EXECUTIVE SUMMARY OF CLIMATE OPPORTUNITIES IN THE U.S. AND CHINA

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INTRODUCTION

Egypt, the host country, has called for COP 27 to be an "Implementation COP," which in Special Envoy John Kerry's words, means "delivering on existing commitments, strengthening commitments that are not strong enough, and adding new commitments and efforts where none exist" (Egypt, U. S. Mission, 2022). Despite some progress since COP26 in Glasgow, the world remains behind what is needed to keep the 1.5 degree goal alive.[1]

Tremendous challenges are in front of us. We need to significantly reduce emissions from fossil fuels, particularly coal. In 2021, coal use trended in the opposite direction as the world used 9 percent more coal than in 2020, and nearly 300 gigawatts (GW) of new coal power is in the construction pipeline. We also need to cut our emissions from the transportation, buildings, and industrial sectors at a faster pace. At the same time, the world is seeing much more frequent climate-related extreme weather events, including more droughts and wildfires. The U.S., China, the EU and other regions are experiencing record-temperatures and droughts, and have increased spending on addressing climate impacts. Adaptation actions must ramp up at a rapid pace.

While the climate crisis is a global issue, not a bilateral one, the U.S. and China, as the world's largest greenhouse gas (GHG) emitters and economies, can make a significant difference by working together. As pointed out by Special Envoy Xie Zhenhua, climate change is an existential threat. Special Envoy John Kerry, his U.S. counterpart, noted that "climate is the one area that should not be subject to interruption because other issues affect us." Although China recently suspended its climate dialogues with the U.S., it is hoped that the suspension is temporary, and the climate talks between the two countries could restart before COP27.

The U.S. and China made a rare joint declaration on climate change at the UNFCCC's COP26 climate summit in Glasgow last November. Although the statement contained little in the way of new commitments, other than China stating that it would start to address its methane emissions, the fact that such a joint statement could be made was a very positive signal of the two countries' intention to coordinate on their climate actions and push each other to do more.

In response to the Joint Declaration, a group of climate experts from the United States and China have come together to analyze current actions and opportunities for both countries to

[1] https://public.wmo.int/en/resources/united_in_science

Table 1 | Review of Climate Policies in the U.S. and China			
	Venue/Policy	**The U.S.**	**China**
Presidential	Commitment	Addressing the climate crisis is a top priority for the President	Addressing major "resource risks" such as energy and food security are a priority, along with "building an ecological civilization" and green development
International Agreements and Commitments	COP26 Statement	-Reaffirmed the global goal of limiting warming to 1.5 degree Celsius; -Launched the Global Methane Pledge, committed to the goal of reducing methane emissions by 30% between 2020 and 2030	Restated its 2030/2060 climate goals
	NDC	50-52% GHG emissions reduction from 2005 levels by 2030	Peaking national carbon emissions prior to 2030 and achieving carbon neutrality by 2060
	Kigali Amendment to the Montreal Protocol	Ratified in September 2022	Ratified effective September 2021
	Other international fora	-World Economic Forum—industrial decarbonization; -Mission Innovation—energy decarbonization; -G7 countries—green infrastructure	At the Convention of Biodiversity COP-15, China pledged 1.5 billion yuan toward a new Kunming Biodiversity Fund, for biodiversity protection efforts in developing countries
Federal/national policy		-Biden's climate Executive Orders (EO): -EO 14008 (2021) Tackling the Climate Crisis at Home and Abroad -EO 14030 (2021) to advance disclosure of climate related financial risk information -EO 14037 (2021) strengthening American Leadership in Clean Cars and Trucks -EO 14057 (2021) catalyzing Clean Energy Industries and Jobs -EO 14072 (2022) strengthening the nation's forests by pursuing sustainable and science-based land management	1+ N Policy and 14th Five-year Plan: -Energy supply, system transition, innovation, and efficiency as four key objectives in the 14th Five-Year-Plan; -New Energy Storage Development and Implementation Plan; -Development of the Hydrogen Energy Industry -Non-CO_2: Implemented the Kigali Amendment to the Montreal Protocol to phase down hydrofluorocarbons (HFCs) on time;

Venue/Policy	The U.S.	China
Subnational action examples	- North Carolina sets new emission targets: 40% reduction by 2025, 50% by 2030, 100% by 2050 (below 2005 levels) - Maryland sets 100% reduction of 2006 levels by 2045	Early carbon peaking plans: Beijing, Shanghai and Hainan before 2025, Guangdong, Jiangsu, Qinghai, and Henan before 2030;
Climate legislation	-Inflation Reduction Act (2022): includes tax credits, incentives and other provisions to help tackle climate change, increase investments in renewable and enhance energy efficiency; -Infrastructure Bill (2021): includes historic funding in $1 trillion to protect the country against climate change	N/A
Judicial decisions	Supreme Court decision on West Virginia v. EPA, ruling that EPA cannot put state-level caps on carbon emissions under the 1970 Clean Air Act	N/A

advance work in the key areas noted in the declaration. This series of papers tackles the range of core climate issues: power sector decarbonization, methane emissions, illegal deforestation, industrial decarbonization, green shipping, green aviation, food waste reduction and fertilizer efficiency, subnational cooperation, build decarbonization and zero-emission vehicle deployment. The paper series lays out the ways the U.S. and China can advance these climate solutions independently and collaboratively.

This working paper acts as an executive summary of those papers while also putting all them in context. It conducts a review of actions in the two countries since Glasgow, both from the federal/national and subnational perspective, and presents a summary of the papers series findings. Based on the review and analysis, we offer an outlook of what could be achieved at COP 27 and actions to follow.

REVIEW OF CLIMATE ACTIONS SINCE GLASGOW

At Glasgow, Washington and Beijing declared an intention to work together to accelerate the phase out of coal usage, address deforestation, and to establish a working group to facilitate actions. This section provides an overview of climate policy and actions in the U.S. and China since 2021, including presidential and international commitments, federal or national policy, subnational action, climate legislation and court decisions.

PROGRESS AND CHALLENGES REMAINING IN THE KEY SECTORS

The key topics of cooperation in the Glasgow Joint Statement include 1) Decarbonization in key sectors, 2) Methane and non carbon emissions reduction, and 3) Deforestation. This section

provides brief updates based on the individual analysis of these topics in the position paper series, capturing the status quo and main challenges in the key sectors.

Reducing Power Sector Emissions

The U.S. and China face similar physical and policy challenges to transform their power sectors, despite different economic and institutional conditions. Although both countries have made significant commitments to decarbonize their power sector, (i.e.,the U.S. committed to a zero-carbon power sector by 2035, while China made in its 14th Five-Year-Plan to achieve 39% non-fossil of total power generation in 2025), neither country's NDC pledges for 2030 are sufficient to achieve the 1.5 degree Celsius target.

Both countries have shared opportunities and challenges for power sector decarbonization:

- Reliability— both countries have struggled recently, facing more frequent extreme weather events;
- Control and retirement of coal-fired generation capacity— the U.S. has made significant progress reducing coal generation and retiring coal-fired power plants, while China is charting its pathway to replace old coal power plants with cleaner and more flexible resources;
- Regional integration—about two-thirds of the U.S. is served by regional transmission organizations (RTOs), while new policies for the electricity market system were started to be introduced in China;
- System flexibility —although both countries' power systems are becoming increasingly flexible, there are problems that need to be further tackled, such as federal-state coordination in the U.S., and to design and implement spot electricity markets in China;
- End-use energy efficiency—states are taking the lead to implement energy efficiency standards and utility incentives in the U.S., and China also prioritizes energy efficiency in its overall energy policy despite the disconnection between energy conservation policies and power sector reform efforts.

To address these challenges, the U.S. should a) accelerate its power transmission capacity expansion, b) increase regional integration and improve electricity markets, c) update state utility planning processes, d) speed up fossil retirement and community transition, and e) prioritize energy efficiency and demand response. Meanwhile China needs to consider a) refinement and implementation of the "National Unified Electricity Market System," b) transparent power sector planning to support reliability during the transition, c) policies to support low-cost system flexibility, and d) integration of the pledge to "give first priority to the conversation and energy" with power sector reform.

As they work on these issues, the two nations can collaborate and learn from one another in a number of areas, including 1) mutual learning on power sector reform, including markets, planning, pricing, operations, demand-side integration, and other topics; 2) jointly coordinated deployment goals and clean energy targets for clean energy resources, targeting 80% carbon-free electricity as soon as feasible; 3) technology knowledge exchange, including on demand response, transmission, hydrogen, and vehicle-to-grid integration; and 4) scientific exchange to understand the impacts of climate change on grid reliability and resilience, and jointly develop policy, analytical, and technological solutions.

Decarbonizing the Industrial sectors

Including emissions from electricity purchased by industry, the industrial sector is responsible for approximately 60% of China's greenhouse gas (GHG) emissions and 30% U.S. emissions. Therefore, industry must adopt technologies and processes to cut its own emissions to zero,

while continuing to support millions of high-quality jobs and produce the technologies needed to decarbonize all sectors of the economy. Strong action to decarbonize industry will be essential if China and the U.S. are to meet their commitments to achieve net zero GHG emissions in the 2050-2060 timeframe.

In China and the U.S., the largest-emitting industries are iron and steel, non-metallic minerals (i.e., cement), and chemicals. Due to the urgency of the issue, it is important to emphasize technologies and policies that are either already readily available or that can be deployed and scaled up in China and the U.S. within the next 10 years. These include energy and material efficiency, circular economy, and direct electrification of industrial heat. There is a need for demonstration facilities for addressing emissions from the top-emitting industries, such as innovative ways to produce zero-carbon primary steel or novel cement chemistries, in the next decade.

Key opportunities for reducing emissions in the industrial sector include:

- Financing for clean industry—to amplify public financing such as co-lending, aggregation, loan guarantees, and bond sales;
- GHG emission trading scheme to incentives reduction through technological switching, demand reduction and use of government revenue;
- GHG emission standards to set as carbon intensity thresholds, to provide long-term signal that can drive innovation;
- Equipment fees, rebates and feebates to incentivize procurement of energy-efficient, low carbon models of equipment to save energy;
- Circular economy policies which are best use through measures such as product longevity, sharing systems, redistribution, remanufacturing and recycling;
- Green public procurement to leverage government's buying power and establish a more stringent standard and scale up clean manufacturing;
- GHG emission disclosure and GHG emission labeling that could enhance the transparency of GHG emissions at firms level.

ZEV deployment

Together, the U.S. and China accounted for over 50 percent of the global vehicle market in 2021. The two countries together dictate vehicle technology development trends and consumer preferences for vehicles. In 2021, ZEV sales accounted for 4 percent of the total light-duty vehicle (LDV) sales in the United States (Minos, 2022), doubling the previous year's market share. California, however, achieved the ZEV penetration rate of 12.4%. China now leads the world in total ZEV adoption both in passenger vehicles and especially in commercial vehicles. China's New Energy Vehicles (NEV) account for about 50 percent of global sales.

As recommended in the America's Zero Carbon Action Plan (Sperling, Fulton, & Arroyo, 2020), the key elements of policy should include 1) long-term binding rules requiring or motivating automakers to electrify their vehicles; 2) incentives for buyers in the near- and mid-term that improve equity; 3) public investment in charging infrastructure, with a focus on multi-family dwellings and public charging; 4) increased outreach, education, and engagement; and 5) local leadership by cities and regions in support of these aforementioned policies. We offer recommendations for the U.S. and China to further strengthen the exchange and collaboration on these activities:

- Exchange of policies and best practices, especially in Heavy and Medium Duty (HMD) trucks. California has already adopted the Advanced Clean Trucks (ACT) regulation. China is developing a similar ZEV mandate for commercial vehicles. The two sides should continue to engage each other and share policy adoption and implementation experiences with each

other. Given the encouraging results of the Dual-credit Policy, we believe that the Chinese ZEV mandate for trucks will have an equal or greater impact on its zero-emission truck adoption.

  - On the business and technology side, the battery-swap HD (BSHD) truck segment is growing rapidly in China. Currently close to half of the 10,120 new energy HD trucks sold in the first half of the year are battery-swap HD trucks (China Automs, 2022), increasing by a factor of 15 over the same period last year. BSHD trucks are the driving force behind China's accelerated adoption of ZEVs in HD trucks. There is no BS truck sold in the United States. Given California's target of a full ZEV fleet in trucks by 2045, it's highly recommended that California explores a demonstration of BSHD trucks as the state is in the process of locking in the investment of expensive high-voltage charging stations and hydrogen stations.

- Full cell electric vehicles (FCEVs) may still take a 5-20 percent of the market share both in passenger vehicles and HMD trucks, given the fact that large countries like China and the United States will need to diversify their energy supply mix away from a single source, electricity or liquid.
  - Densely populated Chinese cities are beginning to run out of fixed parking spaces. In addition to fast chargers, FCEVs may still provide a badly needed service with its advantages in quick refueling and a longer range. Presently, there is a theoretical advantage for FC HD trucks, since they can travel long distances without adding heavy loads and experiencing at least 30/60-minute charging time every 200-300 miles traveled. FCEV adoption is slowing down in California, but in China, a cluster of cities are demonstrating FCEVs with strong government support. In the first half of 2022, about 1,400 FCEVs were sold in China, mostly HD trucks, transit buses, and special vehicles. The U.S. should work with China in harmonizing hydrogen refueling standards, and both countries should open their markets for FCEVs to further bring down the price of fuel cell stacks.

- Vehicle to grid integration is a new area and will play an increasingly important role in the interaction between the vehicle as bidirectional energy storage and the grid as the conduit for intermittent renewable energy. The two countries can share the best practices and lessons learned for mutual benefit.

- Both countries should work to develop an internationally harmonized and standardized carbon emissions accounting and evaluation system with a database for the transportation industry. The two countries should explore ways to set and improve lifecycle carbon emission standards for the manufacturing of vehicles and powertrain products, batteries or fuel-cell stacks.

- Keep investing in developing both high-end technologies such as solid-state batteries with very high charging speed and power performance and lower cost technologies that will cover all market needs. Keep technology neutral as possible.

Building Decarbonization

Buildings are a persistent and growing obstacle to meeting global climate targets, collectively representing 40 percent of the world's greenhouse gas (GHG) emissions. In the U.S., buildings consume three-quarters of electricity and burn one-third of the country's natural gas. China is and will continue to be the country with the largest building stock in the world. China's new building floor area is about 4 billion m2 per year, accounting for nearly half of the world's new building area. The major challenges faced in China include 1) underutilized and substandard buildings, 2) inadequate efficiency in construction and operational phases, 3) on-site fossil fuel consumption, and 4) district heating in Northern China.

Realizing it is impossible to achieve our global climate goals without decarbonizing the built environment, we recommend that the U.S. take the following actions to decarbonize its building sector, including 1) all-electric or electric-preferred new construction codes, 2) policies and programs to encourage low-Global Warming Potential refrigerants, 3) "Buy Clean" and low-

embodied carbon codes, 4) incentives to reduce upfront cost for consumers communities and motivate the supply chain, 5) utility rate reform to lower operating costs, 6) health-protective performance standards for appliances, and 7) alignment with natural gas planning. We recommend these following actions for China: 1) reasonable construction volume with up-to-standard building performance, 2) improve efficiency of building operations, 3) adopt low- or zero-carbon heat sources for district heating systems and develop new technologies, 4) incentivize and promote construction with low-embodied carbon materials, and 5) incentivize and require the elimination of on-site fossil fuel combustion from coal and gas and encourage on-site renewables.

As China and the U.S. take action to decarbonize their building sectors, there are several opportunities for collaboration, including :

- Track II conversations: to create shared learning opportunities between the U.S. and China, both for federal/national level best practice sharing and leadership states/province communication, with a wide range of topics from policy, market mechanism, to technology, etc.
- Global Prize: jointly run a bi-annual prize to encourage market leaders to design and invest in net-zero landmark buildings, with a goal of 300 landmark net-zero buildings by 2030.
- Finance for All: establish a green finance mechanism to promote building decarbonization, such as the U.S.-China fund for zero-carbon-ready affordable housing and U.S.-China green fund for zero-carbon-ready rural housing.
- Joint Research: conduct joint research supported by public funding from both countries to encourage corporate and academic leaders to collaborate on the most urgent topics to advance zero-carbon buildings at scale, such as finding district-level solutions to promote zero-carbon buildings and prefabricated zero-carbon retrofit for urban renewal.
- Policy Benchmarking: conduct U.S.-China policy benchmarking on zero-carbon planning and design, green procurement, and heat pump promotion.
- Technology development: share the progress of technical development in terms of building alternative material technologies, efficiency key technologies, and integrated renewable technologies.

Reducing Methane Emissions

Reducing methane emissions is key to slowing climate change in the near-term and can contribute to limiting global temperature rise to within 1.5 degrees C. In the U.S., the energy and agricultural sectors are the two largest sources of methane emissions. The oil and gas industry accounts for most of the energy-related methane emissions, and, when combined with coal mining, contributes a total of 40% of national methane emissions. Although the Biden administration as well as states are taking serious actions to reduce methane, there are some challenges such as regulatory uncertainty.

China's methane emissions totaled 55.29 million tonnes of methane in 2014, accounting for 10.4% of national GHG emissions (in CO_2-equivalent). Although China's recent NDC includes actions to reduce methane, it is not expressly spelled-out in its 2060 carbon neutrality targets. The major challenges in China's methane mitigation policy and action are a 1) lack of complete emission data and quantitative targets on controlling and reducing methane emissions in existing programs; 2) lack of comprehensive regularly and management frameworks on methane emissions; and 3) insufficient foundational research on science, technology, and policies in support of reducing methane and other non CO_2 GHGs.

As two of the world's largest economies and energy consumers, China and the U.S. are also the first and third largest methane emitters in the world, respectively. Both countries hold significant potential in methane emissions reductions over the next decade, including potential

for reductions at low or no cost. In the U.S., total methane reduction potential using abatement measures at or below $100/tCO$_2$e is 224 MtCO$_2$e in 2030. In China, methane reduction potential is estimated to reach 469 MtCO$_2$e in 2030, or the equivalent of 35% reduction from 2015 levels.

The key opportunities for methane emission reduction are:

- Energy supply sectors: oil and gas, and coal mining— The greatest potential for methane emissions reductions from worldwide energy production is in the oil and gas sector, where the global reduction potential is 29-57 MtCH$_4$/yr. In the U.S., the methane mitigation potential of energy sectors up to $100/tCO$_2$e is 144 MtCO$_2$e, with the greatest reduction potential coming from the oil and gas sector. In 2030, for instance, 256 MtCO$_2$e of methane reduction potential is estimated for China if deep mitigation measures are fully adopted in coal mining with average abatement cost of just below US$14/tCO$_2$e.
- Agriculture—estimated reduction of 4-42 MtCH$_4$/yr from livestock and 6-9 MtCH$_4$/yr from rice cultivation globally. In the U.S., methane mitigation potential in 2030 is estimated at 72 MtCO$_2$e (at $100/tCO$_2$e), with the vast majority of reduction potential coming from the livestock subsector. In China, methane mitigation potential is estimated at 65-116 MtCO$_2$e for similar abatement costs for the agriculture sector. Primary methods to reduce emissions from livestock involve improving feeding and manure management, while for rice cultivation emissions, the main mitigation measures are improved water management, alternate flooding and drainage of wetland rice, direct seeding, and improved yield gains.
- Waste —estimated to provide 29-36 MtCH$_4$/yr reduction potential globally. The U.S. mitigation potential from the waste sector is estimated to be 8 MtCO$_2$e (up to $100/tCO$_2$e) in 2030, while China's mitigation potential is estimated to be 26 - 45 MtCO$_2$e in 2030.

Therefore, we recommended that the U.S. and China collaborate in the following areas:

- Commit to ambitious quantitative methane emission reduction targets with defined timelines;
- A multi-pronged approach to applying different types of policies, programs, and tools to support mitigation efforts;
- Coordination and complementarity between multilateral, national, and subnational mitigation actions; and
- Reporting and data tracking to quantify both baseline emissions and emission reduction impacts of mitigation measures.

Accelerating Zero-Emission Shipping

China and the U.S. are both one of the 10 largest International Maritime Organization (IMO) states with interest in providing international shipping services for decades, whose bilateral trade is responsible for 2.5% of the global shipping carbon dioxide emissions and 4.8% of ship-related global premature deaths caused by air pollution. It is estimated that CO_2 emissions from ships navigating within 12 nautical miles from shore could account for approximately 1% of China's national CO_2 emissions inventory, expected to grow if left unchecked while other sectors start to decarbonize; while in the U.S., the exclusive economic zone (EEZ) accounts for 0.6% of the U.S.'s 2020 emission inventory.

At home, both countries have taken regulatory actions to control criteria air pollutants and GHG emissions from shipping. Historically, the two countries had successfully collaborated to reduce shipping emissions. Between 2008 and 2021, the U.S. Department of State and China's National Development and Reform Commission implemented the Eco-Partnerships program that incubated 45 subnational partners to achieve shared goals in clean air, clean water, and waste reduction. In 2022, the Port of Shanghai and the Port of Los Angeles and C40 cities pledged to create the world's first transpacific green shipping corridor.

Technologies with varying GHG reduction potential and technological readiness are available to

help decarbonize international shipping. The IMO'S Fourth Greenhouse Gas study identified 44 GHG abatement solutions which can be categorized into the following major groups:

- Energy-saving technologies: Two leading technologies that ships can use to reduce their energy use and emissions include air lubrication (5-15% reductions) and wind-assisted propulsion (2-15% reductions). It is estimated that China, if energy efficiency standards are introduced in 2025, could cut CO_2 emissions from China's coastal shipping by 5% in 2030 compared with 2019 levels.
- Use of renewable energy and alternative fuels: Alternative fuels for maritime shipping show the highest potential to decarbonize international shipping, yet questions remain on how to evaluate their GHG reduction potentials. It is suggested that these four fuels and energy sources have low life-cycle emissions: renewable electricity, green hydrogen and its derivatives, advanced biofuels, and port infrastructure and onshore power supply.
- Speed reduction: a 10% reduction in speed can result in voyage-level emissions reductions of about 19%. Even greater emissions reductions are possible at slower speeds. The California Air Resources Board (CARB) estimated that if all ships were to travel for less than 12 knots within 40 nautical miles of ports, GHG emissions within the boundary could be cut by 29%, although China has not yet adopted such voluntary programs, and the IMO has little appetite for any mandatory limits on vessel speeds.

The U.S. and China could expand this type of collaboration to other existing shipping routes between the two countries, with harmonized policy frameworks and financial support on both sides. Since ports handle international trade as well as domestic trade, benefits of such international collaboration can spill over to benefit domestic shipping as well. The ultimate target of U.S.-China Green Shipping Corridors should be to immediately identify feasible pathways to decarbonize the U.S.-China bilateral trade no later than 2050, which would contribute to IMO's GHG strategy to be strengthened in 2023. To support these goals, the following areas of collaboration under the U.S.-China Green Shipping Corridors are recommended:

- Build and deploy zero-emission vessels—the U.S. and China could start by targeting their domestic fleets, including tugs, pilot boats, ferries, and regional cargo ships, and then expand to larger ships that travel longer distances, including deep sea vessels that can sail along green shipping corridors.
- Deploy zero life-cycle emission marine fuels—the two countries could work on harmonized protocols to certify sustainable marine fuel and provide financial incentives to deploy the production, distribution and sales of these fuels to ships servicing a targeted green shipping corridor.
- Showcase zero-emission ports—the two countries could collaborate on eliminating in-port emissions by initiating a paired zero-emission port project, for which the pair is the two end ports of a targeted green shipping corridor.
- Create zero-emission ocean shipping corridors—in addition to LA and Shanghai, the U.S. and China could create other port partnerships and clarify the year by which zero-emission vessels will begin sailing these routes and set targets for the proportion of trade moved by zero-emission vessels along these corridors over time.

Aviation Decarbonization

Aligning aviation with Paris temperature goals requires significant ambition and resources, supported by robust government policies. China and the U.S., the two largest markets, play a crucial role in leading the low-carbon transition of aviation. The two states' combined efforts can help alleviate the major challenges to decarbonizing aviation: inefficient international policymaking and lack of momentum for clean fuel adoption. Across the entire aviation industry, GHG emissions reduction needs to come from clean fuels adoption, fuel efficiency

improvements, demand change associated with market-based measures and modal shift, as well as mitigation of non-CO_2 impacts.

China and the U.S. are the two biggest aviation markets in the world, but are at different stages of economic development and their air traffic growth in the coming decades will vary. Flights departing these two countries accounted for 35% of global passenger operations and 36% of CO_2 emissions in 2019. The two countries will naturally have different plans for decarbonization. Nevertheless, we believe that the two states can agree on the urgency of peaking aviation emissions, align their priorities for decarbonization, and promote collaborations on key levers. Both countries need to provide more support and incentives for high-integrity sustainable aviation fuel (SAF) through domestic policies. China needs to strengthen its ICAO leadership, while the US needs to promote emissions disclosure and invest in high-speed rail.

The potential areas for collaboration range across ICAO leadership, SAF corridor, enhancement of environmental standards, and contrail mitigation through low aromatic fuels. Immediate actions from both countries will be crucial to routing global aviation towards deep decarbonization in the coming decades and staying in line with a Well Below 2 Degrees temperature goal.

Food waste and fertilizer efficiency

Currently, the food system is a large source of global greenhouse gas emissions. In the U.S., food loss and waste (FLW) ranged from 73 to 152 MMT per year with a per capita rate of 223 to 468 kilograms (kg) annually, more than double the global average based on recent estimates. Estimates of inorganic nitrogen fertilizer use in the U.S. range from 11 to 16 MMT annually, with 86% produced domestically. The U.S. is also the world's fourth-largest producer of inorganic nitrogen fertilizer. Recognizing the importance of increasing fertilizer efficiency, the U.S. launched the "Global Fertilizer Challenge in 2022, which aims to increase the adoption of innovative, alternative, and efficient fertilizer practices to alleviate pressure on fertilizer and natural gas supplies, increase global fertilizer availability, lower N_2O emissions, and increase global food security.

As the most populous country in the world, China is also the largest global contributor of FLW. China is also the world's largest producer and consumer of inorganic nitrogen fertilizer, using upwards of 30% of the global supply. To control the negative environmental impacts of agricultural run-off and greenhouse gas emissions--and to optimize the energy use, cost, and nitrogen-use efficiency of farming--the Chinese Ministry of Agriculture has phased out fertilizer manufacturing subsidies and in 2015, implemented the Action Plan for the Zero Increase of Fertilizer Use. Fertilizer use has since declined from 23.6 MMT in 2015 to 18.3 MMT of nitrogen in 2020, with an average annual rate of decline of 1 MMT per year.

Diverting FLW from high emitting waste streams to compost or anaerobic digestion has the potential to lower landfill emissions and provide a nutrient-rich, slow-release organic fertilizer that could reduce inorganic nitrogen fertilizer emissions and increase soil carbon capture and sequestration. Using less nitrogen fertilizer confers fossil fuel savings from fertilizer manufacturing. Additional emissions reduction could be achieved from the diversion of FLW from landfilling and incineration. Adding livestock manure as a feedstock when composting or anaerobically digesting FLW could help lower inorganic fertilizer requirements and offer additional greenhouse gas emissions reductions. Finally, land application of composted or anaerobically digested FLW is likely to increase the sequestration of carbon in soils.

The recommendations for both the U.S. and China include 1) reduce FLW and increase capture, 2) expand composting and anaerobic digestion, and 3) reduce over-fertilization and substitute with composted or digested FLW. There are several opportunities for collaboration between the U.S. and China. Generating standardized approaches to document FLW generation and fate can facilitate comparisons and development of broadly beneficial solutions. Collaboration is needed on strategies to reduce nitrogen fertilizer application and improve the efficiency of nitrogen fertilizer use by supporting the development of technological approaches. The development of

scalable solutions for composting and anaerobic digestion is a particularly promising opportunity for collaboration. Engaging scientists, producers, and urban and rural communities could help ensure sustainable alternatives to FLW management from landfilling and incineration. Strategies to facilitate the development of a supply chain to provide replacement of inorganic fertilizers with FLW-based fertilizers can lead to substantial emissions reductions and carbon removal. Data sharing and collaboration across academic and agricultural institutions between the U.S. and China will improve the outlook for a successful transition to a more climate friendly circular economy in the global food system.

Reducing Deforestation

The U.S. and China are primary players in global supply chains and key to combating deforestation. The two countries have collaborated on the issue in the past. Since 2014, the U.S. and China Climate Change Working Group on Climate and Forests, led to technical and policy exchanges with government, civil society, and the private sector, including work to understand the impact of forest-related overseas investments on greenhouse gas emissions. The U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s from COP26 renewed the countries' commitment to collaboration on deforestation. The U.S.-China Joint Glasgow Declaration focuses specifically on each country enforcing its respective laws on banning illegal imports, and the Glasgow Leaders Declaration seeks to halt and reverse forest loss and land degradation more generally by 2030 while delivering sustainable development and promoting an inclusive rural transformation. Achieving these outcomes will require substantial collaborative effort and capacity on the ground, including at the subnational (e.g., state, province) level. As part of these national and subnational-level commitments, there is consensus that action needs to occur at scale and across entire global supply chains in a way to avoid leakage and ensure long-lasting reductions.

Recognizing that preserving and enhancing global forests is "essential to maintain a pathway to net zero emissions by 2050," the Biden Administration released a Plan to Conserve Global Forests: Critical Carbon Sinks that includes a goal to set "forth a whole-of-government approach to conserving global terrestrial carbon sinks, leveraging a range of diplomatic, policy, and financing tools." This Plan also recognizes that there are "many drivers of deforestation and ecosystem degradation that need to be addressed to successfully conserve critical carbon sinks, including: misaligned incentives, lack of available financial resources, limited political awareness and support, lack of transparent information, poor governance, vested interests, and weak capacity."

China is the world's largest importer, exporter, and consumer of timber and wood products. China's demand and use of wood and deforestation-related commodities has increased dramatically over the last twenty years. Similar to the U.S., China is committed to combating illegal deforestation. In 2019, China amended the Forest Law to ban illegal forest products and monitor sources of timber. Industry and the government have developed various voluntary guidelines to address the impact of overseas trade on tropical forests. The major challenges to addressing deforestation in China's supply chain are: 1) Regulatory fragmentation: authority to address illegal deforestation is spread across trade, finance, environment, agriculture, forestry, and customs units; and 2) many Chinese companies and their suppliers do not yet have the due diligence and traceability systems needed to deliver deforestation-free timber or commodities.

Therefore, we recommend that the U.S. and China accelerate domestic policy measures to reduce deforestation and deepen collaboration in the following areas:

- Share lessons on implementation of the Lacey Act and linking forest companies in both countries to better address illegality in supply chains;
- Support targeted legal, regulatory, incentive, and fiscal approaches to combat various drivers of deforestation. For example, to address deforestation from commercial agriculture, commence joint efforts on embedded carbon emissions in agricultural imports, support

collaborative approaches with farmers and improve access to financing (e.g., credit) and renewable energy sources, and collaborate on wildfire research and modeling.

- Support the development of enforcement mechanisms, transparency and accountability including traceable supply chains and utilization of remote sensing technology, working with countries and companies;
- Support upfront finance mechanisms for subnational and national jurisdictions to implement these actions, participate in programs utilizing high-integrity standards, and attract sustainable private sector investment.
- Align infrastructure programs (Belt and Road Initiative plus new G-7 initiative) with sustainable, low-carbon agricultural and timber production;
- Ensure multilateral nature-based climate solutions, biodiversity, and forest protection commitments at UNFCCC COP and CBD COP 15 are robust and recognize needs on the ground;
- Share bio-technologies with commodity producer countries to enhance agricultural productivity.
- Facilitate knowledge exchange between leading Chinese and American commodity trading companies and financial institutions to accelerate supply chain action for tackling deforestation in line with 1.5°C targets.

CONCLUSIONS

The U.S. and China have important roles to play to support the development and implementation of global climate solutions. The Joint Declaration presents clear areas of cooperation and engagement. The U.S. and China have made climate progress over the last year. The series of the papers, as summarized in the previous section, show the many shared challenges and potential areas of collaboration that exist moving forward. More details are available in each of the individual papers in the series. It is clear that the opportunities are numerous and would support action in both countries with implications for meeting and accelerating climate goals across the world.

We would like to emphasize additional areas for further action and enhanced attention at COP 27:

1) US-China Climate Governance

A key focus of COP27 is on implementation. Given this, the U.S. and China should focus on how they can implement the commitments in the Joint Declaration. This could include:

- Restarting lines of dialogue and communication to support coordination; and
- Developing climate working groups on specific topics including designating members, developing clear timetables and actions plans building on the suggestions provided from in this working paper series.

2) Strengthening subnational climate action

Subnational engagement poses unique opportunities for U.S.-China cooperation, particularly in the areas where subnational governments act and the national (federal) government has limited authority. Both the U.S. and China have leading states that inform the national policy choices. Several sectors present opportunities for collaboration at the subnational level, including:

- Transition from coal and fossil fuels: the U.S. and China could consider expanding subnational engagement on coal transitions and economic diversification in coal states/provinces. The Energy Foundation China organized dialogues in the past linking coal communities from Wyoming and other Chinese coal provinces, setting a good example for future dialogues to include additional stakeholders.
- Energy decarbonization: There are particular areas worth expanding cooperation on, such as the Green Shipping Corridor initiative, currently Port of Los Angeles and Shanghai are partnering for zero carbon-fueled ships by 2030, which could include additional partners;

expanding cooperation on zero carbon building standards and benchmarking, and sharing best practices on clean transportation policy including for LCFS and EVs.

- Climate adaptation and resilience: Expand engagement and collaboration on downscaled modeling of climate impacts, including extreme weather events; engagement at the city level on heat event management; engagement on flood management best practices.
- Methane emission reduction: There are opportunities for subnational pilots in the agriculture and waste sectors and coordination on better subnational data collection/inventories.
- Carbon market design: Deepen ongoing exchange on the integration of subnational and national climate policy in both countries, particularly, the experience from California's cap-and-trade market and China's national and provincial carbon markets.

3) Enhancing International climate finance

As the world's largest historical contributor to climate change, the U.S. has a responsibility to support countries that did not contribute to the climate crisis, but are facing the impacts, particularly the poorest communities, to cut their carbon emissions and be ready for climate change. China, too, as an economic superpower, needs to support countries in need of financing to adapt to climate change.

Although last year, Biden pledged to provide more than $11 billion a year in climate finance by 2024. However, in fiscal year 2022, Congress only approved $1 billion for the direct international climate account. The Biden administration also has a policy in place to eliminate U.S. government support for overseas gas, oil, and coal projects. China needs to increase its support of other countries and ensure that its investment in the Belt and Road countries are sustainable, instead of building those projects that have degrading environmental impact locally.

4) Other gaps/opportunities for collaboration

There are some other areas with potential gaps to fill or opportunities for U.S. and China to collaborate, including:

- Coal phase out: the commitment, which was reframed as coal "phase down" at COP 26, needs to be enhanced to the level of ambition that could effectively limit the temperature rise within 1.5 degree C. Parties, especially the U.S. and China should consider further dialogues and mechanisms to hold each other responsible for making funding and resources available for coal phase out.
- Energy security and other threats worsened by extreme weather events or crises caused by the Russian invasion of Ukraine, that countries need to further develop their energy supply system to be more resilient to the changing climate and global orders.
- Climate resilience: both developed and developing countries, including the U.S. and China, should continue to build up their financial support and infrastructure for climate resiliency.
- Supply chain issues —such as the passage of the Inflation Reduction Act of 2022 in the U.S. and China's rapid expansion of its battery supply chain strategy could potentially provide contradictory and opportunities for bilateral coordination, particularly around transportation electrification.

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