

Perspective



Strait of Hormuz Standoff Puts Clean Cooking in South Asia at Risk

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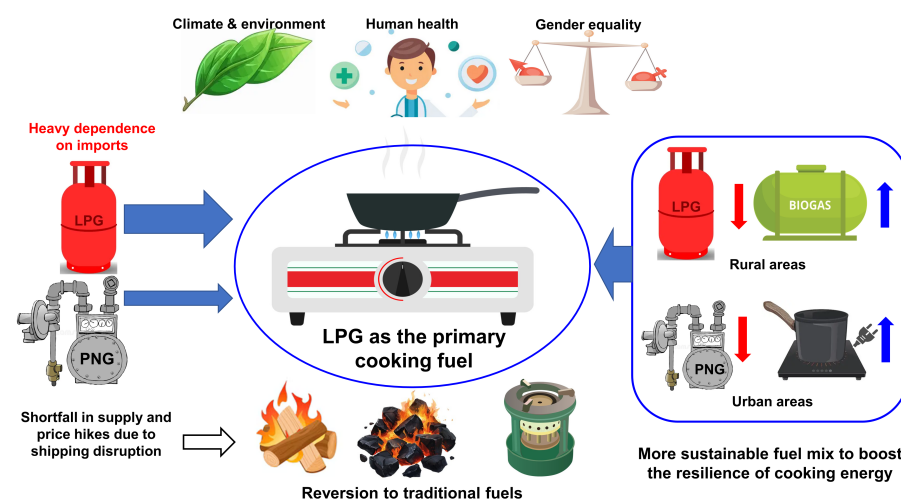
Keywords

sustainability; clean cooking;
clean fuels; air pollutants;
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Highlights

- Disruption in commercial shipping through the Strait of Hormuz greatly impacted oil and gas supply in Asia
- South Asian countries with heavy dependence on fossil fuels from the Gulf region were particularly hard hit
- Shortage of LPG, the primary clean cooking fuel, occurred in India and compromised its clean cooking program
- Adoption of biogas and electric cooking would greatly boost energy security and benefits of clean cooking
- Other LPG-dependent South Asian countries also need to transition towards a more sustainable cooking fuel mix

Abstract: The recent closure of the Strait of Hormuz and substantial damage to energy infrastructure in the Persian Gulf region have sparked a global energy shock, with the South Asian countries being impacted the most. A crisis due to shortage in the supply of liquefied petroleum gas (LPG), which is used primarily as a cooking fuel in urban and rural households, has occurred in India caused by to the disruption in imports from the Gulf region and the limited domestic production capacity. Many rural households and catering businesses temporarily reverted to traditional fuels for cooking, which compromised the human health benefits and undermined the air quality and climate gains achieved through the implementation of the Pradhan Mantri Ujjwala Yojana (PMUY) scheme, the largest clean cooking program in the world. Instead of relying solely on LPG and natural gas, the supply of which depends heavily on imports, India needs to diversify its cooking fuel mix. Support should be provided to accelerate the transition from LPG to biogas in rural regions where abundant feedstock exists, whereas electric cooking, as an attractive and cost-effective option, should be promoted in urban and peri-urban areas with reliable grid infrastructure. Such a fuel mix would boost the sustainability and resilience of cooking energy, and further improve the climate/environmental and public health benefits of clean cooking in India. Similarly, other LPG-dependent South Asian countries also need to diversify the cooking fuel mix by including non-fossil resources alongside existing ones to boost overall energy security and harvest greater benefits from clean cooking.



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1. Introduction

The Iran War has put the Strait of Hormuz, a strategically vital sea passage, on the center stage of global geopolitics since late February 2026. Connecting the oil-rich Persian Gulf with the Gulf of Oman and the Arabian Sea, this narrow strait is one of the world's most important maritime chokepoints (Figure 1a). The Persian Gulf region hosts approximately half of the crude oil reserves in the world, and 35% of natural gas reserves as well. Collectively, the Gulf countries, including Saudi Arabia, Iran, Iraq, Kuwait, the United Arab Emirates (UAE), Qatar, Bahrain, and Oman, produce approximately 1/3 of the world's oil and about 17% of the world's natural gas. Being the primary export corridor for oil and gas produced

in the Gulf region, the strait plays a crucial role in global maritime transport (Figure 1b). Approximately 20 million barrels of crude oil and refined products used to transit through the Strait of Hormuz every day, which account for around 1/4 of the world's seaborne oil trade. In addition, approximately 19% of the global exported liquefied natural gas (LNG) used to transit through the strait, predominantly exported from Qatar and the UAE. Around 80% of the total volumes were supplied to Asian countries, including China, India, Japan, and South Korea, while the rest were shipped to Europe and North America [1]. The geographical constriction, along with heavy shipping traffic, makes the Strait of Hormuz the most important energy chokepoint on the Earth.

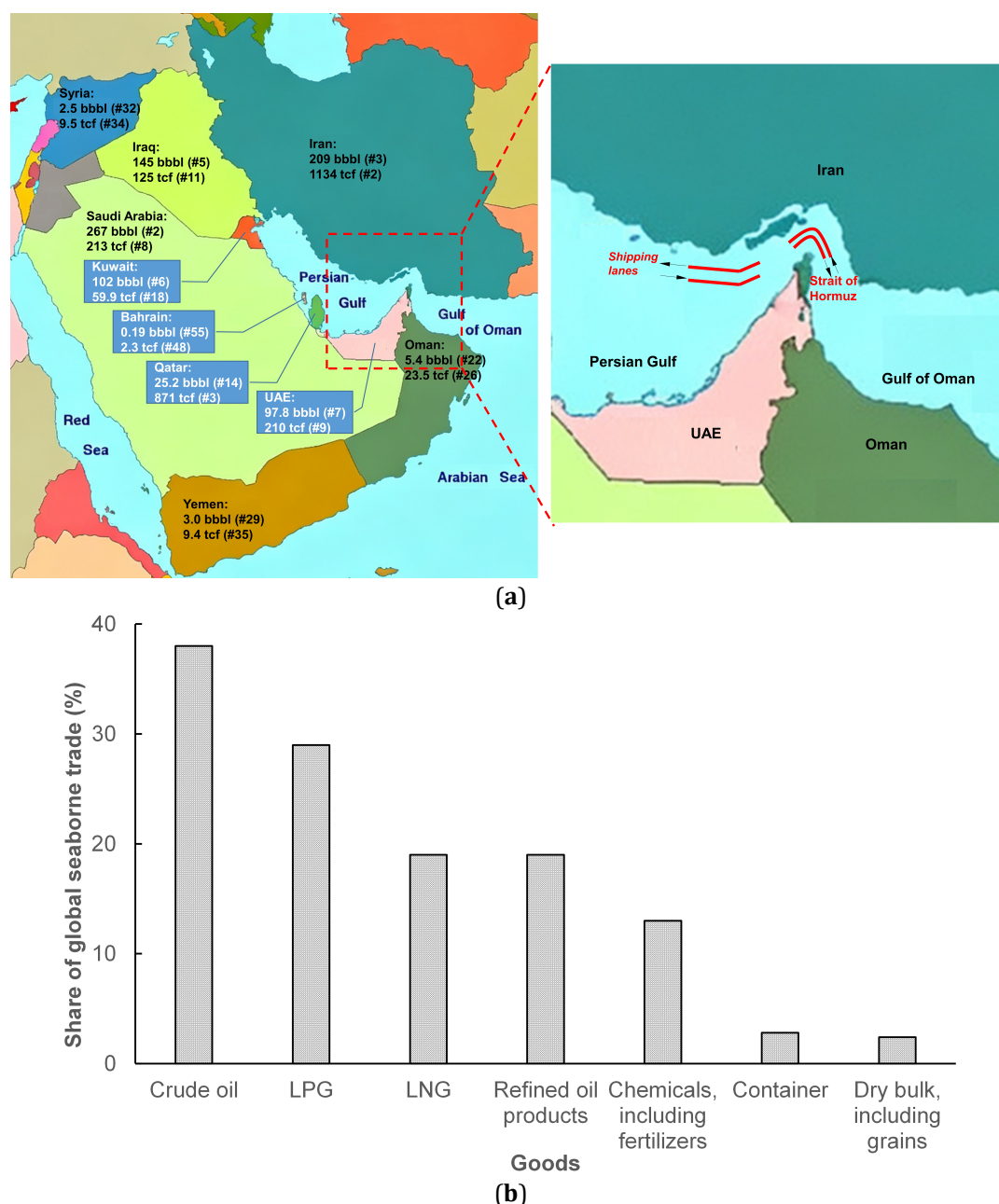


Figure 1. Oil and natural gas resources in the Persian Gulf region and the vital role of the Strait of Hormuz in global maritime transport: **(a)** Reserves of crude oil (in billion barrels, bbbl, with the global rank shown in parentheses) and natural gas (in trillion cubic feet, tcf, with the global rank shown in parentheses) in the Gulf countries (data from [2]), and locations of the

Strait of Hormuz and the shipping lanes that restrict oil and natural gas shipping (although the narrowest point of the strait is about 54 km, the navigable channels for commercial vessels only consist of 2-mile-wide (3.7 km) traffic lanes for inbound and outbound ships separated by a 2-mile-wide buffer zone); and **(b)** Share of global seaborne trade volume passing through the Strait of Hormuz in the week prior to the breakout of the Iran War (data from [3]).

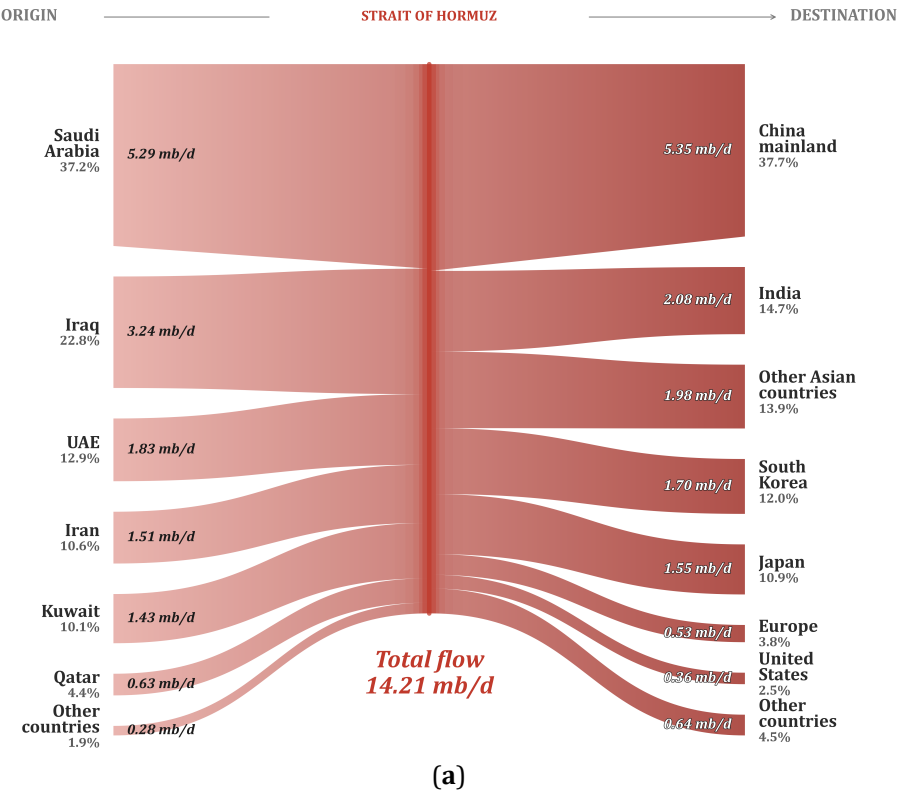
Immediately after the massive strikes on Iran launched by the United States and Israel on 28 February 2026, the Islamic Revolutionary Guard Corps (IRGC) of Iran issued warnings forbidding the passage of vessels through the Strait of Hormuz. The IRGC officially announced the closure of the strait on 2 March 2026, causing the anchoring of over 150 tankers in open Gulf waters. Commercial shipping through the strait was effectively halted due to the cancellation of war risk coverage in the Gulf by the insurance market 3 days after the strikes on Iran. As there are very limited alternative options to ship the huge volumes of crude oil, refined products, and LNG produced in the region, any disruption to passage through the Strait of Hormuz would have a massive impact on the global energy markets. The halt in oil and gas exports quickly forced the producers to cancel shipments and curtail production, while the impact readily rippled through the global energy markets. The affected importing countries had to seek alternative supplies to meet their domestic energy demand, driving sustained price hikes for oil and natural gas. In fact, the 2026 Iran War has evolved from a geopolitical conflict to a global energy crisis, which could severely hurt the economic growth of major energy-importing countries.

Given the dynamic nature of topics covered in this perspective, plenty of grey literature, which fills the gaps

left by peer-reviewed studies, was cited to present the most current information and emerging trends. Nonetheless, we strove to select the news and reports from reputable organizations and carefully evaluated the credibility of their content to avoid potential bias.

2. Impact on Oil and Gas Supply in Asian Countries

Major energy exporters in the Gulf region, including Saudi Arabia, Iraq, Kuwait, the UAE, and Qatar, rely on the Strait of Hormuz to ship crude oil, refined products, and LNG in oil tankers and LNG carriers to international markets. The flow of crude oil and condensate through the Strait of Hormuz before the Iran War was around 14 million barrels per day (mbbl/d) [4]. Chinese mainland, India, South Korea, Japan, and other Asian countries received 84% of the crude oil and petroleum products that passed through the strait (Figure 2a). In addition, roughly 10 billion cubic feet per day (bcf/d) of LNG was transported through the strait before the war [5]. Chinese mainland, India, the Taiwan region, South Korea, and Pakistan were the top destinations for the LNG shipments (Figure 2b). The Iran War has caused effective closure of the Strait of Hormuz since March 2026, and resulted in substantial damage to the energy infrastructure in the Gulf region.



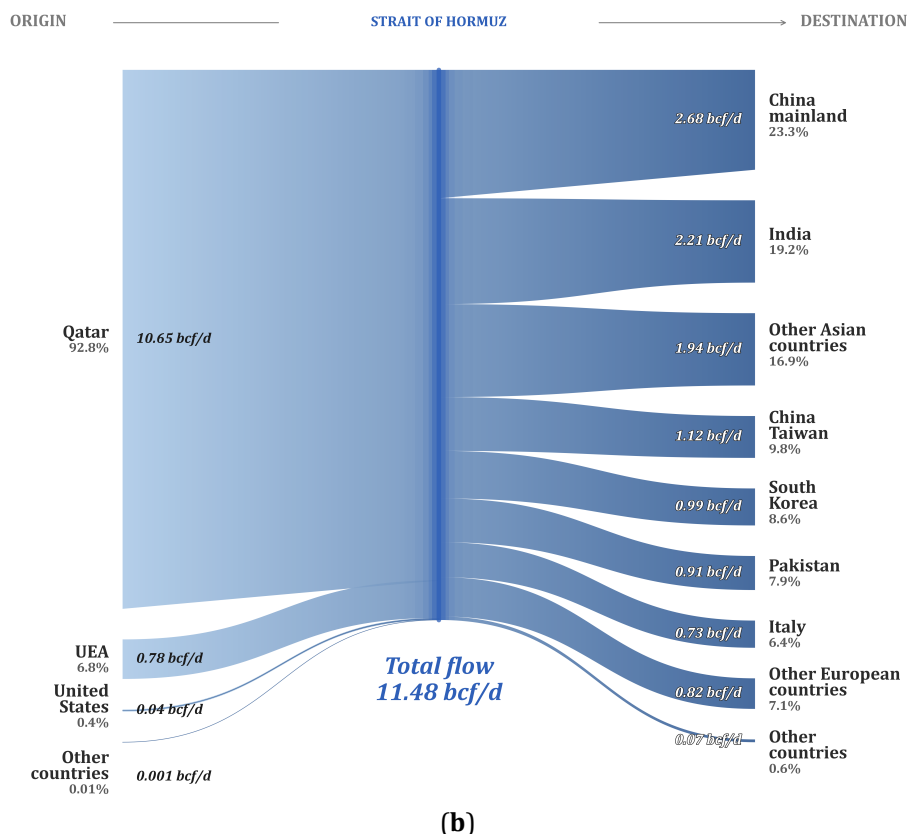
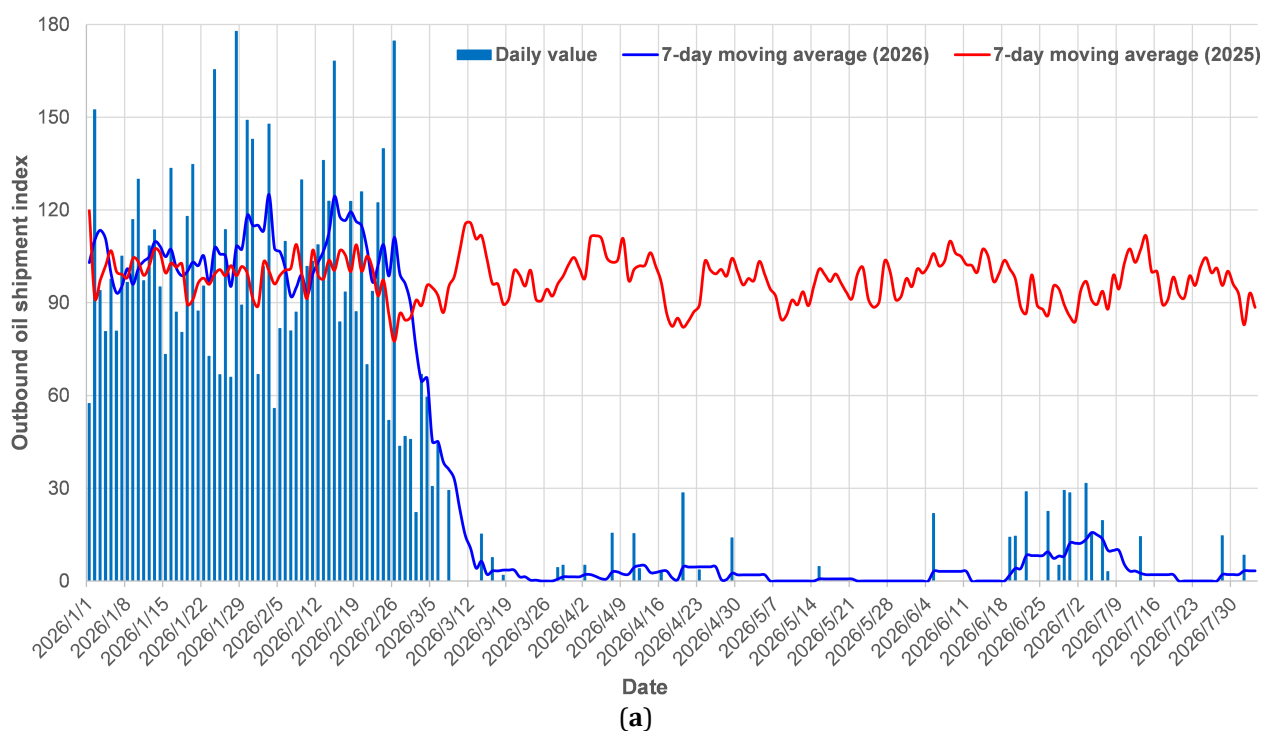


Figure 2. Volumes, sources, and destinations of oil and gas products transported through the Strait of Hormuz in the first quarter of 2025: (a) Crude oil and petroleum products (data from [4]); and (b) LNG (data from [5]). Note: percentages may not add up to 100% due to rounding.

Compared to the first two months of this year, the number of oil tankers, LPG carriers, and LNG carriers crossing the Strait of Hormuz each day (both inbound and outbound) decreased by approximately 85% to 94% between March and May [6]. As a result of the disruption in freight routes, a drastic reduction in the exports of oil

and gas products from the Gulf region has occurred (Figure 3). As the destinations of over 80% of the oil and gas shipped through the strait, Asian countries were most affected by the shock wave across global energy markets triggered by the Strait of Hormuz standoff.



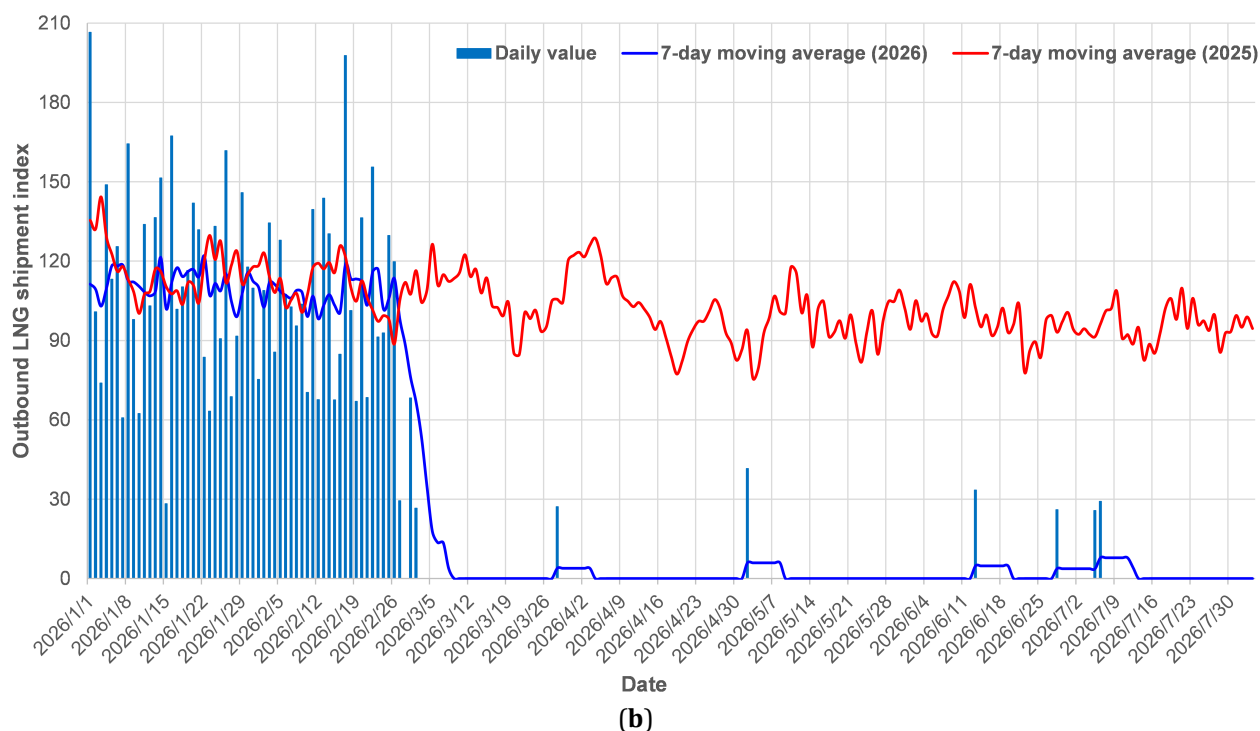


Figure 3. Strait of Hormuz shipping disruption brought by the Iran War (data from [7]): (a) Oil shipments through the strait to destinations outside of the Gulf; and (b) LNG shipments through the strait to destinations outside of the Gulf. The shipment index is calculated as the ratio of daily shipment volume to average daily volume in the 1st quarter of 2025, then multiplied by 100 (i.e., the average of the base period is treated as 100).

While around 40% of oil imported by China used to pass through the Strait of Hormuz, the country has built a massive strategic reserve of crude oil. Under the national Strategic Petroleum Reserve Framework, which combines strategic and commercial reserves under centralized oversight, China stockpiled 1.5 billion barrels of crude oil in 2025 [8]. At the current consumption rate, the import coverage days of national reserves exceed 121, which is far beyond the 90-day benchmark recommended by the International Energy Agency (IEA) [8]. Besides the Gulf region, China also imports large volumes of oil from Russia, Brazil, Angola, and other countries. China is also relatively well buffered against potential short-term supply shocks of LNG. The country's LNG inventories were approximately 6.8 million tonnes (MT) at the end of February of this year, which is much higher compared to the seasonal low of 5.4 MT in the summer of 2025 and is expected to provide an additional buffer of 3 to 4 weeks [9]. Although around 30% of China's LNG imports originate from Qatar and the UAE, the country's imports also come from Australia (34%), Malaysia (10%), Russia (9%), and the United States (6%) [10]. With large stockpiles and alternative supply, China is well-positioned to navigate short-term energy volatility, although it is still exposed to broader economic impact if the standoff at the Strait of Hormuz prolongs.

Countries with high dependence on energy imports are vulnerable to the immediate disruption in supply markets. It is estimated that the Gulf region supplies 75%, 70%, and 60% of the oil imports of Japan, South Korea, and India, respectively, as well as 6%, 14%, and 53% of

the LNG imports of these countries, respectively [11]. In fact, South Asian countries suffer the most from the shipping disruption at Hormuz, particularly with LNG supply. The LNG imports of Pakistan (99%) and Bangladesh (72%) are supplied predominantly by Qatar and the UAE, while these countries have poor storage capacity and procurement flexibility [11]. Besides crude oil and LNG, India also imports large volumes of liquefied petroleum gas (LPG) as a cooking fuel (>20 MT in 2025), with 90% sourced from the Gulf region [12]. While the combined stockpiles held by strategic reserves and commercial inventories for crude oil and petroleum products in March 2026 are reported to be sufficient for 74 to 90 days of consumption, India has a critically limited storage capacity for LPG, which can merely support 2 days of consumption [13].

The significant reduction in fuel supply, as well as the hikes in market prices, would lead to permanent or sustained decline in demand, which negatively impacts economic growth in the affected countries. Meanwhile, consumers would seek substitutes and alternative energy sources to adapt to the shortfall in supply and high costs. Although this rarely happens in the industrial and transportation sectors as alternative fuels are not readily available and/or technologies accommodating the substitutes for petroleum-based fuels cannot be easily switched to, the barriers for such change to occur in the residential sector, particularly household cooking fuel, barely exist. Faced with the difficulty in securing clean fuels and/or the higher costs caused by the standoff at the

Strait of Hormuz, rural households in South Asian countries have started to explore alternative cooking fuels, and the backslide in clean cooking is particularly manifest in India.

3. Setback for India's Clean Cooking Effort

Traditional fuels, including wood, coal, crop waste, animal dung, and kerosene, which are readily available and cheap, are widely used for cooking in developing countries, particularly by households in rural areas and with low income [14,15]. The combustion of such “dirty” fuels in simple stoves emits greenhouse gases (GHGs), as well as a range of incomplete combustion products, including particulate matter (PM), black carbon (BC), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and carbon monoxide, which negatively impact the climate and environment [14,15]. In particular, household fuel combustion is a key source of ambient PM_{2.5} (PM with aerodynamic size less than 2.5 µm), which is the leading environmental health risk factor worldwide [16]. It has been estimated that around 1/5 of the global ambient PM_{2.5} originated from indoor emissions [17]. In particular, household cooking with solid fuels had significant contribution to ambient PM_{2.5} in many regions, including India and China, and its contribution to population-weighted outdoor air pollution was as high as 10 µg/m³ in South Asia (vs. global average of 4 µg/m³) in 2010 [18]. It has also been estimated that household combustion of solid fuels was responsible for 58% of the global emissions of BC, a major short-lived climate pollutant with significant climate and health impacts, in 2020 [19]. Besides impacting the quality of ambient air, the accumulation of air pollutants in poorly ventilated indoor environment poses elevated health risks to the exposed population, mostly women and children. It was estimated that approximately 2.0 billion people in the world relied on traditional fuels and stoves for cooking in 2024 [20], while the associated household air pollution (HAP) caused approximately 2.9 million premature deaths in 2021, including more than 0.3 million children under the age of 5 [21]. The overall costs from damage to the climate and environment, human health, and women's productivity brought by cooking with traditional fuels and technologies worldwide amount to 2.4 trillion USD annually [19]. Improving access to affordable and clean cooking fuels, such as biogas, LPG, biomass pellets, and electricity, and technologies (e.g., high-efficiency cookstoves) not only mitigates climate change, reduces HAP, and improves public health, but also protects forests and biodiversity, and advances gender equity [14,15].

The Sustainable Development Goals of the United Nations set the agenda of providing universal access to

affordable, reliable, and modern energy services by 2030 under target 7.1. Despite the significant efforts devoted to the promotion of clean cooking by international organizations, such as the World Bank, IEA, and Clean Cooking Alliance (CCA), progress has been slower than desired and uneven, due to a multitude of challenges, including fast population growth, resource availability, and affordability [14,19]. Among the array of intervention policies and programs developed worldwide, the Pradhan Mantri Ujjwala Yojana (PMUY), which was launched by the Indian government in 2016, is the largest and most prominent one. Focusing on three pillars of clean cooking energy: affordability, accessibility, and adaptability, PMUY provides clean cooking fuel, specifically LPG, to women from rural and deprived households in India [22]. Its implementation has brought near-universal LPG coverage nationwide, with more than 31.4% of the 332.1 million active LPG connections receiving government subsidy by January 2026 [23]. The share of households using LPG as the primary cooking fuel has grown steadily from 16% in 2000 to 60% by 2024 [24], although the use of firewood for cooking is still common, particularly in rural households (Figure 4a). The success of India's clean cooking revolution not only improved the health outcomes for rural women, but also brought multiple co-benefits, including women's empowerment, forest recovery, and improved environmental sustainability [25,26].

It is worth noting that India's clean cooking strategy carries significant structural vulnerability, i.e., lack of diversity in cooking energy mix, limited domestic production and storage capacity, and heavy concentration of import routes. LPG has become the primary cooking fuel in most urban and rural households, accounting for 83.7% and 48.2% of the fuel consumption of cooking, respectively (Figure 4a). However, the fast expansion in LPG consumption in India was not accompanied by matching supply infrastructure growth, which seriously undermines its resilience (Figure 4b). Along with the fundamental shift in household cooking energy structure, the country's annual LPG consumption has jumped from 12.2 to 31.3 MT between 2009 and 2025 (Figure 4b), although the domestic production capacity remained at around 12.9 MT/year [27]. With limited production by domestic refineries, about 60% of the LPG consumption in India was met by imports. Approximately 90% of the country's LPG imports came through the Strait of Hormuz, with Qatar (34%) being the biggest exporter, followed by the UAE (nearly 26%), Saudi Arabia, and Kuwait [28]. The heavy dependence on foreign supply has exposed India to volatile global energy markets and geopolitical risk [29]. Furthermore, despite being a global leader in the distribution of cooking gas, India has paid little attention to the development of LPG storage facilities due to various technical, geological, and economic factors.

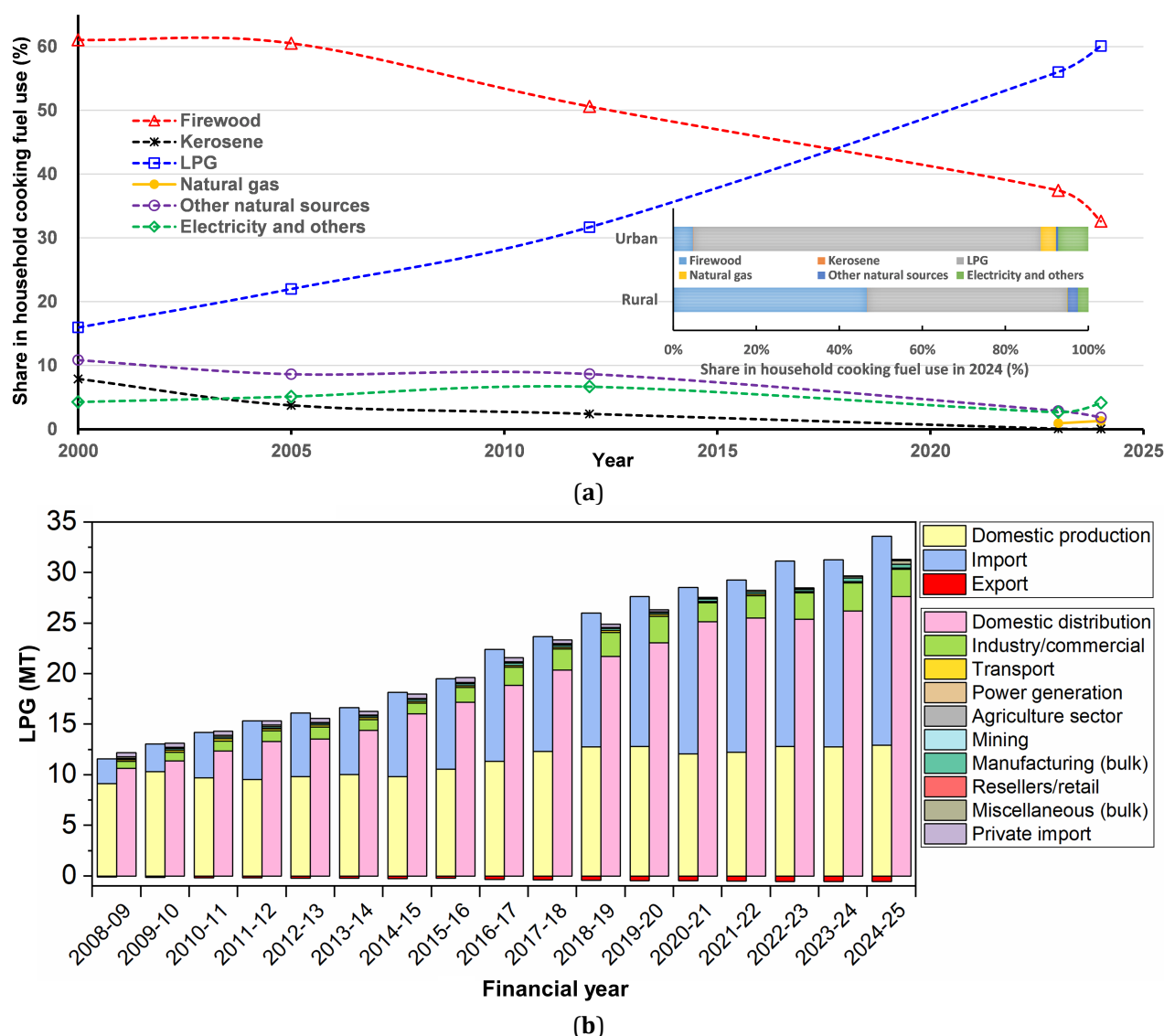


Figure 4. The growth of LPG use in household cooking and its supply and consumption in India: (a) Evolution of household cooking fuels over time, with the insert depicting the fuels used for cooking in urban and rural households in 2024 (data from [24]); and (b) Supply and consumption of LPG between financial year of 2008–2009 and 2024–2025 (data from [27]).

The disruption in fossil fuel shipping from the Gulf region due to the standoff at the Strait of Hormuz, together with the extremely limited strategic reserve (which is merely enough for 2 days of consumption), has resulted in wide shortage of LPG cylinders and price hikes in India [23]. As only less than 40% of the country's LPG consumption is met by domestic production, temporary shortage of LPG cylinders has occurred in megacities, including Delhi, Mumbai, and Chennai, after the closure of the Strait of Hormuz. LPG cylinder price has increased by 0.65 USD, which translates into an estimated 7% increase in household spending on cooking fuel [12]. The daily life and operation of millions of households, businesses, and industries were affected by the LPG supply crisis across the country. To safeguard the domestic supply, the government invoked the Essential Commodities Act, which requires the oil refiners to ramp up LPG production to offset import disruption, and prioritizes the LPG supply for residential use [12]. To lower the LPG demand,

connections of piped natural gas (PNG) were also expanded for households and commercial facilities to provide alternative energy supply. Accordingly, natural gas has been prioritized for the residential and transportation sectors, followed by industrial uses (e.g., fertilizer production) [12]. Supply of commercial LPG cylinders has been restricted to essential services, including hospitals and educational institutions, with the supply halt forcing the closure of many restaurants and hotels.

To ease the fuel shortage, the Indian government allocated the distribution of extra kerosene to support low-income households and approved the temporary use of traditional fuels by restaurants and hotels. As a result of the delays and uncertainty in LPG supply, together with the price hikes, some households, particularly those with low incomes, have temporarily reverted to kerosene, coal, and biomass for cooking, which represents a major setback for India's clean cooking effort [12,30,31]. The shortfall in supply has pushed businesses relying on LPG

as the primary cooking fuel, including restaurants, caterers, food outlets, school lunch canteens, and hotels, in multiple cities to shift to coal, firewood, diesel burners, oxy-fuel combustion technology, and electric alternatives to continue operating. The large-scale reversion to traditional fuels for cooking unavoidably increases the emissions of PM and gaseous pollutants, which cause pollution of indoor air and deteriorate local air quality. This backslide not only compromises the human health benefits from clean cooking, but also undermines the air quality and climate gains achieved by the implementation of the PMUY scheme in recent years. In addition, the increased demand for firewood/charcoal and biomass fuels would accelerate local deforestation and environmental degradation.

4. The Need for Transition towards a More Sustainable Cooking Fuel Mix in India

The standoff at the Strait of Hormuz has left the critical sea passage for fossil fuel shipping from the Gulf region to the rest of the world largely closed, and when the deadlock can be broken is uncertain. Thus, the shortfall in LPG supply in India will persist in the foreseeable future, which could drive continued switching to traditional fuels by households and commercial users and result in a significant backslide for clean cooking in the country. With near-universal LPG coverage achieved in India, the focus of the PMUY scheme has recently shifted towards supplying PNG as the long-term solution to clean cooking in both urban and rural areas, with a target of 125 million PNG connections by 2030 [27]. Accelerating the transition to PNG in urban areas was also taken as a measure to meet the ongoing LPG shortage. However, providing additional PNG connections for households and businesses requires expansion of the pipeline network. Such infrastructure development is costly in India due to the lack of demand for space heating, which is much greater than that for cooking in most countries. Furthermore, the country's natural gas supply also relies heavily on imports, mostly from the Gulf region as well. With both LPG and natural gas depending heavily on imports, the vulnerability to supply disruption and volatility of global energy markets not only compromises India's energy security, but also exerts substantial financial pressure [29]. Besides challenges in sourcing and procurement, market volatility, and logistics of transportation, high costs are associated with the expansion of LPG and LNG infrastructure, such as onshore terminals, storage facilities, liquefaction plants, regasification units, pipeline networks, and refueling stations, to increase their access to residential and commercial users [32,33]. In addition, reforms in trade and import policies, pricing mechanisms, and market regulations are necessary to enhance their competitiveness and expand market penetration in India [34].

While measures on ramping up domestic production, exploring alternative LPG import sources, and prioritizing the supply to the household sector could help ease the cooking fuel shortage in the near term, accelerating the transition towards a clean fuel mix with reliability and resilience will prevent the occurrence of similar crisis and backslide in clean cooking in the future. Securing the supply of LPG through alternative import routes to reduce dependence on the Gulf region, combined with expansion of domestic production and storage infrastructure could help buffer against geopolitical risk and seasonal uncertainty. More importantly, India needs to gradually diversify the cooking fuel mix and strengthen its energy resilience by unlocking non-fossil resources alongside existing ones, which can also support the country's climate goals and reduce air pollutant emissions.

Local availability is a crucial consideration for the choice of cooking fuels in remote areas, where ensuring regular fuel delivery without additional cost can pose a significant challenge. Crop residue and cattle dung, which used to be burnt directly as cooking fuels in rural households, have been steadily displaced by LPG with the successful implementation of the PMUY scheme. Such biomass resources, which are abundant in rural areas, could be utilized as the feedstock for biogas production in anaerobic digesters ranging from household to community scale, although adequate technical support for their maintenance should be established. Experience from China indicates that, with a well-fostered biogas production market, biogas produced from animal waste and agricultural waste could serve as a reliable, low-cost, and sustainable cooking fuel for millions of rural households [35,36]. While solar cooking has been identified as a viable and sustainable cooking alternative with distinct economic, environmental, and health-related benefits, its adoption across India and Asian countries is unsatisfactory so far [37]. A series of technical, socioeconomic, political, and environmental barriers need to be overcome, while policy support and economic incentives are also necessary for its wide adoption [37,38].

In urban and peri-urban areas with reliable grid infrastructure, electric cooking, which is cheaper than non-subsidized LPG and PNG, is widely believed to be a forward-looking and cost-effective alternative to LPG/PNG [29,30]. Electric cooking has multiple advantages, including high energy efficiency (up to 90%), low operating costs, and no generation of HAP, and can reduce the generation of GHGs from cooking with the growing penetration of solar and wind energy in the grid. Cooking device subsidies, incentives to manufacturers, consumer awareness campaigns, and demonstration projects could facilitate public adoption of electric cooking, and thus unlock its full potential in reducing the dependence on imported fossil fuels and alleviating the financial pressure from rising fuel subsidies [29].

Based on the analysis of household surveys and focus group discussions conducted in three northern states and two megacities in India, a recent cost dynamics study found that scaling up the adoption of biogas in rural areas and electric cooking in urban and peri-urban households can significantly reduce LPG imports and government subsidy burdens, and improve sustainability [30]. In particular, the operational costs of electric cooking were already lower compared to PNG and non-subsidized LPG, and the country's LPG imports could be cut by more than half by aggressive promotion of electric cooking alone [29,30]. Meanwhile, policy incentives, financial support, program design, and service delivery are necessary to improve the affordability and reliability of such non-fossil cooking solutions, which would reduce future risk and facilitate the clean cooking transition in India.

5. Implication for Other LPG-Dependent Countries in South Asia

LPG has become a crucial transitional energy source in many developing countries due to rapid urbanization and population growth, together with insufficient infrastructure for PNG. Driven by the rising demand from household cooking energy transition, commercial and industrial applications, and use as automobile fuel, fast growth in LPG consumption has occurred in South Asian countries, particularly India, Pakistan, and Bangladesh (Table 1). Subsidy initiatives have been established by governments and international organizations to promote LPG, which is affordable, clean, and easy to distribute, as

an alternative to traditional fuels for cooking and heating in major South Asian countries, including India, Indonesia, and Pakistan. The resulting shift to less polluting and carbon-intensive LPG in household cooking not only achieved significant public health outcomes by reducing HAP, but also contributed to improved sustainability.

Table 1 compares the demand and supply of LPG in India with those in other LPG-dependent countries in South Asia (i.e., Indonesia, Bangladesh, and Pakistan). While the consumption of LPG in these countries has been growing steadily, substantial shares of the demand were met by imports, mainly from the Gulf countries and the United States. As a result, the disruption at Hormuz caused supply shortage and price hikes in these countries, which affected clean cooking in households, although to different extents, depending on the sources of LPG supply. Similar to India, Bangladesh also depends heavily on imports from the Gulf region for LPG supply, although households in the country still rely mostly on biomass for cooking due to lack of government subsidy [39]. While clean cooking is most affected in India due to its structurally unique Hormuz exposure, that in other South Asian countries is also impacted, albeit to less extents. Obviously, transition towards a more sustainable cooking fuel mix is also necessary in these LPG-dependent countries. With appropriate institutional and financial support, shift to non-fossil clean cooking fuels would significantly boost the overall energy security and further improve the public health and environmental outcomes of clean cooking in South Asia.

Table 1. Comparison of LPG consumption and supply in India with those in other LPG-dependent countries in South Asia prior to the Iran War.

Country	Consumption	Main Uses	Supply Sources (Pre-War)	Key Drivers of Consumption Growth	Major Development Challenges	References
India	Total LPG consumption reached 31.3 MT in 2025.	LPG was primarily used as a cooking fuel (>85%); Industry and commercial use accounted for 8.6% of the total consumption.	About 40–45% of the LPG demand was met by domestic refineries, while imports accounted for around 60% of the total consumption; Gulf countries, including Qatar (34%), the UAE (nearly 26%), Saudi Arabia, and Kuwait were the major sources of India's LPG imports, and nearly all LPG coming from these countries had to pass through the Strait of Hormuz.	Greater energy need, especially for clean cooking fuels, brought by rapid urbanization; Shift away from traditional fuels in rural areas with expanded household access to LPG under the PMUY scheme; Growing commercial and industrial demand in replacing solid fuels under the government's push to reduce air pollution.	Price volatility and supply chain disruptions due to heavy dependence on imports affect affordability and complicate long-term planning; Geopolitical exposure from heavy concentration of import routes compromises long-term energy security; Substantial logistical and infrastructural investments are needed for improving the distribution networks and storage facilities, particularly for the rural areas.	[28,40]
Indonesia	Average annual LPG consumption exceeded 8.5 MT.	Residential sector (cooking and heating in urban and rural households) accounted for 55% of consumption; Commercial sector (mainly restaurants and small and medium enterprises), which widely adopted LPG due to its reliability and cost efficiency, accounted for 29% of consumption; Consumption by the industrial sector was relatively small (16%) due to the limited presence of LPG pipelines that could support high-demand industrial applications.	Annual domestic production was only 1.91 MT, while the import volume was approximately 7.47 MT/year; Around 70–75% of imports came from the United States, another 20% from the Gulf countries, and the rest from other countries, including Australia.	Growing population and urbanization; Rising household adoption of LPG; Extensive government subsidies and initiatives for clean energy.	Price volatility often results in temporary supply shortage or surcharges, which affect overall market stability; Limited pipeline networks limit large-scale industrial adoption, while their expansion needs substantial investment and regulatory approval.	[41–43]

Bangladesh	Annual consumption of LPG surpassed 1.5 MT.	Household use accounted for 80% of consumption; Industrial and commercial enterprises accounted for 12% of consumption; Transportation fuel accounted for 8% of consumption.	Annual domestic production of LPG was 0.3 MT, while the import volume was around 1.2 MT/year; Most of the LPG was imported from the Gulf countries (69%), including the UAE, Iraq, and Oman, while 22% was from the United States, and the rest from other countries.	Significant growth in household consumption was driven by declining local natural gas production and the halt in developing new residential pipeline connections by the government; The growth in industrial use resulted primarily from inconsistent natural gas supply.	New investments in the development of infrastructure (storage, bottling capacity, and distribution networks) and transport facilities are needed to meet the growth in LPG demand; Policy support from the government and significant participation by the public sector are necessary to expand the LPG market and increase its accessibility; Strong government support, investments, and infrastructure development are needed for large-scale industrial use of LPG as an effective alternative to natural gas.	[44,45]
Pakistan	Total annual consumption was estimated to be around 1.4 MT.	Residential sector (primarily for cooking and heating) accounted for 60% of consumption; Commercial sector (mainly hotels, restaurants, and catering services) accounted for 25% of consumption; Industrial sector (manufacturing, textile, and food processing) accounted for 15% of consumption.	Annual domestic production from natural gas processing plants was around 0.876 MT, with the rest of the demand met by imports; LPG was primarily imported from Qatar (71.3%), Iran (14.0%), Nigeria (6.5%), Iraq (4.9%), the United States (1.2%).	Rapid urbanization drove demand for clean cooking fuel, especially under the government's promotion of clean fuel in support of rural energy transition and environmental goals; Industrial and commercial sectors increasingly adopted LPG as a reliable fuel supply; Shortfall in natural gas created LPG demand hikes in winter.	Affordability is a major challenge for the adoption of LPG, as direct LPG cylinder subsidy for low-income households remains to be developed; Seasonal fluctuations in demand and price put significant constraints on the growth of the LPG market; Price deregulation and improved regulatory oversight are needed to ensure the stability of LPG supply; Significant investments are necessary for developing the upstream LPG production and extraction infrastructure, as well as the import infrastructure and supply chain; Policy measures are also needed to encourage long-term investments and promote healthy market growth.	[46–50]

Author Contributions

H.C.: Conceptualization, funding acquisition, supervision, validation, writing—original draft, writing—review & editing; T.J.C.: Conceptualization, data curation, formal analysis, visualization, writing—original draft, writing—review & editing; G.R.: Data curation, validation, writing—review & editing. All authors have read and agreed to the published version of the manuscript.

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Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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