

NetZero Pathfinders Quarterly

The agriculture edition

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The Agriculture Edition: Executive summary

Welcome to the third edition of the NetZero Pathfinders Quarterly, a publication aimed at highlighting the most effective current or impending policies and regulations in a particular sector. By showing what really works, Pathfinders outlines actionable solutions to put the world on track for success this decade.

- The Pathfinders framework identifies the four pillars of net-zero strategies which underpin the most critical areas for policymakers to address.
- This Quarterly encompasses climate actions affecting the agriculture sector, including promoting new technologies, providing incentives for alternative protein production, and imposing strict regulations on food produced on deforested land. These actions also touch on establishing clear ownership of the climate agenda within government.
- NetZero Pathfinders' best practices are powered by the expertise of hundreds of BloombergNEF analysts who utilize clear metrics to identify and evaluate the most impactful climate solutions.

Climate actions and pillars covered in this edition

0 NetZero Pathfinders Strategy Pillar		Agriculture	
1 Accelerate deployment of mature climate solutions	Incentivize farmers to adopt precision technology	Aid deployment of manure management and anaerobic digestion projects	
2 Support the development of new climate solutions	Support technologies to lower enteric methane emissions of ruminants	Provide incentives to promote alternative protein production and consumption	
3 Manage the transition or phase-out of carbon intensive activities	Restrict international trade of goods produced on deforested land	Introduce land sector offset mechanisms and develop carbon mechanisms	
4 Create appropriate climate transition governance structures	Establish clear ownership of the climate agenda within government		

Key: Sector-specific solutions Cross-cutting solutions

Source: BloombergNEF. Note: Please see the appendix for all sectors and climate actions. Sector specific solutions are greyed out if they are not covered in this edition. A cross-cutting solution means the solution is also applicable to other sectors.

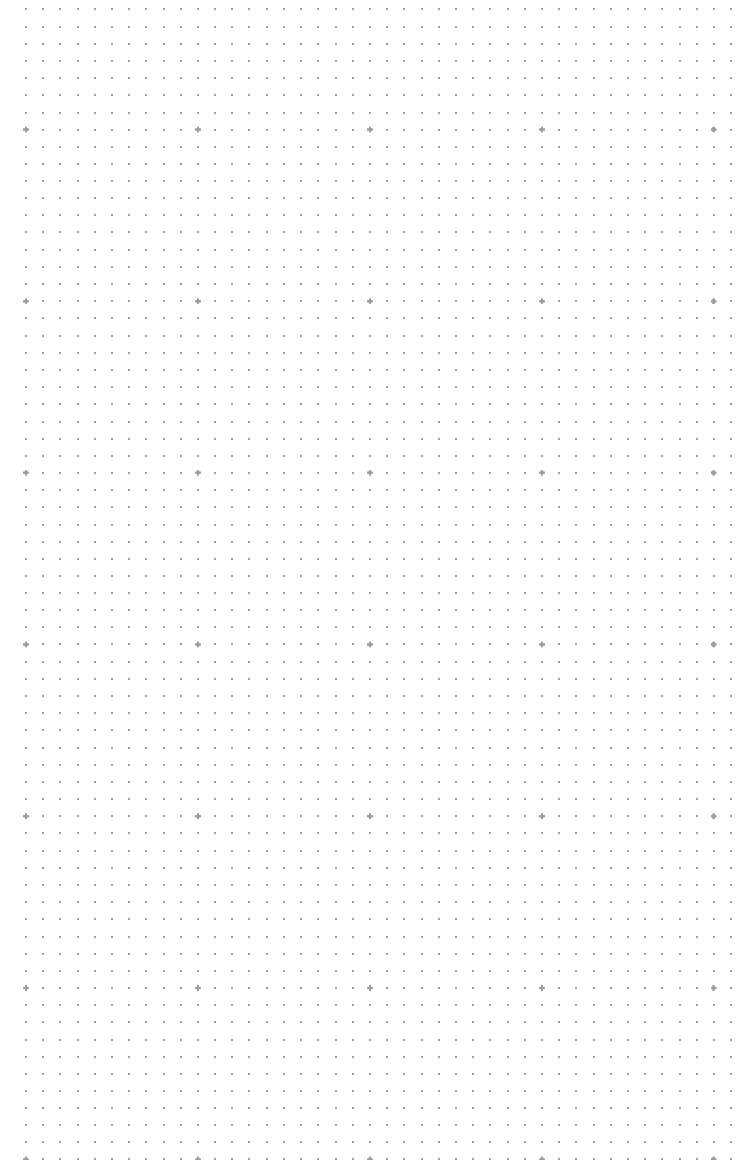
Best practices covered in this edition

PILLAR 1	PILLAR 2	PILLAR 3	PILLAR 4
<ul style="list-style-type: none"> Japan's 'green food' strategy Australia's domestic carbon scheme 	<ul style="list-style-type: none"> Denmark's low emissions policy package Singapore's novel food regulatory framework Australia's livestock methane program 	<ul style="list-style-type: none"> EU's deforestation trade regulation China's fertilizer reduction and efficiency initiative Costa Rica's payments for ecosystem services 	<ul style="list-style-type: none"> Brazil's agriculture research agency

Source: BloombergNEF

PILLAR 1

Accelerate the deployment of mature climate solutions



Accelerate deployment of mature climate solutions

Japan aligns agriculture policies toward 2050 goals

Climate actions covered

1

Accelerate deployment of mature climate solutions

Incentivize farmers to adopt precision technology

3

Phase out carbon-intensive activities

End harmful production subsidies and price supports resulting in over-application of fertilizers, land clearing and residue burning

Japan 'green food' strategy

- Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) introduced the Green Food System Strategy in May 2021 with the aim to eliminate agricultural fossil-fuel emissions and slash pesticide and fertilizer use by 2050.
- The targets are to be delivered by reforming MAFF's existing policy tools and incentivizing technology development and dissemination. The strategy is enforced via the Green Food System Law of July 2022, which stipulates all agricultural subsidies must integrate an environmental component by 2027.
- The Green Food System Law introduced extended repayment terms on interest-free loans to fund climate-positive practices, such as use of integrated pest management or precision spraying technologies. Low-interest and long-term loans and a Green Investment Promotion Tax System were introduced to incentivize investment in machinery, inputs and materials.
- The strategy could build upon the progress made through Japan's direct payment schemes. Since 2011, programs introduced by MAFF have provided payments to farmers for implementing environmentally friendly practices, such as organic farming or planting cover crops.

Green Food System Strategy – selected targets and progress

Topic	Indicator	2050 Target	Standard value	2021 value
Emissions	Zero CO2 emissions from fossil fuel combustion	- 100%	2013 levels	+ 3.8%
Pesticide	Reduce overall use of chemical pesticides by 50%	- 50%	2019 levels	- 9%
Fertilizer	Reduce chemical fertilizer use by 30%	- 30%	2016 levels	- 6%
Organic farming	Expand organic farming to 1 million hectares (25% of Japan's arable land)	+ 4155%	2017 levels	+ 13%

Source: Japanese Ministry of Agriculture, Forestry and Fisheries, BloombergNEF. Red indicates progress is needed; green indicates progress is on-track.

- The strategy was allocated ¥11.7 billion (\$85 million) across Japan's 2021 and 2022 budgets. However, only 2% of a ¥818 billion (\$5.5 billion) stimulus package provided to MAFF by the Japanese government in 2023 was allocated toward environmental programs, with the rest focused on food security measures that can be at odds with the Green Food System Strategy, given yields from organic agriculture can be 19-25% lower than conventional farming. See: G-20 Zero-Carbon Policy Scoreboard 2024: Agriculture (web | terminal).

Accelerate deployment of mature climate solutions

Australian domestic offset market incentivizes technology uptake

Climate actions covered

1

Accelerate deployment of mature climate solutions

Leverage carbon and clean energy incentives to support deployment of manure management and anaerobic digestion projects

3

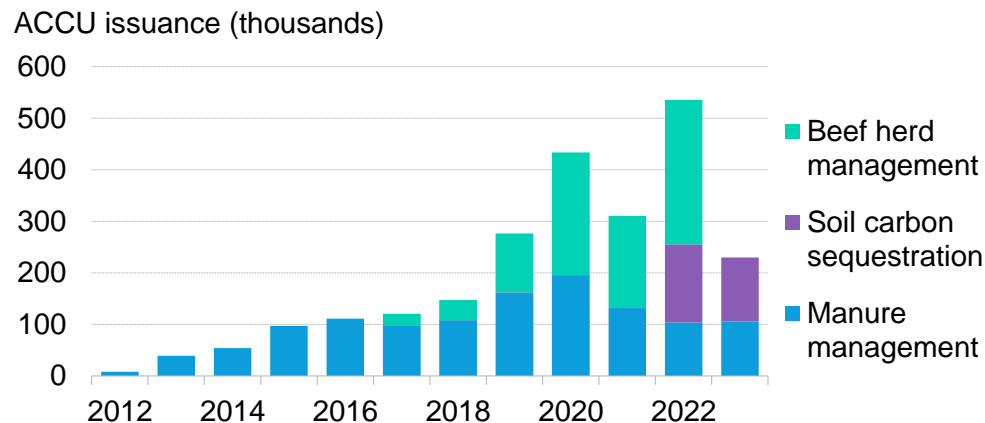
Phase out carbon-intensive activities

Introduce land sector offset mechanisms and develop carbon mechanisms

Australia domestic carbon scheme

- Since 2012, Australian farmers and landholders, as well as other companies, can participate in the domestic CO2 offset market, known as the Australian Carbon Credit Unit Scheme (previously the Carbon Farming Initiative). Farmers can generate income through the tradeable certificates created by implementing sustainable practices, deploying low-carbon technologies or managing vegetation on their land holdings.
- Over 600 agriculture carbon projects are listed on the ACCU registry generated by manure management, soil carbon sequestration and beef herd management methodologies. Farmers can also benefit by engaging in vegetation regeneration projects on their land holdings, which are not considered agriculture ACCUs by the regulator.
- Most agriculture ACCUs are generated under manure management methodologies, the first of which were developed in 2012. Credits are generated from the destruction or avoidance of methane emissions from pig and dairy industries. Additionally, the method credits the capture of biogas for use as a natural gas substitute. See: *Australian Carbon Credit Units: Supply Primer* ([web](#) | [terminal](#))

Agriculture ACCU issuance by methodology

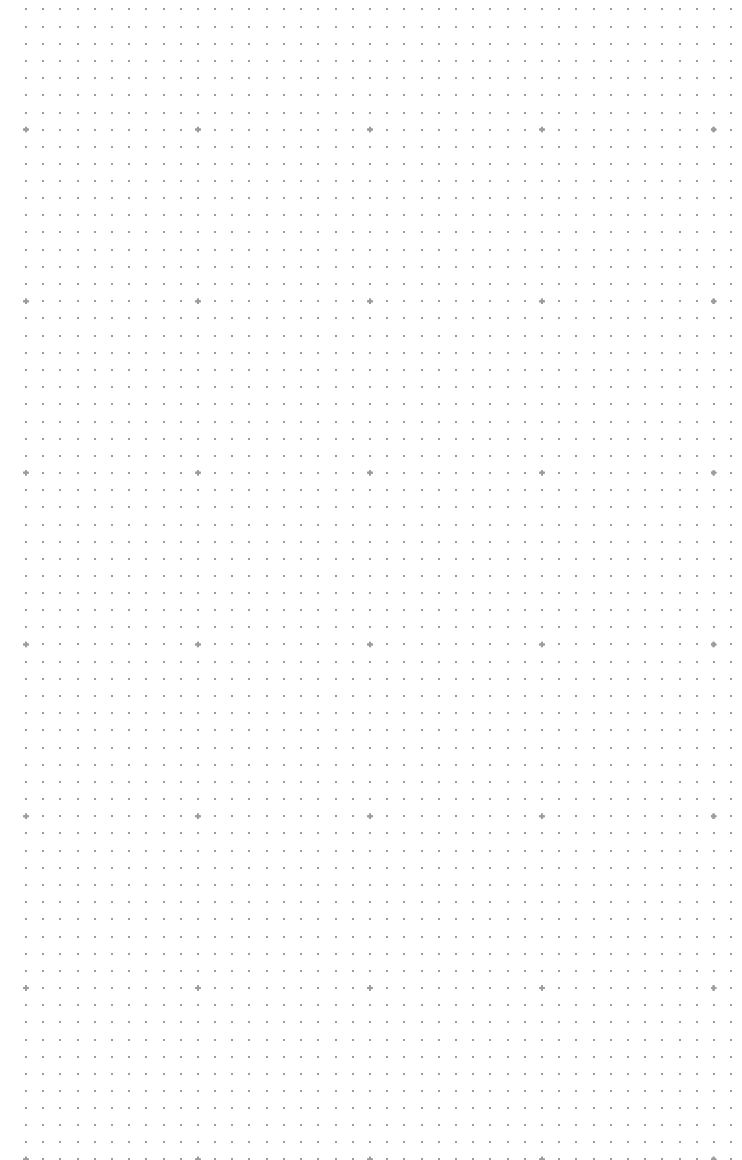


Source: BloombergNEF, Clean Energy Regulator. Note: methodology names have been shortened. Retired methodologies have been grouped with their successors. Issuance under the beef herd management methodology has been paused since 2022 whilst the methodology is under review.

- The second-most common agriculture project generates ACCUs under the beef herd management methodology. Here a farmer earns a credit by reducing emissions through increasing productivity of pasture raised cattle. Since 2015, approximately 4.1% of Australia's beef cattle have been raised under the methodology. Adoption has been driven by the involvement of large agribusinesses and farm asset managers.
- Emerging soil carbon sequestration ACCUs enable crop farmers to engage in carbon markets. The methodology measures changes in the levels of organic carbon stored by plants in lower layers of soils. However, so far, most soil carbon ACCUs have been generated in livestock pasture, not by cropping enterprises.

PILLAR 2

Support development of new climate solutions



Support development of new climate solutions

Denmark redistributes carbon tax proceeds as low-carbon incentives

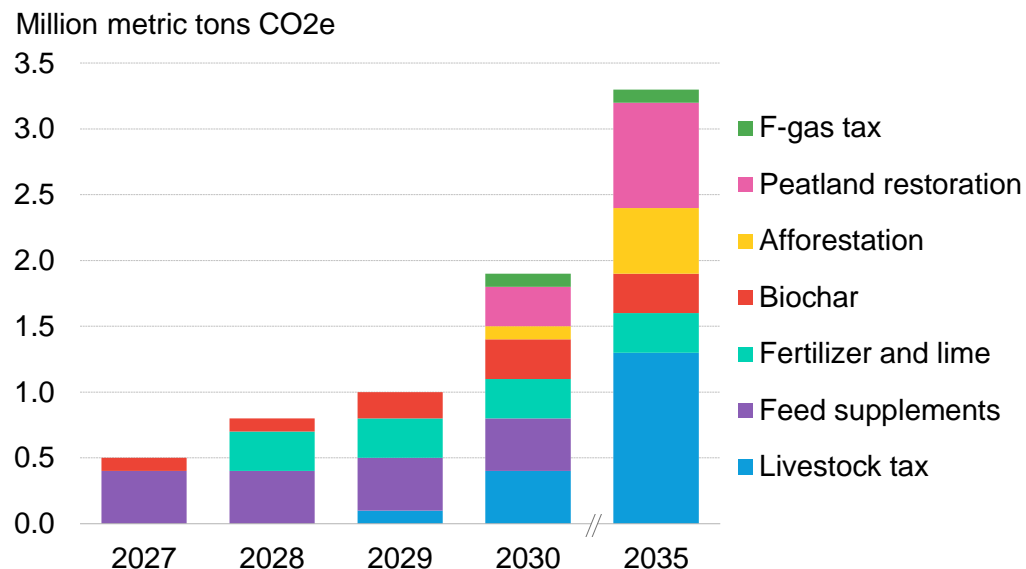
Climate actions covered

<p>2 Support the development of new climate solutions</p>	<p>Support development, commercialization and deployment of technologies that lower enteric methane released by ruminants</p>
<p>3 Phase out carbon-intensive activities</p>	<p>End harmful production subsidies and price supports resulting in over-application of fertilizers, land clearing and residue burning</p>

Denmark low emissions policy package

- Denmark's policy package announced in June 2024 contains a mix of subsidies and levies to address emissions from agriculture and land-use change. If approved by parliament, Denmark will introduce the world's first carbon tax on livestock, the proceeds of which will be used to fund technology development, green initiatives and transitional assistance for affected farmers.
- The pork and dairy industries are Denmark's largest source of agriculture emissions. The livestock tax is meant to reduce these by 400,000 metric tons of CO2 equivalent. Farmers will be charged an effective rate of 120 kroner (\$18) per ton, taking into account an initial 60% tax-free allowance. See: *World-First Danish CO2 Tax to Target Livestock Emissions* ([web](#) | [terminal](#)).
- Fertilizer overuse will be addressed primarily via subsidy, incentivizing precision application and low-carbon nitrogen sources. Farmers who reduce fertilizer emissions will receive 750 kroner (\$112) per ton of CO2e avoided. Fertilizer and liming emissions are expected to decrease by 300,000 metric tons under the policy.

Projected abatement delivered by Danish policy reform



Source: BloombergNEF, Danish government. Note: F-gas (fluorinated greenhouse gas) tax is included in the package but does not pertain to agriculture.

- Additionally, the government has pledged \$1.47 billion toward a biochar subsidy scheme. The ambitious plan aims to achieve 300,000tCO2e abatement by 2030 in the hopes that biochar can become a net negative emissions technology.
- Alongside investment in new technologies and agricultural taxes, the policy will restore agricultural land to nature. Farmers on carbon-rich soils who do not set aside their land for conversion back to natural peatland will be taxed at 40 kroner (\$6) per ton of emissions. Furthermore, subsidized conversion of farmland to forestry aims to lock up carbon across 250,000 hectares, an area more than twice the size of Luxembourg.

Support development of new climate solutions

Singapore gives cultivated meat the nod

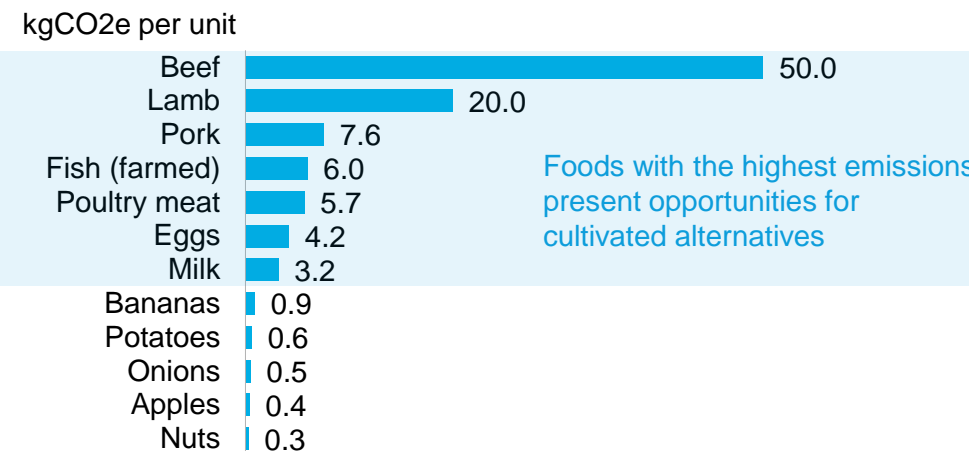
Climate actions covered

<p>2 Support the development of new climate solutions</p>	<p>Provide incentives and regulatory pathways to promote alternative protein production and consumption</p>
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Singapore's novel food regulatory framework

- In December 2020, Singapore became the first economy to approve the sale of cultivated meat when its food agency (SFA) ruled that a lab-grown chicken product was safe for human consumption. While many other regions vacillated over whether to legalize the sale of similar items, the Singaporean government's decision to move forward quickly crowded in investment and created opportunities for food startups.
- A year previously, the SFA developed a novel food regulatory framework to expedite the evaluation of new protein offerings. An expert working group was also convened to advise on toxicology, nutrition, epidemiology and other food safety concerns.
- Government funding helped position the city state as a global leader in alternative proteins, spurring more market development. It provisioned S\$144 million (\$106 million) in 2020 and a further S\$165 million (\$122 million) two years later to bolster R&D efforts for sustainable urban food production, food safety science and innovation.
- Cultivated meats comprise animal cells grown in bioreactors and are distinct from plant-based meats. They have potential as lower-emission protein alternatives to typical meat products. Current consumer demand patterns highlight a reluctance to move away from the familiar taste and texture of beef, lamb, chicken and pork, despite their markedly higher emissions intensity and land footprint.

Greenhouse gas emissions intensity of selected food products



Source: BloombergNEF, *Poore and Nemecek* (2018). Note: Emissions figures are per 100g of protein for animal-derived solids, per liter for milk and per 1,000 kcal for others.

- Eat Just, the startup behind the first lab-grown product, quickly attracted over \$200 million in venture capital, which it invested in equipment and a 30,000 square foot Singapore facility, while selling its faux chicken in small quantities through local channels.
- But as of mid-2024, Eat Just has paused its Singaporean operations, according to The Straits Times. This comes amid a wider 78% slump in VCPE investment into cultivated meat, according to AgFunder News. While startups and investors grapple with technological limitations, concerns over unit economics and consumer scepticism, Singapore serves as a positive example for other regulators to follow. See: *Alternative Proteins: Fake It Till You Make It* ([web](#) | [terminal](#)).

Support development of new climate solutions

Australia invests in tech to measure and manage enteric methane

Climate actions covered

2

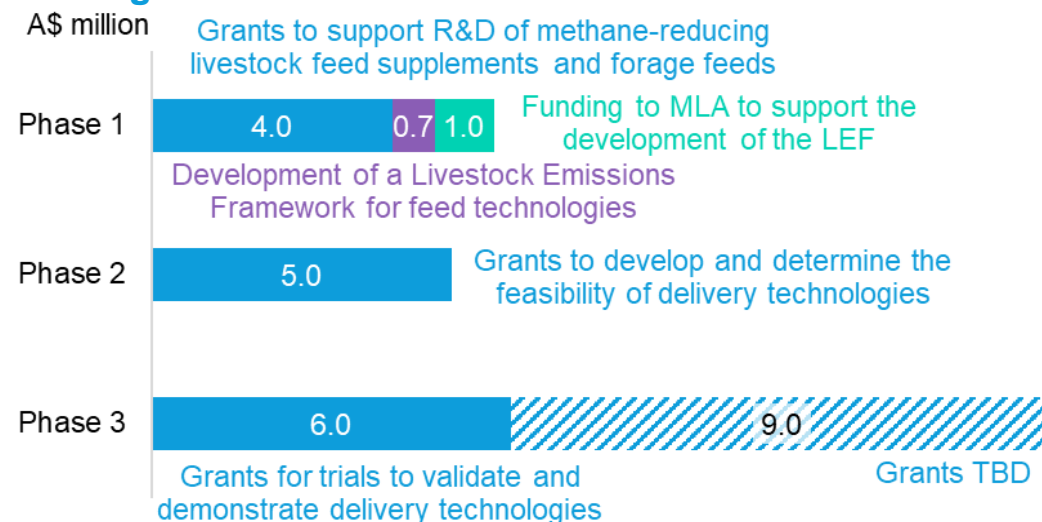
Support the development of new climate solutions

Support development, commercialization and deployment of technologies that lower enteric methane released by ruminants

Australia livestock methane reduction program

- Australia’s Methane Emissions Reduction in Livestock (Meril) program promotes the development and validation of enteric methane-reducing feed additives and delivery technologies for grazing animals. It aims to develop a better understanding of the effect of feed additives on Australia’s agriculture emissions.
- While the initial A\$ 6 million (\$4 million) grant round supported R&D to quantify the abatement potential and productivity impacts of feed-supplements and forage feeds, the final two stages of the A\$29 million (\$20 million) program focus on developing viable delivery options.
- Enteric methane from livestock accounted for 70% of Australia’s agricultural emissions in 2022, according to government data. The vast majority of the nation’s herd graze over large areas, making it difficult to administer the enteric methane solutions available to animals kept in feedlots or controlled environments.
- It is hoped the experience and data collected through the Meril program will promote adoption of feed additives in Australia’s expansive farming systems and inform updates to the Livestock Emissions Framework and National Greenhouse Gas Inventory. The trial findings will be used to populate a model to calculate methane emissions for various feed additives, dose levels, livestock types and grazing systems.

Methane Emissions Reduction in Livestock program funding rounds



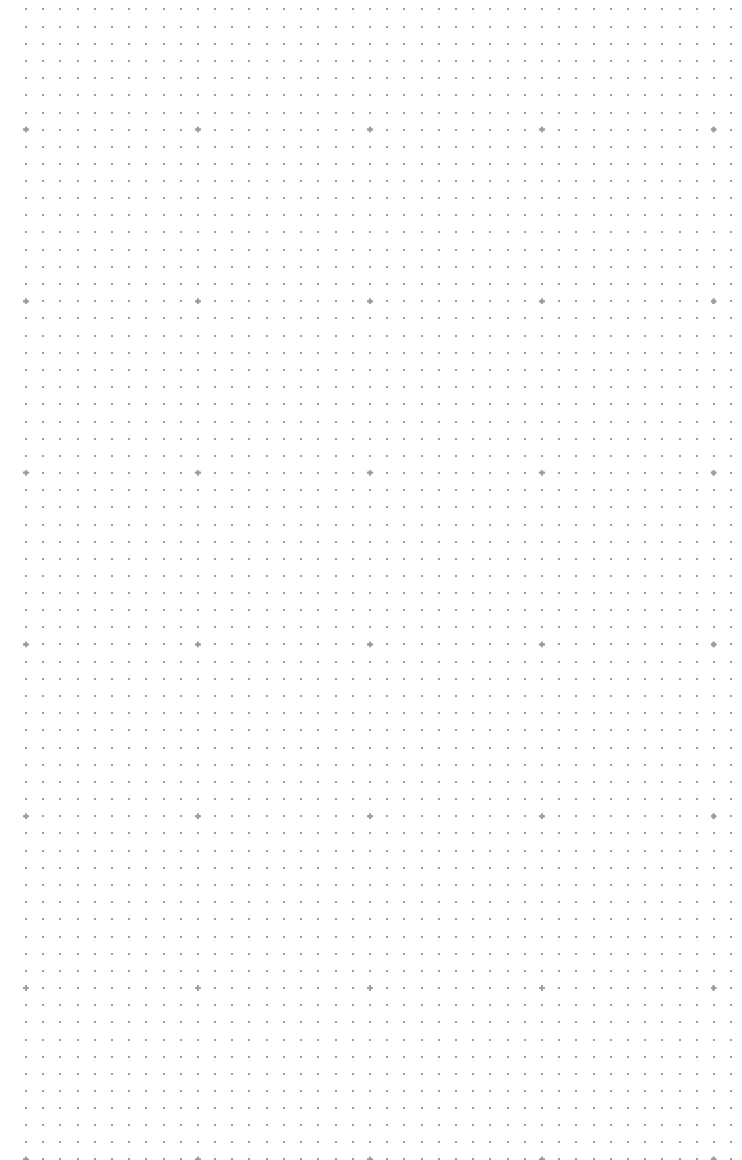
Source: BloombergNEF, Australian government.

Note: Does not include AUD 3 million of unspecified funding. MLA is Meat and Livestock Australia, a levy-funded Research & Development Corporation.

- Australia was already an established leader in methane-reducing feed additives. FutureFeed, a 2023 BNEF Pioneer winner that produces a bromoform feed additive derived from a genus of seaweed known as *Asparagopsis*, was developed by the Australia’s national science lab, Csiro, before being spun out into a private company in 2020. See, [Climate-Tech Startups to Watch in 2023: BNEF Pioneers \(web | terminal\)](#)
- *Asparagopsis* has been shown to reduce methane ruminant emissions by over 80% under ideal conditions. The supplement works by inhibiting the production of methane in the animals’ digestive systems. See: [Tech Radar: Decarbonizing Beef and Dairy Production \(web | terminal\)](#)

PILLAR 3

Phase out carbon-intensive activities



Phase out carbon-intensive activities

Sweeping EU regulation underpins international trade reform

Climate actions covered

3 Phase out carbon-intensive activities	Restrict international trade of good produced on recently deforested land
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European Union deforestation trade regulation

- In May 2023, the EU enacted rules proscribing the trade of seven deforestation-linked soft commodities within the region as part of its flagship Green Deal. Applying from December 30, 2024, the EU Deforestation Regulation prohibits the sale, import or export of cattle, cocoa, coffee, oil palm, rubber, soy and wood – both raw materials and their derivatives – unless they can be proved to be deforestation-free, produced in accordance with local legislation and covered by a due diligence statement.
- Over \$110 billion in imports stand to be impacted by the regulation. Companies placing products onto the EU market must show that they did not entail the conversion of land from forest to agricultural use or involve forest degradation at any time after December 2020.
- The law is the most concerted effort to rein in deforestation, which accounts for almost 12% of total global emissions, according to the IPCC. Between 1990 and 2020, a tenth of the world’s forests – around 420 million hectares – was lost, with agricultural expansion the primary driver. Unlike many other regional laws, the EUDR covers both legal and illegal deforestation.
- To demonstrate the deforestation-free credentials of their products, companies are conducting extensive supply-chain mapping and have begun to deploy satellite technology that enables each commodity to be traced back to its source.
See: *Supply Chains Will Be Challenged by EUDR* ([web](#) | [terminal](#)).

EU imports of commodities covered by the EUDR, annual averages 2018-2022

\$ billion



Source: BloombergNEF, UN Comtrade, Bloomberg News. Note: Trade totals include raw materials and relevant derivatives.

- EU member states will undertake regular checks on operators and traders to ensure compliance. Breaches of the regulation will incur fines proportionate to the damage caused, up to a total of 4% of total company revenue, and potential market exclusion.
- While the European Commission’s own impact assessment report found that that the EUDR will significantly reduce the deforestation footprint of the bloc, its full impact may be diluted as policymakers consider delaying or watering down its most contentious aspects. This is in response to objections from major exporters to the EU, particularly in emerging markets, and several EU member states concerned about the regulation’s costs and reporting burden. A proposed country-level risk labeling plan was delayed in early 2024 after complaints from countries facing the most scrutiny.

Phase out carbon-intensive activities

China's fertilizer subsidy removal cuts agricultural emissions

Climate actions covered

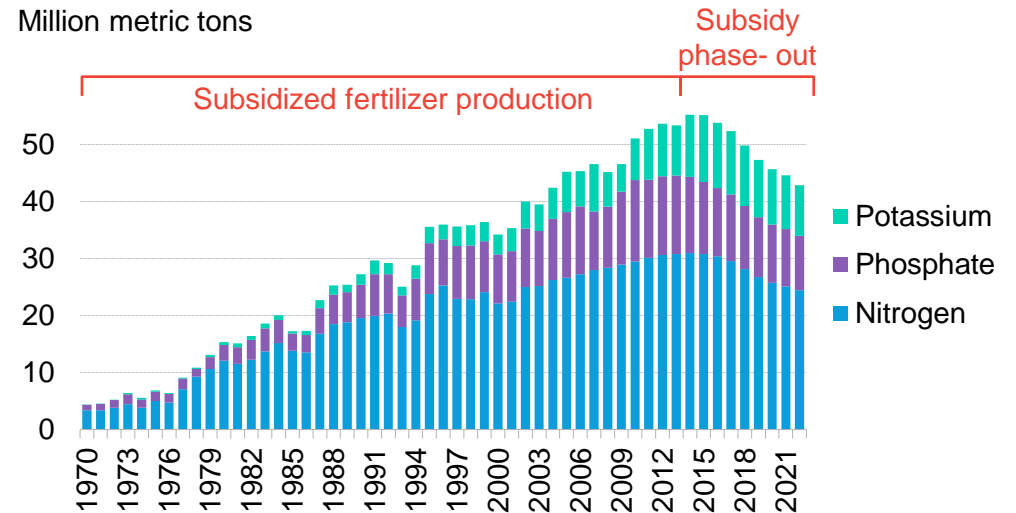
3 Phase out carbon-intensive activities

End harmful production subsidies and price supports resulting in over-application of fertilizers, land clearing and residue burning

China fertilizer reduction and efficiency initiative

- In 2015, China's Ministry of Agriculture and Rural Affairs implemented the Zero Growth Action Plan for Fertilizer Use by 2020, which rolled back its provision of subsidies and preferential tax policies to fertilizer manufacturers. Doing so enabled the economy to lower greenhouse gas emissions without compromising food security.
- Beginning in the 1970s, government support for fertilizers was a key driver of China's agricultural productivity growth and self-sufficiency in staple crops. While subsidies and tax policies increased farmer access to fertilizer, they also resulted in over-application, reaching an average of 409kg of nitrogen fertilizer per hectare in 2015, or 3.4 times the global average. China's total usage increased to 55 million metric tons in 2014, up from four million in 1970. The attendant increases in emissions, eutrophication – excess nutrients in bodies of water – and soil acidification prompted the government to commit to optimizing fertilizer supply through market-based reform and stepped subsidy removal.
- The phase-out of subsidies began in 2015, covering electricity prices, VAT exemptions and rebates, transportation costs and an off-season reserve. Under the initiative, subsidies to fertilizer manufacturers fell from over \$10 billion per year in 2015 to zero in 2018, increasing per unit fertilizer costs for farmers.

Inorganic fertilizer use in China, 1970-2022



Source: BloombergNEF, FAOSTAT. Note: Chart shows total nitrogen, phosphate and potassium fertilizer use in mainland China.

- These actions led to a 3.88 million metric tons of CO2e fall in agricultural emissions, representing around 0.5% of the country's total agri-food system emissions. The reduction is an important contribution from the sector for the market to remain on track to meet its net-zero-by-2060 commitment.
- Critically, China was able to reduce its emissions with a negligible impact on the production volumes of major crops, reaping an 'eighteenth consecutive bumper grain harvest' in 2021. This was achieved through policies that boosted fertilizer use efficiency, including the promotion of more precise fertilization, adjustments to chemical composition, and new application methods.
- For more, see: *Fertilizer Primer: Plant Nutrition Without the Emissions* ([web](#) | [terminal](#)).

Phase out carbon-intensive activities

Deforestation-free Costa Rica issues REDD+ carbon credits

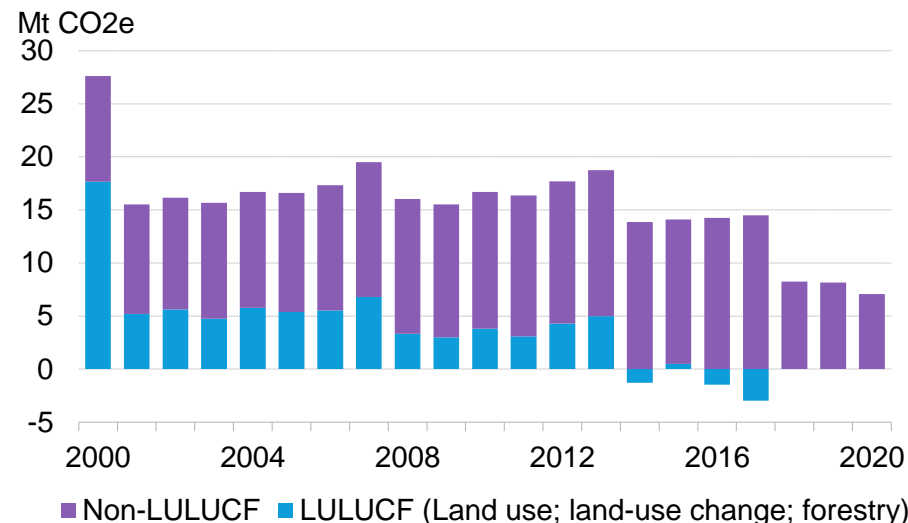
Climate actions covered

3 Phase out carbon-intensive activities	Introduce land sector offset mechanisms and develop agricultural carbon methodologies
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Costa Rica payment for ecosystem services

- Costa Rica introduced one of the world’s first Payment for Ecosystem Services Programs (PESPs) in 1996, when Forest Law Number 7575 was adopted. The National Fund for Forest Financing in Costa Rica (FONAFIFO) operates the program and compensates landowners for providing ecosystem services – the benefits people obtain from functioning natural systems – such as providing habitats for pollinators, water filtration and spaces for recreation.
- Payments are based on the area of primary or replanted forest protected and stipulate a minimum contract period. PESP funding was initially provided by state and international development banks like the World Bank, though recently it has attracted private-sector finance.
- Since introducing the PESP, Costa Rica has halted emissions from land use, land use change and forestry, and in 2017 the state’s forests sequestered almost 3,000tCO₂e. Forest cover was around 25% in 1995, and by 2022 60% of the country was covered in highly biodiverse tropical rainforest. Over 1 million hectares of these forests are under the PESP.
- This has enabled Costa Rica to issue REDD+ carbon credits (a framework paying developing countries for reducing emissions from deforestation). In December 2020, the World Bank signed an agreement to provide Costa Rica \$60 million for delivering 12Mt of emissions reductions out to 2025. Issuance of REDD+ credits could help other jurisdictions finance their own PESPs.

Costa Rica’s GHG emissions by source



Source: OECD, BloombergNEF. Note: Non-LULUCF includes emissions from energy, transport, industrial processes, agriculture and waste. Data on LULUCF emissions not available beyond 2017.

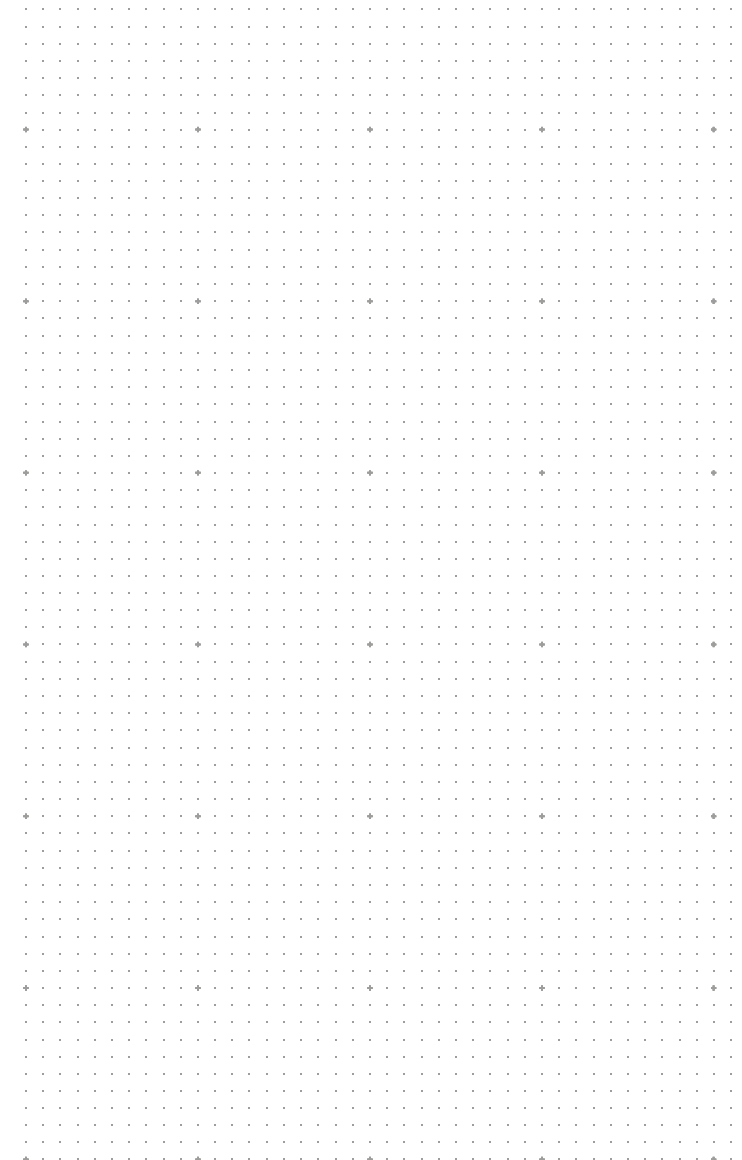
PESP contract structure for selected activities

Activity	Contract term	Total payment per hectare
Forest conservation	10 years	CRC 368,229 (\$702)
Sustainable forest management	5 years	CRC 143,841 (\$274)
Reforestation	5 years	CRC 177,948 (\$339)

Source: FONAFIFO, BloombergNEF. Note: Payments are made in colóns (Costa Rica’s local currency). Data from July 18, 2023.

PILLAR 4

Create appropriate climate transition governance structures



Support development of new climate solutions

Brazil research agency enables fertilizer emissions reduction

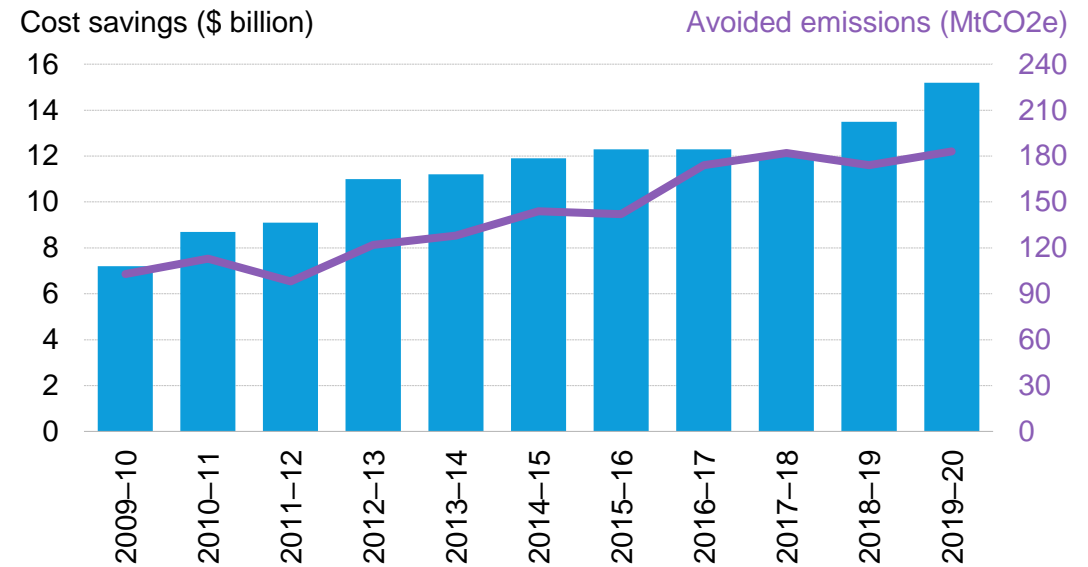
Climate actions covered



Brazil agriculture research agency

- Embrapa, founded by the Brazilian Ministry of Agriculture and Livestock in 1973, was established to ensure domestic food security and to develop international food, fiber and energy markets. The research corporation now has 34 portfolios, many of which focus on climate resilience and emissions reduction.
- Through public and private partnerships, Embrapa finances the deployment of agricultural technologies.
- An example of one such research area is biologicals – a broad category of biologically-derived crop inputs. Embrapa develops low-cost, plant-specific inoculants that mimic naturally-occurring bacteria in the roots of legumes such as soybeans which capture atmospheric nitrogen and ‘fix’ nitrates in the soil.
- The nitrates increase yields without additional emissions associated with synthetic fertilizers. Nitrogen fertilizers, such as urea, break down into nitrates, so are applied to increase yields. During this process, nitrous-oxide is released, contributing 1.15 – 1.56 billion Mt of CO₂e annually. See: *Fertilizer Primer: Plant Nutrition Without the Emissions* ([web](#) | [terminal](#)).

Cost savings and emissions mitigated from use of biological inoculants in Brazilian soybean



Source: BloombergNEF, *Environmental Technology and Innovation*. Note: X axis refers to cropping seasons.

- Inoculants such as those developed by Embrapa have been deployed across 25% of Brazil’s 27.7 million hectares of soybean. By reducing urea use, farmers saved an estimated \$15.2 billion over the 2019 to 2020 harvest, mitigating 183MtCO₂e from Brazilian soybean production. Today, Embrapa’s inoculant portfolio covers other crops with high fertilizer use, including sugarcane, maize, rice and wheat.
- Embrapa estimates Brazil’s bioeconomy industry, incorporating emissions reduction technologies, biomass as an energy source and biologicals could be worth \$284 billion by 2050, providing export opportunities and increasing the climate resilience of domestic agriculture.

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