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King Abdullah Petroleum Studies and Research Center

中国社会科学院工业经济研究所
INSTITUTE OF INDUSTRIAL ECONOMICS OF CASS

China's Policy Drivers of Future Energy Demand

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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Key Points

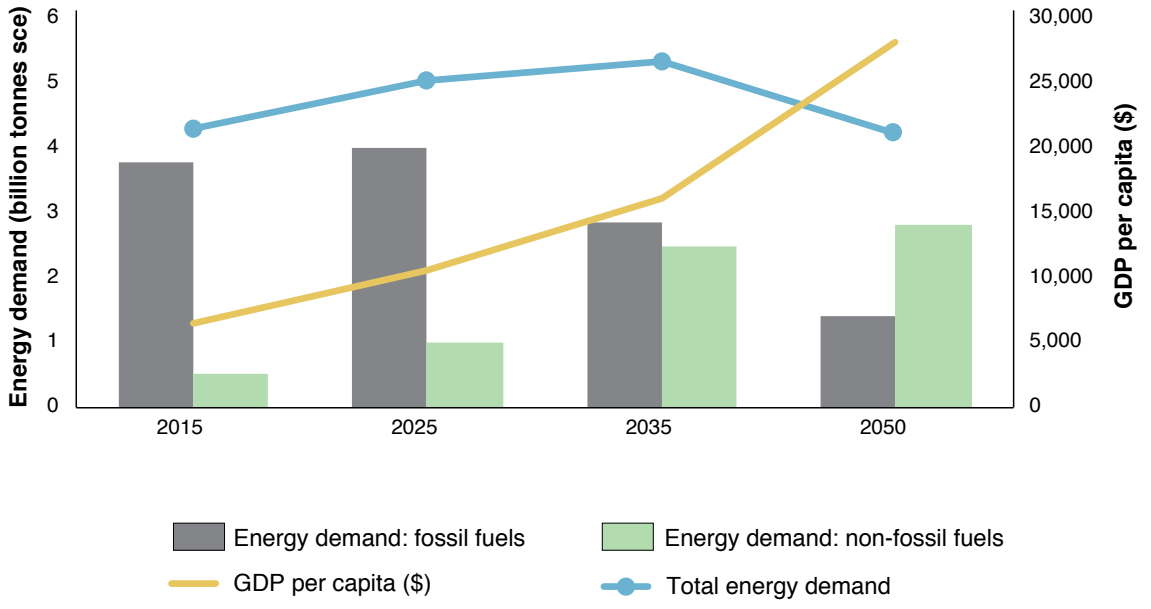
The recent slowdown in China's energy demand, primarily driven by decelerating economic growth and structural changes to its economy, has opened a window of opportunity for reforms aiming to establish a more sustainable energy sector and to increase the role of markets. These initiatives could have a significant impact on the country's future energy consumption and the structure of the energy sector, in turn affecting the global energy markets. They could also have an impact on China's environmental, energy security and long-term economic development goals.

The joint Institute of Industrial Economics, Chinese Academy of Social Sciences (IIE-CASS) and KAPSARC workshop "China's Policy Drivers of Future Energy Demand" held in July 2018 highlighted the following issues pertaining to the future of China's energy demand:

> Despite the consensus that China's future energy demand growth will decline, potential disruptive policy impacts and varying sectoral dynamics make estimating the peak demand level and the timing of the decline difficult.

> The decline in China's energy demand is unlikely to occur before 2030 due to macroeconomic trends and the significant costs associated with rapid fundamental changes to its energy mix. Until that time, China will have to continue relying on fossil fuels and focus on optimizing their use (see Figure 1 below for the graphical representation of this scenario).

Figure 1. China's energy demand peaks despite continued GDP growth.



Note: Demand measured in billion tonnes standard coal equivalent (sce).
Source: Workshop participants.

Key Points

Efficient and sustainable development of China's oil, gas and transportation sectors is hindered by structural problems and the remaining elements of the command-and-control system. Although deregulation may cause a short-term disruption, continued investment misallocation and growing discrepancies between the actual costs and regulated prices will increase the risks associated with executing such reforms in the future.

China's evolving approach to international energy collaboration, from securing supplies towards a more comprehensive collaboration, will have an increasing impact on its domestic energy demand. The transfer of China's industrial capacity and labor to Belt and Road Initiative countries and the establishment of new international supply chains and infrastructure will affect absolute energy consumption levels. Additionally, industrializing China's inland and border regions and the enhanced development of its low-carbon energy industry can shift its geographical patterns of energy demand and the structure of its energy mix.

Summary

China's energy demand has been rising rapidly since the early 2000s and has followed the country's robust economic growth trend. The transition to a 'new normal' – less extensive and more sustainable – economic development has slowed the pace of energy consumption and has shifted the country's policy priorities from merely meeting its energy needs to managing energy demand and targeting a more sustainable fuel mix. Respective energy and industrial policies, ongoing reforms in domestic energy markets and an evolving international energy strategy play an increasingly important role in shaping the future level and structure of China's energy demand.

There is a wide spectrum of projections of the trajectory of China's future energy demand. The National Development and Reform Commission expects primary energy consumption to stabilize by 2050. A study by the China Academy of Social Sciences forecasts a reduction in total demand to 4 billion tonnes of coal equivalent (tce) by 2020, whereas the China National Petroleum Corporation, an oil major, has recently moved its peak demand estimation from 2035 to 2040. The proposed paths to achieve certain absolute demand levels also vary significantly. While there is a general consensus that the current energy mix in China is suboptimal and could be improved, there is no unanimous vision of the future optimal energy demand structure.

Such variety of energy demand targets and projections derives from a number of competing economic, environmental and energy security priorities associated with the development of the Chinese energy sector. Aggressive demand curtailment policies and significant rapid changes to the existing energy mix, such as the forced deployment of renewables, can enhance societal benefits and help meet a number of policy objectives including increased energy independence and international leadership on climate change. However, the costs associated with such transformation programs can be prohibitive, destabilizing the economy in the short run and even having a negative long-run effect on future growth.

The need to balance the pace of energy transformation with its potential impact on economic development makes executing any major shifts in China's energy sector before 2030 difficult. By that time China is expected to have overcome the so-called 'middle-income trap,' which will present the opportunity for more ambitious renewable energy penetration targets and further economic development through energy transformation. It has been suggested that, until then, the priority should be given to coal consumption control measures, moderate stimuli for renewable energy development, and the promotion of technologically advanced high value-added industries.

China faces a number of problems specific to particular energy sectors and domestic fuel markets, besides its strategic fuel mix dilemma. Most of these issues stem from the remaining partial legacy of the command-and-control system, which impedes the efficient allocation of resources and distorts market signals. This regulatory hangover results in demand distortions in the oil and gas sectors due to price interventions, limited access to private and foreign capital in the upstream sector and inefficient third-party access mechanisms to midstream infrastructure. In the transportation sector, implicitly subsidized road freight and rigid railway freight tariff systems prevent the more energy efficient and environmentally sustainable railway sector from fully realizing its comparative advantages in the Chinese market.

Though deregulating these sectors may create a short-term disruption, with consumers exposed to the marginal costs of supply, removing those layers

of monopoly pricing would present an increasingly greater risk for both suppliers and consumers. Investment misallocation and discrepancies between the actual costs and regulated prices will only worsen over time, especially as China will rely on the global market to bridge its increasing demand. Thus, the window of opportunity to implement the needed reforms to achieve associated long-run gains at an acceptable price may be limited.

Since China initiated its 'opening up' policy, its domestic energy market has become increasingly affected by its foreign economic relationships and global markets. China's priorities in international energy cooperation were initially driven by increasing energy demand and energy security considerations and have become mostly focused on securing energy imports and obtaining control over foreign energy assets. China's international strategies are evolving toward a more comprehensive collaborative approach, evident in the new priorities of the Belt and Road Initiative (BRI). Its energy strategy will also embrace new dimensions such as infrastructure and supply chain development, the growing emphasis on green low-carbon energy cooperation, and establishing new energy governance mechanisms.

The dynamics of the BRI collaboration will have significant implications for China's domestic energy demand. Its absolute levels will be affected by the transfer of China's industrial capacity and labor to the BRI countries and by the creation of new international supply chains and infrastructure, especially in the borderland regions. On the other hand, industrializing inland and border regions and enhancing the development of its low-carbon energy industry could shift China's geographical patterns of energy demand and the structure of its energy mix.

Background to the Workshop

Spurred by extensive economic growth, China's energy demand grew rapidly in the first decade of this century, averaging a 9.3 percent increase per year from 2001 to 2011 (CEIC 2018). In recent years, export-driven energy-intensive industries have lost their status as the single major driver in China's economic growth. This has led to a significant decline in energy intensity and the deceleration of energy demand growth – to an annual increase of just 2.5 percent on average. This slowdown has opened a window of opportunity for Chinese policymakers to initiate a number of reforms aiming to establish more sustainable energy production and consumption patterns and to increase the role of markets in its domestic energy sector.

While issues such as pricing mechanisms, sufficient subsidy levels and overcapacity remain to be addressed, the effect of these initiatives is already evident in changes to China's energy mix. The share of coal in total consumption peaked in 2009 at 71.6 percent, followed by a peak of 4.24 billion tonnes in absolute terms in 2013. Over the last decade the share of more expensive but less polluting natural gas has doubled to 7 percent, accompanied by the penetration of renewables.

Shifts in China's energy demand trends and its fuel mix also have significant implications for the global fuel markets due to the magnitude of Chinese energy imports. In 2017, China imported 420 metric tons of crude oil (ITC 2018), surpassing the United States as the top importing country. Its liquefied natural gas (LNG) imports have grown by an impressive 94 percent in just over two years, making China the second highest importer of LNG globally. China's current and proposed energy policy initiatives on the sectoral, national and international levels, along with other economic, technological and population-related drivers will affect domestic demand for specific fuels and energy sources, and its trade and investment patterns. These factors will create opportunities and challenges for energy exporting partners such as Saudi Arabia and other participants of the Belt and Road Initiative (BRI).

The Institute of Industrial Economics, Chinese Academy of Social Sciences (IIE-CASS) and KAPSARC organized a workshop to identify potential impacts that existing and future policy initiatives might have on China's energy demand and international energy cooperation. Over 30 experts in the energy domain, industry representatives and other stakeholders explored the following issues during a two-day roundtable discussion:

- China's macroeconomic and industrial policy outlook.
- Current and potential sectoral and fuel-specific policy developments.
- Challenges facing China on its path to a market-based sustainable energy sector.
- The future dynamics of China's energy imports and the role of energy in China's foreign relations.
- Sino-Saudi energy cooperation opportunities within the BRI framework and beyond.

Towards Sustainable Energy Consumption and Energy Mix

Despite China's significant progress in economic development and market-oriented reforms since the launch of its 'opening up' program, the country still lags behind developed economies in a number of socio-economic indicators, such as gross domestic product (GDP) per capita or median income. The path taken by China to reach its current development level also resulted in a high level of energy intensity in its economy and, consequently, in high energy consumption in absolute terms. Additionally, China has yet to complete its industrialization and urbanization processes, which will likely increase its currently moderate per capita energy consumption levels. These trends indicate that China's energy consumption is poised to increase, at least in the short- to medium-term.

The Energy Supply and Consumption Revolution Strategy, released by the National Development and Reform Commission (NDRC) in 2017, sets a 5 billion tonnes of coal equivalent (tce) energy consumption target for 2020 (more than a 10 percent increase from 2017 consumption) and a 6 billion tce cap for 2030 (NDRC 2016). According to the document, primary energy consumption is expected to stabilize by 2050.

There is a wide spectrum of opinions among subject matter experts regarding the future trajectory of China's energy demand. A study by the China Academy of Social Sciences expects a reduction in total demand to 4 billion tce by 2020 (Reuters 2017a), whereas the oil major China National Petroleum Corporation (CNPC) has recently moved its peak demand estimation from 2035 to 2040 (Reuters 2017b). Moreover, the paths to achieve certain absolute demand levels can vary significantly. From the supply side, projected energy demand can be met by various combinations of energy sources. These can be prioritized based on their availability, economic competitiveness, environmental sustainability, energy security and other economic, social and policy considerations. On the demand side, the pace of economic development, shifts in the country's GDP structure and sectoral energy efficiency improvements affect the energy consumption levels of various sectors of the economy, leading to varying peak levels and peak timing for particular fuels and energy sources.

While the consensus is that the current energy mix in China is suboptimal and could be improved, the proposed optimal future states of the energy sector and the pathways to these states tend to differ significantly. Workshop participants discussed several scenarios for future Chinese energy demand and the implications for its fuel mix:

- The 'Fossil Energy Optimization' scenario projects an increase in natural gas consumption of up to 10 percent of primary energy demand by 2025 and up to 15 percent by 2050. Under this scenario, the share of fossil fuels in China's energy mix will amount to 75 percent by 2025 and 60 percent by 2050.

- The 'Renewable Energy Path' scenario emphasizes active penetration of non-fossil energy sources, which would result in an increase of the share of renewables in the primary energy mix to 20 percent in 2025 and 60 percent in 2050.

- Under the 'Nuclear Energy Path' scenario, nuclear energy will account for 15 percent of the energy mix in 2025 and 40 percent in 2050.

- Finally, the 'Balanced Mix' approach proposes that the energy mix will comprise an equal share of coal, oil and gas, and non-fossil energy.

These scenarios reflect different, often competing, priorities. Significant rapid changes to the existing energy sector structure, such as the aggressive deployment of renewables, can enhance societal benefits and meet a number of policy objectives, including increased energy independence and international leadership in the climate agenda. However, the costs associated with such transformation can destabilize the economy in the short run and have a negative long-run effect on future growth. For example, the Renewable Energy Path scenario would have a substantial economic impact, leading to an extended recovery period for the Chinese economy. Therefore, analyzing the energy sector transformation paths requires not only estimating the costs associated with each potential scenario but also quantifying whether the economic system can absorb these costs, and what the program's long-run impact on economic growth and key sustainability indicators is?

This approach can help find a balance between short-term stability, which can be achieved at a lower cost but may result in marginal, if any, long-run improvements, and a more expensive and potentially disruptive path to achieving long-term strategic goals.

Energy demand in China or any other economy is driven by a number of economic, population and technological factors, as well as by policy initiatives that may have a direct or indirect effect. Certain non-energy and non-economic policy targets, including environmental, geopolitical or security considerations, can impact the country's future energy mix. China is also deeply integrated into the global economy and dependent on the international energy markets. As such, its energy economy is affected by its international policies and global economic engagement and is vulnerable to national and international 'black swan' events.

The workshop participants emphasized the importance of the following drivers and trends: The dynamics of economic growth and its structural shifts will remain a major driver for China's energy demand. The official GDP growth projections for 2016-2021 are bound within a 6.5-7 percent range, similar to actual GDP growth since 2015. This represents a substantial reduction in GDP growth from the double-digit figures reported during the previous decade. The economic transformation that increased the share of higher value-added industries and refocused China's economy away from export-driven growth to domestic consumption has had a positive impact on the country's energy efficiency. The reduced role of energy-intensive sectors in the economy and a decline in embedded energy consumption from the export-oriented industries have also contributed to increasing China's energy efficiency. However, this effect is likely to fade as China progresses into the later phase of industrialization. The reduction in energy demand from energy-intensive industries such as iron and steel, cement, and non-ferrous metals will be partially compensated by the increase in energy consumption from the logistics and transportation sectors, driven by the growth of the tertiary sector and residential consumption.

Population growth is another factor contributing to the projected increase in China's energy consumption. It is estimated that a 1 percent increase in its population could lead to a 0.46 percent increase in energy demand. At present, China's share of residential energy consumption is well below that of developed countries: 11 percent compared to between 20-40 percent. Residential energy demand is poised to grow, both in absolute terms and as a share total China's energy consumption, due to increasing standards of living, continued urbanization and rural revitalization strategies.

A number of studies have estimated to what extent capital and labor can substitute energy as an input factor for the Chinese economy. While the substitution elasticity for capital and energy was generally found to be relatively high, the substitution elasticity for labor and energy was consistently below 1. This indicates that such substitution policies would have a marginal effect, despite the abundance of labor resources in China. It also indicates that capital investment plays a major role in reducing energy consumption. Energy conservation measures, such as mandatory energy efficiency standards in transport, construction and industries, already successfully employed by China, provide an example of such capital/energy substitution policies.

The advantage of energy conservation policies is that they tend to be less obstructive to economic growth than other demand-side management measures such as mandatory capacity cuts in energy-intensive industries such as steel or cement, for example. Economic growth and energy consumption were found to demonstrate a one-way Granger causality, meaning that energy consumption does not cause economic growth and, thus, energy conservation will not obstruct it.

However, not all policies that affect China's energy consumption and energy mix are entirely economically motivated. Policy areas that have other drivers include energy security and energy self-sufficiency. The Energy Supply and Consumption Revolution Strategy outlines an 80 percent energy self-sufficiency target for 2020. Meeting and maintaining this level could be challenging for the Chinese energy sector, given China's current 70 percent dependence on oil imports and its ever-increasing reliance on foreign natural gas supplies. The strategy also sets aggressive environmental and climate targets, including a 15-18 percent reduction in air pollutants by 2020 and a peak in carbon dioxide (CO_2) emissions by 2030 (NDRC 2016).

Although these policies indicate strong support for developing renewable energy and reducing the share of fossil fuels in China's energy mix, the pace of these changes is constrained by their associated costs and the potential impact they might have on economic growth. The necessity to balance economic, environmental and energy security priorities has led experts to assert that any major shifts in China's energy sector would be very difficult to execute in the short- and medium-term, and that such changes should not be forced or expected before 2030. By that time, China is expected to have overcome the so-called 'middle-income trap,' when the competitive advantage of cost-efficient export-oriented manufacturing diminishes due to the rising costs of labor and other inputs but is not yet developed in the higher value-added sectors. Any significant increase in energy costs would make this transition process more difficult.

Under these economic and policy constraints, the path to an optimal fuel mix evolution can be derived from the particular components of the four scenarios presented above:

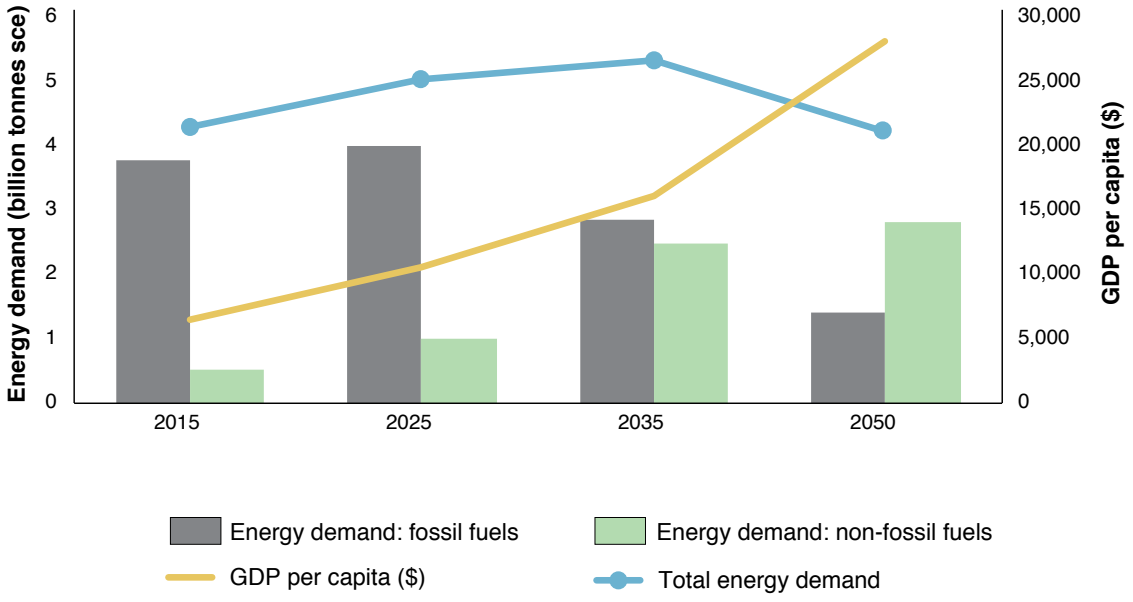
> Until 2025, fossil energy should still play a leading role. The policy priorities for this period may include control of coal consumption (minding the potential negative economic consequences for the coal-producing regions), moderate renewable energy development incentives and the promotion of technologically advanced high value-added industries.

Between 2025-2035, China should be able to achieve more ambitious renewable energy penetration targets if it has reached a sufficiently high economic development level, optimized its industrial structure and overcome the middle-income trap. Such an energy transformation would contribute to further economic development.

From 2035 to 2050, China can reach two major energy transition milestones: (1) 60 percent renewable energy in China's primary energy consumption; (2) 100 percent renewable energy supply in certain areas.

This transition path (see Figure 1 for a graphical representation) can be facilitated by the development of nuclear energy, viewed by a number of experts as an optimal mid-term solution, especially for the coastal provinces.

Figure 1. China's energy demand peaks despite continued GDP growth.



Note: Demand measured in billion tonnes standard coal equivalent (sce).
Source: Workshop participants.

Future Dynamics of China's Energy Subsectors

Fossil fuels will retain their dominance in China's fuel mix, at least in the short- to medium-term. Understanding development trends in the oil and gas sectors is important not only for Chinese domestic energy demand dynamics but also for the respective global fuels markets, given China's significant share in the global oil and gas trade. The workshop agenda included a discussion on China's transportation sector, considered one of the main areas of competition for traditional and new energy sources.

Peak oil demand deferred due to the strong demand for gasoline and the robust performance of the petrochemical sector

The share of oil in China's primary energy consumption has been relatively stable at near to 19 percent. In recent years, it has generally followed the total energy consumption pattern, its average annual growth rate falling from 7.3 percent in the early 2000s to 4.5 percent during 2011-2017. The resulting current absolute consumption value in 2017 was 610 million tonnes per annum (mtpa), second only to the United States (U.S.), about 70 percent of which China had to import due to its stagnating domestic production.

Aside from its increased dependence on foreign suppliers, oil consumption in China raises a number of environmental concerns. The increasing share of oil consumption has led to higher pollution levels from the transportation and petrochemical sectors. Vehicle pollution has contributed to significant levels of particulate matter 2.5 ($PM_{2.5}$) emissions, reaching over 50 percent share of total $PM_{2.5}$ emissions in some provinces, while increased activity in the petrochemical sector has contributed to rapidly growing plastic waste. The projected peak oil demand, primarily driven by fuel substitution in the transportation sector, was supposed to alleviate these issues. However, analysis of the oil demand drivers indicates that peak demand may arrive later than anticipated.

Strong development prospects for the petrochemical industry and mixed demand signals from the transportation sector will likely push peak oil demand in China beyond 2030. This comes despite the projected slowdown effect on oil demand growth from the two major macroeconomic drivers – GDP and population growth – coupled with progress in substitution technologies.

Steady demand growth and stagnant domestic production result in strong projected growth for Chinese oil imports. The increasing accumulation of strategic and commercial oil reserves (+13.5 percent in 2017 compared to 2016) and deregulating access to imported oil for independent refineries, currently responsible for 140 mtpa of imported crude oil out of a total 400 mtpa, also support this trend. On the negative side, oil imports may be affected by stringent environmental policies such as the 'clear sky policy' enforced in certain regions.

Favorable market dynamics and the energy industry's partial deregulation have led to certain shifts in sectoral investment trends. Private companies have started playing a more significant role in a market previously dominated by state-owned enterprises (SOEs); internationalization is gaining traction, with a number of joint venture projects in the refining and petrochemical sectors; and increasing numbers of integrated projects (refining and petrochemical complexes) are being launched. However, generally, the industry remains heavily regulated by the government, with a number

of control mechanisms still in place, especially in the upstream sector. These control levers include price interventions in the oil product markets, limited access to private and foreign capital in the upstream sector, and inefficient third-party access mechanisms to midstream infrastructure.

Further market-oriented reforms could alleviate the Chinese oil sector's problems. Opening up access to oil exploration and development could revive China's domestic production and increase its energy independence. Enabling private companies to access midstream infrastructure and global oil markets would reduce excessive investment and future overcapacity in refineries and midstream infrastructure. Finally, relaxing price controls on oil products will enable consumers to see their true marginal costs, thus providing better supply-demand balancing mechanisms than manual price adjustments, potentially increasing the competitiveness of other energy sources, and providing investment incentives to SOEs and other market participants.

Deepening market reforms to realize the potential of natural gas

In 2017, China's gas consumption reached 241 billion cubic meters (bcm), an increase of almost 16 percent from the previous year and the first time gas demand growth in China was in double figures since 2013. The question remains whether this surge is a short-term rebound or the beginning of a strong sustained growth period.

The government's coal-to-gas switching policy played a significant role in this demand rise. It aimed to improve air quality nationally, particularly in the key regions such as the Beijing-Tianjin-Hebei area, the Yangtze River Delta and the Pearl River Delta, and has led to increased natural gas consumption in the industrial, power and heating, and residential sectors. A 5.5 percent reduction in the citygate prices mandated by the NDRC in 2017 has also stimulated additional demand. And China's strong economic performance in 2016-2017 enabled industrial users to increase their consumption of natural gas even with deregulated pricing.

Imports have played a significant role in fulfilling the rising demand for gas. Notably, imported LNG volumes saw a 46 percent annual increase in 2017. The average utilization of LNG terminals reached a record high of 67 percent of the nameplate capacity in 2017. At present, imports account for almost 40 percent of Chinese gas consumption (CEIC 2018) and this ratio is poised to increase further. According to estimates, China will need to import 21 mtpa of additional LNG in 2020 and 45 mtpa in 2030, in addition to the existing contracted volumes, if its demand for gas continues to rise.

However, this uptrend momentum in the natural gas industry may still be insufficient to meet the ambitious development targets set by Chinese policymakers. Experts estimate that gas demand could reach 320 bcm by 2020 and 500 bcm by 2030. Although this forecast implies healthy growth rates, resulting figures still fall short of the official targets set for these years. Despite its relatively high cost and the fact that its use increases import dependency, natural gas is considered to have many societal benefits, especially environmentally, and Chinese regulators prefer it over other fossil fuels. The 13th Five year Plan and the Energy Supply and Consumption Revolution Strategy propose an increase of the share of natural gas in China's energy mix to 10 percent in 2020 and above 15 percent in 2030 – a significant increase from the recent 6-7 percent levels.

Reliance on macroeconomic drivers such as industrialization, urbanization and economic growth,

and the existing policy stimuli that target specific demand segments may prove insufficient in the long run. Inefficiencies in the current state of the natural gas industry value chain and a complex regulatory framework that comprises market-based and administrative mechanisms are major impediments to the sustainable development of the sector.

Producers in the upstream segment have limited ability to pass costs down to their end-users due to price caps on certain types of demand. This impedes the development of new deposits, including unconventional reserves such as shale gas plays in the Sichuan basin. The monopoly ownership of assets in the midstream, including pipelines, underground gas storage facilities and import terminals, is creating inefficiencies in investment allocation and hurdles for increased gas usage. Lack of efficient third-party access to infrastructure is causing a flurry of new LNG terminals to be built despite the current 67 percent utilization rate of existing facilities. Price caps applied to citygate consumption and pipeline deliveries also induce market participants to alter their logistics decisions in order to be able to supply deregulated market segments, leading to increased costs. Price controls also distort the allocation of natural gas between consuming sectors. Subsidized urban and rural residential demand redirects limited gas supplies away from more economically beneficial industrial consumption.

Analysis has shown that price deregulation and efficient third-party access would not only reduce total midstream costs and the reliance on imported LNG, but it would also lower the long-run marginal costs at consumption locations. The resulting marginal cost would even fall below the current price caps in a number of regions due to optimized delivery costs and better access to cheaper supply sources. These findings raise the question of whether future growth of natural gas demand is impeded more by resource constraints or policy hurdles.

China's gas market deregulation can help identify and unlock the potential of the country's natural gas. However, the window of opportunity to implement the needed reforms may be limited. Investment misallocation and discrepancies between the actual costs and regulated prices will only exacerbate over time, especially as China increasingly relies on global markets to bridge its increasing demand. Deregulation may create short-term disruption, with consumers exposed to the marginal costs of supply. However, removing the layers of monopoly pricing would present an increasingly greater risk for both suppliers and consumers, making it more difficult for China to balance the short-term costs and long-run gains associated with a more sustainable energy mix at acceptable prices.

A suboptimal transportation structure impedes pollution and fuel demand containment

China's transportation sector has been rapidly developing in recent years, reflecting the pace of the country's economic growth. The sustainable development of transportation is integral to China's ongoing economic transformation toward an increased role for the tertiary sector. However, the sector's historic structural and regulatory legacy, exacerbated by its rapid growth, has exposed a number of problematic issues, including traffic congestion, associated pollution, rising fuel demand and increased CO_2 emissions. The transportation sector produces over a quarter of all China's air-polluting emissions; in urban areas this proportion can be much higher. Transportation has also recently bypassed industry as the country's number one CO_2 emitter.

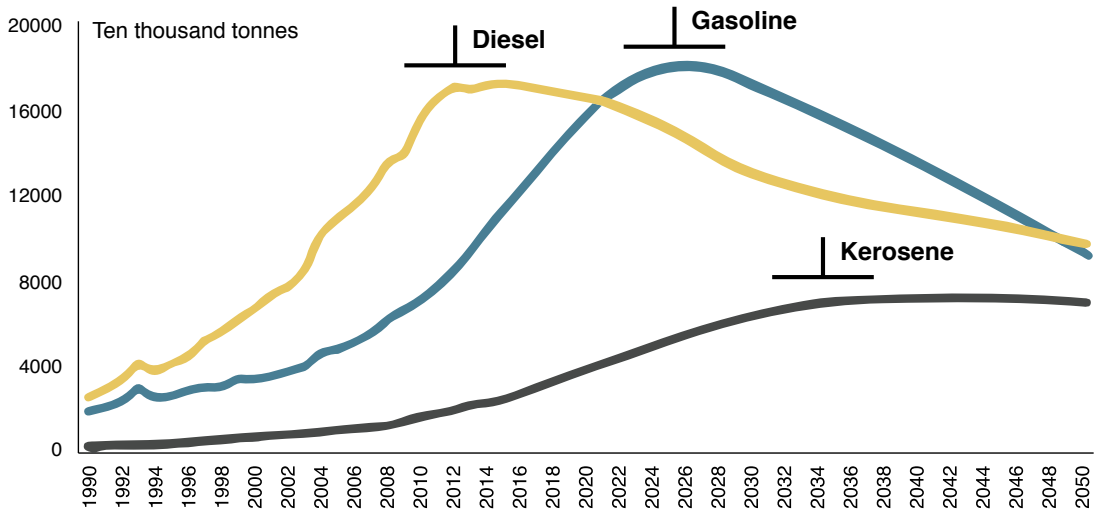
These problems are to a large extent caused by the suboptimal structure of the sector, especially in the freight segment. Although the less energy-consuming

and polluting railway segment has seen increasing freight volumes in absolute terms, its relative share of freight dropped from 13.2 percent in 2008 to 7.8 percent in 2017. China's freight market has not fully exploited the comparative advantages of railways. Illegal refitting, overloading and implied subsidies have made road transportation more affordable and led to the oversupply of road freight capacity, further reducing road freight prices. The rigid railway freight price control system reduces the ability of operators to respond to market signals by changing capacity allocation and investment decisions. Experts also cite the underdevelopment of intermodal transportation, poor connectivity of infrastructure and the inefficient development of hub stations and distribution systems as priority areas for improvement.

The structure of the transportation sector has important implications for energy demand. Road transport is currently responsible for over 85 percent of the energy consumed by all modes of transportation. By 2050, under the 'business as usual' scenario, total energy demand from transportation in China will exceed that of the U.S. as a whole.

The fuel/energy demand levels of subsectors of China's transportation industry are expected to follow different trajectories. The commercial vehicle fleet is likely to stabilize in the short- to medium-term due to structural changes in the Chinese economy, particularly the growth shift from the secondary to tertiary industries. Analysts expect a substantial increase in the passenger fleet: China's vehicle saturation point is likely lower than that of European countries or the U.S.; the latter has 910 vehicles per 1,000 inhabitants. The present level of car ownership in China – below 200 vehicles per 1000 inhabitants – leaves a significant opportunity for growth as per capita income increases. A similar trend should unfold in air traffic. China currently has 0.3 flights per person per year, compared with about 1.2 in the U.S. and the European Union. This gap should reduce in the coming years as China's travel and tourism sectors develop. These subsectoral dynamics will lead to varied peak demand times for major fuels (see Figure 2): diesel may have already peaked in 2015, gasoline should peak around the mid-2020s, and kerosene is not expected to peak before the mid-2030s.

Figure 2. Peak demand estimations for diesel, gasoline and kerosene.



Source: Workshop participants.

Improvements in fuel efficiency and the development of fuel substitution technologies will partially offset increased demand driven by macroeconomic factors. However, the consensus view may have overestimated the potential impact of new energy vehicles on fuel substitution. Despite significant progress in infrastructure deployment and growing sales, the costs of electric vehicles (EVs) are not expected to become economically competitive until 2030. Moreover, the Chinese government plans to phase out EV consumer subsidies in 2020. It is estimated that EVs will replace 4.03 million tonnes of oil equivalent (toe) in 2020 – just 1 percent of total domestic refined oil and 24.84 million toe in 2030, or 6.7 percent of total domestic refined oil.

Some of the measures proposed to curb energy demand and associated pollution from the transportation sector include:

- The optimization of transportation and storage of raw materials and semi-finished products in the industrial value chains.
- Developing the intermodal transportation nodes and improving connectivity.
- Reflecting the comparative advantages and externalities of different modes of transport in their prices; passing on the full cost associated with road transportation to consumers.
- Designing an EV subsidy policy targeted at lower-income consumers.

China's Energy Strategy Under the Belt and Road Framework

The Belt and Road Initiative (BRI), formally announced in September 2013, is a new chapter in the process of opening up the Chinese economy. In the past, China prioritized establishing economic relations with developed economies. The BRI suggests that China's international economic agenda has to an extent refocused on developing countries and emerging markets.

According to analysts, the BRI is driven by both international and domestic economic development priorities. From the foreign trade and investment perspective, the BRI can help to revive China's recently slowing exports. China would benefit additionally from this initiative if the products and services of the 'new economy' such as information technology solutions, e-commerce and other innovative technologies gain a larger share of its total exports. Developing economic relations within the BRI framework would also help reduce the dominance of the U.S. and Japan in China's foreign trade, stimulating Chinese outward direct investment and securing access to partner countries' natural resources.

The potential effect of the BRI on China's domestic economy could also be significant. Many see the BRI as a channel to transfer China's excess capacities and labor surplus that accumulated in the latter phase of its expansive economic growth. Chinese officials also emphasize the opportunity the country has to level off disparities in economic development between the coastal provinces and the lesser-developed inland provinces. The coastal provinces benefited most from China's foreign trade, investment inflows and participation in global supply chains, whereas the inland provinces could benefit from increased economic ties with BRI countries and an increase in associated infrastructure development.

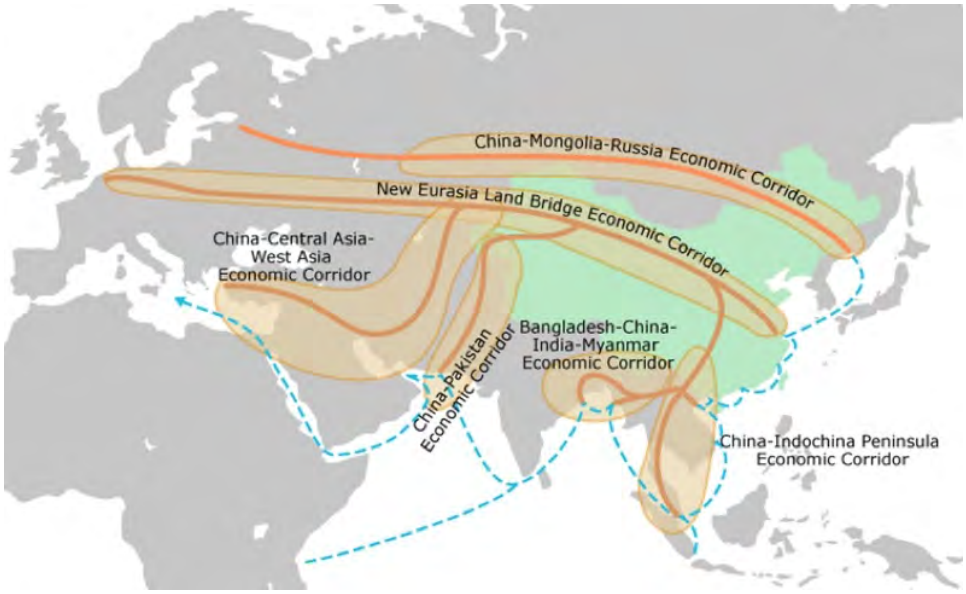
Energy trade and investment have historically been essential components of China's bilateral relations with a number of BRI participants. Many countries in the BRI possess significant fuel reserves. Some of these countries, such as Russia or Kazakhstan, also benefit from having a border with China. As China's energy demand surged following its rapid economic development since the early 2000s, so did its energy imports. At present, nearly two-thirds of Chinese oil imports, over 85 percent of gas imports and nearly 60 percent of coal imports come from the BRI countries.

Rapid energy demand growth and increasing import dependency have also fueled China's energy security concerns. This led to an increased allocation of the country's significant foreign exchange reserves to obtain control over energy assets abroad, primarily through investment in oil and gas upstream projects and midstream infrastructure. As a result, China created four interconnected strategic oil and gas channels directed at the domestic energy market:

- Northwest channel – crude oil and natural gas pipelines from Central Asia.
- Northeast channel – crude oil and planned gas pipelines from Russia.
- South channel – crude oil and gas pipelines through Myanmar.
- East channel – maritime oil and LNG import facilities.

These energy channels can be viewed as precursors of the BRI economic corridors shown in Figure 3, most of which have been laid out along the energy import routes.

Figure 3. Six economic corridors under the Belt and Road Initiative.



Source: Hong Kong Trade Development Council (HKTDC).

China's foreign economic strategy has evolved in recent years. This evolution has been reflected in the BRI's shifting agenda which now represents a broader, more comprehensive perspective on China's bilateral and multilateral relationships. The newly announced priorities of the BRI initiative include policy coordination, infrastructure and facilities connectivity, unimpeded trade, financial integration and developing interpersonal ties. Under this new framework, the traditional paradigm of China's foreign energy strategy – ensuring the security of supply through imports and direct investment – is also changing. Energy cooperation with BRI countries is expected to evolve in the following ways:

- From one-way bilateral limited energy cooperation to two-way multilateral and multi-level energy cooperation.
- From building regional energy cooperation mechanisms to building regional energy governance mechanisms.
- From emphasizing traditional fossil energy cooperation to prioritizing green low-carbon energy and focusing on the whole energy value chain.
- From individual to joint planning, and joint promotion of cooperative projects.
- From government-led cooperation dominated by SOEs to market-driven cooperation with active participation from both state-owned and private enterprises.

These changes in China's energy strategy have been seen in its energy investments in BRI countries since 2013. Despite the increase of China's outbound direct investment (ODI) in energy in absolute terms, its share in total ODI has dropped from 60 to 40 percent. The sectoral breakdown of BRI energy projects supported by loans from the China Development Bank and the Export and Import Bank reveals a preference for infrastructure projects, particularly in the power generation and transmission and distribution sectors, over those

targeted at securing foreign oil and gas supplies. The China-Pakistan Economic Corridor and the Polar Silk Road initiatives provide examples of how the energy component is incorporated into larger strategic infrastructure projects.

Not as much progress has been made so far in establishing the new energy governance structure. BRI participants, including China, still have to fully embrace the concept of regional energy security, and increase their reliance on market mechanisms over the command-and-control measures, to satisfy their national energy demand. This could confer significant potential economic benefits and collaboration opportunities in a number of domains, such as joint reserves stockpiling. China would also have to reassess its traditional preference for bilateral economic and energy cooperation. Establishing well-functioning multilateral governance platforms, such as the proposed Belt and Road Energy Club, might be impeded by a number of persisting disagreements between some BRI participants. However, experts see untapped potential for enhancing cooperation in existing multilateral governance mechanisms, platforms and organizations, such as the Shanghai Cooperation Organization, the BRICS Summit, the Asian Infrastructure Investment Bank and the New Development Bank.

The undergoing changes in China's approach to its international energy cooperation framework with BRI countries will have significant implications for its domestic energy demand. Historically, energy cooperation with BRI countries was viewed from the perspective of securing supply sources. Now it has the potential to become one of the key drivers of China's energy consumption. Potential effects on domestic energy demand may include:

- Reduced energy demand due to the transfer of industrial capacity to BRI countries.
- Increased energy consumption due to international supply chains and infrastructure development, especially in the borderland regions.
- Shifting geographical patterns of energy demand and the structure of China's energy mix by reallocating industrial development to inland and border regions, and the enhanced development of low-carbon energy supply chains.

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About the Workshop

KAPSARC's Markets and Industrial Development program held the workshop "China's Policy Drivers of Future Energy Demand" from July 23-24 in collaboration with IIE-CASS. Over 30 energy experts attended the event to discuss China's energy demand and fuel mix. Topics included oil and gas demand outlooks, focusing on energy mix; economic and policy drivers; uncertainties and potential shocks; transportation policies and energy consumption patterns; the energy dynamics of the Belt and Road Initiative; and Sino-Saudi cooperation opportunities in the global context.

List of participants

Fahad Al Othman – China Country Manager, Aramco Asia

Jan Ban – Senior Research Analyst, OPEC

Randolph Bell – Managing Director, Global Energy Center, Atlantic Council

Reed Blakemore – Associate Director, Global Energy Center, Atlantic Council

Dongmei Chen – Research Fellow, KAPSARC

Mike Chen – Visiting Fellow, Oxford Institute for Energy Studies

Rui Chen – Director, Department of Gas Market Studies, CNPC Research Institute of Economics and Technology

Rubal Dua – Research Fellow, KAPSARC

Philipp Galkin – Research Fellow, KAPSARC

Huiming Gong – Program Director, China Transportation Programme, Energy Foundation Beijing Office

Wenke Han – Senior Fellow, Energy Research Institute of NDRC

Zhao He – Director of China Office, IEA

James Henderson – Head of Natural Gas Programme, Oxford Institute for Energy Studies

David Hobbs – Vice President of Research, KAPSARC

Robert Johnston – Chief Executive Officer, Eurasia Group

Xiaoming Ke – Deputy Chief Engineer, Sinopec Economics and Development Research Institute

Yao Li – Executive Director, SIA Energy

Richard Lu – Director, Strategy and Policy Research, China National Petroleum Corporation

Limei Ma – Postdoctoral Researcher, Chinese Academy of Social Sciences

Xunmin Ou – Professor, China Automotive Energy Research Center

Bertrand Rioux – Research Fellow, KAPSARC

Rami Shabaneh – Research Associate, KAPSARC

Dan Shi – Deputy Director General, Institute of Industrial Economics, Chinese Academy of Social Sciences

Adnan Shihab-Eldin – Director General, Kuwait Foundation for the Advancement of Sciences

Brian St.Sauveur – Policy Research Consultant, Aramco Asia

Masakazu Toyoda – Chairman and Chief Executive Officer, Institute of Energy Economics, Japan

Becky Wang – Vice President, Department of Strategic Relations and Policy Research, Aramco Asia

About the Workshop

Nengquan Wang – Principal Researcher, Sinochem Economics and Technology Research Center

Zhen Wang – Deputy Director General, Policy Research Office, China National Petroleum Corporation

Zhongying Wang – Acting Director-General, Energy Research Institute of the NDRC

Kang Wu – Program Director for Market and Industrial Development, KAPSARC

Xun Xu – Senior Research Associate, KAPSARC

Fuqiang Yang – Senior Advisor on Climate and Energy, NRDC, Beijing

Xinjun Zhou – Deputy Director, China Academy of Railway Sciences

About the Team

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Dongmei is a research fellow focused on China-related policy studies and partnership coordination. She has more than 20 years' experience working in the energy and climate fields in China, including as head of the Institute of Industrial Productivity's China office and director of the Climate Change and Energy Program for the World Wide Fund for Nature in China.

Rubal Dua

Rubal is a research fellow working on vehicle regulatory policy and shared mobility research from a consumer perspective. He holds a Ph.D. from KAUST, Saudi Arabia, an M.S. degree from the University of Pennsylvania, and a B.Tech. from the Indian Institute of Technology, Roorkee, India.

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Philipp is a research fellow specializing in the economic and policy aspects of energy supply and trade. He holds a Ph.D. in International Economic Relations and an MBA.

Bertrand Rioux

Bertrand is a research fellow focused on developing energy systems models and researching market design and regulation. He holds a master's degree in marine science and engineering and completed his thesis on computational fluid dynamics at KAUST.

Rami Shabaneh

Rami is a research associate focusing on global gas and liquids markets. He has over 10 years of research and industry experience in energy market analysis. He holds an M.Sc. in Sustainable Energy Development from the University of Calgary.

Kang Wu

Kang is the former program director for Markets and Industrial Development, with many years of energy research and consulting experience. His research interests cover a variety of issues related to economic, energy (particularly oil and gas) and environmental developments in China and the rest of the Asia-Pacific region.

Xun Xu

Xun is a senior research associate leading the Center's China future transport energy demand project. His research interests include freight transportation, development economics, population economics and the Chinese economy. Previously, he worked at the East West Center and the University of Hawaii's Department of Natural Resources and Environmental Management.

About the Project

The Chinese economy is in transition, shifting from energy- and resource-intensive manufacturing to light and service industries with tougher environmental requirements. Meanwhile, growth is being led by domestic consumption. This economic transition has global significance.

The objectives of this research are to assess China's energy demand drivers, to better understand China's energy policies and energy security strategies, and to assess the implications of China's transition for Saudi Arabia and beyond.

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