Shaping Low-Carbon Futures: China's Pathway toward Demand-Side Climate Mitigation

Introduction

Global climate change has become a present and escalating crisis that demands urgent, coordinated action. While policymakers worldwide focus on supply-side solutions such as carbon pricing and clean technology, demand-side strategies often receive far less attention. The rationale for demand-side climate mitigation policies is simple: they directly engage individuals and communities in reducing greenhouse gas (GHG) emissions by reshaping consumption patterns and promoting sustainable lifestyles.[1] According to the Intergovernmental Panel on Climate Change, demand-side strategies could reduce global GHG emissions by 40% to 70% by 2050, offering immense yet underutilised potential for emissions reductions.[2]

For China, the world's largest carbon emitter and a rapidly growing economic powerhouse, the stakes in addressing climate change and meeting the 2°C climate goal set by the Paris Agreement are especially high. Economic growth pressures, heavy reliance on fossil fuels, and a dominant manufacturing sector create structural constraints for its supply-side policies. In response, China has recognised the significance of incorporating demand-side mitigation policies into its comprehensive environmental strategy to reduce carbon emissions, combat environmental degradation and enhance resource efficiency. However, the nation faces multifaceted challenges in embracing demand-side mitigation, rooted in its unique context yet resonating with global challenges, such as the high costs of low-carbon alternatives, social resistance to behavioural changes, and the difficulty of sustaining long-term behaviour shifts. Addressing these issues is key to achieving China's domestic environmental goals and also strengthens its role in global climate governance.

This case study seeks to explore these dynamics, beginning with the key barriers to demand-side mitigation in China. It then examines potential policy options for China within the "Carrot-Stick-Sermon" policy instrument framework (ie economic incentives, regulatory and decision design, and information), drawing on strategies adopted by other economies to address similar challenges and identify transferable insights. Finally, this study evaluates seven solutions currently implemented by the Chinese government and offers a comprehensive assessment of their effectiveness in advancing sustainable, low-carbon transitions.

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[1] Felix Creutzig, Sofia G. Simoes, Sina Leipold, Peter Berrill, Isabel Azevedo, Oreane Edelenbosch, Tomer Fishman, et al., "Demand-Side Strategies Key for Mitigating Material Impacts of Energy Transitions," *Nature Climate Change* 14 (2024): 561-572.

[2] "Synthesis Report of the IPCC Sixth Assessment Report (AR6) (2023)," Intergovernmental Panel on Climate Change (IPCC), accessed December 11, 2024, https://www.ipcc.ch/report/ar6/syr/.

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Background

Climate Change and China's Nationally Determined Contribution

Efforts to tackle the climate change crisis date back to the establishment of the United Nations Framework Convention on Climate Change in 1992 and its subsequent Conferences of the Parties, where nations have attempted to reach a consensus on reducing GHG emissions. The 2015 Paris Agreement marked a milestone by securing commitments from 196 Parties to limit global warming to well below 2°C above pre-industrial levels and to strive for a 1.5°C limit.[3] It is estimated that global GHG emissions must decline by 45% from the 2010 level by 2030 and reach net zero around 2050 to achieve the 2°C goal.[4] However, current evaluations of Nationally Determined Contributions (NDCs) reveal a troubling reality: even if fully implemented, these commitments are projected to result in a global emissions increase of 11% by 2030 compared to 2010 levels.[5] Existing pledges, represented by current policies and unconditional NDCs, fall significantly short of the reductions outlined in cost-optimal pathways required to meet the 2°C and 1.5°C targets, which aim to minimise global mitigation costs by distributing emissions reductions efficiently across countries, sectors and gases (Figure 1).[6]

[3] "The Paris Agreement," United Nations Climate Change, accessed December 11, 2024, https://unfccc.int/process-and-meetings/the-paris-agreement.

[4] Malte Meinshausen, Jared Lewis, Christophe McGlade, Johannes Gütschow, Zebedee Nicholls, Rebecca Burdon, Laura Cozzi, and Bernd Hackmann, "Realization of Paris Agreement Pledges May Limit Warming Just Below 2°C," *Nature* 604, no. 7905 (2022): 304-309.

[5] Michel G. J. den Elzen, Ioannis Dafnomilis, Nicklas Forsell, Panagiotis Fragkos, Kostas Fragkiadakis, et al., "Updated Nationally Determined Contributions Collectively Raise Ambition Levels but Need Strengthening Further to Keep Paris Goals Within Reach," *Mitigation and Adaptation Strategies for Global Change* 27, no. 5 (2022): 33.

[6] Unconditional NDCs refer to what a country specifies it can do independently to reduce its GHG emissions. These commitments are based on the country's existing resources, policies and capabilities. By contrast, conditional NDCs specify the reductions in GHG emissions that a country expects to achieve with external support (such as assistance from other countries).

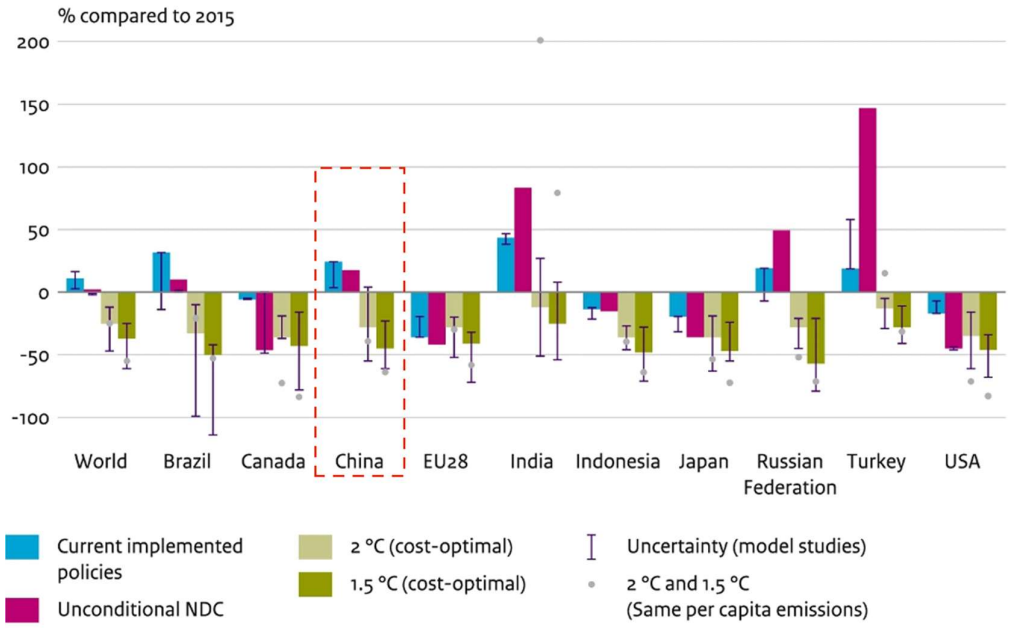

Figure 1 Projected impact of policies and NDCs on GHG emissions in 2030[7]

Note: Total emissions are shown in comparison to 2015 levels (%, with positive numbers indicating an estimated increase in emissions in 2030).

China holds a crucial position in global climate governance. The country's updated NDC, submitted in 2021, commits to peaking carbon emissions by 2030 and achieving carbon neutrality by 2060. While these targets are ambitious, China's current policies and NDC indicate rising emissions in 2030 compared to 2015 levels, falling far short of the reductions required for 2°C or 1.5°C pathways, highlighting a gap compared to some G20 peers like Canada and the US (Figure 1).

Potential for Demand-Side Mitigation

Historically, climate mitigation efforts have largely focused on supply-side solutions, which have proven effective but insufficient to meet climate goals.[8] Growing recognition of their limitations has shifted attention toward the untapped potential of demand-side mitigation as a complementary and essential strategy. Behaviour changes, such as replacing car trips with walking, cycling or public transport, or foregoing a long-haul flight can reduce global energy demand by 10% in 2050.[9] Furthermore, demand-side and supply-side measures can work together to foster a more integrated pathway to climate mitigation.[10] According to the International Energy Agency, 63% of GHG emissions reductions can be achieved through demand-side

[7] den Elzen et al., "Updated Nationally Determined Contributions."
[8] "Annual Report 2022," United Nations Environment Programme, accessed December 11, 2024, https://www.unep.org/resources/annual-report-2022.
[9] "Net Zero by 2050," International Energy Agency (IEA), accessed December 11, 2024, https://www.iea.org/reports/net-zero-by-2050.
[10] Creutzig et al., "Demand-Side Strategies Key."

solutions, with 55% involving low-carbon technologies and citizen participation, and 8% relying solely on behavioural changes and material efficiency (Figure 2).[11]

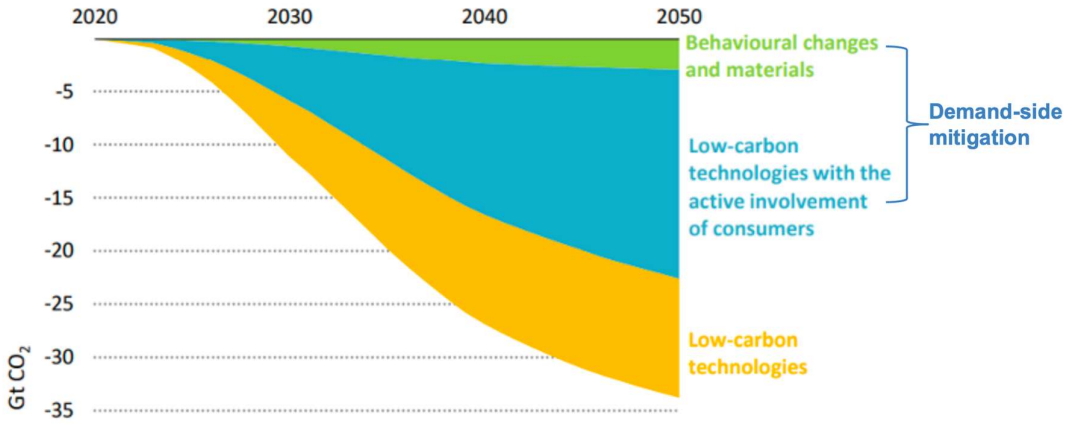

Figure 2 Role of technology and behavioural change in emissions reductions to net zero[12]

Recognising this potential, China has incorporated demand-side actions into its climate strategy since 2007, implementing measures such as energy efficiency labeling for appliances, promoting bike-sharing programmes, expanding electric public transit, and launching campaigns like "Clean Your Plate" and "The National Low-carbon Day." As these measures continue to evolve, they also reveal critical gaps and unresolved issues that demand further attention.

Problems

However, despite the promising outlook, demand-side mitigation faces significant barriers, particularly in driving large-scale behavioural shifts.[13] These barriers are multifaceted and deeply rooted in economic, social and psychological dimensions.

Costs Hindering Climate-Friendly Actions

The adoption rate of demand-side climate mitigation remains relatively low, largely due to higher costs, especially the long-term underappreciated non-pecuniary costs (eg psychological, comfort and time burdens) faced by consumers. These costs can make climate-friendly behaviours appear detrimental to individual well-being, discouraging their adoption and, in some cases, rendering these mitigation strategies nearly unacceptable.

A study examining 12 demand-side mitigation behaviours in Beijing revealed that eight of these actions reduced individual welfare, with annual losses ranging from 5 CNY to 3,180 CNY per person (Table 1). Zooming in on the pecuniary and non-pecuniary parts of welfare, these climate-friendly actions often generate

[11] IEA, "Net Zero by 2050."
[12] IEA, "Net Zero by 2050."
[13] Robert Gifford, "The Dragons of Inaction: Psychological Barriers That Limit Climate Change Mitigation and Adaptation," *American Psychologist* 66, no. 4 (2011): 290-302.

monetary savings but tend to incur larger non-monetary costs, leading to an overall decline in individual welfare.[14] This explains why people are reluctant to adopt many affordable green choices.

Demand-side mitigation behavior		(1) Pecuniary welfare change	(2) Non-pecuniary welfare change	(3) Total welfare change
Transportation	Private to public transportation	19,808	-22,257	-2,449
	Conventional to electric vehicles	2,539	-1,588	951
	Short-haul flight to high-speed rail	186	-122	65
Energy	Turn off ACs in summer	185	-1,767	-1,583
	Turn off lights in every room	31	-11	20
	Cheapest to energy-efficient appliances	-32	0	-32
Diet	Animal protein to *tofu*	840	-955	-115
	Animal protein to plant-based meat	-2,175	-1,005	-3,180
	Eliminate disposable utensils	12	-17	-5
Lifestyle	Waste sorting and recycling	0	-239	-239
	Plastic to reusable bags	2	-11	-9
	Paper books to e-books	187	0	187

Table 1 Welfare implications of demand-side mitigation behaviours

Note: This table is adapted from Tan-Soo et al. (2024).[15] All values are expressed in CNY per person per year.

Social and Behavioural Resistance to Change

Despite growing awareness of climate change and low-carbon behaviours among Chinese citizens, significant social and behavioural resistance persists, hindering the translation from awareness to action. Entrenched social norms often associate high-carbon consumption – such as driving large private vehicles or frequent flying – with social status and success.[16] Over 60% of Chinese households believe that adopting a low-carbon lifestyle would lower their quality of life, further deterring the shift to sustainable behaviours.[17]

Additionally, consumers frequently compare their consumption patterns to those of their peers, fostering a competitive dynamic that favours high-carbon lifestyles. Nearly 30% of Chinese households cite a lack of similar actions among their peers as a key reason for not adopting low-carbon habits.[18]

Furthermore, consumers frequently doubt the performance and reliability of low-carbon products. Take electric vehicles as an example: many consumers remain hesitant to adopt them due to concerns about limited

[14] Jie-Sheng Tan-Soo, Ping Qin, Yifei Quan, Jun Li, and Xiaoxi Wang. "Using Cost–Benefit Analyses to Identify Key Opportunities in Demand-Side Mitigation," *Nature Climate Change* 14 (2024): 1158-1164.

[15] Tan-Soo et al., "Using Cost-Benefit Analyses."

[16] Sara M. Constantino, Gregg Sparkman, Gordon T. Kraft-Todd, Cristina Bicchieri, Damon Centola, Bettina Shell-Duncan, et al., "Scaling Up Change: A Critical Review and Practical Guide to Harnessing Social Norms for Climate Action," *Psychological Science in the Public Interest* 23, no. 2 (2022): 50–97.

[17] "Survey on Low Carbon Awareness and Behaviors of the Chinese Households (2023)," China Environmental Protection Foundation, accessed December 11, 2024, https://www.cepf.org.cn/cepf_english/dynamicnews/202402/t20240207_1066003.html.

[18] China Environmental Protection Foundation, "Survey on Low Carbon Awareness."

driving range, insufficient charging infrastructure and unpredictable long-term costs.[19] Additionally, skepticism about the authenticity of green products remains prevalent. Many consumers question the credibility of environmental claims, particularly due to fears of "greenwashing", where companies exaggerate the environmental benefits of their products.[20] This concern leads many consumers to favour cost-effective products and services over those associated with carbon reduction.

Struggle for Consistent Motivation

Sustained low-carbon behaviours are crucial for fostering a genuinely low-carbon lifestyle. China has relied on awareness and educational campaigns to promote demand-side mitigation. While these efforts have successfully encouraged certain behaviours, such as turning off lights when not in use, they often focus on symbolic actions with limited emissions reduction potential. This misplaced focus prevents policymakers from fully leveraging the potential of demand-side mitigation, while also leaving consumers disconnected from tangible environmental outcomes, ultimately undermining their long-term motivation.

China has implemented financial incentives tied to quantifying carbon reductions from individual energy-saving actions, successfully driving short-term engagement during specific campaigns. However, these incentives often struggle to sustain user activity over time. Similarly, nudge tools like green default options have shown promise in prompting initial behavioural changes by automatically enrolling users in eco-friendly default energy plans. Yet, without systematic reinforcement, their influence often diminishes over time when nudges are discontinued, or when people enter another consumption scenario that does not implement similar nudges.[21]

Policy Options

Given the multifaceted nature of the climate issue, policy options for China involve multiple dimensions. These options can be broadly categorised into three approaches by their mechanism of influence: Rules and Decision Designs ("Sticks"), Economic Incentives ("Carrots"), and Information Policies ("Sermons"). Table 2 presents an overview of potential policy options, their types and aims. Option 1 relies on the use of rules and directives to shape behaviour, ranging from mandatory regulations (Option 1a) to more subtle nudges (Option 1b). Option 2 emphasises influencing consumers through economic incentives (Option 2a) or disincentives (Option 2b). Option 3 aims to prevent harmful actions or promote beneficial ones by raising awareness and providing insights, including formal education (Option 3a) and informal public awareness campaigns (Option 3b).

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[19] Dario Pevec, Jurica Babic, Arthur Carvalho, Yashar Ghiassi-Farrokhfal, Wolfgang Ketter, and Vedran Podobnik, "A Survey-Based Assessment of How Existing and Potential Electric Vehicle Owners Perceive Range Anxiety," *Journal of Cleaner Production* 276 (2020): 122779.

[20] Sebastião Vieira de Freitas Netto, Marcos Felipe Falcão Sobral, Ana Regina Bezerra Ribeiro, and Gleibson Robert da Luz Soares, "Concepts and Forms of Greenwashing: A Systematic Review," *Environmental Sciences Europe* 32 (2020): 1-12.

[21] Hunt Allcott and Todd Rogers, "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation," *American Economic Review* 104.10 (2014): 3003-3037.

Policy Options	Type	Aims
Option 1: Rules and Decision Designs		Regulations and structural interventions that mandate or guide desirable behaviour
1a) Product Bans and Restrictions	Big Sticks	
1b) Behavioural Nudges	Little Sticks	
Option 2: Economic Incentives		Pecuniary and non-pecuniary incentives/disincentives that support desirable behaviour
2a) Subsidies for Green Choices	Carrot	
2b) Taxes on High-Carbon Choices	Carrot	
Option 3: Information Policies		Prevention of wrong or stimulation of the right conduct by offering insights into its consequences
3a) Education	Sermon	
3b) Public Awareness Campaigns	Sermon	
4b) Social Comparison	Sermon	

Table 2 Overview of policy options and their aims

Policy Option 1: Rules and Decision Designs

Option 1a: Product Bans and Restrictions

Given that household consumption activities are major contributors to demand-side mitigation, governments can implement mandatory product bans and restrictions (ie "Big Sticks") to compel individuals to adopt climate-friendly behaviors. These measures could include prohibiting or limiting the consumption of high-carbon products or activities detrimental to environmental sustainability. For instance, Germany's Circular Economy Act has required strict waste sorting since 2012, mandating that recyclables, organic and residual waste be disposed of in designated bins. Penalties for violations range from €10 to €1,500, with severe cases (eg hazardous waste disposal) punishable by up to five years of imprisonment.[22, 23] These "sticks" are highly effective – in 2022, Germany achieved the EU's highest municipal recycling rate at 69.1%.[24] However, implementing such regulations requires substantial support, including infrastructural, institutional and socio-cultural adaptations. Germany's success is partly due to its long history of waste management policies, dating back to the early 1900s, when industrial producers were first held responsible for waste recycling. Over time, waste sorting became ingrained in German culture.

China could adopt similar measures by piloting stricter regulations on environmental practices, including the use of plastic bags, waste sorting and more. Given the lack of historical legal frameworks in this area, a phased approach with robust supporting infrastructure and policies is necessary to ensure laws are effective and comprehensive, while minimising disruptions to residents' lives.

[22] "Recycling: Umweltschutz durch Wiederaufbereitung," Bußgeldkatalog 2025, accessed December 25, 2024, https://www.bussgeldkatalog.org/umwelt-recycling/.

[23] "Unlawful Disposal of Waste (Section 326, German Criminal Code)," United Nations Office on Drugs and Crime, accessed December 25, 2024, https://sherloc.unodc.org/cld/en/legislation/deu/german_criminal_code/special_part_-_chapter_twenty-nine/section_324-326_328-330/section_324-326_328-330.html.

[24] "Recycling Rate of Municipal Waste in the European Union (EU-27) in 2010 and 2022, by Country," *Statista*, accessed December 25, 2024, https://www.statista.com/statistics/1219551/municipal-waste-recycling-eu-by-country/.

Option 1b: Behavioural Nudges

Due to their rigid nature and broad impact, mandatory regulations are best suited for sweeping policy changes but less appropriate for fine-tuning aspects of everyday life. For this, behavioural nudges (ie "Little Sticks"), or choice architecture adjustments, provide a more flexible alternative. By shaping decision-making contexts and the way options are presented, nudges can have beneficial impacts exceeding the actual costs of the options.[25]

First, visual and contextual cues can make desirable options more prominent and accessible. For instance, encouraging plant-based diets can be achieved by placing vegetarian meals at eye level on shelves, ahead of meat options, or increasing vegetarian options on menus and buffet lines in universities and cafeterias.[26] A study conducted at Cambridge University, analysing over 94,000 cafeteria meal choices, found that increasing the proportion of vegetarian options from 1/4 to 1/2 boosted plant-based purchases by 40%–80% without affecting overall food sales.[27] This principle extends to retail, where displaying energy-efficient appliances or prioritising eco-friendly products on e-commerce platforms can drive sustainable consumption.

Second, governments can reframe sustainable choices with positive messaging that highlights personal or social benefits, and high-carbon choices with negative messages. For example, Sweden's "Flygskam" (*flight shame*) movement emphasised the environmental cost of air travel while promoting train travel as a moral and eco-friendly alternative.[28] This led to a 4% decrease in air travel and a corresponding rise in rail usage within a year.[29]

The last but widely used option is setting low-carbon options as defaults. Some governments rely solely on adjusting default choices, while others combine this with information-based strategies to raise awareness of individual behaviours. For example, Germany automatically enrolls consumers in default renewable energy plans unless they opt out, significantly boosting green energy participation.[30] Another well-known example is setting double-sided printing as the default. A study conducted at a US university showed that this approach reduced each student's average paper usage by 14% per semester. In addition to saving money, the double-sided printing default reduced CO_2 equivalent emissions by 700 tons annually among the treatment group of approximately 1,500 students – equivalent to the emissions of a typical car over 114 years.[31]

China's large population and advanced digital economy make nudges particularly impactful, especially when local governments can persuade retail and dining sectors alongside e-commerce giants to prioritise green

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[25] Richard H. Thaler and Cass R. Sunstein, *Nudge: Improving Decisions About Health, Wealth, and Happiness* (New York: Penguin Books, 2009).

[26] Nicky Coucke, Iris Vermeir, Hendrik Slabbinck, and Anneleen Van Kerckhove, "Show Me More! The Influence of Visibility on Sustainable Food Choices," *Foods* 8, no. 6 (2019): 186, https://doi.org/10.3390/foods8060186.

[27] Garnett, Emma E., Andrew Balmford, Chris Sandbrook, Mark A. Pilling, and Theresa M. Marteau, "Impact of Increasing Vegetarian Availability on Meal Selection and Sales in Cafeterias," *Proceedings of the National Academy of Sciences* 116, no. 42 (2019): 20923-20929.

[28] Nina Wormbs and Maria Wolrath Söderberg, "Flygskam / Flight Shame," *Nordics.info*, November 17, 2023, accessed December 8, 2024, https://nordics.info/show/artikel/flightshame-in-sweden.

[29] "Flight Shame: Will It Change How We Travel?" *BBC News*, January 11, 2020, accessed December 8, 2024, https://www.bbc.com/news/world-europe-51067440.

[30] Felix Ebeling and Sebastian Lotz, "Domestic Uptake of Green Energy Promoted by Opt-out Tariffs," *Nature Climate Change* 5 (2015): 868-871.

[31] Jimena González-Ramírez, "The Effectiveness of a Green Default Nudge in Achieving Resource Conservation," *Agricultural and Resource Economics Review* 53, no. 2 (2024): 1-19.

products on their shelves or in search results. These nudges help to balance the interests of businesses and consumers. However, as nudges are subtle, they are most effective when integrated with other policies like monetary incentives ("carrots") and feedback ("sermons"), implying that Chinese governments can combine nudges with other instruments.[32]

Policy Option 2: Economic Incentives

Option 2a: Subsidies for Green Choices

Encouraging green consumption requires providing residents with both motivation and capacity. In this regard, economic incentives can reduce financial barriers and narrow the price gap between low- and high-carbon products, guiding individuals toward sustainable choices. Singapore provides a compelling example with its recently introduced "Climate Vouchers", which allows every Housing and Development Board (HDB) household to claim $300 vouchers to purchase energy- and water-efficient household appliances.[33] With its massive appliance market, advanced energy-saving technology, and good fiscal capacity, China is well-positioned to implement similar measures. However, due to regional economic disparities and uneven local fiscal capacities in China, it is important to ensure that relevant policies allow equal access to subsidies across regions, including both urban and rural areas. Policymakers must also be mindful of the potential fiscal burden these subsidies may create and their possible overstimulating effect on the macroeconomy.

Economic instruments also include non-monetary material resources. For example, Singapore's effort to expand cycling paths in HDB towns, connecting homes to MRT stations, bus interchanges, shopping malls and schools, and Luxembourg's introduction of free public transport in 2020 are forms of economic subsidies, akin to direct cash subsidies.[34, 35] China should consider using similar tools to complement cash subsidy programs.

Option 2b: Taxes on High-Carbon Choices

Taxing high-carbon behaviours is the flip side of economic incentives. After all, the true cost of high-carbon consumption is often underestimated, as it fails to account for environmental externalities. By implementing taxes on these behaviours, governments can make high-carbon choices less appealing. Sweden stands out for its strict taxation policies, it introduced a carbon tax on fossil fuels in 1991, starting at €22 per ton of fossil CO_2 and rising to €134 by 2025 – one of the highest rates globally.[36] It also imposes fixed-rate taxes on aviation

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[32] Tarun M. Khanna, Giovanni Baiocchi, Max Callaghan, Felix Creutzig, Horia Guias, Neal R. Haddaway, Lion Hirth, et al., "A Multi-Country Meta-Analysis on the Role of Behavioural Change in Reducing Energy Consumption and CO_2 Emissions in Residential Buildings," *Nature Energy* 6, no. 9 (2021): 925-932.

[33] "$300 Climate Vouchers for All HDB Households from 15 April 2024," Climate Vouchers Singapore, accessed December 22,2024, https://www.climate-friendly-households.gov.sg/.

[34] "Factsheet: Islandwide Cycling Network (ICN) Programme to Improve Safety and Connectivity for all Path Users," Land Transport Authority Singapore, accessed December 27, 2024, https://www.lta.gov.sg/content/ltagov/en/newsroom/2020/3/news-releases/islandwide-cycling-network--icn--programme-to-improve-safety-and.html.

[35] Daniel Boffey, "Luxembourg is First Country to Make All Public Transport Free," *The Guardian*, December 5, 2018, accessed December 27, 2024, https://www.theguardian.com/world/2018/dec/05/luxembourg-to-become-first-country-to-make-all-public-transport-free?utm_medium=website&utm_source=archdaily.com.

[36] "Sweden's Carbon Tax," Government Offices of Sweden, accessed December 26, 2024, https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/.

tickets and annual charges on all vehicle types.[37] Yet, tax policies can be tricky for governments: without careful planning, they risk public backlash, especially from lower-income households, who spend a larger portion of their income on energy and necessities. Additionally, as contractionary policies, carbon taxes can dampen consumption, making complementary measures essential. To offset these effects, Sweden reduced personal and corporate income taxes when introducing the carbon tax and offered generous subsidies for energy-efficient products.[38] Even so, after weighing the economic and environmental impacts, Sweden announced that it will abolish its aviation tax in 2025, explaining that taxation is not a sustainable long-term solution.[39]

Non-monetary taxes involve restricting access to material resources. Realising that the rapid growth of private cars stems from urban planning that prioritise cars – wider roads, highways and parking spaces – over other modes of transportation, cities like Amsterdam are reclaiming these resources. Amsterdam plans to eliminate 11,200 parking spaces by 2025 freeing up areas to widen sidewalks, bike lanes, parks and walking paths.[40] While these policies do not impose direct costs, the inconvenience deters high-carbon behaviours, pushing individuals toward public transport. Non-monetary policies target specific groups with less economic pressure, serving as effective complements to broader carbon tax strategies in reducing high-carbon behaviours.

Policy Option 3: Information-Based Policies

Option 3a: Environmental Education

Governments can prioritise formal education as a foundation for fostering long-term commitments to sustainability. By integrating environmental knowledge into school curricula and broader societal norms, and clarifying what actions are allowed or recommended, they can foster deeper, long-term commitments to sustainable practices. For instance, Singapore's Ministry of Education includes environmental topics in its science and geography curricula at all levels. In primary school, students learn about pollution, global warming and deforestation, and practice the "3R" principles (reduce, reuse, recycle) as "environmental ambassadors". As they progress to secondary school, they can explore deeper in these subjects.[41]

In China, where over 95.7% of the population benefits from nine years of compulsory education (primary and secondary), integrating environmental education during these formative years could significantly drive

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[37] "Vehicle Tax," Transport Stryrelsen Sweden, accessed December 26, 2024, https://www.transportstyrelsen.se/en/road/vehicles/taxes-and-fees/vehicle-tax/.

[38] Cari Gindi and Emily Collins, "Green Carrot & Stick: How Sweden Became a Heat Pump Success Story," *Zondits*, February 1, 2024, accessed December 8, 2024, https://www.zondits.com/green-carrot-stick-how-sweden-became-a-heat-pump-success-story/.

[39] Aage Krogh and Selma Agopian, "Sweden to Abolish Aviation Tax," *IUNO*, December 18, 2024, accessed December 26, 2024, https://www.iuno.law/news/sweden-to-abolish-aviation-tax/.

[40] Erika Clugston, "Amsterdam Plans to Eliminate 11,200 Parking Spots by 2025," Energetski Portal, April 17, 2019, accessed on December 27, 2024, https://www.energetskiportal.com/amsterdam-plans-to-eliminate-11200-parking-spots-by-2025/.

[41] Parliamentary Reply on "Environmental Education," Ministry of Education Singapore, January 15, 2019, accessed December 26, 2024, https://www.moe.gov.sg/news/parliamentary-replies/20190115-environmental-education.

demand-side emissions reductions.[42] However, county-level disparities in educational resources, especially between urban and rural schools, present challenges – many regions lack qualified teachers to deliver such content effectively.

Option 3b: Public Awareness Campaigns

Similar to education but delivered in a more accessible and informal way, such initiatives can help individuals understand how their behaviours affect energy consumption, carbon emissions and the adoption of green alternatives. When combined with collective action, they can drive consumer behaviour toward sustainability while fostering a new environmental culture. Earth Hour, organised by the World Wildlife Fund, is a famous global campaign that encourages individuals, businesses and governments to turn off non-essential lights for one hour annually to raise awareness about climate change.[43] This initiative has been a starting point for many people's environmental awareness. Various countries also have their own sustainability campaigns. For example, Singapore's Zero Waste Masterplan educates citizens on waste reduction and proper recycling, embedding sustainability into everyday life.[44] In South Korea, the Greenstart Campaign uses periodic campaigns to provide consumers with practical emissions-reduction methods for different life scenarios, such as holidays, travel, summer and winter, demonstrating how to embrace a low-carbon lifestyle through daily tips.[45]

Since environmental protection has not been deeply embedded in Chinese culture and social norms, informal public awareness campaigns and propaganda provide an important complement for the majority who are not significantly influenced by formal education. China could adopt similar public awareness campaigns tailored to its unique context and actively work to encourage greater public participation. Integrating tools like green labeling and friendly social comparison can make environmental behaviours more engaging and appealing, gradually establishing new social norms and cultivating a long-lasting green culture.

Evaluation

Unlike supply-side mitigation policies, which can be widely imposed on all types of producers, there is no one-size-fits-all approach for demand-side mitigation. The relatively uniform nature of production processes allows for standardisation of supply-side measures across emitters. In contrast, demand-side policies rely on individuals' diverse preferences, consumption patterns and localised contexts, making their effectiveness much more variable.

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[42] "Statistical Bulletin on National Education Development in 2023," Ministry of Education of the People's Republic of China, October 24, 2024, accessed December 26, 2024, http://www.moe.gov.cn/jyb_sjzl/sjzl_fztjgb/202410/t20241024_1159002.html.

[43] "Give an Hour for Earth," Earth Hour, accessed December 27, 2024, https://www.earthhour.org/take-part/give-an-hour.

[44] "Zero Waste Masterplan," Ministry of the Environment and Water Resources and National Environment Agency Singapore, accessed December 8, 2024, https://isomer-user-content.by.gov.sg/23/85029cae-9ba1-4144-8a52-26c7f86c04ba/zero-waste-masterplan.pdf.

[45] "Korea Environmental Policy Bulletin – Greenstart Movement," United Nations Environment Programme, accessed December 27, 2024, https://www.unep.org/resources/report/korea-environmental-policy-bulletin-greenstart-movement.

In China's case, a mix of approaches – "carrots, sticks and sermons" – has been introduced to foster climate-friendly behaviours. The effectiveness of these demand-side mitigation policies is evaluated across six dimensions: 1) their potential to significantly reduce emissions, 2) their ability to reach a broad audience, 3) the sustainability of their impacts over time, 4) the ease of practical implementation, 5) their public acceptability, and 6) their contribution to equitable emissions abatement among different groups (Table 3).

	Policy type	High emission reduction potential	Broad policy coverage	Long-term effectiveness	Ease of practical feasibility	High public acceptability	Social equity in climate mitigation
Electric vehicle subsidy		✓				✓	
Bike-sharing system		✓		✓		✓	
Plastic bag ban			✓	✓	✓		✓
Publicity and education			✓	✓	✓	✓	
Energy efficiency labeling			✓	✓		✓	
Green default choice in takeaway		✓			✓	✓	✓
Carbon crediting programs		✓	✓			✓	

Table 3 Evaluations of China's demand-side mitigation policies

Electric Vehicle Subsidy

Electric vehicle (EV) subsidy is a classic example of "carrot" that uses pecuniary incentives to encourage pro-climate choices. Launched in 2009, China's EV subsidy programme provides a range of financial benefits to consumers, including direct purchase subsidies, tax exemptions and funding for infrastructure like charging stations.[46] For instance, the EV subsidy in Beijing is up to 20,000 CNY per vehicle, accounting for 5%-10% of total purchase spending. By 2023, the government had invested over US$230 billion in these initiatives, which in turn boosted domestic demand for EVs.[47] By mid 2024, EVs accounted for over 50% of new vehicle sales in China, a rate more than double that of Europe and five times higher than the US.[48]

Switching toward EVs has notable implications for decarbonising private transportation, with an estimated annual mitigation potential of 150 kg of CO_2 per person. This explains why governments are willing to invest

[46] Han Hao, Xunmin Ou, Jiuyu Du, Hewu Wang, and Minggao Ouyang, "China's Electric Vehicle Subsidy Scheme: Rationale and impacts," *Energy Policy* 73 (2014): 722-732.

[47] Scott Kennedy, "The Chinese EV Dilemma: Subsidized Yet Striking," Trustee China Hand, Center for Strategic and International Studies, June 20, 2024, accessed December 12, 2024, https://www.csis.org/blogs/trustee-china-hand/chinese-ev-dilemma-subsidized-yet-striking.

[48] "China Leading the Race Towards Full EV Adoption," Global Alpha Capital Management, September 19, 2024, accessed December 12, 2024, https://globalalphacapital.cclgroup.com/insight/gacm-china-leading-the-race-towards-full-ev-adoption/.

heavily to encourage the adoption of this green technology. However, the financial burden of subsidies has raised sustainability concerns: immense costs have strained public finances, leading to a gradual scaling back of the programme. Moreover, as it is in people's nature to maximise personal benefits, EV subsidies have led to moral hazard by encouraging excessive purchases – like owning multiple EVs – which can lead to resource overuse and additional emissions.

Bike-Sharing System

The "last-mile" challenge – bridging the 1-3 km gap between public transport stations and final destinations – poses a significant hurdle in urban mobility. Conventional solutions, such as taxis or private vehicles, tend to increase carbon emissions and undermine sustainability goals. In response, bike-sharing systems, introduced in China's major cities in 2007, offer a practical solution. By providing public bicycles and docking stations, the programme facilitates an effective substitution of bicycles for cars for short-distance travel. Over a decade later, the system had gained over 500 million users, with a cumulative cycling distance of 60 billion km.[49]

The bike-sharing system represents another form of "carrot." Instead of directly offering monetary incentives, the government provides users with a convenient and affordable alternative to driving, which enjoys high public acceptance. This approach delivers an estimated annual mitigation potential of 40 kg of CO_2 per user.[50] Moreover, unlike EV subsidies, bike-sharing reshapes individual behaviours in a more sustainable way. Once the new infrastructure is in place, people will automatically choose travel modes according to their preferences, and this is where pro-climate habits start to develop. Nevertheless, bike-sharing falls short of climate equity, as those with higher socio-economic status (eg motorists) contribute less to emissions reductions in this domain.

Plastic Bag Ban

As one of the largest consumers of plastic bags globally, China has introduced two major plastic bag policies in recent years. The first, enacted in 2008, required all retailers to charge consumers for plastic bags. In 2020, a ban was introduced, prohibiting major supermarkets from using non-biodegradable plastic bags. These "*sticks*" are favoured by policymakers for their simplicity and effectiveness. Once legislated, enforcement ensures rapid and sustained changes: the 2008 policy reduced plastic bag usage by 44% in its first year, while the 2020 ban virtually eliminated their use in supermarkets.[51]

However, "sticks" often provoke resistance due to their coercive nature. For example, negative attitudes toward the plastic bag ban have led some consumers to engage in non-cooperative or even violative

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[49] Yuan Li, Shengyou Wang, Justin Hayse Chiwing G. Tang, Zhenhan Peng, and Chengxiang Zhuge, "Public Attention and Attitudes Towards Bike-Sharing in China: A Text Mining Approach," *Transportation Research Part D: Transport and Environment* 134 (2024): 104348.

[50] "2024 Annual Report on Sharing Bikes and Sharing Electric Bikes Riding in Major Chinese Cities," China Academy of Urban Planning & Design, accessed December 20, 2024, https://www.cnii.com.cn/rmydb/202409/t20240920_602531.html.

[51] Bairong Wang and Yong Li, "Plastic Bag Usage and the Policies: A Case Study of China," *Waste Management* 126 (2021): 163-169.

behaviours.[52] In turn, the abatement effect of "stick"-based policies can be weakened by these unintended "boomerang effects".

Waste Sorting Campaign

The climate action campaign is a classic example of a "sermon" that China has employed for decades. These initiatives include urging major media outlets to produce reports on emissions reduction, airing public service advertisements and organising awareness campaigns. One prominent example is the nationwide waste sorting program, which was piloted in megacities like Shanghai in 2019 before being expanded across the country. This initiative relies heavily on publicity, community workshops and strict enforcement to promote recycling and environmental awareness.[53]

"Sermons" like this are easy to implement and can reach a wide audience at relatively low cost. Moreover, they often have long-lasting effects; for instance, instilling pro-environmental values in children tends to carry over into adulthood.[54] However, the influence of "sermons" can be uneven. Limited attention spans and varying levels of interest in climate issues mean that only a subset of the population – those already concerned about the environment – are likely to be significantly influenced. This results in an unbalanced distribution of emissions reduction responsibility, as individuals less engaged with climate issues often remain unaffected.

Energy Efficiency Labeling

China's energy efficiency labeling system, introduced in 2004, exemplifies how "sermons" can be tailored to affect consumer behaviours. The programme mandates that appliances such as refrigerators, air conditioners and washing machines bear energy efficiency labels, helping consumers make informed purchasing decisions. By 2020, the labeling scheme had expanded to 42 product categories, including televisions, rice cookers and water heaters.

Unlike general propaganda campaigns, energy efficiency labeling not only promotes environmental awareness but also offers tangible financial benefits, such as lower electricity bills, to consumers. This in turn makes labeling more effective than general advocacy. Ideally, this initiative could significantly reduce household electricity consumption by over 50%, as estimated by the government.[55] However, this effect is often undermined by an unintended rebound effect, where people tend to intensify the use of energy-efficient appliances compared to conventional ones, ultimately reducing the effectiveness of emissions abatement.

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[52] Dongqing Yan, Xiang Cai, Meiying Xie, Sohail Ahmad Javeed, Fengqin Liu, and Qun Cao, "Why Is Reusable Bag Consumption Easier to Say than Do?" *Frontiers in Psychology* 13 (2022): 956998.

[53] Jiayuan Wang, Hongping Yuan, Xiangping Kang, and Weisheng Lu, "Critical Success Factors for On-Site Sorting of Construction Waste: A China Study," *Resources, Conservation and Recycling* 54, no. 11 (2010): 931-936.

[54] Gary W. Evans, Siegmar Otto, and Florian G. Kaiser, "Childhood Origins of Young Adult Environmental Behavior," *Psychological Science* 29, no. 5 (2018): 679-687.

[55] "Shop for Efficiency – The Many Aspects of China's Energy Efficiency Labeling, " Power Integrations, April 26, 2023, accessed December 21, 2024, https://www.power.com/community/green-room/blog/shop-efficiency-many-aspects-chinas-energy-efficiency-labeling.

On top of this, consumers who are indifferent to energy consumption or environmental issues are less likely to pay attention to these labels. Consequently, the policy's emissions-reduction benefits are largely driven by individuals with existing pro-climate awareness.

Green Default Choice in Takeaway

Nudging individuals toward greener behaviour is a strategy often discussed but rarely implemented in China. A notable exception is the "no tableware" default option introduced by Ele.me, a leading food delivery platform, in 2017. The feature, which encourages users to opt out of receiving disposable cutlery, aligns with local regulations that ban single-use tableware unless explicitly requested. This policy combines elements of "carrots, sticks and sermons". The default choice acts as a soft regulation ("little stick") to encourage voluntary action, while informational prompts remind users of the environmental benefits, reflecting a "sermon"-like approach.

The results have been striking: the frequency of orders without cutlery has increased by over 600%.[56] If implemented nationwide, such measures could save more than 21 billion sets of disposable tableware annually. However, nudges like this often lack lasting impact. Once discontinued, individuals are unlikely to sustain these behaviours independently, as nudges operate subtly and do not fundamentally change consumer mindsets.[57]

Carbon Crediting Programmes

Carbon crediting programmes represent a uniquely innovative approach in China's climate policy landscape, leveraging digital platforms to promote individual green behaviours. Under these programmes, users are rewarded with carbon credits for adopting low-carbon practices. These actions are tracked via apps or self-reported by users, verified by authorities and converted into measurable emissions reductions. Credits can then be redeemed for rewards, blending "carrots" with "sermons" to motivate continued action.

One standout example is Ant Forest, a programme launched by Alipay in 2016. Users earn "green energy points" for low-carbon actions, which are used to plant real trees in desertification-prone regions. By 2024, Ant Forest had attracted over 700 million users and facilitated the planting of 548 million trees.[58] Building on this success, government-led carbon crediting programmes have expanded rapidly, with two thirds of Chinese provinces adopting such initiatives by late 2024.

These programmes effectively combine the benefits of financial incentives and education, encouraging behavioural shifts while fostering pro-environmental values. However, their success depends heavily on

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[56] Guojun He, Yuhang Pan, Albert Park, Yasuyuki Sawada, and Elaine S. Tan, "Reducing Single-Use Cutlery with Green Nudges: Evidence from China's Food-Delivery Industry," *Science* 381, no. 6662 (2023): eadd9884.

[57] Claudia F. Nisa, Jocelyn J. Bélanger, Birga M. Schumpe, and Daiane G. Faller, "Meta-Analysis of Randomised Controlled Trials Testing Behavioural Interventions to Promote Household Action on Climate Change," *Nature Communications* 10 (2019): 4545.

[58] "Alipay Ant Forest: Using Digital Technologies to Scale up Climate Action | China," United Nations Climate Change, accessed December 12, 2024, https://unfccc.int/climate-action/momentum-for-change/planetary-health/alipay-ant-forest.

thoughtful design to sustain user engagement. Moreover, current participation skews toward younger, tech-savvy individuals with existing climate awareness, leaving those indifferent to climate issues largely unaffected.

Epilogue

Under the severe climate crisis, demand-side climate mitigation policies have become more critical than ever, not only for their potential to reduce emissions significantly but also for their role in addressing environmental degradation and improving resource efficiency. Despite the Chinese government's application of various tools within the "Carrot-Stick-Sermon" framework, there is still a long way to go in advancing demand-side climate mitigation. With China's vast and diverse population, financial constraints, regional disparities and unequal access to information often exclude vulnerable groups. This raises a critical question: how can policies be designed to ensure everyone is included in the low-carbon transition?

Moreover, while demand-side actions are vital for achieving climate goals, placing excessive responsibility on individuals introduces concerns about fairness and feasibility. Critics argue that this focus on personal responsibility risks overshadowing the broader structural changes needed at institutional and industrial levels. These critiques emphasise the importance of policies that go beyond assigning responsibility to empowering individuals and supporting systematic change actively.

Building on this, structural and cultural shifts toward sustainability are crucial for sustaining long-term impacts. While deeply ingrained habits and societal norms cannot change overnight, building a low-carbon future requires sustained efforts and the active participation of all stakeholders. Fostering collaboration among governments, industries and individuals may hold the key to embedding sustainability into everyday life and paving the way for a truly low-carbon future.

Discussion Questions

1. What other policies can you suggest to make demand-side climate mitigation more equitable and accessible in China?
2. What opportunities exist for enterprises (service and product providers like Ele.me and Ant Group mentioned in the case) to lead demand-side climate mitigation, and how can they influence consumer behaviour?
3. What are the shortcomings of each policy instrument – "carrots", "sticks" and "sermons" – when it comes to demand-side mitigation? How can they be combined to maximise impact?
4. Do you agree that implementing demand-side strategies in a large, diverse country like China is more challenging than in a smaller nation, like Singapore? If so, why?