

Implemented by



Supported by:



on the basis of a decision
by the German Bundestag

Energy security in Germany and China

Experience with and reactions to the 2021-2023 energy crisis in the context of the transformation of the energy system and achieving targets under the Paris Agreement

Working Paper of Sino-German Track II Dialogue on Climate Change and Sustainable Development





Executive Summary

Both individual and common conclusions can be drawn about the Chinese and German experience with the energy crisis. These provide common lessons learnt that can be useful in the ongoing energy transformation and for tackling the climate crisis.

1. Balancing Short-term Crisis Response with Long-term Strategy

The point of departure when the energy crisis hit was different for China and Germany. In China, there was a severe shortage of electricity supply in several regions, which determined the focus of the crisis response. Germany was most concerned with excessive prices and with avoiding a potential future supply shortage.

During the energy price crisis in 2021-2023 both China and Germany needed to reconcile their short-term crisis response with long-term targets. The common long-term considerations of both countries relate to their ongoing energy transitions and their plans to become climate neutral.

Though long-term climate goals and the transformation of the energy system are alike, mid-term considerations diverge between Germany and China. This leads to different assessments related to the demand for and supply of energy. Since economic growth is much faster in China than in Germany, the Chinese focus lies on satisfying additional demand caused by economic growth. Whereas in Germany, the focus is rather on demand reduction through energy efficiency and saving measures, as well as on the climate neutrality of the fuel mix.

In order to reconcile mid- and long-term goals with the short-term crisis response, it is important to find synergies between long-term goals and short-term measures. Priority needs to be placed with measures that serve the triple goals of securing supply, containing costs and achieving climate goals. Energy saving and energy efficiency measures are the most important candidates in this respect, as well as the development of renewables.

2. Security of supply

Renewables

Both China and Germany increased their efforts to expand renewables in the face of the energy crisis. For Germany, this was partly driven by EU initiatives and included better regulatory and financial support for renewables, in particular onshore wind and solar. Similarly, China has been vigorously promoting the construction of large-scale wind power and photovoltaic bases in desert areas and new energy projects in rural areas and industrial parks, and streamlined project management processes, as well as providing more incentives.

Fossil fuels

Coming out of a severe shortage of electricity, China placed the focus in the energy crisis on measures related to coal and coal-fired electricity and heat generation, whereas Germany was most concerned with shoring up gas supply and gas reserves.

Related to coal, China enacted a series of price, tax and financial measures aimed at increasing the capacity of coal mines, enhancing coal-fired electricity generation capacities and stabilising prices. Germany has a goal for phasing-out coal-fired power generation by 2030 and therefore allowed reopening of reserve coal power plants at limited capacity, for a limited time and only after taking into account the emissions impact of this measure.

Related to natural gas and oil, Germany took a series of immediate actions and strategic measures, including rapidly decreasing imports from Russia and securing imports for alternative sources, including through newly built LNG terminals. Measures implemented by China related to the exploitation of national reserves and contractual measures.

3. Demand side management and protection of vulnerable consumers

Germany sought to reduce demand in the short- and long-term by promoting efficiency and the reduction of energy consumption. To reduce energy consumption in the short term, Germany passed a number of regulations. To reduce energy demand in the long term and increase efficiency, Germany also set up new investment support and informational initiatives during the

energy crisis. It was possible to significantly reduce energy consumption in 2022, while growing economic output. This showed that increasing energy efficiency and behaviour-based energy savings are effective in practice.

China also attached great importance to promoting energy conservation and phasing out outdated production capacity in industries. For energy-intensive and high-emission projects, an approach of list management, classified disposal, and dynamic monitoring was adopted. Enterprises below the efficiency level have been suspended for rectification and been forced to improve energy efficiency. For industries that has saturated, the production capacity is reduced in accordance with the principle of "reduction and substitution". For industries that has not saturated, the entry threshold is raised in line with international advanced level. And for emerging energy-intensive industries, they are guided to implement green and low-carbon technologies to improve energy efficiency.

China aimed at protecting consumers through guaranteed supply of electricity and heat and elimination of unjustified fees and stabilising energy prices. Measures for consumers in Germany encompassed both measures aimed at the whole population, as well as targeted measures for low-income households. Measures included income support, price support, as well as support for increasing efficiency and lowering consumption.

Common lessons learnt

The point of departure determines the short-term crisis response. China faced severe short-term peak power shortages at the time and attached great importance to securing coal supply and orderly electricity consumption. Germany had put more emphasis on measures related to efficiency and the reduction of consumption, as well as on supporting households.

Learning from short-term measures for long-term strategies. Securing supply and supporting consumers will be important during the energy transition and in fighting the climate crisis. Good practices from the crisis response can be made permanent if they have proved successful. In both countries, short-term measures showed that instant results are possible if barriers are removed.

Finding synergies between long-term strategies and short-term crisis response. Expanding renewables, improving efficiency and reducing the demand for fossil fuels increases energy security and reduces GHG emissions. Both China and Germany placed a particular focus on

renewables as a crisis response. Short-term measures related to energy efficiency and energy savings in Germany showed that these measures are effective without hurting economic growth.

Efficient targeting of support measures. Germany targeted some measures at the most vulnerable groups, but the bulk of the measures provided support for all citizens. China targeted some measures at civil energy consumption in certain areas. In order to ensure efficient targeting of support measures, the countries need to be able to identify citizens in need and be able to reach them.

Efficiency first. In the spirit of the Efficiency first principle another learning is that reducing energy consumption and increasing efficiency through investments and information serves the triple goal of securing supply, reducing emissions and containing costs for consumers.

International collaboration. China and Germany ought to enhance communication and collaboration to collectively tackle global challenges like the energy crisis and climate change more effectively.

Introduction: The energy crisis 2022

In this working paper, we investigate how China and Germany reacted to the 2021-2023 energy crisis. We analyze the measures taken both on the supply-side and on the demand-side and reflect on the strategic elements of the reaction and how these reactions fit into China's and Germany's medium and long-term climate strategies. We compare the crisis response in China and Germany to derive common lessons learnt that take into account the specific circumstances in each country. We take an ex-post focus on the energy crisis which was most acute from 2021 to 2023 and derive lessons learnt that can also inform the ongoing energy transformation and efforts tackling the climate crisis.

Germany's reactions to and experience with the energy crisis

Starting in the second half of 2021, the prices of fossil fuels and in particular natural gas on European markets increased significantly. By December 2021 prices were 11% higher compared to 2020 (Figure 1). This price increase was mainly a result of the reduced supply of these fuels to Europe. The Russian war of aggression against Ukraine starting in February 2022 and the rapid decline of gas imports from Russia to the EU and Germany exacerbated the crisis. This led to a price increase of 127% over 2020 levels in November 2022. Since then, prices for natural gas have started to decline and stabilized in February 2022 at a level of 85% higher than in January 2020 (Figure 1).

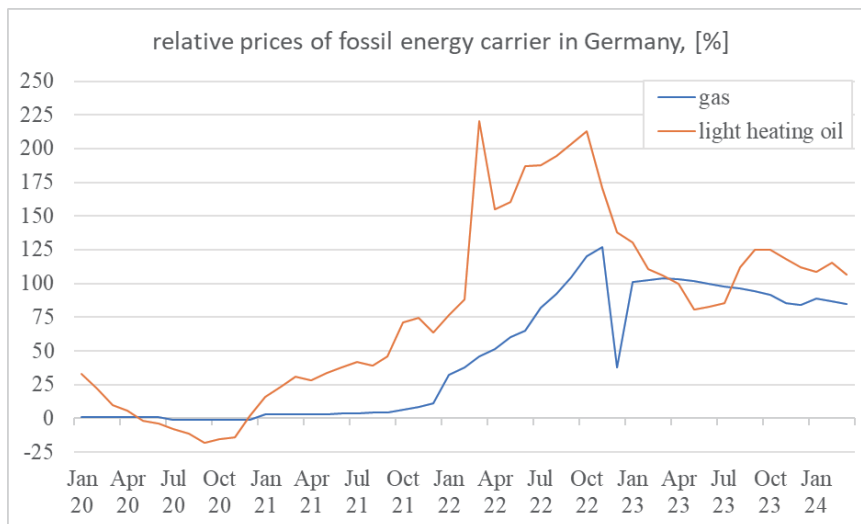


Figure 1 German prices of gas and light heating oil, relative price changes to 2020 in percent

Source: (destatis.de)

1. Measures related to energy security and energy supply

In response to the limited gas supply, Germany took a series of immediate actions and strategic measures, including rapidly decreasing imports of hydrocarbons from Russia and securing imports from alternative sources:

i. Oil and Gas

At the end of 2022, Germany reached an agreement with Kazakhstan to supply oil to Schwedt refinery at 1.2 MTP/a starting at the end of 2024 with potential to increase supplies going forward.

The German legislator allowed for the temporary provision of additional electricity generation capacity based on mineral oil (until March 2024) which had previously been part of the grid reserve capacity. Mineral oil electricity generation increased from 4.6 TWh in 2021 to 5.7 TWh in 2022.

Shortly after the escalation of the Russian war of aggression against Ukraine and the following gas supply disruptions, the German government significantly extended LNG supply infrastructure and secured LNG supply contracts to replace pipeline gas supplies from Russia (which were responsible for about 55% of German gas imports before 2022). A deal to import LNG was signed with Qatar Energy among other sources. Most of the spot cargoes of LNG in

2022 were imported from the US. Parallel to that, several LNG floating terminals were leased for the winter of 2022/23. To speed up the permit and construction process the government adopted the 'LNG Acceleration Act'. It should be noted that all new gas infrastructure is supposed to be 'hydrogen-ready' and designed to import green hydrogen in the future.

Another key measure to avert tight supplies included filling the gas storage facilities before the heating season of 2022/23. The agency in charge, Trading Hub Europe (THE), purchased gas on the spot market, and by November 2022 the German gas storage facilities were filled at 95% capacity. According to the newly passed "Gas Storage Act", German natural gas storage facilities must be filled with at least 95% capacity by 1 November of each year.

All those measures helped to stabilize the market and avoid a supply crisis. The EU launched several strategic measures to ensure the long-term supply of EU member states with gas, lower the risk of inflationary spiraling of gas prices on the global market and keep consumer energy prices stable. Measures included a "toolbox" to strengthen resilience against future shocks (Energy prices, eu). One of these measurements was to bundle the gas imports of the EU member states and buy gas as a union on the gas market, to prevent overbidding on the TTF.

ii. Coal

In 2021, the newly formed German coalition government signed an agreement that coal phase-out in Germany should be implemented 'ideally by 2030' (instead of 2038). Due to the energy crisis, in October 2022 the German government increased the amount of coal to be used for electricity generation for a limited time (until March 2024) to secure electricity supplies, and it passed the emergency "Substitute Power Plant Provision Act" to reopen reserve coal power plants to replace some gas-fired power plants. Reactivated lignite plants were operating at limited capacity and were allowed to stay online only until June 2023.

However, these temporary measures did not change the long-term phase out plans for coal. The major direction of German energy transition and long-term energy security strategy remains unchanged and continues to be focused on developing renewables and limit the use of fossil fuels. To assess the potential mid- and long-term impacts of the strategic measures taken, an electricity market modelling analysis was carried out before the decisions were taken.

iii. Nuclear power plants

Initially, the shutdown of the last 3 operating German nuclear plants was planned for December 2022. Due to the energy crisis, the nuclear power plants continued operation in stretch-out mode until 15 April 2023. Hence, the crisis also did not reverse the end of the nuclear power era in Germany.

iv. Renewable sources of electricity

Increasing the effort of building up renewable energy capacity and use goes hand in hand with the reduction of fossil energy carrier imports. Hence, Renewable sources of electricity (RES) were declared as of over-riding public interest in Germany and measures were taken on the European level to speed up the installation of RES capacity, which were transposed into the following German legislation on short notice:

- Faster permitting procedures for wind energy onshore and photovoltaics
- New regulations for repowering of ground-mounted photovoltaic plants
- Rooftop solar plants of up to 50 kW, which are used mainly for self-consumption, are assumed to be permitted, if the authority or the grid operator in charge does not contradict within four weeks
- The maximum capacity of ground-mounted photovoltaic systems, which are supported through tenders, was increased from 20 MW to 100 MW (from 2025: 50 MW).

2. Measures related to energy demand

To reduce natural gas consumption, two regulations were passed. The measures contained in the two ordinances were expected to save households, companies and the public sector EUR 10.8 billion in energy costs over two years.

The Ordinance on short-term measures to secure the energy supply regulated energy saving measures in the building sector for a period of six months from September 2022 to February 2023. It contained rules on maximum indoor temperatures in public non-residential buildings and obliged energy suppliers to provide information on price increases for utilities and for owners of residential buildings. Since October 2022, the Ordinance on mid-term measures to secure the energy supply regulates the optimization of gas-driven heating systems and the

implementation of energy efficiency measures which have been identified as economic during energy audits or by energy management systems in companies.

Both gas and electricity consumption fell noticeably in absolute terms in 2022: by 11.7% for gas and 3.4% for electricity compared to 2021, and by 8.6% for gas and 9.6% for electricity compared to 2008. All sectors (but the transport sector) reduced final energy consumption: Households by 5.5% (compared to 2008: -6.7%), industry by 7.8% (compared to 2008: -6.6%) and the trade/commerce/services sector by 6.6% (compared to 2008: -22.9%). Although industry had to cope with gas cuts, it reduced its energy consumption more than the gross value added: Gross value added fell less sharply (-0.5 percent compared to the previous year; +18.0 percent compared to 2008) than sector-specific final energy consumption (-7.8 percent compared to the previous year; -6.6 percent compared to 2008). Final energy productivity in industry therefore rose noticeably by 7.9% compared to the previous year, from EUR 1,318/megawatt hour (MWh) to EUR 1,383/MWh (compared to 2008: +26.3%).

It was possible to significantly reduce energy consumption in 2022 in all sectors except the transport sector. At the same time, the economic output of Germany's economy rose and that of the industrial sector fell only slightly while significant energy savings were achieved. Without the energy saving and energy efficiency measures taken by the population and companies, in the first winter of the energy crisis significantly more fossil fuels would have had to be burned and there would have been greater dependence on energy imports. Increasing energy efficiency and behavior-based energy saving are therefore not only central to the energy transition in theory but are also effective in practice.¹

3. Measures related to supporting consumers and vulnerable groups

At the end of 2021, the European Commission published a "toolbox" of appropriate measures to react to rising energy prices and protect consumers (European Commission 2021). Starting in early 2022, the German government adopted three relief packages with a volume of over EUR 100 billion to address the impacts of the energy crisis on consumers and vulnerable households (IW 2023, Oeko-Institut and FOES 2022). As a central relief measure the electricity, gas and district heating "price brakes" were put in place in 2023. For these price brakes, an additional EUR 200 billion were earmarked.²

-
1. It is not possible to attribute all of these outcomes to the energy saving measures taken ex-post. In addition to the energy saving measures the increased energy prices may have influenced energy consumption significantly (UBA 2024)
 2. However, not all of these funds were needed, as energy prices on wholesale markets dropped starting in 2023.

Many of the measures in the relief packages were temporary and are no longer in place. The packages offered a mix of different measures (Oeko-Institut and FOES, 2022):

- **Income support**

- Heating cost support for vulnerable groups (including students)

- Broad-based income support

- Income support for families

- One-off payments for people receiving social benefits

- **Price/expenditure support**

- Electricity, gas and district heating price brakes (designed as one-off payments)

- Abolishment of the renewable energy surcharge

- Reduced price tickets for public and regional transport (9 EUR/month)

- CO₂ price moratorium

- Reduction of the value added tax on gas

- **Reducing energy demand and increasing efficiency**

- Energy saving campaign

- Information campaign for vulnerable groups

- Optimisation of heating systems

- Changes in the investment support for building efficiency retrofits

Specific gas and electricity price brakes were introduced for industry and the commercial sector. This price reduction measure was coupled with efficiency and savings incentives: The price cap only applied to 70% of a company's historical consumption. For consumption in excess of this, the regular market price had to be paid. Therefore, companies were still encouraged to reduce their electricity and gas consumption to keep cutting costs. Furthermore, companies receiving more than EUR 50 million in support were obliged to submit a plan setting out the measures intended to improve environmental protection and security of supply.

At the level of households, the energy price crisis hit vulnerable groups particularly hard. Figure 2 shows while the lowest 10% of the income distribution spent 10% of their net income on electricity and heat in 2020, this rose to 13% in 2022. In 2023, due to lower energy prices,

the expenditure dropped to an estimated 11.5%. For the top 30% of the income distribution, expenditure on electricity and heat stayed below 5% of their net income both before the crisis and in the crisis.

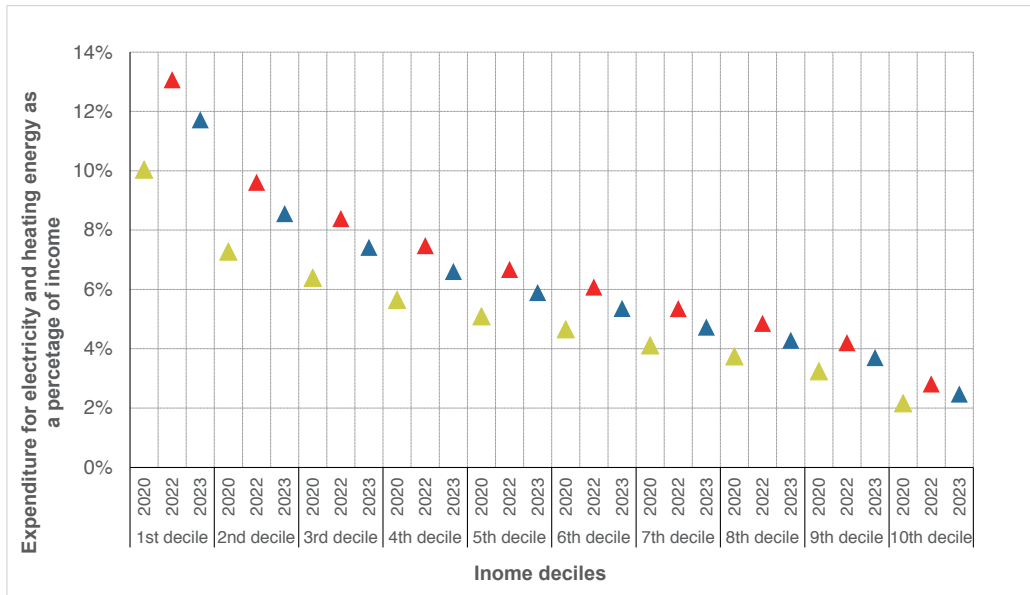


Figure 2: Expenditures on electricity and heat energy by German households by income group in 2020, 2022 and 2023

Source: Oeko-Institut based on the German Income and Expenditure Survey and relevant price information from BDEW, BMWK, BNetzA, Destatis

Measures aimed at households and related to direct income support include one-off payments to different segments of the population (working population, retired population, families, individuals receiving social benefits). Price-reducing measures enacted during the energy crisis in Germany include a moratorium on the CO2 price increase and reduction of electricity, gas, petrol and diesel price components that are controlled by the state. In addition to these measures, which were primarily intended to guarantee the affordability of existing fossil-fuel-based applications and transport options, the relief package also included measures that specifically promote low-carbon mobility: For 90 days, a nation-wide ticket for all public and regional transport was made available for EUR 9 /month.³ A number of energy saving ordinances

3. The instrument has been maintained to this day in a revised and adapted design. It is now available at the cost of 49 Euro/month. This example shows that short-term measures in response crisis can provide an impetus for long-term policy implementation, as I the case here in low-carbon public transport.

and campaigns were enacted that were aimed at reducing household energy demand and thus cost. The electricity and gas price brakes for households were also designed as a one-off relief payment based on the previous year's energy demand in order to keep the price signal and the incentive to save energy intact.

4. Summary: Germany's performance during the energy crisis

The measures enacted in Germany can be deemed successful in terms of securing supply and supporting consumers and vulnerable groups. The rapid response related to the diversification of fossil fuel imports, storage facilities and measures in the electricity sector ensured that the energy supply was secured at all points during the crisis.

The short and medium-term ordinances to safeguard energy also contributed to the success of the crisis response, as have the savings activities of the population and companies, the many energy-saving campaigns and the high energy prices. The energy policy should build on this, meaning e. g. to make the "Efficiency First" principle to the new normal, prioritizing the renovation of the worst buildings by means of mandatory minimum standards, energy saving obligations or white certificate systems for different sectors, a frontrunner approach for product efficiency, and an activating and prominently placed energy saving campaign. Energy-saving policy needs to be flanked by social policy to avoid energy-saving measures being associated with disadvantages for vulnerable groups, but rather lead to an improvement in the quality of life.

The relief packages and price brakes enacted in 2022 and 2023 were aimed at this type of support for consumers in general and vulnerable households in particular. Overall, the relief packages significantly reduced the burden for households caused by the drastic rise in energy prices. It is important to keep incentives and market forces alive. Therefore, income-supporting measures should be given preference over price-dampening measures for the relief measures required in the short term. In the long-term, only measures that achieve an overall reduction in fossil energy demand for vulnerable groups can insure against negative impacts of future price spikes.



China's Response to the Energy Crisis: Experience and Actions

Energy security plays a crucial role in driving overall economic and social development. During the 12th collective study session of the Political Bureau of the CPC Central Committee, General Secretary Xi Jinping underscored the imperative of fostering new energy sources while ensuring national energy security in a harmonized manner. He emphasized the ongoing commitment to the principle of prioritizing the adoption of new technologies before phasing out older ones. Furthermore, he highlighted the importance of striking a balance between new and traditional energy sources, as well as between national and local interests. He emphasized the need for effective coordination between governmental interventions and market dynamics. Moreover, he stressed the significance of concurrently advancing both energy development and the conservation and utilization of new energy resources. The overarching goal is to propel the high-quality development of new energy sources, thereby enabling China to play a more significant role in global endeavors aimed at fostering a clean and sustainable world.

Between 2021 and 2022, China faced persistent challenges in its power and coal supply and demand dynamics, that can be attributed to various factors. These include the notable surge in energy prices across the global market, precipitated by the ongoing Russia-Ukraine conflict. (Refer to Figure 1 for an illustration of China's energy imports.) More than 20 provinces have implemented electricity rationing measures in response to short-term power shortages. Particularly affected are the northern regions, grappling with challenging heating conditions, which are exerting notable impacts on both local economic activities and the daily lives of residents. Overall, a shortfall in short-term peak load supply is evident across most areas, albeit with varying causes contributing to power deficits. These include several factors: a notable decline in hydropower and wind power output attributed to climate change effects, a scarcity of coal for power generation stemming from years of capacity reduction initiatives and diminished power coal imports, reduced incentives for coal-fired power enterprises to generate electricity owing to elevated coal prices, rapid proliferation of energy-intensive and high-emission projects in certain regions, and an upsurge in electricity demand triggered by extreme weather events.

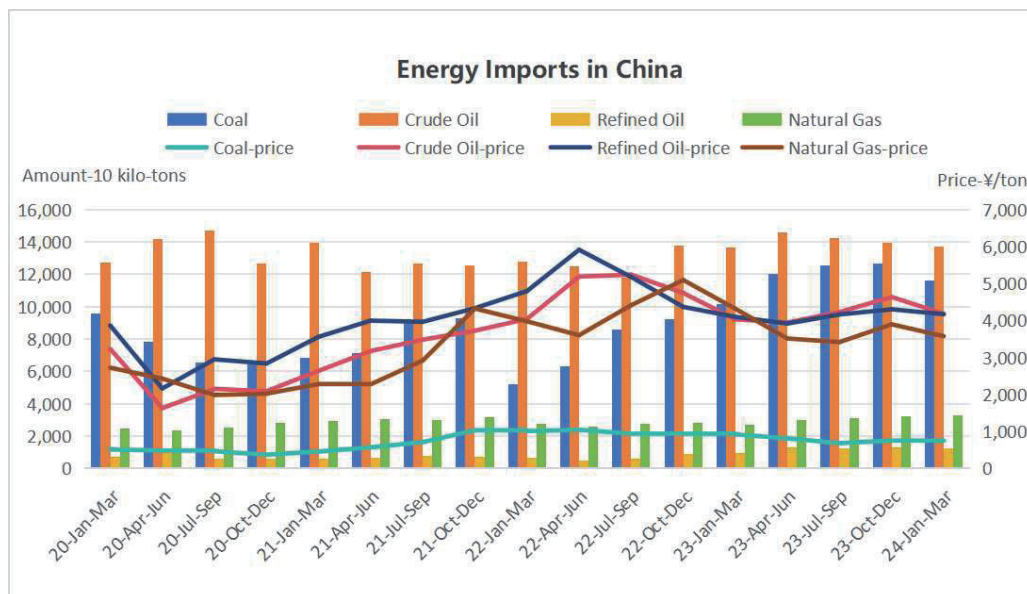


Figure 1 Energy Imports in China

Source: General Administration of Customs

1. Measures related to energy security and energy supply

Amidst the nationwide short-term power shortages, the CPC Central Committee, the State Council, and pertinent government bodies have promptly enacted policy measures. These initiatives aim to stabilize coal prices for power generation, rationalize the electricity pricing mechanism, ensure reliable electric power supply, and facilitate energy transition while ensuring energy security.

i. Maximizing the fundamental and underpinning role of coal

Since September 2021, the CPC Central Committee and the State Council have consistently stressed "the imperative of achieving energy self-sufficiency and independence for China". Energy security is intricately linked to both developmental and national security concerns, with supply shortages representing the most significant threat to energy stability. On October 8, 2021, during the executive meeting of the State Council, six key measures were proposed. These included adjustments to the floating range of market-traded electricity prices and the formulation of tax, financial, and pricing policies aimed at bolstering coal-fired power enterprises to enhance power supply capabilities. The executive meeting emphasized the imperative of rigorously implementing the responsibilities of all stakeholders concerning

energy supply and workplace safety. It mandated key coal-producing provinces and enterprises to undertake measures aimed at boosting production and supply capacities. On October 20, 2021, during the executive meeting of the State Council, additional measures were proposed to tackle speculation in the coal market in accordance with the law. The meeting also advocated for the enhancement of the pricing mechanism for coal-fired electricity and the exploration of a market-oriented pricing mechanism integrating coal and electricity. Furthermore, the National Development and Reform Commission and the National Energy Administration have introduced several policies aimed at ensuring supply stability and price stabilization.

- Stabilizing coal prices. Addressing the abnormal surge in coal prices following the winter peak requires reinforcing supervision and guidance over futures and spot markets to manage expectations effectively. Moreover, efforts should be directed towards restoring the dominant futures contract for power coal and ensuring that spot prices for 5,500-kcal power coal at Qinhuangdao Port return to a reasonable range.

- Ensuring supply of coal for power generation. With a primary focus on security, coal mines in critical regions should be encouraged to expedite the deployment of high-quality production capabilities. Enhancements to the assessment system for coal reserves in power plants are imperative, alongside prompting localities and enterprises to elevate their coal storage capacities. Additionally, heightened endeavors are warranted to fulfill the transportation capacity requirements for medium- and long-term contracts pertaining to coal for power generation. This entails addressing transportation bottlenecks across railroads, highways, and ports in a synchronized manner. Furthermore, targeted supply assurances should be extended to nearly 100 electric power plants with low inventory levels.

- Ensuring supply of thermal power. Effective implementation of policies such as tax deferral, rebates, reductions, and financial assistance is crucial to alleviate the challenges faced by coal-fired power enterprises. Additionally, there is a need to introduce measures aimed at deepening the market-based reform of feed-in tariffs for coal-fired power generation. This entails orderly liberalization of feed-in tariffs for all coal-fired power generation, expanding the floating range of market transaction prices, and fully establishing mechanisms for power grid agents to purchase electricity. Furthermore, establishing a regular working mechanism to verify unplanned shutdowns of generating units and disruptions in generated output is essential. Other imperative steps include rationalizing the planning of installed capacity for new coal-fired power plants and intensifying the efficient and clean upgrading of existing coal-fired power generation units.

- **Ensuring energy for heating.** Building upon the assurance of implementing signed medium- and long-term coal contracts, there is a necessity to coordinate coal enterprises in Shanxi, Shaanxi, and Inner Mongolia to fulfill the 150 million tons of medium- and long-term contracts with national power generation and heating supply enterprises. This concerted effort aims to achieve comprehensive coverage of medium- and long-term coal contracts for these enterprises. Special attention should be directed towards guaranteeing coal supply for heating purposes in the northeast and northern regions.

ii. Ensuring stable supply of natural gas and oil

China, being a significant importer of natural gas, is inherently impacted by global market dynamics. However, Long-Term Agreement (LTA) gas with a lower price accounted for the majority (78%) of imported gas. Although the spot price of imported Liquefied Natural Gas (LNG), constituting 22% of the total, is heavily influenced by the international market, its limited import volume has not significantly affected the overall pricing of natural gas in China. Consequently, natural gas prices in China remained relatively stable throughout 2021-2022. Measures implemented by China to ensure stable natural gas supply: facilitating the signing and rigorous enforcement of medium- and long-term natural gas contracts, proactively allocating resources in advance and adhering strictly to contract terms to ensure stable gas supply and consumption; intensifying efforts to bolster nationwide exploration and development initiatives, thereby fostering increased domestic natural gas reserves and production. This fortifies the foundation of domestic resources to guarantee sustained natural gas supply; expediting the establishment of a diversified and secure import supply system to ensure the safety and stability of imports; advancing the market-based reform of the natural gas sector and enhancing the operational efficiency of the pipeline network through improved scheduling mechanisms.

From 2021 to 2022, China's external oil dependence remained high, accounting for approximately 72%. The surge in international oil prices and the significant increase in the cost of crude oil imports led to a decline in imports in 2021, accompanied by a rise in costs.

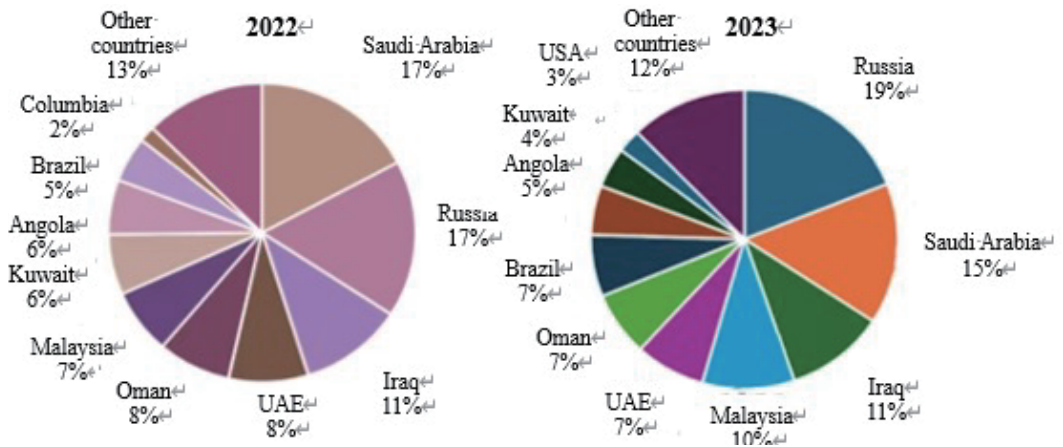


Figure 2 China's Primary Sources of Crude Oil Imports

Source: General Administration of Customs

In 2021, China's crude oil imports totaled 512.98 million tons, marking a 5.4% decrease compared to the previous year. However, the total import value surged by 34.4% year-on-year, reaching RMB 166.18 billion. Measures implemented by China to ensure stable oil supply: increasing domestic exploration and development efforts to enhance the effective supply of domestic crude oil. This includes augmenting investment, optimizing operational plans, and boosting reserves and production capacities; diversifying sources of imports (refer to Figure 2 for details).

iii. Vigorous developing renewable energy

It is imperative to accelerate the advancement of renewable energy and establish a new energy framework conducive to phasing out fossil fuels.

- Emphasizing both distributed and centralized approaches to facilitate the development and utilization of renewable energy sources.

The construction of large-scale wind power and photovoltaic bases, with a focus on desert areas, the Gobi, and other desert regions, must be accelerated. Efforts should be intensified to support the rapid development of new energy projects, such as distributed photovoltaic and decentralized wind power installations, in rural areas and industrial parks. Additionally, innovative models like green microgrids for the industrial sector, which integrate sources, grids, loads, and storage, as well as direct power supply from renewable sources, should be actively promoted. Furthermore, pilot projects for

green power trading need to be initiated, and institutional innovations in the organization of green power trading, grid scheduling, and pricing mechanisms should be promoted.

- Accelerating the establishment of a new type of power system. Efforts should be expedited to construct a new type of power system. This entails systematically optimizing the spatial and temporal layout of sources, grids, loads, and storage to comprehensively enhance the regulation capability and flexibility of the power system. The overarching goal is to continuously improve the overall capacity of the power system to integrate new energy sources and enhance the capacity of the distribution network to accommodate distributed new energy installations.

- Consistently encouraging the involvement of new energy sources in power market transactions. At the heart of power market regulations lies the assurance that the participation of new energy sources can yield predictable returns on investment. Therefore, it is crucial to incentivize long-term electricity purchase and sale agreements. Additionally, new energy projects should be encouraged to engage in power market transactions through contracts for differences, particularly in the designated pilot areas of the spot electricity market.

- In terms of policy mechanisms, there is a pressing need to reinforce the implementation of the responsibility weighting system for the absorption of electricity from renewable energy sources. The national-level responsibility weighting should progressively increase each year, while the weights assigned to provincial governments and market entities responsible for absorption should also rise or remain consistent annually. Furthermore, it is imperative to gradually reduce regional disparities in these weights. Notably, the new consumption of electricity from renewable sources will not be factored into the local assessment of total energy consumption.

- Streamlining the project construction management process. Enhancing the efficiency of project approval and simplifying project management procedures are essential objectives. The investment approval (filing) system for new energy projects requires refinement, while transitioning the approval system for wind power projects to a filing system is recommended. Additionally, for integrated energy projects centered around new energy sources, such as those involving a balanced energy mix, source-network-and-storage configurations, as well as micro-grid projects, approval (filing) procedures can be consolidated for a more efficient handling process.

2. Measures related to energy demand management

To reduce energy demand during the period of electricity shortage, China has been actively taking measures to strengthen the demand control and management.

- **Demand Response.** In January 2022, the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) issued the Opinions on Improving the Institutional Mechanisms and Policy Measures for Green and Low-Carbon Energy Transition. The latter put forward measures to improve the demand response mechanism in the power sector, promoting the inclusion of demand-side adjustable resources in the power balance, broadening the scope of implementation of power demand response, and supporting user-side adjustable resources and virtual power plant operators to participate in electricity market and power system operation. Consumers are encouraged to voluntarily adapt their consumption behaviors in line with the operational demands of the power system. This helped facilitate peak shaving and valley filling, thereby enhancing the flexibility and stability of the power system.

- **Orderly electricity consumption.** Some provinces and cities in China issued orderly electricity consumption work plans and proposals to maintain the normal order of power supply and consumption, and ensure the power supply of residents and other key users. Measures include setting electricity consumption quotas, arranging collective overhaul among high-energy-consuming enterprises during the summer times, stopping the electricity consumption of urban landscape lighting and outdoor advertising in shopping malls and stores, and rescheduling construction activities to avoid peak hour. Families and communities are encouraged to save electricity, charge electric vehicles at night, and reduce the use of elevators and air conditioners.

- **Electricity conservation.** In 2021, the National Development and Reform Commission and other departments issued the "Several Opinions on Strict Energy Efficiency Constraints to Promote Energy Conservation and Carbon Reduction in Key Areas" and "Advanced and Basic Energy Efficiency Standards for Key Areas of Energy-intensive Industries (2021 edition)", to promote energy-saving and carbon-reduction in high-energy-consuming industries. Measures include carrying out energy efficiency surveys on existing projects and establishing two enterprise energy efficiency lists: one for enterprises whose energy efficiency reached the advanced level (Advanced Energy Efficiency List), and the other for those who did not reach the basic level (Backward Energy Efficiency List). Guiding the orderly phaseout of inefficient production capacity, requires strictly implementing the "Guidance Catalogue for Industrial Structure Adjustment" and

other regulations, and resolutely eliminating backward production processes, technologies and equipment. In addition, government bodies carried out special energy-saving supervision to strengthen the supervision and inspection of the implementation energy efficiency standards in enterprises and to ensure that policy requirements are strictly complied with.

3. Measures related to supporting consumers and vulnerable groups

Aligned with the directives of the CPC Central Committee and the State Council concerning energy supply security and price stability, China's foremost obligation is to consistently uphold the principle of prioritizing people's livelihoods and safeguarding the baseline of energy consumption for citizens. Key measures encompass:

- Firmly ensuring energy utilization for people's living and heating during winter.

Adherence to the principle of prioritizing people's livelihoods is imperative to guarantee the utilization of coal for power and heat generation, particularly during winter in the northeast. In September 2021, the National Development and Reform Commission explicitly mandated that medium- and long-term coal contracts directly provide insurance and full coverage for power generation and heat supply enterprises. Furthermore, endeavors should be undertaken to elevate the proportion of medium- and long-term contracts for these enterprises in annual coal consumption to 100%.

- Prioritizing livelihood security in orderly electricity consumption programs.

Between 2021 and 2022, provinces and cities including Shanghai, Shandong, Hebei, Liaoning, Ningxia, and Shenzhen issued plans for orderly electricity consumption. These plans underscore the importance of prioritizing people's electricity consumption and emphasize the restriction of electricity usage by high-energy-consuming, high-emission industries.

- Rectifying unjustified fees and charges.

In the urban gas sector, five government agencies, including the National Development and Reform Commission, collectively issued the Opinions on Rectifying and Standardizing Fees and Charges in the Urban Water Supply, Electricity Supply, Gas Supply, and Heating Sectors to Promote High-Quality Development. This initiative aims to extensively eliminate unregulated fees and charges within the gas sector.

In July 2021, the National Development and Reform Commission (NDRC) issued the "Notice on Further Improving the Time-of-Use Electricity Pricing Mechanism", which encouraged the northern region to formulate seasonal electricity pricing policies for electric heating, and promoted further reduction of the cost of electricity for clean heating, so as to effectively secure

residents' needs for clean heating in winter. The time-of-use electricity pricing policy for residents was further promoted to gradually widen the price gap between peak and valley electricity prices. In October 2021, NDRC also issued the "Notice on Further Deepening the Market-based Reform of Feed-in Tariffs for Coal-fired Power Generation", which helped to provide residents and the agricultural sector with stable electricity prices and more low-cost power sources.

4. Summary: Chinese performance during the energy crisis

- Adhering to the principle of building the new before discarding the old is crucial during the energy transition. The phase down of fossil fuels should occur through safe and orderly substitution with renewable energy.
- Vigorously promoting the high-quality development of new energy is paramount for ensuring energy security, overcoming developmental constraints, and advancing the transition to green and low-carbon development, ultimately achieving the "dual-carbon" goal. It is neither feasible nor advisable to revert to coal-fired power.
- The extensive development of new energy imposes greater demands on the power system's flexibility. Hence, expediting the construction of a new type of power system characterized by integrated source, grid, load, and storage becomes imperative. Addressing the intermittent and volatile nature of wind and photovoltaic power generation is crucial.
- China and Germany ought to enhance communication and collaboration to collectively tackle global challenges like the energy crisis and climate change more effectively.

During the twelfth collective study session of the Political Bureau of the CPC Central Committee, General Secretary Xi Jinping underscored the imperative of actively advancing clean energy and facilitating the transition to green and low-carbon economic and social development. This aligns with the prevailing consensus within the international community aimed at addressing global climate change. It is imperative that we align ourselves with this trend and intensify efforts to promote the high-quality development of China's new energy sector. By doing so, we can ensure safe and reliable energy security for Chinese-style modernization and make significant contributions to the creation of a clean and beautiful world.

(Authored by the Working Group 1 of Sino-German Track II Dialogue on Climate Change and Sustainable Development)