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King Abdullah Petroleum Studies and Research Center

How to Achieve Economic Prosperity Through Industrial Energy Productivity Improvement

September 2017 / KS-2017--WB08

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.

Legal Notice

Key Points

The King Abdullah Petroleum Studies and Research Center (KAPSARC) and the Energy Research Institute (ERI) of China's National Development and Reform Commission (NDRC) have initiated a joint study into how industrial energy productivity can improve economic prosperity. This study comes at a time of deeper bilateral cooperation under President Xi Jing Ping's One Belt One Road Initiative and aims to increase understanding of key policies and driving forces around industrial strategy and energy use in Saudi Arabia and China.

Enhancing industrial energy productivity through energy efficiency and diversification has multiple benefits including supporting competitiveness and higher quality jobs while reducing the environmental impact of production.

China has enormous experience capturing these benefits through its system of national energy intensity targets, industrial energy efficiency benchmarks and energy price reform.

The Kingdom has set out ambitious plans in its Saudi Vision 2030 to reduce the economy's reliance on oil through a program of privatization, diversification, renewable energy, energy efficiency and energy price reform among other initiatives.

Greater efforts to share international experiences in energy productivity can play an important role in supporting investment conditions aimed at achieving economic transformation and sustainable development goals.

Summary for Policymakers

While the energy economies of China and Saudi Arabia differ in many respects, they are similar in that both countries have rapidly growing economies that are in transition. In both countries the industrial sector accounts for the majority of energy demand at around 66 percent and 60 percent, respectively, compared with industry consuming around 40 percent of total energy globally. The question of how industrial energy productivity supports economic growth is thus of particular importance for sustainable development in both countries. The insights from this workshop are organized around five main themes:

What is the added value of focusing on energy productivity?

When considering which factors of production drive economic growth, labor and capital are often emphasized, while energy is simply incorporated into 'other resources' or 'materials' of production. However, given the critical importance of energy and the dramatic shifts underway in how we secure, price and use it, there is a strong case to focus on how energy supports economic growth, from both technical and policy perspectives. Energy productivity is an emerging policy agenda focusing on how energy can best be used to create value in the economy, and it also incorporates a number of specific indicators that integrate economic performance and energy consumption. As an indicator, its connotations differ at the macroeconomic and microeconomic levels. At the macroeconomic level, energy productivity is equivalent to its mathematical inverse of energy intensity – or how much energy it takes to produce a unit of gross domestic product (GDP). At the microeconomic level, energy productivity focuses on the revenue produced per unit of energy consumed by a company or sector. Energy efficiency, on the other hand, is generally focused on the output produced per unit of energy consumed (e.g., GJ/tonne of cement). Because of this difference, energy productivity provides a better foundation for industrial policy than a sole focus on energy efficiency does. Energy productivity more strongly incorporates industrial upgrading and structural reform, as well as energy efficiency.

What are the key economic and energy objectives in both China and KSA and how does industrial energy productivity support these plans?

Saudi Arabia has entered a new era of deregulation and privatization with vast potential investment opportunities for the private sector. Industrial diversification and upgrading, renewable energy and energy efficiency are all priority areas that are likely to raise energy productivity in the Kingdom. China has a lot of experience managing the economy with national energy intensity targets, applying industrial sub-sector energy efficiency benchmarks to energy intensive industries, and transitioning domestic energy price reform from an administered to a more market-based approach. There are many potential benefits in establishing a greater mutual understanding of economic reform plans and in shared leadership of energy efficiency. Several international initiatives have been launched at facilitating this, including through the G-20, International Energy Agency (IEA) and International Partnership for Energy Efficiency Cooperation (IPEEC).

How far can energy efficiency in energy-intensive industry move the needle?

As the single largest energy consuming sector of both China and Saudi Arabia, industry should offer some of the best potential opportunities for improving overall energy consumption per unit of GDP. Both countries have established energy intensity sectoral targets and programs to improve energy efficiency in their biggest energy consuming companies. Transparency in the publication of sector and sub-sector targets is likely to assist companies looking to invest and also help encourage the energy efficiency service company sector. For example, the electricity sector in Saudi Arabia has a target to improve fuel utilization in power generation from a baseline of 33 percent to 40 percent by 2020. In addition to energy efficiency in heavy industry, finding a way to produce water with less energy will deliver significant benefits to the Kingdom.

What is the importance of industrial strategy for managing structural economic change?

It is not preordained that economies will naturally evolve from relying on basic resource-dependent and energy-intensive industries to high-value growth models. In China, the supply-side structural reform process initiated in 2015 dominates economic policymaking, shaping everything from the government's efforts to reduce excess industrial capacity to incentives to reduce property inventory, curb high levels of corporate debt and lower corporate costs. The drive against overcapacity is focused on basic and energy-intensive industries, but might be extended to other sectors including automobiles, new materials and renewable energy. Transformation to higher value production depends on a professional skill base, research and development, and higher incomes to support domestic demand. The evolution of industry requires careful policy management to maintain a competitive advantage in energy-intensive sectors while cultivating more value in the production of downstream high-value products and activities.

How does energy price reform support industrial transformation goals?

When goods are priced higher, society tends to value them more and put them to their highest value use. Saudi Arabia's industrial sectors have been distorted by low energy prices that do not reflect true market demand and supply. Energy price reform is key to encouraging energy efficiency and achieving the right incentives for industries to develop. There is no reason why price reform cannot be structured to both preserve the competitive advantage of energy-intensive industries and provide sufficient incentive for energy-intensive industries to align with international benchmarks of energy efficiency. A hybrid pricing system that allows some market flexibility within politically acceptable bounds is one strategy that has been successful in China.

Background to the Workshop

This workshop provided an interactive roundtable discussion on the industrial development and energy efficiency experiences of China and Saudi Arabia. The objective was to discuss what lessons may be learned from sharing international experiences, including from other G-20 countries, and to identify key issues for research in a joint KAPSARC-ERI project. We also sought to develop a clearer understanding of the distinction between energy efficiency and energy productivity in the industrial context and the role these concepts can play in guiding industrial strategy and sustainable development.

The workshop will inform joint research initiatives and build collaboration between stakeholders on 'How to achieve economic prosperity through industrial energy productivity improvement.' A joint KAPSARC-ERI research report will be produced this year to help inform actions and strengthen ties between the Kingdom and China on energy productivity.

What is the Added Value of Focusing on Energy Productivity?

When considering which factors of production drive economic growth, labor and capital are usually emphasized, while energy is often simply incorporated into ‘other resources’ or ‘materials’ of production. However, given the critical importance of energy and the dramatic shifts underway in how we secure, price and use it, there is a strong case to focus on how energy supports economic growth, from both technical and policy perspectives.

Energy productivity is both an emerging policy agenda focusing on how energy can best be used to create value in the economy, and it also incorporates a number of specific indicators that integrate economic performance and energy consumption.

At the macroeconomic level, energy productivity describes how much GDP can be produced using an amount of energy, or alternatively the mathematical inverse of energy intensity (energy consumed per unit of GDP). It is thus both a reflection of the economy’s structural makeup between energy-intensive and non-energy-intensive activities, as well as of how efficiently energy is used in those activities across the sectors.

At the microeconomic level, energy productivity focuses on how much revenue is produced from economic activities per unit of energy consumption. This is related to but distinct from energy efficiency, which focuses on how much physical output is produced per unit of energy consumption. For example, in the industrial sector, measures of energy efficiency focus on total energy use per unit of output, such as GJ/tonne of steel. In contrast measures of energy productivity focus on company revenue/total energy use. Therefore energy-intensive industries, such as petrochemicals and cement, tend to have much lower energy productivity than sectors such as aerospace, health care or automotive manufacturing, irrespective of how energy efficient they are within their sub-sector.

Achieving higher energy productivity is the result of using technologies that increase the size of the economy or improve business profitability as well as those that reduce energy consumption through energy efficiency and/or diversification strategies. It is important to note that both these actions – promoting growth or revenue on the one hand and reducing energy consumption on the other – are key elements of an energy productivity agenda.

A broader view of energy productivity is being developed by the Climate Policy Initiative in conjunction with the South Pole Group and other stakeholders (see Figure 1).

This puts forward the idea of ‘integrated energy productivity’ which incorporates the environmental as well as social benefits attached to energy use in addition to the economic or ‘traditional’ components. By including these ‘additional’ elements, the concept of integrated energy productivity more explicitly brings into focus sources of economic value such as health benefits from pollution reduction, positive employment effects from higher value industry development, avoided greenhouse gas emissions and energy efficiency’s full suite of benefits.

People have debated whether the difference between energy intensity and energy productivity is purely rhetorical. If energy productivity is simply viewed as the inverse of energy intensity, there is a case to suggest that there is little difference between the two. Some people, notably policymakers in Australia and the United States,

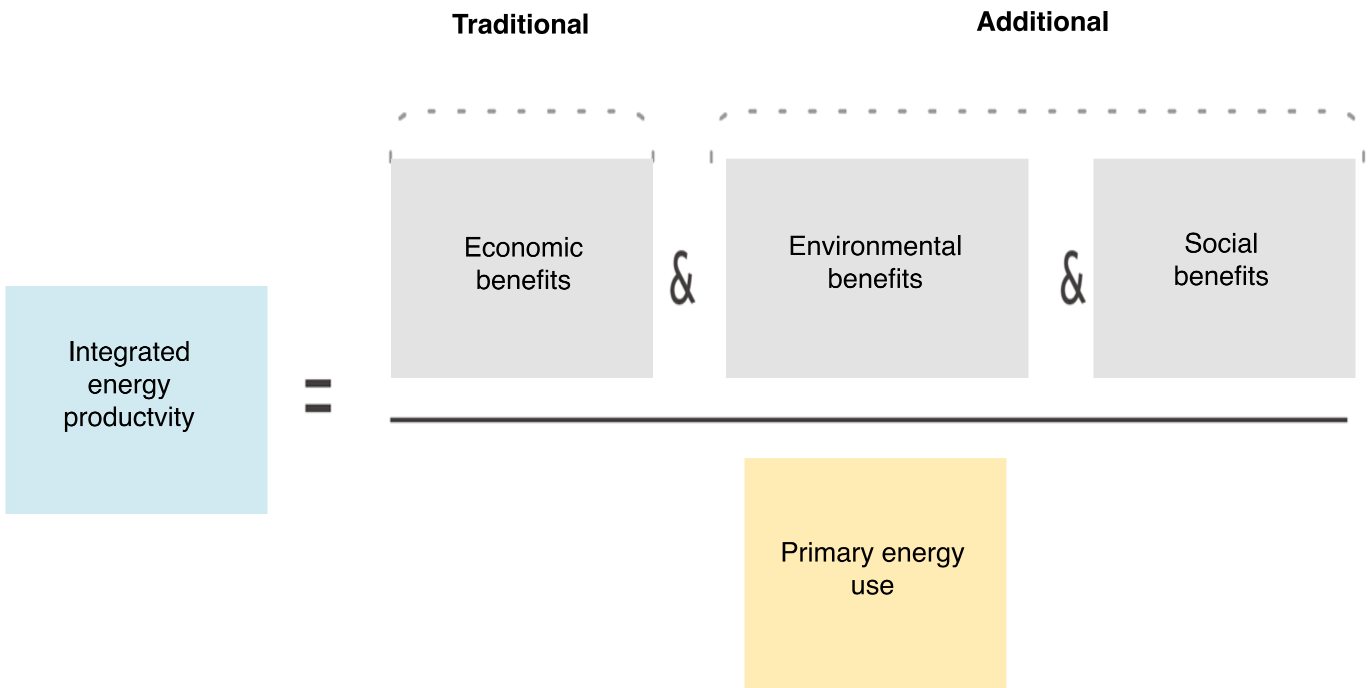

Figure 1. Integrated energy productivity.

Source: Energy Foundation China based on Climate Policy Initiative.

have argued that energy productivity has a more positive connotation since it focuses on valuing the additional economic output, rather than shrinking energy demand.

Others argue that people are used to using the term ‘energy intensity’ and that this is reason enough to maintain attention on it. China, for example, has a long history of using energy intensity targets. However, because energy productivity and intensity can be used to focus on different objectives – increasing growth on one hand and reducing energy consumption on the other – what might seem to be a simple technical distinction can attract a significant amount of debate and even controversy stemming from deeply held convictions around what is most important for public policy.

Ultimately what may be most important in the energy productivity-intensity discussion is not the choice of metric, but whether the target is ambitious but realistic and is backed up by strong energy efficiency and modernization policies to promote socially desirable investment and change.

Key Targets of Economic and Energy Plans in China and Saudi Arabia

Building on Saudi Arabia's competitive advantages, Saudi Vision 2030 sets out a new economic plan for the Kingdom. The plan articulates key targets across social, economic, and governance domains aimed at lifting private sector investment and creating a more sustainable, diverse economy, with a goal to reduce reliance on oil and generate employment opportunities for an ambitious and young population.

Under the Vision, the contribution of the private sector to GDP is targeted to rise from 40 percent to 65 percent by 2030. Many government-owned companies in sectors such as electricity generation, water desalination, airports, seaports, the postal service, health care and airlines are scheduled to be privatized, while the government plans to focus on policy setting, defense, internal security, foreign affairs, basic education and selective infrastructure development. Large subsidies will be phased out to provide market-based incentives more aligned with international norms and to allow a market rate of return for investors. Vision 2030 contains significant investment opportunities including the traditional oil, gas, chemical and mining sectors as well as railways, services and the move to high-end technologies. It also sets a renewable energy target of 9.5 GW by 2023, which is expected to make up around 10 percent of the Kingdom's electricity mix.

When China experienced rapid economic growth in the early 2000s, the expansion of energy consumption at a rate faster than GDP growth prompted policymakers in China's 11th Five Year Plan (2006-2010) to bring in a system of mandatory energy intensity targets to encourage more moderate growth in energy consumption, enhance energy efficiency, control air pollution and carbon emissions. These targets were expanded and refined in China's 12th (2011-2015) and 13th (2016-2020) FYPs and are widely recognized as having played a major role in managing China's sustainable economic development (Table 1).

While the development experiences of China and Saudi Arabia are very different from a GDP perspective, they share similarities in terms of energy consumption. In both countries, total energy consumption has gone up by around the same percentage since 1990 (see Figure 2). This growth has been driven by common underlying factors – massive expansion of energy-intensive industries such as steel, petrochemicals, cement and other basic commodities. This shared experience of the industrial sector, combined with common ambitions to diversify into consumer driven service sectors and higher value added advanced manufacturing, supports a strong case for exchange in trade, investment and policy learning between the two countries.

Building on several decades of bilateral relations, President Xi Jing Ping's Belt and Road Initiative followed by visits to China from the Crown Prince and King Salman has opened up a new era of deeper bilateral relations between the two countries. As part of these efforts, 14 collaboration agreements have been signed with a total value of $65 billion covering economic development and trade, energy, industrial production, culture and education as well as science and technology exchange. These initiatives provide a substantial scope of mutual benefits between the two countries, and also create opportunities in the areas of energy efficiency and structural reform

Key Targets of Economic and Energy Plans in China and Saudi Arabia

Table 1. China's energy and energy productivity targets in 13th FYP period (2016-2020).

2020 Targets	13th FYP for National Economic and Social Development	13th FYP for Energy Development	Energy Conservation and Carbon Reduction Comprehensive Work Plan	Level of 2015
Cap of total energy consumption	5 Gtce	5 Gtce	5 Gtce	4.3 Gtce
Energy consumption per GDP unit	-15% (from 2015 level)			0.71 tce/10,000 RMB (constant price in 2010)
Energy consumption per industrial value added			-18% (from 2015 level)	1.16 tce/10,000 RMB (constant price in 2010)
CO2 emission per GDP unit	-18% (from 2015 level)			NA
Share of non-fossil fuel in primary energy consumption	15%	Above 15%		12%
Share of coal in primary energy consumption		Below 58%		64%
Share of natural gas in primary energy consumption		10%		5.9%
Added-value of strategic and emerging industry in total GDP			15%	8%
Added-value of service industry in total GDP			56%	50.2%
Installed capacity of wind		Above 210 GW		129 GW
Installed capacity of solar		Above 110 GW		43 GW
Installed capacity of hydropower		380 GW		320 GW

Source: NDRC planning documents.

toward higher-value economic activities. These are the two core elements of energy productivity.

The international community is also playing a key role by providing a platform of shared leadership and international cooperation to help achieve the national targets. For example, the International Partnership for Energy Efficiency Cooperation (IPEEC), under the G-20 Action Plan on Energy Efficiency, recently released the G-20 Energy Efficiency Investment Toolkit. Another example is the Asia-Pacific Economic Cooperation's (APEC) regional goal to reduce its overall energy intensity by 45 from 2005 levels by 2035. This covers countries that are responsible for 60 percent of world energy demand.

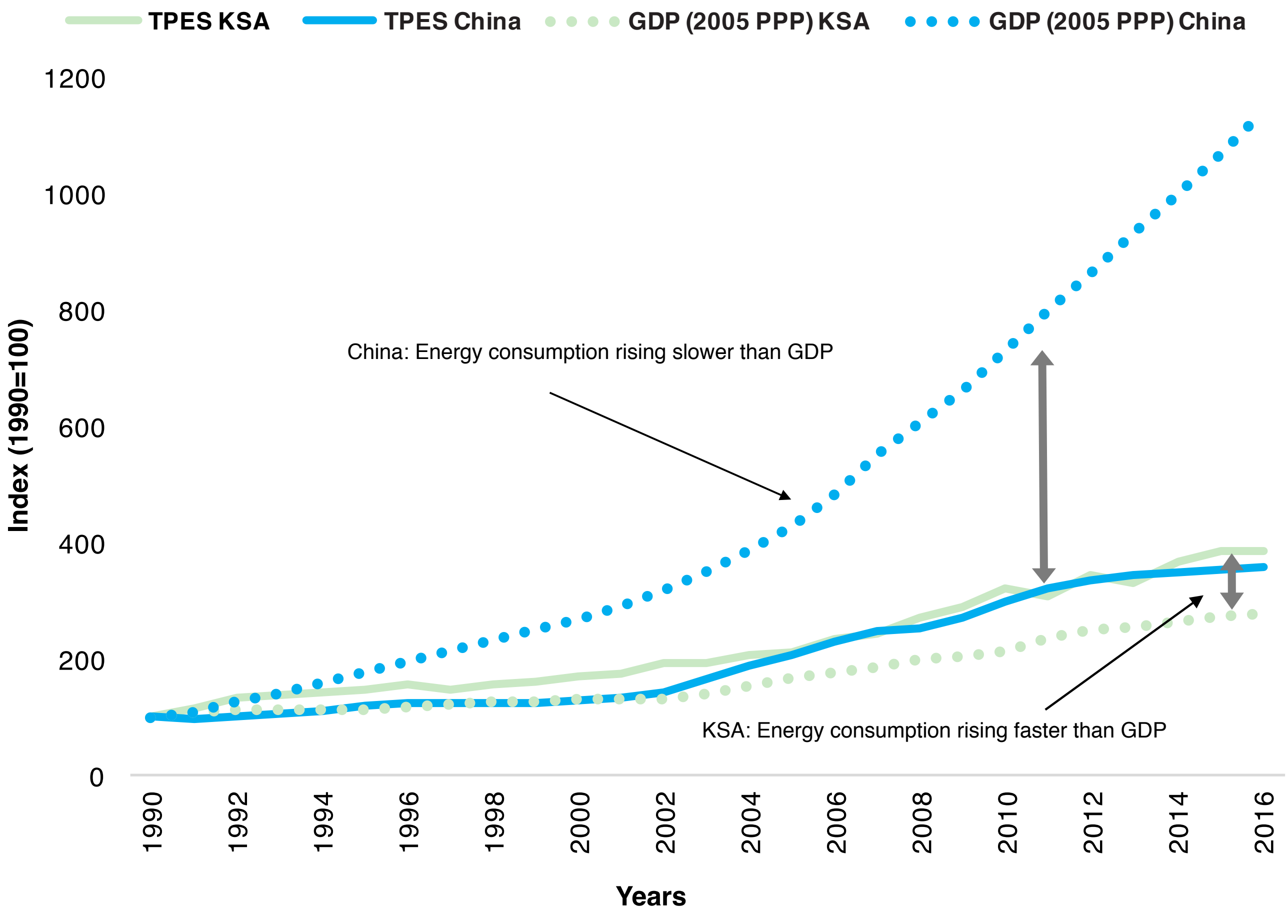

Figure 2. Energy consumption and GDP growth in China and Saudi Arabia (1990=100).

Source: Enerdata (TPES=Total Primary Energy Supply).

How Far Can Energy Efficiency in Energy-Intensive Industries Move the Needle?

The top six industrial sectors, including iron and steel, non-ferrous metals, building materials, petrochemicals, chemicals and power, made up 70 percent of the total industrial energy consumption in China. From 2006 to 2015, the share of industrial value added decreased from 42 percent to 34.4 percent in national GDP, while the industrial energy consumption has fallen recently from around 70 percent of total primary energy supply to 66 percent. To improve energy productivity of energy intensity industry, China has adopted a differentiated strategy for namely three types of industrial enterprises:

> Existing industrial enterprises are required to achieve a mandatory target set by the government through establishing energy management systems, energy efficiency benchmarking, energy auditing, and investment in energy efficiency measures.

> Outdated production capacity is scheduled to be closed down according to the standards and legislation on energy, environment, quality, safety and technology, with iron and steel, coal, cement and glass sub-sectors as a special focus.

> New production capacity is required to meet the market entrance requirements for each industrial sector and can only be built after obtaining approval through an energy conservation assessment for fixed-asset investment.

Through implementation of the key-industry-orientated policy package (see Figure 3), known as Top 1,000 Program in the 11th FYP and the Top 10,000 Program in 12th FYP, energy consumption per 10,000 RMB of industrial value added (by constant price in 2010) has decreased from 1.89 tce in 2005 to 1.16 tce in 2015, saving 1.3 billion tce in total. However, over this time the industrial sector's total energy consumption rose sharply from around 1.84 billion tce to 2.92 billion tce, or about 58 percent. In response to this rapidly rising energy consumption, in its 13th FYP China set a cap of total energy consumption in addition to its established mandatory energy intensity targets. As part of this, China is also implementing supply-side reforms to eliminate excessive industrial capacity, and accelerating energy market reform.

In Saudi Arabia, the industrial sector represents the area with the greatest potential impact for managing domestic energy consumption. Leading this effort is the Saudi Energy Efficiency Center (SEEC), which was established by the Council of Ministers to coordinate a multi-agency, national program to rationalize energy consumption and enhance energy efficiency. In consultation with key stakeholders, SEEC has developed the policies, regulations and rules to support implementation and participation in pioneering energy efficiency projects.

With three of the most important industrial sectors, – petrochemicals, cement manufacturing and steel manufacturing – SEEC has begun the process of establishing baselines and benchmarking frameworks for over 180 industrial plants from 59 different production processes (see Figure 4). The SEEC has agreed on aspirational energy efficiency targets for 2019 and reviewed energy efficiency improvement plans for 42 companies. Eleven government entities have signed joint agreements to help plants achieve their goals. Overall, these initiatives are expected to save around 9 percent of total industrial energy consumption by 2019, compared to a 2011 baseline.

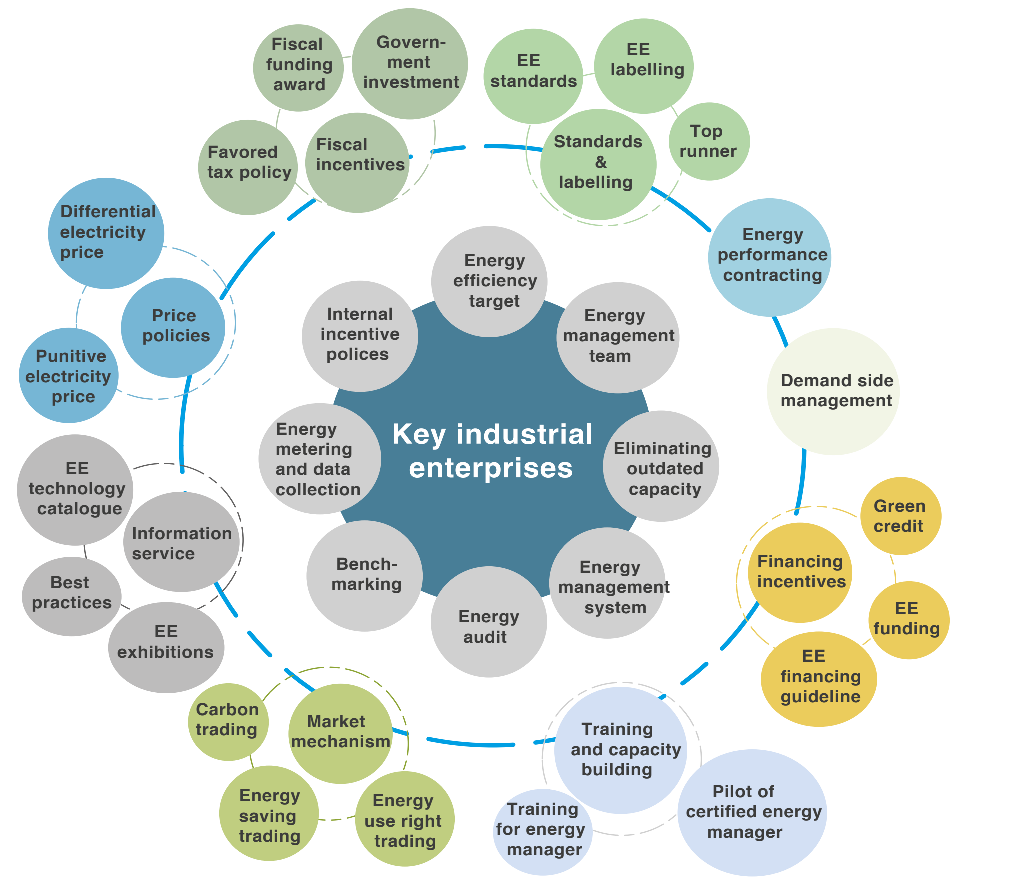

Figure 3. Chinese policy framework for industrial energy efficiency.

Source: Energy Research Institute.

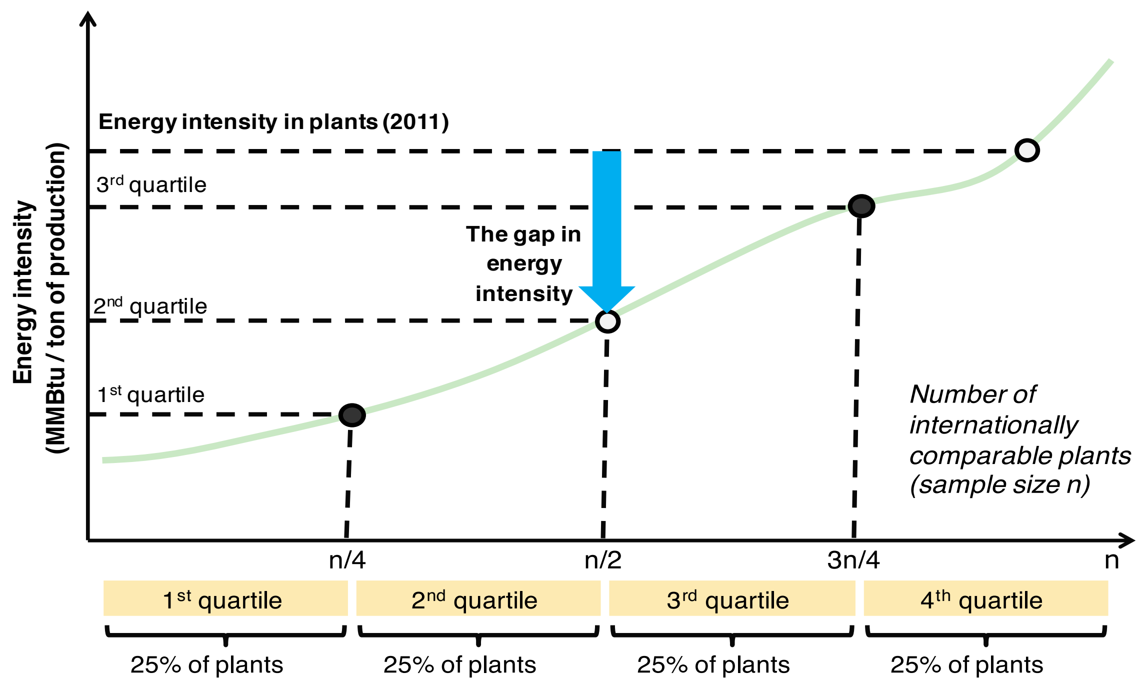

Figure 4. General approach for benchmarking energy efficiency in Saudi Arabia.

Source: Saudi Energy Efficiency Center.

Vision 2030 also highlighted reform in energy efficiency within the power generation sector, with a target to increase fuel utilization efficiency in the electricity sector from a baseline of 33 percent to 40 percent by 2020, compared with a global benchmark efficiency of 44 percent. Finding a way to desalinate water with less energy is of special priority for Saudi Arabia as the world's largest producer of desalinated water. Desalination powered by renewable energy offers tremendous potential. In times when there is excess electricity capacity, such as during the winter months, the production of water can be considered as one way to store energy or optimize reserve capacity.

The Importance of Industrial Strategy for Managing Structural Economic Change

While industry's energy efficiency shapes how much energy it takes to produce a physical tonne of output, industry's energy productivity also considers the amount of value or revenue (turnover) created per unit of energy consumed (revenue/joule or kg coal equivalent). One of the objectives of industrial policy is to develop sectors which generate improved economic or employment outcomes and revenue possibilities for business. Moving up the production value chain from simply exporting mineral resources and basic commodities to more advanced manufacturing and services is an industrial transformation process that some countries seem to manage more successfully than others (see Figure 5).

Structural changes in the economy geared toward less energy-intensive sectors have also been a driving force for reducing carbon emissions in some developed countries and curbing the expansion of energy-intensive industry in developing and emerging economies. This has given rise to concerns around embodied carbon in trade, pollution havens and the need to support transparency and the greening of global supply chains. It has highlighted the notion that greenhouse gas emissions reduction need not

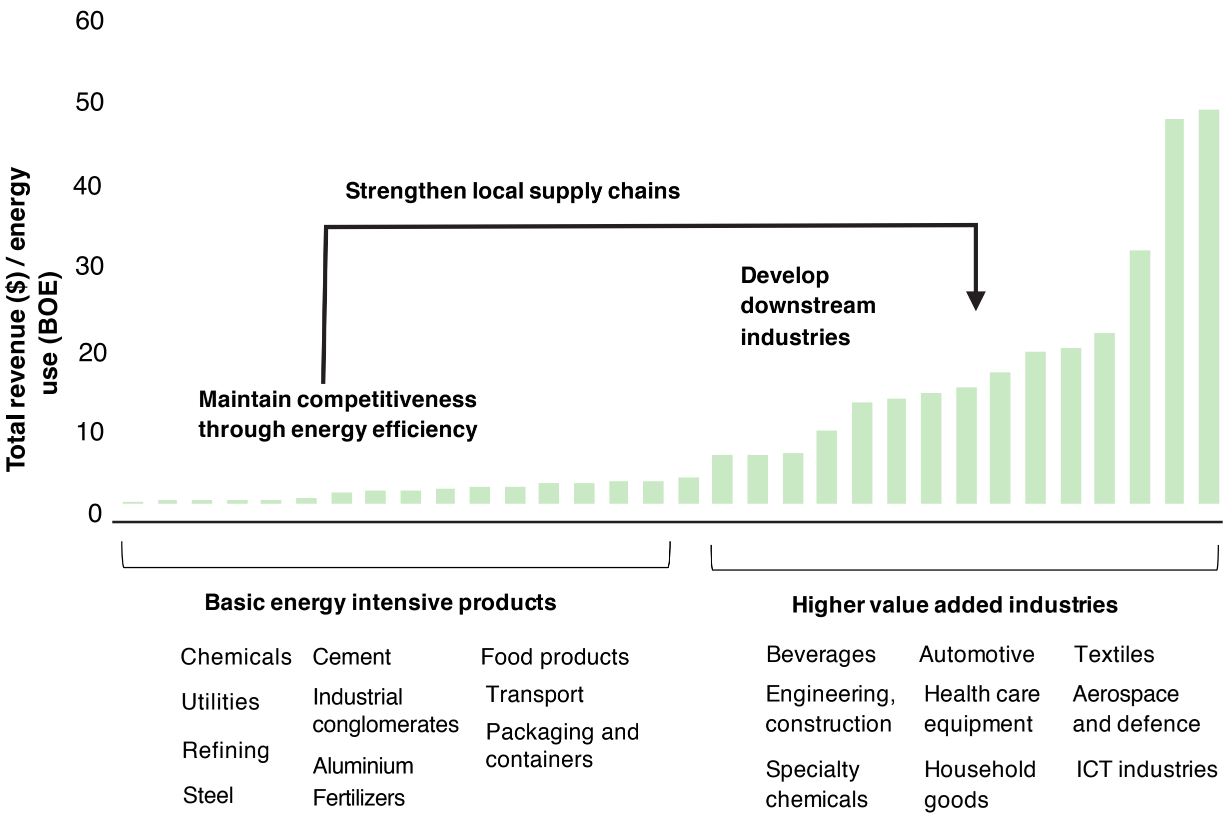

Figure 5. Energy productivity as a framework for industrial strategy.

Source: KAPSARC based on ClimateWorks.

mean deindustrialization. Strong, energy-efficient industry with high quality jobs for citizens should ideally go hand in hand with economic and energy transformation.

In China, the manufacturing industry has been seen as a major engine of economic growth. Between 1991 and 2014, the value added from industrial manufacturing grew from $126 billion to $2,876 billion. This has helped make China the largest country in the world in terms of manufacturing value added and the largest producer of goods for about 210 products. However, heavy reliance on energy and resource-intensive investment, especially in basic commodities such as steel, has put pressure on the economic and environmental sustainability of China's growth model.

China's progress to more advanced stages of industrialization relies on two important conditions: a foundation of skills, research and development aligned with new higher-value activities, and rising per capita incomes and urbanization to support domestic consumer demand for new higher-value goods and services. With greater volume and quality of consumption comes new demand for education, culture, health and other public services. This supports growth in emerging sectors such as services and high technology, which can then take the lead from industry as the primary engines of growth.

Government programs have played an important role in industrial restructuring, transformation and upgrading in China. For example, the first Industrial Transformation and Upgrading Plan (2011-2015) was released in 2012 and emphasized improving technological innovation on environmental protection industry and smart manufacturing. The "Made in China 2025" plan, released on May 19, 2015, has laid out a 10-year blueprint to shift China's manufacturing competitiveness from mid- and low-end products to higher-end sectors. The supply-side structural reform process initiated in 2015 currently dominates the economic policymaking landscape. It shapes everything from the government's efforts to reduce excess industrial capacity to initiatives designed to reduce property inventory, curb high levels of corporate debt and lower corporate costs.

How Does Energy Price Reform Support Industrial Transformation Goals?

When goods are priced higher, society tends to value them more and put them to their highest value use. This is the key idea behind energy pricing for greater energy productivity in industry (see Figure 6). Evidence from countries in the Organization for Economic Cooperation and Development (OECD) suggests that there is some correlation between energy prices and industrial energy intensity. However, there are many other important factors that shape this relationship, such as the structure of the economy and energy efficiency regulations and energy management systems.

In December 2016, as part of Saudi Vision 2030, the government announced a Fiscal Balance Program which includes plans to increase domestic energy prices in the Kingdom from levels consistent with the costs of production to levels reflecting the opportunity costs of international benchmarks. This is likely to increase energy costs, currently among the lowest in the world, by a factor of 2 or 3 depending on prevailing energy market conditions and the reference prices used. The program is scheduled to be implemented gradually in order to provide sufficient time for industry and households to adapt.

The energy price reform program will play a central role in aligning economic incentives toward greater energy efficiency and an allocation of capital toward higher value activities in the economy. While energy price reform will unambiguously support long-term energy efficiency (energy consumed per unit of output) in energy-intensive industries, its impact on energy productivity (revenues per unit of energy

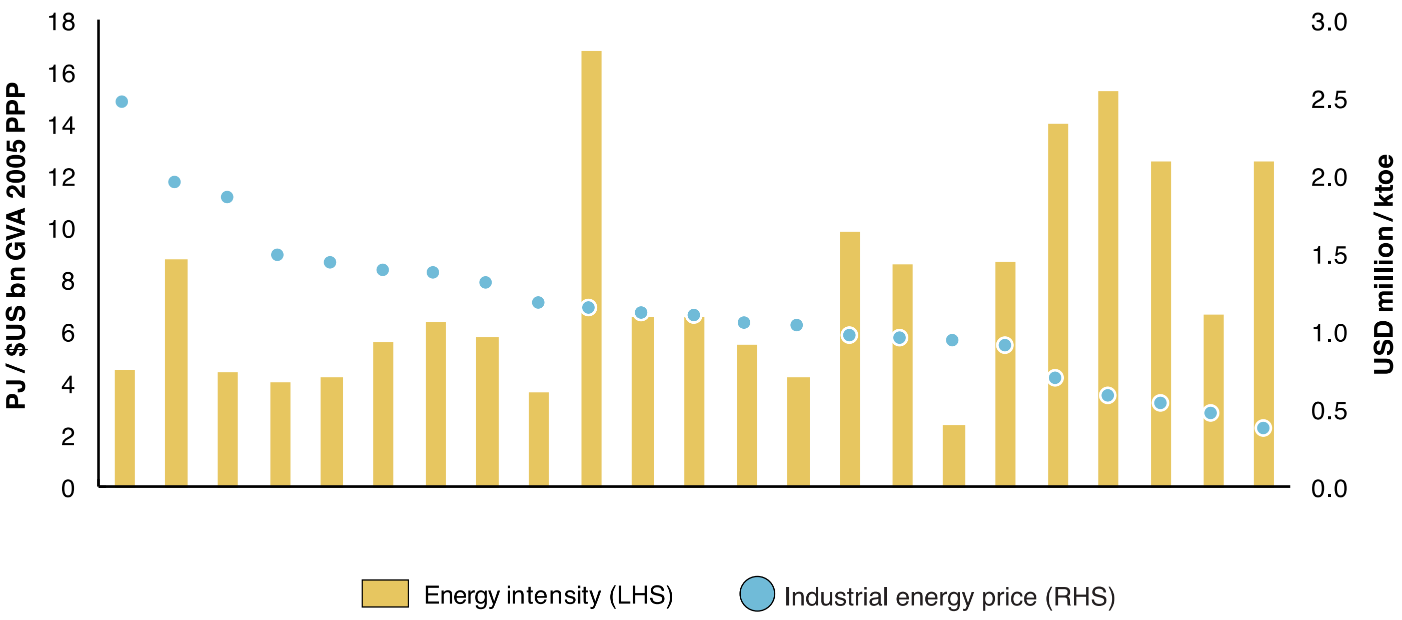

Figure 6. Industrial energy intensity and energy price.

Source: IEA.

consumed) for these industries is less certain. Higher energy prices will result in energy-intensive industries losing their competitive advantage, and domestic firms may lose market share, especially for goods that are internationally traded. If this occurs and corporate revenues fall faster than any decline in energy consumption, energy productivity in the energy-intensive sectors will also fall.

With reforms starting in 1992, coal pricing was the first energy commodity in China to be reformed toward a market oriented regulatory approach. China had traditionally applied a dual-track pricing system for coal used in power generation, which allowed the government's intervention to secure supplies at lower prices for the sake of power price stability and economic stability. The cancellation of dual-track pricing system for coal in 2013 signaled the shift toward a full market-based approach to pricing coal for all uses.

In an effort to improve the competitiveness of the oil industry and resource efficiency for the national economy, China has reformed its oil pricing mechanism from a completely government regulated approach toward a more flexible approach, tying retail oil product prices more closely to international crude oil markets. However, when and to what extent prices are adjusted is still in the hands of the government.

Natural gas pricing is very much diversified across China. Significantly, onshore natural gas recently changed from a cost-plus and wellhead controlled gas pricing system to a net-back pricing regime. The net-back pricing regime links the city-gate prices in key cities relative to an index of alternative fuels such as liquefied petroleum gas (LPG) and fuel oil. The city-gate price reference for 29 provinces and municipalities is still administered by the central government.

As reforms of the oil and gas sector unfold upstream and downstream, private investment is being encouraged to increase the operational efficiency of state-owned enterprises. During the 13th FYP period, China will continue its energy price reform process with a focus on liberalizing the production and final sale of energy while maintaining government control over transmission and distribution. As these reforms touch on important sectors, a pragmatic approach will probably be needed, especially for transmission and distribution networks, the most sensitive portion of the reform process.

Energy price reform should aim to preserve the competitive advantage of energy-intensive industries, but be high enough to incentivize energy efficiency in line with international benchmarks. Providing industry and households with assistance can help with implementation and improve the social equity dimensions of how hydrocarbon wealth is shared in the Kingdom.

About the Workshop

KAPSARC and the Energy Research Institute (ERI) of the National Development and Reform Commission (NDRC) convened this joint workshop in Riyadh, Saudi Arabia on March 28, 2017. The workshop, which was attended by more than 45 experts from government, industry and academia, was held under a modified version of the Chatham House Rule. Participants consented to be listed below, however, none of the content in this briefing can be attributed to any individual attendee.

Iqbal Adjali – Research Fellow, KAPSARC

Linah Al Hamdan – Research Analyst, KAPSARC

Nabil Al Khowaiter – Office of HE the Minister, Ministry of Energy, Industry and Mineral Resources

Khalid Al Ohali – Vice President of Strategy, Planning and Development, Ma'aden

Naif Alabbadi – Director General, Saudi Energy Efficiency Center (SEEC)

Samer AlAshgar – Ministry of Energy, Industry and Mineral Resources

Saleh Alawaji – Deputy Minister for Ministry of Water & Electricity

Wesam Al-Ghamdi – Ma'aden

Mohammed Al-Huwaimel – Transmission Engineer B, Saudi Electricity Company (SEC)

Mansoor Al-Mansoor – Vice President of Finance & Operations, KAPSARC

Yaser Al-Omar – Power Control Dispatch Specialist, Saudi Electricity Company (SEC)

Abdulsalam Al-Otabi – Transmission Engineer, Saudi Electricity Company (SEC)

Naif Al-Ragass – Assistant Director for Technical Affairs, Saudi Energy Efficiency Center (SEEC)

Mohammed Altamimi – Leader of Thermal Energy Research Team, King Abdullah City for Atomic and Renewable Energy

Yasir Alturki – Assistant Professor of Electrical Engineering, King Saud University (KSU)

Quan Bai – Director of Energy Efficiency Center, Energy Research Institute, National Development and Reform Commission

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Karoline Steinbacher – Senior Consultant, Energy Policy & Advisor German Ministry for Economy

Yutao Wang – Deputy Director General, China Cement Association

Daohong Wu – President Shenwu Co., Ltd

Yang Xiaoliang – Visiting Researcher, KAPSARC

Zhaoyuan Xu – Director of Industrial Development, Development Research Center, the State Council

Phyllis Yoshida – Fellow for Energy and Technology, Sasakawa Peace Foundation

Zidan Yousef – Coordinator Belt and Road Initiative (BRI), Ministry of Energy, Industry and Mineral Resources

Jianfeng Zhang – Managing Director, China Triumph International Engineering Company

Xiaomin Zhao – CEO/General Manager, Qingdao Chutian Energysaving Co., Ltd

Ming Zhao – Deputy Director, ESCO Committee of China, Energy Conservation Association

Ren Zhongyua – Visiting Researcher, KAPSARC

Yiying Zhu – Standing Deputy Manager, Beijing Sinowise Co., Ltd

Notes

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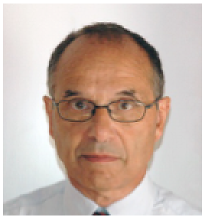
About the Team

Dongmei Chen

Dongmei is a research fellow at KAPSARC for China-related policy study and partnership coordination. She has more than 20 years of experience in the energy and climate field in China, acting as head of the Institute of Industrial Productivity China Office and Director of the Climate Change and Energy Program for WWF China, respectively.

Nicholas Howarth

Nicholas is a research fellow at KAPSARC leading work on energy productivity. He is an applied economist with 20 years of experience working with governments and industry. He has a Ph.D. in Economic Geography from Oxford University, specializing in energy, technological change and climate change.



Alessandro Lanza

Alessandro is a visiting researcher at KAPSARC. He is Professor of Energy and Environmental Policy at LUISS University, Rome and a member of the Board of Directors of ENEA, Italy. He holds a Ph.D. in Economics from University College London.

Padu S. Padmanabhan

Padu is a visiting researcher at KAPSARC and is the former program director of the South Asia Regional Initiative for Energy Integration (SARI/EI) and senior energy advisor for USAID/India's bilateral economic assistance program. He has worked with the World Bank in Washington DC.

About the Project

KAPSARC and ERI are working together to prepare a joint report comprising of a comparative review of the status of energy productivity and associated policies in Saudi Arabia and China. The review will assess the current status and future plans of industrial development, with a focus on energy efficiency, and discuss the policy practices that might be relevant and valuable for the Kingdom drawing on China's experiences. This study aims to inform activities and deeper collaboration under China's One Belt One Road Initiative, which is supported by the Kingdom and aligns with investment priorities as part of Saudi Arabia's Vision 2030.

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