KAPSARC Quarterly

Research highlights

Energy Productivity as a New Growth Model for GCC Countries

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Impacts of Higher Energy Efficiency on Growth and Welfare across Generations in Saudi Arabia

Energy policies in oil-rich countries of the GCC region does influence their domestic growth in the long run. Accordingly, they also redistribute income across generations over long periods.
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Understanding how energy demand responds to prices changes is crucial for policymakers around the world. Elasticity is a quantitative measure of this response. This subject has been widely analyzed in empirical studies, but the quality of the results varies, leading to limited comparability across countries.
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Energy security is not a new topic for policymakers in Northeast Asia (NEA). The paradigm usually adopted by both researchers and policymakers has been to view energy security as an asymmetric risk. Energy suppliers worry about security...
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In preparation for the upcoming mid-term review of the U.S. Greenhouse Gas (GHG), Emissions/Corporate Average Fuel Economy (CAFE) and Zero Emission Vehicle (ZEV) programs, policymakers will be interested in insights as to the likely...
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China's past reforms have moved its electricity sector to the middle ground between fully functioning markets and a command system. The price formation mechanism in particular is still heavily regulated...
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Policymakers in new commodity producing countries are inundated with warnings about the resource curse, Dutch Disease and absorptive capacity constraints. While these are all significant policy issues...
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The mobility sector is undergoing significant shifts including the rise of shared, automated, multi-modal and electric mobility options based on the concept of mobility as a service model. The shared vehicle ecosystem has expanded from...
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Prices Versus Policy: An Analysis of the Drivers of the Fossil Fuel Energy Mix

This paper analyzes the drivers of the fossil fuel mix in the U.S. and compares them to those in Germany and the U.K., given the varied evolution of the fossil fuel mix and the different roles played by relative prices and policies in North America and Europe. To achieve this, a dynamic stochastic...
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The expectations of citizens are some of the most important, yet overlooked, aspects of developing oil and gas reserves in new-producing countries. These expectations are closely tied to the forecast income from developing the oil and gas reserves...
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Global gas markets are facing a fundamental change as a result of declining prices and an approaching wave of new liquid natural gas (LNG) supply over 2015-20. With the start of the first U.S...
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The past quarter (Q3 2016) has seen KAPSARC deliver a range of research insights in areas as diverse as boosting energy productivity for economic growth in the Gulf region, rapid transitions underway in the power generation and transport sectors globally, and how changes in energy demand and supply are driving re-assessment of the fuel mix at national and regional levels. Asian energy relations and the challenges for new oil and gas producing countries of eastern Africa were also areas of focus.

Our upcoming calendar in the KAPSARC Energy Workshop Series sees gatherings of experts in demography and energy (Cape Town), Indian energy policy and global coal markets (both in New Delhi), and workshops addressing energy policy analytics and electric power transitions (each in Riyadh). Finally, in this issue, we are excited to highlight new tools and data, as well as to introduce new colleagues as the Center grows towards maturity.

Energy Productivity in the GCC

Our focus this quarter is on the first outputs of our research collaboration with the United Nations Economic and Social Commission for West Asia (UNESCWA) on energy productivity in the Gulf Cooperation Council (GCC). In a series of papers, the lead being *Energy Productivity as a New Growth Model for GCC Countries*, we share details of the methodologies used to model the opportunities and benefits for energy productivity in the region. Accompanying these methodology papers, we assess the benefits to economic growth in the short, medium and long term, and the impact on intergenerational equity.

Applying the concept of Kuznets curves to energy productivity, in *Energy Productivity in the GCC: Evidence From an International Kuznets Curve Analysis*, KAPSARC compares turning points for more economically effective use of energy in developed economies. The analysis found that the GCC will likely continue with high energy intensity at higher levels of national income per capita than countries less well endowed with oil and gas resources. Many advanced economies show strong evidence of having successfully decoupled economic growth from energy consumption along a high energy productivity pathway. GCC countries exhibit this trait only weakly, if at all. However, the availability of low-cost energy does not mean that there are no benefits to economic growth through implementing policies that focus on higher energy productivity. The authors suggest that greater economic value and per-capita income are possible along a high energy productivity growth pathway. This can “help address the Gulf’s energy paradox of the current growth model driving higher energy consumption as a proportion of energy production, while relying on energy export revenues for public investment and spending to support growth.”

To quantify the effects on growth and welfare across generations of different energy policies in Saudi Arabia, we developed MEGIR-SA (a Model with Energy, Growth and Intergenerational Redistribution for Saudi Arabia). As highlighted in *Macroeconomic and Welfare Effects of Energy Policies in the GCC: MEGIR-SA Model*, the model is designed to assess the impacts of diverse policies including increasing end-use energy prices, fostering alternative energy mixes, bolstering energy efficiency and defining different levels of oil production over time while developing a sovereign wealth fund.

Energy policies in the oil-rich countries of the GCC region influence their domestic growth in the long run. This implicitly redistributes income across generations. *Impacts of Higher Energy Efficiency on Growth*

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and Welfare across Generations in Saudi Arabia finds that an annual increase of 4 percent in future energy efficiency would result by 2030 in 1 million barrels per day (bbl/d) of avoided domestic energy consumption, potentially available as additional oil exports. If fully recycled through public current spending or investments, the upward effect on growth could be between 0.3 and 0.6 percent per year by 2030. Most of these benefits accrue to those born after 1990 – who now account for more than half of the current Saudi population – or to future generations. But what of the opportunities for the current generation of the working age population?

Today, GCC governments face a constrained fiscal environment in which consumers expect low domestic energy prices to remain in place. *Investing for Energy Productivity in the GCC: Financing the Transition* suggests that policymakers consider a market-based 'negabarrel' program to stimulate energy productivity investment. Such a program would commoditize the value of avoided energy consumption and could provide social benefits in terms of extra energy available to export and avoided capital expenditure on new electricity generation capacity. This value is currently not available to the private sector and low prices provide weak incentives for the private sector to invest in energy productivity. Furthermore, the creation of energy service companies (ESCOs) could generate up to 1.2 million new jobs in the region and reduce the reliance on welfare during this down phase of the fiscal revenue cycle.

Similarly, large opportunities exist to generate savings to the economy and provide additional employment through buildings efficiency programs. *Evaluating Building Energy Efficiency Investment Options for Saudi Arabia* finds that, given the low electricity prices in Saudi Arabia, it makes little sense for households and other private organizations to invest in energy efficiency. However, when the system-wide benefits from avoided fuel consumption and the reduced need for electricity generation capacity are incorporated, energy efficiency investments are highly cost-effective, especially for residential buildings. Payback periods of less than one year contrast with the current focus of public policy on governmental buildings and the longer term, more ambitious programs contemplated in that sector. It is not a case of “either or” but “both and”.

Electric Power Transitions: Market Opportunities and Emerging Challenges

Technological advance can disrupt the fundamentals of the electric power sector and make obsolete the current role of utilities. A workshop, *New Business and Regulatory Models for Utilities of the Future*, investigated two possible outcomes. First, the penetration of distributed energy resources (DERs) could lead to policies becoming increasingly local and the power sector being more fragmented, both in its value chain and services traded. Second, the value chain can be unbundled further by creating a platform, potentially operated by the utility, to trade these products and services. The challenge for regulators is to create functional markets that can handle unbundled services, prevent technological lock-in and protect the vulnerable.

Considering that the “local” component of energy policies will probably become increasingly important with high penetration of DERs, a recent discussion paper examines the question, *Is Unbundling Electricity Services the Way Forward for the Power Sector*? The paper discusses the value attributes of electricity (from different stakeholder perspectives), emerging business models, the principles of the sharing economy and rapid innovation in technology.

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The Renewable Energy Policy Paradox examines challenges created by boosting the share of renewables to decarbonize the power sector, which creates a paradox in liberalized markets. Successful penetration could make renewables a victim of their own success, increasing the cost of future deployment while reducing their scalability. If all power had zero marginal cost, which is true of some renewables, it could lead to the collapse of a liberalized electricity market. To streamline a transition to low-carbon sources, current power markets require restructuring – potentially even a reversal of liberalization.

India's bid to transition to a comparatively low-carbon economy involves one of the world's largest renewables programs. The workshop on *Renewable Energy Policy in India: Creation, Implementation and Efficacy*, examined the enormous implications for policy and sustainability associated with the target to build 175 GW of renewable capacity by 2022. Power generation developers and investors are calling for better policy alignment to improve the operational and financial performance of utilities. Unless policy creates a financeable business proposition, free of political interference to provide unsustainably subsidized electricity and reflecting appropriate grid integration and management costs, India's underdeveloped capital market will constrain deployment.

Future of Mobility

Two workshops explored different perspectives on the future of mobility. In *Drivers of Transportation Fuel Demand: Aligning Future Scenarios and Policy Expectations*, initiatives in California were examined as a test bed for policies to drive adoption of alternative vehicles. The zero-emissions vehicle (ZEV) mandate currently straddles the line between an innovation policy and a technology-forcing policy. The near-term goal is to foster innovation and introduction of ZEV technologies in a way that accelerates both cost reduction and consumer familiarity, while the long-term goal is to achieve extensive greenhouse gas (GHG) reductions.

A second workshop, *Mobility-on-Demand: Understanding Energy Impacts and Adoption Potential*, explored the potential for ride-sharing services to alter the outlook for fuel demand. Enhanced personal mobility and economic gains from mobility-on-demand are expected to affect societal welfare — impacting energy demand, GHG emissions, alternative fuel vehicle adoption and congestion. The outcome of either an increase or decrease in vehicle miles travelled will depend on whether mobility-on-demand replaces mass transit or personal driving.

Energy Demand and Drivers of the Fuel Mix

Much of KAPSARC's work is focused on demand, in line with our aim to develop insights in the 'white spaces' of the energy sector that are not as well served by existing institutions. *Quantifying Worldwide Demand Elasticities as a Policy Tool* makes use of data developed in collaboration with the Euro-Mediterranean Center on Climate Change (CMCC) to provide a comprehensive worldwide database of estimated elasticities for electricity and natural gas for households as a function of income, price, capital stocks and weather conditions.

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As fuel prices are reformed in the GCC, a key question is whether the empirical estimates of demand elasticities will continue to hold true for the potentially large adjustments being discussed. *The Responsiveness of Fuel Demand to Gasoline Price in Passenger Transport: A Case Study of Saudi Arabia* provide a techno-economic estimate of the price elasticity of fuel demand that incorporates consumer choices as a result of several factors, including fuel substitutes, available transport modes, income, value of time and magnitude of price change. It provides reassurance that even price changes beyond the range of historical experience are likely to lead to predictable changes in gasoline demand.

Prices Versus Policy: An Analysis of the Drivers of the Fossil Fuel Energy Mix is part of a project analyzing drivers of the existing mix and the transition to a future mix in which renewables will have a key role. This initial study undertakes a macroeconomic analysis of the importance of prices relative to policy in shaping the mix for three economies (the U.S., Germany and the U.K.) over the last 35 years.

Asian Energy Relations and Chinese Power Regulations

Over the past 18 months, KAPSARC has been leading a collaboration with a group of research institutes and think tanks to explore the relationships between countries in the GCC and the economies of Northeast Asia (NEA). *Energy Relations and Policy Making in Asia* summarizes the key insights from the book of the same name, soon to be published by Palgrave MacMillan.

Our work on building a new model of the Chinese energy economy continues, with the electric power sector now being added to complement a previous discussion paper on the coal sector, which noted the savings from improved logistics and the potential spillover into global seaborne coal prices. The new work on the economic inefficiencies that appear to result from price caps in the electric power sector notes that “capped on-grid tariffs incentivize market concentration and vertical integration so that generators can cross-subsidize power plants, ensure an uninterrupted supply of fuel and reduce the impact of volatility in fuel prices.” But at what cost? *Potential Gains From Reforming Price Caps in China’s Power Sector* also finds that “tight price caps can cause the system to deviate from the least-cost capacity and fuel mix. In 2012, this resulted in an additional annual cost of at least RMB 45 billion, or 4 percent of China’s total power system cost.”

Natural Resource-Led Development in New Producing Countries

Our work on East Africa’s new producers has been supported by a developing community of policymakers and researchers. A recent workshop, *The Expectations of Stakeholders in Eastern Africa’s Oil and Gas*, addressed the importance of managing stakeholder expectations in order to maintain the social license to operate. One of the simplest ways to do this is to have early discussion on what, in real terms, an individual or family can expect in welfare gains from the windfall revenues that will go to the government.

Our briefing on *Sub-Saharan Africa Resource Development and the Demographic Dividend* finds that “natural resource-driven development in Africa to date has not led to economic growth that significantly improved the welfare of people in these countries. The sector will not create enough jobs to cater for the number of people entering the workforce in the future without proper investment in health care, education and nutrition.”

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Discovery of massive oil and gas resources, such as those in Eastern Africa, can potentially lead to increasing exports, higher government revenues and foreign direct investment, and accelerating the pace of economic growth. An additional workshop on the *Macroeconomic Impacts of Natural Resource Development*, explored the reality that new producing countries must learn to manage both the macroeconomic impacts of these discoveries and the expectations of stakeholders in oil and gas development. This requires joint effort by the executive branch planning authorities, including ministries of finance, planning and development, and central banks.

Oil and Gas Markets

Two years of collaborative work with the Oxford Institute for Energy Studies (OIES) culminated in the publication of *LNG Markets in Transition: The Great Reconfiguration*. This report sets out current pressures on the global gas business resulting from the medium-term overbuild of capacity and their lasting echoes in the structure of LNG markets. One key question is how the European gas market will evolve. In *Will There Be a Price War Between Russian Pipeline Gas & US LNG in Europe?*, we provide insights into how Russia could respond to the potential challenge of large quantities of LNG flooding European gas markets.

The surge in tight oil production, coupled with the fall in oil prices, has spawned a variety of opinions about the robustness of these supplies to lower prices. A joint paper with researchers from MIT, Schlumberger and the Brookings Institution, *Tight Oil Development Economics: Benchmarks, Breakeven Points and Inelasticities,* provides some thoughts around how these different "$ per barrel" figures relate to each other and what drives breakevens.

Energy-Water-Food Nexus

Over the past two years, KAPSARC has released several studies examining the intersection among energy, food and water. This culminated in a workshop to launch a special issue of the *International Journal of Water Resources Development*. The briefing on discussions at the workshop, *Emerging Issues for the Energy-Food-Water Nexus*, notes that, "as economies in the Middle East and Asia grow and develop, there will be further strain on water, energy and food resources – each inextricably linked to the others." Much of the Middle East is energy-abundant, but population growth and economic development have led to severe water and food scarcity. In Asia, despite a comparative abundance of water, energy and food, the problem is increasingly one of economic scarcity – the inability to finance the mobilization of these vital resources.

Energy Workshop Series

November 2016

Coal Markets
New Delhi, *November 15, 2016*

India Energy Policy
New Delhi, *November 16, 2016*

Demography and Energy
Cape Town, *November 21, 2016*

December 2016

Energy Policy Analytics
Riyadh, *December 13, 2016*

Energy Transitions
Riyadh, *December 15, 2016*

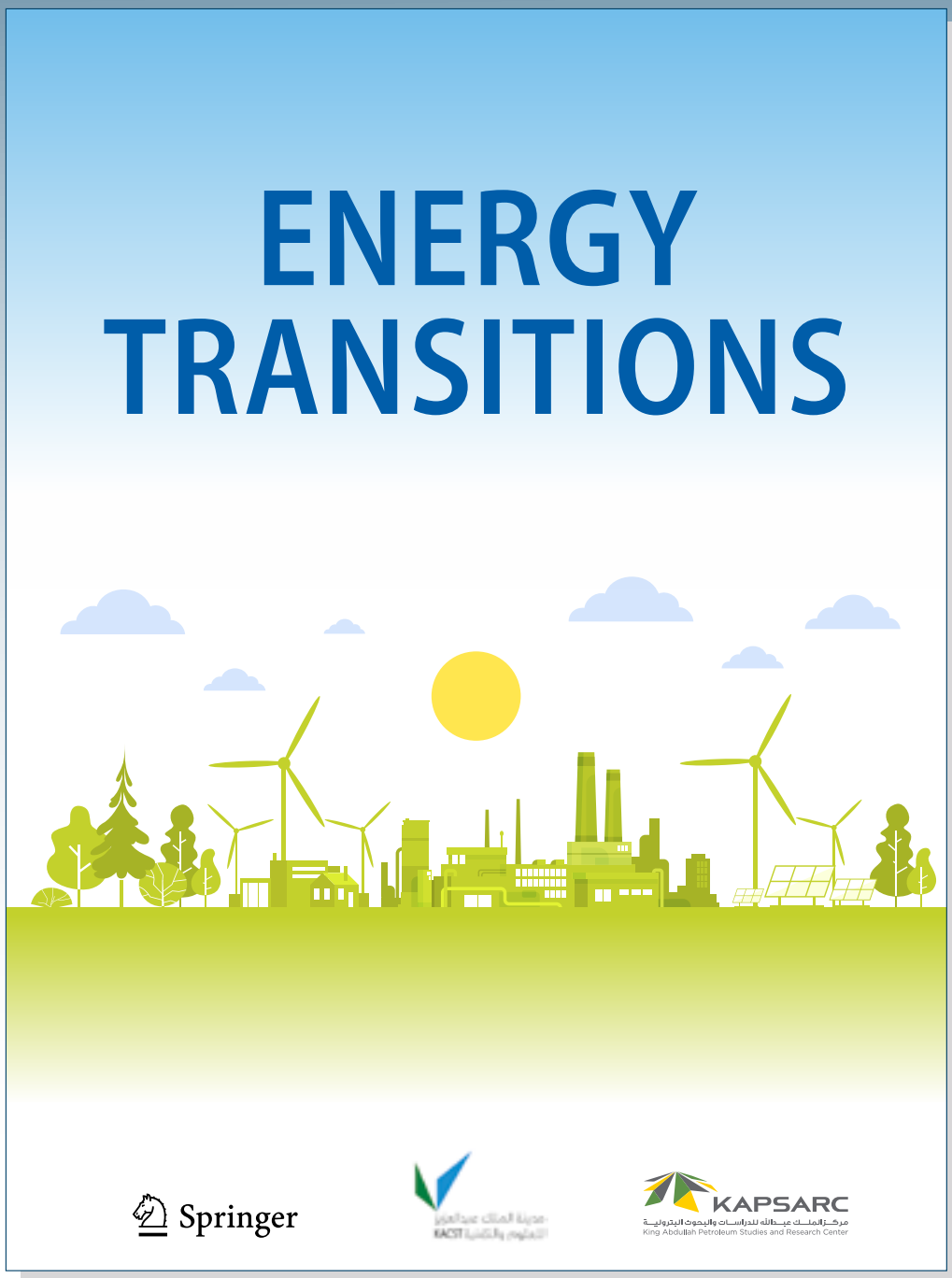
January 2017

Energy Systems Modeling
Riyadh, *January, 2017*
TBA

Announcing a new journal
co-edited by KAPSARC and KACST

Energy Transitions is an international, multidisciplinary journal that evaluates the policy, economic, and technical challenges and opportunities of energy transitions in the Middle East and North Africa region.

Submissions will be welcomed from December 2016 and the first issue will be published early in 2017. To register your interest please email energytransitions@kapsarc.org



ENERGY PRODUCTIVITY IN THE GCC

Energy Productivity as a New Growth Model for GCC Countries

Kankana Dubey, Marzio Galeotti, Nicholas Howarth and Alessandro Lanza

The first decade of the 21st century was a time of unprecedented economic growth. The world got richer, and the countries that make up the Gulf Cooperation Council (GCC) raced ahead off the back of a commodities super-cycle and booming government revenues.

With the financial crisis of 2008 came the fall. Today, with China slowing, low energy prices and weak economic demand, governments around the world are confronting the reality that the growth models of the past were built on shaky, and in many cases, debt-laden foundations.

Of the three main growth tools available to policymakers – monetary policy, fiscal policy and structural reform – cash-strapped governments have over-relied on their central banks. While productivity has long been recognized as the foundation of an economic growth, we have heard a lot less about the structural reform needed to drive it than perhaps we should. This paper makes the case for placing energy productivity at the center of an economic development strategy in GCC countries. With energy such a vital resource in the region, energy productivity provides a natural measure of how well an economy is doing at utilizing the energy it consumes, focusing on gross domestic product (GDP) growth, economic diversification, innovation and energy efficiency. It thus captures a significant part of the economic reform agenda in the GCC.

At the macroeconomic level, energy productivity describes how much value (generally measured in GDP) can be produced using an amount of energy (generally measured in tons of oil equivalent [toe]). It is thus a reflection of both what activities are undertaken in the economy (degree of structural diversification) as well as how energy is used (energy efficiency). It goes beyond energy efficiency to focus on the optimization of energy use in generating income and economic value.

A simple comparison of energy productivity in the GCC with a selection of advanced economies shows several important trends and features. First, over recent decades the energy productivity of advanced economies has improved, whereas in the GCC it has been on a falling trend, except in Bahrain and Qatar where it has risen. In 1980, energy productivity was high in the GCC, reflecting the high level of GDP (consistent with the strong oil revenues of the era) and low domestic energy consumption (reflecting the relatively immature stage of economic development at the time).

Following the collapse of oil prices in the 1980s, government revenue and GDP fell, bringing down energy productivity from these high levels. In the 1990s, the region slowly recovered through a program of economic development, which sought to improve its resilience to swings in the oil market through economic diversification. In the first part of this century, the resurgence in oil prices and government revenue allowed for ambitious spending programs and brought great advancements in infrastructure and human development. Following the recent volatility in oil prices, concerns have once again resurfaced about the region's over-reliance on oil and gas for its economic development. Diversification and energy efficiency policies have assumed a new urgency, as governments carefully evaluate the fiscal sustainability of existing growth models.

The evidence from an international Kuznets curve analysis conducted for this paper suggests that greater economic value and per-capita income is possible along a high energy productivity growth pathway. While many advanced economies show strong evidence of having successfully decoupled economic growth from energy consumption along a high energy productivity pathway, GCC countries exhibit this trait only weakly, if at all.

This paper argues that setting national energy productivity targets would offer a powerful political narrative to amplify and extend existing efforts in the policy arenas of economic diversification, energy efficiency and innovation. Setting targets would also provide greater transparency around monitoring and evaluating progress against such goals. National targets can also be used as a coordinating instrument for institutions with shared goals.

Download the Paper

Energy Productivity in the GCC: Evidence From an International Kuznets Curve Analysis

Marzio Galeotti, Nicholas Howarth and Alessandro Lanza

This paper explores energy productivity trends at a national level for the countries of the Gulf Cooperation Council (GCC) and puts them in an international context. This analysis can be used as part of an evidence base for setting nationally-appropriate energy productivity targets.

The need for this research is motivated by recent volatility in oil markets, which has spurred an urgency among GCC policymakers to find a new growth model that reduces their dependence on oil and gas, currently accounting for between 60 to 90 percent of government revenue. Some effort has been made toward this goal, primarily through diversification and energy efficiency, but with low domestic energy prices a strong feature of GCC markets, whether meaningful progress is being achieved warrants closer attention. To assess this, energy productivity offers a useful metric and strong policy narrative.

To support this process, this paper applies an energy productivity Kuznets curve analysis for the GCC and compares this with G-7 countries and Australia.

The group of advanced economies investigated shows strong evidence of having successfully decoupled economic growth from per-capita energy consumption – even as per-capita incomes rose. GCC countries exhibit this trait only very weakly, if at all. This highlights the significant structural challenges the GCC region faces in decoupling per-capita income from energy consumption in the context of low energy prices. This paper presents the detailed data and analysis behind its companion paper *Energy Productivity as a New Growth Model for the GCC* (Dubey, et al. 2016).

This work is part of a program of research being conducted by KAPSARC with the United Nations Economic and Social Commission for West Asia (UN ESCWA), aimed at providing the evidence base, policy tools and institutional capacity to improve energy productivity in the Gulf region.

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Macroeconomic and Welfare Effects of Energy Policies in Saudi Arabia: Introducing the MEGIR-SA Model

Frédéric Gonand

MEGIR – Model with Energy, Growth and Intergenerational Redistribution – investigates the long-run implications for growth and equity across generations of different energy policies. It is the first general equilibrium model with overlapping generations to be developed and applied for energy policy analysis in the Arabian Peninsula. The version presented here is parameterized on Saudi data. It is a new and thoroughly revised version of the model developed for western countries by Gonand and Jouvet (2015). It is designed specifically for the economies of the Gulf Cooperation Council (GCC) states, particularly insofar as it incorporates an oil-exporting sector and public finances benefiting massively and directly from oil exports.

Its range of applications goes from modeling the impact on growth and intergenerational equity of higher energy efficiency, to the assessment of the effects of different potential fuel mixes and/or end-use energy prices on long-term growth and welfare distribution by age cohort. The MEGIR-SA model is also well suited to being adapted to include a sovereign wealth fund or for other oil-exporting countries. The main advantage of MEGIR-SA is its ability to analyze precisely and simultaneously the effect of energy policies on potential growth and on intergenerational equity. This has some unavoidable cost in terms of modeling other aspects of the economy – e.g., the modeling of the supply side is more simplified than in models incorporating input-output matrix.

This paper provides the detailed technical description of the model that is used in other companion, policy-oriented, KAPSARC papers. It also gives the characteristics of the baseline, no-reform scenario for the Kingdom of Saudi Arabia (KSA) as assessed by MEGIR-SA.

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Impacts of Higher Energy Efficiency on Growth and Welfare across Generations in Saudi Arabia

Frédéric Gonand

Energy policies in oil-rich countries of the Gulf Cooperation Council (GCC) region do influence their domestic growth in the long run. Accordingly, they also redistribute income across generations over long periods.

KAPSARC developed MEGIR-SA (Model with Energy, Growth and Intergenerational Redistribution – Saudi Arabia) to assess the quantitative effects on growth and welfare across generations of different energy policies in the Kingdom – such as increasing end-user energy prices, fostering alternative energy mixes, bolstering energy efficiency and defining different levels of oil production over time while developing a sovereign wealth fund. A particular strength of MEGIR-SA is its capacity to compare the welfare effects of energy policies across age groups, current or future, and to compute simultaneously the aggregate impact of these policies in a unified setting.

This paper uses MEGIR-SA to assess the aggregate effects of higher energy efficiency in Saudi Arabia. Increasing energy efficiency can be significantly achieved through tighter efficiency regulations rather than by additional direct government spending – especially in Saudi Arabia. In MEGIR-SA, an increase in energy efficiency affects the economy through three main channels: a) Substitution effect – which lowers energy consumption for a given level of output and which is partially offset by an income effect resulting from higher available income and leading to higher levels of activity and energy consumption; b) Oil income effect – where the lower domestic energy consumption stemming from improved energy efficiency accounts for higher Saudi oil exports and public income; c) Recycling effect – where the additional public oil income is recycled in the Saudi economy through higher current public spending or higher public investments.

Results suggest that an annual increase of 4 percent in future energy efficiency would result by 2030 in 1 million bbl/d of

avoided domestic energy consumption and thus enable additional oil exports. Saudi oil income could increase by SAR 50 to SAR 100 billion per annum by 2030, depending on oil market conditions. If fully recycled through public current spending or investments, the upward effect on growth could be between 0.3 and 0.6 percent per year by 2030. Under pessimistic oil market and domestic oil production assumptions, our model suggests there would be a significant benefit in recycling additional oil revenues into public investments in infrastructures.

Most of the economic benefits of higher energy efficiency gains would accrue to individuals born after 1990 – who account for more than half of the current Saudi population – or to future generations. The welfare effect is limited for those Saudis who are already adults.

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Investing for Energy Productivity in the GCC: Financing the Transition

Kankana Dubey, Steven Fawkes, Nicholas Howarth, Moncef Krarti and Padu S. Padmanabhan

An unprecedented infrastructure investment boom occurred in the Gulf Cooperation Council (GCC) in the first part of the 21st century. Strong public capital spending supported by high energy prices provided governments with an opportunity to accelerate economic diversification and infrastructure investment, lifting economic growth and per-capita incomes. The 2014 collapse in oil prices created an added impetus for a transition to a more sustainable growth model, less dependent on volatile energy markets. Here we make the case for a greater focus on energy productive investment to drive this transition.

Although evidence suggests that some GCC countries are beginning the transition to a more energy productive investment paradigm, in other countries capital investment is not lifting energy productivity. Particular progress has been made in recent years in the UAE, Saudi Arabia and Kuwait. Qatar has experienced the strongest growth in infrastructure investment (in percentage terms), but in recent years its energy productivity has declined significantly. In Bahrain, a decline in capital investment has also been accompanied by stagnation in its once-improving energy productivity. Oman remains strongly on a low energy productivity growth path.

Given that GCC governments face a constrained fiscal environment and low domestic energy prices remain in place for consumers, we suggest that policymakers consider a market-based 'negabarrel' program to stimulate energy productivity investment. Such a program would commoditize the value of avoided energy consumption and could provide social benefits in terms of extra energy available to export and avoided capital expenditure on new electricity generation capacity. This value is currently not available to the private sector and low prices provide weak incentives for the private sector to invest in energy productivity.

A 'negabarrel' program on the scale of around USD 100 billion across the GCC implemented over 10 years could incentivize private sector investment, generate around 800,000 to 1.2 million new jobs and increase government revenue, if a robust energy service company (ESCO) market can be established. Implementation programs, such as super-ESCOs, need careful planning, but can deliver substantial economic benefits and employment opportunities for GCC citizens in the area of energy auditing and management.

Even in a low oil price environment, there are significant opportunities to improve energy productivity in a cost-effective way across the GCC economies. The potential national benefits should make this an investment priority. Within Saudi Arabia improving energy productivity can sit well within the 2030 vision direction. Recent increases in end-user energy prices across the GCC, have shifted the balance of benefits more toward the energy user but joint public-private sector actions will still be necessary to catalyze the required actions.

Download the Paper

Evaluating Building Energy Efficiency Investment Options for Saudi Arabia

Kankana Dubey, Nicholas Howarth and Moncef Krarti

This paper explores investment options for policymakers interested in improving the energy efficiency of the building stock in Saudi Arabia. To inform such efforts, we provide a comprehensive analysis of large-scale retrofit options for both new and existing buildings in terms of avoided energy consumption, power generation capacity, job creation and carbon dioxide (CO_2) mitigation. This study fills a gap in published literature on the topic as most other work has only considered a limited set of design and operating measures and generally focuses on residential buildings, rather than the entire building stock, as we do here.

Our optimization analysis assesses the impact of different types of investment at both the individual building and the national building stock levels. We focus on the application of well-established and proven measures and technologies. The study is based on detailed simulation analysis of prototypical buildings located in five cities with differing climates across Saudi Arabia.

From an economic perspective, given the low electricity prices in Saudi Arabia, it makes little sense for households and other private organizations to invest in energy efficiency. However, when the system-wide benefits from avoided fuel consumption and reduced need for electricity generation capacity are incorporated, then energy efficiency investments become highly cost-effective, especially for residential buildings.

As would be expected, the benefits from energy efficiency are amplified when retail electricity prices are higher. In this report, we calculate the benefits from energy efficiency investments using a range of prices from current average tariffs after the recent round of price reforms of approximately USD 0.05 per kWh, up to an electricity price of around USD 0.17 per kWh.

Three levels of energy efficiency investments are considered, from basic through to deep retrofits. We also highlight the results for residential buildings and the entire building stock, which includes commercial and government buildings.

A basic energy retrofit program based on easy-to-implement energy efficiency measures for the existing building stock and implemented for residential buildings could reduce electricity consumption by about 10,000 GWh/year, peak demand by 2,290 MW and CO_2 emissions by 7.6 Mt/year. Such a program is highly cost-effective with an investment payback period of less than a year, driven by a reduced need for power generation capacity (USD 2.7 billion over the lifetime of the program) and an avoided cost of electricity consumption of between USD 500 million and USD 1.7 billion per year, depending on the assumed power tariff.

Deeper retrofits for residential buildings are still cost-effective within a reasonable payback period, but their attractiveness is significantly influenced by electricity tariffs, highlighting the importance of further price reforms in the Kingdom.

Our analysis suggests the most cost-effective investments are to be found within the residential building stock, rather than the commercial or government sectors. This contrasts with where the bulk of recent state investments have been made, focused mostly on public buildings. While it is perhaps easier to implement energy efficiency measures on government buildings, our analysis suggests the payoff is probably higher if investment is extended to other building types.

Another potential reason for this distribution of attention is that most of the benefits of energy efficiency investment accrue at the system level and therefore to the mostly state-owned utilities. In this paper, we have (conservatively) not included the value that selling avoided energy consumption may have in terms of increased oil exports, which we evaluate elsewhere (Dubey, et al. 2016). Even so, the analysis in this paper suggests that the system-wide benefits at the utility level are attractive enough for the public sector to play a strong role in encouraging greater private sector investments through incentive programs, which is also explored in detail by Dubey, et al. (2016).

Download Paper

ELECTRIC POWER TRANSISTIONS: MARKET OPPORTUNITIES AND EMERGING CHALLENGES

New Business and Regulatory Models for Utilities of the Future

Workshop Brief

The electricity sector could soon be in turmoil as technological advances, mainly in distributed energy resources (DERs), threaten to disrupt the market, both upstream and downstream, and possibly even make the current role of utilities obsolete. Up to now, no single universal regulatory or business model solution has emerged to accommodate and support these changes. What is currently available are diverse, local specific proposals.

New technologies may result in two consequences that business and regulatory models cannot ignore. First, local considerations would become increasingly important at the expense of national policies. Second, calls would increase for further unbundling of activities, products and services, which include reliability (MW), energy (MWh), system savings (NWh) and environmental benefits (CO_2 emission reduction).

Distributed technologies have shown that it is no longer possible to lump costs and cross-subsidize activities. Thus, successful future utility business models will be those that are able to create new products, establish more efficient pricing mechanisms and monetize services, which customers could no longer receive free-of-charge.

Regulation will need to adapt to the technological innovations. In the past, with fewer players in the sector, governments were in greater control and could enforce regulations more effectively. The challenge now for policymakers is to come up with frameworks that allow an increasing number of agents to interact and produce socially optimal outcomes. There is, however, a danger that regulation could promote one particular innovation to the detriment of future technologies. Another risk is that a technological solution may end up leaving vulnerable people without a safety net.

Longer term developments could include peer-to-peer transactions, effectively transforming households into energy companies.

Distributed Energy Resources

Distributed energy resources (DER) are smaller power sources, typically in the range of 3kW to 50 MW, which can be aggregated to provide electricity for regular demand. DERs are usually located close to where electricity is consumed, e.g., a home or business. They are parallel to the electric utility or stand-alone units. Power can be sold back to the grid where feasible or permitted by regulation.

Examples of DERs are technologies that produce power outside the utility grid including fuel cells, micro turbines, biomass, wind turbines and photovoltaics. Also, distributed power and any technology that produces or stores power such as batteries. Further examples are demand response, demand-side measures and, on some occasions, electric vehicles.

Source: https://www.wbdg.org/resources/der.php

Download Paper

Is Unbundling Electricity Services the Way Forward for the Power Sector?

Rolando Fuentes

High penetration of distributed energy resources (DERs) will lead to further fragmentation of the power sector, both in the services offered and its value chain. Thus, successful future business models will be those that are able to create new products, establish more efficient pricing mechanisms and monetize services, which customers could no longer receive free-of-charge. We suggest that the principles of what is known as the ‘‘sharing economy’’ could be applied to redefine these products and manage the fragmentation of the industry while keeping transaction costs in check.

The important feature for business models is that DERs eliminate opportunities for implicit cross-subsidy between these attributes, exposing the presence of potential free riding among customers and making it difficult to lump all services into a single tariff. Therefore, the challenge for new business models would be to find a way to monetize the value of each of these attributes separately, according to the consumer’s preferences.

Future electricity business models can borrow elements from companies that operate on the sharing economy principle. The analogy with the sharing economy is relevant in the organization of the electricity sector as under-utilized assets are the norm rather than the exception. Also, because technological advances could lead to a world of distributed autonomy in which no single entity has full information or is able to bring about collective coordination. Thus, the new role of utilities could be as a system integrator and platform provider.

The experience of regulating sharing economy firms can also illustrate the challenge ahead for electricity regulators.

Representative companies from the sharing economy act in parallel to the formal sector, such as taxis or hotels, and in overregulated sectors. Most DERs operate behind the meter, alongside the formal power sector. Incumbent firms and regulators have not challenged new entrants’ behavior until they have achieved a noticeable market share. The same logic applies to incumbent utilities and regulators with a growing number of prosumers. The challenge for regulators would be to create functional markets, which can handle unbundled services and prevent technological lock-in. There is a risk of technological lock-in unless regulators stay abreast of innovations in the industry and act to prevent this.

Download the Paper

The Renewable Energy Policy Paradox

Jorge Blazquez, Carlo Andrea Bollino, Rolando Fuentes and Nora Nezamuddin

Renewables with low or zero marginal costs of dispatch – such as solar, wind and hydro power – could fall victim to their own success after capturing large shares in liberalized power markets. Given existing liberalized market structures in most of the developed economies, future deployment of renewables could become more costly and less scalable because of their impact on electricity prices. Paradoxically, a "too-successful" renewables policy could reduce the efficiency and effectiveness of future such policies.

Current liberalized market mechanisms are based on two assumptions: positive marginal costs and the dispatchability of power. Neither of these assumptions is applicable to renewable technologies, because renewables are intermittent and non-programmable, and have almost zero marginal costs. These two characteristics explain why high market penetration of renewables leads to artificially depressed and more volatile electricity prices.

In this scenario, renewables incentives become more expensive and lead to less deployment. In addition, based on existing market designs, 100 percent renewables penetration cannot be achieved because developers of renewable generation would be unable to earn a return on their investment without conventional technologies to provide a floor for electricity prices.

Two important implications of this finding are:

- This paradox applies only to liberalized markets and not to centrally planned systems.
- Penetration of renewables capacity in the current configuration of liberalized markets has limits.

Ignoring these findings can slow adoption and increase the costs of deploying new renewable technologies

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Renewable Energy Policy in India: Creation, Implementation and Efficacy

Workshop Brief

India needs energy to meet its economic growth objectives, yet almost a quarter of its population has limited or no access to electricity. Providing every citizen with access to affordable energy has always been high on the Indian government's agenda. With the rapidly changing economics of solar power, the government has realized that solar and other renewables can potentially transform the energy landscape, increase access and help India meet its climate change objectives. Grid transmission capacity has been a barrier; however, distributed and off-grid solar solutions provide a viable solution in increasing energy access.

Although the government of India has promoted renewable energy (RE) since 2003, the states hold primary responsibility for developing the electricity industry (generation, transmission and distribution). The states have been proceeding with caution on RE, largely because of their political interest in keeping tariffs low. Being dependent primarily on cheap coal-based power generation, the states hold the view that any increase in RE's share of electricity generation will further exacerbate their local distribution companies' current poor financial situation.

Over the years, India has established fairly comprehensive policy and regulatory frameworks to encourage RE development. However, the institutional mechanisms responsible for policy implementation are insufficient or even absent.

To achieve the quantum leap in national-level RE targets by 2022, states will need to realign their goals and strengthen their existing policy and regulatory frameworks. However, the energy generation issues of individual states cannot be ignored. Having additional latitude for states to meet national targets in a coordinated manner could reduce societal costs. Feed-in-tariffs have provided a high level of certainty to investors. However, regulators risk imposing unnecessary costs on society if they fail to adapt to market signals, learning curves and technology innovations. Such adjustments will reduce the policy cost that must be borne by either taxpayers or consumers. Furthermore, balancing requirements brought on by large-scale integration of intermittent renewables will eventually exceed the ability of existing dispatchable power generation to provide this service. The system will then require additional investment in peaking power, increasing overall costs.

Financing will be crucial to achieving the RE target of 175 GW, which comprises 100 GW of solar, 60 GW of wind, 10 GW of small hydro and 5 GW from biomass. Transforming the operational and financial performance of the electricity industry can be achieved by eliminating general subsidies from the supply side and applying them only to those customers in need. Investors see less risk in the "financial covenant" provided by the aggregated balance sheets of customers paying prices that cover production costs than in the government's promise to pay.

The financial and operational challenges of bringing power to communities that are currently off-grid may be better achieved by implementing RE projects. Newly served customers are likely less driven by reliability of service than by cost per unit of delivered electricity. Such installations can support the development of microgrids that serve to aggregate demand and therefore underwrite the costs of future grid connection. Policymakers will have to be cognizant of the fact that an integrated approach to energy policy will be needed to meet future energy requirements. Renewables are just a part of the solution, not the complete solution in itself.

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FUTURE OF MOBILITY

Drivers of Transportation Fuel Demand: Aligning Future Scenarios and Policy Expectations

Workshop Brief

In preparation for the upcoming mid-term review of the U.S. GHG/CAFE and ZEV programs, policymakers will be interested in insights as to the likely outcomes, how these compare with policy expectations and how they could be better aligned.

The current U.S. vehicle regulatory structure represents a layer cake of regulations. The layer cake, with carve-outs such as the ZEV mandate, is a valid approach to achieving the ZEV transition. However, a more stringent, single, unified long-term performance-based standard, with appropriate ZEV incentives, could also achieve an eventual transition to technologies with zero emission capacity, possibly at lower cost than the ZEV mandate. This would be at a slightly slower, but sustainable, pace, however, with equivalent cumulative GHG impact.

It is important to examine the details of each program and to align the expectations and assumptions made during policy formulation with current realities and likely future scenarios. The GHG/CAFE rulemaking assumed that vehicle manufacturers would not change their sales strategies as a result of changed fuel prices. Low gasoline prices imply low fuel cost savings, which reduces the incentive for consumers to pay up front for fuel efficient technologies. Such conditions could lead to more pricing induced sales shift strategies being adopted by automakers. Under such a scenario, higher emission vehicles could end up subsidizing and supporting sales of lower emission vehicles, an outcome similar to that achieved in Europe by discriminatory taxation of higher emission vehicles. It remains debatable what is the most efficient and cost-effective way of achieving the same outcome.

Data from 2012-2014 suggest that some of the assumptions of the regulatory agencies related to technology deployment, efficiency improvements, market drivers (e.g., fuel price) and consumer acceptance may require adjustment. The model year (MY) 2025 standards require overall fleet energy efficiency to be higher than best existing diesel powertrains, which have greater efficiency than today's top 1 percent advanced spark ignition powertrains. This calls into question the degree of hybridization and the penetration of advanced turbocharged spark ignition engines that would be needed to meet the standards.

Although originally conceived as an innovation policy, the high market share mandated by the ZEV regulation from 2018 onwards suggests that it would transition to a GHG reduction policy. The ZEV program seems to be evolving in this manner because it is not easy to encourage industry to pursue radical innovation for public good when the externality costs are not internalized. From a GHG reduction perspective, the carbon dioxide (CO_2) abatement costs for ZEVs, relative to conventional gasoline internal combustion engine vehicles, are in the range of hundreds to thousands of U.S. dollars per metric ton of CO_2 avoided, which is much higher than the social cost of CO_2. Even if the ZEV mandate is still considered as an innovation policy, cost is an important part of the discussion because of the difficulty of scheduling innovation. To round off the cost discussion, it is also important to consider the cost of waiting, with regard to the "irreversible" effects of GHG emission on climate change.

From a societal cost-benefit point of view, it is worth considering emission reductions from transport sectors other than transforming the passenger fleet to ZEV. It may be worth analyzing whether the ZEV mandate and the public-private sector support for subsidizing ZEV production and deployment may be a case of sub-optimal allocation of resources. However, when assessing government support for ZEVs, it is important to consider this in the context of government support for other legacy systems such as fossil fuels.

It is worth examining whether the ZEV mandate is the best possible solution to bring innovative research to the market. It is difficult to understand how encouraging one technology over another, e.g., battery electric vehicles (BEVs) over plug-in hybrid electric vehicles (PHEVs), would lead to more innovation. It might be a reaction to the experience in Europe and China, where although PHEVs helped in complying with the GHG/CAFE standard, they continued to run on gasoline. Europe provides an interesting contrast to the U.S. ZEV program. However, in European countries, a lot more public sector resources are being devoted to ZEV deployment. Thus, from the societal cost benefit point of view, they may be less justifiable than the U.S. ZEV program.

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Mobility-on-Demand: Understanding Energy Impacts and Adoption Potential

Workshop Brief

The mobility sector is undergoing significant shifts including the rise of shared, automated, multi-modal and electric mobility options based on the concept of mobility as a service model. The shared vehicle ecosystem has expanded from station-based car sharing to app-based ride-sourcing, with shared autonomous mobility holding promise for the next phase of the evolution. Shortcomings of the current mobility model, namely high upfront cost of personal vehicle ownership coupled with new consumer preferences and technological developments, are contributing to this evolution.

App-based ride-sourcing, also known as mobility-on-demand, has the ability to influence key aspects of travel behavior, such as vehicle ownership, vehicle miles traveled (VMT) and mass transit use. In developed countries, mobility-on-demand could displace the need for a second vehicle in many households. It could also affect the demand for alternative fuel vehicles (AFVs), such as battery electric vehicles (BEVs), which generally tend to be acquired as a second vehicle. Fuel-efficient AFVs hold promise for adoption by mobility-on-demand drivers and fleet providers because of the higher mileage per vehicle expected. In developing countries with low per-capita income, mobility-on-demand could potentially make vehicle ownership redundant.

Mobility-on-demand could complement other shared-use modes such as mass transit (trains, subways and buses) by helping to resolve the “last-mile” problem. Increased mass transit usage and shared mobility-on-demand could reduce overall VMT.

On the other hand, if a significant number of consumers start using mobility-on-demand in place of mass transit, that could increase VMT. Higher VMT may also occur by demand from sections of the population that previously were unable to drive such as children, the infirm, elderly and disabled.

Enhanced personal mobility and economic gains from mobility-on-demand could result in either societal benefits or costs

depending on its utilization. By using fuel-efficient vehicles, getting the right-sized vehicle to match customers’ needs and higher vehicle occupancy through shared ridesourcing, transport greenhouse gas (GHG) emissions could be reduced. Shared mobility-on-demand in place of driving a personal vehicle could also contribute to lower congestion.

Continued growth of mobility-on-demand will depend on the satisfaction of consumer needs and the value they derive. Personal vehicle ownership offers intangibles other than just mobility, which providers of the mobility service have to understand in order to succeed. At the same time, if consumers get benefits from the mobility-on-demand model that is not currently offered by vehicle ownership, such as using the time during the journey for practical functions, or enhanced social interaction during shared mobility-on-demand, growth may become exponential. Understanding the needs and motivations of current and potential users holds the key to gaining insights into this evolution of mobility.

Download the Paper

ENERGY DEMAND AND DRIVERS OF THE FUEL MIX

Quantifying Worldwide Demand Elasticities as a Policy Tool

Tarek Atalla, Simona Bigerna and Carlo Andrea Bollino

Understanding how energy demand responds to price changes is crucial for policymakers around the world. Elasticity is a quantitative measure of this response. This subject has been widely analyzed in empirical studies, but the quality of the results varies, leading to limited comparability across countries.

In this paper, we provide a new and more accurate approach to estimate aggregate energy demand elasticity for 117 countries. The model that we developed provides a coherent and integrated empirical tool for policymakers to quantify how energy demand responds to policies. The model allows simultaneous variations of prices, income and capital stock or productive capacity, while including climate conditions as an uncontrollable factor.

Our approach is unique in accurately estimating demand response to prices by explicitly modeling a utility-maximizing rational behavior for consumers in each of the countries studied. This implies a better estimation of the energy demand function as it is computed using a structural model based on a simultaneous system of equations, thus avoiding potential econometric bias in the resulting parameters.

Our econometric estimation provides new refined quantitative evidence on the impact of changes in prices and income on energy demand. Specifically, we found that the aggregate energy elasticity to price has a world average of 0.19 and the electricity elasticity to price is between -0.10 and -0.20 for most countries, meaning that both energy and electricity have limited price elasticity. The study found that emerging economies have a lower energy demand price elasticities than advanced ones. In addition, the intra-fuel analysis shows that natural gas is generally perceived as more of an essential good than electricity, especially in less developed economies. This is partly due to the fact that natural gas is mostly used for essential needs such as heating and cooking.

We found that the demand elasticity for cooling needs is triple that of heating, which means more final energy is used for cooling than heating on a per-capita level. Yet people in richer countries are rooted in their comfortable lifestyle when it comes to their heating needs, resulting in positive gas elasticity to heating degree days. This is aligned with the general observation that countries with natural gas endowments prefer to maximize its usage. These findings have welfare-improving policy implications, because appropriate policy strategies can help decision makers to promote production efficiency and consumer welfare.

Download the Paper

The Responsiveness of Fuel Demand to Gasoline Price in Passenger Transport: A Case Study of Saudi Arabia

Ibrahim M. Algunaibet and Walid Matar

Demand for transportation fuels change as the price of these fuels fluctuate. Past empirical analyses provided estimates of a single figure for price elasticity based on historical consumption and prices. However, a concern for policymakers is that this elasticity may not remain constant as the magnitude of the price change becomes larger. A prospective price movement may well be outside of historical variation and consumers may respond more readily when the changes are significant.

Transport is seen as a service first, from which the consumption of fuel arises. Once consumers have made a decision to travel, they can then choose an available mode to satisfy that demand. These decisions to travel are based on a variety of factors, including the costs they perceive – for example, fares, time spent waiting for buses or trains, in-vehicle time, fuel and maintenance costs for private vehicles. Diesel and jet-fuel costs are not directly incurred by travelers, as they are mostly consumed by buses, trains and airplanes, although their levels of use contribute to fares.

We developed a model that considers several factors when assessing consumer choices: the ability to substitute fuels and modes, income and spending budgets, value of time and behavior, and the magnitude of price change from the initial price. We validated and calibrated this methodology in a long-run framework using Saudi Arabia data for 2013. This analysis simulates how people's choices would vary as the price of gasoline is gradually raised to 350 percent above its initial value. A long-run price elasticity curve is generated by considering the aforementioned factors.

This methodology can help governments formulate more effective transport policies and provide assurance as to the validity of elasticity estimates when they want to test policies that fall well outside historical price variations. It also provides insights into how consumers may react to changes in fuel prices, including substantial increases.

Download the Paper

Prices Versus Policy: An Analysis of the Drivers of the Fossil Fuel Energy Mix

Tarek Atalla, Jorge Blazquez, Lester C. Hunt and Baltasar Manzano

This paper analyzes the drivers of the fossil fuel mix in the U.S. and compares them to those in Germany and the U.K., given the varied evolution of the fossil fuel mix and the different roles played by relative prices and policies in North America and Europe. To achieve this, a dynamic stochastic general equilibrium (DSGE) model was developed.

We found that the evolution of the fossil fuel mix in the U.S. for the estimated period 1980-2014 was mostly driven by the evolution of fossil fuel prices, i.e., the prices of oil, natural gas and coal. On the contrary, Germany and the U.K. faced policy and structural changes during the 1980s and 1990s, resulting in an energy transition from coal toward natural gas. During this transition, the prices of fossil fuels played a marginal role. Following each country's transitional period, and once energy policies had stabilized, prices took over as the main drivers of the fossil fuel energy mix (as is the case in the U.S.).

Additionally, to assess the impact of the changes in the energy mix on the German and U.K. economies, we considered a measure of the volatility of private consumption and output for the pre- and post-reform periods. We found that the reforms toward liberalizing the energy markets brought about a transition from coal to natural gas, but at the cost of increased macroeconomic volatility.

Finally, the energy transitions in both Germany and U.K. came about due to a combination of political and structural changes. In Germany, the transition was primarily due to the reunification of East and West Germany, and the subsequent move away from the heavily central-planned coal-fired power system. In the U.K., the transition was driven by the 1980s Thatcher government's agenda to reduce the role of the state and increase efficiency by deregulating, liberalizing and privatizing different parts of the energy industry. Both transitions, however, resulted in a deregulated market-driven energy system where the fuel mix was primarily determined by relative fuel prices – more akin to that in the U.S.

Although this resulted in a "cleaner" fuel mix – as the share of gas increased at the expense of coal – neither transition was instigated by the climate change agenda and the need to reduce carbon dioxide (CO_2) emissions. However, Europe is now in a new 'energy transition' era given the environmental constraints, with a move to increase significantly the proportion of renewables by introducing command and incentive policies to bring about a different energy mix to that would ensue if left purely to the market. It will, therefore, be interesting to see the impact this policy change will have on the sector and how the energy mix evolves over the next couple of decades in Europe compared with that in the U.S.

Download the Paper

CHINA ENERGY POLICIES AND REGULATIONS

Energy Relations and Policymaking in Asia

A Brief Summary of the Book

Energy security is not a new topic for policymakers in Northeast Asia (NEA). The paradigm usually adopted by both researchers and policymakers has been to view energy security as an asymmetric risk. Energy suppliers worry about security of demand; energy consumers worry about security of supply and often about diversity of supply. Our premise is that it is time to replace this paradigm with a new one. Energy security need not be about asymmetric risks: policymakers can, by adopting a broader view, use these energy relations to reinforce mutual interdependence between economies and reduce the risk asymmetries.

These ideas were discussed in a series of workshops held in the GCC and NEA throughout 2015. The result was a collection of papers from 16 different collaborating research institutions on a range of perspectives, with four main themes: the consequences of trade and connectivity, domestic policies, energy security, and energy and the environment. These collected papers are being published by Palgrave Macmillan in 2016, under the title *Energy Relations and Policy Making in Asia*.

In 2013, the countries of the GCC exported $367 billion worth of goods, almost entirely hydrocarbon related, to NEA while imports from NEA totaled $104 billion. To put these numbers in perspective, 44 percent of GCC exports flowed to NEA and 23 percent of GCC imports came from NEA. By contrast, 10 percent of NEA imports came from the GCC, a market which accounted for only 3 percent of NEA's exports. The picture of NEA dependence on the GCC changes markedly if the focus is centered on oil: Japan imports 74 percent of its oil from the GCC, South Korea 71 percent and China 35 percent.

Despite this trade, and the interdependence it might suggest, in other areas the energy relations are very limited. Restrictive upstream ownership laws in both the GCC and NEA have reduced joint ventures to a handful, mostly downstream in refining or through the liquefied natural gas (LNG) projects of Qatar Gas. The only upstream GCC-NEA joint venture is Kuwait's stake in China's Yacheng oil field.

The hydrocarbon trade between the GCC and NEA is also vulnerable to a trio of potential shocks: price volatility; the discovery and exploitation of new fuel sources, such as methane hydrates; and even new supply sources for conventional hydrocarbons. Any of these could shift the energy relationship between the two regions, suppressing economic growth and oil demand, or fundamentally altering the current supply and demand balance and associated trade flows. How the GCC responds to these vulnerabilities will be key to shaping future relationships.

For some years, NEA, and especially China, has been seen almost as a boundless market, soaking up oil and gas. However, demand growth is weakening, storage facilities are filled and NEA markets may no longer be able to absorb excess cargoes. Even in China, the gas supply situation may become much less tight by 2020, once again presenting a challenge to GCC exporters. How countries in the GCC respond to this, to their own growing demand and even to within-region politics and rivalries will again shape the inter-regional relationships. By contrast, the development of oil stockpiles in NEA, and of energy cooperation within and between the regions, could do much to deepen and strengthen the relationships, even against the backdrop of shifting demand.

Despite forecasts by Japan's Institute of Energy Economics (IEEJ) that fossil fuels will continue to supply 80 percent of global energy needs until 2050, environmental concerns have raised the profile of low-carbon technologies, in the form of either renewable energy or improved energy efficiency. More importantly, the costs of renewables continue to fall, and forecasts suggest that solar and wind will be the fastest-growing energy sources in the years to come. This is an area that seems perfect for building cooperation between the two regions. The GCC, with plentiful renewable energy resources, is suffering from growing energy demand and has struggled to improve its energy efficiency. In contrast, NEA economies have great expertise in renewable and energy efficient technologies, and can share lessons learned in using policy to drive improvements in energy efficiency.

Taken together, the energy relations between the GCC and NEA are robust and, while there are vulnerabilities, opportunities exist to offset them. Energy relations need not be merely transactional. In the 21st century, they can also be a way to improve mutual interdependence, to build trust and to lower risk.

Download the Paper

Potential Gains From Reforming Price Caps in China's Power Sector

Bertrand Rioux, Philipp Galkin, Frederic Murphy and Axel Pierru

China's past reforms have moved its electricity sector to the middle ground between fully functioning markets and a command system. The price formation mechanism in particular is still heavily regulated with the government capping prices at which generators sell to utilities. These price caps, which differ by region and generation technology, are designed to limit electricity costs while reflecting market conditions and promoting or restricting a particular technology or fuel type. However, the caps increase costs because the frequency of the price cap adjustments do not always match market movements. This is especially evident when compared against the deregulated domestic coal sector.

Chinese utilities are the sole buyers of power in their regions, making them monopsonists. They can lessen the effect of the on-grid tariff caps by using their market power to redistribute the number of generation hours among contracted power plants and, consequently, price more capacity below the caps. Often, such a redistribution does not match the least-cost solution that would have been available without the caps. The power generators can both improve their profits and lower the cost to the utilities by acquiring an array of power plants that run on a mix of technologies, which are cross-subsidized profitably in contracts with the utilities. The acquisition of multiple plants by producers increases the market concentration of generation.

The risk of volatile coal prices due to the deregulation of coal in association with capped coal-fired generation tariffs that don't allow excess payment schemes – such as fuel adjustment clauses – to cover such fluctuations, encourages vertical integration to alleviate fluctuations in fuel costs and ensure uninterrupted supply. However, the losses incurred by power generators, as well as various subsidies received from national and provincial governments, suggest that these strategies are insufficient to mitigate distortions caused by the price caps.

In order to assess the effect of the on-grid tariff caps, we designed a bottom-up, mixed complementarity problem (MCP) model that represents Chinese coal and power sectors and minimizes the total systems costs with and without market-altering regulations. We calibrated the model based on 2012 data and developed a set of scenarios to illustrate the impact of China's price control policies on power generation within the current energy system and under a range of wind capacity targets.

We found that price deregulation eliminates generator losses and the need for cross-subsidization among power generation technologies, and would have resulted in at least RMB 45 billion of cost savings in 2012, or equal to 4 percent of the power system costs. It also facilitates grid integration because regions no longer need to hoard base-load generation to stay below the caps and, consequently, raises interregional electricity trade by 234 TWh. This increased power transmission would eliminate 6 percent of physical coal transportation, reducing required investment in coal railway infrastructure.

Abolishing restrictive tariff caps on coal-fired generation does not increase coal consumption because of a drop in the utilization of coal plants for peak shaving. On the other hand, forcing significant wind capacity into the market also does not substantially reduce coal use – due to coal's cost-competitiveness.

Deregulation increases the amount of government subsidies required to bring wind capacity online by shifting the cost burden from the utilities. However, as installed wind capacity increases, the demand for coal decreases, lowering the price of coal. As a result, the revenue constraint is relaxed and the effect of distortions due to the caps is also reduced. This conclusion holds true as long as the Chinese regulators do not reduce the caps in response to lower coal prices.

Download this Paper

NARURAL RESOURCE-LED DEVELOPMENT IN NEW PRODUCING COUNTRIES

The Expectations of Stakeholders in Eastern Africa's Oil and Gas

Workshop Brief

The expectations of citizens are some of the most important, yet overlooked aspects of developing oil and gas reserves in new-producing countries. These expectations are closely tied to the forecast income from developing the oil and gas reserves, but these revenues are only part of the value proposition. The economic spillovers of local content may also be part of the prize, but the complexity of these benefits are not always well understood by domestic stakeholders.

Local content has recently been seen as a political imperative to extract more rent from the value chain, but often this is conceived without concern for how it affects the economics of the projects. Local content could be recast as an economic imperative that seeks to maximize domestic participation in the sector, but not to the detriment of the project and the total revenues to be received by the government.

The timing and complexity of developing oil and gas reserves will have a significant impact on the amount and economic impact of local content. Upstream projects generally present the earliest opportunity for maximizing local content in new-producing countries. Despite having commercially viable amounts of oil and gas reserves that could generate significant windfalls, for example the reasonable expectations of stakeholders in Uganda and Mozambique should be radically different:

> The scale and timing of developing Uganda's reserves mean that the bulk of investment will be completed before the skills and capacity to undertake the complex engineering and fabrication have been developed. Unless development plans for their oil reserves are materially delayed, the opportunity for local content will probably be restricted to service industry jobs supporting the international oil companies (IOCs) and oilfield service companies. There is an implicit trade-off between the rents and the spillovers.

> By contrast, the scale and timing of developing gas reserves provides Mozambique with an opportunity to build a natural gas-driven economy with high levels of local content. This is true even if initial levels of local content are low.

Getting the expectations of stakeholders "right" is key to maintaining the social license to operate. With low oil and gas prices shrinking the fiscal prize, policymakers in new-producing countries are beginning to see local content as an economic imperative. Realistic expectations for stakeholders in the areas where oil and gas projects will be undertaken will be essential to prevent the political imperative from denying them the benefits of the economic spillovers

Download the Paper

Sub-Saharan Africa's Demographic Dividend: Is There a Role for Natural Resources?

Daniel J. Mabrey

Sub-Saharan Africa (SSA) has bountiful oil, gas and mineral deposits yielding more resource-rich states than in any other region in the world. This includes almost 30 percent of the world's known reserves of minerals, and 7.6 percent of the world's proven oil and natural gas reserves. These numbers are even more impressive given that Africa is underexplored compared with the rest of the world.

The region will have an estimated 2.4 billion people by 2050, which will be almost 25 percent of the world's population. These will be mostly young people, with more than 30 percent aged 10-24. By 2030, there will be roughly 24.6 million people entering the job market annually in SSA, and SSA's total workforce will increase by 910 million by 2050.

Generally, this interplay between changes in a population's age structure and economic performance is called a "demographic dividend." It seems clear that SSA will experience such a demographic transition. The question is whether SSA countries can create an economic environment where these working-age people can find well-paying jobs. As a result, politicians in most of these countries are under increasing pressure to create job opportunities and focus fiscal policies on achieving economic growth. Could natural resource development play a role in achieving a demographic dividend in SSA countries?

There are many lessons out there for SSA countries to learn from to ensure that their natural resource development does not turn into a curse similar to what happened in Sierra Leone following the mining of diamonds or in Equatorial Guinea after the discovery of oil. There are success stories from around the world, and from Africa as well as, for SSA states to emulate. How Botswana used revenues from diamond mining to grow its economy is one such example.

The argument for developing natural resources is clear and simple. Countries with mineral and hydrocarbon resources can earn significant economic rents, which their governments can invest or spend to improve public welfare and create intergenerational wealth. With proper management, natural resource revenues can enhance development that leads to sustainable economic growth. Countries seeking to use their fledgling energy sector to garner economic development would do well to focus on human capital development to create forward and backward linkages that can achieve positive economic spillovers.

Download the Paper

Macroeconomic Impacts of Oil and Gas Discoveries in New-Producing Countries

Workshop Brief

Policymakers in new commodity producing countries are inundated with warnings about the resource curse, Dutch Disease and absorptive capacity constraints. While these are all significant policy issues related to developing natural resources, there is also growing evidence that unexpected macroeconomic impacts can occur almost immediately after the announcement of new oil and gas discoveries. These initial macroeconomic impacts, such as drop in employment, rise in savings and decline in investments, are probably tied to the expectations of government officials, private sector and society at large on what this new resource wealth will mean for their country.

In many new-producing countries, there is a collective capacity building process that must occur after commercially viable discoveries are announced. During this period when technocrats and government officials are learning about the natural resources and their responsibilities to manage the sector, there will be political pressure to begin borrowing against expected future revenues. The crucial question for policymakers is the risks of borrowing now against expected future revenue versus the welfare benefits of spending the money immediately or 10-20 years later, once the fields start producing.

The expectations of a country's stakeholders are set in this early period, shortly after the discoveries are announced. While the initial focus is rightfully on enabling exploration and production, there is also an early role for the ministries of finance to begin to manage the expectations of these stakeholders.

In many ways, managing these expectations is just as important as assessing the traditional macroeconomic impacts that can be expected when monetizing a finite resource base. As literature from the resource curse shows, many countries that have developed oil and gas reserves have not seen positive growth outcomes, and in some cases have been worse off than they were before the discovery of natural resources.

Download the Paper

OIL AND GAS MARKETS

Will There Be a Price War Between Russian Pipeline Gas and US LNG in Europe?

Anne-Sophie Corbeau and Vitaly Yermakov

Global gas markets are facing a fundamental change as a result of declining prices and an approaching wave of new liquified natural gas (LNG) supply over 2015-20. With the start of the first U.S. LNG cargoes out of the Gulf of Mexico in February 2016, the conclusion that a glut on the global gas markets is approaching appears inescapable. But this is just the start of the boom in LNG supply: most LNG capacity additions, which are from Australia and the U.S., will come over the period of 2016-18.

Low gas prices have not triggered a significant rebound in gas demand in Asia and Europe, the two largest importing regions (KAPSARC 2016). As a result, the combination of demand from existing Asian LNG importers and from new importers appearing in Africa, the Middle East and Asia may not be sufficient to absorb these large incremental volumes of LNG (Corbeau and Ledesma 2016). The main uncertainty in this area is future Chinese LNG demand. While Europe and China stand out as the two potential battlefields between pipeline gas and LNG, China may actually prefer pipeline gas to LNG.

This saturation of LNG markets elsewhere is making Europe the residual market for surplus LNG. Europe has tried to reduce its dependency on Russian pipeline gas for over a decade, with little success. It has plentiful and under-utilized regasification capacities, liquid and well-developed gas trading hubs in Northwest Europe, and relatively well-developed pipeline infrastructure that allows for a certain degree of flexibility in terms of diversifying sources of gas for intraregional flows. The European Commission (EC) has been vocal about the need to diversify away from Russian gas, and to consider LNG as one of the possible alternatives. The EC published a new LNG and storage strategy in February 2016.

The key questions are how much LNG will be left targeting Europe? And whether this will threaten Europe's main pipeline gas supplier, Russia? Russia has ample spare gas production capacity, still supplies around one-third of Europe's gas needs and is a low-cost supplier. In this context, Russia may put the resilience and tenacity of LNG suppliers to the test, just as Saudi Arabia has been testing the resilience of U.S. tight oil producers and other higher cost producers by increasing

supply and exposing its competitors to a prolonged low oil price environment. Two key elements of Russia's defensive strategy could be putting more of its gas on European hubs and restricting flexibility (by limiting buyers' nominations rights) in its contracts with Europe. Should Gazprom turn to more hub indexation and become a price taker, this may not be enough to undercut competition, pushing Russia to trigger a price war by pricing its gas below the variable costs of U.S. LNG exporters.

The pricing environment for gas has fundamentally changed as the period of high prices – notably in Asia – has come to an end (KAPSARC 2016). Both at the U.K. NBP and in Asia, spot prices stood at around USD 4-6/MMBtu in July 2016. Lower gas prices may not be sufficient to trigger a significant switch from coal to gas-fired plants since coal prices have also fallen and gas prices are at much lower levels now than was anticipated at the time of sanctioning of most LNG projects. If the oversupply situation continues, prices may fall to the price floor on the basis of the variable costs of supply.

Download the Paper

Tight Oil Development Economics: Benchmarks, Breakeven Points and Inelasticities

Robert L. Kleinberg, Sergey Paltsev, Charles K. Ebinger, David Hobbs, and Tim Boersma

From 2011 to mid-2014, Brent crude oil generally traded above USD 100/barrel (bbl). During that period, U.S. crude oil production increased from about 5.5 million bbl/d to about 8.9 million bbl/d. Most of the increase was due to the growth in production of tight oil, which is often erroneously termed “shale oil” (as explained in Kleinberg, forthcoming) but is correctly defined by the U.S. Energy Information Administration (EIA 2016d). As a result of this rapid increase in oil production, numerous publications declared America to be a rival to Saudi Arabia as the world’s marginal producer (e.g., The Economist 2014).

Many analysts suggested that the oil price needed to maintain the economic viability of the preponderance of U.S. tight oil projects was in the range of USD 60/bbl to USD 90/bbl (e.g., EY, 2014; Wood Mackenzie, 2014; Bloomberg, 2014). It was further widely believed that once the oil price fell below USD 60/bbl, many investments in tight oil projects would end and “since shaleoil [sic] wells are short-lived (output can fall by 60-70% in the first year), any slowdown in investment will quickly translate into falling production” (The Economist, 2014). Thus the USD 60-90 range for the U.S. tight oil breakeven point was thought to act as a shock absorber, with tight oil projects quickly coming onto production as prices increased, and dropping out of production as prices decreased through this range.

With tight oil accounting for roughly 4 percent of global production, and seemingly able to respond to price signals considerably faster than conventional projects, analysts predicted that this new resource could bring welcome stability and price support to oil markets (see e.g. Krane and Agerton 2015; Ezrati 2015; The Economist 2015). There is no documented evidence that OPEC acted on these assessments, but we can speculate that these considerations might have influenced their decision late in 2014 to pursue a strategy to preserve their share of the international oil market by increasing oil production. If the conventional wisdom were to hold true, moderate increases in Middle East oil production, accompanied by a moderate oil price decline, would result in prompt declines of tight oil production, thereby preserving OPEC market share.

The analysts were wrong. As the West Texas Intermediate benchmark oil price fell from $108/bbl in mid-2014 to $32/bbl in early 2016, tight oil production was sustained even as prices fell below minimum breakeven points calculated by energy economists. Even more perplexing, tight oil production continued to increase; in the Permian Basin, increased production continued into 2016 (EIA, 2016b). Companies were not cutting back production as quickly as a simple view of breakeven points would imply. Thus it is incumbent on us to investigate what breakeven points and other benchmarks are used, how they are calculated, and how they can provide misleading signals to analysts and markets.

Download the Paper

ENERGY-WATER-FOOD NEXUS

Emerging Issues Facing the Water-Energy-Food Nexus in the Middle East and Asia

Workshop Brief

As societies grow and develop, more strain is placed on water, energy and food resources – each of which is inextricably linked to the others. This phenomenon is evident in several parts of the world, including the Middle East and Asia, despite the geographic differences of each region. Much of the Middle East is energy abundant, but rapid population growth and economic development have put pressure on water and food supplies. The region currently mobilizes a sizable portion of its vast energy resources to meet its water and food needs at significant economic and environmental costs. In Asia, similar rapid economic and population growth are beginning to stretch water, energy and food resources, despite a comparative abundance of these resources. Furthermore, economic scarcity – the inability to finance the mobilization of these vital commodities – has made development prospects much more difficult in some emerging Asian countries.

By examining case studies from both the Middle East and Asia, delegates explored to what extent best practices in each region can be transferred, given the geographical and economic differences. The following issues, which are worth considering when making decisions on the water-energy-food nexus were highlighted at the workshop:

Water for agriculture: As demand for water resources increases, it is important for countries to ensure that robust data on the interdependencies of water, energy and food are collected, so that adequate economic, environmental and social impact assessments can be performed before policy decisions for resource management are made.

Transboundary governance: Water basins do not match national boundaries, making their management more difficult. When conflicts occur, bottom-up solutions (such as cooperation for sub-basin management) can provide a platform for international water management. Examples of successful transboundary governance are found in the Mekong River delta and Nile River basin.

Infrastructure financing: Securing least-cost water and energy utility provision options is important, given financial constraints faced by every economy. In Asia, private sector participation is one approach that is being used to combine private sector efficiency with public sector development goals. This is seen through the ‘pro-poor public-private partnerships’ (5P) scheme, an example of which is the Cinta Mekar micro-hydro project in Indonesia.

Coordination: Energy and water infrastructure projects are not always planned in coordination with one another, for example availability of cooling water for power plants. An integrated planning process can improve work flows among different institutions and result in more resilient, efficient and sustainable infrastructure investments.

Download the Paper

02 // OpenKAPSARC

Our Tools and Datasets

A core part of our mission at KAPSARC is to equip stakeholders with the models, tools and data to make the most educated and informed decisions possible.

We have invested in the development of several analytical platforms, some of which have resulted in tools and datasets that we are now making available through our website. The model codes can be downloaded and any data that are not proprietary to third parties can be downloaded and reused freely. The current key platforms are:

KAPSARC Energy Model (KEM)

An approach to analyzing energy economies in which government interventions override liberalized markets and competition in setting prices and allocating volumes. Initial implementations include KEM-Saudi Arabia, KEM-China and KEM-GCC. The latter two are under development but sub-modules that have been completed are available, as well as the more complete models of Saudi Arabia that cover partial equilibrium, long-term static and multi-period versions. Shortly, a CGE version of the entire Saudi economy will also be ready.

KAPSARC Toolkit for Behavioral Analysis (KTAB)

This toolkit comprises a suite of building blocks for analyzing collective decision making processes (CDMPs). These can include political bargaining, commercial negotiation and any multi-stakeholder issue where an understanding of how each player's attempts to maximize their own positions drives the ultimate settlement (or not). The software for each type of CDMP is available and we are building a library of illustrative applications to help users understand the limits and benefits of this type of analysis.

KAPSARC Energy Policy Database (KEPD)

We are creating a comprehensive source of reference for underlying initiatives of energy policies within our geographic focus. Most policy databases provide original documents (sometimes with short summaries of the key elements). However, it is increasingly rare that individual policies restrict themselves to single issues. KAPSARC's approach of breaking down policies into their constituent initiatives allows for a richer understanding of the evolution of policy approaches in a country as well as greater visibility on the alignment, or lack thereof, among insititutions when they attempt to regulate the same activity with differing objectives. Initial releases for China's coal industry and India's renewables industry are available. These will be continuously updated as additional policies are broken down and coded.

CMCC-KAPSARC Global Weather Database

Weather can have a profound effect on energy consumption, especially extremes of hot and cold temperatures. These variations drive residential and commercial energy demand for heating and cooling needs. Commonly available analyses tend to be either local or short term, or both. However, the customization of methodology to a particular geography renders invalid comparisons of the effects of weather among countries.

KAPSARC has worked with the Euro-Mediterranean Center for Climate Change (CMCC) to create a database covering 147 countries over a period of several decades, based on consistent methodologies such that the impacts of local climate on energy consumption can be analyzed and valid comparisons among regions performed.

Differences in energy productivity of countries are due to a variety of factors, some controllable (including the structure of the economy and efficiency standards) and some uncontrollable (including weather and access to water). The CMCC-KAPSARC Global Weather Database is one of the tools now available to policymakers to separate the weather signal from the noise in benchmarking performance and guiding policies aimed at improving the energy productivity of their economies.

KAPSARC India Solar Policy Atlas

We have developed a web-based energy policy reference tool that systematically describes energy sector policies. This tool, also of use to external researchers, is intended to facilitate better understanding of policy instruments and track evolution of policies from draft to enactment worldwide.

KAPSARC has released part of this research in a Solar Policy Atlas, which provides specific, state and national level coverage of policies in India. It presents a policy landscape using large numbers of policy design elements that are relevant in different geographies to gain holistic insights of policy frameworks and make comparisons. Each policy design element has a comprehensive description in the context of India and is intended to improve the understanding of the subject at national and state levels.

KAPSARC Solar Photovoltaic Toolkit

This toolkit and dataset are intended for any individual or institution interested in the solar photovoltaic (PV) industry and its cost trends. It compiles capital costs (CAPEX) and levelized cost of energy (LCOE) data for PV technology by year and country, and presents the data in an interactive manner. In addition to the interactive dataset, the raw dataset is provided in Microsoft Office Excel should the user wish to perform his/her own post-processing. An LCOE analyzing tool, specifically tailored for solar PV technology, accompanies this toolkit, enabling the user to aquire the LCOE using the capacity factor or solar irradiation.

Other platforms/ datasets

We have built a data transformation team that serves our internal research needs but will also increasingly release curated data resources to all our stakeholders. These include data on Saudi Arabia's energy economy and will grow over time in both the breadth of their scope and the area of coverage.

KAPSARC develops economic frameworks to reduce the overall costs and environmental impacts of energy supply, increase the value created from energy consumption and achieve effective alignment between energy policy objectives and outcomes.

We collaborate with leading international research centers, public policy organizations, and industrial and government institutions, freely sharing our knowledge, insights and analytical frameworks.

03 // Team News

Growing Our Global Team

In the last quarter, the following individuals joined our Research Team:

Anup Kumar

Anup has joined KAPSARC's Energy Information Management Team. He has extensive database management and web development expertise, including developing data management applications for market research and customer insight functions.

Anup has worked for several large data publishers and startups with immense energy data portals, and has developed several data transformation tools – from data source to consumption – using new platforms such as ElasticSearch, JavaScript and MongoDB. He also specializes in extract-transform-load process, and has automated hundreds of manual processes, significantly improving speed and efficiency.

He holds a Bachelor of Computer Science Engineering from Jawaharlal Nehru Technological University, India, and is Pentaho data integration (data transformation, business analytics and reporting) certified.

JOIN US AT KAPSARC

KAPSARC is searching for talented and open-minded thinkers to add to our growing research and business management teams.

Visit our careers website at

www.jobs.kapsarc.org

Hector Lopez

Hector has joined the Transport Team. He has worked as a junior researcher for the French Environment and Energy Management Agency (ADEME) and ENERDATA; and as a post-doc at the National Centre for Scientific Research (CNRS) and the European Commission's Joint Research Centre (JRC) Institute for Prospective and Technological Studies (IPTS). Most recently, he worked as a full-time researcher for the European Institute for Energy Research in Germany.

Hector's work focuses on transport economic modelling as a support in policymaking processes. His projects have always focused on long-term sustainable transport policy scenarios and model-based policy analysis. His interest for coupling modelling and policy studies led him to focus his research on the link between the economy, the environment and the use of energy in passenger and freight transportation activities. His work has been published in various peer-reviewed journals books and reports. It has also been used in an all-ages comic book and a TV documentary exploring the future of transport.

Noura Mansouri

Noura has joined KAPSARC's Human Geography of Energy Research Team. Her previous postings include post-doctoral research fellow at the mechanical engineering department at MIT, manager of strategy and marketing at AREVA, and research assistant at the Center for Global Energy Studies in London. She maintains a visiting scholar status at MIT, and is also a Future Energy Leader (FEL-100) at the World Energy Council.

Her research and work covers transition management, sustainability transitions, clean energy, renewables, carbon dioxide (CO_2) management, life-cycle assessment, energy policy, energy technology innovations, hydrogen fuel cells, sustainable water desalination systems, nuclear human capacity building, and nuclear business.

Noura has published on energy and transition paths to sustainable economies, energy consumption and CO_2 emissions in the Saudi electricity sector, carbon capture and storage, solar photovoltaics, sustainable desalination systems, solar desalination and nuclear desalination in Saudi Arabia.

She holds a PhD in Sustainable Energy Transition and an MBA with a sustainable energy technology management concentration from Queen Mary, University of London.

03 // Team News

Growing Our Global Team

In the last quarter, the following individuals joined our Research Team:

Abdel-Rahman Muhsen

Abdel-Rahman has joined KAPSARC's Human Geography of Energy Research Team. He is a certified GIS professional with extensive industry and research experience in GIS and geo-information management. He holds a Master of Geomatics Engineering from the University of Calgary, Canada.

Abdel-Rahman has joined the Research Team from the consulting industry where, working for Accenture and independently, he utilized system design strategies and enterprise architecture principles to help clients in the oil and gas industry design, implement and manage their ArcGIS platform and spatial data repositories. Prior to that, he worked for ESRI in technical and leadership roles.

He is passionate about working with data and integrating it with spatial databases using FME and Python. He possesses expertise in designing, managing and integrating enterprise Geodatabases (SDE) with data pertaining to disciplines in many industries.

Shreekar Pradhan

Shreekar has joined KAPSARC's Energy Systems and Modelling Research Team. He has taught and worked as Assistant Professor at the Tribhuvan University's Center for Energy Studies (CES) in Nepal. He also worked as Research Associate at the Asian Institute of Technology (AIT) in Thailand.

Shreekar is interested in evaluating energy policies in regional energy-economic models, with a broader focus on international trade and environment. His research employs economic modelling frameworks that encompass general equilibrium and partial equilibrium models. Additionally, Shreekar finds interest in understanding environmental and fiscal policies' dynamic effects in open economies. His research, which focused on the effects of climate mitigation on energy systems in developing countries, has been published in energy policy, climate policy and energy journals.

He holds a PhD in economics from the University of Tennessee, and a MSc in Agricultural Economics. He also holds a MSc in Renewable Energy Engineering from the Tribhuvan University in Nepal.

David Pugh

David has joined KAPSARC's Utilities of the Future Team, bringing with him extensive practical expertise in software engineering, large-scale economic simulation modeling, and "big data" analytics.

Specific topics that interest David include developing open-source, scalable, data-driven, and reproducible agent-based models (ABMs) of economic systems using "big data" technologies such as Akka, Cassandra, Scala, and Spark. Broader topics of interest include computational economics, particularly algorithmic game theory and mechanism design, as well as "big data" econometrics. His research has led to the development of a number of open source software libraries including contributions to QuantEcon project which is funded by the Alfred P. Sloan Foundation to coordinate the development of high quality open source code for all forms of quantitative economic modeling.

David holds a PhD and MSc in Economics from the University of Edinburgh and a BSc in Mathematics from the College of William and Mary. He is currently an associate fellow at the Institute for New Economic Thinking at the University of Oxford.

About KAPSARC

Our Mission

To advance understanding of energy economics and act as a catalyst for dialogue, charting a path to better welfare for societies, locally and globally.

Our Values

We strive to combine creativity and rigor in our research and operations.

We achieve results with effective teamwork and collaboration.

We seek to maximize positive societal impact.

About us

Affordable, sustainable energy underpins the growth of a country's economy and the wellbeing of its citizens. Yet effective energy policy is one of the greatest challenges for governments and other stakeholders across the globe.

KAPSARC was founded as a global non-profit institution for independent research into the economics of energy and understanding its complex intersections with energy policy, technology and the environment with the objective of contributing to societal wellbeing and prosperity.

From our base in one of the world's most important energy-producing regions, KAPSARC develops economic frameworks to reduce the overall costs and environmental impacts of energy supply, to increase the value created from energy consumption and to better understand energy policy such that policy objectives and outcomes are better aligned.

We collaborate with leading international research centers, public policy organizations, and industrial and government institutions through workshops, joint papers and the development of open-source datasets and tools, freely sharing our knowledge, insights and analytical frameworks.

KAPSARC studies topics of global scope with a particular focus on the Kingdom of Saudi Arabia, the GCC, China and India.

Our focus areas

Allocating resources in an economy

Options to allocate energy resources efficiently in regulated markets — where governments intervene in setting prices and/or volume quotas.

Scope includes: optimal energy and technology mix; effects of reforming market rules and energy prices; and environmental impacts of policy choices.

Energy flows and market impacts

The impacts of changes to energy flows between regions and the scale and nature of their effects on supply, demand and prices.

Scope includes: influence of energy prices on energy sources and flows; impact of local energy efficiency standards on relative energy demand growth; and effects of domestic policies on the local energy mix and the ripples they create in global markets.

Energy productivity

The value extracted from energy consumption, understanding the driving forces of energy productivity and its relationship to energy efficiency.

Scope includes: determining energy efficiency policies that deliver the largest productivity improvements; recognizing the drivers of productivity performance in energy intensive industries; and productivity improvements through diversification to higher value-added economic sectors.

Energy transitions

Focuses on economically efficient policy instruments for incentivizing a transition towards more sustainable power generation mixes, including nuclear, renewables and fossil fuels.

Scope includes: results of continuing innovation in incumbent systems, raising the bar for emerging energy sources and technologies; and balancing the efficacy and economic efficiency of renewables support policies.

Social an Evironmental Spillovers of Energy Policy

The interrelationships between socio-economic, environmental and other factors that drive energy production and consumption choices.

Scope includes: identify practical policy options that balance the interests of different stakeholders; opportunities for localizing the economic effects of energy resource development; and recognition of the range and risk of potential departures from intended policy outcomes.

Transportation; modes, fuels and technologies

Transportation policies and how changes in technologies and choices between modes of transport affect energy demand.

Scope includes: influences on consumers to adopt different modes of transportation; impact of fuel efficiency regulations and prices on transportation fleet mix; and impact of evolving behaviors on demand for transportation.