KAPSARC
مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

Fostering Joint Leadership on Energy Productivity Transitions in Saudi Arabia and China

July 2018

Doi: 10.30573/KS--2018-WB18

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

This workshop explored specific opportunities where the Kingdom of Saudi Arabia and China can benefit from cooperation around efforts to improve industrial energy productivity. This is especially timely as both countries move into a closer phase of engagement under China's Belt and Road Initiative (BRI) and Saudi Arabia's Vision 2030 plans. Three common themes emerged from the workshop discussion:

Diversification: A push to diversify Saudi Arabia's economic structure, energy mix and economic players will shape the Kingdom's energy transition in the years to come. The goal is to deliver broader-based growth which can provide higher quality jobs for local Saudis and more stable sources of government revenue other than oil. International partnerships and investment, especially with China, are key elements of this new growth model.

Transformation: The energy sector is also an important part of the economic transformation underway in both Saudi Arabia and China. The Kingdom's plans for 200 gigawatts of renewable energy capacity by 2030 and China's focus on green development as part of the BRI offer many opportunities. It is also clear that a more integrated policy approach to renewable energy and energy efficiency is urgently needed. With its focus on creating the most value, energy productivity (see Figure 1, below) is a good integrating framework for energy policy.

Collaboration: Joint leadership and international cooperation between China and the Kingdom, especially around petrochemicals, can help maximize the benefits from transformation while reducing the risks of structural change and trade conflicts. Development and the clean energy transition are not substitutes or a zero-sum game. The structural costs of change will be lower and benefits increased through a collaborative approach to international trade and investment. Goals to boost long-term growth potential and the overall economy are much more desirable than pursuing narrow short-term national interests.

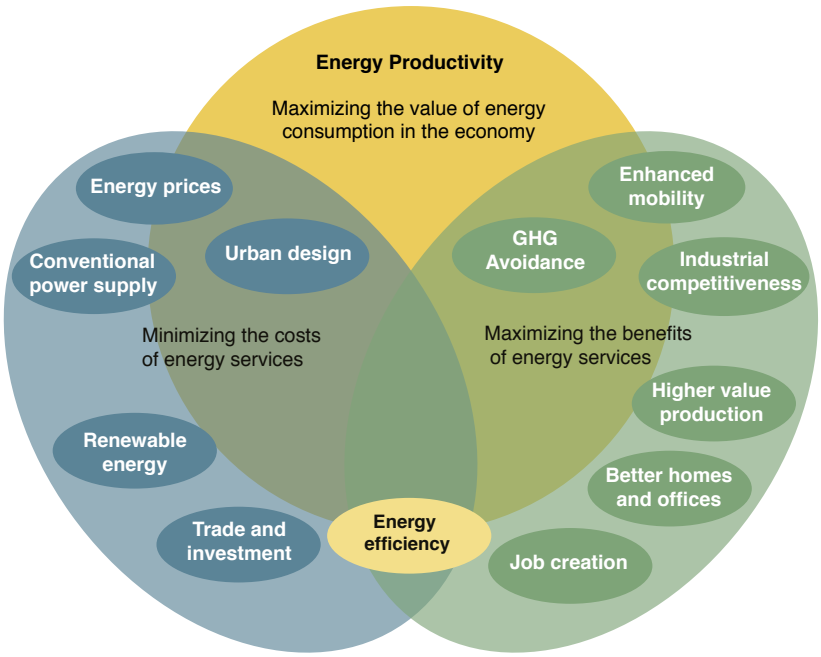


Figure 1. Energy productivity as an integrating concept for sustainable development.
Source: KAPSARC, based on workshop discussions.

Summary for Policymakers

China's Belt and Road Initiative (BRI) could be an important catalyst for achieving Saudi Arabia's economic transformation goals in terms of fostering a stronger collaborative relationship. The focus of the Chinese government on green development within the BRI may also offer an opportunity to improve the production and use of energy efficient, resource efficient and renewable energy technologies in the Kingdom's infrastructure and development projects.

For example, China has the world's largest energy service company (ESCO) market, valued at $56 billion in 2016. Saudi Arabia recently formed a $500 million super ESCO focused on public buildings. There is rich potential to extend the Kingdom's approach to industrial energy efficiency, which accounts for over 50 percent of energy consumption in both countries.

China is also the world's largest producer and installer of renewable energy (RE) technologies. Saudi Arabia has a target to build 9.5 gigawatts (GW) of RE capacity, or 10 percent of generation, by 2023 and recently outlined plans for up to 200 GW by 2030. The National Renewable Energy Program eProcurement Portal offers a gateway to participate in the Kingdom's RE transition.

Saudi Arabia is the world's largest exporter of basic petrochemical polymers, while China is the largest importer and consumer. Demand for polymers is expected to increase by around 3.5 percent year-on-year during the next decade. The historical model of development and trade in this area has focused on basic materials being sent from the Kingdom to China where they are transformed into a range of higher value products. There is a strong desire in the Kingdom to move from simply being a source of cheap feedstocks, to encourage greater local production of some of these value-added products. Research and collaboration can play an important role in helping chart pathways towards mutually beneficial opportunities which avoid potential trade risks or conflicts.

Setting energy productivity or intensity targets and using energy productivity as a strategic narrative can help policymakers integrate a range of economic and energy policy objectives. The goal of energy productivity, to maximize value from the energy system, economically, socially and environmentally, can also appeal to a wide range of stakeholders. China has had a long experience setting such targets. Their adoption in Saudi Arabia could help provide investors with clearer signals and increase certainty around long-lasting energy investments.

Industrial energy efficiency financing, petrochemical trade and investment, renewable energy, district cooling and energy access are all areas identified as having potentially high benefits for research and collaboration.

Background to the Workshop

In 2017 KAPSARC and the Energy Research Institute (ERI) of China's National Reform and Development Commission conducted a joint study looking into how industrial energy productivity can improve economic prosperity. This study comes at a time of closer bilateral cooperation under China's BRI and Saudi Arabia's Vision 2030, with the aim of increasing understanding of key policies and driving forces around industrial strategy and energy use in Saudi Arabia and China.

KAPSARC and the ERI conducted workshops in March 2017 in Riyadh and in December 2017 in Beijing. With the input and support of the International Partnership for Energy Efficiency Cooperation, they launched their report in February 2018 at the G20 Energy Efficiency and Renewable Energy Summit in Buenos Aires, hosted by the Argentinian government.

Their work highlights how policymakers can use an energy productivity narrative to integrate a range of energy policy and development issues, while keeping energy efficiency center stage as the 'first fuel.' Using energy productivity – or energy intensity – as an indicator and a target is also a powerful tool for governments to give strategic direction to energy efficiency and sustainable development goals.

The interactive roundtable discussion in Beijing further examined how to build joint leadership between China and Saudi Arabia on industrial energy productivity. It concluded with proposed areas for further collaboration between KAPSARC, ERI and workshop participants.

Towards Greater Economic and Energy Diversification

The Kingdom of Saudi Arabia's Vision 2030 outlines a plan to move beyond an economy dominated by petroleum to a more balanced, sustainable development pathway. In an internationally connected world, this diversification push is of interest to other countries, especially those with strong trading relationships with the Kingdom, such as China. Key elements will involve:

Diversification of the economic structure. This is being driven by the need to provide jobs for a young population and to expand opportunities in areas of higher value-added industrial activity. Vision 2030 looks to develop sectors including tourism, defense, information and communication technologies, health, non-oil mining, and downstream petrochemical industries.

Diversification of the energy mix. The international energy landscape is shifting, with the possibility of prolonged downwards pressure on oil prices driven by the shale revolution in the United States (U.S.) and increases in the energy efficiency of transport, including electric vehicles. Domestic energy mix diversification, especially focused on electricity, will see a significant shift toward gas, renewables and other alternative energies. In the area of renewable energy, there is huge collaboration potential between China and Saudi.

Diversification of the players. The Kingdom is moving from a government dominated system to a more privatized, market-oriented system with foreign investment and local entrepreneurship.

The Chinese experience of diversification and shifting to a more market- and consumer-oriented economy offers an example of how better to reflect supply and demand relationships while maintaining elements of a centrally managed structure. Care needs to be taken to maintain the social license for market reforms by minimizing any associated environmental or social damage.

Energy efficiency can play a crucial role within the broader movement towards greater diversification. For example, the Chinese experience shows that with proper policies, energy efficiency can encourage and develop a whole new market consisting of energy service companies (ESCOs), energy efficiency facilities, and an energy information and management sector.

In Saudi Arabia, three rounds of renewable energy projects have been planned for the first phase of the National Renewable Energy Program, with a target to install 9.5 gigawatts (GW) of renewable energy by 2023. Energy generated at the sites will be sold to a limited liability company, guaranteed by the Saudi Electricity Company. Recently announced plans outline an ambition to deploy 200 GW of renewable energy capacity by 2030, compared with total electricity generation capacity of around 75 GW at present.

To realize such opportunities, a more positive and long-term view of renewable and energy efficiency technologies is needed, moving from viewing them as a cost to the economy to a source of growth (Figure 2). For China, green industrial development which is energy and resource efficient is the core of the shared vision with all BRI country partners. An energy productivity perspective can be a helpful way to reframe sustainable energy technologies by emphasizing their contribution to growth.

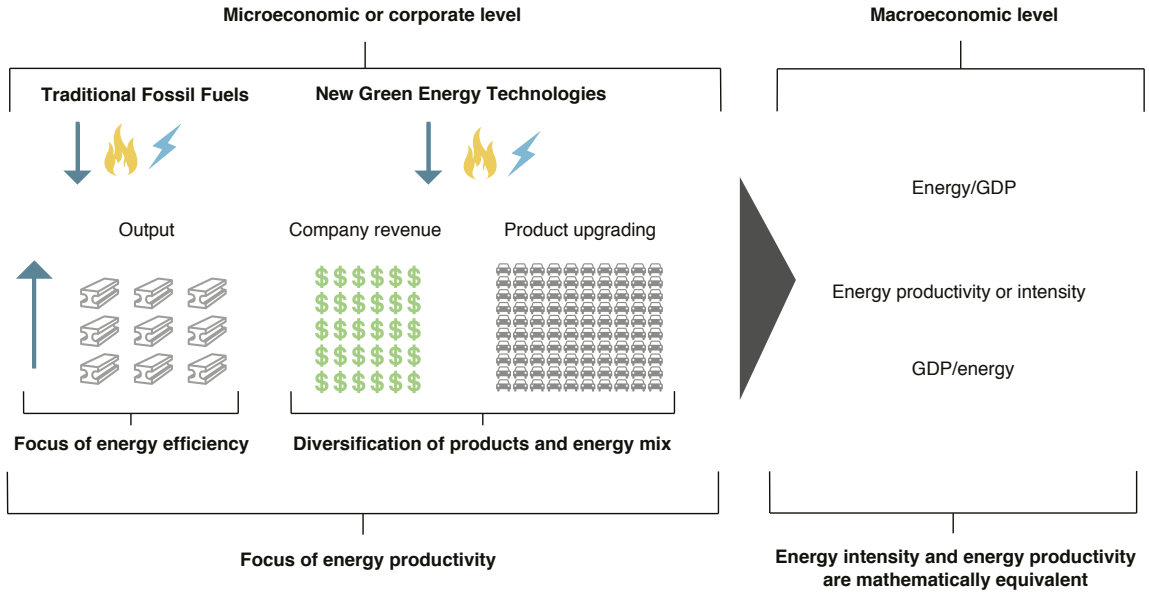


Figure 2. Energy productivity as a framework for more sustainable development.
Source: KAPSARC.

For example, China has implemented a system of energy intensity targets, energy efficiency benchmarking, structural reform for industry and energy price reform which have helped it achieve one of the highest rates of energy intensity reduction in the world of around 5 percent per year. In Saudi Arabia, energy intensity may have peaked in 2010 at just above the G20 average, but its rate of reduction has been much more variable. Energy intensity is simply the inverse of energy productivity.

"While mathematically equivalent, energy intensity reduction generally implies energy conservation as the goal. Energy productivity emphasizes getting the most value from energy, which may be more appropriate when energy demand is rising strongly."

—Workshop participant

Examples of where improvements in industrial energy efficiency in China have fostered broader economic growth include the following:

- Cost-reductions from energy efficiency improvements helped lift profitability for coal-fired power plants, aluminum, cement, iron and steel production, especially as energy input prices rose. For example, 55 million yuan was saved every year for the Huaneng Henan Qinbei Power Company from reduced coal consumption by upgrading to a 600 megawatts supercritical power plant from its previous subcritical unit.

- Implementation of national energy efficiency standards helped create jobs and new business opportunities for energy services, environmental equipment and associated supply chains, especially electric motors and LED lighting.

- Implementation of energy management systems has led to more integrated production design for energy-intensive products, resulting in cost-savings and improved profitability.

- Stricter requirements for monitoring and analyzing energy data have facilitated the development of new businesses and jobs involving precision control technologies, remote control technologies and innovations around big data and cloud computing.

- The development of China's ESCO market has created an industry which grew in value from around 1.7 billion yuan in 2003 to over 356 billion yuan in 2016.

- New business models have been developed for shared heat supply systems between industrial production and residential communities.

China's Top Runner Program also provides a policy-driven case study of how the petrochemical sector has made economic gains through improved energy efficiency. So far, 17 types of petrochemicals covering 29 products are managed under a continuous improvement cycle. These include ammonia, methanol, calcium carbide and caustic soda. The program promotes an efficient level of energy use through management, technology updates and regularly updating energy efficiency standards. It does this by setting targets based on the value of the most energy efficient process at the time of the target setting process.

"Integrated with government incentive policies and knowledge sharing activites, over five years China's Top Runner Program achieved reductions in the energy consumption per unit of product of 9.1 percent for ethylene, 4.9 percent for ammonia, 9.3 percent for ionic membrane caustic soda, and 9.6 percent for calcium carbide."

—Workshop participant

Transformation to Higher Value Opportunities

China's 19th Communist Party Congress and Saudi Vision 2030 both require systematic and transformative, rather than marginal, changes. For China's energy sector, the State Council has emphasized that technological change on the supply side is required through diversifying the energy mix away from coal. On the demand side, it will be important to moderate upward pressure on energy consumption through price reform and energy rationing. For Saudi Arabia, its domestic energy price reform process, renewable energy plans and diversification program, supported by its Public Investment Fund, will completely reshape the Kingdom's energy and economic landscape.

> **"Economic transformation will create winners and losers. How can it be managed (so as) to minimize any negative impacts while shifting to the industries of the future?"**
>
> –Workshop participant

A more systemic view which looks at the energy and industrial sectors as a whole is needed. This should take into account both the benefits and the trade-offs that result from energy policies. Some policies and technical fixes for one problem can lead to significant problems in other areas. For example, renewable energy and energy efficiency are often pursued separately. Development focused on non-energy-intensive sectors such as tourism, health and information and communication technology (ICT) is often pursued separately from the more traditional energy-intensive production of basic commodities like ethylene, steel and cement. Promoting one sector or technology while not thinking about system-wide effects will increase the costs of the energy transition.

Energy and industrial development will be at the heart of transformation in China and Saudi Arabia. Transformation has to benefit local development and population to be accepted. The petrochemical sector is the largest industrial sector in the Kingdom. Policymakers want businesses to move up the value chain of production into the downstream uses of petrochemical polymers (see Figure 3). This is a market where China is currently the world's largest producer and has competitive advantage.

> **"Collaboration should aim to promote win-win opportunities around access to low cost feedstock on one hand, and developing higher value downstream petrochemical industries on the other. Trade and investment mean economic transformation and energy transition will not be a zero-sum game."**
>
> —Workshop participant

Through the mutually beneficial BRI, opportunities can be identified to increase the economy so that all stakeholders benefit from the desired industrial transformation to higher value opportunities.

For example, the relative cost of feedstocks is one of the largest drivers of steam cracker/petrochemical plant competitiveness. It is estimated that, in the next five years, ethylene and propylene production capacity will add 35 million tonnes per annum globally, driven by China. In a low oil price environment, the cost advantage of ethane, sourced from gas, over naphtha, from oil, is reduced, flattening the overall shape of the cost curve. Under a high crude oil price environment, this relative cost advantage towards gas-based feedstocks is increased.

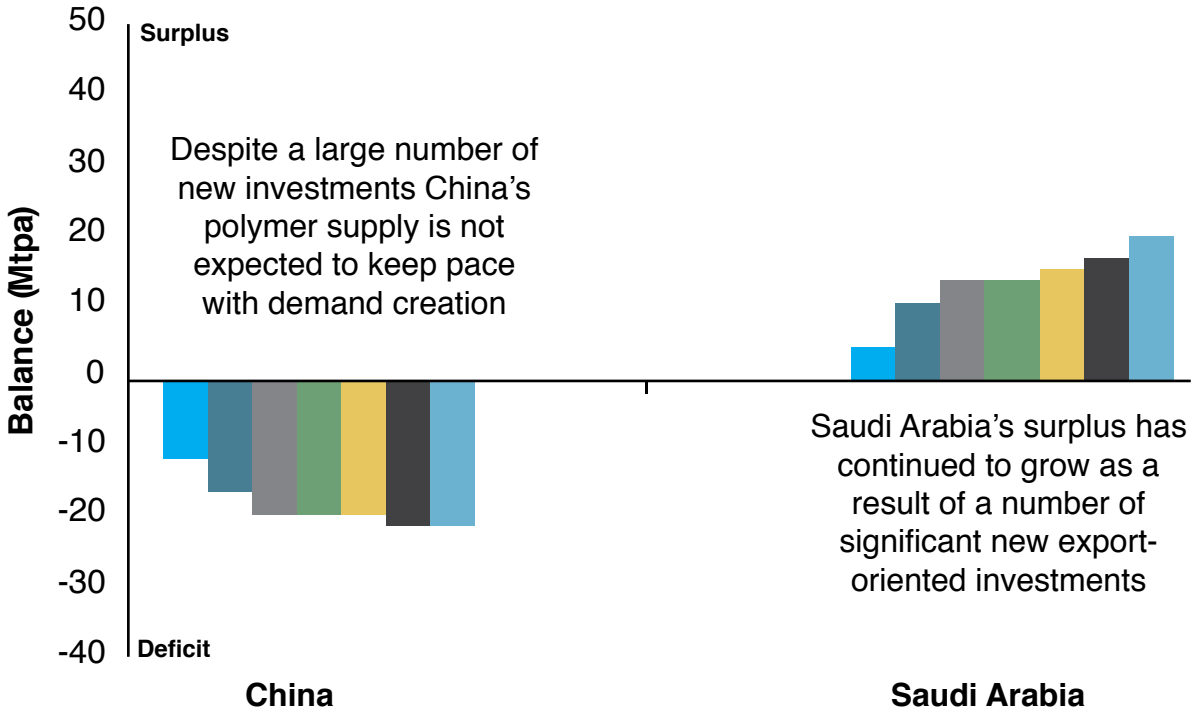


Figure 3. China and Saudi Arabia polymer net balance.
Source: Wood Mackenzie, PCI (polymers include PE, PP and PS).

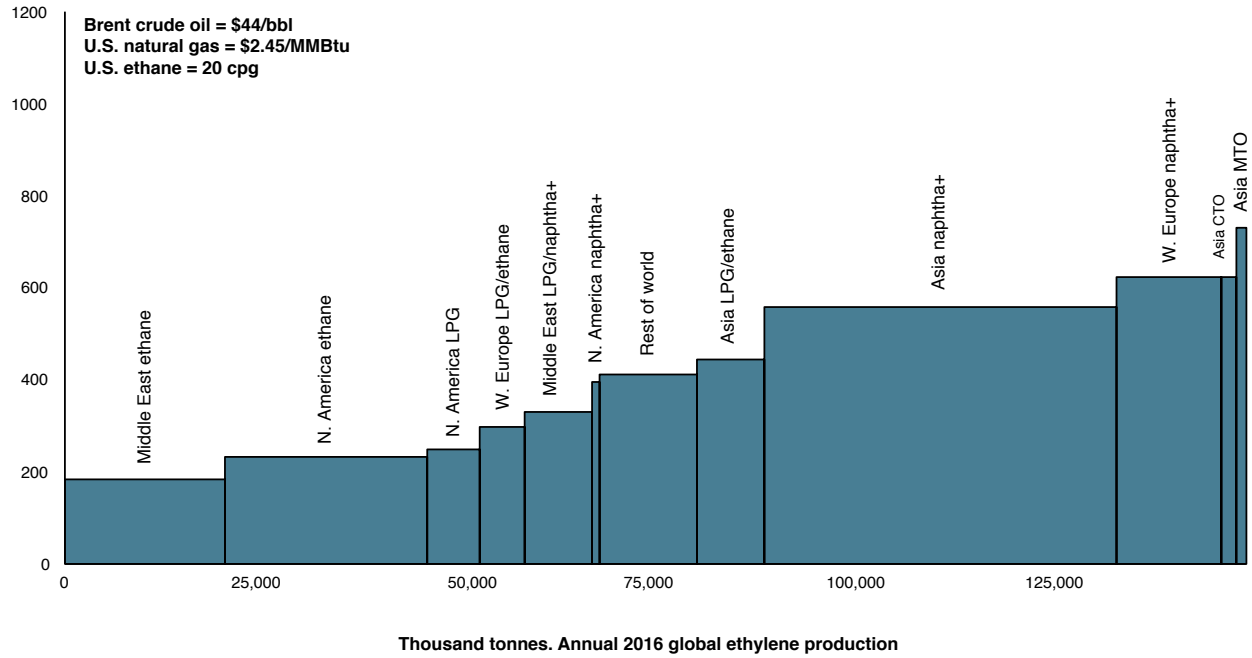


Figure 4. Average global ethylene production cost supply curve 2016 ($/tonne).
Source: Wood Mackenzie.

The availability of feedstock and convenience for transport is crucial for market development in each country. Saudi petrochemical plants have access to large volumes of domestic gas, while China has limited gas feedstock availability and often relies on domestic naphtha from refineries and imported naphtha. This has led to Chinese technological innovations to enable the use of domestic coal as an alternative petrochemical feedstock.

Industrial transformation needs to look at the sector from an integrated standpoint and to go beyond the dichotomy between energy-intensive industries and the high value-added industries. An integrated approach should examine supply chains, and energy efficiency potential and methods in the so-called 'low-end' and 'high value-added' industries, to adapt to both countries' changing socio-technical structure. This is crucial to avoiding the potential hollowing out of industrial zones and also the problem of carbon leakage or simply shifting polluting activities to a less energy-efficient location.

Research and exchange of ideas can usefully explore how China and Saudi Arabia can work together to develop an integrated market and optimize decisions on where to invest in production facilities and transport infrastructure. They could pursue more joint ventures.

Moving Beyond a Zero-Sum Game Through International Collaboration

The shift to more sustainable energy can follow multiple transition pathways depending on the local context, including national resources, goals and capabilities. The strength of energy productivity as a policy narrative is that it can be used to focus on a range of economic and energy policy issues. Too often policy in one area can reduce the effectiveness of achieving transition in another. For example, renewable energy and energy efficiency policies are often pursued in isolation from each other, or even in competition. Likewise, more integrated thinking is needed when formulating policies on urban development and cities of the future, industrial production and the potential of digitization of energy and the sharing economy.

Minimizing the costs of providing energy services while maximizing their benefits is key to maximizing the value from energy consumption. This is the overarching objective of enhancing energy productivity and can provide a strong integrating narrative for policymakers (Figure 1).

The bilateral collaboration between Saudi Arabia and China has historically been focused on the oil trade, gradually extending to the upstream and downstream sectors of the oil and gas industries. A growing number of Chinese companies have also entered the engineering service market in Saudi Arabia:

- Joint ventures between Saudi Aramco and Sinopec have established refining projects in Yanbu and Fujian.
- Joint ventures between SABIC and Sinopec have established a refining project at Tianjin.
- CNPC is involved in pipeline construction in Ras Tanura and Hawiyah-Haradh with a total contract value of U.S. $517 million.
- China Power Construction Corporation is involved in the construction of the Rabigh oil power plant and the master gas system gas booster station.
- China Nuclear Energy Industry Corporation has initiated cooperation with the Saudi Geological Survey Bureau on nuclear resources exploration.

Saudi Arabia's Vision 2030 includes plans to build a mega city called NEOM and construct industrial cities including Gazan Economic City, Ras AL-Khair Industrial City and Al-Hasa Industrial City. These have created new opportunities for collaboration with BRI around the local production of industrial equipment for oil and gas engineering services, energy efficiency equipment, power generation and grid upgrading. Given the countries' significant relationship around petrochemicals, it is likely this sector will offer many opportunities to develop the energy service industries to support energy efficiency. In particular, the Chinese experience in implementing its Top Runner Program for petrochemicals provides good policy learning opportunities around setting benchmarks and energy management.

Effective communication at different levels is crucial for collaboration. In addition to dialogues and discussions between policymakers, research institutes and business groups, the G20 platform can also be helpful in bringing international best practices and insights to bear on specific issues.

With the need for an integrated approach in mind, several specific questions were identified for future research and collaboration:

- Saudi Arabia is rapidly developing its programs and capabilities in the area of energy efficiency and ESCOs focusing on public buildings. Drawing on international best practice, especially from China which has the world's biggest ESCO market, what are the best strategies to extend the Kingdom's approach to cover the industrial sector? Can a more integrated approach involving renewable energy be taken?

- What is the scope and potential for greater use of district cooling to improve energy efficiency in Saudi Arabia?

- What are the strategies for creating mutually beneficial pathways for economic transformation and energy transition for industries like petrochemicals in Saudi Arabia, especially as domestic feedstock prices rise?

- How does new knowledge creation and technology shape the evolution of high value industries and what is the link between energy efficiency and other elements for industrial upgrading?

- How can a better alignment of local regulatory approaches with regional – Gulf Cooperation Council states – and global standards reduce the risks of investing in infrastructure and new technologies related to energy transition in the Kingdom?

About the Workshop

KAPSARC and the Energy Research Institute (ERI) of China's National Development and Reform Commission (NDRC) convened this joint workshop in Beijing on December 7, 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, though none of the content in this briefing can be attributed to any individual attendee. A special acknowledgement, however, is due to Dr. Yuge Ma from Oxford University's School of Geography who provided a valuable synthesis of the workshop, upon which this brief draws.

List of Participants

Quan Bai – Executive Director of Energy Efficiency Center, Energy Research Institute of NDRC

Chris Barry, Principal – Wood Mackenzie

Jeroen de Beer – Associate Director, Navigant Energy

Dongmei Chen – Research Fellow, KAPSARC

Oleg Dzioubinski – Economic Affairs Officer, United Nations Economic Commission for Europe

Guanyun Fu – Researcher of Energy Efficiency Center, Energy Research Institute of NDRC

Shixian Gao – Deputy Director General, Energy Research Institute of NDRC

Abeer Al Ghamdi – Research Associate, KAPSARC

Faisal Al Ghamdi – Research Associate, KAPSARC

Lijing Gu – Associate Researcher, Energy Research Institute of NDRC

Naif Hawwas – Renewable Energy Project Development Office, Ministry of Energy, Industry and Mineral Resources, Saudi Arabia

Ping He – Director of Industry Program, Energy Foundation

David Hobbs – Vice President of Research, KAPSARC

Tao Hong – Researcher of Resource and Environment Institute, Development Research Center, the State Council

Nicholas Howarth – Research Fellow, KAPSARC

Sultan Al Jebreen – Credit Team Leader, Saudi Industrial Development Fund

Ying Jia – Senior Manager of Health, Safe and Environmental Protection, SINOCHEM

Jian Jiao – Deputy Director of Energy Efficiency Investment and Assessment Committee, China Energy Society

Yujing Li – Deputy Chief of Energy Division, Industrial Development Department, China Petroleum and Chemical Industry Federation

Benoit Lebot – Executive Director, International Partnership for Energy Efficiency Cooperation (IPEEC)

Nan Li – Researcher, Energy Research Institute of NDRC

Jianguo Liu – Assistant Researcher, Energy Research Institute of NDRC

Yuge Ma – Research Fellow, School of Geography, Oxford University Center for the Environment

Ahmed Al Mohamed – Associate Professor, King Saud University

Steven Nadel – Executive Director, American Committee of Energy Efficiency Economy (ACEEE)

Monsour Ohali – Saudi Center for International Strategic Partnerships, Ministry of Energy, Industry and Mineral Resources, Saudi Arabia

Arthur Oke – Wood Mackenzie

Padu Padmanabhan – Visiting Research Fellow, KAPSARC

Qingbing Pei – Researcher, Energy Research Institute of NDRC

Jing Sang – Executive Director, China Committee of Energy Efficiency Economy (CCEEE)

Jigar Shah – Principal Industry Specialist, International Finance Corporation (IFC)

Abdullah Al Shebel – Associate Professor, King Saud University

Dan Shi – Secretary of Party Committee, Industrial Economy Research Institute of China Academy of Social Science

Honglei Sun – Director for Science and Research Division, Energy Research Institute of NDRC

Pengcheng Sun – Energy and Environment Department of Sinopec

Samuel Thomas – Energy Efficiency Division, International Energy Agency (IEA)

Hamad Al Towaijri – Associate Professor, King Saud University

Johannes Urpelainen – Prince Sultan bin Abdulaziz Professor for Energy, Resources and Environment, Institute for Sustainable Energy Policy, Johns Hopkins School of Advanced International Studies

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

Huawen Xiong – Deputy Director of Energy Efficiency Center, Energy Research Institute of NDRC

Juan Yang – Researcher Market and Price Research, Institute of NDRC

Xiaofan Yang – Analyst, Economic and Technology Research Institute of Sinopec

Yuxia Yin – Senior Project Manager, German International Cooperation Agency (GIZ)

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

Jiqing Yu – Division Chief, China Petroleum Planning and Engineering Institute

Enrui Zhang – China Quality Certification Center

Junfeng Zhang – Division Chief of Health, Safety and Environmental Protection Department, CNOOC

Siyao Zhang – Assistance Researcher, Energy Research Institute of NDRC

Xiangnong Zhang – Division Chief for Energy Management and Environmental Protection, SINOPEC

Yousheng Zhang – Deputy Director General, Energy Research Institute of NDRC

Junhua Zhou – Deputy Chief of Energy Conservation and Low Carbon Division, Industrial Development Department, China Petroleum and Chemical Industry Federation

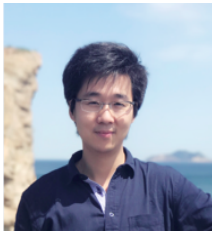
Sheng Zhou – Professor, Tsinghua University

Yuezhong Zhu – Director for International Research Center, Energy Research Institute of NDRC

About the Team

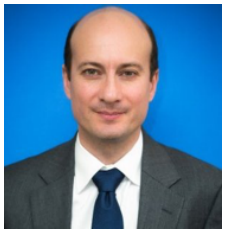
Dongmei Chen

Dongmei is a research fellow at KAPSARC focused on 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 before she joined KAPSARC.



Fu Guanyun

Fu has been working in the Energy Efficiency Center, Energy Research Institute of the National Development and Reform Commission since July 2010. He mainly focuses on energy consumption and energy efficiency policies research and quantitative analysis in the industry sector.



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 holds a Ph.D. in Economic Geography, specializing in energy, technological change and climate change, from Oxford University.

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 adviser for the U.S. Agency for International Development/India's bilateral economic assistance program. He has worked with the World Bank in Washington D.C.

Kang Wu

Kang is the Program Director for Markets and Industrial Development at KAPSARC. He conducts research on energy policy, energy security, oil and gas markets and the environmental impact of energy use with a special focus on Asia (particularly China) and the Middle East. Prior to joining KAPSARC, he was vice chairman, Asia, at FGE, an international consulting company, for three years and held various research positions at the East-West Center in Honolulu, Hawaii, for over 20 years. Kang holds a Ph.D. in Economics from the University of Hawaii at Manoa.

About the Project

This project highlights how an energy productivity narrative can be used by policymakers to integrate a range of energy policy and development issues, while keeping energy efficiency center stage as the 'first fuel.' Using energy productivity – or energy intensity – as an indicator and target is also a powerful tool available to governments to give strategic direction to energy efficiency and a range of sustainable development goals. At the macroeconomic level, energy productivity is driven by energy efficiency and the structural balance between energy intensive and less energy-intensive industries. At the microeconomic level, energy productivity relates to the amount of revenue created per unit of energy, whereas energy efficiency typically relates to the amount of energy required to produce a ton of output such as steel or cement. Energy productivity thus incorporates energy efficiency but can also integrate many areas of energy policy.

Selected Energy Productivity and China Project Publications

KAPSARC-ERI (2018) Toward Economic Prosperity Through Industrial Energy Productivity Improvement: A Saudi Arabia-China Joint Report, Riyadh and Beijing, February 2018/KS-2018-DP28

KAPSARC-UNESCWA (2017) Growth through diversification and energy efficiency: Energy productivity in Saudi Arabia. KAPSARC-UNESCWA Consultation Report, December KS-2017-DP024.

Howarth, N. Chen, D. and Guan F. (2017) Achieving growth in Saudi Arabia and China through joint leadership on industrial energy productivity, IPEEC Bulletin, 21 December, Paris.

Gelil, I. Howarth, N. and Lanza, A. (2017) Growth, Investment and the low carbon transition: A view from Saudi Arabia, KAPSARC Discussion Paper, July 2017/ KS-2017-DP14

KAPSARC (2016) Step by Step: The Reform of China's Energy Economy, KAPSARC Workshop Brief, KS_1625_WB024A.

Howarth, N., Lester, L., Min, J., & Xia, Y. (2014). Managing China's energy productivity potential: Lessons for policy makers. KAPSARC Discussion Paper. October, 2014 KS-1409-DP03A

Notes

www.kapsarc.org