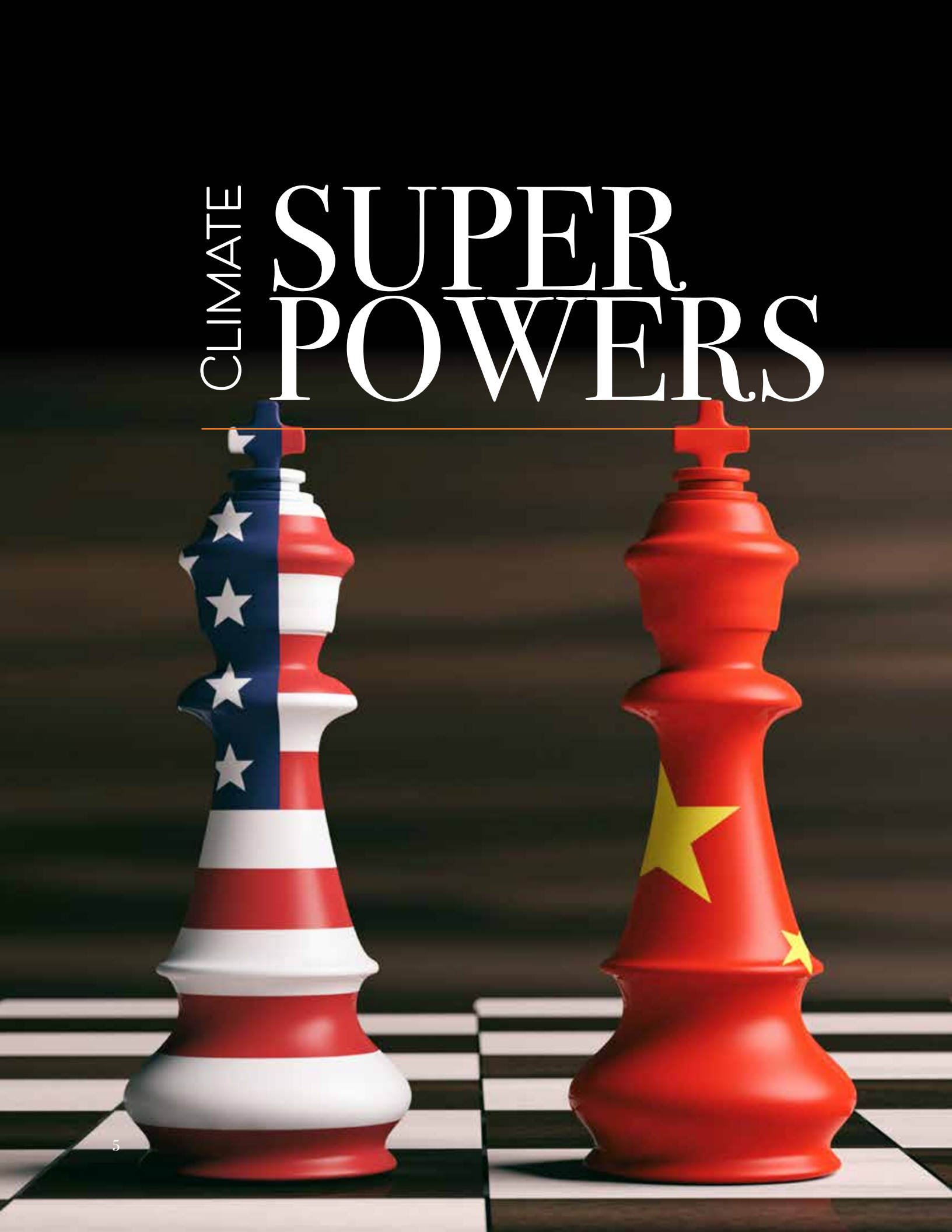
CLIMATE SUPER POWERS



"Climate Superpowers?" Why the Cold War is the Wrong Analogy for our Heating Planet

Huiyao Wang

Great power competition has cast a shadow over our global response to the COVID-19 pandemic. The outbreak should have been a chance for China and the United States to work together for a common cause. Instead, the pressures it has unleashed have inflamed tensions between the two countries.

The looming climate crisis is also a double-edged sword for great power relations. On the one hand, this global challenge that no country can solve alone should be a catalyst for cooperation. On the other hand, climate change can act as a destabilizing "risk multiplier" in geopolitics. It aggravates stressors on societies, economies, and institutions, and opens new areas for competition that can exacerbate friction between states.

Cohesion or conflict? Which of these countervailing forces of climate change prevails may be the most important question of our lifetimes. The answer will be shaped by political will and leadership. It will also depend on the course of China-U.S. relations.

China and the United States are the world's two largest economies, energy consumers, and carbon emitters, jointly accounting for over 40 percent of global emissions.[1] They are leaders in clean tech, industry standards, and represent the developed and developing world respectively. Interplay between these two "climate superpowers" will shape prospects for effective climate governance and the development and deployment of clean technologies.

If they can work together, China and the United States have the critical mass to put us on the road to a sustainable climate future. But if they cannot cooperate, it is difficult to see how we can get there.

Great Power Relations in the Age of Climate Change

Of the many historical analogies applied to China-U.S. relations in the 21st century, it is the Cold War metaphor that has become most pervasive.

Viewed through this lens of bipolar zero-sum competition, the divisive potential of a climate crisis stands out. Environmental flux and the quest for decarbonization simply open new areas for great power rivalry, whether the prize is control over new waterways and undersea resources in the melting Arctic, dominance in climate-adaptive technologies, or access to the critical minerals that enable these. Decoupling and the emergence of distinct trade blocs, in this view, inhibit growth and lead to suboptimal patterns of clean technology adoption, while discord and strategic competition hinder progress on multilateral climate governance.

This framing does not make for a cheery outlook. But is it the right way to understand China-U.S. relations in an age of climate change?

Each era of great power relations has its own dynamic and characteristics. Two features of 21st century geopolitics make China-U.S. relations quite different to great power relations that came before.

The first is interdependence. Economic globalization and value chains have bound the great powers of our age together in a way quite unlike the Cold War or most other models from history. Some argue that the pressures of decoupling and deglobalization may weaken these linkages. But even so, COVID-19 shows that the effects of "ecological globalization" are only getting stronger. Climate change links our fates together via our shared atmosphere and ecosystems. Indeed, failure to manage climate change could also increase the risk of future pandemics by impacting natural habitats and raising the chance of zoonotic transmission. In the 21st century, the greatest threats we face are not from other states but are transnational in nature, like climate change and epidemics.

The second feature is multipolarity. Long-term structural trends, in particular the rise of Asia and emerging markets, mean that no single power can dictate global norms and rules by itself. The shift of gravity is arguably even more pronounced with respect to climate change. In 2000, Europe and North America made up more than 40 percent of global energy demand and developing Asian economies around 20 percent. This situation will be completely reversed by 2040 according to IEA forecasts. Carbon emissions from India's power sector will overtake that of the United States before 2030.[2] No solution to climate change is possible without the joint efforts of a broad coalition of developed and developing countries.

These realities call for a new understanding of security and power in the 21st century. Cross-cutting non-traditional security issues matter more than ever and cannot be addressed with brute military or economic force. In the face of a common existential threat like climate change, the salient notion is not "power over" but "power with" other countries, to draw on Joseph Nye's distinction.

Foregrounding Climate Response in China-U.S. Relations

One paradox of the Cold War was that deadly nuclear weapons brought a degree of stability to direct interactions between the superpowers. Both sides recognized they had to cooperate to avoid mutually assured destruction.

Compared to the threat of nuclear weapons, climate change is a more complex problem. It involves more actors, greater uncertainty, difficult tradeoffs, and questions of equity between countries and generations. However, in the long-run, there is a certain parallel in logic of nuclear weapons and climate change. Both demand coordination and cooperation to avert an outcome that destroys everyone. Like the Cold War in the last century, great powers in the

21st century must also work together to prevent a potential catastrophe, albeit one that unfolds gradually rather than ends in a bang.

But the cooperative logic of climate change goes far beyond simply avoiding disastrous lose-lose outcomes. The shift to a carbon-neutral world presents many tangible rewards for China and the United States. It would help both countries to protect their environments, create wealth for their citizens, and edge closer to energy security. Reduced dependency on fossil fuels and the shipping lanes that transport them could also reduce tensions in potential flashpoints such as the South China Sea.

Clean tech will be a huge growth sector in years and decades to come—and it will have to be, given that fossil fuels still account for 84 percent of global primary energy consumption.[3] The World Bank estimates that climate change commitments have opened nearly $23 trillion in opportunities for climate-smart investments in emerging markets alone by 2030.[4] Chinese and U.S. companies have complementary strengths in low-carbon sectors. China is a top manufacturer of climate-friendly technologies such as wind and solar PV; the United States is a leader in systems that integrate these products into power grids and cities. By working together, they can tap synergies to develop new solutions and unlock third market opportunities in areas like infrastructure, green buildings, and smart cities. On top of common environmental concerns, these partnerships and shared economic interests would give groups on both sides more incentives to maintain stable bilateral relations, providing a ballast that has been lacking in recent years.

The vision of China and the United States as joint architects of a low-carbon future might seem like a tall order in the current moment, with bilateral tensions frayed and a climate skeptic in the White House. But it is worth remembering that green issues were a bright spot for the relationship until recently. China-U.S. cooperation was instrumental in the 2015 Paris climate agreement. The U.S.-China Climate Change Working Group, created in 2013, saw fruitful collaborations and sharing of expertise between companies from both countries in fields such as smart grids, carbon capture, and vehicle emissions reduction.

In the long-term, China remains optimistic that the United States will again become an active partner in climate management, given the growing global consensus and support for action among younger generations. Clearly, the upcoming presidential election weighs heavily on near-term prospects for climate cooperation at the national level. But

regardless of the outcome, there are other ways for the two sides to work together.

China can cooperate more with the United States at the sub-national level. For example, the California-China Climate Institute was launched last September to exchange ideas, bring experts back and forth between the two countries, and promote more ambitious policy. There is scope for more such platforms to facilitate cooperation between policymakers and industry, such as climate summits at the state-provincial or municipal level, though sub-national governments will eventually need more support from their federal or central counterparts.

Like the Pugwash Conferences on science and world affairs served as a channel for dialogue during the Cold War, Track II diplomacy can play an important role in China-U.S. climate cooperation. More exchange between think tanks and nonprofit organizations across the Pacific can help strengthen understanding and explore solutions for mutually beneficial collaboration.

Once the right political window opens in Washington, China and the United States should seize the chance to foreground climate change in the bilateral relationship. In this way, they can nurture its cohesive potential and help proactively manage its destabilizing effects.

It is perhaps inevitable that the China-U.S. relationship will be colored by rivalry and disagreements. But we must not let unbridled competition undermine efforts to overcome the gravest threats to humanity. The Cold War shows it is possible for leading powers to cooperate on existential threats even amidst intense strategic rivalry. Yet in many other ways, it is a flawed analogy to understand a 21st century world that is more multipolar and interconnected than ever, not only through economic and cultural links, but also shared challenges like climate change. Our heating planet needs more imaginative forms of statecraft in great power relations that can ringfence bilateral frictions and spur cooperation to manage our global commons. To lose sight of that bigger picture would be the biggest strategic mistake of all.

Endnotes

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Defanging Great Power Competition

Kori Schake

Climate Superpowers

China's unwillingness to become a 'responsible stakeholder' is the issue of contention in great power competition. The objective of U.S. policy continues to be to compel China to abide by rules. The urgency of climate in Western policy agendas gives China significant leverage to exact technology and financial aid, or asymmetric policy capitulations (for example, averting our eyes from Chinese aggression in the South China Sea in order to keep cooperation on climate). But if handled smartly in Western policies, climate also has the potential to defang great power competition by fostering change within China and better organizing the West with regard to channeling China into rule-abiding behavior.

China is not a superpower in any way except one. It does not have a military that could defeat the United States' (despite the anguished concern of military planners). Its per capita gross domestic product of $16,842, even at purchasing power parity, ranks it 79th in the world, between Iraq and the Maldives.[1] Its GDP growth rate has halved since 2008, its debt has quintupled, and its demographic dividend of working age population is about to reverse into an aged population without an adequate social safety net or working-age population to support it. It lacks self-sufficiency in food, water, and energy.[2] The one metric in which China is a superpower is pollution. China's carbon emissions surpass those of the United States and European Union combined.[3]

Surprising Progress

Strange as it may seem, despite withdrawing from the Paris Climate Accords, despite a regulatory rollback at both the federal and state levels and the overt hostility of the Trump Administration, the United States was in 2018, according to UN Secretary General António Guterres, on track to meet the climate goals in the Paris Accords.[4] The U.S. is achieving its goals through a combination of states like California and cities like Chicago setting rigorous standards,

incentives offered by philanthropists like Michael Bloomberg, corporations like Apple Computers seeking brand association with advancing pro-climate policies, the military's aspiration to reduce reliance on vulnerable or expensive supplies, and growing public awareness driving consumer choices in climate-protecting directions.

This disparity would seem to further aggravate great power competition. China has a weapon —pollution—it can leverage to influence government policies in the West, where vibrant civil societies (absent in China itself) affect policy. China can piously claim to be a poor country in need of Western technology and financial assistance to reduce its carbon footprint, and then use those resources to its advantage in economic competition with Western companies and for military improvements that expand its potential to threaten Western allies and interests. It can confront Western policymakers with trade-offs between threats their public cares about (climate) and systemic corrosion of the rules-based international order (rejecting Tribunal findings) or direct threats that may not seem relevant to many in the West (Hong Kong, Taiwan).

But ruthless and repressive as the Chinese government is toward its own people, it is not wholly insensitive to public concern. The U.S. Embassy in Beijing proved that in 2008, by beginning to monitor and tweet out air quality data, first in the capital and eventually in 70 Chinese cities. That simple and inexpensive action by the United States forced the Chinese government to be more accountable to its own public, to dramatic policy consequence: the
Chinese government could no longer successfully falsify data, and concern about public reaction pushed climate way up the government agenda.[5]

We know what the Chinese government is afraid of: its own people. It fears they will demand outcomes the government can't deliver, especially economically. Given Chinese public concern about pollution, the government may not carry the argument with its own public that rich countries' historical responsibility for environmental damage precludes assigning any responsibility for current damage on poorer countries creating it. And that gives the West a second weapon: using economic policies that would penalize China for climate damage as a way to channel the Chinese economy into accepting the practices other countries abide by on climate, and perhaps set an important precedent for wider rule abiding.

A Climate Club

As Jeff Colgan has argued, the urgent needs of addressing climate change offer the opportunity for the United States and its allies to draw China into more cooperative participation with the rules-based order. Colgan proposes the creation of a 'climate club' of countries that meet agreed minimum standards of climate preservation policies and apply trade tariffs to products and services of countries that do not.[6]

Creating a climate club like this would not address the security problems of Chinese state firms' military links or espionage, but it could provide an important area of cooperation to stabilize great power competition and begin building trust that will be essential for progress in other more contentious areas, like arms control or resolving competing territorial claims. It would also give Western powers a positive and publicly popular agenda to organize around, something less fractious than 5G infrastructure decisions. In doing so, it would strengthen the major advantage the U.S. has in great power competition, which is the ability to play team sports.

From Competition to Climate Protection

Current trends both in China and the West risk militarizing the U.S.-China competition. China has accelerated its repression against Hong Kong political activism, Uighur culture, and disputed territorial boundaries in all azimuths from the Himalayas to the East China Sea. The U.S. is structurally biased toward military policy tools because of chronic under-investment in other government agencies, and the erratic belligerence of the Trump administration sends confusing signals that can exacerbate crises.

Developing a climate agenda that advances the U.S. objectives of pulling China into more rule-abiding international behavior would be a major victory in the emergent great power competition, organize Western countries into a sustainable common front pushing China on an issue of great concern to their own publics, prevent China from utilizing climate as a predatory economic policy, and create the basis for greater trust and cooperation on other issues. And, incidentally, provide a way to prevent terrible damage to our planet.

Endnote

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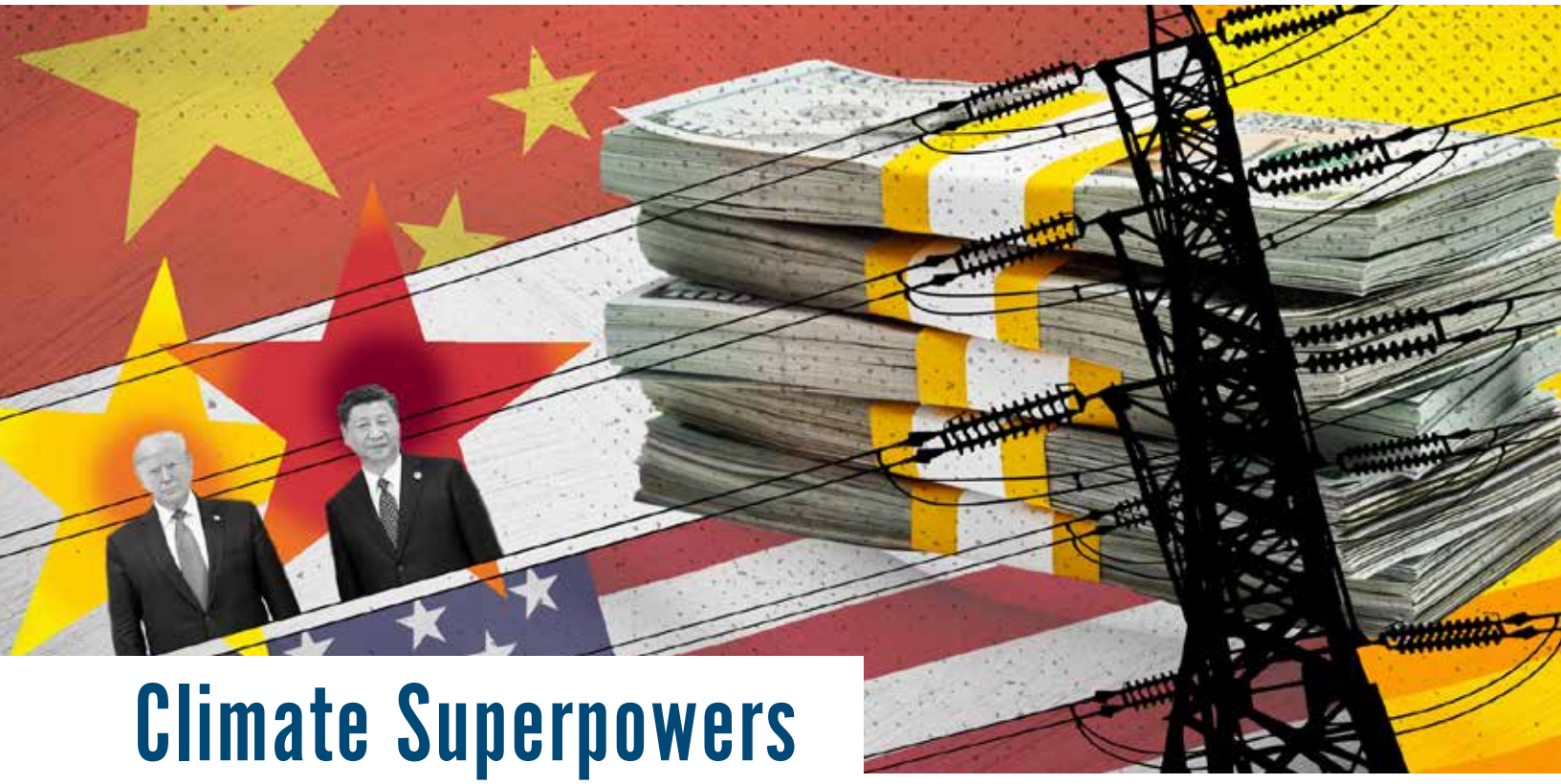


Climate Superpowers

Lydia Powell

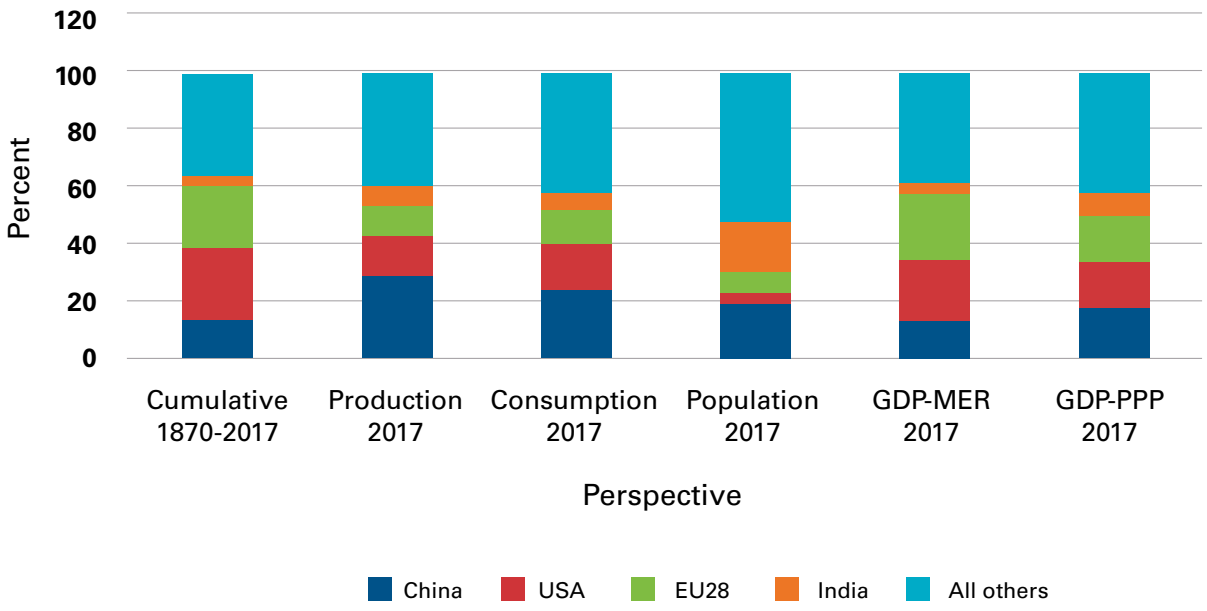
The Climate Scoreboard

In the current environment—where nationalism is on the rise—solidarity is not likely to cross national borders. Even when it comes to addressing the critical challenge of climate change, national interests are likely to dominate responses. This is particularly true of global powers, the United States and China, whose economic and technological interests are competing for dominance. For both superpowers, the nation state is the master discourse that legitimizes the climate discourse.[1]

Being geopolitical superpowers in international affairs has an effect on climate change negotiations, as we have seen in debates where both China and the United States have pursued economic competitiveness, or energy security or "energy dominance," even at the expense of climate action. Superpower rivalry plays a real role in international climate talks, and China and the United States have, thus far, primarily used their power to subordinate climate action to national economic and geopolitical interests.

The sheer size and economic weight of China and the United States also means that they are climate superpowers by dint of their potential to mitigate climate change: China and the United States account for roughly 30 percent of global economic output and are responsible for 43 percent of cumulative carbon emissions (see Chart 1).[2]

Chart 1: Responsibility for Emissions by Perspective



Data Source: Global Carbon Project (Note: MER - Market Exchange Rate, PPP - Purchasing Power Parity)

In 2019, China was the top emitter, accounting for 28 percent of global carbon emissions, with the United States in second place with 15 percent of emissions.[3] Inevitably, the economic and technological competition between China and the United States will strongly influence the effort to climate-proof the world.

This is not necessarily a bad thing. Competition between superpowers can accelerate progress in identifying economic and technological pathways to decarbonization. Climate change provides an opportunity for both the United States and China to increase cooperation and signal their commitment to the rest of the world, even if hostility persists in other spheres of engagement.

The history of the United States and the USSR working together in the area of space research, despite being at the opposite ends of the Cold War, offers hope for cooperation between China and the United States on responses to climate change.[4]

Participation in Multilateral Agreements

In 2017, when the United States announced its withdrawal from the Paris Agreement, China was largely credited with taking over leadership on climate action by virtue of its endorsement of the agreement.[5] This was despite the fact that China's Nationally Determined Contribution (NDC)

to the Paris Agreement was substantially less ambitious than it should have been on the basis of fairness and equity[6], and despite the fact that China, together with India, accounted for more than half of the increase in carbon emissions in 2017.[7]

The 2015 Paris Agreement gave every country in the world the ability to set its own goals to prevent a 2°C increase in global temperature by the end of the century.[8] The agreement is legal in character and contains provisions for reviewing the NDCs every year to move the cumulative contributions closer to the goal of limiting temperature increases.[9] However, the NDCs are often described as vague, aspirational, and unenforceable; the Agreement's provisions for monitoring, reporting, and verification are far from watertight; and the mechanisms to support poor countries are under-developed.[10]

In the elegant framework of Robert Putnam's two-level games theory[11], China's NDCs leveraged the strengths and weaknesses of the Paris Agreement to pursue domestic and international goals while minimizing economic compromises. China's emphasis was on economic costs and international reputation. As a superpower in waiting, the prestige and soft power that comes with being part of a multilateral agreement mattered more to China than to the United States.

As a democracy, the U.S. approach to multilateral agreements has been more fluid, reflecting the ideological changes in the country's leadership. Years of effort to improve bilateral climate cooperation with China under the previous U.S. administration led to a joint statement by China and the United States in 2014 where both announced their 2030 climate targets.[12] This paved the way for China's participation in the Paris Agreement. The current administration chose to upset the Paris table, taking advantage of domestic politics to legitimize its hawkish approach internationally. As the reigning superpower, the United States could afford to shun moral high ground and adopt positions that give primacy to the market over the state.[13] This position may yet be altered when the country's leadership changes in the future. Technically, under Article 28 of the Paris Agreement, the United States will remain under the Paris Agreement until 5 November 2020. Ironically, this date falls two days after the U.S. presidential election, in which commitment to the Paris Agreement may play a role.[14]

Notwithstanding the decision of the current U.S. administration to withdraw from the Paris agreement, 15 U.S. states and territories have taken legislative or executive action to move toward a 100 percent clean energy future.[15] The bipartisan U.S. climate alliance coalition of 24 state governors—representing more than half of the U.S. population and an $11.7 trillion economy that would be the third-largest

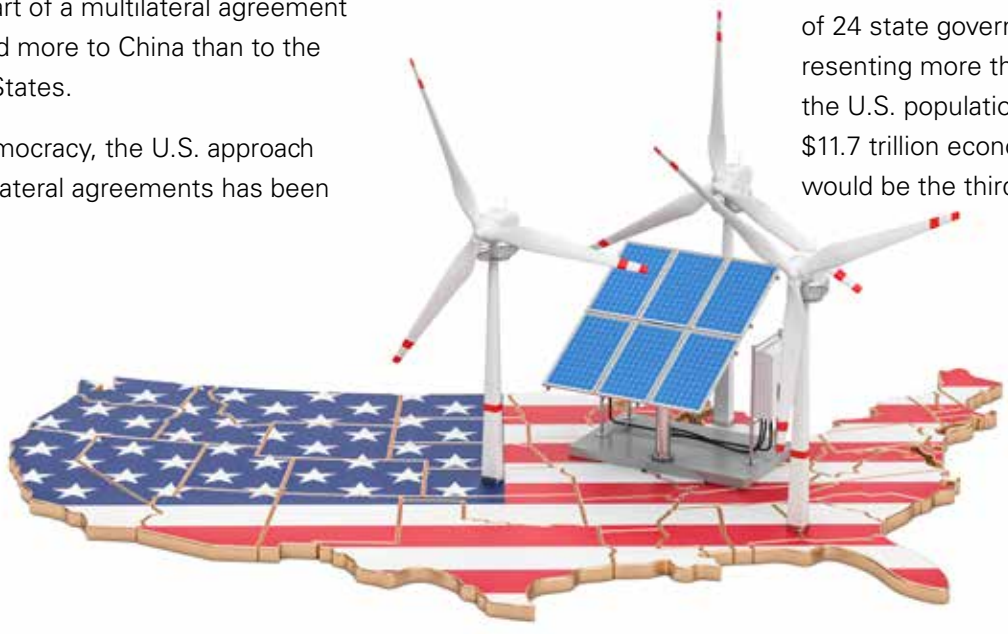
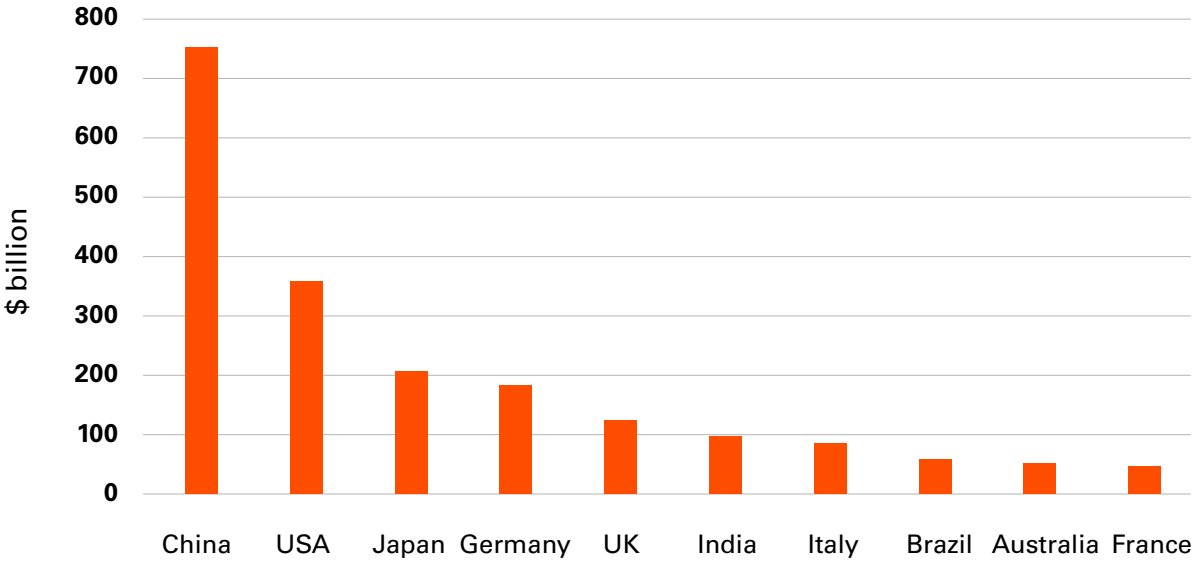


Chart 2: Renewable Energy Capacity Investment 2010 – 2019



Source: Frankfurt School-UNEP Centre/BNEF [17] (Note: 2019, includes only first half of the year)

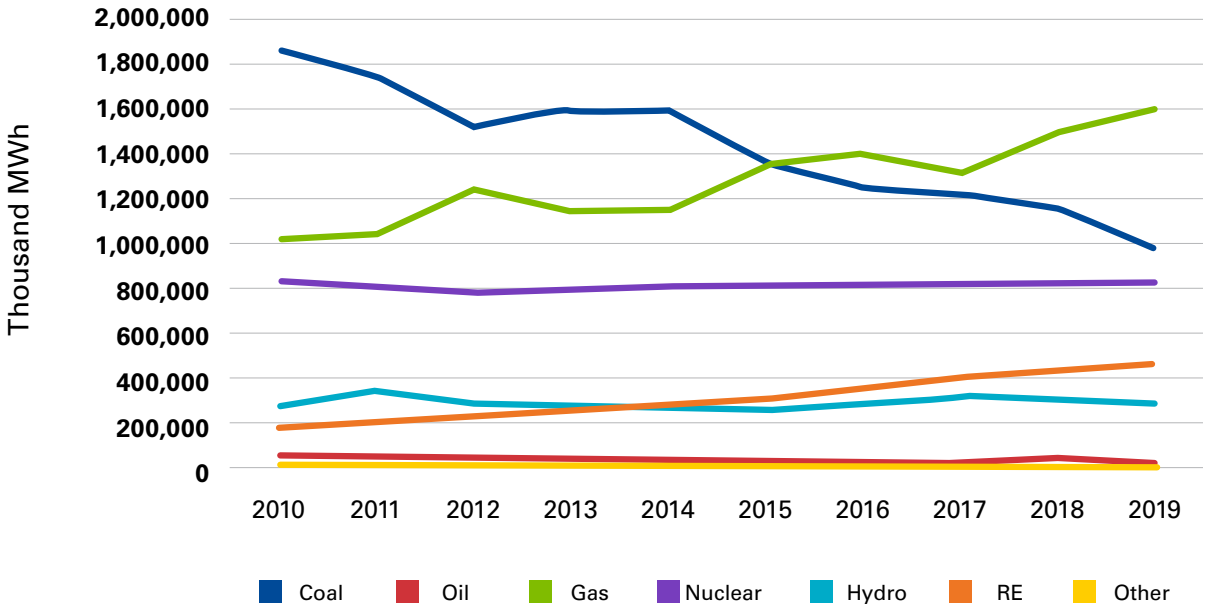
in the world—is committed to reducing carbon emissions by 26-28 percent below 2005 levels by 2025.[16]

Overall, both the United States and China are moving towards a low carbon future, although the motivations and mechanisms for action differ (see Chart 2). As a wealthy liberal democracy, the United States is more dependent on democratic choices of its people and the outcome of market competition between technologies. China, on the other hand, is a middle-income country that depends more on executive mandates on governance and technology to achieve roughly the same goal of decarbonization.

Harnessing Markets

The United States is the largest producer and consumer of oil and gas and the second largest producer and consumer of fossil fuels (oil, gas, and coal) after China.[18] In 2018 the United States produced more than 15.3 mbpd (million barrels per day) of oil, compared to the 12.2 mbpd of oil that Saudi Arabia produced. That same year, Russia—the largest exporter of gas—produced about 670 bcm (billion cubic meters) of natural gas, while America produced over 830 bcm of natural gas (see Chart 3).[19] The ability to harness technology and capital to bring domestic energy resources into production influences the United States' regional development, environmental quality, and national security through energy and climate policies.

Chart 3: U.S. Net Electricity Generation by Fuel



Data Source: Energy Information Administration, United States

Domestic energy production that reduces energy imports has always been a component of U.S. national security. This idea, captured in the slogan "energy independence," has influenced U.S. energy policy for over four decades.[20] Under the energy independence narrative, actors with economic and political interests in the domestic natural resource industries were able to present any commitment to reduce carbon emissions as a threat to national security. The slogan of "energy dominance" adopted by the current government is broader as it includes the idea of the United States emerging not just as a large energy producer, but also as a large exporter of energy, particularly of oil and gas.[21]

Producers of gas from shale plays are highly exposed to swings in oil and gas prices, as the current COVID crisis has demonstrated.[22] With gas demand plunging after the lock-down, taking with it the price, gas production from U.S. shale resources has decreased dramatically[23] and some large companies have filed for bankruptcy.[24] However, shale plays can return to production in a very short time if oil prices rebound, which illustrates the influence of markets over the U.S. oil and gas sector.[25]

Market forces that strongly influence the production and flow of domestic energy resources are driving critical shifts in the United States' fuel basket, with the unintended side benefit of reducing carbon emissions. In the 1980s and 90s, the United States was referred to as the Saudi Arabia of coal as it had a quarter of world coal reserves, the largest in the world.[26] In 2000, when coal accounted for roughly 50 percent of power generation, the U.S. electricity industry believed that the transition away from coal would be very expensive, and potentially impossible.[27] Unlike oil

and gas production, which is largely confined to four states, 26 states produced coal and thus there was greater political opposition to a shift away from coal.[28]

Yet in the last two decades, relatively cheap natural gas combined with the higher efficiency of gas-based power plants has substantially displaced coal in power generation. In 2015, the share of coal in power generation fell to 35 percent, with gas increasing its share to 32 percent.[29] Since gas-fired power plants emit half as much carbon as coal plants, in 2015, the U.S. emissions were 21 percent lower than 2005 levels[30]—the lowest emission levels since 1993. In 2019, coal accounted for just 23 percent of power generation.[31]

A similar transition has already begun to displace both coal and gas in favour of solar and wind for power generation, though this shift was not entirely driven by the market. State interventions in the form of tax credits for clean energy at the federal level and mandates to absorb clean energy through portfolio standards, net metering, and feed-in-tariffs at the state level[i] are pushing investment in clean energy that could eventually displace natural gas.[32]

In 2018, the United States generated 10 percent of its electricity from clean energy (not including hydro and nuclear), higher than the 8 percent share in China, though China generates more electricity from clean sources in absolute terms.[33] As of 2018, U.S. carbon emissions were 10 percent below its 2005 levels, which is roughly two-fifths of the way to the Paris Agreement target of 26 percent below 2005 levels by 2025.[34]

Coal-to-gas switching accounted for 33 percent of the reduction while structural changes in demand for energy accounted for another 30 percent. Clean energy was responsible for 20 percent of the reduction; efficiency, along with a fall in transportation demand (surface and air), accounted for 15 percent.[35]

The market cannot take all the credit for displacing coal in favor of gas. Tough environmental regulations on coal plants under the Obama administration assisted the switch to gas. Moreover, the unconventional gas (shale gas) production that is behind the United States' coal-to-gas switching is the result of substantial federal investment in research on fracking and horizontal drilling in the 1970s.[36] Nevertheless, coal-to-gas switching has not arrested growth in carbon emissions. In 2019 carbon emissions from gas use in the United States reached 1.7 GT (giga tonnes) which was a 3.5 percent increase over emissions in 2018, while emissions from coal decreased by 10.5 percent to 1.1 GT.[37]

At the federal level there are no market-oriented instruments for carbon reduction, such as cap-and-trade[ii] or a carbon tax. These instruments could potentially reduce emissions at a lower social cost (the monetary estimate of damages associated with an incremental increase in carbon emissions in a given year) than a more prescriptive regulatory approach due to the greater flexibility that they offer in determining how to reduce emissions. However, it is not easy to accurately determine how the costs of a market-oriented climate policy will be distributed across households with different consumption

i As of October 2019, 39 states and the District of Columbia have state-developed mandatory net metering that facilitates installation solar panels on private properties.

ii Some American states and the European Union have put in place carbon emissions trading schemes. China is also planning to implement a carbon-trading scheme.

patterns and levels of wealth. Because of the large uncertainties in the effects of climate change and the subjectivity of the discount rate, estimates of the social cost of carbon differ widely, from $10.2/ton to $105,213/t.[38] Anecdotal evidence from protests against taxes on fossil fuels in France[39] and Australia highlights the complexity in imposing market-based solutions to address climate change.

U.S. reliance on markets has so far pushed the energy sector towards lower-carbon fuels. Nevertheless, the critical force behind decarbonization was American public investment in the production of knowledge and technologies that were leveraged by capital to produce lower carbon energy.[40] Investment in research and energy by the United States is a public good that makes a huge contribution in shaping technological responses to climate change.

Imposing Mandates

In 2018, China produced more coal than the United States produced oil and gas in energy equivalent terms.[41] Electricity generated from cheap coal supports relatively low cost export-oriented manufacturing in China that is key to its economic success. China's coal demand is expected to plateau by 2022[42], but this is not necessarily because of its Paris pledges.

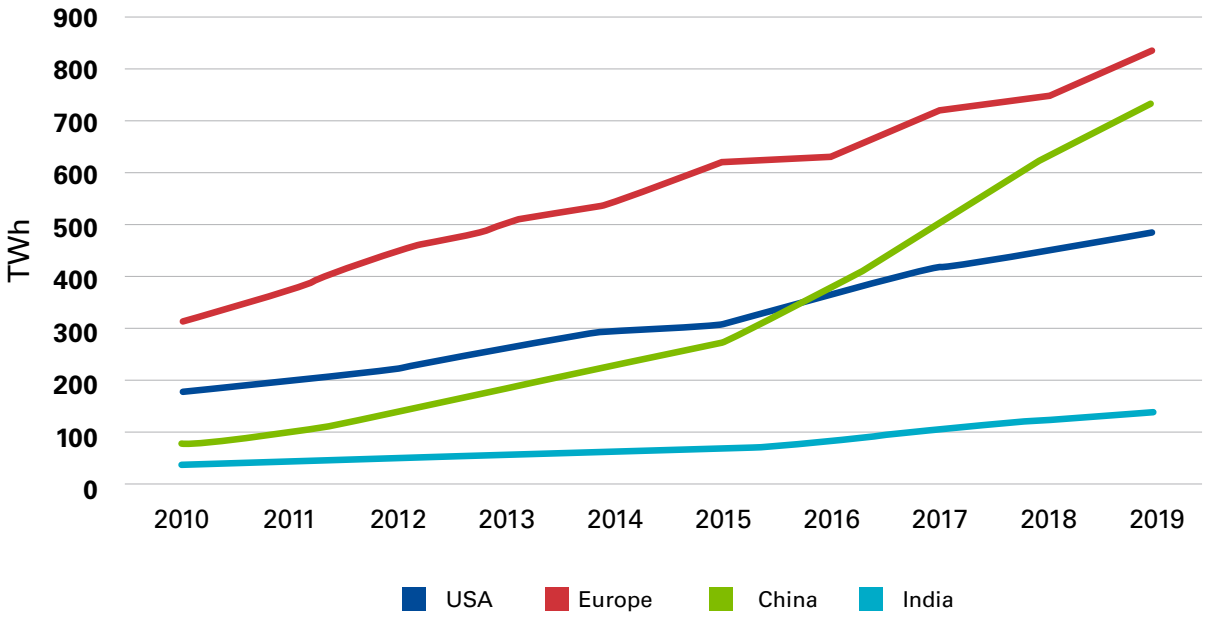
China's solar energy program, the biggest in the world today, was initially designed to meet low-end demand for electricity from rural households. China leveraged this manufacturing capability to respond to high-end demand for solar panels from Western Europe in the 1990s.[43] Provincial and local governments generated skilled and semi-skilled jobs by setting up solar manufacturing facilities, leveraging funding support for "strategic industries" from the central government.[44] Economies of scale from this expansion led to a dramatic reduction of solar panel and module cost for renewable energy consumers initially in Europe and eventually in other parts of the world.[45] From a climate perspective, this cost reduction is a public good because relatively poor countries can now afford large clean energy projects thanks to imports of cheap clean energy equipment from China.

In the early stages of solar manufacturing, China catered to markets in Western Europe, which tended to create excess capacity as European policies to subsidise installations of solar panels kept changing. The need to absorb excess capacity drove domestic installations of solar panels in China.[46]

Following Germany's lead, China introduced attractive feed-in-tariff[iii] to promote the domestic use of solar energy in 2013, and by 2015 China surpassed Germany as the largest market for solar energy in the world.[47] China's wind energy industry traced a similar path, as acquisition of small German companies with cutting-edge wind turbine technology eventually put China in the lead. China's leadership in electricity storage and electric vehicles is now following a similar approach, with rapid acquisition of technology and resources to scale manufacturing to meet state and federal level mandates and targets. China now easily takes all the prizes in the production and consumption of clean energy (see Chart 4).[48]

iii Feed-in-tariff is the price offered to roof-top or equivalent private producers of solar electricity who sell into the grid. This is generally higher than the average electricity tariff which serves as an incentive to install solar panels and generate solar electricity.

Chart 4: Renewable Power Generation



Data source: BP Statistical Review of World Energy 2020

China derives its economic strength more from the size of its population than from the economic efficiency and knowledge-driven productivity that supported U.S. power after the Second World War. At $15,376 (in purchasing power parity in current international dollars), China's per person income was a quarter of the United States' per person income in 2018.[49] China is keen to catch up on this vital economic parameter, irrespective of whether this is fueled by brown or green energy. It was to this end that China built clean energy manufacturing capabilities.[50] Essentially, China leveraged its industrial policy in its climate and clean energy policies—not the other way around.

From China's economic vantage point, the global conversation about climate change has moved from "well-intentioned" environmentalism to the future geopolitical international economic order, and not investing in low carbon energy sources would affect China's economic and trading competitiveness.[51] Trade barriers in clean energy, such as the carbon related border adjustment taxes proposed originally in the American Clean Energy & Security Act 2009[52] and now pursued by the European Union[53], suggests the possibility of "green-marginalization" of China.[54] The heavy investments in clean energy manufacturing by China in the last two decades sought to avoid tariff barriers to its exports manufactured using

fossil fuel based energy.[55] Notwithstanding the motive, the means (clean energy manufacturing) has benefited the world with substantial scaling of low cost clean energy production.

However, China is also facilitating the expansion of fossil fuel use in countries under the Belt & Road Initiative (BRI), which may be counterproductive to addressing climate change.[56] In 25 of the 65 countries under the BRI initiative, China is reportedly involved in 240 coal-fired power projects of about 250 GW capacity[57], roughly equal to current coal-based power generating capacity in the United States.[58] It is important to note here that the key driver of the decision to use coal-based power by relatively poor BRI countries such as Bangladesh, Mongolia, and Vietnam is driven by cost rather than indifference to climate commitments. Though these countries are exposed to climate-related disasters, the concern that the costs of mitigating climate change by reducing emissions could slow down their economic catch-up overrides their climate concerns.[59]

This highlights the critical question of economic inequality between countries and the consequent need for financial assistance from richer to poorer countries to address climate change. Article 4 of the UN Framework Convention on Climate Change (UNFCCC) echoed Article 9 of the Paris Agreement by calling for financial assistance to poor countries to address climate change. Available evidence shows that climate finance grants to poor countries are far lower than the $100 billion promised by developed countries.[60] This could be an opportunity for the United States and other developed countries to offer grants for clean energy to BRI countries under the climate finance mechanism. It is very unlikely that these countries would opt for loan-based coal projects offered by China under BRI if a cheaper clean energy alternative were made available.

Technology Innovation

The most recent report of the IPCC (Intergovernmental Panel on Climate Change) observes that the share of clean energy must increase to 52-62 percent of global primary energy supply by 2050 to limit global average temperature increase to 1.5°C.[61] Industrialised countries have responded by increasing research and development (R&D) spending in clean energy technologies in the past few decades to stay ahead in the race.[62]

The United States, China, Japan, France, and Germany were the five leading countries for public spending on energy R&D in 2018.[63] These five countries accounted for around 70 percent of all such spending worldwide. In 2018, China's energy R&D budget grew most in absolute terms, with spending on clean energy and higher-performing fossil fuel technologies increasing the most. The U.S. budget for energy R&D also increased by more than 12 percent in 2018, with notable increases for solar energy, hydrogen, and alternative vehicle technologies.[64] However, the share of China based start-ups in total venture capital value for early-stage energy technologies overtook the traditionally dominant United States, with Chinese companies receiving over half of the deal value.[65]

According to WIPO (World Intellectual Property Organisation), patents for clean energy technologies account for only 1 percent of overall patent applications, but these applications grew by 546 percent between 2002 and 2012.[66] That growth has continued: in the period 2010 to 2019, Japan led the table for clean energy technologies with 9,374 applications, followed by the U.S. with 6,300 (see Chart 5). China was in fifth place with 1,659 patent applications, with Germany and South Korea taking third and fourth place respectively. However, China's patent applications

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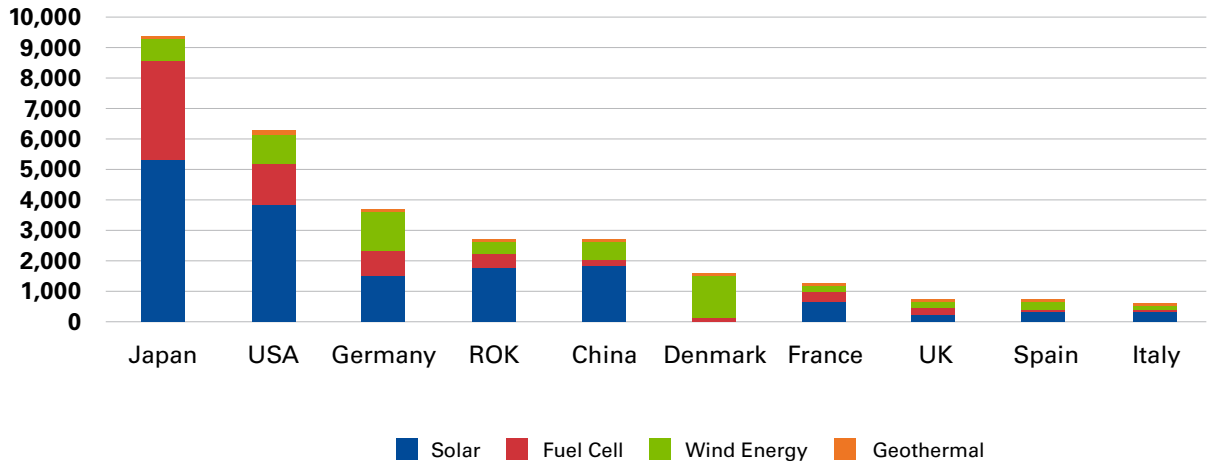
increased substantially in the second half of the decade (2015-19) to 1,522 applications, pushing China to third place after Japan (3,114 applications) and the United States (2,247 applications). In the period 2013-17, China was the undisputed leader in applications for clean energy patent families with 45,472 applications (see Chart 6). Patent families offer greater potential for commercialization as patents cover more jurisdictions.

China's emerging dominance in R&D investment in clean energy (and other sectors) need not be interpreted as a threat, especially when seen through the climate change lens. In investing in R&D, China is merely imitating the United States' post-war state-led industrial policy that facilitated its growth as an industrial powerhouse.[68] The state-led development of the United States, based on Hamiltonian economic philosophy, held that a big country needs big organizations to succeed and that the federal government in particular should collaborate with private enterprise to build infrastructure and finance scientific research. The only difference is that China is much larger and its pace of change much faster. However, climate change can benefit from rapid changes, especially when it comes to replacing fossil fuels with low carbon energy from wind and solar plants.

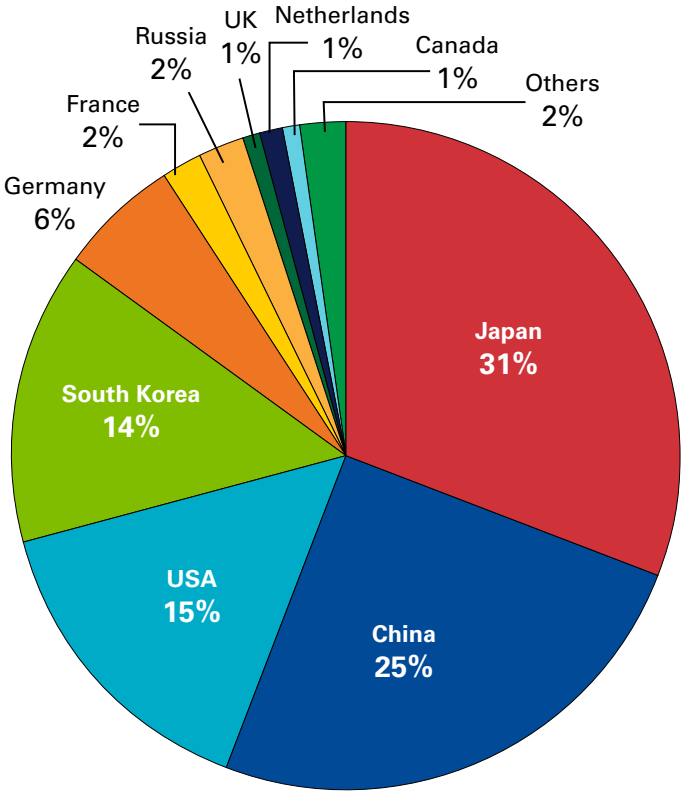
The claim that solar and wind electricity is cheaper than fossil fuel-based electricity and can therefore compete with traditional grid based power without state assistance is only partially true. At the system level, where dependable electricity must be supplied 24 hours of the day, all days of the year, and across all geographies, clean energy is not necessarily cheap as it requires back-up energy sources.[70] For clean energy to realistically compete with traditional grids, battery technologies that store electricity for back-up must become much cheaper and more efficient, or intelligent networks that monitor and displace demand to match supply must be developed.[71]

Chart 5: Patent Applications for Renewables 2010-2019



Source: WIPO News Magazine, March 2020[67]

Chart 6: Patent Families in Green Technologies by Origin 2005-2015



Source: WIPO[69]

The UN Environment Programme (UNEP) calculates in its annual "emissions gap" report that, in the 2020s, the difference between what countries have pledged to the Paris Agreement and what is necessary to limit warming to 2°C degrees is 13 to 15 GT of carbon annually.[72] To bridge the gap, all countries will need to reduce carbon emissions between 5 and 8 percent a year, something no country has ever achieved.[73] No natural rate of technology substitution, even assuming the best possible cost projections, will be fast enough to meet the 2°C target by the end of the century.

The critical need for rapid technological innovation can benefit from the advantages that China has over the United States: its massive domestic market, its centralized power, and its willingness to employ state-sponsored industrial policy and government support.[74] The expansion of scientific and technological capabilities in China has created a more multipolar global scientific landscape. In a multipolar scientific landscape, the big challenge is to institute traffic systems between China and the rest of the world to reduce transaction costs by ensuring that everyone plays by the same rules.

In the future, China and the United States may cooperate, reinforcing their strengths to address climate change much like the technological co-operation between the United States and USSR during the Cold War. While there were of course long periods of mistrust and overt hostility between the United States and the

USSR between 1957 and 1991, there were also periods of accommodation that led to the many cooperative agreements in arms control. It is not rational to rule out similar agreements between China and the United States in the context of climate change.

Conclusion

China and the United States are actively working to retain their leadership in a decarbonizing world. In the near term, competition between the two dominant powers can accelerate progress in finding economic and technological pathways to decarbonization even if economic competitiveness and energy security are the primary goals. U.S. energy markets have harnessed public investment in clean energy technologies and made inroads into traditional energy markets dominated by fossil fuels. China's clean energy manufacturing capabilities, developed to maintain its competitive edge, have lowered the cost of decarbonization for relatively poor countries. Both countries have independently created public goods in the form of clean energy technologies that have helped the whole world to address climate change.

As clearly demonstrated by responses to COVID-19, sovereign efforts, while necessary, are not sufficient to address climate change, a complex planetary problem. Even the most self-interested nation cannot deny that a globally coordinated response to the pandemic led by the superpowers would have substantially reduced public health and economic costs for all nations. Responses to climate change are not likely to be any different if solidarity is forged on a global scale for common and sustainable life.

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Harvesting Ill Will:

Can the U.S. and China Turn a Budding Cold War into a Clean Energy Space Race?

Scott Tong

It is no great insight to suggest that the differences between China and the United States are approaching irreconcilable. In July, Beijing slammed Washington's "gangster logic" after President Trump ordered the end of Hong Kong's special economic status with the U.S.—itself a retaliation for the mainland's new national security law. One month prior, China's foreign ministry warned of "consequences"[1] over a new American law to punish Chinese officials over the mass detention of minority Muslim Uighurs in western China. On social media, Chinese citizens have mocked Trump as a "joker" for proclaiming victory against COVID-19. There's anger that the United States is taxing imports from the mainland, denying visas to Chinese researchers, and pursuing criminal prosecution against the vice president of tech titan Huawei, whose smartphone sales last year leapfrogged those of the iPhone. The perceived slights have turbocharged Chinese nationalism. "If you look carefully at the Huawei logo," a cabbie in Shenzhen told me last summer, grinning from his rearview mirror, "it looks like a sliced-up apple."

In the United States, meantime, as I write this there's talk of an entry ban on every single member of the Chinese Communist Party, down to the apolitical, twenty-something opportunists who

joined the organization purely for the networking. The president has tweeted of "a complete decoupling"[2] from China, given its alleged theft of U.S. business secrets and market rules nudging aside foreign competition. A newly aggressive Beijing, as the bipartisan narrative goes, is bullying neighbors[3] in the South China Sea, booting out American reporters[4], and spreading misinformation[5] in the States. The United States, in an unusual and risky move, has sent three aircraft carriers to patrol the waters in the South China Sea, prompting threats of "countermeasures."[6] It is hard to keep up.

Antagonism is rising in tandem with the two superpowers' carbon emissions. As the Earth warms, the two largest greenhouse gas emitters are navigating toward a Cold War rather than toward a carbon-free 2050. As the Trump administration prepares to exit the Paris Agreement, U.S. climate collaboration with China at a federal level—diplomatic meetings, ministerial level communications—has largely shut down. Cooperation seems implausible. "What we've seen is a decoupling not just in business and trade but across the board," Orville Schell, director of the Center on U.S.-China Relations at the Asia Society, told me. "Under Nixon and Kissinger, when they went in 1972 of course the common danger was the Soviet Union. Now the common danger is climate. Can we reorganize ourselves to confront that common enemy? I'm not so sure."

A Space Race in the Climate Space

The question is whether this doom and gloom presents an opportunity. Is there a way to harness this ill will to fuel great power competition? To stoke a "race to the top"[7] in cleantech innovation, as a report from the Center for Security and International Studies (CSIS) think tank puts it? Already, U.S.-China relations are being framed as having entered a new era: of competition. "The era of engagement with China has come to an unceremonious close," Kurt Campbell, a top East Asia diplomat in the Obama administration, wrote last fall in an influential essay[8] co-authored with Jake Sullivan in *Foreign Affairs*. "Coexistence means accepting competition as a condition to be managed rather than a problem to be solved."

A new mindset would cast climate friendly solutions less in terms of global benefit and future generations—always a policy challenge—and more in terms of national self-interest. "A space race in the climate space" is how Sarah Ladislaw, energy and environment scholar at CSIS, puts it. "Can China hawks [in Washington] have a climate strategy that's globally relevant?" Adds Kelly Sims Gallagher[9], energy and environment professor at Tufts: "There is plenty of room for healthy competition. I have wondered about the U.S. competitive spirit in the clean energy domain."

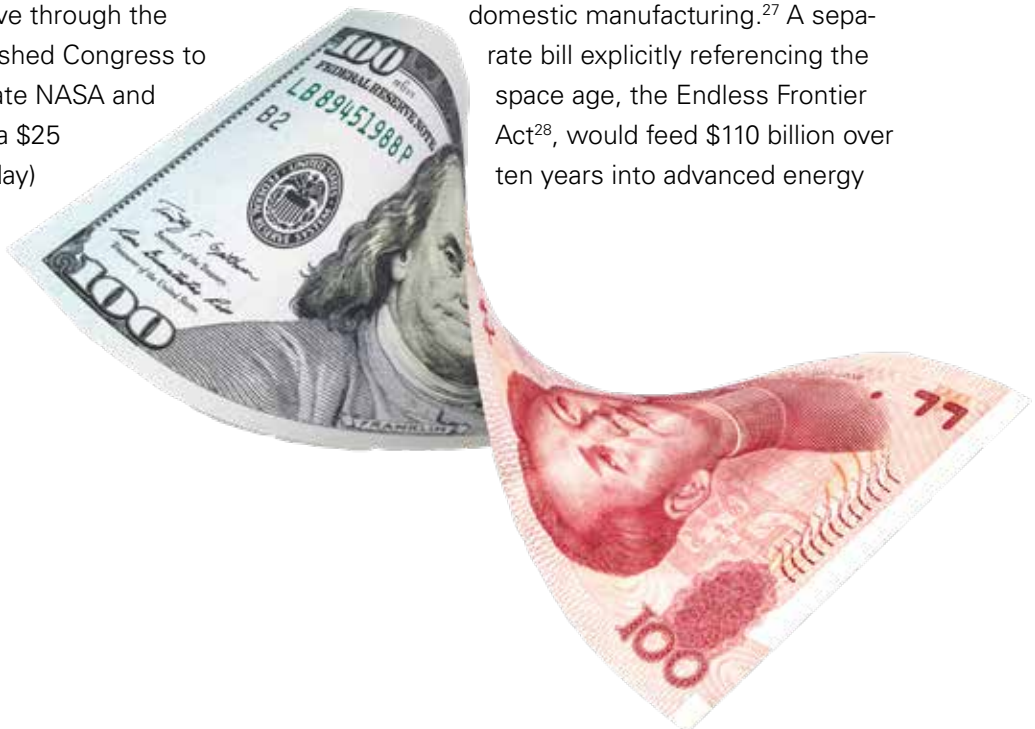
A jog back to the actual superpower Space Race of the 1950s and 60s suggests that yes, Cold War enmity did yield technology breakthroughs, not only Lasik[10] eye surgery and the development of memory foam[11], but also step changes in energy including LED lighting[12] and early solar cells.[13] With the right policies and investments, the argument goes, Space Race 2.0 could accelerate the development of essential yet still immature green technologies. The International Energy Agency has declared that several such innovations are not yet on track[14] to displace incumbent fossil solutions: energy from ocean waves, geothermal power, biofuels as alternatives to petroleum, and capturing carbon emissions from fossil fuel plants and sticking the pollution underground forever.

Rhetorically, the idea of country v. country competition syncs up with rising economic nationalism around the world. Tariffs have come back into fashion, including those on solar modules[15] and steel for wind turbines.[16] Economic drawbridges are going up in many corners of the world, blocking the flow of capital[17], business travelers[18], researchers[19], semiconductors[20], and journalists.[21]

Still, in the decarbonization space, fruitful competition is not just about rivalry. It must also be about money. In the 1950s the Soviet launch of Sputnik 1 sent a shock wave through the American body politic and pushed Congress to open its wallet. It helped create NASA and funded what would become a $25 billion[22] (that's $110 billion today) moon project. The federal government put nearly $1 billion into hard sciences.[23] "First in space means first, period," President Lyndon Johnson declared. "Second in space is second in everything." Likewise in Moscow, Soviet Premier Nikita Khrushchev crowed after his country put the first man into space in 1961 that the feat was the "greatest triumph of the immortal Lenin's ideas."

By 1966 NASA's budget accounted for a whopping 4 percent of the federal budget.[24] What would it cost today to green the entire U.S. electricity system? The consultancy Wood Mackenzie projects a price tag of $4.5 trillion[25], spread out over as long as two decades. On a per-year basis, the math over 20 years comes out to … 4 percent of the federal budget. Competition costs money.

To skeptics, turning negative energy from fear and discord into something useful may seem a Hollywood fantasy (recall Pixar's animated tale of an hourly worker named James P. Sullivan, a stinky blue monster who scares the daylights out of boys and girls, harvesting zero-carbon "scream energy" for his employer, Monsters, Incorporated[26]). In the real world, though, several members of Congress, motivated in part by a desire to one-up China, are making a green funding push. One bill would inject more than $20 billion into cutting-edge semiconductor research and domestic manufacturing.[27] A separate bill explicitly referencing the space age, the Endless Frontier Act[28], would feed $110 billion over ten years into advanced energy



…in the decarbonization space, fruitful competition is not just about rivalry.

It must also be about money.

technology, artificial intelligence, and materials science among other areas. One observer tags it Made in America 2025[29], a nod to Beijing's Made in China 2025 tech blueprint.

While he's not a member of Congress, Joe Biden, the Democratic nominee for President, has spoken of the "competition for the future against China."[30] His new climate plan is for the federal government to invest $2 trillion over four years.

Ladislaw adds that the Trump administration already has sought to reduce U.S. dependency on China and pursue homegrown breakthroughs in critical minerals[31], nuclear energy, semiconductors and the power grid. Investments in these areas by federal and state governments and American industry are already framed, to some degree, as "beating China." As far as mobilizing private sector capital, the United States and China rank #1 and 2 as the most attractive countries for renewables investments, according to the consultancy EY.[32]

Clean Energy Dominance Today

A window for these investments is open now as countries, including the United States and China, are spending billions to jump-start their economies and recover from the world's COVID-19-induced economic coma. The International Energy in June proposed that leading nations commit $1 trillion dollars annually in stimulus over three years to spark a "sustainable" recovery[33], bringing strong returns to investors and the environment. A May 2020 working paper from environmental scholars at Oxford University identifies five stimulus areas with high economic and planetary payoff[34]: clean physical infrastructure, building efficiency retrofits, investments in education and training, natural capital investment, and clean energy research & development.

Specific sectors where American industries could "win" include electric vehicles, smart grids, ultra-high voltage electricity transmission, solar cells, wind turbine gearboxes, and advanced battery manufacturing, said Gallagher, who studies global energy supply chains at Tufts. In the last two decades, "we have ceded a lot of those markets to China without a fight. All of those are primarily manufactured in China now." Gallagher offers this cautionary lesson of standing on the sidelines: during the Obama administration the MIT-based battery startup A123 received federal loan support. But as A123 tried to scale up manufacturing domestically, the domestic electric vehicle industry "didn't have the policy support in the U.S.," Gallagher said. In the end, the firm went bankrupt and its assets were acquired by Chinese auto firm Wanxiang.[35]

Today, Gallagher sees encouraging signs, notably in the nascent U.S. offshore wind sector. Up and down the Atlantic seaboard, states from Rhode Island to Virginia have committed to buy whopping amounts of electricity from ocean-based wind farms with towers as tall as the Eiffel Tower. Industry analysts see North America as potentially a next big offshore wind market[36], drawing supplier companies and high-paying jobs to coastal cities.

These programs have skeptics. Critics of large public investments in a single industry—green or not—deride the idea of policymakers rather than market forces "picking winners." Industrial policy can be a risky and expensive bet. Whereas Asian

and European economies over the years have plowed billions into targeted low-carbon sectors, industrial policy "has never been fashionable in the U.S.," Gallagher said. Now, though, she suggests the widespread impetus to reshore industrial industries and reduce dependence on China can provide political cover.

As for China, the aspiration to dominate key industries, including cleantech, is well documented. When I first moved to Shanghai in late 2006 to open my news organization's first bureau there, the catch phrase I heard countless times at factories across China was "indigenous innovation," a program of procurement rules and tax breaks to coax domestic science and tech breakthroughs. Its policy descendent, the "Made in China 2025"[37] plan, names new energy vehicles, power equipment, and modern high-speed rail as pillar sectors for which 70 percent of the core content should be domestic. Beijing has declared intentions to become a global technology superpower by 2049.[38] To be sure, this program has helped create the underlying ill will with the United States, fueling accusations[39] that Beijing is freezing out U.S. competition, extracting American technology, and violating free-trade pledges. It is clear, however, that China has joined the green race.

There is one additional way to channel superpower hostilities into planetary good: tariffs on goods with large carbon footprints. Already, trade walls have gone up around the world against Korean washing machines, Chinese solar panels, European commercial plants, and American soybeans. These import barriers have reinvigorated European Union plans for a carbon border tax in its COVID-19 economic recovery plan.[40] The idea is to tax products from climate laggards, including the United States. This levy, a top priority for European Commission head Ursula von der Leyen, is designed to tackle the pernicious problem of "free riding"[41] that has long bedeviled

climate talks: key countries enjoy the benefits of lower emissions and cleaner air, yet don't pull their weight and in the process encourage others to ride without paying, too.

Arguing and Chewing Gum at the Same Time

To most observers, climate competition would likely have to occur in a context of global cooperation. Extreme decoupling, pitting the United States and China on opposite sides of an industrial iron curtain, could backfire, threatening a tried-and-true model of producing green solutions—manufacturing globalization. It's not unlike the production of a Samsung Galaxy S20 phone or the latest crop top from Zara: making world-beating solar panels and wind turbines depends on global supply chains to connect ideas, equipment, money, talent, and scale. This combination is helping solar and wind increasingly undercut fossil energy on price.

Take solar cells. In her book, *The Globalization of Clean Energy Technology*[42], Gallagher documents the product's globe-trotting development story, noting the key role of ideas being shared across borders. To the Tufts professor, it's no accident that two early Chinese executives in the industry, at photovoltaic manufacturers Suntech and Yingli, returned to the mainland after receiving doctorates in Australia, where they acquired equipment and production know-how. This is a familiar pairing of western ideas and Chinese capital. In Suntech's case, founder Shi Zhengrong set up his plant in the eastern city of Wuxi, thanks to $6 million in local government subsidies. When I visited Suntech a decade ago, Shi told me how Chinese manufacturing drove down global prices: "The Chinese market will not support expensive products. Secondly, in the middle of a [global] financial crisis China has much better financial liquidity [due to the Chinese government's economic stimulus], so this will support the realization of these projects."[i]

Finished Chinese panels find customers at home, as well as countries that have made commitments to purchase large amounts of renewable power, including Germany, Spain, Japan, Italy, the United Kingdom, Brazil, and India. Key states in the United States—notably California Nevada, Hawaii, and New Jersey—made similar pledges. By Gallagher's reckoning, global trade in cleantech in the first decade of the 2000s grew by 259 percent, more than double the growth rate of total manufactured goods. "As we look back on the remarkable cost reductions in solar and wind," she said, "we can attribute that largely to the globalization process."

Which means it may be hard to simply extract China from any green supply chain. Jonas Nahm, who researches energy and industrial policy at the Johns Hopkins School of Advanced International Studies, has published research suggesting China's key role in solar and wind talent and supply chains.[44] The sequence to him looks something like this: The United States births large numbers of startups—often from universities. Then European countries, notably Germany, chip in production expertise and advanced factory equipment (visitors to Chinese factories have surely attended plant tours that invariably include a show-the-German-machines moment). Finally, firms in China contribute manufacturing R&D and capital to produce at scale. Beijing's $586 billion stimulus during the 2008-09 financial crisis provided ample green financing. Provocatively, Nahm argues that countries engage in this global

i Suntech went bankrupt in 2013, largely due to Chinese overproduction, which pushed prices down further.[43]

distribution of labor *despite domestic policies to bring all the jobs home*. It's hard to compete with these market efficiencies.

"If we want to have an impact on carbon emissions in a short time frame, I don't see a way to replicate China's skills," Nahm told me. To be sure, global trading partners have legitimate reasons to complain about Beijing's industrial rules and contentious home-field economic advantages. "But if we [the United States and China] spend ten years arguing, we will lose Florida."

The upshot: the world's two climate superpowers may have to find ways to compete and yet collaborate at the same time. It would be challenging, for instance, for an American electric vehicle producer to gain market share without access to Chinese middle-class drivers. It's worth noting that in many sectors, despite trade frictions and tariffs, China-centric global supply chains tend to be sticky. Of note: China is home to 90 percent of the world's critical minerals, 50 percent of electric vehicles, and 60 percent of solar panels, by one estimate from by one estimate from New America.[45]

Global Talks: The Essential Role of Climate Superpowers

Superpower collaboration also comes into play with global climate negotiations. Back in 2015, delegations from Beijing and Washington played key roles in sealing the Paris climate accord when they jointly announced emissions targets a year in advance. This laid the groundwork for other nations to follow suit.

The Trump administration, of course, plans to bail on the Paris deal[46], and is loosening domestic rules on power plant and auto emissions. If the United States remains on the sidelines, many analysts argue it could take the pressure off China, providing space for Beijing to underperform as well. In fact, China's COVID-19 stimulus efforts appear more brown than green to many observers; coal plant approvals are said to be on the rise.[47]

Of course, Xi Jinping's government could step into the void and assert global leadership on climate, as it has in global institutions including the World Health Organization. But those signs are less clear. Angel Hsu, an environmental studies researcher at Yale-NUS College in Singapore, has spent years interacting with Chinese climate researchers and negotiators. During the November 2016 UN climate summit in Morocco, Hsu was with the Chinese delegation when word came that Donald Trump, who'd called climate change a "hoax," was elected. Would China step forward to lead, Hsu asked a top Chinese negotiator? "He said 'no,' the typical Chinese stance," Hsu said, adding "'we are still a developing country behind the West, still waiting for the U.S. to show leadership.'"

Elections can change things. For all the global angst about Washington appearing to ignore climate change, Hsu thinks a potential Biden presidency in 2021 could bring a quick pivot. She researches sub-national level climate collaboration between China and the United States and says that even in today's decoupling environment, bilateral connections still exist. Policy dialogue between California and Beijing continues today on emissions reductions, cap-and-trade emissions trading rules, and air quality regulation. At least 24 states in the United States have approved emissions reduction plans.[48] If there's a Biden presidency, Hsu says, those existing building blocks could help reassemble a broader climate relationship.

Is it realistic to imagine great power competition, and collaboration, on climate issues? For proponents, there may be some hope from history: In the 1930s, during the ugliest trade war of the 20th century, which would later drag the world into a Great Depression, the international community nevertheless found ways to work together on several environmental initiatives: to protect fauna and flora, limit fishing nets, and set standards for whaling and wildlife preservation. And even in the Cold War 1950s, the United States and Soviet Union were able to collaborate on the development of a polio vaccine.[49] At least back then, the world's existing and emerging superpowers found ways to argue and chew gum at the same time.

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THE BATTLE FOR EARTH'S CLIMATE WILL BE FOUGHT IN AFRICA

Jack Goldstone

In 2019, for the first time, CO2 emissions in both the European Union and the United States declined.[1] Much of the planet's hope for maintaining a livable climate depends on that trend continuing, and the focus of emissions reductions skews heavily towards the actions of the world's largest emitters, which are largely concentrated in North America and Asia. The actions of countries in these regions—especially the United States, China, and India—are key to global success on climate. But on their own, they will not be enough.

In discussions of climate change, African countries are usually portrayed as victims of climate impacts, rather than as contributors to the crisis.[2] Historically, the continent has contributed the least of any global region to fossil fuel emissions, yet it is already experiencing some of the world's most dramatic changes in terms of drought, flooding, heat waves, and viable land use. Often missing from these conversations is the recognition that African countries are in fact critical partners for global climate change response.

Under President Biden's leadership, the United States is working to reestablish its leadership on international climate action, and is taking steps to break with the previous administration's foreign policy. As African countries take steps to grow their economies, ensuring that climate dialogues and decision-making are inclusive of the continent's needs and priorities will be key to ensuring that future emissions from the region do not eclipse progress made elsewhere. It will take a global effort, enlisting the energy and contributions of Africa's own youthful activists, skilled engineers, and patient leaders, spurred by investments and encouragement from abroad, to build a low-carbon future that nonetheless supports and propels Africa's rapid economic growth.

Africa's Future Impact on Global CO2

Africa is both the world's sole remaining region with a rapidly growing population, and the most rapidly urbanizing region. At the same time, it starts 2021 as the world's least energy-consuming region per capita. That energy deficit needs to be addressed if Africa's economies are to develop. Africans need and have a right to more consumer electricity use, more transportation, more energy input to agriculture and manufacturing, more housing construction.

There are vast differences in populations, economies, governments, and societies across the continent. What almost all African countries share today, however, are very low levels of greenhouse gas output, and very large, youthful, and rapidly increasing populations eager to build and share in the benefits of modern economies. Sub-Saharan Africa produces, on average, only .8 tonnes of CO2 per person per year, compared to a global average of 4.8 tonnes.[3] However, highly developed and coal-dependent South Africa produces nearly ten times that per person, while the low-population but oil-rich countries of Libya and Equatorial Guinea produce nine and five times that much, respectively. But these are the exceptions; the largest country in Africa in terms of population, Nigeria, emits below the average level (.7 tonnes per person per year), while most other countries, whether giants like Ethiopia, the DRC, and Tanzania, smaller countries like Mali and Niger, or medium sized countries like Mozambique, all currently have CO2 output that is almost negligible, at .1 to .3 tonnes per person.[4] For comparison, per capita CO2 emissions in the United States are 16.2 tonnes.[5]

Africa's continued transformation will involve both rapid increases in population and major increases in energy use per capita. The trajectory of how that energy is produced—whether Africa follows the fossil-fuel path taken by other developing regions, or embarks on a novel trajectory in which renewable energy dominates—will thus have a disproportionately large impact on our climate's future.

To date, Africa's CO2 emissions from commercial and industrial activity have been minimal. In 2018 the continent's largest emitter of CO2, South Africa, emitted only 6.6 percent as much of this greenhouse gas as the United States, and only 3.5 percent as much as China.[6] That same year Africa as a whole emitted 1.45 gigatonnes of carbon dioxide total, less than Russia by itself. 75 percent of that comes from just five fossil fuel dependent industrializing countries: South Africa, Algeria, Nigeria, Egypt, and Morocco. Even compared to India's 1.9 tonnes per person per

year CO2 emissions, Africa's annual output per person of 1.1 tonnes per year remains modest (for reference, India's population is comparable to the population on the African continent).[7] In short, Africa's fossil fuel consumption to date bears no responsibility for the world's rapid climate change.[i]

Even on an income-adjusted basis, African countries are low CO2 producers, given that it is not only that their incomes are lower than developed countries, but the structure of their economies differs as well. In 2019, the income per person in the United States was USD$65,000 (PPP terms); in Ethiopia, it was USD$2,320.[8] The difference is thus a factor of 32; yet CO2 output per person in 2019 in the United States was 160 times that of Ethiopia (16 tonnes per person per year versus 0.1). If we look at Nigeria, which is more urbanized and developed than Ethiopia, U.S. income per person in 2019 was 12 times higher, but the U.S. CO2 output per person was 23 times higher. In short, the inequity in energy consumption between Africa and the U.S. is even greater than the inequities in overall economic development and income.

But Africa's CO2 output per person has been growing fast—much faster than its population. That is to be expected as increases in income and urbanization lead to higher per capita fuel and electric consumption. From 1950 to 2016, Africa's CO2 emissions increased by a factor of 14.[9] Today, Africa is home to 1.3 billion people; this number is projected to grow to 3 billion by 2060.[10] If CO2 emissions per capita by that date were merely to rise to the level of India today, Africa's total CO2 output would quadruple to 5.8 gigatonnes of CO2 per year—the same level as U.S. emissions today. Put another way, if by 2060 African energy use produces the same emissions level per person as India does today, then even if China, the United States, India, Russia, Japan, and Germany were ALL to cut their CO2 emissions by 20 percent by 2060, it would not offset the increases to CO2 output from Africa. If in forty years, Africa's population as a whole should reach the emissions per capita level of such countries as Egypt (2.5 tonnes per capita per year) or Botswana (3 tonnes) have today, then by 2060 the increase in CO2 emissions on the continent would be so large as to entirely offset even a 60 percent decrease from today's levels in China.

In short, climate decision-making and investment that is not inclusive of Africa's economic growth priorities and does not support a clean energy transition on the continent will undercut the world's efforts to achieve desired global emissions reductions. Increases in African countries emissions per person to very moderate levels over the coming decades would produce total emissions growth so large as to overwhelm efforts made elsewhere by high-emitting countries to reduce global CO2 emissions. In other words, Africa's trajectory on energy generation and fossil fuel use does not matter only to the region's future—because of the low base of current energy use and its rapidly growing and youthful population, the continent's future energy trajectory matters to the entire world, as much as that of any other major region.

i To be sure, deforestation of Africa's rainforests does generate a significant amount of CO2, perhaps in the worst years as much as the U.S. generates (see https://www.carbonbrief.org/africas-tropical-land-emitted-more-co2-than-the-us-in-2016-satellite-data-shows). That is a separate issue, however. This brief focuses just on how African CO2 output would grow with increasing energy consumption, which is far less appreciated as a global issue.

Prospects for Green Growth on the Continent

To be clear, a massive rise in CO2 emissions from Africa cannot be avoided by policies aimed at curbing African population growth or energy consumption. Africa's population growth over the next forty years is large "baked in" because most of the young women who will enter their reproductive years in that period have already been born and their numbers are huge. Any reasonable reduction in African fertility in the next few decades will only have a moderate impact on population levels in 2060; the difference between the United Nations' "Medium Variant" projection for African population in that year, at 2.97 billion, and the "Low Variant" projection at 2.56 billion is less than 15 percent.[11] Current reductions in fertility in Africa will mainly change projected population after 2060. Similarly, one cannot expect energy use not to increase with rising incomes in Africa; energy use per person is already so low that even modest increases in income will produce large rises in energy demand. No doubt a voluntary shift to smaller families and energy conservation will be valuable for Africa's long-term future. But for the next forty years, the only way to avoid massive increases in Africa's CO2 output will be for Africa to avoid a fossil-fuel dependent path of economic development.

It is critical that income and energy use across Africa increase to address entrenched poverty and livelihood insecurity. At the same time, keeping greenhouse gas emissions from African countries low as they continue their economic growth is key to ensuring that the reductions in CO2 output in today's high emissions countries serve to reduce global greenhouse gas output, and help us keep climate change within reasonable bounds.

Fortunately, the prospects for doing so are excellent—certainly much better than they seemed a decade ago. Thanks to improvements in engineering and the scale of production, the costs of wind and solar electric generation have plummeted. University of Cape Town Professor, Carlos Lopes, notes that the cost of solar photovoltaics and onshore wind has fallen dramatically, from 81 percent and 46 percent, respectively, over the last decade, and that energy from new renewable facilities is already less expensive than energy from coal in the African context.[12]

Some African countries also have major hydropower reserves. To be sure, dams can cause

photovoltaic solar panels on a farm in the Karoo outside Touwsrivier in the western cape of south africa. courtesy: Dewald Kirsten/Shutterstock.com

major displacements of population and even lead to geopolitical tensions, as with Ethiopia's new Grand Renaissance Dam.[13] Moreover, to distribute electricity from dams requires extensive, costly, and environmentally disruptive transmission grids. These countries would be wise to use hydropower selectively, and only where large-scale and high voltage power is essential. In the continent's many rural areas, where most of the population still lives, local wind and solar power would be far more efficient, as wind and solar power can be efficiently produced locally, avoiding the need to construct massive national power grids in regions with large land areas and low population density.

Avoiding large-scale dependence on fossil fuels to power growth across the continent is critical not only for reducing global greenhouse gas emissions, but for the long-term resilience and economic prosperity of African countries. Coal-based electricity production is the worst pitfall. It is the dirtiest and most dangerous energy source. Moreover, creating an infrastructure dependent on coal-based electricity creates terrible future incentives, as once established, the concentrated employment of thousands in mining and transportation of coal creates a constituency for coal use to continue and grow. Conversely, once the labor force is trained for the installation and construction of solar and wind energy, the growth of such alternative energy industries creates job opportunities that can spread across a region.

Fortunately, African leaders are already engaged, both individually and collectively, in developing strategies and policy initiatives to focus their development on renewable energy sources. Cooperative initiatives include the Africa Environment Action Plan, the Africa Clean Energy Corridor[14] and the Africa Renewable Energy Initiative.[15]

International projects cooperating with African countries include the Switch Africa Green Project[16] and the World Bank's Climate Business Plan, just launched in 2020. Some countries are already global leaders in utilization of renewables; for example, Morocco currently derives 35 percent of its energy from solar, and had a goal of increasing this to 42 percent by the end of the year.[ii] There is also an increasing level of green investment on the continent, responding to pressures in both donor countries and within Africa.

China's Investments in Africa

Unfortunately, there are constraints to the choices available to African countries. Many African countries lack the capital to rapidly expand their energy production so they leverage loans and other financing from companies and donors willing to invest in their infrastructure. Today, the leading contributor to infrastructure investments in Africa is China, and China's government and corporations are largely promoting the construction of fossil-fuel projects on the continent.

Chinese investments in Africa have been growing rapidly since the 1990s, and China has become Africa's largest trade and investment partner. From 2005 to 2018, Chinese investments and contracts in African nations totaled nearly USD$300 billion, an amount that President Xi Jinping promised to increase by another USD$60 billion as part of the "Belt and Road Initiative."[17]

China's investments are driven by both its supply and demand concerns. China looks to Africa as a vital source of raw materials, including minerals such as copper and cobalt, and especially oil

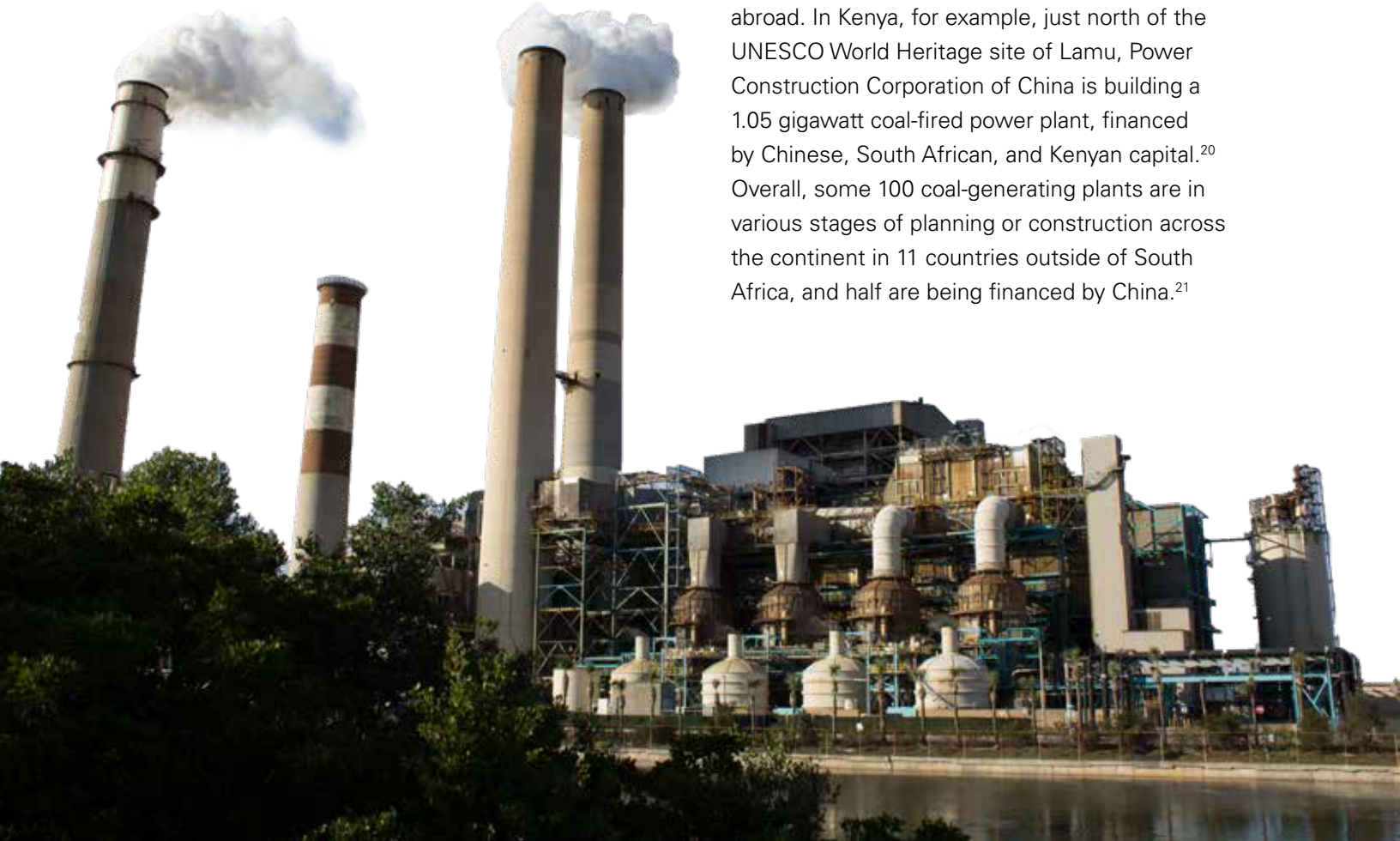
ii Morocco is remarkable in its construction of solar plants, boasting the world's largest concentrated solar farm among a host of solar power installations. See https://www.cnn.com/2019/02/06/motorsport/morocco-solar-farm-formula-e-spt-intl/index.html.

For too long, **the world's nations have neglected** both the immediacy of the need to tackle climate change, and the crucial role that Africa's future will play in determining whether **efforts to reduce global CO2 emissions will succeed or fail.**

and gas, as it seeks to diversify its sourcing of petroleum products away from the Middle East. Across Africa, there are dozens of countries where Chinese investments have helped increase petroleum output and given China a privileged position as a customer. Sinopec, China National Petroleum Corporation, and China Offshore Oil Corporation are all actively expanding output from African nations.[18]

China's government has instructed its banks to provide credit, and Chinese companies to invest in Africa, to advance China's goals of winning friends and expanding its role in the international economy. Yet, Chinese investments are not guided by a single national master plan. Rather, individual companies seek out opportunities to deploy their capital and expertise. In addition to the major oil and other mining and extraction companies, China has many construction companies with extensive experience and excess capacity after completing China's enormous domestic programs of urban residential and commercial construction and transportation infrastructure. These companies are looking for opportunities to use their experience and capacity abroad. This creates the opportunity for Chinese firms to utilize a "projects for resources" approach, in which Chinese investment banks and investors finance a wide range of projects, including highways, railroads, residential housing, commercial office towers, electricity generation, hotels, mines, and oil production, that are paid for by giving Chinese firms long-term contracts for oil and other products and materials for export.[19]

Naturally, the projects that Chinese firms prefer to finance are those in which they have excess capacity at home, and in the field of energy production, that includes construction of coal-fired electric plants. In fact, as China has cancelled plans for many of its own coal-fired power plants, seeking to clean up its dirty air and deploy more wind and solar power domestically, China's power firms have sought construction contracts abroad. In Kenya, for example, just north of the UNESCO World Heritage site of Lamu, Power Construction Corporation of China is building a 1.05 gigawatt coal-fired power plant, financed by Chinese, South African, and Kenyan capital.[20] Overall, some 100 coal-generating plants are in various stages of planning or construction across the continent in 11 countries outside of South Africa, and half are being financed by China.[21]



To be sure, China is also financing hydropower projects in Africa, and some Chinese solar and renewable companies are seeking new markets abroad, including in Africa.[22] Yet capacity for wind and solar generation is in great demand within China and in developed countries; construction of coal-generating plants, by contrast, has almost ceased in those areas, leaving plentiful capacity, especially among Chinese firms, for construction in low-income developing nations. Thus China remains the leading—and in many regions the only—country financing large coal-generation projects. As Lauri Myllyvirta, lead analyst for the Centre for Energy Research and Clean Air, an independent research body, has observed, "China has enormous state-owned thermal-power manufacturing and engineering firms that rely on overseas deals to stay in business."[23] Offering such projects in exchange for African oil and gas and other materials is a logical step for China.

Fortunately, there is still time to take many of Africa's planned coal-fired electricity projects off the board. In 2016, driven in part by local environmental activism led by Chibeze Ezekiel, an award winning environmentalist, Ghana cancelled a planned 7 gigawatt coal plant that was to be built by China's Shenzen Energy Group.[24] At present, China has plans to triple the amount of coal-fired electricity generation that it finances in Africa by 2060; most of these plans should also be scrapped or converted to renewables in order for international commitments to cut greenhouse gas emissions to succeed. As China's President Xi Jinping has promoted his plans for green and sustainable development in China, claimed a role in global environmental leadership, and begun to speak of a "green belt and road," both African and international environmentalists should respond by demanding that these Chinese-backed coal generation projects in Africa be set aside in favor of Chinese support for wind, solar, and geothermal power generation.

A Role for the United States and International Partners

Of course, Africa needs energy and growth and it will not walk away from Chinese-backed investments in coal-powered generation unless it has alternatives. Here it is crucial to see that Africa's energy needs are also creating new opportunities to foster innovation, entrepreneurship, and job growth across the continent. As noted, African leaders are already aware of the possibilities and are developing green development strategies. Through diplomacy and development assistance, the United States and international community have an important role to play in supporting Africa's efforts to develop and adopt pathways designed to help African countries advance through clean energy growth.

Ensuring that Africa's largest and fastest growing countries do not experience rapid growth in CO2 emissions as they develop will require more than just stopping the construction of coal-fired power plants. It will require comprehensive planning to adjust to a low-carbon economy, including electrified transport, renewable energy generation for as many end uses as possible, energy-efficient design and construction (especially for rapidly growing cities in the region), and low-emission agriculture.

Partnering with African countries to support the region's energy development is good for global emissions, but it is also good business. One country already seeking to rapidly increase its

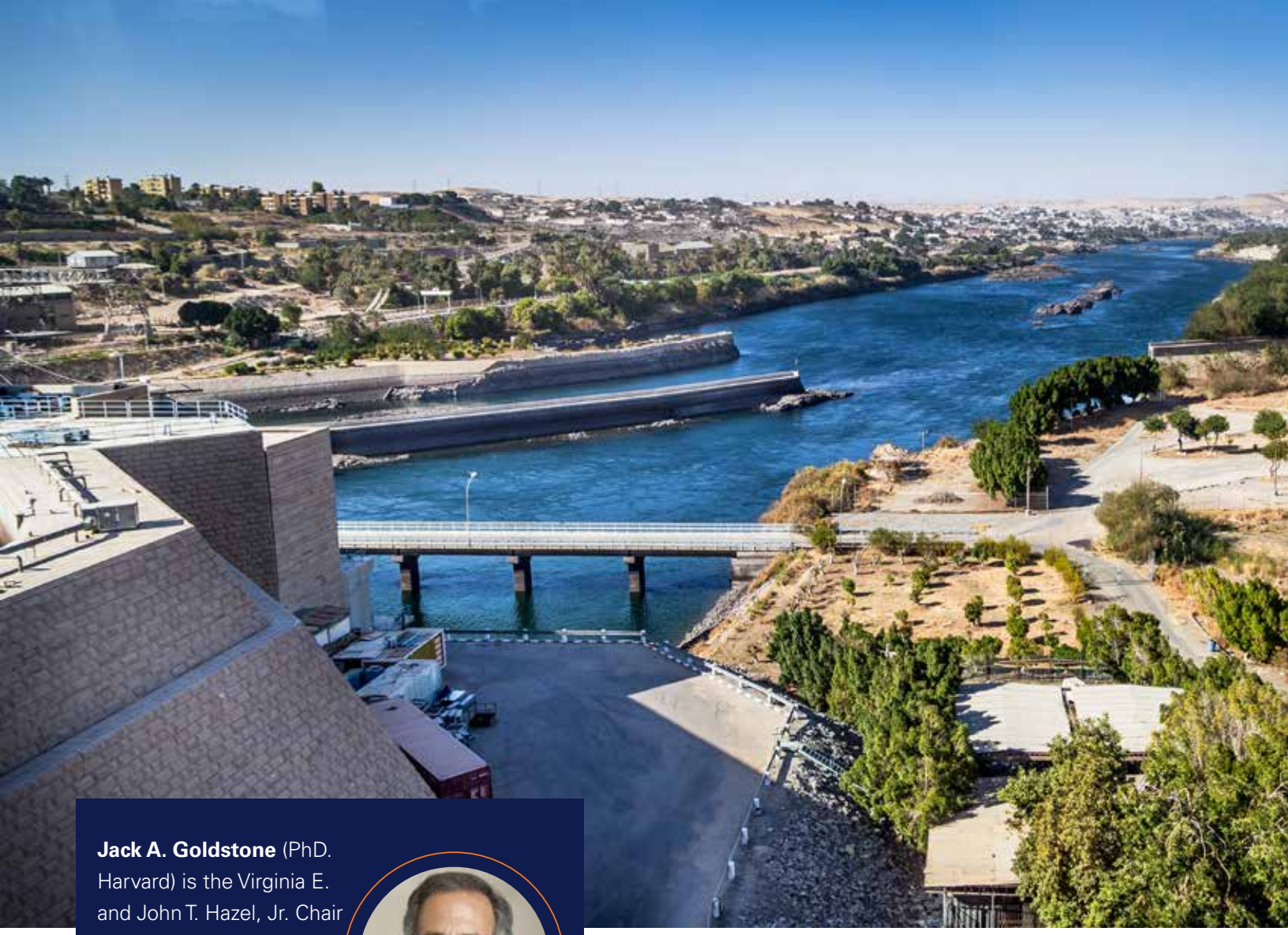
investments in Africa is Japan—but it is doing so with a very different set of priorities than China. Although Japan's investments, which totaled $20 billion over the three years 2016-2019, are just a fraction of those of China, Japan is seeking to leverage that investment through partnerships with private African companies that provide training and employment for Africans.[25] Japan has financed projects in agriculture, including biodiesel fuel production and production of fertilizers specially blended for African soils; local solar photo-voltaic powered kiosks to charge consumer electronics; and water purification systems designed to operate without high power consumption or expensive filters and maintenance. Japan has even invested in major infrastructure projects, including a bridge over the Nile in Uganda and port facilities in Kenya and Mozambique, as well as a geothermal power plant in Kenya and digital broadcasting stations in Botswana.[26]

Japan does not see itself in zero-sum competition with China, but rather as simply providing diversification opportunities for African firms and governments.[27] Indeed, small projects that nonetheless point to new directions and improvements in energy efficiency in areas ranging from agriculture to construction to consumer goods may do more to support economic growth and development in Africa than highly polluting mega-projects.

For the United States, the enormous success of health-care investments in Africa—such as the U.S. government-led PEPFAR plan to tackle HIV-AIDS, or the Gates Foundation's efforts to reduce child mortality and malaria—may serve as models for innovative efforts in energy and urban design. Peer level engagement and participatory processes that engage decision-makers from local to national levels to pinpoint their priorities, and adaptive management that allows for effective solutions to emerge with local input, will help ensure success. Indeed, an Achilles' heel of Chinese investors is their reluctance to engage with local civil society actors; whereas for U.S., Japanese, and European governments and firms, a willingness to team up with local civil society groups in identifying and meeting social needs provides greater opportunities and insights.

For too long, the world's nations have neglected both the immediacy of the need to tackle climate change, and the crucial role that Africa's future will play in determining whether efforts to reduce global CO2 emissions will succeed or fail. Despite their currently low level of CO2 emissions, Africans need to be welcomed as full and vital partners in global efforts to tackle climate change, as Africa's energy future is of critical global importance.

As the Biden administration takes office, one way to clearly show its commitment to global leadership on climate change is to pledge to work with African countries to map a pathway to rapid economic growth and job creation enabled by renewable energy, and to support that path with American investments. Ensuring that as America develops its own future as a cleaner economy, it enables other countries to follow that path, will help restore America's global leadership role.



The High Dam. Aswan, Nubia, Egypt.
Photo courtesy of: Graficam Ahmed Saeed/shutterstock.com

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Outside a Coal Burning Power Station in Witbank, South Africa.
Photo courtesy of: Sunshine Seeds/shutterstock.com