3 July 2023

Charting Asia's Protein Transition

Defining the region's pathway to protein security and climate safety.

Dave Luo, with guidance from Kate Blaszak

ARE
ASIA RESEARCH & ENGAGEMENT

Asia Research & Engagement (ARE)

ARE is a social enterprise whose mission is to catalyse corporate change through investor-backed engagement. We provide structured collaborative engagement programmes that emphasise dialogue between listed companies, banks, and institutional investors. Our current themes are energy transition and its financing, protein transition, and sustainable real estate. ARE is headquartered in Singapore and was founded in 2013. In 2023, ARE opened an office in Beijing.

Asia Protein Transition Platform

The Asia Protein Transition Platform was launched by Asia Research & Engagement (ARE) in December 2022, in collaboration with five founding investors representing USD 3 trillion in assets. The platform sets a 2030 vision and goals for Protein Transition in Asia, along with investor-expected disclosures for companies to move towards more responsible and sustainable proteins.

Authors **Dave Luo,** with guidance from Kate Blaszak

Editing & comments **Wayne Arnold**

Design **Wondertabs**

Cover photo by **Ivan Bandura**

Acknowledgement

We would like to acknowledge the technical guidance on alternative proteins kindly provided by the Good Food Institute. We note that the final research findings and report are the responsibility of ARE.

Contents

01 Executive Summary 01

02 Introduction 03

2.1. Protein's Rising Risks 03
2.2. Background: A Climate Emergency 06
2.3. Asia's Protein Predicament 07
2.4. Setting Science-Based Targets 08
2.5. The Aim Of This Research 08

03 Methodology In Brief 09

3.1. Scope 09
3.2. Science-Based Modelling 10
What Are "Alternative" Proteins In Asia? 11

04 China 12

4.1. Business as Usual (BAU) Scenario 13
Definition 13
Comparison With Climate-Safe Scenario 14
4.2. Best Case Mitigation (BCM) Scenario 15
Definition 15
Comparison With Climate-Safe Scenario 15
4.3. Protein Transition (PT) Scenario 17
4.4. The Ten Asian Markets In Brief 19

05 Discussion 30

5.1. Priority Actions 30
5.2. Variation Across Markets And Many Eating Excess Meat And Seafood 30
5.3. Enabling Protein Diversification 32
Comparable Projections And Enabling Capital Expenditure For China 32
Enabling Policy And Finance 33
5.4. Other Scenarios For Climate-Safety (China) 36
Complete Mitigation Of Enteric Fermentation And Animal Manure Emissions 36
Exploring Substitution —Seafood Replacing Red Meat Scenario 38

06 Conclusion 40

07 Appendices 41

Methodology In Detail 41
7.1. Climate-Safe Scenario 41
7.2. Consumption Factors 41
7.3. Production Factors 42
7.3.1. Emissions Intensities 42
7.3.2. Production Systems 42
7.3.2.1. Smallholder Vs. Industrial 42
7.3.2.2. Wild-Caught Vs. Aquaculture 43
7.3.2.3. Alternative Proteins 43

01 Executive Summary

To align with Paris Agreement targets and a climate-safe outcome in Asia, the region's production and consumption of protein needs to transition from business as usual. Production of animal protein will by 2030 need to start declining in favour of plant-based and other alternative forms of protein. And by 2060, alternative proteins will in most countries need to account for more than half of protein production. Achieving this will entail dedicated funding, necessitating a sustained commitment by the Asian food industry, investors, and banks.

The Paris Agreement's goal of limiting global warming to 1.5°C cannot be reached without transforming the food system, particularly production of animal protein. Producing the food we eat accounts for one-third of global greenhouse gas (GHG) emissions. Half of those comes from livestock production, primarily from clearing forests to grow animal feed.

Asia has an essential role to play. Home to most of the world's population, Asia's hunger for protein has soared alongside rising populations and rising wealth. Global consumption of protein rose by almost half in the first two decades of this century; Asia accounted for more than 60% of that growth.

Asia's food companies recognise the need for greater sustainability, but pressure for faster and greater progress is building. Consumers increasingly want their food to be healthy and sustainable; demand for alternative proteins is growing. Investors are in turn becoming more averse to environmental risks. As capital markets shift, regulatory pressures are emerging. Asia's leading food companies are responding, but more action is required at all levels to support Asia's transition.

This report quantifies the minimum alternative proteins needed to achieve the region's net-zero climate goals. As a starting point, it updates ARE's earlier projections for greenhouse gas emissions from protein production and consumption in 10 major Asian markets—China, India, Indonesia, Japan, Malaysia, Pakistan, the Philippines, South Korea, Thailand, and Vietnam—from a base year of 2020 through 2060, creating a "Business-as-Usual" scenario, or BAU, for each.

To determine target emissions for each market's protein sector, we rely on recommendations from the Food, Land and Agriculture, or FLAG, Guidance published last year by the Science Based Targets initiative (SBTi), a partnership between the CDP, the United Nations Global Compact, the World Resources Institute and the World Wide Fund for Nature. In addition to eliminating deforestation in the food supply-chain, the FLAG Guidance has quantitative targets for emissions reductions, which we apply to each market to determine a "Climate-Safe Scenario."

We evaluate various means of reducing emissions in the BAU scenario, incorporating ambitious assumptions for mitigation potentials that each contributes to a "Best-Case Mitigation" scenario, or BCM. Lastly, we determine the minimum proportion of lower-emission, alternative proteins that would be additionally required to pull each market's emissions under its climate-safe threshold from a base year of 2020 through 2060—forming a "Protein Transition" scenario, or PT.

A detailed analysis of emissions in China's protein industry serves to illustrate our models. China's huge population and rising demand for protein make it both emblematic of Asia's predicament and a singular challenge: China is the world's largest producer and consumer of animal proteins. Domestic animal production has intensified to astonishing levels, while importing feed for its herds—and financing the trade—are major contributors to South American deforestation.

In a BAU scenario, China's protein consumption and emissions will grow alongside per-capita incomes until 2030, at which point its declining population will result in falling aggregate protein consumption and, with it, lower protein production and related emissions. Even with ambitious mitigation assumptions applied in the BCM scenario, these reductions will be insufficient to bring China's emissions within climate-safe levels. Eliminating deforestation in its supply chains and shifting animal production to clean energy can yield significant additional reductions, but not enough. Similarly, scenarios explored for China to curb all emissions from livestock's enteric fermentation and manure, or simply to swap red meat for seafood, are also inadequate for climate-safety.

To achieve a climate-safe scenario, China will also have to diversify its protein sources. With a projected pathway, alternative proteins—plant-based, fermentation-derived, and cultivated—would need to comprise at least half of China's overall protein consumption by 2060.

Our research yields similar results for Asia's other markets. Even with ambitious assumptions for mitigation, none of the 10 markets we examine will keep its protein-related emissions on target and risk not only climate crisis but also protein insecurity. Most will need to follow China's example by diversifying and upscaling alternatives for at least half their protein needs by 2060.

How much each nation stands to gain from reducing existing emissions depends on demographics, income levels and environment. Indonesia, Malaysia, and Vietnam stand to reap dramatic reductions by eliminating deforestation in their animal feed and beef supply chains. Rising consumption, however, will eventually erase those gains. Japan and South Korea, like China, have declining populations. They will see emissions fall as their appetite for protein ebbs, but not enough to maintain climate safety. In stark contrast are India and Pakistan: with booming populations and incomes, their protein demand is still soaring. Both will need at least 85% of their proteins by 2060 to come from sources other than animals.

Meeting these transition targets is feasible with prompt action, supportive policies—and targeted investment. Our analysis of China's projected alternative protein requirement and the present industry suggests it will need roughly $730 billion in capital expenditure between 2020 and 2060 to build sufficient production capacity in its PT scenario.

We believe this cost is by no means prohibitive provided that policy, corporate strategy and financing align. There are myriad benefits beyond climate to reducing Asia's consumption of meat: lower land, water, animal and antibiotic use, less pollution, avoided deforestation and biodiversity loss, not to mention less risk of diseases linked to industrial production systems and over-consumption of meat. As this report demonstrates, promoting alternative proteins and reducing meat consumption are vital to Asia's climate and protein security. Asian banks, food companies and governments must help to enable the Protein Transition by integrating and scaling alternative proteins into sustainable business strategies and lending frameworks to most effectively deliver protein security and climate-safety.

'We see a great need for this sort of research, providing solution pathways for 10 major Asian market towards climate safety. As novel work for the Asia region, transitional pathways from business as usual are critical for discussions with policy makers, companies and banks to demonstrate needs and opportunities for them to align and support a food system that helps us achieve Paris Climate goals'.

Andy Jarvis
Director of Future Food at Bezos Earth Fund

02 Introduction

2.1. PROTEIN'S RISING RISKS

Emissions from animal protein production and sourcing increasingly jeopardise the food industry, its profitability, and financing. Asian food companies hesitate to set absolute emission reduction targets, however, due to concerns about impeding sales growth and profits. Until recently, they have faced little pressure from shareholders or lenders to approach the issue differently.

That is changing, starting with customers. Consumers in Asia's more developed markets increasingly demand healthier food with a lower environmental impact. While alternative proteins still represent less than 1% of Asia's overall protein diet, a 2021 report by PwC, Rabobank, and Temasek determined that consumers in China and Southeast Asia had reduced their consumption of meat for the previous three years. The same report projected that consumer-conscious behaviour, particularly the desire for healthier and sustainable food, would drive 55% of food spending in Asia by 2030, equivalent to USD 2.4 trillion.[1] European consumers may also be Asian customers. Signals from Europe may also set future consumer and supply chain expectations in Asia, particularly for full supply chain due diligence and responsible marketing. European Parliament recently backed draft legislation to ban misleading marketing and use of carbon offsetting alone for carbon neutral labelling of products in Europe[2].

Investors have been signalling concerns for some time. Many remain focused on the reputational risks to food companies and their stakeholders if they fail to make measurable commitments to reducing negative supply chain impacts. Equally dangerous is exaggerating or misrepresenting that commitment—greenwashing—which can cause reputational damage and have legal consequences.

[1] https://www.theasiafoodchallenge.com/
[2] https://www.europarl.europa.eu/news/en/press-room/20230505IPR85011/parliament-backs-new-rules-for-sustainable-durable-products-and-no-greenwashing

Figure 1: Key climate risks for the agriculture and aquaculture sector

	Risk	Summary
Transition Risks	Increasing carbon price	Implementing carbon taxes could raise production and operating costs for carbon-intensive agriculture.
	Public policy restrictions	Governments could implement policies targeting industrial farming, pasture expansion, deforestation, and oil palm plantations.
	Advancements in less carbon-intensive technology	Traditional producers could face competition for resources and market share from companies using less carbon-intensive technologies.
	Shift in market preferences	Rising awareness of the industry's large carbon footprint could prompt consumers to shift further to sustainable alternatives.
	Growing investor action	Increasing concern about climate risks could prompt greater action by investors to compel companies and banks to reduce emissions and other impacts.
	Rising reputational risk	Companies and banks linked to agricultural activities contributing to climate change, such as deforestation, are increasingly vulnerable to backlash from investors, civic organisations, and consumers.
Physical Risks	Droughts and heat stress	Heatwaves and droughts threaten animals, crops, and agricultural workers, potentially reducing supplies of feed, water and livestock.
	Extreme storms and flooding	Extreme storms and floods endanger crops, pastures, workers and related infrastructure, reducing supplies of feed and animals.
	Sea level rise	Rising sea levels, associated flooding and saltwater intrusion reduce biodiversity and soil quality, damaging crops, pastures, and related infrastructure .
	Wildfires	Increasingly frequent and severe wildfires threaten crops, animals, workers, and related infrastructure.
	Ocean acidification	Increasing acidity in the oceans due to climate change threatens marine biodiversity by compounding pollution and creating aquatic dead zones.
	Invasive species and infectious diseases	Invasive species reduce the resilience of agricultural systems and hasten biodiversity loss, spreading infectious diseases and compromising food security and public health.

Source: UNEP FI, Climate Risks in the Agriculture Sector, refined by ARE.

As climate change's impact becomes clearer, investors are voicing concern about the tangible business and financial risks posed by environmental exposure in food supply chains (See Fig. 1). Companies producing vulnerable commodities such as soy, other raw feed materials, and livestock are at even greater risk.[3]

Many institutional investors are actively assessing their portfolios for protein, climate and deforestation risks, and demanding companies diversify their protein mix[4]. They are also insisting on science-based climate commitments from companies, including a public Zero Deforestation Commitment that verifies deforestation-free supply chains.[5]

Environmental concerns are not limited to equities; bondholders are increasingly sensitive to environmental risks to corporate creditworthiness. Major international banks, moreover, are committing to net zero emissions targets and sustainable lending frameworks (see page 34). Asia's financial regulators are working alongside them to build the framework for sustainable finance and create a level-playing field.[6]

Regulatory requirements are also rising. Asian stock exchanges are encouraging climate disclosures and commitments. Singapore already requires sustainability reports, Hong Kong has proposed tightening climate-related disclosure rules next year, and South Korea will in 2025 start requiring ESG disclosure.

Capital markets are evolving to reflect the environmental costs imposed and the risk in turn that climate change poses to industry and its financing. Animal protein producers unwilling to prioritise emissions reduction will eventually face higher capital costs. Asia's banks, meanwhile, must confront their role in underwriting deforestation and reduce exposure to volatile sector facing rising climate-related risk.

Leading Asian food companies are setting emission targets, committing to zero deforestation in supply chains, and diversifying into alternative proteins. Many are collaborating with regional start-ups to expand and improve their range of alternative proteins, with the best setting ambitious goals (See page 34).

More needs to be done at every level to facilitate Asia's transition to a protein system that meets its growing needs, safeguards the environment, and improves the health and welfare of people and animals. A climate-safe protein transition can do both, helping the region achieve emissions reduction goals, while alleviating public concerns about industrial farming and excessive meat consumption in favour of a healthier, balanced, and sustainable diet.

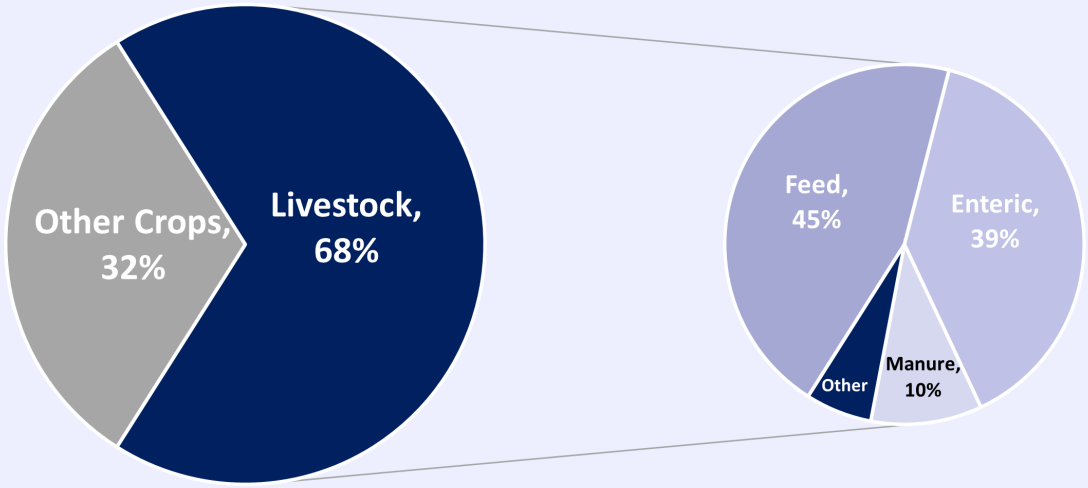
Production and sourcing companies must set targets for eliminating deforestation, prioritise effective mitigation strategies, and diversify protein output, sourcing, and sales. Asian policy makers should incentivise them by reviewing food, agriculture, and nutrition policies and redirecting subsidies to protein transition. Banks have a vital role to play by establishing sustainable lending frameworks that incentivise this transition, and committing to their own climate and anti-deforestation targets.

[3] https://www.fairr.org/resources/reports/coller-fairr-protein-producer-index-2022-23-asia-trends-report
[4] https://cdn-group.bnpparibas.com/uploads/file/bnpparibas_csr_sector_policy_agriculture.pdf; also https://www.fidelityinstitutional.com/static/master/media/pdf/esg/deforestation-framework.pdf; https://cdn-group.bnpparibas.com/uploads/file/bnpparibas_csr_sector_policy_agriculture.pdf; https://www.columbiathreadneedle.hk/en/intm/insights/food-security-challenges-put-spotlight-on-sustainable-transition/; https://www.avivainvestors.com/en-gb/views/aiq-short-reads/2022/03/sustainable-diets/ https://asiareengage.com/wp-content/uploads/2022/12/Expected-Disclosures-and-Recommended-Goals-for-Asian-Food-Companies.pdf
[5] https://climatechampions.unfccc.int/leading-financial-institutions-commit-to-actively-tackle-deforestation/
[6] https://www.mas.gov.sg/news/media-releases/2023/industry-taskforce-launches-third-consultation-on-green-and-transition-taxonomy

2.2. BACKGROUND: A CLIMATE EMERGENCY

The United Nations Climate Change Conference in Dubai later in 2023 will, for the first time, include discussions on the urgent need to change how we produce, distribute, and consume our food.[7] That food has finally landed on the agenda of the 28th Conference of the Parties—or COP28 as it is commonly known—is a long-overdue acknowledgement of our food system's tremendous impact on the climate and the essential need to transform it to meet the Paris Agreement Goal.[8]

Figure 2: Emissions from livestock production (excluding seafood), by source



Source: ARE analysis from UN Food and Agriculture Organisation (FAO) 2018

The stakes are high: The 2015 Paris Agreement on climate change established a goal of keeping the mean global temperature from climbing by more than 1.5°C above pre-industrial levels. But the report for policymakers from the Intergovernmental Panel on Climate Change (IPCC), released in March 2023, warned that existing policies—from carbon taxes to emissions trading—have failed.[9] The growth of new emissions still outpaces progress in reducing them. In May, the World Meteorological Organisation warned that the odds of exceeding the 1.5° limit within the next five years had climbed above 50:50.

Determining the most effective measures for reducing GHG emissions in the food system, however, requires understanding where those emissions are concentrated throughout the entire value chain. Production accounts for 68% of total food system emissions.[10] The majority of this comes from livestock production, as Figure 2 shows. The main sources of livestock emissions are from feed production, enteric fermentation, and animal manure.

While meat, dairy, farmed fish, and eggs account for only 18% of the calories we eat and 37% of our protein intake, livestock production emits more GHGs than all other edible crops combined.[11] Industrial animal production is the leading emitter of GHGs and pollution, and the leading driver of deforestation and biodiversity loss.[12] It uses more land, water, animals, and antibiotics than any other industry, producing and spreading infectious diseases and antibiotic resistance, often related to the poor conditions in which animals are bred and raised. The World Bank's 2023 report "Detox Development," highlighted how livestock subsidies exacerbate these problems, harming people, animals and the planet.[13]

[7] https://www.cop28.com/en/
[8] Clark et al. (2020), Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. https://www.science.org/doi/10.1126/science.aba7357
[9] https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf
[10] https://www.nature.com/articles/s43016-021-00225-9
[11] https://assets.ciwf.org/media/7432824/ciwf_strategic-plan-revise18-lr2.pdf
[12] https://www.unep.org/news-and-stories/press-release/our-global-food-system-primary-driver-biodiversity-loss https://ipbes.net/assessment-reports/ldr https://ipbes.net/global-assessment
[13] http://hdl.handle.net/10986/39423

Clearing forests to grow food for livestock and build new farms is one of the biggest sources of emissions in animal protein production. The Science Based Targets initiative (SBTi), a partnership between the non-profit CDP, the United Nations Global Compact, the World Resources Institute, and the World Wide Fund for Nature, notes in its Food Land and Agriculture (FLAG) guidance that achieving the Paris Agreement's targets will require eliminating deforestation completely by 2025.[14]

Companies sourcing products such as meat or soy from countries where forests are being cleared, along with banks that support them, are increasingly being linked to that deforestation.[15] Europe has responded by advocating and legislating for deforestation-free products and supply chains. Major international commodity companies have also pledged to eliminate deforestation in soy sourcing, with some revising their deadlines to 2025 to align with SBTi FLAG.[16]

But until food companies and banks adopt Science Based emission targets and a Zero Deforestation Commitment, while verifying their sourcing to ensure it complies, banks, protein producers, manufacturers, retailers, and other end-users risk contributing directly or indirectly to the climate emergency.

2.3. ASIA'S PROTEIN PREDICAMENT

Home to 60% of humanity, Asia not surprisingly supplies more than half the world's animal proteins, both land animals and seafood. In our 2018 report "Charting Asia's Protein Journey," ARE projected that consumption of meat and seafood in Asia was on track to grow 78% by 2050, with corresponding GHG emissions growing almost 90%, to 5.4 billion tonnes of carbon dioxide equivalent (CO_2-e), along with quantified increases in water, land, and antibiotic use.[17]

Meeting the region's soaring demand for cheap animal protein has been met by rapid expansion of industrialised agriculture and animal production—and the emissions they produce. Animal protein production in Asia's more advanced economies (e.g., Japan, South Korea, Malaysia, and Thailand, among others) is already 95% or more industrialised. But Asia's emerging economies —including China, India, Indonesia, and Vietnam—are catching up fast.

Obtaining feed for these animals has an even wider impact, as the region clears its own forests and increases emissions cultivating soy, maize, palm meal, and other raw materials. Asian nations also rely heavily on imported soy for animal feed, and import beef, chicken, and pork from Argentina, Brazil, and Paraguay, and so may export deforestation along these supply chains.

When ARE conducted research for its baseline benchmark for responsible protein sourcing in Asia, none of the 158 Asia-listed protein companies we reviewed had acknowledged the risk of deforestation-linked soy in their supply chains. Asian companies also fared poorly in U.K.-based environmental think tank Global Canopy's annual Forest 500 index, a reference for some investors determining commodity-based deforestation and related human rights concerns.

Since 2018, there have been important data updates and significant advances in Asia and elsewhere towards alternatives to meat, dairy, eggs, and seafood. ARE has in that time also published two reports on the potential in Asia for plant-based protein raw materials and how a shift towards a lower-meat, flexitarian diets can enable land conservation.[18]

[14] https://sciencebasedtargets.org/sectors/forest-land-and-agriculture
[15] https://insights.trase.earth/insights/china-and-eu-risk-importing-illegal-soy-from-brazil-s-atlantic-forest/ https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/Uncovering%20the%20Deforestation%20and%20Climate%20Risks.pdf
[16] https://www.reuters.com/business/cop/cop27-major-food-firms-detail-plans-eliminate-deforestation-by-2025-2022-11-07/
[17] https://asiareengage.com/charting-asias-protein-journey/
[18] https://asiareengage.com/asian-cropportunities-supplying-raw-materials-for-plant-based-meat/; and https://asiareengage.com/exploring-the-appetite-for-alternative-proteins/

2.4. SETTING SCIENCE-BASED TARGETS

Over time, researchers have clarified that protein security cannot be achieved by supply-side mitigation or simply switching to different meats—e.g., from red meat to white meat or seafood (see analysis for China, page 36)—or by further industrialising protein production to make it more efficient.[19]

In 2022, the SBTi released its Food, Land and Agriculture (FLAG) Guidance for what the food industry needs to do to reach a "climate-safe scenario," that is, achieve the Paris Agreement's goal of limiting global warming to no more than 1.5° C.[20] In addition to its finding that deforestation would need to be completely eliminated by 2025, the FLAG Guidance offers companies the first set of science-based targets for reducing emissions and achieving climate safety. The FLAG Guidance advises "reducing emissions 72% by 2050 from base-year levels, using a linear reduction from the most recent year to 2050."[21]

A few Asian food companies have submitted emissions targets to SBTi for validation, and will need to publicly disclose those targets and start reporting annual progress. The journey to becoming truly climate-safe remains a long one that will require a firm commitment from company executives, their shareholders, lenders, and other key stakeholders.

2.5. THE AIM OF THIS RESEARCH

There have been few reports that attempt to enumerate what is needed to achieve protein security in a climate-safe scenario or provide pathways for doing so. Fewer have explored this question for Asia. Our aim is that this report helps fill that void.

Previous reports modelled the transition globally or in other regions. The Global Innovation Needs Assessment platform, for example, conducted a global analysis of protein diversity and found a range of potential economic benefits, including new jobs.[22] Similarly, the collaborative report by the Inter-American Bank and International Labour Organisation found that transitioning to a net-zero economy and switching to healthier, more sustainable diets in Latin America could create 19 million jobs in agriculture and plant-based food production, offsetting the 4.3 million jobs that would likely be lost in livestock, poultry, dairy, and fisheries.[23]

This report supports our Asia Protein Transition Platform.[24] Collaborating with a group of investors that collectively manage around USD 3 trillion, the Platform defines protein transition as a balance of responsible animal proteins and more sustainable proteins. The Platform's 2030 vision for a protein transition in Asia initially states:

> **"Asian food companies contribute to regional and global protein security by growing the share of sustainable proteins and limiting the share of animal proteins from industrial farming and fisheries."**

The Asia Protein Transition Platform envisions large-scale adoption of alternative proteins in addition to reducing industrial animal production's emissions and other negative impacts.[25] What we did not know until conducting this research, however, was just how significant the shift to alternative protein would need to be, nor how much industrial animal production would need to decline. This report makes the first quantitative estimates for how large a role alternative proteins need to play in Asia's future as well as how soon industrial animal protein production needs to peak.

This report outlines new research focused on Protein Transition scenarios as solutions in key markets in Asia, for Asia. It aims to encourage regional companies, banks, and policymakers to integrate a Protein Transition into their strategic planning as they strive to make their supply chains and business models sustainable, supporting biodiversity and public health, protecting natural capital, and meeting their climate commitments.

[19] https://www.chathamhouse.org/sites/default/files/field/field_document/20141203LivestockClimateChangeForgottenSectorBaileyFroggattWellesleyFinal.pdf and http://www.nature.com/doifinder/10.1038/nclimate2353, and https://www.nature.com/articles/s41586-018-0594-0 https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf https://www.researchgate.net/publication/303287111_Reducing_emissions_from_agriculture_to_meet_the_2C_target

[20] https://sciencebasedtargets.org/sectors/forest-land-and-agriculture

[21] Ibid

[22] https://www.climateworks.org/wp-content/uploads/2021/11/GINAs-Protein-Diversity.pdf

[23] https://www.ilo.org/brasilia/noticias/WCMS_752093/lang--pt/index.htm

[24] https://asiareengage.com/protein-transition/

[25] https://asiareengage.com/protein-transition/

03 Methodology In Brief

In “Charting Asia’s Protein Transition,” we updated and expanded our Business and Usual analysis, and explored a combination of mitigation measures to project pathways for protein sectors in 10 major Asian markets - to achieve climate-safety as defined by the SBTi’s FLAG Guidance.

Starting with ambitious assumptions for how a range of mitigation measures might reduce emissions from animal production, we then factored in the massive potential for alternative proteins to further reduce emissions.

3.1. SCOPE

Markets

Because China is broadly representative of regional protein trends and the region’s largest protein market, we devote most of the report to modelling its pathways to climate safety. We then present projected pathways and key findings for Asia’s nine next-largest markets: India, Indonesia, Japan, Malaysia, Pakistan, Philippines, South Korea, Thailand, and Vietnam.

Protein Types

We include dairy and eggs, beef, mutton, pork, poultry, and seafood (wild-caught and farmed) in our models, as well as a range of alternative proteins when broadly projected to become commercially available in each market.

Time Horizon

We extended the endpoint of the SBTi’s deadline from 2050 to 2060 to reflect the fact that food and agriculture are increasingly recognised as a “hard-to-abate” sector that will likely require mitigation beyond 2050.

Impact

Asia’s expanding protein production has a variety of negative effects on the environment, from lost biodiversity, pollution, water scarcity and soil degradation to poor animal welfare, antibiotic resistant bacteria, and infectious diseases. This report, however, confines its discussion to mitigating GHG emissions, though our analysis also includes the impact on emissions of land conversion, notably deforestation.

3.2. SCIENCE-BASED MODELLING

Rather than rely on market-based estimates for growth in protein consumption and production, we used the latest empirical data with science-based projections, combined with technical guidance from The Good Food Initiative (GFI) on alternative protein projections, to determine the trajectory of industrial animal production and the need for priority mitigations and alternative proteins.

While complete details on our modelling process are described in the appendix, our modelling broadly followed steps 1 through 4 for each market:

01

We modelled for protein-related emissions in the BAU scenario with the latest life-cycle data and included all protein types (meat, dairy, seafood, and eggs).

02

We then calculated the excessive emissions between projected BAU emissions and the SBTi FLAG climate-safe level, assuming all increases in future conventional animal protein demand are met with industrial production.

03

Next, we projected how much ambitious mitigation measures stand to reduce emissions from conventional animal protein production towards SBTi's climate-safe level, creating notional "Best-Case Mitigation" scenarios, or BCM.

04

Where emissions in the BCM scenario remained above the climate-safe level, we determined the minimum level of diversification into alternative proteins required in addition to close the gap, creating a "Protein Transition Scenario," or PT.

05

For China, we went further to estimate the capital expenditure required for facilities to produce the necessary alternative proteins through to 2060.

06

For China, we then also explored two separate scenarios: one that envisions the complete elimination of emissions from enteric fermentation and animal manure, and another substituting red meat for farmed seafood.

WHAT ARE "ALTERNATIVE" PROTEINS IN ASIA?

Alternative proteins are substitutes for conventional meat, seafood, dairy and eggs. Many aim to replicate the taste, texture, and appearance of animal products, and are marketed that way. Aside from producing fewer emissions, alternative proteins offer a variety of other environmental benefits, including using less land, energy and water, and no live animals or antibiotics.

There are three types of alternative proteins: plant-based, fermentation-derived, and cultivated meat or seafood. Hybrid products with a combination of alternative proteins also exist, offering a range of taste, texture, sustainability, cost, and price benefits.

Plant-based proteins are derived from soybeans, peas, wheat and other grains or pulses. They are processed to extract protein-rich components that can be used to create meat, dairy, seafood and egg substitutes like plant-based burgers, mince, fish, and dairy alternatives like soy, nut, oat, coconut milk, ice cream and cheese.

Fermentation-derived proteins involve using microorganisms like bacteria or fungi to convert plant-based ingredients into protein-rich products. Precision fermentation products include a more complex process that amplifies proteins like whey to make dairy products without dairy animals.

Cultivated meat and seafood are produced from a small number of animal cells growing in a facility without the need for traditional animal farming. This involves growing muscle, fat, or other cells in a bioreactor to create products like cultivated beef, chicken or seafood.

Not all non-meat proteins are alternative, though. Plant-based products that aren't explicitly marketed as meat replacements (e.g., tofu, bean curd products, wheat, tempeh, beans, pulses, etc.) have been part of traditional Asian diets for millennia. Though plant-based and sustainable, they don't historically function as meat substitutes in Asian food culture. Similarly, soy milk is a traditional beverage throughout East and Southeast Asia. They are—and will continue to be an increasingly important part of—the region's total protein mix.

Language also matters. For example, Chinese refer to "xindanbai" (新蛋白), which directly translates as "new protein" (versus the long history of mock meats in China).

04 China

China exemplifies Asia's challenges. While India's population recently surpassed China's, China remains the largest consumer of animal proteins, and the largest producer of pork, farmed fish, and eggs. It ranks second in producing meat chickens after the United States. China thus faces the same challenges other nations do regarding protein demand and its impact on the environment, but on an unparalleled scale. In addition, retail, restaurants, fast food, and distribution networks have boomed. Animal protein has never been more accessible in China.[26] Per-capita meat and seafood consumption continue to grow.

To improve food and biosecurity, China has rapidly intensified animal production. Vertically integrated companies have outcompeted smallholders, becoming some of the world's largest meat, egg and dairy producers. Swine companies have also built vertically, exemplified in Hubei province with a 26-storey pig farm capable of raising and slaughtering 1.2 million pigs a year.[27]

China now produces 30% of its chicken, 65% of its pork, and 80% of its beef, dairy and, mutton using intensive systems.[28] But the high livestock density has left China's herd vulnerable to recurring end evolving epidemics, including those transmissible to humans such as avian and swine flu. Northern shifts in the pig industry also contribute to African Swine Fever outbreaks which led to the culling of hundreds of millions of pigs, and major economic losses, further consolidating the pork industry.[29] Intensive dairy farms, restricting cows from grass and importing feed, have also decoupled animal-crop cycles, while producing vast quantities of manure and other environmental pollution.[30]

The impact of China's protein demand spreads far beyond Its borders. China is the largest importer and consumer of South American soy, accounting for 55% of the continent's total 2018 soy exports, with roughly 60% of China's soy originating from Argentina and Brazil.[31] This soy feeds China's livestock. Yet few Chinese commodity companies, animal producers, retailers, or restaurants have established verified sourcing or adopted Zero Deforestation Commitments.

Neither have China's banks, which continue to be one of the biggest sources of funding for deforestation-related activity. A 2019 CDP report estimated that up to 40% of the loans made by Chinese banks to the country's soy-related sector between 2013 and 2017, USD 2.1 billion in credit, may have financed deforestation.[32] A 2021 study by Forests & Finance concluded that China's banks were second only to Brazilian banks in funding deforestation, having lent roughly USD 15 billion between January 2016 and April 2020 to companies involved in deforestation.[33]

Public concern in China is rising, however. In 2022, China introduced green finance guidelines, though they are non-binding and criticised for largely ignoring deforestation.[34] Leading Chinese food companies are taking initial steps, evaluating deforestation risks in their supply chains and sourcing soy certified as "deforestation-free."[35] China Mengniu Dairy this year became the first Chinese dairy company to make a Zero Deforestation Commitment.[36]

Chinese authorities and companies have been researching methods to reduce emissions from enteric fermentation and animal manure even longer. The Chinese Communist Party's 13th Five-Year Plan for 2016 to 2020 called for reducing methane emissions from the agricultural sector but did not set quantitative targets or identify specific areas for mitigation.[37] Ultimately, China has set a dual carbon goal, aiming to peak emissions by 2030 and achieve carbon neutrality by 2060.[38]

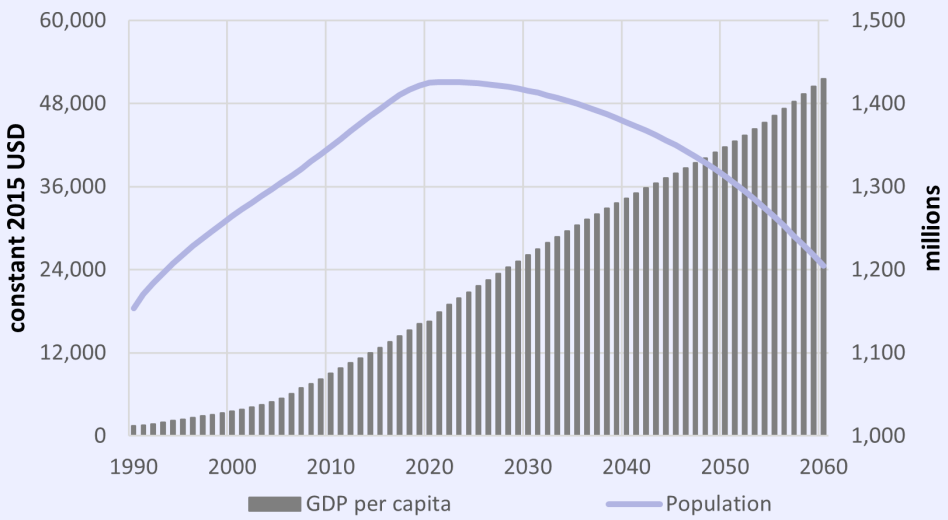
[26] https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/for-love-of-meat-five-trends-in-china-that-meat-executives-must-grasp#/
[27] https://www.theguardian.com/environment/2022/nov/25/chinas-26-storey-pig-skyscraper-ready-to-produce-1-million-pigs-a-year
[28] https://www.eurogroupforanimals.org/news/new-report-presents-key-opportunities-eu-and-china-partner-driving-animal-welfare-and-prevent
[29] https://www.nature.com/articles/s43016-021-00362-1 https://www.frontiersin.org/Community/AbstractDetails.aspx?ABS_DOI=10.3389/conf.fvets.2019.05.00051&eid=6796&sname=GeoVet_2019
[30] https://www.sciencedirect.com/science/article/abs/pii/S0921344922000817 ; also https://www.frontiersin.org/articles/10.3389/fsufs.2020.00044/full
[31] https://www.cdp.net/en/articles/forests/soy-chinas-deforestation-dilemma; also https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/Uncovering%20the%20Deforestation%20and%20Climate%20Risks.pdf
[32] https://cdn.cdp.net/cdp-production/cms/reports/documents/000/004/574/original/CDP_China_soy_finance_research_report.pdf
[33] https://forestsandfinance.org/wp-content/uploads/2021/05/Chinese-banks-forest-risk-financing-1.pdf
[34] https://chinadialogue.net/en/business/chinas-new-green-finance-guidelines-have-a-deforestation-blind-spot/
[35] https://accountability-framework.org/fileadmin/uploads/afi/Documents/Resources/How-to-Write-a-Strong-Ethical-Supply-Chain-Policy-Dec-2020.pdf
[36] http://www.mengniuir.com/pdf/esg/EN_20230425.pdf
[37] https://www.oecd-ilibrary.org/sites/6ddf11b9-en/index.html?itemId=/content/component/6ddf11b9-en
[38] http://en.people.cn/n3/2022/1017/c90000-10159758.html

4.1. BUSINESS AS USUAL (BAU) SCENARIO

DEFINITION

Our projections for China's protein consumption start with estimates of its population and income. Figure 3 shows China's population peaking around 2021, followed by a gradual decrease through 2030, then a steeper decline. Per-capita incomes, measured in purchasing power parity, are projected to rise past USD 50,000 by 2060.

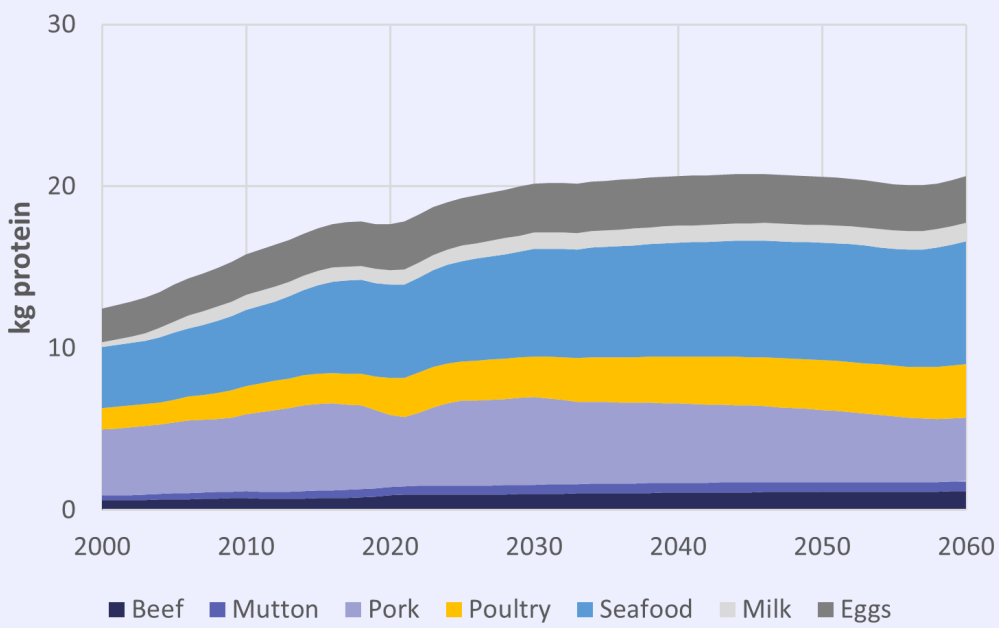
Figure 3: Population and GDP per capita, China



Source: UN Population Division, OECD Long-Term GDP Projections

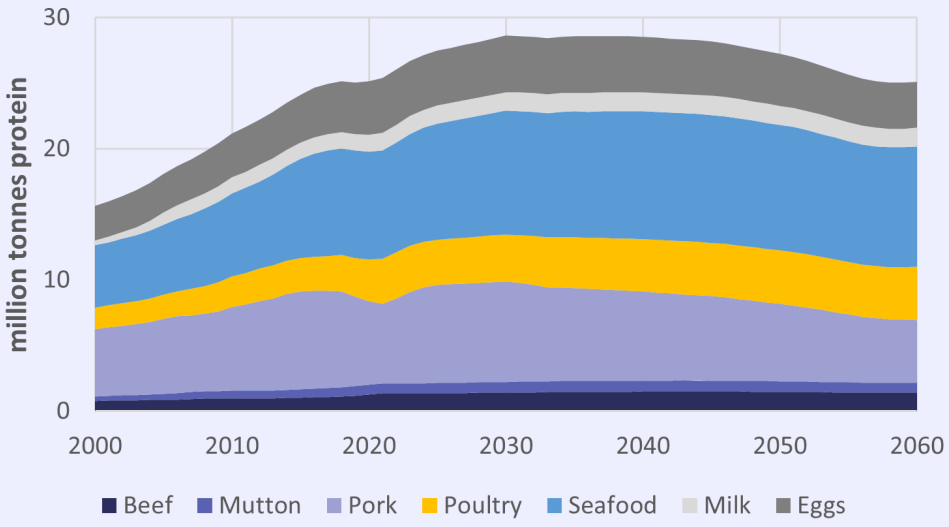
China's per-capita consumption of protein is projected to continue growing rapidly alongside incomes until 2030 when the population peaks, as shown in Figure 4. At that point, per-capita consumption is projected to rise more gradually until 2040, then plateau as higher incomes no longer translate into greater consumption of meat as the population ages. Seafood and pork are projected to remain the two main sources of animal protein, with seafood extending its dominance slightly.

Figure 4: Per-capita animal protein consumption by source, China



The combination of a shrinking Chinese population and peaking per-capita demand for animal protein will translate into a gradual decline in aggregate consumption from 2030, until it stabilises from 2055 onward, as shown in Figure 5. Total consumption will fall even more rapidly from 2030, in line with a steeper decline in the country's population.

Figure 5: Animal protein consumption by source, China

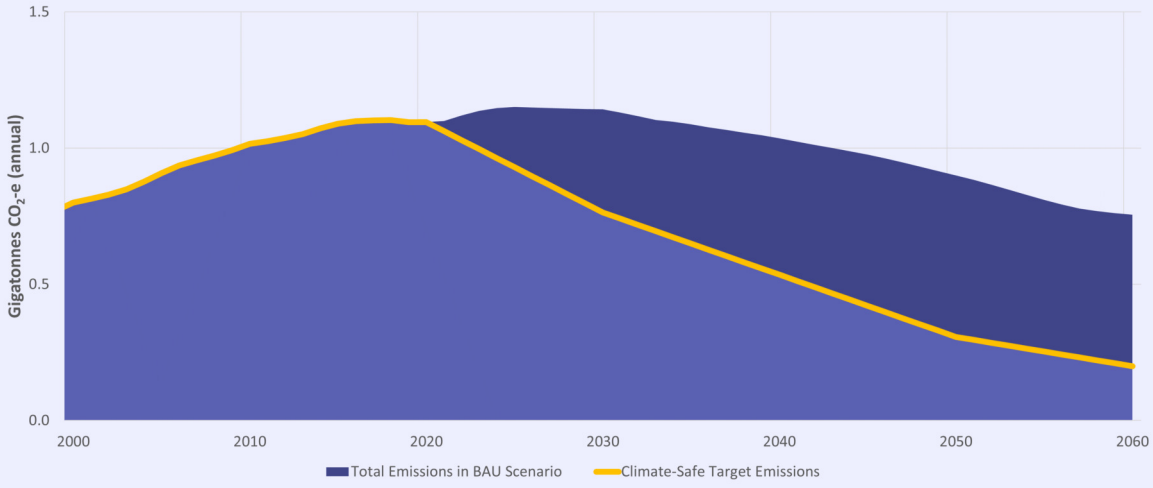


The combination of a 2030 peak in aggregate consumption translates into a corresponding peak in protein production and, with it, emissions. We project that emissions from China's conventional animal production will peak before 2030, which is consistent with its first National carbon goal.[39] A group of Chinese researchers projected in 2021 that emissions were likely to peak in China's agriculture, building, manufacturing, and transportation sectors well before 2030.[40]

COMPARISON TO CLIMATE-SAFE SCENARIOS

As explained earlier, the SBTi's climate-safe scenario requires a reduction in emissions of at least 72% by 2050. A percentage reduction target requires a base year. SBTi allows companies to choose any base year after 2015 for which emissions data is available. We used 2020 as the base year since our estimates for consumption volumes and emissions intensities are from the period 2015 to 2020.

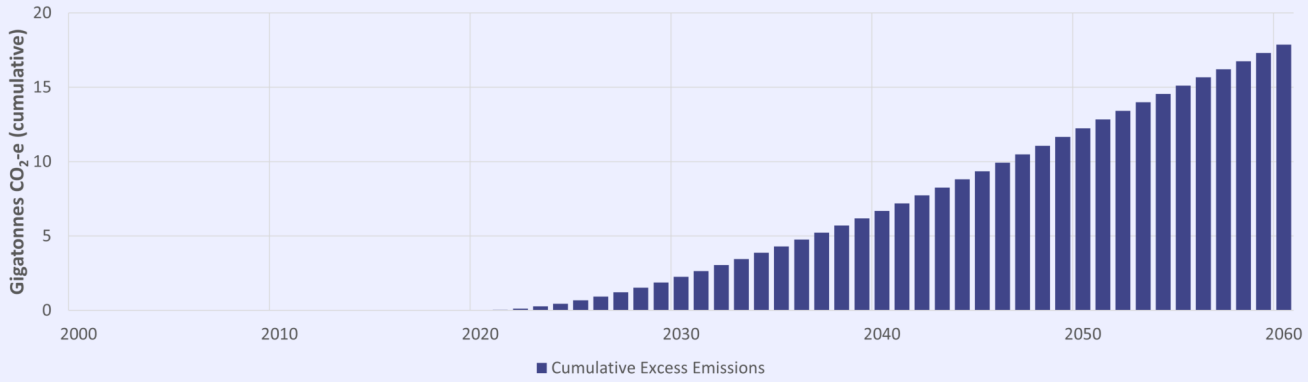
Figure 6: Annual emissions vs. climate-safe level, China BAU



[39] http://en.people.cn/n3/2022/1017/c90000-10159758.html
[40] https://www.sciencedirect.com/science/article/abs/pii/S0306261921013349

We project that China's emissions in a BAU scenario will consistently exceed emissions allowed under the climate-safe scenario, despite projected declines in its population and total emissions. These surplus emissions will widen to almost 0.6 gigatonnes of CO_2-e in the year 2050 (Fig. 6). Cumulatively, China stands to contribute 17.9 gigatonnes of CO_2-e in excess of the climate-safe scenario between 2020-2060, more than double the emissions from all global transport in 2021 (Fig. 7).

Figure 7: Cumulative emissions above climate-safe level, China BAU



4.2. BEST-CASE MITIGATION (BCM) SCENARIO

DEFINITION

"Best-case" might suggest that we intended to apply these mitigation measures at their optimal impact, i.e., immediately and with 100% effectiveness. Our aim was to determine the highest level of mitigation that China might be reasonably expected to achieve within a realistic timeframe to create a "Best Case Mitigation" (BCM) scenario. Although desirable, it would appear unrealistic for instance, for China to eliminate deforestation from its protein supply chain by the SBTi's deadline of 2025. Hence, we apply parameters for elimination by 2030 at the latest. In Figure 8, we list our BCM assumptions for China's conventional protein production mitigation, which we consider ambitious but necessary.

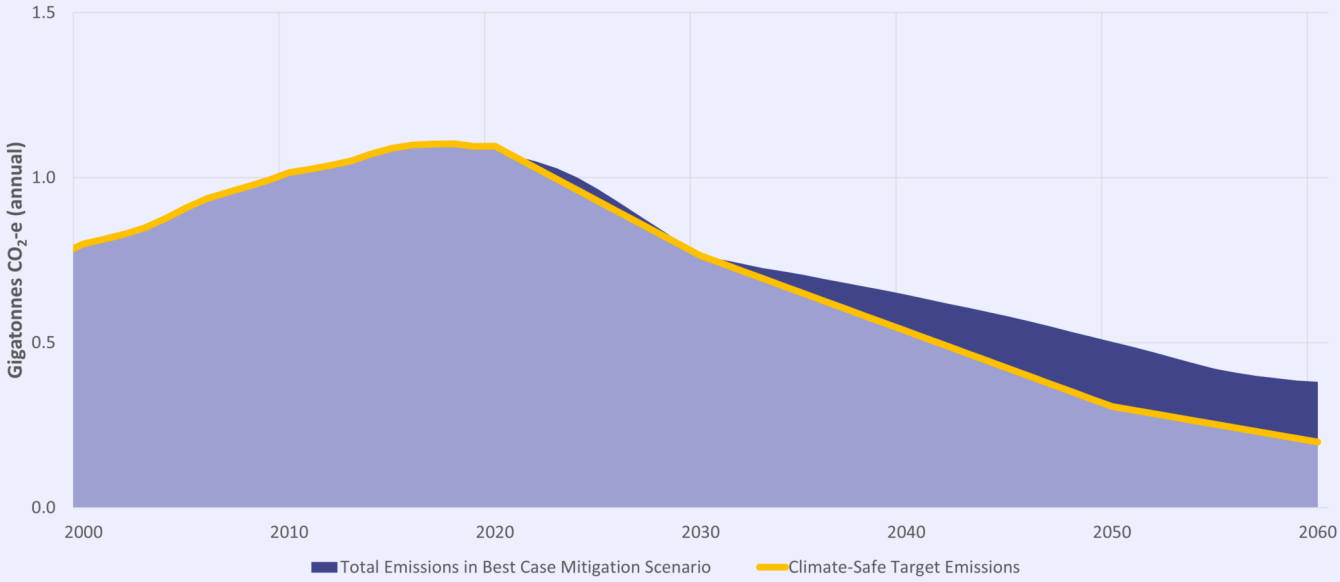
Figure 8: Mitigation parameters for China's BCM scenario

Zero-Deforestation Target Year	2030
100% Clean Energy Target Year	2055
Enteric Fermentation Mitigation (% Reduction by 2060)	40%
Manure Emissions Mitigation (% Reduction by 2060)	40%
Feed Emissions Mitigation (% Reduction by 2060)	40%
Food Waste Reduction (% Reduction by 2030)	30%
All % reduction targets uses 2020 as baseline	

COMPARISON TO CLIMATE-SAFE SCENARIOS

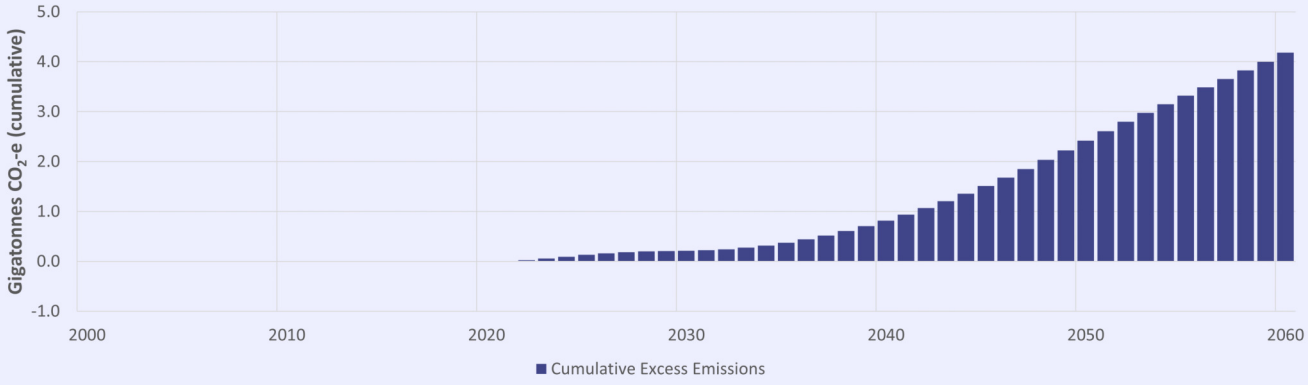
Even if China achieves these best-case targets for reducing emissions from its projected BAU animal production, it will continue to exceed climate-safe targets—albeit by a smaller margin. Eliminating deforestation holds the most promise, potentially narrowing China's excess emissions to almost zero before they resume growing.

Figure 9: Annual emissions vs. climate-safe level, China BCM



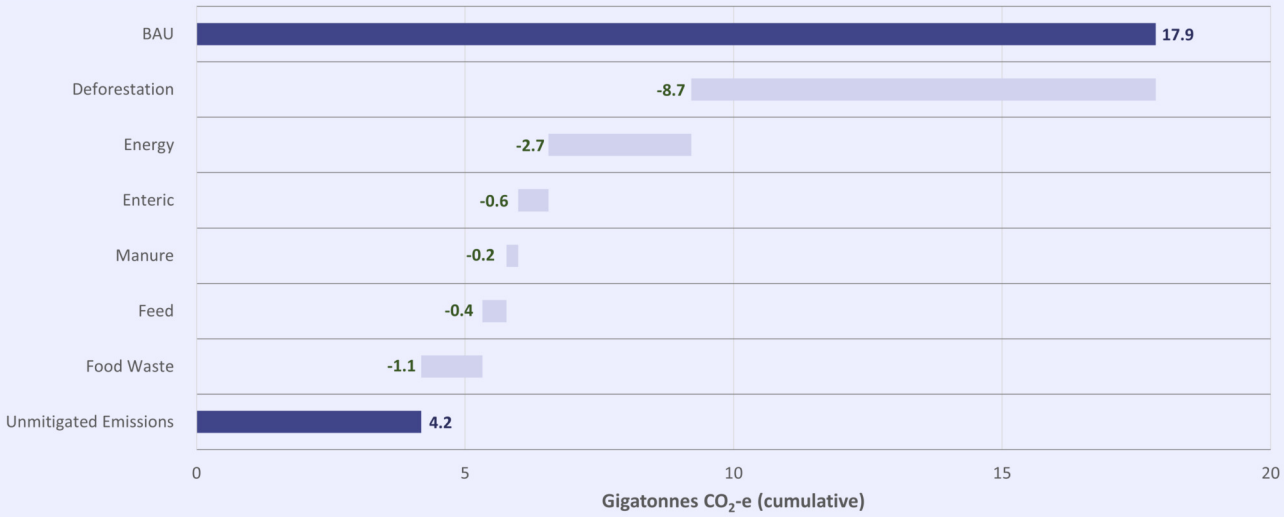
Once zero-deforestation has been reached, other mitigation efforts won't be sufficient to keep China's emission reductions on track. In this best-case scenario, therefore, China's cumulative emissions between 2020 and 2060 would exceed the SBTi's climate-safe goal by 4.3 gigatonnes CO_2-e. That represents a more than 75% improvement in excess emissions than the 17.9 gigatonnes CO_2-e projected in our BAU scenario, but still falls well short of climate safety.

Figure 10: Cumulative emissions above climate-safe level, China BCM



Of the various mitigation measures we examined, achieving zero-deforestation by 2030 and 100% clean energy by 2055 stand to contribute the most potential reductions. Reaching zero-deforestation by 2030 has the potential to lower emissions by 8.7 gigatonnes of CO_2-e, while transitioning to 100% clean energy would save 2.7 gigatonnes of CO_2-e.

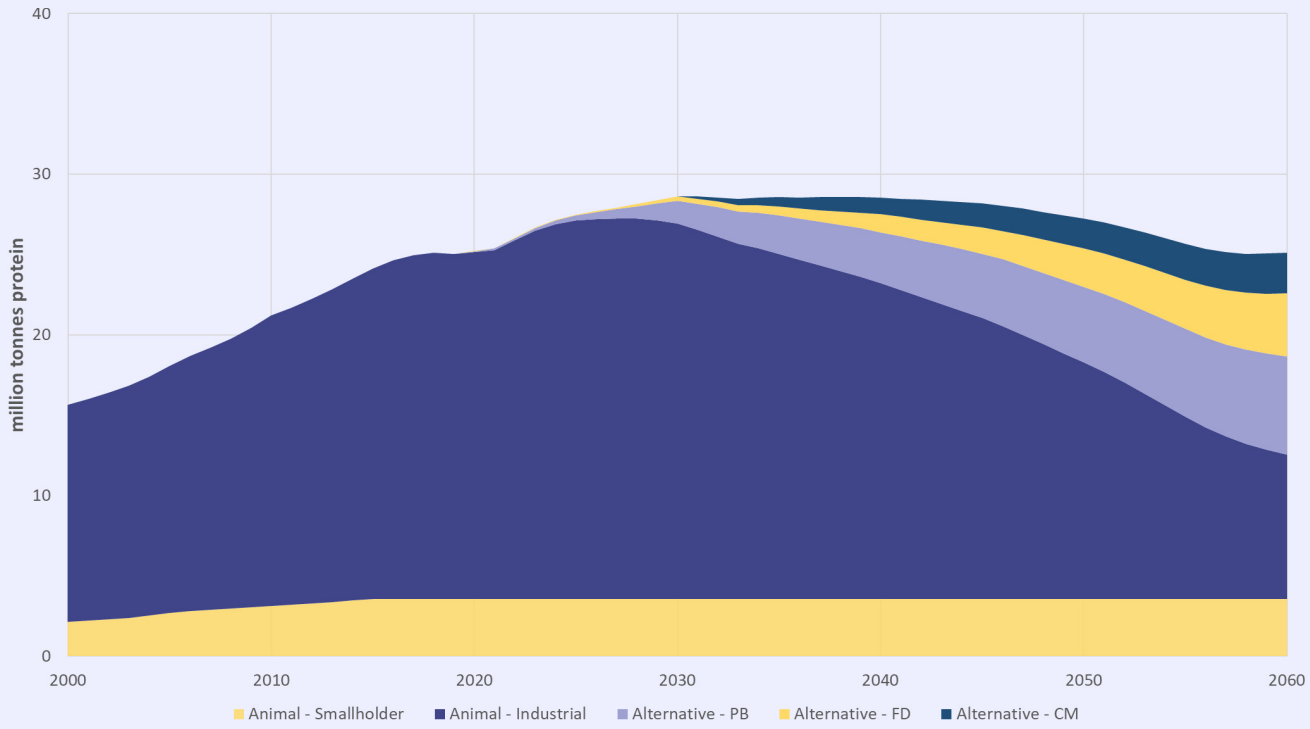
Figure 11: Cumulative mitigation by measure, China BCM 2020-2060



4.3. PROTEIN TRANSITION (PT) SCENARIO

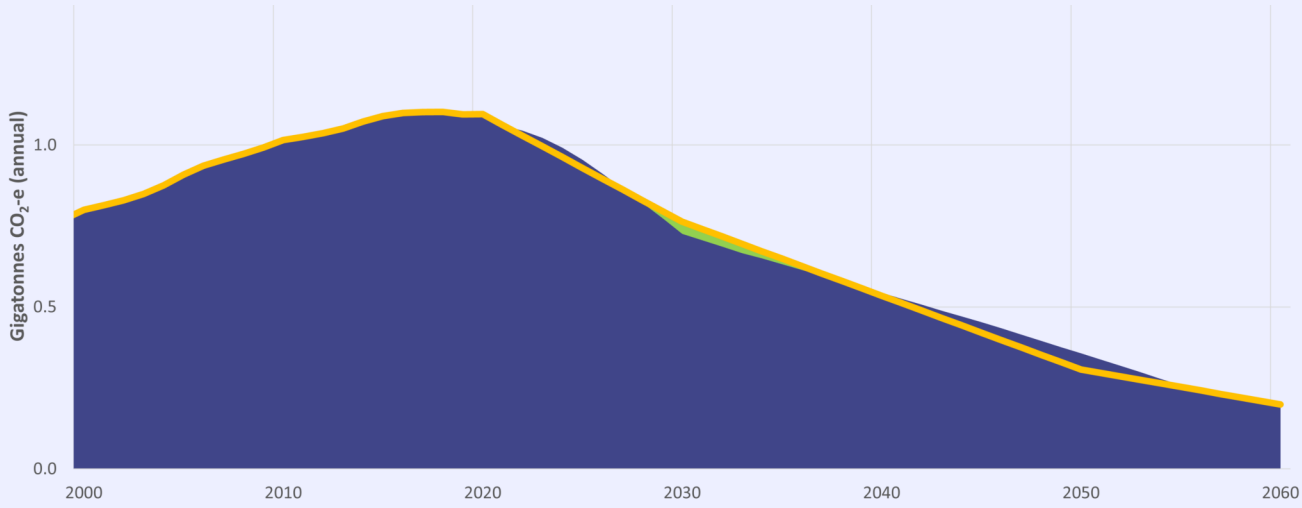
Figure 12 illustrates the mix of proteins required for China to achieve a climate-safe scenario. We project that China will need to rely on alternative proteins for 50% of its total protein consumption by 2060, including 24% from plant-based protein, 16% fermentation-derived, and 10% from cultivated meat or seafood. Note that this is an estimate of the diversification required to bring emissions from China's protein production within climate-safe limits. It is by no means a forecast for how China will diversify, whether because of market forces, policy, or any other influence.

Figure 12: Protein production by type, China PT Scenario



This diversification mix can bring protein-related emissions into alignment with the SBTi's climate-safe scenario, as illustrated in Figure 13.

Figure 13: Annual emissions vs. climate-safe level, China PT



Cumulative excess emissions in this scenario amount to just 0.5 gigatonnes CO_2-e, which can be reduced further with carbon removals and offsets (Fig. 14).

Figure 14: Cumulative emissions above climate-safe level, China PT

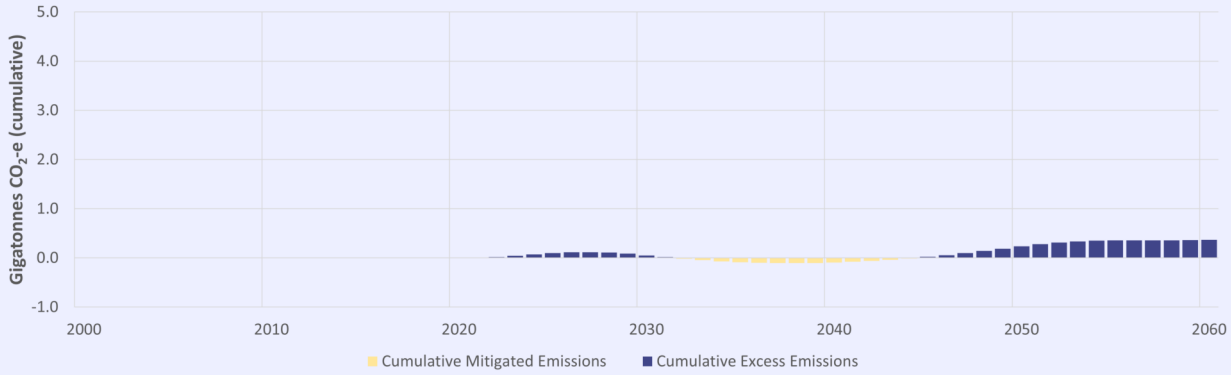
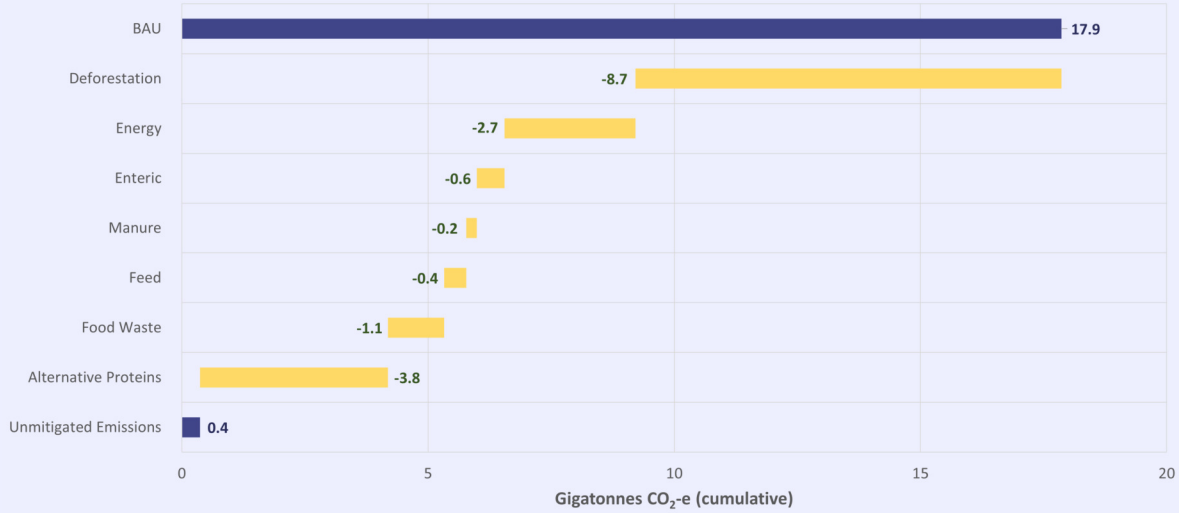


Figure 15 illustrates the contribution from each mitigation measure. Diversification into alternative proteins contributes a reduction of 3.8 gigatonnes of CO_2-e, the second-largest source of emission reductions after eliminating deforestation in the supply chain.

Figure 15: Cumulative mitigation by measure, China PT 2020-2060



Given these results, we determined that the highest priority actions for achieving protein sector climate-safety in China are:

Eliminating deforestation in the supply chain by 2030;

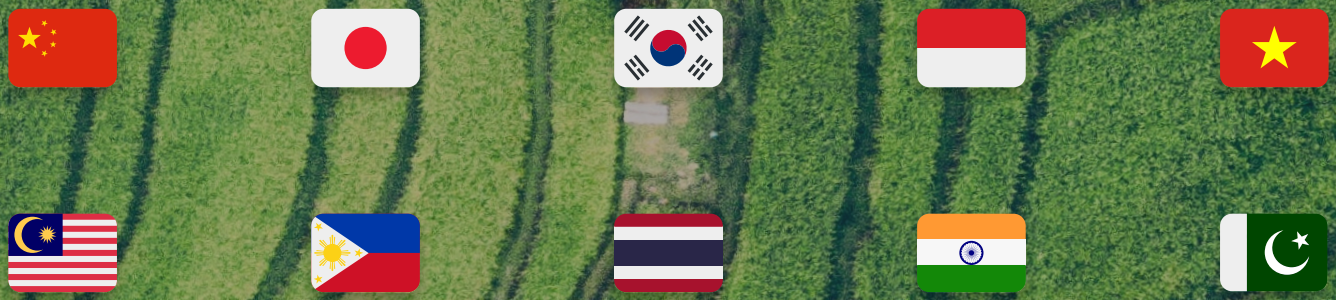
Ensuring that industrial production of animal protein peaks by 2030; and

Diversifying and increasing alternative protein production's market share to 50% by 2060.

These conclusions are broadly consistent with our findings in Asia's other markets. We found that production of alternative proteins would need to grow to between 30% and 90% respective to the specific markets, to achieve climate-safe emission levels. Higher levels of alternative proteins will be required in markets where current animal production contributes less to deforestation, lowering the potential reduction possible by eliminating deforestation in the supply chain.

The specific market findings are provided in one-pager summaries as below.

4.4 The Ten Asian Markets in Brief



ARE
ASIA RESEARCH & ENGAGEMENT

China

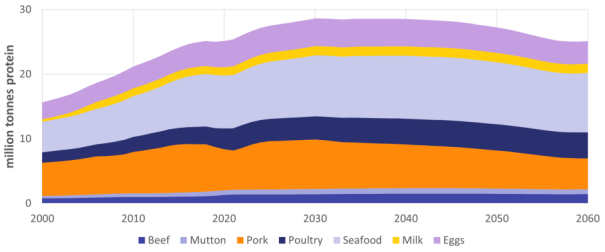
China is the world's largest producer of pork, eggs, fish and the second-largest chicken producer after the United States. Despite a declining population, consumption is projected to grow further alongside increasing per-capita GDP until 2030. China imports 60% of its soy (for animal feed) and 33% of its beef from Brazil, Argentina, and Paraguay, driving massive deforestation. We project China will not be able to decarbonise its protein system without eliminating deforestation, peaking industrial animal production by 2030, and scaling its alternative proteins to 50% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

17.9 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	1,425	1,205	-15%
GDP per Capita (constant thousand USD)	16.5	51.6	+213%
Protein consumption per capita(kg / year)	17.7	20.6	+17%
Total Protein Consumption (million tonnes / year)	25.2	24.9	-1.3%

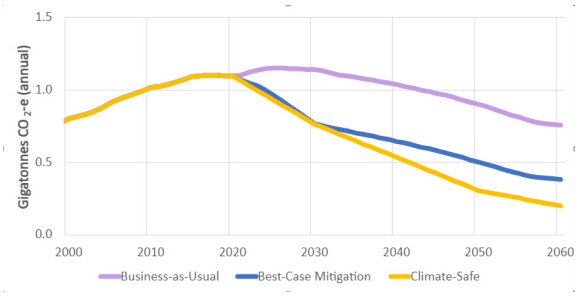
Protein Consumption by Protein Type



BEST CASE MITIGATION

13.7 Gt CO_2-e mitigated, 4.2 Gt CO_2-e remaining

Emissions from Protein Production



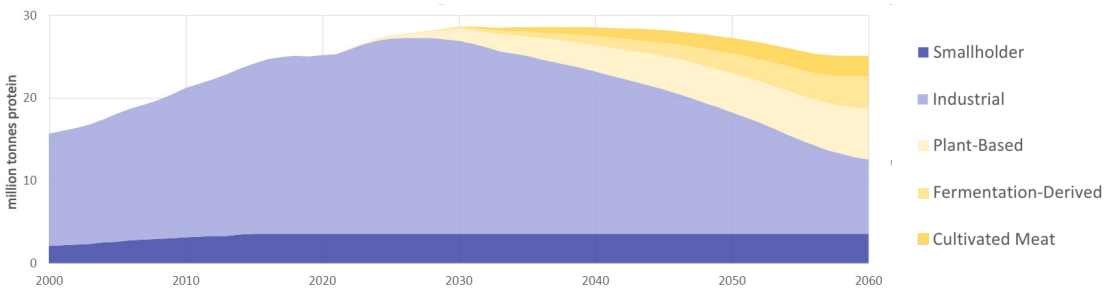
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	8.7
100% Clean Energy	2055	2.7
Enteric Fermentation Emissions	40%	0.6
Manure Emissions	40%	0.2
Feed (non-LULUC*) Emissions	40%	0.4
Food Waste Reduction	30%	1.1

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

3.8 Gt CO_2-e further reduced with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production by 2030
- 50% Alternative Protein by 2060

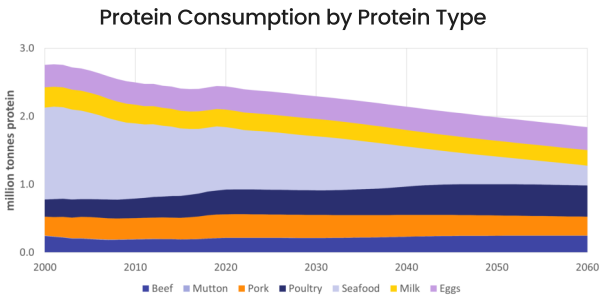
Japan

Japan's animal production is already fully industrialised. Excessive per-capita meat and seafood consumption will almost plateau, while population and total consumption will decline. In 2021, Japan imported ≈13% of its soy (for animal feed) from Brazil, possibly contributing to deforestation. We project that Japan will not be able to decarbonise its protein system without ending growth in industrial animal production ASAP, reducing food waste, and increasing alternative proteins to roughly 45% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

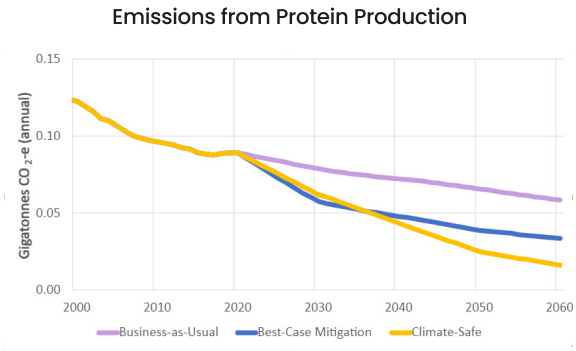
1.6 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	125	97	-23%
GDP per Capita (constant thousand USD)	40.8	65.5	+61%
Protein consumption per capita(kg / year)	19.4	18.9	-2.5%
Total Protein Consumption (million tonnes / year)	2.43	1.83	-25%



BEST CASE MITIGATION

1.4 Gt CO_2-e mitigated, 0.2 Gt CO_2-e remaining



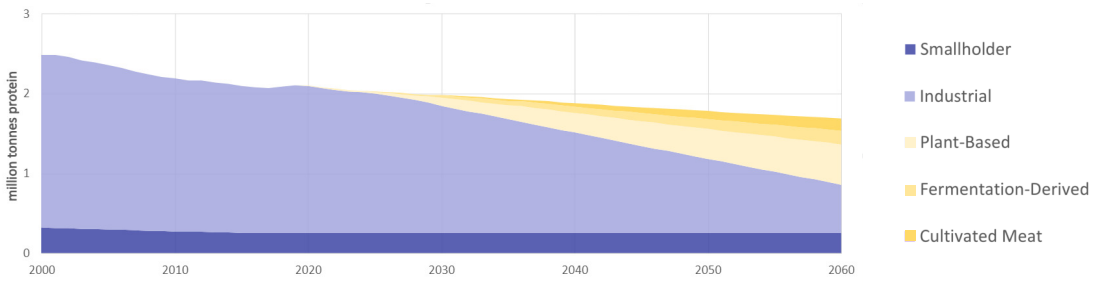
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	0.60
100% Clean Energy	2050	0.26
Enteric Fermentation Emissions	40%	0.04
Manure Emissions	40%	0.02
Feed (non-LULUC*) Emissions	40%	0.02
Food Waste Reduction	30%	0.41

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.3 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- No New or Replacement Industrial Production ASAP
- 45% Alternative Protein by 2060

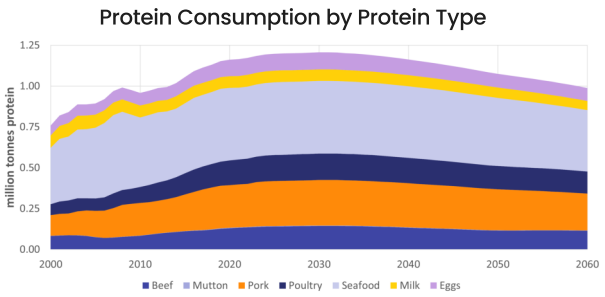
South Korea

South Korea's animal production is already fully industrialised. Total meat and seafood consumption continues to grow then stabilise due to declining population. In 2021, South Korea imported around half of its soy (for animal feed) from Brazil, contributing to deforestation. We project that South Korea will not be able to decarbonise its protein system without ending growth in industrial animal production and deforestation by 2025 and scaling its alternative proteins to around 50% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

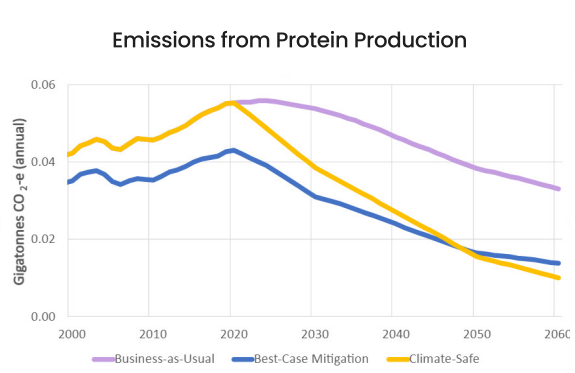
0.7 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	52	41	-21%
GDP per Capita (constant thousand USD)	41.2	70.2	+70%
Protein consumption per capita(kg / year)	22.4	23.9	+6.4%
Total Protein Consumption (million tonnes / year)	1.16	0.98	-16%



BEST CASE MITIGATION

0.6 Gt CO_2-e mitigated, 0.1 Gt CO_2-e remaining



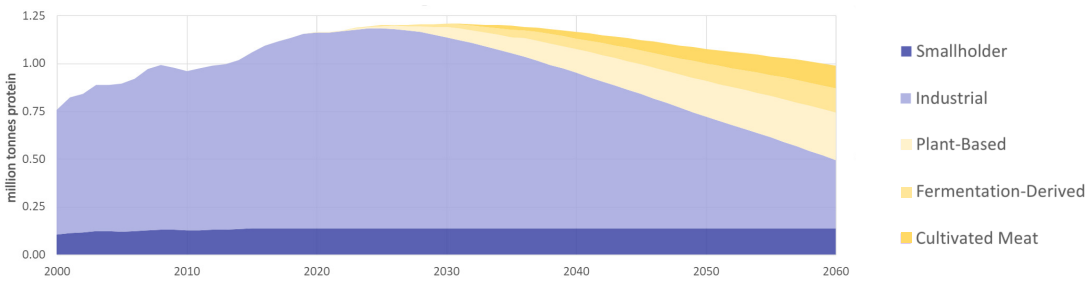
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	0.31
100% Clean Energy	2050	0.14
Enteric Fermentation Emissions	40%	0.03
Manure Emissions	40%	0.01
Feed (non-LULUC*) Emissions	40%	0.01
Food Waste Reduction	30%	0.05

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.2 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production around 2025
- 50% Alternative Protein by 2060

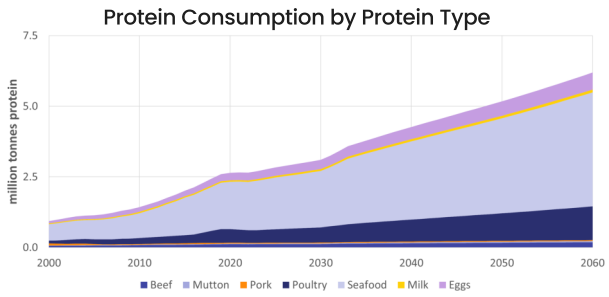
Indonesia

Indonesia's animal protein production–particularly of chicken, dairy, eggs, beef, and fish–is intensifying rapidly. Per-capita and total consumption are growing alongside GDP. Indonesia imports some of its soy (for animal feed) and beef from Argentina and Brazil, but Indonesia's biggest deforestation occurs at home from clearing for pasture and palm plantations. We project that Indonesia will not be able to decarbonise its protein sector without ending deforestation and growth in industrial animal production by roughly 2030 and developing alternative proteins to around 60% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

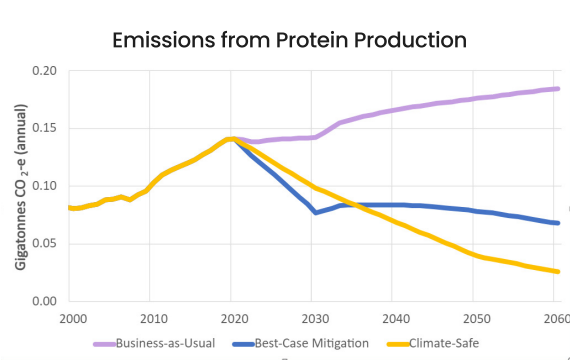
3.7 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	272	319	+17%
GDP per Capita (constant thousand USD)	11.6	38.6	+232%
Protein consumption per capita(kg / year)	9.8	19.4	+98%
Total Protein Consumption (million tonnes / year)	2.67	6.20	+132%



BEST CASE MITIGATION

3.1 Gt CO_2-e mitigated, 0.6 Gt CO_2-e remaining



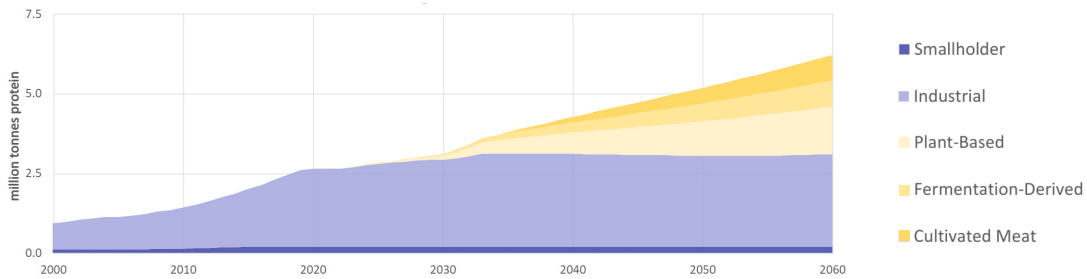
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	2.23
100% Clean Energy	2060	0.57
Enteric Fermentation Emissions	40%	0.06
Manure Emissions	40%	0.03
Feed (non-LULUC*) Emissions	40%	0.04
Food Waste Reduction	30%	0.15

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.6 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production around 2030
- 60% Alternative Protein by 2060

Vietnam

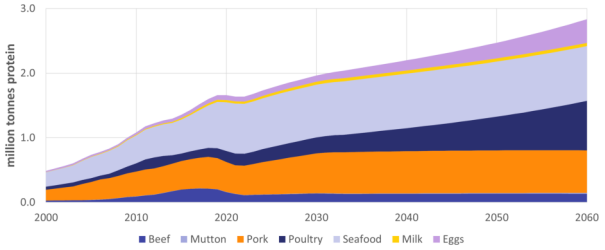
Vietnam's animal production is intensifying rapidly. High per-capita GDP growth is driving consumption of meat and seafood beyond already excessive levels. Vietnam is a large importer of soy (for animal feed) from Argentina. Expansion of local pastures and farms also contributes to deforestation. We project that Vietnam will not be able to decarbonise its protein sector without ending deforestation and growth in industrial animal production by 2030 and boosting alternative proteins to roughly 40% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

2.8 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	97	106	+10%
GDP per Capita (constant thousand USD)	10.5	59.2	+466%
Protein consumption per capita(kg / year)	17.3	26.7	+54%
Total Protein Consumption (million tonnes / year)	1.67	2.83	+69%

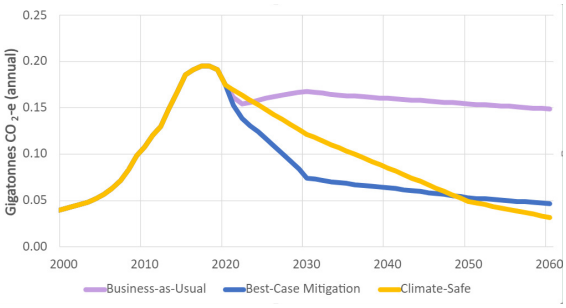
Protein Consumption by Protein Type



BEST CASE MITIGATION

2.9 Gt CO_2-e mitigated

Emissions from Protein Production



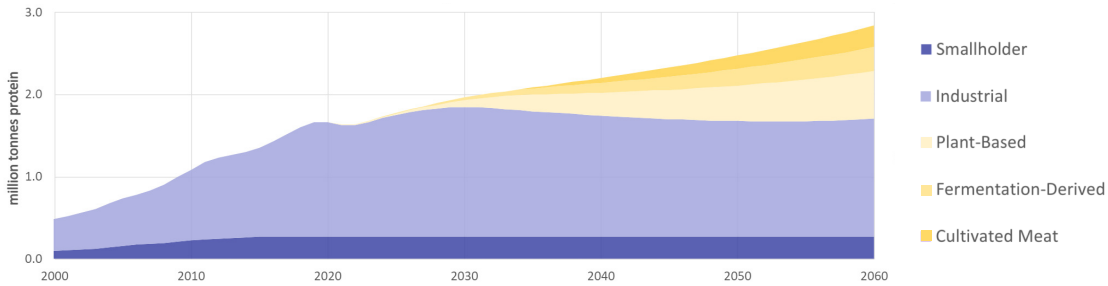
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	2.88
100% Clean Energy	2050	0.32
Enteric Fermentation Emissions	40%	0.06
Manure Emissions	40%	0.02
Feed (non-LULUC*) Emissions	40%	0.05
Food Waste Reduction	30%	0.12

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

1.0 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production around 2030
- 40% Alternative Protein by 2060

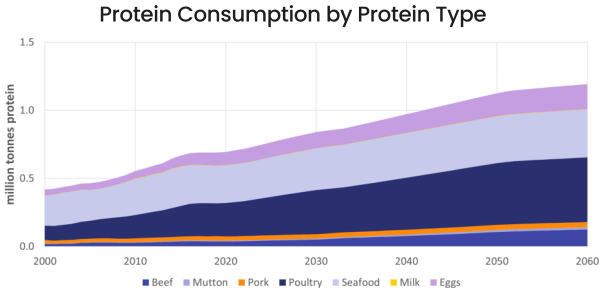
Malaysia

Malaysia's animal protein production is mostly industrialised, particularly of chicken, dairy, eggs, fish, and beef. Growth in per-capita GDP is driving consumption of meat and seafood beyond already excessive levels. Malaysia imports its soy (for animal feed) primarily from Argentina, while local pasture expansion also contributes to deforestation. We project that Malaysia will not be able to decarbonise its protein sector without eliminating supply chain deforestation and growth in industrial animal production by 2030 and boosting alternative proteins to around 50% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

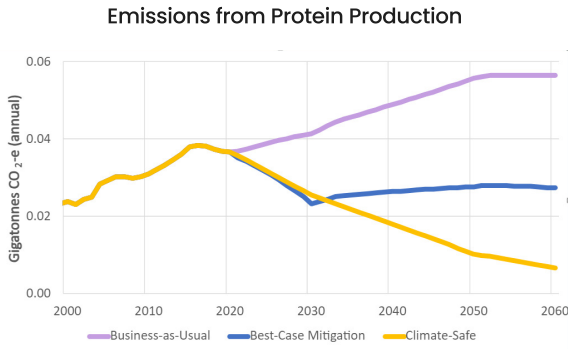
1.3 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	33	42	+27%
GDP per Capita (constant thousand USD)	25.8	63.0	+144%
Protein consumption per capita(kg / year)	21.2	28.4	+34%
Total Protein Consumption (million tonnes / year)	0.70	1.19	+70%



BEST CASE MITIGATION

1.0 Gt CO_2-e mitigated, 0.3 Gt CO_2-e remaining



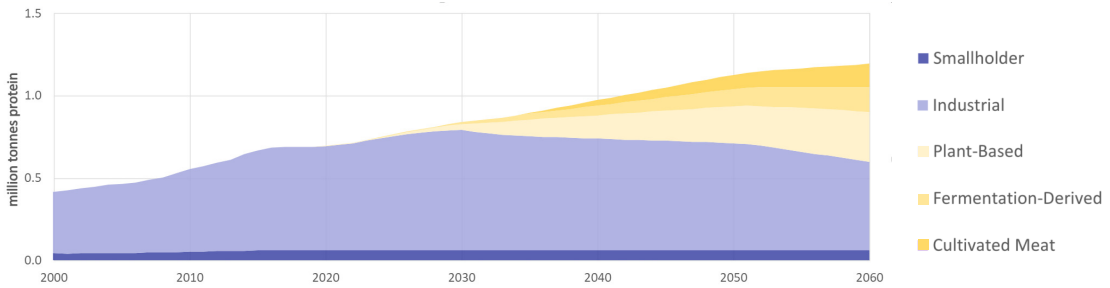
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	0.76
100% Clean Energy	2050	0.17
Enteric Fermentation Emissions	40%	0.03
Manure Emissions	40%	0.01
Feed (non-LULUC*) Emissions	40%	0.01
Food Waste Reduction	30%	0.05

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.3 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production by 2030
- 50% Alternative Protein by 2060

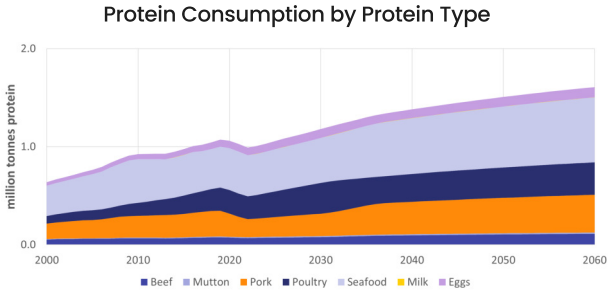
Philippines

Philippine animal production is steadily intensifying, especially chicken, pork, eggs, fish, and beef. Rising population will drive consumption of animal proteins. The Philippines imports around a third of its soy (for animal feed) from Argentina and Brazil, while local pasture expansion also contributes to deforestation. We project that the Philippines will not be able to decarbonise its protein sector without ending supply chain deforestation and growth in industrial animal production by 2030 and boosting alternative proteins to roughly 50% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

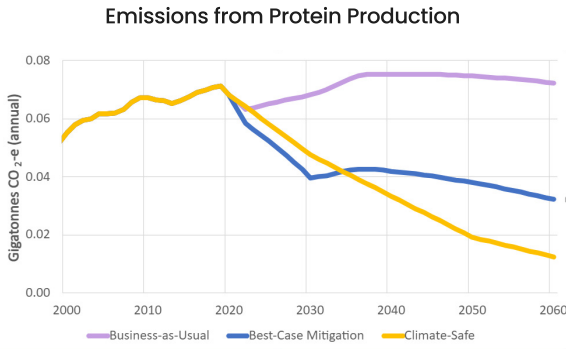
1.5 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	112	168	+50%
GDP per Capita (constant thousand USD)	7.8	26.6	+243%
Protein consumption per capita(kg / year)	9.6	9.6	+0.0%
Total Protein Consumption (million tonnes / year)	1.08	1.62	+50%



BEST CASE MITIGATION

1.2 Gt CO_2-e mitigated, 0.3 Gt CO_2-e remaining



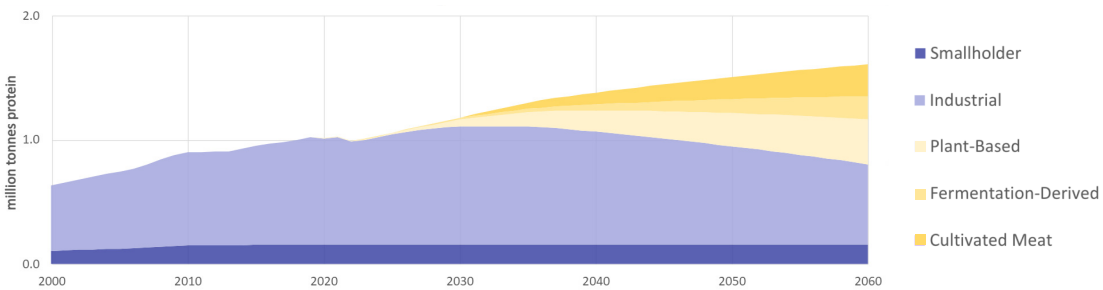
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	0.90
100% Clean Energy	2060	0.15
Enteric Fermentation Emissions	40%	0.03
Manure Emissions	40%	0.01
Feed (non-LULUC*) Emissions	40%	0.03
Food Waste Reduction	30%	0.07

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.3 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production around 2030
- 50% Alternative Protein by 2060

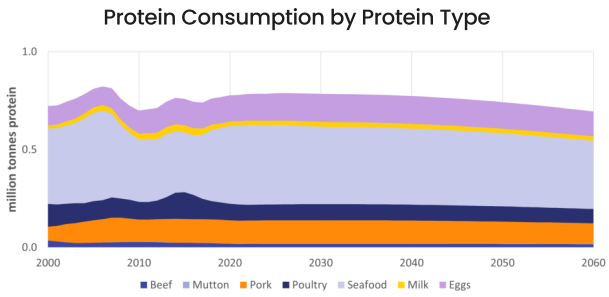
Thailand

Thailand's animal production is largely industrialised. Total consumption will decline with the population. Thailand imports its soy (for animal feed) primarily from Brazil, Argentina, and Paraguay, contributing to deforestation. We project that Thailand will not be able to decarbonise its protein sector without ending growth in industrial animal production ASAP, ending supply chain deforestation by 2030 and boosting alternative proteins to 30% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

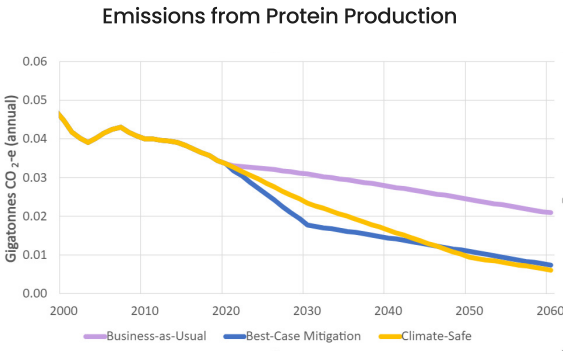
0.4 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	71	63	-11%
GDP per Capita (constant thousand USD)	16.8	52.1	+209%
Protein consumption per capita(kg / year)	10.9	10.9	-0.0%
Total Protein Consumption (million tonnes / year)	0.78	0.69	-12%



BEST CASE MITIGATION

0.5 Gt CO_2-e mitigated



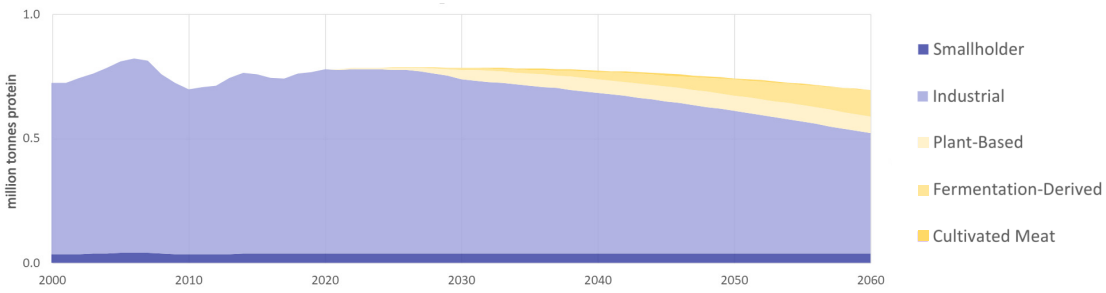
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	0.34
100% Clean Energy	2060	0.09
Enteric Fermentation Emissions	40%	0.01
Manure Emissions	40%	0.00
Feed (non-LULUC*) Emissions	40%	0.03
Food Waste Reduction	30%	0.04

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

0.1 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- No New or Replacement Industrial Production ASAP
- 30% Alternative Protein by 2060

India

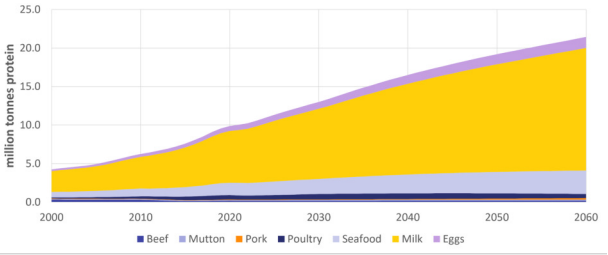
India has a relatively low per-capita animal protein consumption, but massive per-capita GDP growth will drive significant consumption growth. India imports 45% of its soy (for animal feed) from Argentina and Brazil, contributing to deforestation. We project India will be unable to decarbonize its protein sector without ending supply chain deforestation and growth in industrial animal production by 2030 and boosting alternative or traditional plant proteins to 85% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

23.2 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	1,396	1,695	+21%
GDP per Capita (constant thousand USD)	6.0	24.9	+313%
Protein consumption per capita(kg / year)	7.1	12.7	+77%
Total Protein Consumption (million tonnes / year)	10.0	21.5	+115%

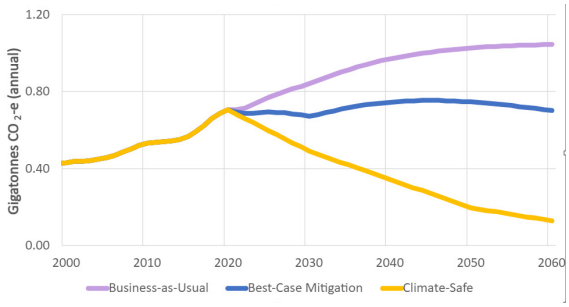
Protein Consumption by Protein Type



BEST CASE MITIGATION

7.6 Gt CO_2-e mitigated, 14.6 Gt CO_2-e remaining

Emissions from Protein Production



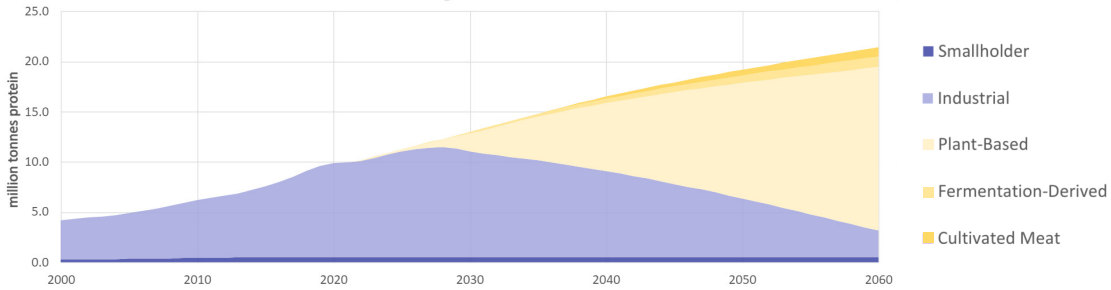
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	4.82
100% Clean Energy	2060	1.24
Enteric Fermentation Emissions	40%	0.84
Manure Emissions	40%	0.12
Feed (non-LULUC*) Emissions	40%	0.21
Food Waste Reduction	30%	1.35

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

11.9 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production by 2030
- 85% Alternative Protein by 2060

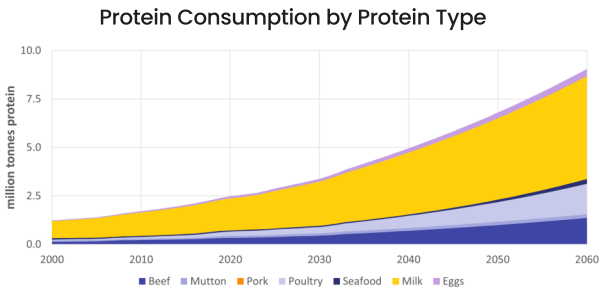
Pakistan

Rapid per-capita GDP growth may more than double per-capita consumption from relatively low levels. Total consumption is set to grow more rapidly with a boom in the population. We project Pakistan will not be able to decarbonise its protein sector without ending growth in industrial animal production by 2030 and increasing alternative or traditional plant proteins to 90% of protein volume by 2060.

BUSINESS-AS-USUAL (BAU)

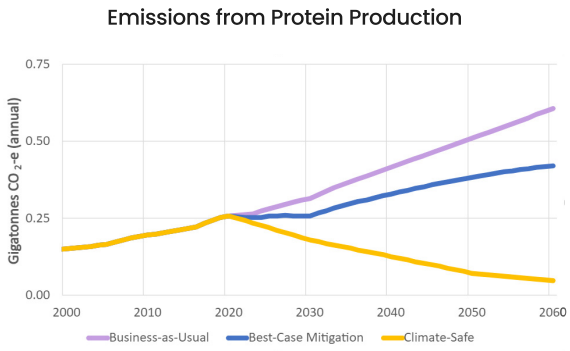
11.7 Gt CO_2-e in excess of climate-safety

	2020	2060	% Change
Population Size (millions)	227	408	+79%
GDP per Capita (constant thousand USD)	5.0	16.0	+219%
Protein consumption per capita(kg / year)	11.1	22.4	+102%
Total Protein Consumption (million tonnes / year)	2.52	9.13	+262%



BEST CASE MITIGATION

3.7 Gt CO_2-e mitigated, 8.0 Gt CO_2-e remaining



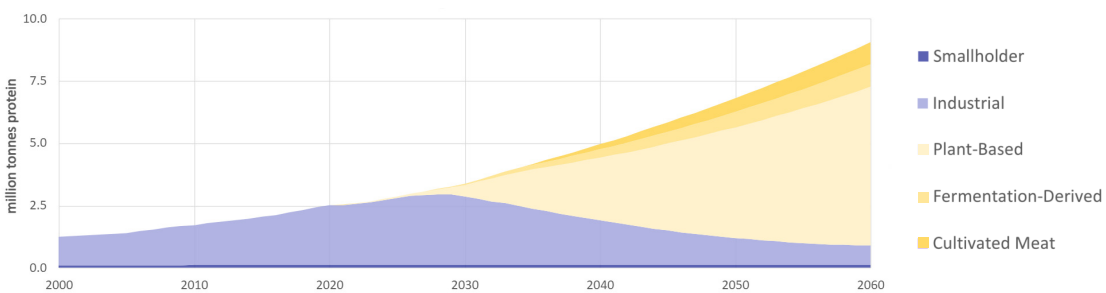
	Mitigation Target (Year / %)	Potential Mitigation (Gt CO_2-e)
Zero-Deforestation	2030	2.02
100% Clean Energy	2050	0.40
Enteric Fermentation Emissions	40%	0.46
Manure Emissions	40%	0.06
Feed (non-LULUC*) Emissions	40%	0.09
Food Waste Reduction	30%	0.63

*LULUC refers to Land Use, Land Use Change

PROTEIN TRANSITION

7.3 Gt CO_2-e further mitigated with alternative proteins

Protein Production by Source



PRIORITY ACTIONS FOR CLIMATE-SAFETY AND PROTEIN-SECURITY

- Eliminate Deforestation in Supply Chains by 2030
- Peak Industrial Production by 2030
- 90% Alternative Protein by 2060

05 Discussion

Our findings for Asia are consistent with global and other regional studies that conclude that supply-side mitigation of conventional animal protein emissions will be insufficient to meet the Paris Agreement targets.[41] These and other researchers have concluded that a major shift towards plant-based diets is essential.[42] Our research further demonstrates that, to meet those targets, Asian nations will need to begin reducing industrial animal production by no later than 2030, replacing it with a substantial proportion of plant-based and other alternative proteins. This is consistent with findings from other recent academic modelling of 520 food system scenarios. Once deforestation is eliminated, this study concluded, the most effective way to reduce GHGs will be to eat less meat, and thus substantially reduce the need for animal feed.[43]

5.1. PRIORITY ACTIONS

The most effective measures China and other Asian nations can take are to eliminate deforestation from the supply chain, peak industrial production by 2030, and diversify into alternative proteins. This is true despite the wide variation in each country's projected consumption trends. Asia's policymakers, food companies and banks need to align towards these priority actions.

5.2. VARIATION ACROSS MARKETS AND MANY EATING EXCESS MEAT AND SEAFOOD

Our findings vary as expected for how much each Asian nation can gain from a single mitigation and levels of diversification needed across the ten Asian markets. Much depends on each market's projected population and particularly income growth, as well as its consumers' preferences for different types of animal protein. While the need to peak animal production related emissions by or well before 2030 is fairly consistent, Japan and South Korea stand out with immediate need to peak their industrial animal production emissions. Except for Pakistan, most Asian markets also stand to mitigate substantial emissions by eliminating their deforestation and other land use changes in their protein supply chains, particularly due to their imports of soy and beef among other meats consumed from South America.

Reducing consumption of meat and seafood is an important climate and health mitigation measure, especially in markets with consumption well in excess of the EAT-Lancet Commission recommendations for a healthy and sustainable diet. The EAT-Lancet Commission recommends 98 grams of red meat (pork, beef, or lamb), 203 grams of poultry and 196 grams of fish per week[44]. This translates to 25.8kg of meat and seafood per year, providing 5.1kg of actual protein consumed from these animal products.

[41] https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf ; also https://www.researchgate.net/publication/303287111_Reducing_emissions_from_agriculture_to_meet_the_2C_target ; and https://www.researchgate.net/publication/275118744_Importance_of_food-demand_management_for_climate_mitigation

[42] https://www.researchgate.net/publication/275118744_Importance_of_food-demand_management_for_climate_mitigation and https://www.nature.com/articles/s41586-018-0594-0 and https://www.sciencedirect.com/science/article/pii/S0048969720328709 https://www.researchgate.net/publication/299342863_Analysis_and_valuation_of_the_health_and_climate_change_cobenefits_of_dietary_change

[43] https://www.sciencedirect.com/science/article/pii/S0048969720328709

[44] https://eatforum.org/lancet-commission/eatinghealthyandsustainable/

As seen in Figure 16, many of the Asian markets studied will now consume more meat and seafood than the EAT-Lancet recommendations, with some nations consuming nearly twice or three times the recommended levels per capita. In 2020, China, Japan, South Korea, Malaysia, and Vietnam consumed between 8.9kg and 12.3kg of protein from meat and seafood, well in excess of the EAT-Lancet recommended 5.1kg.

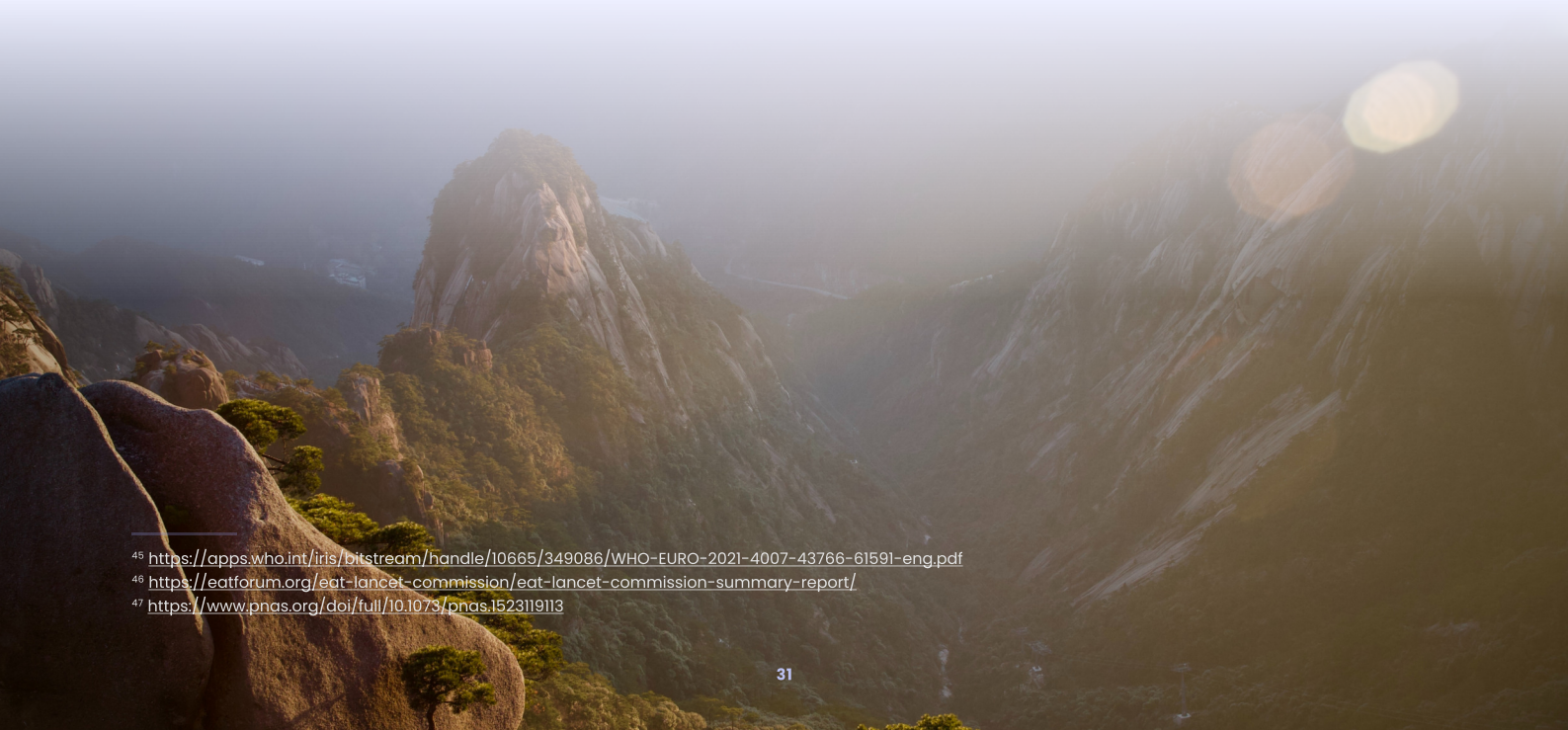
Figure 16: Annual meat and seafood consumed, and derived protein per capita (2020)

Market	kg product per capita	kg protein per capita
China	**48.8**	**9.0**
Japan	**47.9**	**9.0**
South Korea	**65.9**	**12.3**
Indonesia	29.9	5.8
Vietnam	**48.1**	**8.9**
Malaysia	**65.3**	**12.3**
Philippines	14.0	5.6
Thailand	27.8	5.1
India	6.2	1.2
Pakistan	10.5	2.1

Source: OECD-FAO, extracted by ARE

We did not integrate a specific level of absolute meat and seafood reduction in our modeling but acknowledge the additional and immediate mitigation potential for many of these Asian markets. Our projected pathways for protein security and climate-safety however, imply that per capita consumption of animal protein declines by 2060 and is replaced by a growing proportion of alternative proteins.

A more sustainable, flexitarian diet with less meat (fat, sugar and salt) and more plant-based foods and alternative proteins would also contribute to better health, less disease and lower diet-related mortality.[45] The EAT-Lancet Commission concluded in 2019 that shifting toward healthy diets, including in many markets cutting meat and seafood consumption, would likely result in major health benefits and prevent approximately 11 million global deaths per year to 2050.[46] This would in turn have economic benefits, regionally and globally, with emerging economies standing to benefit most of all.[47]



[45] https://apps.who.int/iris/bitstream/handle/10665/349086/WHO-EURO-2021-4007-43766-61591-eng.pdf
[46] https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report/
[47] https://www.pnas.org/doi/full/10.1073/pnas.1523119113

5.3. ENABLING PROTEIN DIVERSIFICATION

COMPARABLE PROJECTIONS AND ENABLING CAPITAL EXPENDITURE FOR CHINA

Our projections for necessary protein diversification may at first glance seem unrealistic or overly ambitious. But they are achievable if prompt action is taken to divert resources, promote sustainable diets, and re-orient subsidies.

Past projections (including by some banks) for how large a share alternative proteins will gain of the total market have ranged as high as 60% by 2040.[48] A 2021 analysis by Boston Consulting Group and Blue Horizon predicted that alternative proteins would by 2035 represent 11% of all protein eaten.[49] Our research suggests that China will need to rely on alternative proteins for only slightly more than that—12% of its proteins—by 2035 to achieve climate safety.

The task ahead for China might not seem so formidable to 2035. But ensuring that the supply of alternative proteins continues to grow sufficiently past 2035, however, will require a sustained and coordinated effort by all stakeholders involved.

We estimated the capital expenditure required to meet the alternative protein production projected in China's Protein Transition scenario. Using various techno-economic analyses, we calculated the approximate cost of building production facilities for each type of alternative protein—plant-based, fermentation-derived, and cultivated-meat. Our projections are detailed in Figure 17.

Figure 17: Production volumes and capital expenditure needed for facilities to scale alternative proteins for China (2020-2060)

	Production need at the end of period (million tonnes of protein)			Number of facilities required			Capital expenditure in the period (nominal USD billion)			
	PB	FD	CM	PB	FD	CM	PB	FD	CM	Total
2020-2030	1.4	0.3	0.0	302	16	0	10	5	0	15
2030-2040	3.2	1.1	1.0	667	62	518	12	16	233	261
2040-2050	4.7	2.4	1.8	983	134	922	20	30	182	232
2050-2060	6.1	3.9	2.5	1277	218	1270	22	45	157	223
PB refers to Plant-based, FD to fermentation-derived, CM to cultivated meat, seafood										731

Source: ARE analysis, with inputs from various sources

The USD 731 billion required in capital expenditure up to 2060, if divided equally over the 40-year period from 2020 to 2060, would amount to USD 18.3 billion in investments each year. This amounts to just 2.38% of the gross production value of China's livestock farming industry in 2020, which amounted to RMB 5.3 trillion, or USD 738 billion. The average capital expenditure for companies in the agriculture sector is 3.34%. While the investment required to achieve adequate protein diversity in China may seem staggering, it represents only a small fraction of the livestock industry's total revenue.

[48] https://cultivateinsights.com/2019/07/22/alternative-meats-could-be-60-of-the-market-by-2040/
[49] https://www.bcg.com/publications/2021/the-benefits-of-plant-based-meats

ENABLING POLICY AND FINANCE

The UN Food and Agriculture Organisation (FAO) defines sustainable diets as;

> **"diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources."** [50]

In their 2023 report "Driving finance for sustainable food systems: A roadmap to implementation for financial institutions and policy makers" FAO clearly acknowledge the emissions consumed in meat production and consumption.[51] They are strangely silent, however, on the potential of alternative proteins in food system transformation, beyond mentioning the GHG emissions comparison of beef, pork and traditional plant-based proteins. FAO does however consult and report on the food safety of cultivated meat (cell based) and collaborates with various national authorities to engage a range of researchers and enabling stakeholders.[52]

China's policymakers have already articulated plans to reduce food waste and promote more sustainable diets.[53] The country's policies for agricultural transformation and innovation already advocate alternative proteins. China and other Asian governments, however, still have policies to intensify animal production and support implicit or explicit subsidies. Environmental regulations and health imperatives may require they be modified, and subsidies may eventually be re-oriented to better support a Protein Transition benefiting people, the planet, and animals. A 2022 study also found that Farm Transition Carbon Offset Protocols can align with existing carbon offset protocols, and provides a preliminary methodology to calculate farm transition emissions reductions also in Asia.[54]

Some Asian Governments offer some support for development of alternative proteins, encouraging research, incubation, and commercialisation of alternative protein technologies. Singapore and South Korea stand out for encouraging regulations, incentives, and funding that support alternative protein innovation. Asia's new alternative protein entrants can also count on significant support and guidance from organisations active in the region, including the Good Food Institute, ProVeg, and a variety of regional plant, fermentation or cultivated meat associations.

Consumer surveys with a focus on Asian markets and alternative proteins are increasing collective knowledge and may forecast market potential. They suggest cultivated proteins will win acceptance among Asia's consumers, particularly if informed, but the feasibility of adoption is beyond the scope of this report.

[50] https://www.fao.org/nutrition/education/food-dietary-guidelines/background/sustainable-dietary-guidelines/en/#:~:text=Sustainable%20diets%20are%20those%20diets,for%20present%20and%20future%20generations
[51] https://www.unepfi.org/publications/driving-finance-for-sustainable-food-systems/
[52] https://www.fao.org/food-safety/scientific-advice/crosscutting-and-emerging-issues/cell-based-food/en/
[53] https://chinadialogue.net/en/food/where-chinas-food-policies-and-climate-goals-meet/
[54] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3832304

BANKS WITH SUSTAINABILITY FRAMEWORKS AND THE GROWING OPPORTUNITY IN TRANSITION FINANCE

Some of the world's major banks are establishing sustainability frameworks and criteria for financing. These banks tend to fund businesses and projects that reduce environmental and social risks, and encourage sustainable business practices. While they may lend to companies investing in or supplying equipment for the production of alternative proteins, most still do not actively promote Protein Transition pathways. Here are a few that have developed some form of relevant sustainability position:

ABN-AMRO has a comprehensive 2020 policy for Sustainability Requirements for Animal Protein Production. Among other requirements, the Dutch bank will not finance large cattle, sheep, or goat projects, or projects with deforestation risks. It requires that projects involving soy and other high-rick commodities be certified deforestation-free. It also requires that borrowers have an SBTi-verified target and publish a record of their progress toward achieving it.[55]

Standard Chartered's 2022 agro-industries position statement lists what it will and will not finance, with detailed criteria for fisheries, livestock, and agricultural commodities such as soy. The British bank stops short however, of requiring science-based climate targets and clear transitional pathways.[56]

ASN Bank's 2022 sustainability criteria guide outlines how it has stopped lending to livestock farming and related businesses altogether.[57] "We avoid investments in livestock farming because it currently involves problems in the areas of food security, climate, biodiversity, health and human rights," the Dutch bank's guide says. "We also avoid customers of livestock farms, such as abattoirs and transport companies." Triodos also doesn't lend for industrial animal production.

Other banks are also beginning to finance support towards responsible protein production and plant-based proteins. Some of the banks offering transition finance or products include: **National Australia Bank** (Australia), **Banco do Brasil**, **Brazilian Development Bank** and **Itau Unibanco** (Brazil), **Barclays** (U.K.), **Goldman Sachs** (U.S.), and Netherlands-based **Triodos, and de Volksbank**, which also supports shifting to plant-based diets. There are other banks that offer climate transition finance for a range of GHG mitigations to the agribusiness sector.

DBS, a Singaporean bank aims to set a path to net zero supporting a low-carbon economy, and acknowledges the size of the climate and other negative impacts of current food and agribusiness. They also admit there are no adequate or truly feasible supply-side mitigations at present. They state they are waiting for industry consensus or research, such as ours, to commit to clear policies and targets for GHG emissions reductions for these sectors.[58]

The opportunity in Asia for a first mover offering Protein Transition finance remains wide open.

DIVERSIFYING FOOD COMPANIES OPENING UP ASIA'S TRANSITION

Century Pacific Foods (CNPF), Philippines

A meat manufacturer, CNPF used its existing equipment and expertise to develop meat-free products in a relatively short time and at prices close to its meat-based products. Since launching its plant-based range in 2020, it has expanded from pizzas to meat-free burger patties, sausages, and "un-cheese," and started exporting to China, the Middle East, the U.K., and the U.S. It is now looking to produce more shelf-stable products and Asian tailored offerings, as well supply its subsidiary restaurants.

[55] https://assets.ctfassets.net/1u811bvgvthc/5g8G0m7T530JoELM6n8wFW/33fe1dc24112056b12429d2185c66f2e/ABN_AMRO_policy_for_the_animal_protein_sector_summary.pdf
[56] https://av.sc.com/corp-en/content/docs/agro-industries-position-statement.pdf
[57] Downloads/guide-asn-sustainability-criteria-2022%20(2).pdf
[58] https://www.dbs.com.sg/documents/1038650/382494047/Our+path+to+net+zero+food+and+agribusiness.pdf/ba15b514-7400-31a2-a0fe-f5b08fa3b53b?t=1663025525707

> "CNPF launched 'unMEAT' in 2020 in response to the expanding consumer preference for healthier, better-for-you, and better-for-the-planet food choices. The company goes by the philosophy that eating plant-based should be easy, thus offerings are made and priced as close as possible to their analogue counterparts."[59]

Thai Union, Thailand

Led by a dedicated managing director for alternative proteins, Thai Union aims to increase sales of its plant-based OMG Meat products—which includes dim sum, crab dumplings, and chicken nuggets—to USD 30 million by 2025. Early this year, it launched John West Vegan Fish-Free Tuna, the first branded product from its Marine Proteins business unit, which plans to introduce more alternative protein products later in 2023. Thai Union has also partnered with Blue Nalu and Calysta, among others, to develop cultivated seafood.

> "Young consumers in Asia are increasingly adopting a more flexitarian eating style–eating a mixture of plant-based foods and meats in a more flexible manner. They are interested in exploring food for better health while also caring for the planet, with plant-based protein producing less carbon."[60]

CJ CheilJedang, South Korea

Within 10 months of launching plant-based dumplings and kimchi under its PlanTable brand in late-2021, CJ CheilJedang had sold three million units. It has since expanded to plant-based short rib patties and hamburger steaks, and exports PlanTable to more than 30 countries, including Australia, India, Japan, and the U.S. It aims to boost sales of its plant-based products to KRW 200 billion (USD 156 million) by 2025.[61]

CP Foods, Thailand

As part of its 2030 sustainability strategy, CP Foods aims for low-carbon products—including alternative proteins—to account for 40% of sales. It launched its Meat Zero brand in 2021 and aims to be one of the world's top three alternative meat companies by 2026. It already exports these products to Asia, Europe and the U.S. CP Foods is also investing in cultivated meat research.[62]

Retailers

Twenty five of the largest international food retailers have also diversified their protein offerings.[63] A range of Asian retailers under listed companies such as Sun Art (China), CP ALL (Thailand), CJ, Pulmuone, Lotte Shopping and E-Mart (South Korea), and others also offer a growing range and sales in plant-based proteins.

[59] https://centurypacific.com.ph/century-pacific-expands-unmeat-plant-based-range-unveils-dairy-alternatives-and-shelf-stable-vegan-line; also https://centurypacific.com.ph/wp-content/uploads/2022/06/CNPF-2021-Sustainability-and-Annual-Report.pdf (IR2021, p. 131)
[60] https://www.greenqueen.com.hk/maarten-geraets-thai-union-cultivated-seafood/; also https://www.thaiunion.com/en/newsroom/press-release/1313/thai-union-launches-plant-based-protein-omg-meat-to-thai-market, and https://www.thaiunion.com/en/blog/sustainability/1607/thai-unions-marine-protein-business-unit-launches-john-west-vegan-fish-free-tuna-in-the-netherlands
[61] https://www.kedglobal.com/food-beverage/newsView/ked202211290007
[62] https://www.cpfworldwide.com/en/sustainability/performance/CPF2030_Sustainability_Strategy_Handbook.pdf; also https://www.greenqueen.com.hk/meat-zero-thai-agfood-giant-looks-to-build-leading-global-alt-meat-brand-within-5-years/
[63] https://www.fairr.org/news-events/press-releases/affordability-and-innovation-drive-record-commitments-on-protein-diversification

5.4. OTHER SCENARIOS FOR CLIMATE-SAFETY (CHINA)

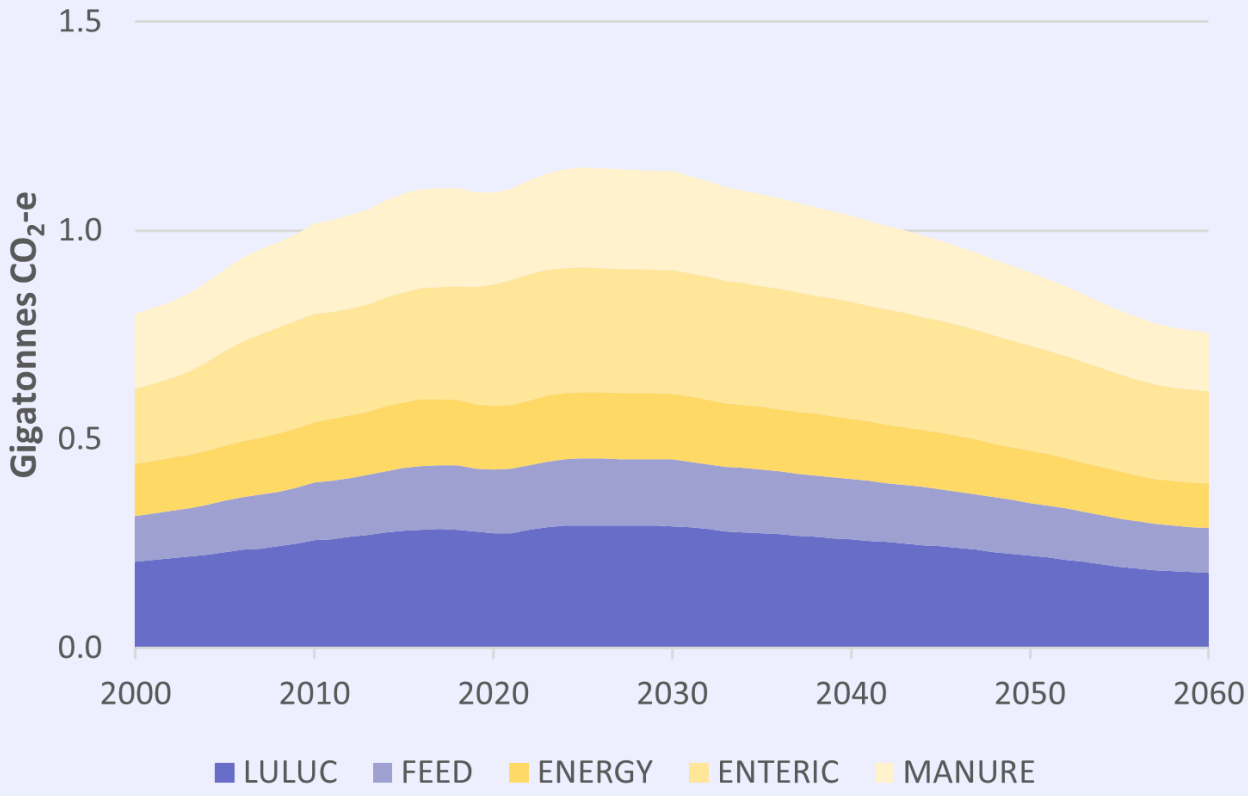
COMPLETE MITIGATION OF ENTERIC FERMENTATION AND ANIMAL MANURE EMISSIONS

Significant attention and resources have been devoted to GHGs produced by enteric fermentation (in the digestion of cows and other livestock) and from animal manure. The livestock industry has focused its greatest investments in time and money toward mitigating these emissions, with additions to cattle feed, methane capture and anaerobic biodigesters (for pig and cattle manure) just a few of the solutions attempted.

It is true that livestock production is the single largest source (32%) of anthropogenic methane, which is a much more potent contributor to global warming than carbon dioxide. But an even more potent contributor is nitrous oxide, which is produced by animal digestion and is a major by-product of agricultural fertilisers and fuel combustion. Reducing the use of fertiliser and the nitrous oxide it produces, along with other pollutants, thus stands to have a much greater impact on emissions reduction.

Most of the livestock industry's greenhouse gases are produced not by animals, but as by-products of clearing forests for feed crops and using fertilisers. Animal GHGs are significant and should be reduced. But mitigating them is not the most urgent or effective way to reduce GHGs in China, and would likely have little impact on its total emissions in our BAU scenario.

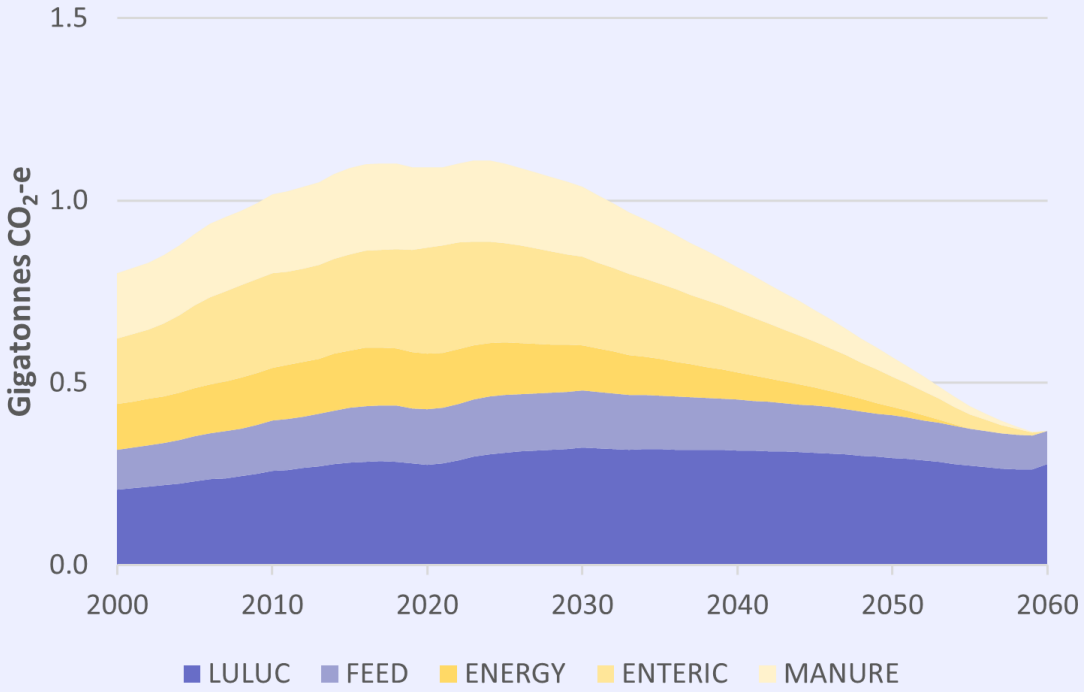
Figure 18: BAU emissions by source, China



LULUC refers to Land Use, Land Use Change

To illustrate this, we projected emissions for China by 2060 if, instead of tackling deforestation and diversifying into alternative proteins, it managed to eliminate emissions from enteric fermentation and animal manure. Mitigation from clean energy usage, reduced feed emissions and food waste remained the same in this exercise.

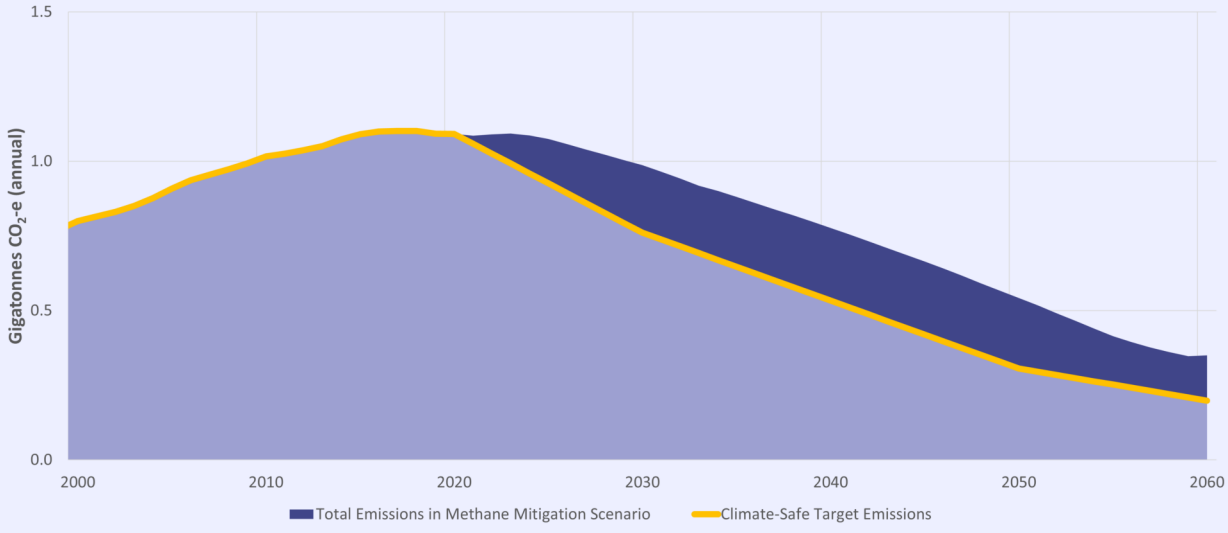
Figure 19: Emissions after mitigation of enteric fermentation and manure, China



LULUC refers to Land Use, Land Use Change

It's an implausible premise: There is little data to suggest that any of the proposed methods for reducing animal emission—including feed optimisation, feed additives and genetic selection—could be implemented on a large scale in China or work if they were.[64]

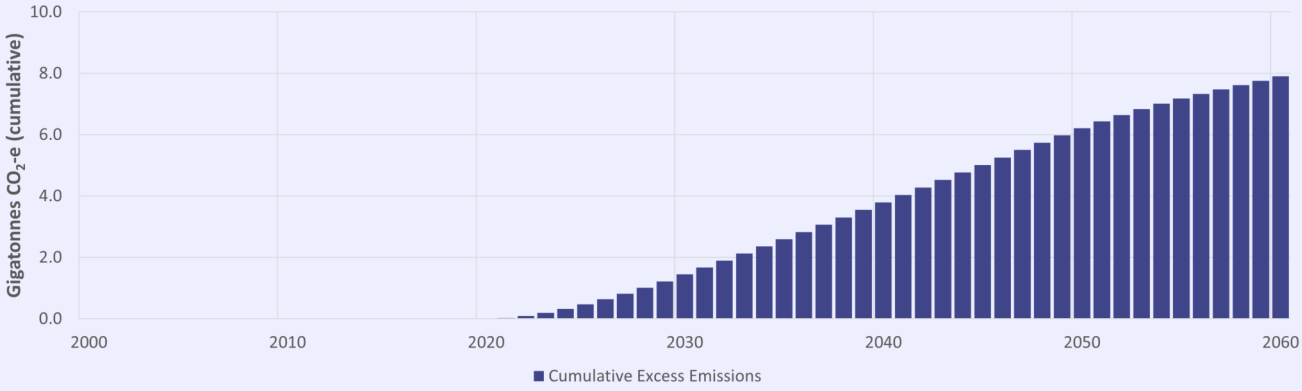
Figure 20: Annual emissions with enteric and manure mitigation vs. climate-safe level, China



The results were no more encouraging: Figures 18-21 show China's projected emissions would remain consistently above the climate-safe threshold, producing a cumulative excess of 7.9 billion tonnes of CO_2-e at the end of the period.

[64] https://ccafs.cgiar.org/research/projects/shrinking-environmental-footprint-livestock-china

Figure 21: Cumulative emissions over climate-safe level, enteric and manure mitigation, China



EXPLORING SUBSTITUTION —SEAFOOD REPLACING RED MEAT SCENARIO

Another proposed solution for reducing protein-related emissions is to substitute red meat—beef, mutton, and pork—with white meat such as poultry and seafood. To test this solution, we performed a similar exercise, projecting emissions for China by 2060 if, instead of tackling deforestation and diversifying into alternative proteins, it swapped industrial production of red meat with farmed seafood (Fig. 23). The only remaining production of red meat in this scenario would be from smallholders. As in the previous scenario for animal methane, we kept mitigation from clean energy usage, reduced feed emissions and food waste the same.

Figure 22: Animal protein consumption by source, China BAU

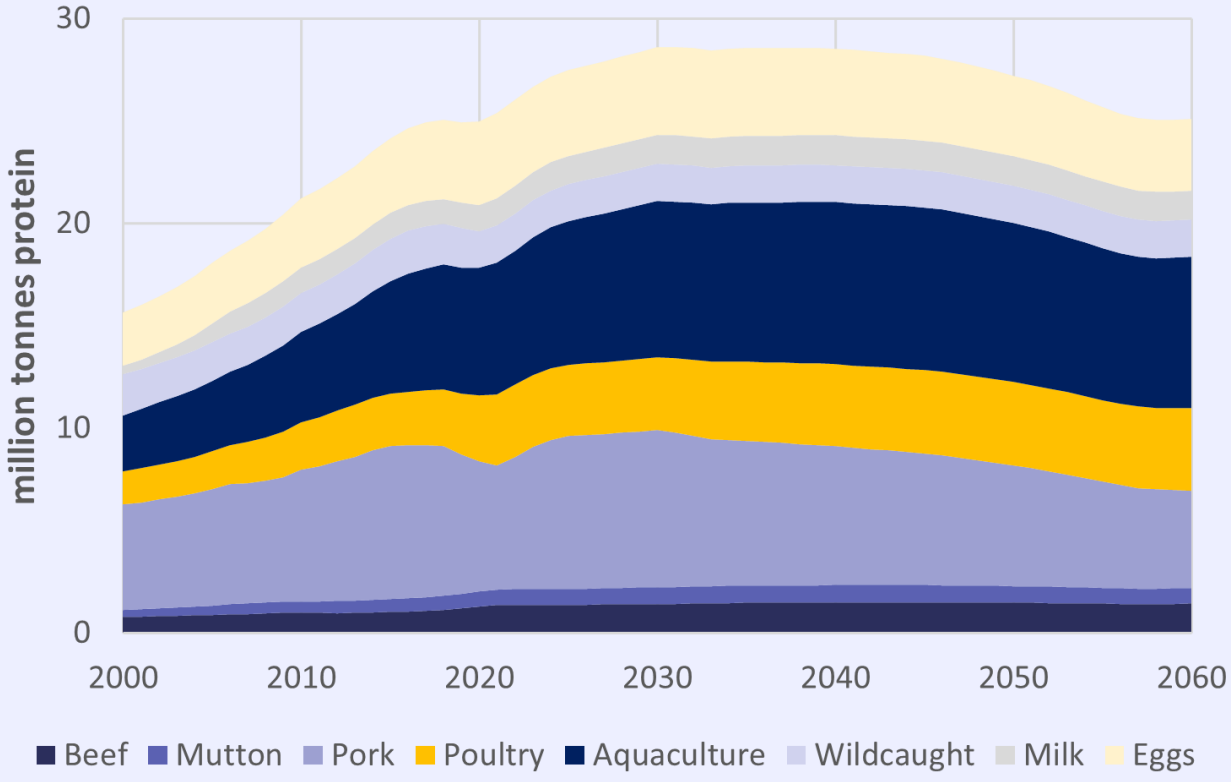
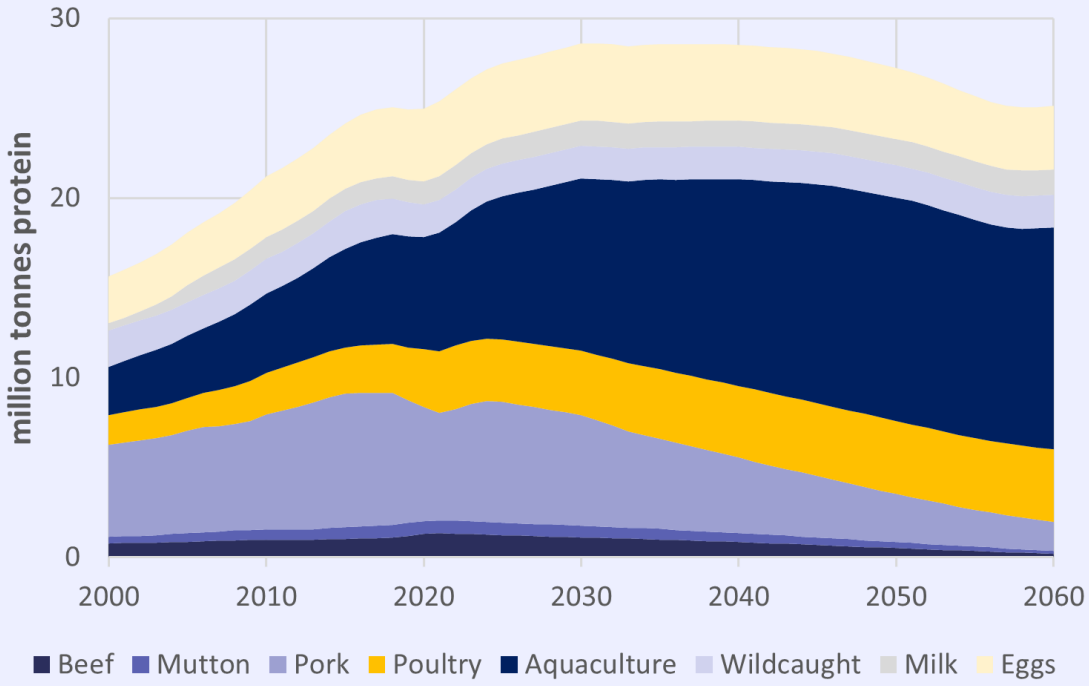


Figure 23: Animal protein consumption by source, China swaps red meat for seafood



Figures 24 and 25 illustrate the results: China's projected emissions would remain consistently above the climate-safe threshold, producing a cumulative excess of 8.8 billion tonnes of CO_2-e at the end of the period. Substituting red meat with poultry produced similar results.

Figure 24: Annual emissions vs. climate safety, China swaps red meat for seafood

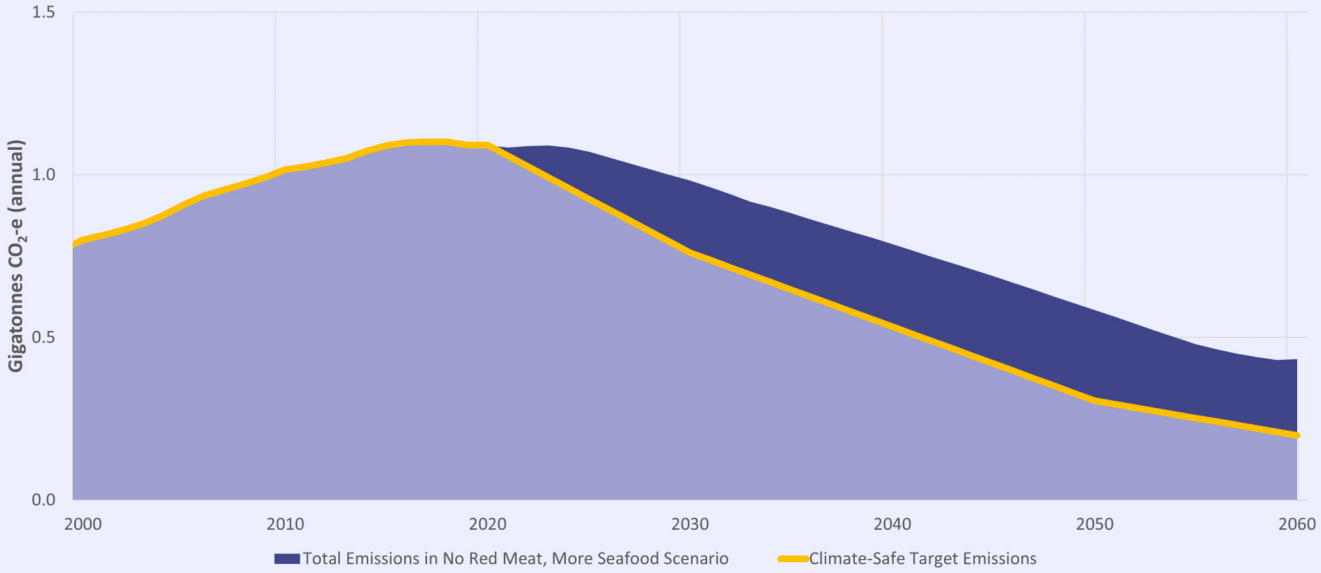
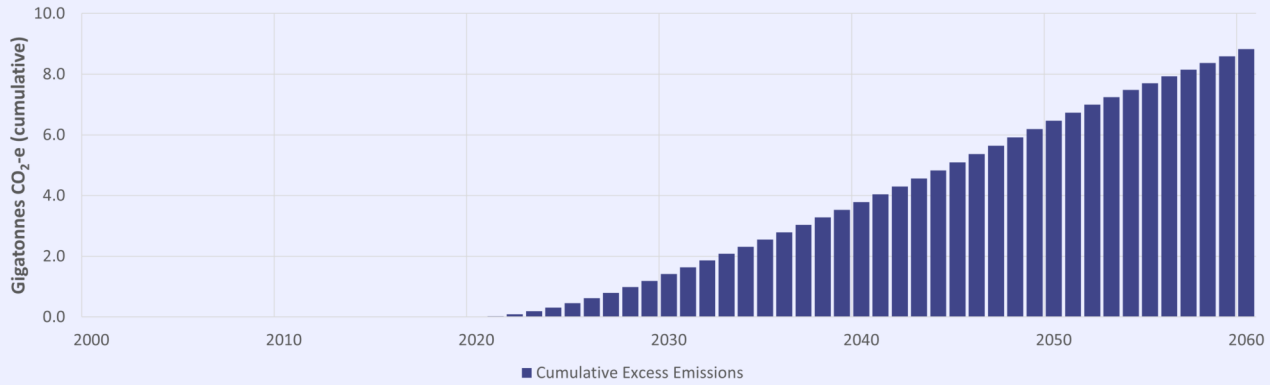


Figure 25: Cumulative emissions above climate-safe, China swaps red meat for seafood



06 Conclusion

Asia's protein system remains a long way from achieving climate-safety, but this report for the first time lays out a pathway for ten of its largest markets.

Even ambitious cuts in emissions from deforestation, energy consumption, enteric fermentation, animal manure, and food waste won't be enough for the region to meet the goals of the Paris Agreement. The region will need to ensure that industrial animal production and its associated emissions peak by 2030 or sooner. Significant diversification of proteins will be required thereafter: more sustainable, alternative proteins will need to gradually grow to between 30% and 90% of market share by 2060.

Reducing industrial animal production by 2030 promises additional benefits, including lower health risks and disease. It will also help reduce biodiversity loss, antimicrobial resistance, animal welfare violations, land and water scarcity, and pollution. Diversifying into alternative proteins, meanwhile, stands to provide the region with dramatic reductions in protein-related emissions on top of the emissions avoided if countries eliminate deforestation in their protein supply chains.

The cost of this shift may seem daunting, but our analysis of the investment required for new facilities to meet China's alternative protein balance suggests it can be accomplished without increasing capital expenditures above what the animal protein industry already makes.

As we hurtle ever closer to the Paris Agreement's 1.5°C warming limit, however, it is becoming increasingly urgent that Asia succeed in making this Protein Transition. If market forces fail to set a more aggressive pace, policies and regulations may be needed to accelerate the shift. This is already happening in the EU. Banks, corporations, and shareholders that anticipate these regulatory changes by promoting the transition before they are imposed stand to gain first-mover advantage.

Asia's banks, in particular, have a vital role to play. In lending to major food companies, they need to support responsible animal protein production and strategies for scaling alternative proteins, prioritising loans for mitigation measures with the highest potential—deforestation and diversification. That means not just withholding funds for projects that contribute to the clearing of forests, but channelling funds to projects that develop and boost production of alternative proteins for sustainable and healthy diets.

07 Appendices

METHODOLOGY IN DETAIL

7.1 | CLIMATE-SAFE SCENARIO

We derived our criteria for emissions allowed under a climate-safe scenario from the Science-based Targets initiative (SBTi). In September 2022, SBTi released its Food, Land and Agriculture (FLAG) Guidance,[65] which provided the first standards for companies in land-intensive sectors to set science-based targets for emissions reductions and removals in line with the Paris Agreement's goal to limit global warming to 1.5°C. Companies are required to set FLAG targets if they are from FLAG-designated sectors or if more than 20% of their overall emissions across scopes 1-3 are FLAG-related emissions.[66] It should be noted that the list of FLAG-designated sectors includes Food Production-Animal Source, Food and Beverage Processing, Food and Staples Retailing, as well as Forest and Paper Products, and Food Production-Agricultural Production.

While the level of emissions reduction required from each company depends on its specific business structure and activities, the FLAG Guidance has stated that "minimum forward-looking ambition aligns with reducing emissions 72% by 2050 from base-year levels, using a linear reduction from the most recent year to 2050." The FLAG guidance also provides short-term commodity pathways for beef, pork, poultry, and milk, which were adopted to determine the climate safety allowance up to 2030.

7.2. | CONSUMPTION FACTORS

We identified population, income per capita, and age demographics as the most important factors in determining the volume of protein consumption from animal sources. This aligns with the discussion on meat consumption projections in the annual OECD-FAO Agricultural Outlook.[67] We obtained historical data (from 1990 to 2020) and projected estimates (from 2020 to 2060) for these indicators from the United Nations Department of Economic and Social Affairs–Population Division and from the Organisation for Economic Cooperation and Development.

Beyond long-term GDP growth and age demographics, consumption of any protein type in any given year can be affected significantly by negative supply shocks from extreme weather events, disease, or war. We do not attempt to project the frequency or impact of these events or their effects on consumption. We have also chosen to use the three-year moving average of annual consumption for our regression analysis to remove the noise from such short-term events, which are not our focus.

We incorporated into our projections for production and available consumption an estimated 20% loss due to food waste. This is what is typically incurred after production of any edible product, and generally occurs during transport (from the processing plant to retailers), retailing (within the inventory of retailers), and post-retail (after purchase by the consumer).

65 https://sciencebasedtargets.org/sectors/forest-land-and-agriculture
66 https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf
67 https://www.fao.org/3/cb5332en/Meat.pdf

7.3. | PRODUCTION FACTORS

7.3.1 Emissions Intensities

We obtained the bulk of our data on emissions intensities from the Food and Agriculture Organisation's (FAO) Global Livestock Environmental Assessment Model (GLEAM). GLEAM provides emissions intensities for each protein type based on geographic region, animal species, herd type, and production system. This data can also be separated by specific sources along the value chain, such as pasture expansion, enteric fermentation, manure, etc. GLEAM does not provide estimates for emissions intensities of seafood, either wild-caught or from aquaculture. We supplemented this information through various academic sources.[68]

GLEAM's third iteration, which the FAO published in 2022, is based on 2015 data.[69] ARE's 2018 report, Charting Asia's Protein Journey (CAPJ), relied on GLEAM 2.0, which was based on 2010 data. GLEAM 2.0 also aggregated data for East Asia and Southeast Asia, whereas GLEAM 3.0 provided separate estimates for these sub-regions. These differences explain some discrepancies between the BAU scenarios presented in CAPJ and those in this report.

There are some limitations to our projections (on the impact of deforestation, for example) due to GLEAM's aggregation of certain data across markets. For example, GLEAM aggregates the factor for emissions intensity from deforestation across markets in East Asia, but China's protein consumption is more closely associated with deforestation risk than its East Asian neighbours' thanks to China's higher imports of soybeans for animal feed from Latin America.[70]

Our projections are thus likely to slightly understate China's deforestation-linked emissions somewhat and also the potential for mitigating emissions by eliminating deforestation in China's protein supply chains. Conversely, our projections are likely to slightly overstate the mitigation potential of deforestation in Japan and South Korea. That may also produce a slight underestimate in our projections for both markets of the necessary proportion of alternative proteins.

We also did not factor in the likely impact of climate change on crop yields or livestock production, which is likely to lead to higher emissions in the production of both animal and alternative proteins.

We incorporated a 1% increase each year in the productivity of industrial production and adjusted projected emissions intensities downward to reflect these improving yields. This 1% year-on-year improvement may not be a precise forecast for each protein type. But it serves as a rough estimate for the purpose of extrapolating historical trends.[71] We incorporated a smaller, 0.5% annual increase for smallholder productivity. Smallholders have lower access to new technology and finance. They are thus typically slower to adopt innovations that improve productivity.

7.3.2 Production Systems

7.3.2.1 Smallholder Vs. Industrial

We were sensitive to the potential impact of a Protein Transition on the livelihoods of smallholder farmers of animals. At the same time, we believe it is highly unlikely that production from smallholders will increase. The number of smallholders and their production has already been declining in many markets. Disease (e.g., African Swine Fever in pigs and Avian Influenza in chickens), as well as limited access to capital, resources, and training, has left many smallholders unviable, accelerating consolidation and the shift toward industrial animal production.[72]

To minimise the theoretical impact of the Protein Transition scenario on smallholders, we kept the estimated contribution to total protein production from smallholders in our projections unchanged from estimated volumes over 2015-2020. We assert the need for a just protein transition. The growth in alternative protein production in our projections, therefore, comes entirely at the expense of industrial production, not smallholders.

[68] https://doi.org/10.1002/fee.1822; also https://www.fao.org/3/i7558en/i7558en.pdf
[69] https://www.fao.org/gleam/dashboard/en/
[70] https://supplychains.trase.earth/explore
[71] https://doi.org/10.1017/S0021859610001188
[72] https://www.scmp.com/news/china/politics/article/2184850/chinas-small-pig-farmers-are-being-wiped-out-deadly-african; also https://www.frontiersin.org/articles/10.3389/fvets.2021.734236/full

7.3.2.2 Wild-Caught Vs. Aquaculture

Overfishing in recent decades has strained wild fish populations, leading to smaller catches.[73] Wild-caught production has stagnated as a result.[74] For our projections of seafood production and consumption, therefore, we assumed that wild-caught production would never exceed 2020 levels and would only decline in future.

Aquaculture production has boomed in Asia, which now accounts for more than 90% of global aquaculture production. China is by far the largest producer of farmed seafood, followed by Indonesia and India.[75] Since we assume a cap in wild-caught production, any increase in projected seafood consumption in our projections is from increased aquaculture. Conversely, where seafood consumption is projected to decline, it is due to decreasing wild-caught production.

7.3.2.3 Alternative Proteins

Plant-based products that are not explicitly branded as meat replacements (e.g., tofu, bean curd products, seitan, tempeh, beans, pulses, etc.) do not function as meat substitutes in Asian food cultures. We, therefore, included them in our projections of existing consumption, not as alternative proteins.

Alternative proteins produce widely varying levels of emissions, so how much their adoption reduces overall emissions depends largely on which alternative proteins get adopted. The emission intensities of cultivated proteins, for example, depends on what kind of energy is used to make them. For our projections, we assumed that the clean energy mix used to produce alternative proteins and animal proteins would be equal in any given year. This is a conservative approach that does not give favourable treatment to alternative protein producers by assuming they will have greater access or more inclination to choose clean energy than producers of conventional animal protein.

We also assumed equal diversification into various types of alternative proteins. For example, we projected growth in consumption of alternatives for chicken, pork, or beef at the same rate as alternatives for eggs or dairy. Alternatives for dairy (especially alternative milks) and meat are ahead of alternatives for seafood and eggs in terms of consumer adoption. But we see no reason to assume that any protein type will reach a greater level of adoption than others. Industry policy, subsidies, regulations, cultural factors, consumer preferences and market development may affect adoption, but it is beyond our capacity to predict how.

After consulting researchers at the GFI, we believe that plant-based and fermentation products will contribute most to alternative protein production. Due to higher production costs and environmental impact, cultivated meat will likely make up a smaller percentage of alternative protein production, with most used in hybrid products.

We based our estimates of required investments in plant-based protein production on the GFI's 2021 study, which estimated that producing 25 million tonnes of plant-based meat per year by 2030 would require USD 27 billion in new investment.[76] This translates to roughly USD 33 million per plant-based meat facility, with an annual production rate of 30,000 tonnes.

For fermentation-derived protein, we referred to various techno-economic analyses to estimate that the capex for a biomass fermentation plant with a production rate of 40,000 tonnes would be roughly USD 345 million.[77]

For cultivated protein, we used CE Delft's report "TEA of cultivated meat: Future projections of different scenarios," which estimated that USD 450 million in capital expenditure would be needed to build a cultivated meat facility with an annual production capacity of 10,000 tonnes.[78]

We then calculated the number of facilities needed to fulfil alternative protein production needs each year by dividing our projections of future alternative protein needs by each production facility's capacity. To determine the total capital expenditure requirement, we multiplied the number of facilities built each year with the estimated cost to build each one. We assumed that production facilities are retired and replaced after 20 years (for plant-based and fermentation-derived facilities) and after 30 years (for cultivated meat facilities).

The capital expenditure estimates are in constant 2020 USD. We made no attempt to predict inflation or future fluctuations in construction and raw material costs. GFI's 2021 study dealt with these variables by assuming that capital expenditure would remain constant throughout the period (in real dollars), because the overall effect of opposing market forces cannot be determined (e.g., economies of scale vs. rising demand for raw materials.)

For USD estimates of China's livestock industry, we used the average exchange rate in 2020 of RMB 6.9022 per USD to convert to industry-wide sales.

[73] https://www.fao.org/3/cc0461en/online/sofia/2022/status-of-fishery-resources.html
[74] FAO FishStatJ (figures and charts are available from ARE)
[75] https://www.fao.org/3/cc0461en/online/sofia/2022/world-fisheries-aquaculture-production.html
[76] https://gfi.org/resource/anticipating-plant-based-meat-production-requirements-2030/
[77] https://doi.org/10.1016/j.biteb.2021.100683; also http://dx.doi.org/10.1039/D1GC01021B
[78] https://cedelft.eu/publications/tea-of-cultivated-meat/

Disclaimer

ARE has taken all reasonable precautions to ensure that the information contained in this Report. is current and accurate as of the date of benchmarking. No representations or warranties are made (expressed or implied) as to the reliability, accuracy, or completeness of such information. Although every reasonable effort is made to present current and accurate information, ARE does not take any responsibility for any loss arising directly or indirectly from the use of, or any responsibility for any loss arising directly or indirectly from the use of, or any action taken in reliance on any information appearing in this Report.

Copyright

ARE
ASIA RESEARCH
& ENGAGEMENT