Japan, which will export CO2 to be stored in countries such as Australia, Malaysia and Indonesia.

Some of the world's biggest energy companies, such as BP, as well as national power companies like Pertamina and Petronas are behind these projects.[9] This is despite the patchy track record of CCS projects such as Gorgon in Western Australia to capture CO2. Initiatives like the Asia CCUS Network, backed by the Japanese government, also promote the technology in the region.

Emissions

CCS has to date overwhelmingly been used by the oil and gas industry to support more oil and gas extraction, and this is the case with some of the MoUs for AZEC projects. For example, at the Sukowati oil field in Indonesia, the Indonesian state oil company Pertamina, in collaboration with the Japan Petroleum Exploration Corporation, began a small-scale pilot in mid 2023 to inject CO2 for enhanced oil recovery. Following the success of this project a larger CO2 injection field test was agreed during the AZEC ministerial meeting in August 2024. This project is supported by the Japan Organization for Metals and Energy Security (JOGMEC).

Using CCS to produce oil and gas means that in effect the technology continues to enable the burning of fossil fuels at a level that under certain scenarios could use up 30% of the remaining global carbon budget. One of the reasons for this is that CO2 capture rates have been lower than promised. Finally, there is potential for CO2 leakage which would mean that CO2 that has been captured would be released back into the atmosphere.

Affordability

Relying heavily on CCUS to achieve net-zero by 2050 could cost USD 30 trillion more than relying on the increased use of renewable energy, electrification and energy efficiency.

The IPCC also found that CCS is less effective at reducing emissions and more expensive than actions such as fuel switching (electrification), improving energy efficiency, material efficiency and enhanced recycling.

Notes on categorisation methodology

Biomass

For this analysis, biomass is not included in the breakdown between renewable and fossil-based technologies. It is treated as a separate category due to the contentiousness over its renewable status given its lifecycle emissions. Harvesting trees for fuel releases

[7] Zero Carbon Analytics analysis of the IEA CCS Database, the Global CCS Institute and the AZEC Community Progress Report 2023.
[8] Zero Carbon Analytics analysis of the IEA CCS Database, the Global CCS Institute and the AZEC Community Progress Report 2023.
[9] Zero Carbon Analytics analysis of the IEA CCS Database, the Global CCS Institute and the AZEC Community Progress Report 2023.

more carbon than if they were allowed to degrade naturally. Burning woody biomass can emit up to 30% more carbon per unit of energy than coal. The time it takes for new trees to absorb the carbon emitted by trees harvested to burn is between 44 and 104 years and could be even longer.

In its research on global bioenergy, Global Energy Monitor (GEM) found that woody biomass capacity grew more than seven-fold in the last decade in Japan and South Korea, despite doubts on profitability and sustainability. The Global Environment Forum (GEF) has conducted a risk assessment of the biomass/biofuel projects listed in the AZEC agreements and concluded that the majority are not green.

Green hydrogen and ammonia

For this analysis, green hydrogen and ammonia were categorised as renewables and electrification technologies. Any mention of non-green hydrogen or ammonia – which in Asia typically use fossil fuel feedstocks to produce hydrogen to then synthesize ammonia – was categorised as a fossil fuel technology.

However, the use of green hydrogen/ammonia in the power sector, which many Asian countries advocate for, is inefficient and contradicts IRENA's recommendation to deploy green hydrogen in sectors where decarbonisation is difficult and there are no renewable alternatives. Green hydrogen is found to be expensive and uncompetitive compared to fossil-based hydrogen, which makes it a poor contender for the power sector, according to consultancy Capgemini. Even after all the expense, co-firing still produces nitrogen oxides emissions and particulate matter which direct renewable energy does not.