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Oil has defined the modern-day development of the Gulf region in a way seen in no other place in the world; together, the six members of the Gulf Cooperation Council (GCC), Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE), are home to around a third of known global reserves of oil, and nearly a quarter of its natural gas. Saudi Arabia remains the world's most important producer of conventional oil, and continues to hold the majority of the world's spare capacity, while Qatar has become the world's largest producer of liquefied natural gas (LNG). This reflects the GCC states' continuing pivotal role on global energy markets as a key centre of world energy supply.

The fast-track economic growth and development experienced by the GCC economies since the mid-20th century in particular, however, has also left its toll on the region's energy profile. No longer just global suppliers of energy, the GCC states have become a key centre of energy demand growth in their own right, accounting to a large extent for projections such as those by the IEA that see the Middle East alongside Asia as the world's future energy demand growth centres well into the 2030s. This collection of articles reflects on the variety of options and challenges faced by the GCC states more than a decade into the new millennium, and offers perspectives on future policy choices inside one of the world's most important group of energy producers.

GCC energy challenges in the 21st century

The issue heads off with a perspective from Saudi Arabia. In his article, *Prince Abdulaziz Bin Salman Al-Saud* describes Saudi Arabia's efforts at raising the efficiency of its domestic economy. Prince Abdulaziz Bin Salman Al-Saud argues that energy efficiency has become 'a strategic imperative' in light of the Kingdom's rapidly rising levels of energy intensity and overall energy consumption. As Saudi Arabia focuses on addressing the dual challenge of economic growth and development and the parallel need to manage demand, the Kingdom aims to engage all stakeholders – at state level and in the private sector alike – in contributing towards a more sustainable energy future.

Justin Dargin provides an overview over the challenges faced by the GCC states, as the region continues on its path towards becoming an increasingly important centre of energy demand growth throughout the coming years. While oil and natural gas have played a crucial role in the region's development, Dargin argues that the Gulf states will increasingly need to open themselves

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to fuel alternatives to power their domestic economies. He argues that while 'a healthy and vibrant economy will continue to consume more energy … the question is merely what type of energy will supply it, and in light of structural constraints in the Gulf energy sector, whether there will be sufficient natural gas production to meet regional demand.'

Frontier technologies, 'green energy', and the low-carbon economy

Marianne Haug and *Laura El-Katiri* discuss the 'next energy frontier' in the GCC, renewable energy. Haug starts off, asking whether renewable energy sources could form an increasingly important part of the region's supply-side response to growing electricity demand at home. In principle, she welcomes the GCC states' growing interest 'to join the USA, Europe, Japan, and China in financing and supporting the R&D, learning, and scaling-up process for renewable electricity'. However, the author cautions, successfully diversifying the GCC economies' domestic energy mix will require continuous commitment and a dedicated policy framework that takes renewable energy plans beyond 'hypes' and 'green-washing'.

Laura El-Katiri considers the economic value of renewable energy in the GCC, in light of its fundamental benefits for the Gulf economies, but also its cost vis-à-vis conventional energy sources. Investment in more renewable energy, particularly solar power, could be an important means for the GCC states to save their more valuable crude oil resources for export. However, El-Katiri argues, a more obvious starting point to address the GCC states' surging domestic demand for energy would be the removal of those structural market distortions that have incentivized the creation of highly energy-intensive economies in the first place: domestic energy prices. If fiscal policies to promote renewable energy deployment in the GCC could be used to this end, the author suggests, the value of renewables in the region could be great indeed.

Samar Khan argues that rather than supply-sided solutions only, the efforts of GCC states should focus on the management of demand, including through improvements in energy efficiency. Looking at the case of Saudi Arabia, Khan points towards some frequently overlooked domestic hurdles in the way of achieving such targets, including the lack of environmental and technological awareness amongst the public, a customary reliance on private, rather than public transport in the Kingdom, and the overall lag in delivering messages on sustainable energy use through the education system.

Steve Griffiths looks at what is perhaps the region's largest experiment in sustainable energy provision so far, at Masdar City. Conceived by policymakers in Abu Dhabi initially as the world's first carbon-neutral, zero-waste city, the 'City of Possibilities' has the opportunity to become a paradigm for sustainable cities in the region and globally, the author argues. This seems more possible since Masdar has survived the first obstacles caused by the financial crisis in 2008 and is beginning to offer a clearly replicable model for beyond the region.

The nuclear option

Two of our articles debate the pros and cons of nuclear energy in the GCC contact. *Adnan Shihab-Eldin* and *Holger Rogner* trace some of the historical debate surrounding the nuclear option in the Middle East, arguing the use of nuclear power is seen as an important step that could extend the lifetime of reserves and release additional domestic oil and natural gas production to earn revenues for exporters, while supporting net-importers of energy in the MENA region by reducing the cost of expensive fossil fuel imports. Geopolitical considerations may also play a role, according to the authors, who suggest developments on the side of Iran are closely watched in the wider Gulf and nuclear power may eventually result in a race for 'capacity parity'.

Giacomo Luciani looks more closely at nuclear power in Saudi Arabia. He maintains that nuclear power is a strategic choice for Saudi Arabia, which needs to diversify its domestic energy mix and requires large additions of power generation capacity over the next two decades. Geopolitically, Luciani contends that nuclear energy may involve a very welcome by-product: 'a regime considering the acquiring of a nuclear energy component, possibly including some eventual enrichment and reprocessing capability', he argues, 'knows very well that if it goes ahead, its own stability becomes much more important to the rest of the world', and, not only in the context of the current debate surrounding the fading US interest in the Middle East, 'will see this as a welcome by-product'.

Energy pricing and regulatory responses

Several articles deal with the issue of how to respond to surging domestic energy demand in the GCC via changes to domestic energy market regulation, in particular energy pricing. *Robert Bacon* provides an overview over the region's overall price environment, which he sees as being largely obsolete and in need of comprehensive reform at national and regional level. While the GCC states' long-established practice of charging among the lowest energy prices in the world to domestic customers reflects important economic and social goals, Bacon argues, they also impose large

costs on the economies, including large fiscal losses, and underfunded utilities, and hence recurring power shortages. 'Incomes have risen throughout the GCC', he says, 'to a level where it is unnecessary to provide energy subsidies in order to induce the poorest to switch to modern forms of energy.'

Bassam Fattouh and *Lavan Mahadeva* provide insights from a recent OIES study, which uses a model-based approach to simulate the effects of pricing reform on Kuwait's utility sector. With the GCC's lowest electricity tariff band – unchanged since its first introduction during the 1960s – Kuwait faces surging domestic demand for electricity, driven by decades of low pricing incentives. Consumers, ranging from residential users to industries, now need to conserve and rationalize their use of electricity, and this confronts the country with the enormous task of providing enough generation capacity over the long run, while effectively running a constant deficit inside power generation. Fattouh and Mahadeva reveal that different scenarios regarding consumer welfare changes are possible, depending on the type and size of accompanying mitigation measures.

Ayele Gelan offers additional insights from his forthcoming study on the reform of Kuwait's electricity pricing system based on a newly developed computerized general equilibrium model. He confirms that substantial potential economic benefits could be generated from a domestic pricing reform, and shows that when households are compensated for the welfare loss associated with utility price increases, aggregate GDP and household welfare effects will also be positive, in addition to savings made through reduced electricity consumption.

Faisal Ali Rashid and *Katarina Uherova Hasbani* offer a glimpse into future energy planning in Dubai. With among the GCC states' most advanced long-term energy strategies in the making, Dubai has begun to systematically re-regulate and provide incentive schemes aimed at encouraging a more efficient use of energy and water across all sectors, including residential, commercial, and industrial users. More than any supply-sided policies, the authors argue, it will be the rationalization of demand that will promise the greatest economic rewards, as is evident in Dubai's ambitious target of cutting energy consumption by 30 per cent by 2030.

The GCC and climate change

Robin Mills makes the case for the greater use of carbon capture and storage (CCS), for whose development the GCC could be a major market. Despite various plans for more CCS usage, most importantly in Abu Dhabi, Mills notes that progress in CCS deployment across the GCC has been lagging as a result of the industry's and the region's various disincentives. These include the continued absence of strict global emissions limits or carbon pricing, as well as domestic market pricing incentives and the general risk-averseness of national oil companies. In the future, he maintains, CCS could make an important contribution in the GCC towards a more sustainable use of fossil fuels in the presence of rising domestic energy demand and climate change.

The issue closes with a perspective on the GCC and climate change. In her article, *Mari Luomi* calls for a fundamental rethinking of the region's traditional policy stance, as the GCC economies now count towards the most carbon-intensive economies in the world. While some Gulf states, most importantly the UAE, have already embarked on a number of policy, project, and sector-wide efforts at climate mitigation in line with broader development priorities, such as economic diversification and efficient resource use, many of them 'still mostly exist only on paper, and consist of fragmented actions with low transformative impact'. Luomi advocates a more strategic approach to low-emission development that integrates emission reduction goals to broader resource efficiency, economic sustainability, and resource security goals.

A brief on Saudi Arabia's Energy Efficiency Program (SEEP)

Prince Abdulaziz Bin Salman Al-Saud

The importance of energy efficiency for the Kingdom's economic and social development

The Kingdom has witnessed unprecedented economic and industrial development in the last decades, which has led to an increase in the Kingdom's domestic energy consumption. Based on the local energy consumption trends, forecasts indicate an increase in domestic energy consumption with a growth rate which could reach 4 per cent to 5 per cent annually until 2030. Although this growth in demand is partially attributed to the industrial growth and growing economic prosperity in the Kingdom, a rather significant portion of it results from the inefficient use of energy; deeming this accelerated growth unsustainable. Whereas the vast majority of countries have managed to lower the energy intensity of their economies, the Kingdom's energy intensity increased significantly over the last two decades. Hence, it is a strategic imperative for the Kingdom that energy efficiency becomes a major topic for all decisions related to an increase in demand for fuel and feedstock.

The Kingdom's demand-side energy efficiency journey

The first National Energy Efficiency Program (NEEP) was launched in 2003 as a three-year term temporary programme to improve the management and the efficiency of electricity generation and consumption in the Kingdom. This programme was ended in 2006.

To build on the experience gained from the previous programme and to sustain and unify energy efficiency efforts under one permanent roof, in 2007 the Ministry of Petroleum and Mineral Resources, supported by other government entities in the Kingdom, recommended the creation of a permanent national entity. As a result of this recommendation, the Saudi Energy Efficiency Center (SEEC) was established in 2010 by a Council of Ministers' decree. Since then, SEEC has been responsible for the demand-side energy efficiency effort in the Kingdom, with the mission to improve domestic energy consumption efficiency, and coordinate all related activities between governmental and non-governmental stakeholders. SEEC is temporarily under the King Abdulaziz City for Science & Technology (KACST) with a Board of Directors composed of more than 20 entities from ministries, government entities, and companies. The key objectives of SEEC are to:

- Develop a national energy efficiency programme;
- Propose energy efficiency policies and regulations, and monitor their implementation;
- Promote awareness;
- Participate, as needed, in the implementation of pilot projects.

In 2012, SEEC launched the Saudi Energy Efficiency Program (SEEP – called hereafter 'the Program') with the objectives of improving the Kingdom's energy efficiency by designing and implementing initiatives and their enablers.

A sub-committee was established by SEEC's Board, chaired by the Ministry of Petroleum and Mineral Resources and composed of members from all related government entities, to establish the Program. The sub-committee focused the Program's scope of work on three main sectors (buildings, transportation, and industry) representing more than 90 per cent of the Kingdom's energy consumption, and five enablers (regulations, Energy Services Companies, funding, governance, and awareness). The sub-committee also ensured that the Program followed a set of guiding principles:

- The Program is limited to energy demand-side management only;
- The Program does not include price reforms;
- The Program designs energy efficiency initiatives based on the effects on the end-users (to ensure reasonable payback periods);
- The Program designs the initiatives in consensus with the stakeholders, including the private sector if necessary.

Since its inception, the Program has been a consensus-based inter-governmental effort involving all government, semi-government, and private stakeholders through weekly working sessions, workshops, and detailed technical research and studies. In addition, partnerships and collaboration were established with foreign government entities and experts to benefit from their experience (for example best practice exchange, data sharing).

'IT IS A STRATEGIC IMPERATIVE … THAT ENERGY EFFICIENCY BECOMES A MAJOR TOPIC FOR ALL DECISIONS RELATED TO AN INCREASE IN DEMAND FOR FUEL AND FEEDSTOCK.'

Approximately 120+ professionals from 20+ entities have been mobilized to work directly on the Program while hundreds of government employees have been working on implementing

the energy efficiency initiatives. The Program is organized in specialized work-streams by sectors and enablers; the technical teams have used the same fact-based bottom-up approach to define the strategy, the initiatives, the enablers, and their implementation plan. The approach has been as follows:

Step 1 – Energy demand analysis consisting of:

- Data collection and analysis of energy demand by end-use sectors in the Kingdom;
- Identification of key energy consumption drivers for each sector;
- Prioritization of sectors and drivers.

Step 2 – Establishment of technical teams and mobilization of stakeholders consisting of:

- Identification of government, semi-government, and private sector stakeholders for each sector;
- Creation of technical team for each sector with stakeholders' representatives and technical experts;
- Liaison with international organizations and experts, and establishment of partnerships.

Step 3 – Design and planning of initiatives and enablers consisting of:

- Benchmarking of energy efficiency initiatives globally and assessment of applicability in the Kingdom;
- Proposal of energy efficiency initiatives to the sub-committee (monthly meetings);
- Selection of energy efficiency initiatives by the sub-committee;
- Design and implementation plan detailing for selected energy efficiency initiatives.

Step 4 – Implementation of energy efficiency initiatives and enablers consisting of:

- Ensuring that enablers are in place: (i) budget and manpower for government entities, (ii) private sector infrastructure (e.g. testing labs, ESCOs), (iii) regulations & standards;
- Handing over of energy efficiency initiatives to the relevant entities for implementation;
- Monitoring of implementation and evaluation of impact on energy consumption / efficiency.

The energy efficiency initiatives are implemented by the various entities in accordance with their jurisdiction and mandate. The Program may provide temporary support to launch and monitor the implementation of the initiatives until the entities have been enabled through allocation of new resources.

The Program is being monitored by the Review & Coordination Team (RCT) to ensure adherence to the initiatives' objectives and their timeline commitments. In addition, the RCT coordinates and identifies interdependencies amongst the Program's teams and the various government entities implementing the energy efficiency initiatives.

Developments in the buildings sector

The Program has focused its initial efforts on increasing the minimum energy performance standards (MEPS) for air conditioners (ACs), lighting products, various other home appliances (such as washing machines and driers), and on enforcing thermal insulation in new buildings. In addition, efforts have been initiated with the National Committee of the Saudi Building Code to enhance and revise measures and enforcement mechanisms related to energy efficiency in new buildings. Existing public buildings will be retrofitted to increase their energy efficiency, whereas households in residential buildings will be incentivized through financial schemes to replace existing inefficient products with efficient ones.

Developments in the industrial sector

The Program has been focused on the petrochemical, cement, and steel industries, representing roughly 80 per cent of industrial energy consumption.

Existing plants (in those sectors) are to be given aspirational energy intensity

ACs example: Cooling of buildings roughly accounts for half of the electricity consumed in the Kingdom. Yet at the outset of the Program, the MEPS for ACs were low and inadequately enforced. The Saudi Standards Metrology & Quality Organization (SASO) and the Program worked with ASHRAE, AHRI, and the AC industry (manufacturers, importers, and distributors) to increase MEPS in line with international best practices. Subsequently, all stakeholders, such as the Ministry of Commerce & Industry (MoCI) and Saudi Customs, jointly revamped the AC product control mechanism to enforce a high level of compliance with the new MEPS. Local and international testing laboratories were also engaged to ensure the readiness of the testing/inspection/certification (TIC) infrastructure in the Kingdom. Split AC MEPS were raised on 7 September 2013 to 9.5 Energy Efficiency Rating (from 7.5) with an additional increase to 11.5 EER in 2015, yielding a 30–35 per cent electricity saving for cooling compared to the business-as-usual scenario. To date, around 50 AC suppliers have declared more than 800,000 non-compliant AC units to be re-exported, dismantled for spare parts, or revamped to meet new MEPS.

(EI) levels based on international benchmark average performance, to be achieved within a specific timeframe. A consensus is being built with the industry players to ensure that these levels are not jeopardizing their competitiveness. In addition, the Program is putting in place tools to support the industry in achieving these levels.

New plants will have to be designed and built to meet international energy efficient standards in order to obtain the various licences and permits required to operate in the Kingdom.

MEPS for electrical motors have been increased and the Program will follow suit with other common industrial equipment (such as boilers).

Developments in the land transportation sector

Land transportation accounts for over 90 per cent of the energy consumption of the transportation sector in the Kingdom. The Program has focused most of its initial efforts on light duty vehicles (LDVs) with two goals in mind: enhance the fuel economy of incoming vehicles and reduce the fuel consumption of on-the-road vehicles.

As for new incoming LDVs, a label reporting the fuel economy of the vehicle will be mandatory starting in August 2014. In addition, automotive manufacturers are to comply with the Kingdom's new fleet average fuel economy standard for incoming LDVs, starting in the second half of 2015 or early 2016.

For the on-the-road fleet of LDVs, the Program is assessing the opportunity to incentivize owners to replace their old inefficient vehicles with new efficient ones. In addition, the Program is collaborating with multiple government agencies to establish temporary mass transport solutions until the planned public transportation projects are completed.

Heavy duty vehicles (HDVs) have not been overlooked, since they account for a significant share of the energy consumption. Multiple HDV initiatives are currently under analysis including: anti-idling regulations, aerodynamic additives, and retirement programmes for old vehicles.

Both LDVs and HDVs are to be subject to rolling resistance and wet grip requirements for tyres starting November 2015 and November 2016 respectively.

Enablers

The Program has been collaborating with the various government entities involved in urban planning decisions to ensure that energy efficiency requirements are included in their guidelines.

The Program has placed special attention on product control mechanisms and enforcement (Testing, Inspection, and Certification) to ensure a high level of compliance with the new regulations and standards.

The development of awareness campaigns by the Program has been synchronized with changes to the regulations and standards, in order to provide the general public with the rationale for those changes. For example, an unprecedented AC awareness campaign is set to be launched before the summer in full collaboration with the AC industry, which will be contributing financially with its Corporate Social Responsibility (CSR) programmes.

The Program has worked with the Ministry of Finance to establish a mechanism with quantitative criteria for selecting initiatives with financial incentives. Those potential energy efficiency initiatives would be focused on incentivizing households to accelerate the retirement of their inefficient assets (such as AC, lighting products, and cars).

The Program has been devising strategies to support the development of Energy Services Companies in the Kingdom. These include the establishment of an accreditation system, a measurement and verification protocol, and standard energy services performance contracts. In addition, the ambitious government buildings retrofitting lead-by-example initiative will create strong demand for their services.

'COOLING OF BUILDINGS ROUGHLY ACCOUNTS FOR HALF OF THE ELECTRICITY CONSUMED IN THE KINGDOM.'

The government intends to have a Saudi Energy Efficiency Law and it has been working with an international law firm and the legal representatives from the stakeholder government entities to draft it.

Lessons learnt by the Program through the challenges faced

A number of important lessons were learned during the development of the Program:

1. *Technical expertise and approach:* The team should use a fact-based systematic methodological approach in the design and implementation of the Program to avoid conflicts of opinions and give confidence to the stakeholders that decisions are rational and unbiased.
2. *Stakeholder engagement:* The team should engage with the government and private sector stakeholders from the inception of the Program to ensure practical initiative design and buy-in for smooth implementation.
3. *Leadership commitment:* The team should have the continuous support

of the highest level of the government, to alleviate the hurdles which are bound to present themselves for the Program, as the interest of the Kingdom might conflict with the status quo.

4. *Coordinated enforcement:* Enforcement of the regulations and standards ought to be optimized by developing a unified enforcement approach and coordinating the various government entities' enforcement efforts, in order to ensure high levels of compliance.

Meeting the Gulf energy challenges for the 21st century

Justin Dargin

Energy has long been a major factor in the development of countries and their economies. Concerns relating to environmental pollution, economic diversification, and regional competitiveness have recently intensified in the Gulf region, and the area is now attempting to overcome its energy challenges systematically.

'… SINCE THE EARLY 2000s, THE GULF REGION (EXCLUDING YEMEN) HAS EMERGED AS ONE OF THE HIGHEST ENERGY CONSUMING REGIONS IN THE WORLD …'

The member states of the Gulf Cooperation Council (GCC) have the most prodigious energy reserves in the world. As of 2012, the region held 486.8 billion barrels of proven oil reserves, approximately 37.5 per cent of global supply, with the Kingdom of Saudi Arabia holding the lion's share, at 20 per cent of the global total. The latest BP figures for 2013 indicate that the area collectively produced 17.3 mb/d (million barrels per day). With the advantage of enormous oil reserves and small, albeit growing, populations, the region exports the majority of its oil production. The region also holds approximately 42 Tcm (trillion cubic metres) of natural gas, about 23 per cent of global natural gas reserves, but it only produces about 8 per cent of total global production. At current production rates it is estimated that the region's current proven oil reserves will last another 70 years and its natural gas reserves for another 118 years.

Nonetheless, since the early 2000s, the Gulf region (excluding Yemen) has emerged as one of the highest energy consuming regions in the world, trailing only India and China, both of which have significantly larger populations. Over the past three decades Gulf gas demand has nearly doubled every decade and gas deficits began to appear in the region around 2007–8. In 1980, when the region's industrialization programmes were just being initiated and population growth was insignificant, the region consumed less than 3 per cent of global gas demand. Currently, the figure stands at around 12 per cent. Over this 30 year period, significant domestic demand – centred upon petrochemicals, industrial expansion in energy-intensive industries, power generation, and water desalination – has developed in nearly every energy-rich Gulf country.

The unique role of natural gas

Natural gas has a unique role to play as an energy source supporting development in the Gulf region. Its development has traditionally been neglected in energy-rich countries in comparison with that of its hydrocarbon cousin, oil. Nevertheless, due to energy shortages and the potential for massive development of non-associated, shale, tight, and sour gas, the GCC member states have developed a renewed interest in natural gas as a bridge fuel for continued regional industrialization.

The case for continued and expanded Gulf natural gas production as the primary industrial and power generation fuel is predicated on five main factors: (i) Natural gas is the most economical fuel source in abundance in the region on a per unit basis, when compared to other alternatives (such as nuclear) and hydrocarbon fuel sources. (ii) Because of improved seismic and extraction technology, the potential to produce non-associated natural gas reserves in the Gulf region economically has significantly improved. (iii) The development of deployable energy-efficient gas-fired power plants has the potential to attract large-scale capital investment in the electricity sector and reduce the environmental externalities associated with other hydrocarbon fuels. (iv) The use of natural gas inputs in industrial processes allows Gulf countries to engage in horizontal economic diversification into energy-intensive industries such as: cement, lime, glass, non-ferrous metals, petrochemicals, and steel, and enables it to achieve its job creation goals in linked economic sectors. (v) The global reaction to certain environmental externalities (ecological pollution and greenhouse gas emissions) associated with other fuel sources has focused attention on the potential for natural gas to mitigate and solve those problems for the short and long term.

Three main challenges

Natural gas is the essential cornerstone of economic development and energy security. However, to promote energy security and sustainability in the Gulf, three main challenges need to be overcome: high energy intensity rates, expanding natural gas consumption that outstrips production, and the difficulty of unlocking production of non-associated natural gas reserves (such as tight, shale, sour, and deep gas).

'BECAUSE OF HIGH ENERGY CONSUMPTION RATES, MANY ENERGY-RICH GULF COUNTRIES HAVE INCREASINGLY DIVERTED ENERGY TO DOMESTIC CONSUMPTION RATHER THAN TO EXPORT.'

In meeting these challenges, there are two important and intertwined issues that need to be understood. Firstly, lowering overall energy and natural gas consumption should not be the central focus of Gulf policymakers. An expanding and industrializing economy will, by definition, consume more energy inputs, it is an unbreakable equation. A healthy and vibrant economy will continue to consume more energy, even while energy intensity is lowered, in the aggregate. The question is merely what type of energy will supply it, and in light of structural constraints in the Gulf energy sector, whether there will be sufficient natural gas production to meet regional demand. Gulf policymakers should concentrate simultaneously on both energy intensity reduction and the production of new sources of natural gas (indigenous tight gas and imported natural gas) to supply economic expansion. High energy intensity rates are wasteful and do not contribute to a sustainable energy sector.

Secondly, given the impressive figure for the region's indigenous natural gas reserves, production of this resource should be expedited. In order to stimulate production, the natural complementary strengths of IOCs and Gulf NOCs must be leveraged. The most effective way in which Gulf governments can facilitate this process is by improving the investment and contractual terms in the upstream sector. IOCs can bring their collective experience and technology to assist in a mutually beneficial collaborative relationship to develop these resources. With a major share of the world's proven oil and gas reserves, the Gulf region is poised to play a significant role in the global energy market for the coming decades with the execution of various megaprojects. As these megaprojects require a significant amount of capital outlay and technology/expertise, strategic alliances between NOCs and IOCs have the potential to expedite regional capacity building for the independent development of indigenous natural gas resources.

The first challenge: energy intensity. Since the 1970s, due to energy-intensive industrial expansion and favourable energy pricing policies, the Gulf region's energy intensity rates have risen much more rapidly than those of any other region in the world. In the Gulf region, nearly every energy-rich country is attempting to achieve economic growth along the energy-intensive industrialization path. While diversification has continued apace, energy intensity in the residential, industrial, and commercial sectors has increased exponentially. The rising energy intensity rates have the potential to harm regional economic competitiveness in strategically important industries, especially in industrial competition with Asian-based firms.

The second challenge: rising Gulf energy consumption. The rise in energy consumption in the Gulf region has been quite spectacular over the past two decades. Since the early 2000s, the Gulf region has emerged as one of the highest energy consuming regions in the world, trailing only India and China, both with significantly larger populations. Because of high energy consumption rates, many energy-rich Gulf countries have increasingly diverted energy to domestic consumption rather than to export. Significant opportunity costs have been created by oil or natural gas being consumed domestically at administered prices, as opposed to being exported at international market prices, or when precious natural gas has been used in the relatively non-productive residential sector (as electricity), rather than being provided to the productive sectors (petrochemicals, energy intensive industries, fertilizers). This situation has profound implications for the ability of many energy-rich Gulf states to continue their industrial expansion, support foreign revenue generation, and preserve their position as primary global incremental energy suppliers.

The third challenge: unlocking natural gas potential. While the Gulf region has grappled with high energy intensity and natural gas consumption rates, it has attempted to meet consumption needs by exploration and production of non-conventional gas reserves. In both absolute terms and in relation to the number of years in which production can be sustained at current production levels, the productive capabilities of the Gulf region are enormous. Most energy-rich Gulf states have reserve-to-production ratios of approximately a hundred years. Due to high natural gas consumption rates, exacerbated by high energy intensity rates, Gulf states which have formerly been self-sufficient in 'easy' conventional associated natural gas will need to produce from non-associated gas reserves to continue meeting future demand.

Combatting energy intensity

In order to lower energy intensity sufficiently, there must be a process by which performance-based regulations which can provide a 'push' to drive technological change and investment – such as Mandatory Efficiency Performance Standards (MEPS) and Energy Efficient Resources Standards (EERS) – can be implemented. In tandem, market-based incentives (fiscal rewards and tax credits, where applicable) should be used as a 'pull' to encourage investment in energy-efficient technology. This 'push' and 'pull' dynamic will encourage cross-sectoral energy efficiency implementation through a three-pronged strategy of: educational campaigns; government regulations mandating energy efficiency in the industrial, commercial, and residential sectors; and promulgation of fiscal incentives to forge consumer demand for energy-efficiency technology.

If the Gulf states institute moderately aggressive energy efficiency programmes, an overall energy demand reduction of 25 per cent by the year 2030 is possible. If Gulf governments promote energy efficiency implementation aggressively, it would be possible to achieve demand reductions of 50 per cent by the same year. Untapped energy efficiency is the single most effective step, as well as the least expensive, that Gulf policymakers could take to combat increasing energy consumption and environmental externalities.

Mandatory Efficiency Performance Standards (MEPS). MEPS are essential in any energy efficiency policy which aims to reduce energy intensity to a sustainable level. MEPS should be applied in the residential, commercial, and industrial sector to moderate power demand. High Gulf energy intensity rates, compounded by favourable pricing, have hampered the attempts of Gulf states to supply sufficient natural gas. MEPS will provide the 'push' necessary to drive technological change and lower energy intensity.

Energy Efficiency Resources Standards (EERS). The creation of EERS would foster improvements in efficient electricity generation and transmission on the supply side of the Gulf states' power sector. EERS are conceptually similar to a Renewable Portfolio Standard (RPS) or Alternative Energy Portfolio Standard (AEPS), in the sense that EERS require utilities to reduce energy use by a specified and declining percentage, or an absolute amount on an annual basis. As MEPS drive efficiency gains on the demand side, EERS would be able to reduce energy intensity on the supply side effectively.

Creating a favourable natural gas investment climate

The GCC states should implement a structured programme to encourage IOCs to invest in unconventional gas fields. Collaborative relationships with IOCs will assist in bridging the technology and expertise gap which currently prevents Gulf states from producing their non-associated gas potential. Many majors have developed advanced techniques and technology (specifically: hydraulic fracturing, directional and horizontal drilling, micro-seismic imaging) over the years of exploiting North American tight gas reserves and they would be able to leverage their expertise in the proper enabling environment.

'IF THE GULF STATES INSTITUTE MODERATELY AGGRESSIVE ENERGY EFFICIENCY PROGRAMMES, AN OVERALL ENERGY DEMAND REDUCTION OF 25 PER CENT BY THE YEAR 2030 IS POSSIBLE.'

This process should be fostered by reformation of IOC investment and contractual terms in the natural gas sector. Moreover, a competitive bidding process that protects intellectual property rights and supports IOC capital investments (by a minimum guaranteed return on investment for a predetermined period for investments made in especially difficult-to-produce fields) would have an advantageous impact on the stimulation of natural gas production. There should also be a reformation of the domestic pricing framework in order to encourage IOCs to supply the domestic market rather than exporting to international customers via LNG.

LNG import as a bridge fuel

As there will be a certain delay between initial field investment and production of non-associated natural gas fields, Gulf states with unfulfilled gas requirements should utilize the global LNG market as a fuel source to bridge any existing supply shortfalls. In those Gulf states with no existing LNG import infrastructure, authorities should implement fast track construction of required facilities to ensure that power generation and industrial gas consumption are not interrupted during the interregnum. The global LNG market would be able to fill any supply gaps until indigenous non-associated natural gas supplies come online. In light of the gas supply constraints, the UAE and Kuwait currently import LNG, with Bahrain being in the process of completing its first LNG terminal projects. These LNG import projects illustrate the fact that the Gulf states do understand that the global LNG market is a crucial part of their strategies to ensure energy security going forward.

Justin Dargin's study 'The Impact of North American Shale Gas Production on the Gulf Petrochemical Sector' for the Oxford Institute for Energy Studies is forthcoming in 2014.

Renewables in GCC countries: the next frontier?

Marianne Haug

More than 20,000 people attended the 7th World Future Energy Summit in Abu Dhabi earlier this year. The buzz and excitement is understandable in view of the many initiatives announced. Are national and international investors, contractors, technology providers, and suppliers ready to scale up renewables in GCC countries? Are they ready to shoulder the learning and localization challenges? As most renewable technologies require subsidies for years to come, will the GCC policy makers deliver the expected markets AND incentives? The article briefly summarizes the GCC countries' initiatives. It explores the challenge of sharing equitably the costs and risks of renewables technology development, market uptake, and local industrial development, with industry participants. The GCC countries may find that long-term commitment, flexibility, and localization of policies may offer cost effective or efficient solutions to this dilemma.

Existing targets and policies

Among the most noteworthy initiatives are those in Saudi Arabia (KSA). The Kingdom established the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) in 2010 to encourage innovation, the use of alternative energy technologies for power generation and water desalination, and to build a world-class alternative energy sector. The K.A.CARE programme set a 54 GW renewable energy target – of which 41 GW is to come from solar (16 GW from PV and 25 GW from Concentrated Solar Power (CSP)), 9 GW from wind, 3 GW from waste-to-energy, and 1 GW from geothermal – to generate 23–30 per cent of the Kingdom's electricity through renewable resources by 2032. A 2013 KSA White Paper sketches the framework for its implementation. Earlier this year, K.A.CARE presented the Renewable Resource Atlas for Saudi Arabia as part of its Renewable Resource Monitoring and Mapping Program (RRMM). K.A.CARE established the government-backed Sustainable Energy Procurement Company (SEPC) to handle the tendering for renewables projects. An introductory, competitive procurement round of 5–7 wind and solar Independent Power Producers, for 500–800 MW on pre-identified sites, is expected later this year. In parallel, the Saudi Electricity Company (SEC) invited Expressions of Interest (EOI) to build, own, and operate a 550 MW Integrated Solar Combined Cycle (ISCC) plant with a 20–30 MW parabolic trough CSP booster.

'WHILE THE KSA HAS THE MOST AMBITIOUS RENEWABLE DEVELOPMENT PLANS, THE UAE HAVE BEEN AT THE FOREFRONT OF RENEWABLES INVESTMENT IN THE GULF TO DATE.'

R&D programmes for renewable technologies have also been initiated by other KSA scientific centres, in collaboration with top international research centres, not just by K.A.CARE and the King Abdullah University of Science and Technology (KAUST). Localization and value chain development from human capacity building, education and training, technology development, R&D to industrial investment, and job creation is at the core of the KSA effort in the non-hydrocarbon sector. Completed PV installations in the KSA include, for example, the KAUST solar rooftop (2MW), the King Abdullah Petroleum Studies and Research Center (KAPSARC) Riyadh 3.5 MW PV plan, the 17 MW Princess Nora University solar water heating plant, and a polysilicon manufacturing facility at Jubail II. Solar desalination plants, off-grid village solar networks, street lighting and control panels powered by PV, and the 100 MW PV Makkah project are in the planning stage. Saudi companies, such as ACWA Power have been active internationally as developers and EPCs (Engineering, Project management and Construction) for CSP projects in Morocco and South Africa; and Sun & Life, now TAQNIA Solar has acquired Flabeg, the German high-technology glass and mirror provider. SunEdison, Saudi Arabia's Public Investment Fund (PIF), and Sanibel Investments are jointly financing a feasibility study to establish a 3 GW polysilicon-to-modules manufacturing facility in Wa'ad Al Shammel.

While the KSA has the most ambitious renewable development plans, the United Arab Emirates (UAE) have been at the forefront of renewables investment in the Gulf to date. Abu Dhabi adopted a 7 per cent target for installed electricity capacity equivalent to 1.5 GW by 2020. Abu Dhabi hosts IRENA, the International Agency for Renewable Energy with 160 member states, and has used Masdar, a subsidiary of the state-owned Mubadala Development Company and the Abu Dhabi Fund for Development (ADFD), to fund and develop renewable energy, at home and globally. Masdar's initiatives include the Masdar Institute of Science and Technology, Masdar Power (that invests in utility scale renewable power projects), and Masdar City, the sustainable city powered by renewable energy with a 10 MW PV installation. Masdar Power, in a Joint Venture with TOTAL and

Abengoa, completed the Shams 1 CSP 100 MW plant in Madinat Zayed and sponsors the 30 MW wind installation at Sir Bani Yas. Overseas, Masdar Power has invested in tower and parabolic trough CSP power plants in Spain, and a thin film PV modules production facility in Germany. The 100 MW Noor 1 PV plant, Taqa's 100 MW waste-to-energy plant, and a 500 MW solar rooftop programme are in the planning stage. Dubai plans to generate 5 per cent of its power from renewables by 2030. A 13 MW thin film PV plant is in operation, and bids for a 100 MW extension will be tendered later this year by the Dubai Water and Electricity Authority (DEWA) for an Independent Power Producer (IPP) with a 49 per cent private sector stake. More ambitious are plans for a floating solar island project (1 MW) and the Mohammed bin Rashed Solar Park of 1 GW by 2030.

'SOLAR IRRADIATION LEVELS ARE SOME OF THE BEST IN THE WORLD.'

Kuwait announced a target of 1 per cent of electricity generation to come from renewable sources by 2015, 10 per cent by 2020 and 15 per cent by 2030 (equivalent to 2 GW). The Kuwait Institute for Scientific Research (KISR) has been supervising research on solar energy systems, drafted the renewable energy strategic plan to 2030, and launched the bidding process for the 70 MW Shagaya Renewable Energy Complex. This (initial) project of 10 MW wind, 10 MW PV, and 50 MW thermal energy with 10 hour energy storage has been planned to assess the performance of different renewable technologies under Kuwaiti climatic conditions. Preparation for a 280 MW Integrated Solar Combined Cycle (ISCC) plant with a 60 MW solar booster field at Al Abdaliya continues.

Oman has set itself a target of 10 per cent of its electricity to come from renewables by 2020. A 6 MW PV demonstration plant and Glasspoint's 7 MW CSP plant for Enhanced Oil Recovery (EOR) have been completed, and Power Purchase Agreements for a rural solar PV project in the Al Mazyunah State has been signed by the Omani Rural Areas Electricity Company (RAECO). Further initiatives await the completion of an overall strategy for renewable generation, which is expected later this year. Qatar expects to generate at least 2 per cent (640 MW) of electricity from solar resources by 2020. One of the immediate projects is a group of solar installations to help cool and power the stadium and facilities for the FIFA World Cup to be held in Qatar in 2022. More ambitious programmes to develop Qatar as a solar industry leader – to build a 3.5 GW ISCC plant with 500 MW of CSP and a 1.8 GW PV plant – have been under discussion. Bahrain announced a 5 per cent renewable energy target, to be achieved by 2020 with a focus on mature technologies. Wind turbines are installed at the Bahrain World Trade Center and projects such as a 25 MW waste-to-energy plant are in the planning stage.

World-class solar resources… and a strong case

The KSA White Paper, the academic literature, and energy analysts all agree on the strategic and economic case for renewable energy in GCC countries. Solar irradiation levels are some of the best in the world. Space is no constraint for utility-scale solar PV or CSP installations, and both on-grid and off-grid, decentralized installations for power, cooling, and water desalination are needed. Robust population, economic, and industrial growth increase electricity demand, which the IEA estimates will grow at 2.5–3 per cent a year in the next two decades. If this electricity is generated using oil and gas, this will limit exports of hydrocarbons, reduce export revenues at international oil and gas prices, and lead to early resource depletion.

The GCC countries are among the highest per capita carbon emitters in the world. Thus, adding renewable technologies to the energy mix will bring environmental benefits, or positive externalities. Last, but not least, the GCC economies have considerable public and private expertise in the funding, building, and operation of energy and construction projects. Bringing this expertise to bear on the emerging renewable sector can create jobs and new industries locally, while extending the role of GCC countries as leading energy producers and exporters.

A difficult business case

The business case, however, is more difficult to make: first, the highly subsidized electricity and water tariffs, together with a production cost based on domestic fossil fuel prices, fail to give price signals to consumers and producers, and burden government budgets. Second, the current levelized cost of electricity (LCOE) using solar is estimated by Bloomberg/BNEF at 9–24 US cents/kWh, with a cost of 6–14 US cents/kWh for wind and waste-to-energy, a multiple of the financial cost using conventional fuels. As funding will have to be guaranteed under 20 year Power Purchasing Agreements or other long-term incentive schemes, the renewables diversification and industrialization strategy will inevitably add a financial burden on the treasuries and public/private funding resources of the GCC economies – even if some international equity and non-recourse loan financing can be mobilized. Third, the adaptation of solar technologies to the climatic conditions of the GCC countries is still a work in progress. Dust, humidity, and extreme temperature variations will impact

efficiency levels, requiring further R&D and location-specific adaptation with as yet unknown financial costs.

Can IPPs deliver?

The GCC countries have a long (and successful) tradition of public investment in the power and water sector, national and international public/private partnerships, and joint ventures. Thus, competitive tendering has been the preferred process to source renewable expertise and award contracts for Independent Power Producers (IPP) with agreed off-take and remuneration under Power Purchase Agreements. The K.A.CARE White Paper envisages substantial local content requirements to localize services and manufacturing, special R&D and training surcharges, equity contributions, and project-based loan financing for the winning tenders.

Observers and potential investors question whether such a competitive tendering process is a sufficient policy framework to scale up an industry by the proposed factor. They call for electricity market liberalization and renewable policy frameworks similar to the support policies in the USA, Europe, or Japan. Caution is called for here, at this early stage of deployment. Policy frameworks for renewables vary widely among countries; they grew out of the fiscal and regulatory traditions of each country and are subject to change, often according to budgetary limitations and political changes. Localization pertains not just to (a) adapting technologies to local conditions, or (b) developing jobs, technologies, and skills along the entire value chain, but (c) calls for policies that are anchored in local institutions, the national public/private business environment, and the industry structure of the technology in question.

Others wonder whether Independent Power Producers (IPPs) will deliver competitive technologies AND the local value chain development that is an integral part of the diversification strategy of GCC countries. Will technologies chosen now under 20 year Power Purchase Agreements become obsolete, and ultimately rather costly? Will manufacturing facilities become stranded assets within a few years as lower-cost solar technologies are developed elsewhere? Indeed, the challenge of the GCC countries' renewable strategy lies NOT ONLY in the details and sequencing of tendering processes and policies but (a) in the nature of the still emerging and fragile renewables industry structure, and (b) the early development and deployment stage of solar technologies. The following three examples of the role of IPPs in emerging technologies and the evolving market structure of PV and CSP illustrate these points.

Renewables industry too uncertain for IPPs?

Typical localization and transfer of technology strategies rely on established national and international firms, functioning markets, and relatively mature technologies. None of these conditions exists in the potential deployment of renewables technologies in the Gulf. Energy companies, utilities, conventional power plant EPCs, and equipment suppliers have entered the renewables space – left, re-entered, and often left again. They are themselves still in a learning phase with limited deployment experience and appetite for major equity, risk, and guarantee commitments. Few solar developers or technology providers have the financial strength, international experience, or long-range commitment to act as Independent Power Producers. As incentives for renewables have been, or will be, further curtailed in Europe and the USA, and the Japanese, Chinese, and Indian markets remain difficult to penetrate, the international renewable industry is looking at the GCC countries as being the market that can bankroll further deployment. At best, this is a joint learning process.

'… THE ADAPTATION OF SOLAR TECHNOLOGIES TO THE CLIMATIC CONDITIONS OF THE GCC COUNTRIES IS STILL A WORK IN PROGRESS.'

Challenges facing the solar PV industry

The GCC countries plan to install more than 20 GW of solar PV by 2032. Worldwide installed capacity reached 135 GW by the end of 2013 and is estimated to reach 1000 GW by 2030. Thus, GCC plans are only a fraction of the present and anticipated global market (IEA, 2013). The global PV manufacturing industry is in the middle of a consolidation phase with high-cost producers and developers exiting. After overcapacities are absorbed, the industry expects further technology push and cost reduction after 2015. Thus, the localization of competitive EPC and O&M services for PV installations is an obvious and achievable first priority. The development of a niche market for PV panels specific to the climatic conditions in the Middle East would require substantial R&D commitments, in competition with established panel manufacturers. In contrast, the localization of an internationally competitive PV manufacturing sector is a more costly and risky endeavour.

The potential of CSP technology

While the Gulf States' share in the present and future global PV market is relatively small, the 25 GW planned KSA investment in CSP with storage could account for as much as 50 per cent of the estimated global CSP market by 2030, according to IEA and CSP Today figures. Tower, parabolic trough, linear Fresnel technologies for

power, industrial steam and ISCC booster production have been demonstrated and are in commercial operation, inter alia, in the USA, Europe, Morocco, and India. However, global, capacity is less than 3.5 GW. The KSA investment in CSP will be crucial for testing the comparative advantages of the competing CSP technologies, driving down their cost, scaling up the most promising technologies, and taking advantage of local expertise. This is a dynamic process that requires flexibility, but it offers global technology and market leadership along the entire value chain However, success is not a forgone conclusion; more rapid, cost competitive development of PV and storage technologies may ultimately limit the future, global importance of CSP despite its dispatchability.

Conclusion

Currently standing at a total of 4 per cent of the world's electricity generation, power from solar, wind, waste-to-energy, and geothermal resources is still a vision. The technologies need to be developed further, adapted to local conditions, costs drastically reduced, and industries scaled up. Experience shows that this process is messy and lasts for decades, with stranded assets and companies failing until dominant, internationally competitive technologies and mature companies emerge, and incentive schemes fade away. The decision of GCC countries, in particular the KSA, to join the USA, Europe, Japan, and China in financing and supporting the R&D, learning, and scaling-up process for renewable electricity is both economically justified and welcome. It requires long-term commitment and flexibility to adjust policies and partners to changing circumstance. Last, but not least, it requires a hard-nosed and realistic assessment of what it takes and costs to build a world-class alternative energy sector – no hypes, no green-washing.

Why renewable energy could be a chance for the GCC economies

Laura El-Katiri

The GCC economies have come a long way since the onset of the age of oil. When the first oil well was struck in Jebel Dukhan in Bahrain in 1931, few would have forecast that the fortunes of the sheikhdoms along the Gulf would be so fundamentally shaped by a single energy commodity as has turned out to be the case. Today's wealth, visible in the global capital cities Riyadh, Abu Dhabi, and Kuwait City, is as much the result of the region's unique gift of natural resources as it is of historical leadership in the use of these resources in promoting the region's unparalleled economic development. Safeguarding this wealth will also, in the future, require answers to strategic questions; these include how to prioritize between the domestic value of regional oil and gas resources and their marginal export value, in view of the GCC economies' own rapidly rising domestic energy needs. Renewable energy sources could form an important part of the answer to such questions, provided they are used in a clever way.

Oil is where you find it

Oil has, without a doubt, played a defining role in the socio-economic history of the Gulf region, predating the formation of the modern-day member states of the Gulf Cooperation Council by several decades. Home to some of the world's most important conventional oil and natural gas reserves, the GCC economies have had sensible reasons to maximize the use of their valuable natural resources for the purpose of economic development. The region's overall low production costs for oil and, initially, for natural gas have fuelled their use as a low-cost fuel for domestic power generation and water desalination, and for the rapid extension of access to transportation in the GCC states' highly urbanized centres. Oil and subsequently natural gas have also, under multiple GCC government strategies, been feeding into domestic energy-intensive industrial clusters, to diversify the area's domestic economies away from primary commodity exports towards higher-value chain products, such as petrochemicals.

'… THE GCC ECONOMIES HAVE HAD SENSIBLE REASONS TO MAXIMIZE THE USE OF THEIR VALUABLE NATURAL RESOURCES FOR THE PURPOSE OF ECONOMIC DEVELOPMENT.'

Natural gas first entered GCC energy markets slowly during the 1970s, then rapidly during the 1980s and 1990s. Initially disregarded and flared as an unwanted by-product in oil production, natural gas has become a key substitute for oil in domestic power generation and petrochemicals production, freeing the higher-value oil for export. Qatar, Abu Dhabi, and Oman have also been exporting gas as an export commodity in its own right; this policy has turned Qatar, with some of the world's largest gas reserves, into the world's largest producer of liquefied natural gas (LNG). Exports of natural gas have also helped

save Qatar from the drastic decline in state revenues which was linked to the island state's comparably limited oil reserves; this decline had set Qatar, Oman, and Bahrain apart from the more oil-rich parts of the GCC which expect to produce for many more decades to come.

Shifting global energy demand

The GCC states' impressive economic development trajectory – which in a mere 60 years has lifted them out the world's economic backwaters to the status of global urban and industrial centres – has also left its mark on the region's energy footprint. Decades of fast population growth, rapidly improving living standards, and a focus on energy-intensive industrialization have hiked energy consumption across the GCC to levels otherwise seen only in highly industrialized economies. Qatar, the UAE, and Kuwait are now amongst the world's largest per capita consumers of primary energy and electricity, at rates which are multiples of those seen elsewhere amongst their regional neighbours in the Middle East and North Africa.

With 2.94 mb/d of oil consumption Saudi Arabia is also, in absolute terms, amongst the world's six largest consumers of oil; this is matched by the Kingdom's equally rampant natural gas consumption of some 100 Bcm/year. Alongside Iran, Saudi Arabia and the GCC economies are expected to account for a majority of the Middle East's energy demand growth which is seen in projections by the IEA and others. Under IEA forecasts the Middle East will, alongside Asia–Pacific, account for the majority of demand growth in primary energy well into the 2030s, a prospect that could – and should – do more than raise eyebrows, in expectation of the region's fundamentally changing role on international energy markets.

On blessings and a curse…

The prospect of continuingly surging domestic energy consumption in the GCC states holds tremendous strategic significance; if anything, it can be considered one of the big game changers for energy planning in the GCC for many years to come. It is joined by one other likely game changer: the onset of relatively high oil prices on international markets since the early 2000s, which has considerably added to the value of oil on international, as opposed to domestic, markets. The GCC states' most formidable energy policy dilemma, which is likely to unfold over the coming years, lies in the implications of rising domestic energy demand for the allocation of its valuable oil and gas resources. Oil and, in some cases, natural gas have traditionally fulfilled the dual functions of capturing export revenues on international markets, while providing a low-cost fuel for domestic industrial development and energy supply. The GCC states' oil and gas resources capture value abroad, while they are supposed to create value domestically.

The equation is illustrated by a comparison of prices, where the domestic price of oil in most GCC states is usually tied to a measure of production cost – historically around several dollars per barrel – compared with an international price of, on average, between $100–110 per barrel in 2013. A significantly narrower price gap for natural gas explains the preference for gas over oil for domestic use in the GCC, given that the economic opportunity cost is vastly lower than that for oil. Growing domestic energy consumption in the GCC, fuelled continuously by domestic oil and gas reserves, is hence associated with a rising economic cost, in the form of foregone government export revenues.

The potential socio-economic consequences of 'doing nothing' are, on all measures, an expensive option which few of the Gulf states are likely to want to experiment with. Export revenues for regional oil and gas resources account for between 60 and 95 per cent of government revenues in the GCC – an exceptionally high share which has not only enabled GCC governments to provide their citizens with high-standard social welfare states which include free health and education, but also to do away with general income taxation altogether. This use of oil and gas revenues for socio-economic development accounts for the GCC states' high living standards – unparalleled not only in the Middle East, but also in the wider range of emerging economies – which defy preconceived links between the GCC and the widely popular, yet largely inapplicable, 'resource curse' in oil producing countries. The relative political stability of most of the GCC states, since the onset of political turmoil across the Arab world since the early 2010s as part of the 'Arab Spring', has frequently been linked to the GCC states' ability to provide uninterrupted generous welfare to their citizens.

Concerns over growing domestic oil consumption have been voiced most forcefully in Saudi Arabia where, back in 2010, Saudi Aramco CEO Khaled Al-Falih lamented the Kingdom's current use of its oil resources, pointing out that as much as 3 mb/d of crude oil could be lost by 2028 if consumption patterns were not addressed inside the Kingdom. The comments were later followed up by widely quoted Chatham House and Citibank reports, which offered highly alarming forecasts of the status of Saudi Arabia's oil export capacity by the 2030s if domestic demand continued to grow unabatedly and supply continued to be met solely by the country's oil resources. While such business-as-usual projections are

highly unlikely to capture a realistic long-term demand-and-supply picture in the region, they underline the intrinsic importance of policy shift and the consideration of different supply- and demand-side options, in order to respond to what can safely be assumed to be another few decades of increasing demand for energy in the Gulf.

New places, old ideas or old places, new ideas?

It is against this background that an increasing number of the Gulf monarchies have been turning their eye towards energy alternatives, including nuclear and renewable power. Protecting their income stream, while offering their growing domestic energy markets feasible long-term supply alternatives to conventional fossil fuels, makes a great deal of both economic and political sense. In addition, renewables offer many additional benefits, such as the potential to create new high-quality jobs and to reduce the region's surging carbon footprint. Making use of these benefits, while ensuring the incentives encouraging renewable energy deployment are right, will nevertheless prove to be an enormous economic challenge.

The region's vastly distorted domestic energy prices are one key challenge. Indeed the practice of supplying domestically produced fossil fuels at around production cost in most GCC states discriminates on a market basis against alternative technologies; this applies to renewables as much as to nuclear or other alternative options. The current practice of either subsidizing natural gas imports – as in the case of Kuwait – or electricity tariffs generally across the region does little to help uncover the economic benefit that potential energy alternatives such as renewables hold for the region. A 2012 ESIA report highlights this distortion; while at current domestic market prices solar technologies prove uneconomic everywhere in the GCC, a reconsideration of the benchmark price for fossil fuels against which the cost of alternative energy technologies is compared raises the viability of alternatives significantly. The study concludes that solar PV technology would be fiscally viable at an oil price of $80/bl and a domestic gas price of $13/MMBtu ($5/MMBtu at open cycle plants for some locations), a price range that is likely to further sink in the coming years as technology costs for photovoltaic power are likely to continue to decrease.

Integrating renewables will thus require a reconsideration of the pricing mechanisms of conventional and alternative fuels for domestic GCC markets. A domestic market pricing reform, discussed separately in this issue, would constitute an economically efficient solution, ensuring that economic deadweight loss, such as through wasteful consumption, is reduced in line with the introduction of new energy technologies. Another alternative would be the introduction of fiscal incentive schemes (the practice in many European and North American markets) which would aim to 'correct' the price disadvantage suffered by new energy technologies as a result of current market pricing. While such a scheme would probably be more palatable politically than a radical domestic energy price reform, support mechanisms for renewables also bear some economic risk, by merely reallocating economic resources in the form of explicit government subsidies through mechanisms such as feed-in tariffs.

A similar 'trap' could lie in using renewables as a way of generating employment opportunities – the 'green' economy dilemma. While renewable energy offers the GCC a sensible industry cluster in which to invest resources in order to increase local know-how and add to research and development activities, the number of jobs created inside a potential GCC-based renewables industry is unlikely to be at the level that policymakers may wish for. It is also unlikely that the GCC will be able to compete in terms of cost with China in industry segments such as production and manufacturing. Promoting renewable industries in the Gulf in a different way could eventually lead to the mere replication of economic waste which has afflicted other energy sources.

'THE PROSPECT OF CONTINUINGLY SURGING DOMESTIC ENERGY CONSUMPTION IN THE GCC STATES HOLDS TREMENDOUS STRATEGIC SIGNIFICANCE.'

Renewables, under such policies, will feature in a similar way to domestically produced fossil fuels: they will capture state revenue, which could have been used differently, thereby tying fiscal benefits to energy consumption. This way of using renewables is unlikely to address an essential part of the 'problem': rising and often wasteful energy consumption based on financial signals which reduce the value of energy in the GCC states' domestic economies. Addressing this challenge structurally, by managing demand in addition to supply, will prove critical to a truly sustainable long-term growth path, for the Gulf economies are in desperate need to do more, using less, not the other way around. If the pursuit of renewable energy could be used by the GCC states to reconsider the way they value different energy resources in their domestic economies, the contribution of renewables to GCC economic development could be great indeed.

Laura El-Katiri recently published a study titled 'A Roadmap for Renewable Energy in the Middle East and North Africa' for the Oxford Institute for Energy Studies, available on the OIES website.

Energy efficiency: the first renewable

Samar Khan

The world has seen ample research focusing on the topic of energy efficiency and how consumers can reduce their energy consumption, and in the 1990s researchers introduced yet more energy topics to consider: sustainability, climate change, environmental impact, consumer behaviour, and the promotion of sustainable consumption via methods such as recycling, energy efficiency, and conservation. However, Saudi Arabia sees the situation differently, and has done so historically. One of the problems often cited by Saudis engaging with energy efficiency issues is the lack of understanding of the concept of sustainability. The Arabic word *Istidaama* has only been applied in this context in Saudi Arabia in recent years, and the concept of using energy more efficiently is both new and vague. It has been argued that whilst most developed countries are starting to increase consumer awareness about energy efficiency, people in Saudi Arabia still believe that their country floats on a river of oil.

'ONE OF THE PROBLEMS OFTEN CITED BY SAUDIS ENGAGING WITH ENERGY EFFICIENCY ISSUES IS THE LACK OF UNDERSTANDING OF THE CONCEPT OF SUSTAINABILITY.'

Saudis have been accused of ignoring the truth that although Saudi Arabia is one of the world's largest oil producers, the country is also amongst the highest in terms of energy consumption. In 2012, the country consumed approximately 3 mb/d (million barrels of oil per day), and it is likely that this will continue to rise, according to EIA figures. Currently, Saudi Arabia is planning to devote billions of dollars and widespread resources to the development of renewable energies across the country. This is crucial because the current energy efficiency situation in Saudi Arabia is problematic and still neglected. Some Saudi economists argue that the problem of the country's increasing oil consumption may be solved by re-pricing fuel and electricity, but politicians are cautious about this method, as they want to avoid the kind of political unrest that has occurred in other Arabic countries because of the Arab Spring.

A challenging energy future

However, renewable energy investment and energy productivity are not the only factors contributing to the maintenance of energy security in the Kingdom; other tasks should be dealt with before switching to renewable energies (although one of the most crucial targets currently faced by Saudi Arabia is the building of renewable energy technologies in order to improve its sustainability status). The Kingdom faces a range of barriers in terms of building a more sustainable future: cars, rather than public transport are the main mode of transportation; the education system is encumbered with weak curricula, dilapidated school buildings, and unqualified teachers; and domestic energy consumption and continuous excessive petroleum usage is increasing at a time when other countries are beginning to control their energy consumption. Furthermore, recycling, conservation, efficiency, and 'green thinking' are mostly alien terms in Saudi Arabia. Although there is much research and practical guidance relating to energy efficiency, Saudi Arabia has a long way to go if it is to be regarded as an energy efficient country in the next five years.

Saudi Arabia certainly faces several serious challenges. Some of the key challenges include its heavy dependence on oil export revenue, the massively growing domestic energy demand, the rapid population growth, and the lack of interest in efficiency and conservation. However, the most important of these for Saudi Arabia are: the reduction of uncontrolled demand, production sustainability, and energy pricing. The challenges faced by Saudi Arabia have been summarized by Waleed Al-Rumaih of the National Saudi Transmission Company as 'diversity away from oil on the one hand, and optimizing the country's energy consumption on the another'. He also suggested that 'one of the big challenges in Saudi Arabia is the need to reduce energy without raising the domestic energy price'. The reality facing Saudi Arabia has been summarized by an energy expert from King Abdullah City for Atomic and Renewable Energy (K.A.CARE) in the following: 'The energy landscape in Saudi Arabia is characterized with reactionism; slow to move, lack of leadership and a continuous gap between where we ought to be and where we are.'

Important first initiatives

Regarding what is currently happening in relation to energy efficiency in the Kingdom, some important policy initiatives were introduced last year to reduce domestic consumption. These policies tended to focus on installing insulation, and adapting air conditioners and other household electrical appliances. In 2010, the Ministry of Water and Electricity began considering thermal insulation systems. A new set of regulations is now being

implemented and the Ministry of Water and Electricity has announced that it will not issue building licences for new buildings unless they have been installed with thermal insulators.

'INTRODUCING ENERGY EFFICIENCY MEASURES WILL HELP POLICY MAKERS AND ENERGY PLANNERS TO DISTRIBUTE MORE APPROPRIATE AMOUNTS OF ENERGY …'

In 2013, the Ministry of Commerce and Industry and the Saudi Energy Efficiency Centre (SEEC) focused on air conditioning use, as air conditioners consume 70 per cent of all electricity production in Saudi Arabia (partly due to the fact that local air conditioners have a low energy efficiency ratio). This focus is likely to broaden out to all electrical appliances in 2015. However, there is a major concern that when an SEEC team tries to investigate the extent of energy efficiency awareness among Saudis in Riyadh, they tend to find that most Saudis are unaware of the energy efficiency poster campaign on air conditioners and other home appliances. This illustrates the fact that even with government efforts to reduce domestic consumption, consumers still do not understand the main aim of the energy efficiency campaign. Furthermore, air conditioner traders are selling low-efficiency ACs at lower prices and thus their sales are rising. Such activity, largely resulting from lack of awareness, is illegal.

Introducing energy efficiency measures will help policy makers and energy planners to distribute more appropriate amounts of energy, thereby helping to reduce unnecessary energy waste; this will ensure energy is utilized in shorter bursts during peak times, rather than nonstop.

Whilst the benefits of using renewable energy cannot be disputed, it is unlikely that renewable energies will be used on a large scale in the Kingdom of Saudi Arabia in the near future, due to the absence of a clear institutional and legal framework. However, there is mounting pressure on the government to enhance its efforts to transform Saudi society from being knowledge-poor in relation to energy use to becoming knowledge-based, by following some crucial steps. Firstly, because energy efficiency remains a poorly understood concept in Saudi Arabia, there is an urgent need for an effective approach to the task of increasing public awareness of the need to use energy more efficiently. This approach can only be achieved through education via a curriculum that can address people of all ages about the concept of energy efficiency. Whilst developing such a curriculum will take time, more basic measures can be introduced in the meantime. These measures should include: attempting to change the nation's behaviour, creating awareness about energy efficiency, improving the nation's understanding of energy security, subsidy reform, and, most importantly, correcting the misconception that Saudi Arabia's oil resources are infinite. Such measures can be kick started by launching country-wide campaigns.

Achieving a sustainable energy mix

Currently, Saudi Arabia's main aim is to achieve a sustainable energy mix (a combination of solar, wind, and nuclear power) by 2030. With a sustainable energy mix, the Kingdom's economic priorities should focus on moving from a natural resources-based market structure to a knowledge-based structure. Although Saudi Arabia is currently lagging in many areas – such as energy efficiency, environmental concerns, and efficient transportation – there is something positive to take from this: the Kingdom has an opportunity to duplicate developed countries' best practices and use them to solve its problems. As such, Saudi Arabia does not need to 'reinvent the wheel'. Innovative ideas are there for the taking, and the country can tailor such ideas to its own circumstances.

It is worth pointing out that increasing public awareness of energy consumption and environmental issues is one of the reasons why energy consumption in many countries has decreased. For example, the UK has seen a dramatic change in energy consumption by the average household. With this in mind, it is essential that Saudi Arabia begins drawing up serious solutions designed to raise awareness of energy efficiency which will ultimately reduce domestic energy consumption. It is unfortunate that this Islamic country has been unable to follow the Prophet Muhammad's (Peace be upon him) simplest commands, such as 'Conserve water, even if you reside at the edge of a high-flowing river'.

'SAUDI ARABIA'S MAIN AIM IS TO ACHIEVE A SUSTAINABLE ENERGY MIX (A COMBINATION OF SOLAR, WIND, AND NUCLEAR POWER) BY 2030.'

The rate of energy consumption growth in the country has exceeded that of most other countries and this is threatening the future of the Saudi Arabian economy. The Kingdom must plan for tomorrow today, and the first step will require a reform of domestic energy prices. Whilst it may appear desirable to allow the Saudi government to continue letting its people live in luxury, it is essential to ensure the safety and comfort of future generations.

Masdar City: 'City of Possibilities'

Steven Griffiths

As the global population continues to migrate to cities, new models for sustainable city design are being developed and tested. Masdar City in Abu Dhabi, United Arab Emirates is one such project. In 2006, the government of Abu Dhabi announced that it intended to spend $22 billion with the aim of becoming a leader in renewable energy; a key part of this plan was to build a new carbon-neutral, zero-waste city from the ground up to demonstrate state-of-the-art sustainable city design. As initially conceived, Masdar City was something of an experiment: a clean-technology incubator powered by renewable energy, which was intended to exhibit the highest levels of efficiency. Partly due to the global financial crisis of 2008 and partly due to experience gained from continued assessments of the original concept, Masdar has scaled back the initial ambitions for the city's carbon and waste targets, as well as the development approach and timeline for the entire city. This, however, may ultimately prove to be the best outcome for Masdar City if it is truly to become a model for sustainable cities of the future.

Masdar City – the concept

Masdar City, located in the emirate of Abu Dhabi in the United Arab Emirates, is part of the broader Masdar Initiative. Masdar was founded in 2006 by the Abu Dhabi government to diversity the UAE economy away from dependence on oil and gas and toward a more sustainable energy and economic system. Masdar is wholly owned by the Mubadala Development Company, which itself is an Abu Dhabi-owned enterprise. Masdar has a mandate to advance sustainable energy through education, research and development, investment, and commercialization.

To achieve this mandate, Masdar is organized into three main business units: Masdar Capital, Masdar City, and Masdar Clean Energy, as well as an independent research university, the Masdar Institute of Science and Technology. Masdar Capital is a major investor in clean-technology companies around the world, while Masdar Clean Energy focuses on the development of large-scale renewable energy and carbon abatement projects. Masdar City is a special economic zone and a model for commercially viable sustainable living. The Masdar Institute of Science and Technology is a graduate-only university developed in cooperation with the Massachusetts Institute of Technology (MIT). Although not under the Masdar corporate umbrella, the university is a key part of the Masdar concept as it is located in Masdar City and is intended to be an anchor for intellectual activity within Masdar City and the UAE more broadly.

'… TO BUILD A NEW CARBON-NEUTRAL, ZERO-WASTE CITY FROM THE GROUND UP TO DEMONSTRATE STATE-OF-THE-ART SUSTAINABLE CITY DESIGN.'

Although Masdar is a broad initiative with impact on environmental sustainability far beyond the borders of the UAE, Masdar City is the iconic feature that many associate most closely with the brand. Masdar City is a 6 sq. km development located approximately 17 km from downtown Abu Dhabi City. It is Masdar's vehicle for the demonstration, through a combination of urban design and technology, of a new paradigm in sustainable living. The originally announced plan for Masdar City was that by 2016 it would be the world's first carbon-neutral and zero-waste city, with all of its buildings sitting on an elevated platform where 40,000 residents and 50,000 commuters would engage daily in educational, work and social activities. It was always apparent that a relatively small development such as Masdar City, with substantial financial backing from the Abu Dhabi government, could be a test bed for the new technologies required to meet extremely demanding sustainability targets. This resulted in a great deal of Masdar's early emphasis on environmental sustainability via architectural design and technology deployment, which had the aim of capturing economic benefits from patents, IP ownership, game changing technology innovations, strategic alliances, and direct technology ownership.

In parallel to the development of a number of technology roadmaps intended to achieve these technology ambitions, Masdar undertook various assessments to identify how the city could rapidly become a commercially viable clean-technology hub capable of providing a home to a diverse assortment of organizations, including multinational companies, start-ups, research institutes, and NGOs. The idea was to leverage all the elements of the Masdar concept to create a small-scale version of Silicon Valley within the UAE. Partially influenced by the global financial crisis of 2008 and partially based on the results of strategic assessments, Masdar City's development strategy was revised to accommodate a more measured pace of development, and some of the most expensive and challenging elements – such as having the entire city built on top of a podium with a personal rapid transportation network underneath – were eliminated. Plans for power,

water, and waste technology demonstrations for commercial purposes have been largely disregarded due to regulatory challenges, as well as the large scale required for meaningful demonstrations. Likewise, the state of the regional clean-technology market, the undeveloped nature of the local research and innovation ecosystem, and the lack of local frameworks for attracting global companies made rapid and commercially viable development of a clean-technology cluster impossible within the timeframe initially planned for the city's development. Hence, Masdar City's development strategy has adjusted to reflect the reality of developing a new city with many simultaneous ambitions, some of which have taken decades to realize in other countries.

In fact, Masdar City's strategy today is built on a more incremental approach, focusing less on buildings and technology, and more on the establishment of a new model for city form, structure, and mobility. This necessary course correction is one that provides Masdar with the opportunity to avoid the fate of infamous 'eco-cities' such as Dongtan in China, which was full of visions for sustainability that could not ultimately be realized economically. It would seem that Masdar City is now moving toward triple bottom line sustainability, which is an essential aspect of future city design both regionally and globally. Therefore, the three lenses of environmental, economic, and social sustainability can be used to assess Masdar City's current trajectory and future evolution.

Environmental sustainability

Environmental sustainability remains at the heart of Masdar City's design. When benchmarked against comparable buildings in Abu Dhabi, the city's buildings are intended to yield a 40 per cent energy demand reduction, a 30 per cent interior water demand reduction, and a 15 per cent reduction in embodied carbon in construction materials. No potable water is used for exterior purposes in the city, and 50 per cent of operational waste and 70 per cent of construction waste is diverted from landfill. Rigorous building and city vehicle emissions standards are also core aspects of the city's environmental sustainability plan. In order to meet these sustainability targets, Masdar has evaluated both procurement and technology development options, with the intention of capturing financial returns from technology development partnerships in the domains of smart buildings, supply chain, transportation, ICT, lighting, and cooling. These domains are ones that promote partnership with companies seeking to engage Masdar City for technology demonstration, and hence are aligned with the city's overarching commercial strategy.

Economic sustainability

Masdar City's model for economic sustainability has improved significantly and is now based on a model in which Masdar acts as both real estate developer and master builder. As a real estate developer, Masdar leases land to third parties that must adhere to the development, design, and sustainability guidelines set forth by the City and aligned with Abu Dhabi's broader sustainability ambitions. Sustainability in Abu Dhabi's built environment is realized through the Estidama programme, an initiative developed and promoted by the Abu Dhabi Urban Planning Council (UPC). Similar to BREEAM (British Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design), the Estidama programme has a rating systems called Pearls, which covers buildings, villas, and neighbourhoods. Like LEED and BREEAM, Pearls is a point-based system that awards projects points for different credits that are grouped under a number of general categories; these are added together to give a final rating, which ranges from One to Five Pearls. It is expected that only a very small number of buildings in Abu Dhabi will achieve a Five Pearls rating as this requires a net positive contribution to the environment in terms of energy, water, and improving diversity and health of living systems. In Masdar City, all developed property must be at least 3 Pearls. This is perhaps a conservative standard given the city's desire for sustainability, but demand for sustainable development in Abu Dhabi must be proven before a more demanding requirement can be realistically imposed.

In its role of master builder, Masdar develops buildings according to projected demand, and owns these buildings. The Masdar Institute of Science and Technology campus and the soon to be completed 32,000 square metre Masdar headquarters building (a 4 Pearls building), are examples. Finally, Masdar builds to the demand of the government and private sector. Siemens' new headquarters building for the Middle East region in Masdar City is an example of this model. The building has been designed to optimize both its natural environment and carbon efficiency, to offer a sustainable and commercially viable solution. It meets the highest requirements in terms of architecture, energy efficiency, and equipment, with the objective of achieving a 45 per cent reduction in energy consumption (benchmarked against the internationally acknowledged ASHRAE standard) and a 50 per cent reduction in water consumption (compared to LEED baseline).

Social sustainability

Social sustainability in Masdar City, and cities in general, relates to understanding what people need from the places they live and work in, and in providing them with an enduring quality of life. For this reason, Masdar City's current development strategy is most intriguing with regard to its emphasis on social dynamics. Social dynamics in Masdar City's current development plan are tied to a structure predicated on distinct neighbourhoods linked by a network of mobility. This approach to city design comes from Masdar's relatively recent recognition that the building blocks of a city are, in fact, not large districts or downtown cores the size of Masdar City itself, but rather neighbourhoods. In the Masdar City concept, neighbourhoods are not just residential, they can also be working neighbourhoods, mixed-use neighbourhoods, and R&D neighbourhoods. As such, the Masdar City development plan is now organized into nine neighbourhoods with Masdar Institute as an R&D neighbourhood at the core. Mobility between these neighbourhoods, and outside the boundary of the city, is accomplished by pedestrian corridors, a group rapid transit corridor, and a light rail transit corridor, thus making multiple forms of sustainable transportation possible. Because the city continues to be designed for an optimum microclimate that takes advantage of passive design and natural cooling, walking through internal courtyards, urban squares, and parks is possible all year round. In fact, Masdar City has the opportunity to become a new model for urban mobility that integrates transportation, commerce, and social interaction while eliminating vehicle traffic, carbon emissions, and urban heat islands. Although some may argue that Masdar City is too small for its evolving concept of interconnected neighbourhoods to create a paradigm shift in urban design, it is a concept that reflects Masdar City's emphasis on replicable design and social sustainability.

'ENVIRONMENTAL SUSTAINABILITY REMAINS AT THE HEART OF MASDAR CITY'S DESIGN.'

Final thoughts

Today Masdar City calls itself the 'City of Possibilities'. This tagline is very fitting given its current trajectory and its long-term ambition to become a city that fully embodies environmental, economic, and social sustainability. Starting from a concept that seemed to many to be more of a showcase for architecture and technology than a model of sustainable development, Masdar City now has the opportunity to become a paradigm for sustainable cities both in the region and globally. The mandate for Masdar City's development has pivoted toward a complete package of sustainability with a comprehensive focus on economy, society, and the environment. Masdar now seeks to provide a city model that integrates sustainable urban design, future city technologies, as well as supportive social and commercial frameworks. This is a reflection of a more general pattern in the UAE, whereby aspirations for the establishment of a sustainable, knowledge-based economy are slowly becoming a reality through increasingly thoughtful investment in sectors where the country has or can establish a competitive advantage.

In the case of Masdar City, the idea of neighbourhoods linked by sustainable transportation is clearly replicable. Furthermore, the gradual development of these neighbourhoods allows Masdar City's design to be responsive to rapidly evolving technological and social trends – such as workplace automation, on-demand mobility, and social media – which will increasingly change the way people live, work, and interact in cities. Aligned with Masdar's ambitions for global impact, exportable knowledge can be generated and captured not only from the human and intellectual capital produced by Masdar Institute, but also from the companies attracted to Masdar City because of the Institute as well as the rest of the City's evolving ecosystem. However, Masdar City will only fulfil its ambition of becoming a model for future cities by maintaining a thoughtful course focused on brand development, partnerships, and its unique offering that is distinct from the rest of the massive real estate build out taking place in the UAE and elsewhere in Asia. If this course can be successfully navigated, Masdar City may ultimately achieve true sustainability and become a replicable model for sustainable cities of the future.

The case for nuclear power in the Middle East and North Africa

Adnan Shihab-Eldin and Holger Rogner

Introduction

Several Middle Eastern and North African (MENA) countries have, over the past decades, declared an interest in nuclear power, although aside from some limited R&D programmes based on research reactors in a few Arab countries (Egypt, Algeria, and Libya, for example) and Iran, until recently no MENA state has committed to a concrete nuclear power programme. This changed in the new millennium, with the UAE's firm nuclear programme that will add 20 MW of nuclear power by 2020, turning it into the first Arab country to produce nuclear power for domestic use. Other regional neighbours, such as Saudi Arabia, Egypt, Jordan, and Kuwait have been announcing plans for similar programmes. This article summarizes the rationale for nuclear power in both the GCC and MENA countries, before reviewing economic competitiveness in the regional context, the requirements for infrastructure and regulation, and the status of regional programmes.

The rationale for nuclear power in the MENA

The GCC countries hold around 40 per cent of world oil and 25 per cent of gas reserves. Government revenues are 80 per cent dependent on hydrocarbons. The demand figures for both electricity and water are growing at close to double digit rates, absorbing increasing amounts of national oil and gas production, having already forced previously gas self-sufficient countries to become importers of natural gas. Demand comes predominantly from residential buildings; this has grown at very high rates, reflecting very low electricity tariffs. Efforts on efficiency measures are increasing, but the impact has been minimal so far. Tariff increases are politically difficult, but without them average annual electricity demand growth over the next ten years could exceed 6 per cent, draining the region's hydrocarbon resources for use in domestic power generation still further. For many regional oil and gas producers, the use of nuclear power is seen as an important step that could extend the lifetime of reserves, releasing additional domestic oil and/or natural gas production to earn revenues for exporters.

For other MENA countries, in the Levant and North Africa, the nuclear power option provides a secure alternative energy source to meet demand – which rises with population. Almost 50 per cent of Turkey's fuel mix consists of gas imported from Russia and Iran; 70 per cent of Egypt's needs come from its domestic gas resources, which are predicted to be depleted within two decades; Jordan is completely dependent on imported energy. In all these countries, nuclear power could reduce reliance on the import of expensive fossil fuels, thereby saving expenditure over the long term.

'FOR MANY REGIONAL OIL AND GAS PRODUCERS, THE USE OF NUCLEAR POWER IS SEEN AS AN IMPORTANT STEP THAT COULD EXTEND THE LIFETIME OF RESERVES …'

Limited finance is the major challenge; this has resulted in original and innovative funding, initiated by Russian ambition to increase its role as an international nuclear provider. For the first plant in Turkey Russia will fully fund and resource a national company to Build Own and Operate (BOO), selling a proportion of output to the state at 'preferential rates' with freedom to market the balance. Later, minority private sector participation will be sought. A similar BOO model is reported to have been offered by Russia to Jordan, but this is beset with additional difficulties. Siting is constrained by seismicity and cooling water availability. The presently favoured site relies on treated wastewater. Popular opposition to nuclear power, not least in the wake of Fukushima's recent disaster, is strong and rising.

Regional economics

As 95 per cent of the costs of nuclear power are unrelated to the uranium price, nuclear offers security against price variation and fuel supplies. There have been some security and safety related costs based on lessons learned on preparedness for extreme events as a result of Fukushima, and while these are specific to the physical environment of each site, capital costs are unlikely to exceed $6500/kW. The BOT funding models, with a high proportion of state equity and favourable credit ratings for residual debt, enable the outsourcing of economic and financial risk. With discount rates of 7 per cent and capital costs of $6500/kW, the generating cost will then be near $85/MWh. The $124/MWh proposed by Russia to Turkey is indicative of costs resulting from BOO and other funding models elsewhere in the region.

In the GCC, competitiveness with the lowest cost alternative technology, CCGT, depends on gas source. Nuclear is uncompetitive with firing domestic gas (including difficult non-associated gas) up to marginal costs of $8/MMBtu but this source is

limited in many countries. Nuclear is highly competitive with a cost of $140/MWh for imported LNG, priced at parity with oil at $100/bbl, and with $175/MWh cost for steam plants at the same oil price.

The cost-competitiveness of nuclear power depends on the cost of plant, the cost of capital, and the fuel prices of fossil alternatives. To illustrate the point, international oil prices higher than US$50 per bbl and LNG price higher than about US$8/MMBtu would be more than sufficient to pay for nuclear power plants costing US$6500 per kW with an interest rate of 5 per cent. Non-dispatchable generation costs for wind and solar are currently around $150/MWh and are predicted to approach $100/MWh within two decades. However, the cost of these resources to a load-serving power purchaser also include the costs of system integration and the combination of back-up fossil plant or the storage necessary to ensure firm capacity, making them significantly higher.

Other drivers of nuclear power in the MENA

Having among the world's highest per capita energy consumption levels, and these being based entirely on fossil fuels, translates to correspondingly high per capita CO_2 emissions and related environmental concerns, with some GCC countries being amongst the highest emitters worldwide. With significantly lower CO_2 emissions than conventional fossil fuels, nuclear power can contribute towards lowering the MENA region's overall carbon footprint, as an important step towards mitigating climate change. Clearly, the Arab countries are also endowed with enormous potential for renewable energy, especially solar energy. Costs of Photovoltaic (PV) and Concentrated Solar Power (CSP) have been declining substantially in recent years – a trend that is expected to continue. However, intermittency of supply remains a principal issue. Solar energy needs a companion and nuclear power can, in principle, play that role.

There are also geopolitical considerations. Iran's uranium enrichment capability has raised concerns of a potential military dimension. Most of the region's countries that are interested in the adoption of nuclear energy have declared that they are not interested in any domestic fuel cycle activities (except uranium extraction) and that they will be fully compliant with their national safeguards obligations. While all Arab countries are part of the Non-Proliferation of Nuclear Weapons Treaty (NPT) regime and have in place comprehensive safeguards agreements with the International Atomic Energy Agency (IAEA), not all have joined the 'Additional Protocol'. If current negotiations between Iran and the international community produce an agreement that retains Iran's capacity to enrich reactor fuel (up to 5 per cent), other key powers in the region may see this as reason to develop their own nuclear power programmes that would seek similar nuclear fuel cycle (NFC) 'capacity parity'.

Requirements and challenges

Nuclear power has many highly complex technological dimensions. Mastering these to reap its benefits is an even more challenging task. Nuclear power is less forgiving than other energy technologies, requiring persistent discipline in its operation and maintenance, especially with regard to the need for strict adherence to safety standards and regulatory requirements. Competent and effective regulatory oversight is equally important. The Fukushima Daiichi accident is testimony to the fact that that even technologically advanced countries can have serious weaknesses in their national nuclear programmes.

In technologically less advanced countries without a well-developed safety culture, such as those in the MENA region, the introduction of nuclear power needs to balance the added risk with the benefits. Therefore, the development of a successful, safe, and secure nuclear power programme requires a strong and unwavering long-term national commitment, with strong initial efforts aimed at developing the required infrastructure; this would focus especially on human resources and an effective and disciplined management system for all components of the nuclear fuel cycle and related organizations – a cumbersome and time-intensive process.

The introduction of nuclear power in the MENA requires a permanent national commitment to human resource development, sophisticated institutional infrastructure, international cooperation, transparency and a stringent safety culture (including security of nuclear materials), and adequate waste management and decommissioning plans. Such a move would be unprecedented in the region. Infrastructure requirements include: the devising of laws and enforcement of roles and responsibilities, an empowered independent regulator, and entities regulating and overseeing operating, safety, and radiological protection. Some MENA countries have engaged for decades in nuclear R&D activity, which would provide a basis. However, the UAE has successfully established the region's first nuclear power programme without such a benefit, by outsourcing from the technology provider and international entities. Practically, this approach is an essential fast track, but parallel development of citizens to assume key roles, thereby ensuring national commitment, is essential.

Other aspects of the nuclear power option that need continuous attention are (a) the permanent and safe disposal of high-level waste (HLW) – here, fuel leasing and take back arrangements are potential alternatives for the region; (b) the risks of nuclear weapons proliferation; (c) the physical security of nuclear material and facilities; (d) ensuring the highest level of safety in technology design and facilities operation; (e) lower construction costs; and (f) public acceptance of the technology. Insistence on enrichment or plutonium extraction has been justified as being the development of a national scientific capability for peaceful nuclear power or as maximizing the value of national uranium resources fully within NPT rights and obligations. But such activities may, for some, be related to strengthening a country's national political position by attaining nuclear fuel cycle (NFC) capacity parity in the absence of an internationally recognized and guaranteed total ban on dual purpose NFC capability and a regional weapon-free zone (including Iran and Israel).

'THE COST-COMPETITIVENESS OF NUCLEAR POWER DEPENDS ON THE COST OF PLANT, THE COST OF CAPITAL, AND THE FUEL PRICES OF FOSSIL ALTERNATIVES.'

Electricity grid stability is rendered more difficult by large generating units. Current commercially available reactor technology of 1000 to 1600 MW may not fit the grid capacity of several Arab countries (notwithstanding the fact that these grids are going to be at least twice today's sizes by the time nuclear power can realistically be introduced in 10 to 15 years), whose electricity grids do not currently exceed a few thousand MW. However, numerous smaller unit sizes are under development and may be commercially available by 2020 to 2025. More intra-regional electricity trade could also help overcome this problem, for instance through the existing GCC Interconnection Grid and North Africa's interconnected grids.

Plans for nuclear power in the MENA region

Country	*Current and under construction (2020)*	*Firm and long-term plans (2030–35)*	*Target (%)*
UAE	5 GW	+ 20 GW (25 GW)	12% nuclear 2030
KSA	–	18 GW	15% nuclear 2030
Jordon	–	6 GW	30% nuclear 2030
Egypt	–	4.8 GW	
Morocco	–	2 GW	
Algeria	–	2 GW	14% nuclear 2030
Tunisia	–	0.6–1 GW	
Total	**5 GW**	**(58.8 GW)**	
Turkey	–	9.6 GW	10% nuclear 2023
Iran	0.9 GW	(20 GW)	!
Grand total	**5.9 GW**	**(88.4 GW)**	Only one-third of long-term plans and targets likely

Status of regional programmes

In one way or another, almost all Arab countries, large and small, have expressed at least some interest in nuclear power. Starting around 2005, smaller countries like Bahrain, Kuwait, Oman, and Qatar, without either nuclear infrastructure or nuclear engineering expertise, became involved in activities such as: carrying out energy studies, signing international nuclear cooperation agreements, gathering information on prerequisite nuclear infrastructure requirements, and adhering to international nuclear treaties, protocols and conventions. After the Fukushima Daiichi accident, however, these countries have dropped or suspended their national nuclear plans. Other countries have continued, or even speeded up, their nuclear plans. As can be seen from the adjacent table, four Arab countries are currently pursuing plans for nuclear power, with varying levels of certainty.

The UAE is on schedule to commission 4 x 1.4 GW APR-1400 pressurized water reactors (PWRs) at Barakah on the Gulf between 2017 and 2020 on a BOT arrangement with South Korea. The programme has been exemplary from its initiation in 2007 with regard to both establishment of infrastructure by outsourcing and also parallel nationalization and compliance with non-proliferation requirements. A further 20 GW is proposed by 2030. Saudi Arabia has announced plans to build 18 GW of capacity by 2032, naming sites on the Gulf and the Red Sea. Infrastructure is being established. The programme is still to be confirmed but is expected to proceed. Reactor types and funding models have not yet been announced. Jordan established a nuclear commission and regulator in 2007 and has conducted preconstruction evaluations since 2008. The Russian BOO proposal for 2 x 1 GW reactors at the Al Amra desert site has now been selected and is being finalized. A decision to proceed is expected in

2015 with first unit operation in 2021. Egypt has reactivated its programme and is in pre-construction planning of 4 x 1.2 GW reactors at the El-Dabba site. However, the current transitional political environment will further delay the programme.

Fukushima prompted extensive safety reviews and stress tests for nuclear power plants around the world, and has also prompted rigorous reviews of the risks and benefits of nuclear power in interested MENA countries. Nevertheless, the rationale for nuclear – high- and volatile-cost fossil fuel resources, energy security, high electricity demand growth, requirement for low-cost base load generation, low emissions and atmospheric pollution, and technological spinoffs – is unaffected and has continued to drive nuclear plans in those countries that have chosen to move ahead with nuclear programmes.

Conclusions

Is there a solid case for nuclear power in the MENA countries? For the GCC states, the nexus of escalating energy demand and inability to exploit gas resources presents an economic hazard of income loss due to diversion of national resources from export, rising expenditure on imports, limitation of diversification plans, and security of energy supply. Nuclear power could offer the MENA region an important energy alternative to conventional oil and gas, thereby saving revenue for exporters in the long-term while providing resource-poor MENA countries with a cost-effective alternative to imported oil and gas. The strong fiscal positions of the GCC states add to the case for the adoption of nuclear power as part of a future energy mix in the region.

While there are many promising benefits, there are also demanding challenges and daunting obstacles to overcome on the road to introducing nuclear power. Dismissing one energy option without specifying its replacement on a level playing field is of no avail. There is no perfect technology – without risks and interaction with the environment. Moreover, as much as sustainable development is a dynamic process, technology is also subject to change. Innovation and technology change and improve most aspects of a technology's performance from one generation or investment cycle to the next. The UAE programme is certainly exemplary, but it calls for continued diligence. Saudi Arabia's programme is not yet confirmed or defined in detail, but is considered likely to proceed because of the inevitability of the above rationale. When realized, it offers the rationale for several bilateral programmes and intensified regional cooperation.

Nuclear power in Saudi Arabia

Giacomo Luciani

The paradox of the world's foremost oil exporting country struggling to provide enough energy for itself is by now well known. On the face of it, it does not make much sense to spend time prioritizing alternative approaches: whether consumption should be reined in or alternative sources of electricity developed; or whether among the latter, priority should be given to renewables or nuclear. All of the above need to be pursued in parallel: hence my argument is not that nuclear power should be preferred to other solutions, but simply that it is likely to be part of the solution.

Diversifying the Kingdom's energy mix

No energy system should depend on a single energy source: individual sources of energy have different characteristics which complement each other, and only a diversified system can offer the most appropriate source for each of a wide variety of uses. Nuclear energy is a source of concentrated heat, which can be used to produce electricity but also, intrinsically, in other industrial contexts – a consideration especially important to the hydrocarbons industry.

The main characteristics of nuclear energy are well known:

- Investment costs are high, while running costs are relatively low; the final cost of the energy produced depends crucially on (a) the cost of construction of the plant (including the time for construction); (b) the cost of capital (the interest rate or hurdle rate of return); and (c) the degree of utilization;
- Fuel costs are limited; the fuel is easy to store and procure in advance, so even if it is not produced domestically it allows for a considerable degree of security of supply;
- GHG emissions are very low, even if one considers the full life cycle – in other words, emissions in the construction phase, including the materials used for construction;
- On the other hand, nuclear energy can be mishandled and lead to major accidents, although opinions on the exact impact of accidents, in terms of human lives, are far from convergent

(but no one disputes the fact that coal is a much worse killer than nuclear). Safety can be enhanced through improved technology (entailing added cost), careful siting, and strict adherence to established procedures (human error is the foremost cause of accidents – but humans do err).

So far, an overwhelming share of heat and electricity needs in Saudi Arabia has been procured through burning hydrocarbons. Light crude oil or residual fuel oil yields a controlled and potentially continuous source of heat, which is desirable for industrial uses and for meeting base load electricity demand when burned in conventional thermal power plants. The cost of the fuel may be regarded as being either: very low if, at any given moment in time, we ask what is the marginal cost of taking a barrel out of the ground for burning in a power plant (assuming that export demand has been satisfied already); or very high, if we consider that crude oil burned in power plants could have been exported (not immediately, but rather at some future time; but to calculate this you would need a view of future prices and the discount rate).

'THE PARADOX OF THE WORLD'S FOREMOST OIL EXPORTING COUNTRY STRUGGLING TO PROVIDE ENOUGH ENERGY FOR ITSELF IS BY NOW WELL KNOWN.'

That said, if we consider that there is a ceiling on Saudi crude oil production, then obviously an increase in domestic consumption will eventually compress crude availability for export. Nuclear energy can neatly substitute for crude oil in providing steady heat or base load electricity.

The characteristics of gas powered generation are different from those of nuclear energy:

- The investment cost per MW of capacity is lower and economies of scale are also lower, meaning that smaller plants may reach top efficiency;
- The opportunity cost of the fuel is obviously higher (considerable repressed demand for gas exists in the Kingdom, and the cost of producing gas from non-associated or even non-conventional formations is considerably higher than current gas prices);
- Depending on whether an open gas turbine or a combined cycle configuration is chosen, flexibility in output is gained and the plant is suitable for meeting medium or peak load (also due to lower investment cost and greater modularity).

Nuclear energy does not make a good substitute for gas – there are ways in which a nuclear power plant can be used for medium or even peak load, but it is a very expensive way of solving the problem.

The strategic value of Saudi Arabia's nuclear programme is high

Among other renewable sources, hydro is a convenient and flexible source of electricity, but obviously does not have a chance in Saudi Arabia. Wind is intermittent and highly variable, so it eats into the base load but cannot be relied upon for continuous operation. Photovoltaic (PV) is intermittent, although less variable than wind, but similarly must be combined with a back-up source. Concentrated solar power (CSP) may in theory be coupled with heat storage, enabling the provision of round-the clock-power, but would still not be available in cloudy or even hazy conditions.

Greater penetration of wind and solar can certainly help in reducing the burning of gas for power generation, less so for reducing the burning of oil (flexibility is an issue); but neither can entirely substitute for hydrocarbons, while nuclear potentially can. Thus, if the strategic problem of Saudi Arabia is to create a position where the country can survive in a future – however distant – when hydrocarbons might no longer be available, nuclear must be part of the picture (I am now excluding imported coal or gas as an alternative).

The requirements of desalination must be considered in this context. Solar desalination has been proposed, but the production of desalinated water in the volumes needed to satisfy demand (which admittedly is wasteful and should be reined in) would require the devotion of huge spaces to solar ponds or distillation units. Alternatively, concentrated solar power can be used for distillation: water, unlike electricity, can be stored and therefore direct CSP distillation is more promising than CSP power generation. But nuclear works even better for a combination of desalination and power generation for base load.

Desalination can also 'support' nuclear if an appropriate mix of technologies that will allow maximum flattening of the load is adopted. This is because some desalination technologies absorb electricity, and could be run when excess power is available; while others may be coupled with electricity generation. Again, water can be stored while electricity cannot, although some very large seasonal storage might be needed in order to achieve a significant flattening of the load in the presence of extreme seasonal demand excursion, as we have in Saudi Arabia. Such storage might be very expensive, but after all it could be a good strategic move, considering the extreme vulnerability of the country to a potential collapse in desalinated water supply.10

Thus the strategic value of acquiring a nuclear component of total primary energy supply appears to be very strong for Saudi Arabia. Only CSP

comes close to giving the same degree of confidence and sustainability in the long run, although the issue of intermittency has not yet been completely solved. Which of these solutions is economically more attractive is a moot question, as the answer depends entirely on the assumptions we may formulate on construction costs, cost of capital, and degree of utilization. Nuclear energy from standardized plants that do not face delays in construction (the South Korea–UAE model), at a time when the Saudi Government sits on a large accumulated surplus (invested in US Treasury bonds), and with the prospect of such nuclear plants being used in excess of 8000 hours per year, is very likely to be comparatively very cheap.

'NUCLEAR ENERGY CAN NEATLY SUBSTITUTE FOR CRUDE OIL IN PROVIDING STEADY HEAT OR BASE LOAD ELECTRICITY.'

The potential for space concentration of power generation capacity is much greater for nuclear than for CSP or other renewable sources. The literature frequently sees spatial distribution of power generation as a positive element, but in fact in Saudi Arabia both population and industrial activities are concentrated in a limited number of large clusters. CSP will probably be preferable for serving dispersed smaller agglomerations, while the major cities are better served by large nuclear energy parks.

A further important aspect is the potential use of nuclear or renewable sources in the hydrocarbon industry. The latter requires considerable heat inputs at all stages: in EOR if steam-assisted gravity drainage is required, and also in refining and petrochemicals. Decarbonizing the production of fossil fuels and petrochemicals is an important consideration which affects the acceptability of the products in an environmentally conscious world. Although in the end the burning of fossil fuels always generates emissions, the minimization of the carbon footprint of the hydrocarbons and petrochemicals industry should be a strategic concern for a major oil producer like Saudi Arabia. Use of nuclear energy to assist in hydrocarbon production, refining, and transformation is of strategic importance in this respect. Use of CSP might also be contemplated but – apart for the much greater land use required – intermittency is likely to be viewed as a major problem, because no one would consider shutting down a distillation column or a cracker because of a cloudy day.

Decision-making and the geopolitical dimension

Finally, we need to consider the decision-making process: who decides which solution is adopted? Most decisions about energy efficiency need to be made by literally millions of individual consumers or households, and the government is limited to adopting policies that may encourage these millions to take the right decisions. Such policies are frequently unpopular, and are vulnerable to procrastination. Similarly, photovoltaic solar installations are mostly very small scale and also require investment decisions from a large number of private investors. Nuclear energy is at the opposite extreme: it is a technology that requires centralized decision making and control, careful institution-building, and justifies securitization. In this respect, it is very well adapted to regimes where decision-making is strongly centralized, and in turn it helps to justify the centralization of power. Hence nuclear energy is not very well suited to democratic regimes where power is distributed and public acceptance is paramount, but is very well suited to regimes – democratic or authoritarian – where power is concentrated and whoever holds it enjoys a considerable degree of autonomy with respect to public opinion.

'… NUCLEAR WORKS EVEN BETTER FOR A COMBINATION OF DESALINATION AND POWER GENERATION FOR BASE LOAD.'

This point is also likely to be paramount when considering the country's international relations. There is a way of thinking that tends to present interest in nuclear energy as necessarily a cover or preliminary for an eventual attempt to acquire nuclear weapons. This attitude has hindered the uptake of nuclear energy around the world and is fundamentally flawed. Surely, in the face of the almost total bankruptcy of the non-proliferation regime, the temptation for non-nuclear weapon countries to acquire weapons capability is growing – but the correct response is to re-establish the credibility of the Non-Proliferation of Nuclear Weapons Treaty (NPT), not to hinder the uptake of peaceful nuclear technology.

At the same time, a regime considering the acquiring of a nuclear energy component, possibly including some eventual enrichment and reprocessing capability, knows very well that if it goes ahead, its own stability becomes much more important to the rest of the world, and it will see this as a welcome by-product. To all sorcerers' apprentices who still argue that the Saudi monarchy is part of the problem, not of the solution, the consideration that the country will have significant access to nuclear technology in the future may be quite sobering. The Kingdom's decision makers surely take this into account.

The author's most recent book
The Political Economy of Energy Reform: the Clean Energy – Fossil Fuel Balance in the Gulf States *(co-edited with R. Ferroukhi) was published in March 2014. He further discusses the challenges of nuclear power in his chapter 'The Political Economy of Gulf Energy Reform'.*

Devising an energy pricing strategy for GCC countries

Robert Bacon

All the GCC states provide their domestic economies with energy at a fraction of the international price, using both direct and indirect subsidies. Although such subsidies reflect important economic and social goals, they also impose large costs on their economies. The increasing scale of such subsidies is becoming harder to justify and a strategy for their reform will become ever more pressing.

What is meant by a subsidy?

Subsidies are a feature of those markets where prices are controlled by the government, rather than being set by a free market. A consumer subsidy is defined as the difference between the actual price paid by a consumer for an item, and the price at which that item would be sold in a free market. For a country that is a net importer of the energy source in question, the free market price would be the import cost c.i.f. plus domestic distribution costs, while for a net exporter the free market price would be the export price f.o.b. minus distribution costs required to export the product. The export price may be above the domestic cost of production and it represents the maximum value that could be achieved by its sale. Selling domestically at cost would forgo the extra revenue obtainable from export markets; this could be used to benefit the domestic economy according to the government's strategy.

With the exception of Bahrain, all the GCC states, are net exporters of oil and gas, so any subsidies on petroleum products or gas will arise from setting domestic prices below export prices. For GCC producers the costs of oil and gas production are usually low, so that the price charged to consumers still leaves a substantial margin for the national oil company, as well as for the government through its taxation structure. The argument that the resulting price structures do not qualify as subsidies fails to take into account the fact that were the domestic price to be set at the export price level, there would then be an increase in government revenue larger than the loss of consumer surplus from charging higher domestic prices. After all, the revenue from the export – rather than domestic consumption – of domestically produced energy could be used by the government in ways that produced an overall net increase in welfare for the economy, although some individual consumers might be worse off.

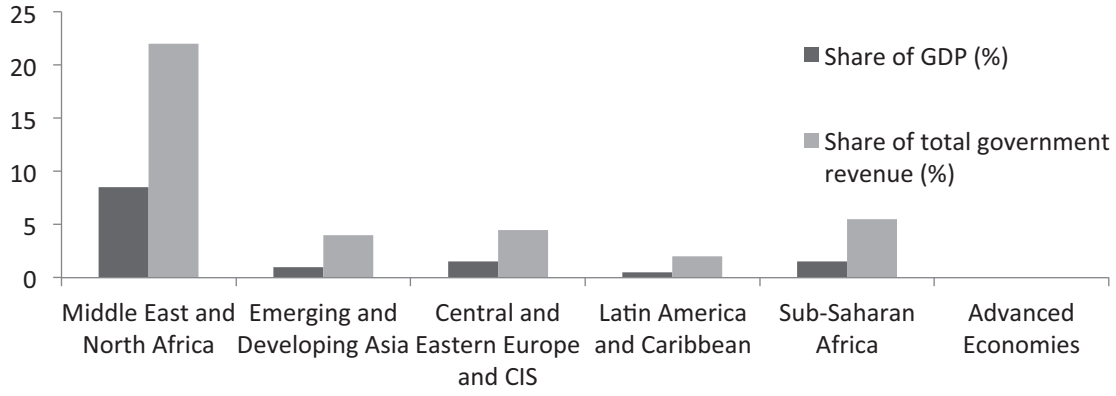
'ALL THE GCC STATES PROVIDE THEIR DOMESTIC ECONOMIES WITH ENERGY AT A FRACTION OF THE INTERNATIONAL PRICE, USING BOTH DIRECT AND INDIRECT SUBSIDIES.'

Electricity is markedly differently from domestically sold oil and gas; it is little traded so that selling below the cost of production requires an explicit subsidy, unless oil or gas are as used as inputs and provided below market prices. In the latter case there is an implicit subsidy since the power utilities do not experience financial losses that need to be reimbursed.

The benefits of energy subsidies, and unwanted side effects

A number of reasons have been advanced by governments for the use of subsidized energy prices, these include: the expansion of access to energy, particularly in countries where a large fraction of the population cannot afford electricity connections or petroleum products for household use; and supporting low-income households, particularly against energy price inflation. Two other objectives are also of particular relevance for oil and gas producers: sharing national wealth and encouraging industrial development. Countries that produce oil or gas receive a rent from the revenues accruing to the government. As a way of sharing this wealth among all citizens, it has been common practice to provide the associated energy products at subsidized prices. Because higher income households purchase more energy, they end up receiving larger benefits from this form of rent distribution. Supplying energy to certain industries at a price below the international equivalent will provide a competitive advantage and could possibly encourage the growth of such a sector as it substitutes imports and even starts to export. As the sector grows, employment may be expected to increase and this is attractive for countries where employment opportunities are limited.

In practice, the use of subsidized energy prices has a number of side effects that can partially or totally negate their original purposes, and these effects have been emphasized by studies describing the need for subsidy reform. The direct costs to the budget of explicit subsidies, or the opportunity costs of implicit subsidies, take resources away from other goals of public spending that may be more desirable than the goals of the energy subsidies. Lowering the price charged for energy, particularly when this applies to all users, encourages the demand for energy to increase, which increases the total subsidy costs and



Total pre-tax energy consumer subsidies as shares of GDP and of total government revenues by region in 2011 (%)

Source: IMF, 2013

distorts the pattern of the economy. Furthermore, many studies have shown that higher income households receive a much larger share of the total subsidy benefit than do poorer households, so attempts to use subsidies to protect lower income households have unnecessarily high fiscal costs as a result of leakage to better-off households. Finally, where utilities are forced to accept losses, through the provision of subsidized prices in the absence of compensation from the government, they will tend to under-invest. This can result in shortages of energy supply, as evidenced by power rationing and blackouts.

How large are energy subsidies in the GCC?

The diagram illustrates IMF calculations for energy subsidies that rely on a price-gap measure of energy prices, and shows the importance of energy subsidies in the Middle East region. The shares of subsidies in GDP, and as a share of total government revenue, were higher for oil exporters than for oil importers in the Middle East, but both were much higher than in any other region. The losses of government revenue through the use of energy subsidies were equal to almost 10 per cent of GDP and to a quarter of the governments' total revenue.

Data for consumer subsidies on individual energy sources for the GCC countries are shown in the table. These indicate that not only are subsidies on petroleum products and natural gas very large, but that subsidies on electricity are also substantial.

These figures indicate the magnitude of the resources in GCC countries which are devoted to providing consumers with energy below the market price equivalent. The demand for power and for petroleum products is likely to increase at least proportionately as GDP rises in these economies, so that without some pricing reform the burden of subsidies will not decline. Indeed, judging by past experience, the burden may well increase. GCC countries, facing the large budgetary implications of their energy subsidies policies, have to consider whether the rationale for such policies is still valid and, if not, how to reform energy pricing without damaging the economy.

Incomes have risen throughout the GCC to a level where it is unnecessary to provide energy subsidies in order to induce the poorest to switch to modern forms of energy – there are no large groups without electricity, or who use biomass as a household fuel instead of electricity or petroleum products. Nor can it be argued that

Pre-tax consumer subsidies by category in GCC countries in 2011, % of GDP

Country	*Petroleum products*	*Electricity*	*Natural gas*	*Total*
Bahrain	5.4	2.6	n.a.	8.0
Kuwait	3.1	2.9	1.3	7.3
Oman	3.0	0.8	2.2	6.0
Qatar	1.2	1.2	1.1	3.5
Saudi Arabia	7.5	2.5	n.a.	10.0
United Arab Emirates	0.5	1.9	3.4	5.8

Source: IMF, 2013

energy subsidies help equality by providing greater assistance to low-income households. The reverse is probably true – the share of subsidies going to the better-off households is much greater than the share going to the poorest households. This observation can, in fact, help to explain the persistence of the magnitude of energy subsidies in certain countries. The removal of energy subsidies would have a substantial negative impact on large middle-income groups of the population who are not among the leading beneficiaries of the nation's wealth. Protests from such groups can appear threatening to the government and hence, even though it is recognized that energy subsidies may have an overall negative impact on the economy, governments are unwilling to risk energy price reform. This is particularly true where the government has limited resources to 'buy-out' possible opposition to increasing energy prices. Where political agitation is present, as has been the case in Bahrain, governments may discuss energy price reform but be unable to find a path to implement it.

'LOWERING THE PRICE CHARGED FOR ENERGY, PARTICULARLY WHEN THIS APPLIES TO ALL USERS, ENCOURAGES THE DEMAND FOR ENERGY TO INCREASE …'

Governments of countries that are major oil and gas producers have been able to subsidize energy, even while devoting substantial spending to other social goals (such as health and education). In addition, support to domestic industry, as a means of job creation, remains important. Were the subsidies to be suddenly withdrawn, some industries would no longer be competitive and jobs would be lost. Because the provision of employment can be a crucial policy goal, in order to avoid social unrest and disenchantment, governments are likely to continue to look for means to support such industries, and the use of subsidized energy inputs, rather than direct subsidies to the industries in question, may be politically expedient. The challenge is thus to find ways to support these industries using more focused assistance than is possible with a broad energy subsidy and that can also be phased out as the industry grows and becomes able to compete without continued government financial support.

Strategies for energy price reform

The reform of energy prices, where a government has decided that the present system of subsidies is not optimal, is achieved through adopting new rules for setting the official administered prices. However, governments nearly always also need to adopt complementary policies that can offset some of the effects of the subsidy reform itself. There are two major considerations involved in such a step: the impacts of the new prices and other policy changes on all affected parties in the economy; and the extent and effectiveness of opposition to the new policy.

Experience from several countries where there have been attempts to reduce energy subsidies has shown that failure to fully consider such impacts has led to policy abandonment or reversal. There are several steps that need to be taken before the actual implementation of an energy pricing reform occurs. These include: *stakeholder identification* – all parties affected by the change of consumer subsidies and the proposed complementary policies should be considered; an *impact assessment* to quantify the impacts of alternative policies on affected parties should be carried out (the importance of such changes can be correlated with a power analysis of the various groups – large losses for a group that has considerable power to obstruct the change may require an adjustment of the policy, or the introduction of some compensation mechanism); and finally, *a policy marketing strategy* – experience from many countries relating to the introduction of large policy changes suggests that a well-articulated information campaign may be able to reduce opposition (based on misinformation and misunderstanding) to a proposed policy change.

'THE REMOVAL OF ENERGY SUBSIDIES WOULD HAVE A SUBSTANTIAL NEGATIVE IMPACT ON LARGE MIDDLE-INCOME GROUPS OF THE POPULATION …'

For the GCC states in particular, these general considerations suggest that for successful reform of energy prices in a GCC member state, a detailed action plan would be required; this would identify beneficiaries of the present price structure and quantify costs of subsidies to these groups, while considering alternative pricing regimes in which the subsidy cost might be reduced. This could include: changes in the amount of a universal subsidy (as for petroleum products); the removal or reduction of exemptions to the pricing regime (such as government departments that receive free electricity); the introduction of smart cards to allow price discrimination by quantity purchased, or by category of user, for certain petroleum products; changing the tariff structure for the power sector by, for example, replacing a rising block tariff by a volume-differentiated tariff; replacing energy subsidies by targeted cash transfers limited to lower income or needy households; or developing targeted industrial policies that are limited to support for key aspects of industries that need help to compete but that have the potential to evolve to a position where support is no longer needed.

Price reform in Kuwait's electricity and water: assessing the benefits

Bassam Fattouh and Lavan Mahadeva

Kuwait's electricity and water sector has been in disarray for several years, struggling with several decades of fast-rising demand resulting from industrialization, rapid population growth, rising living standards amongst its citizens, as well as the artificially low consumer prices set by the government. The country's electricity demand has been growing at an impressive rate, estimated at an annual rate of 5.3 per cent between 1999 and 2009, and its per capita electricity consumption has exceeded 16,000 kWh, one of the highest in the world. With per capita water consumption of 500 litres per day, Kuwait is also the world's largest water consumer. According to Kuwait Institute for Scientific Research (KISR), the current cost of providing a reliable source of fresh water in Kuwait (principally through desalination plants) exceeds US$1.2 billion annually. By 2050, given current consumption patterns, it is estimated that the majority of the country's oil-generated revenue will be required to fund the increased production of desalinated water.

'BY 2050 … IT IS ESTIMATED THAT THE MAJORITY OF THE COUNTRY'S OIL-GENERATED REVENUE WILL BE REQUIRED TO FUND THE INCREASED PRODUCTION OF DESALINATED WATER.'

The rapid increase in demand has placed some serious strains on supply of these utilities. The EIA describes Kuwait as being already 'perpetually in a state of electricity supply shortage and experiences frequent blackouts and brownouts each summer'. Its desalinated water supply is also expected to come under strain, even though capacity has been increasing on average by 4.1 per cent from 1992 to 2008. In response to the shortfall in supply of these key services, the government has announced plans for new investment in key infrastructure projects. The 2010–14 Kuwait Development Plan envisages a massive increase in the scale of Kuwait's electricity and desalinated water co-generation. The centrepiece of the plan is the Al Zour gas-fired power and seawater treatment plant. When completed, this project will account for almost 12 per cent of Kuwait's power generation capacity and almost 25 per cent of its desalination capacity. In addition, there are government plans to build a new refinery (the Al Zour refinery) with a capacity of 615,000 b/d; of this, 225,000 b/d will consist of low-sulphur fuel oil to meet the growing demand from the power sector.

Kuwait's power and desalinated water generation inadequacies are as much a consequence of the low prices charged for Kuwait's utilities as its insufficient infrastructure. The Kuwaiti government provides these basic utilities at a very low cost. Historically, the price of electricity had some links with the cost of production, but this link has been broken, and rather than raising electricity prices, the government has reduced them over time. In 1953, the selling price was 27 fils/kWh but between 1953 and 1955, when oil revenues started flowing into the state's coffers, the government decreased the selling price to 18 fils/kWh. The electricity tariff continued on its downward trend over the years until 1966, when the government set the price at 2 fils/kWh (0.7 US cents) for ordinary consumers and 1 fils/kWh (0.35 US cents) for industrial companies, very low even by regional standards. The 1966 tariff structure is still in force today, though for chalets/villas, the price of electricity has been raised to 10 fils/kWh (3.5 US cents).

Due to these low prices, there is a wide gap between production costs and the selling prices of electricity. In the early 1980s, the average cost of electricity production was estimated at 26 fils/kWh, while the price was administratively set at 1–2 fils/kWh. The rise in oil prices in international markets in the mid-2000s, together with Kuwait's increasing reliance on LNG imports to fuel its power sector, means that the gap has continued to widen.

The transition to market prices: net benefits

Given the rapid increase in demand for electricity and water, there is an urgent need for the Kuwaiti government to reconsider its low pricing policy for these basic utilities. In a recent study, published at the Oxford Institute for Energy Studies, we argue that a reform of utility pricing could yield substantial net benefits for Kuwait's economy, while alternative mechanisms to distribute savings made could offset some of the negative implications of higher utility prices for its citizens.

In our study, we use a model-based methodology to compare the current pricing scheme against an alternative where consumer prices are raised to market levels and consumers are on average compensated by cash transfers that do not distort their economic decisions. The model captures four important economic features of the production of electricity and water:

- The greatest share of production is taken by fuel, whose market price is unpredictable;

- The maximum supply in the short run is constrained by the existing level of infrastructure, and when output is close to that limit, marginal costs rise sharply and the system becomes congested;
- Electricity is produced by a domestic power generator and that infrastructure investment is needed to maintain capacity such that supply is not elastic;
- The demand for these services is quite inelastic.

The model was calibrated to match Kuwait's electricity market data and simulated in two modes. In the first mode, the government fixes a low price to the consumer and the producer has to receive a high enough price to ensure a sufficient rate of return at the prevailing level of output. The difference between the high producer price and the low consumer price (multiplied by output) is a fiscal cost that is currently being financed by the government. In contrast, in the second mode, consumers pay the unfettered market price, but they are compensated on average (through a cash transfer scheme) for the utility-equivalent loss from moving to the market regime. The cash transfer scheme involves an alternative fiscal cost, replacing the subsidy costs in the first mode. The net benefit from transitioning to market prices is the fiscal cost in the second mode minus the fiscal cost in the first mode.

Potential fiscal benefits could be enormous

The results in our study demonstrate that the potential fiscal benefits of reform are so large that consumers can be compensated on average whilst still leaving large fiscal savings and allowing a more reliable level of spare capacity. Specifically, we find that:

(i) *A realignment of prices at or closer to the market price level confers a benefit on current and future generations of Kuwaitis in terms of fiscal savings that outweighs the impact of raising electricity and water consumer prices to market price levels.* Specifically, in the market price scenario with consumer prices at about ten times current levels, there is a total fiscal cost of about one-third of the value of fuel input used in the power sector (or about 1.5 per cent of GDP), entirely due to the cash transfer. But this is just less than one-fifth of the fiscal cost of the current low pricing regime and in principle represents a massive saving. The net benefit of moving to market prices is 140 per cent of the value of the fuel input, or 6.3 per cent of GDP. As high as this might seem, it compares well with the IMF's estimate (5.3 per cent of GDP in 2011) of the actual cost of electricity and water subsidies in Kuwait.

(ii) *As the price of these basic utilities increases tenfold, the share of electricity and water in the budget increases from 0.3 per cent to 0.9 per cent, roughly threefold, but it is still less than 1 per cent of consumption*. The effect of the higher prices is to lower the amount of electricity and water consumed, offsetting higher prices to some extent. Once we take account of the mitigating cash transfer, the net share rises by only 0.1 per cent, a very small increase. Hence the cash transfer offsets the effect of the higher prices on the average consumer's budget.

(iii) *Producer prices need to be higher than otherwise when consumer prices are fixed at low levels, because producers require more compensation per unit to compensate for their losses resulting from operating at an inefficiently higher level of production.* Though producers can, to some extent, alter wages and infrastructure demands in order to compensate for price differences, the distortion created by the need to supply a much larger subsidized demand in the face of fluctuating fuel input prices implies higher-than-otherwise producer prices. This is a natural consequence of having a less than perfect elastic supply for the subsidized consumer good.

(iv) *In the subsidy regime almost 50 per cent of costs are taken up by infrastructure while in the full market price regime it is 38 per cent.* There is less need for infrastructure when consumers are sharing some of the burden of efficiency. It is in this sense that congestion pricing is a complement to infrastructure.

(v) *Output is proportionately closer to its maximum (and hence closer to the congestion zone) in the low price regime compared to the market price regime.* Particularly, the ratio of average electricity output to maximum capacity generation is 46 per cent in the market price regime compared to 60 per cent in the current subsidized regime. This is key, as the capacity factor determines how the system is able to cope with unforeseen shocks to demand. It follows that the shift to a market pricing regime will be a more efficient route to achieving spare capacity in the electricity and water system.

The key to understanding our results is that higher prices serve to make consumers more efficient in their use of energy. The promotion of efficiency in use through better prices is called *congestion pricing*. Congestion pricing can be contrasted to a *financially sustainable pricing* policy, where the main concern is whether the price charged is affordable by the ultimate financer of the investment. Given ample oil reserves and revenues in Kuwait, even very low prices for generated electricity can be fiscally sustainable.

However, as Nobel prize winner William Vickrey explains, congestion pricing should dominate the financially sustainable price as the relevant concept whenever there is a public benefit from limiting individual usage: the 'delusion still persists that the primary role of pricing should always be that of financing the service rather than that of promoting economy in its use'.

Alternative cash transfers raise many more questions …

In short, our results show that there is a substantial benefit to be gained from allowing the prices of electricity and water to rise to market levels. The fiscal savings are more than sufficient to compensate consumers on average for the loss, while still leaving a substantial surplus. While electricity and water price charges will be much higher, they will still be less than 1 per cent of consumption. Moreover, current and future generations of Kuwaitis, who are ultimately the beneficiaries of any savings, should gain from the fiscal savings of the market reform. Thus there may be no need to redress consumers on average for their loss on pure economic grounds.

'… HIGHER PRICES SERVE TO MAKE CONSUMERS MORE EFFICIENT …'

Therefore, any potential cash transfer scheme should be judged on its ability to gain political acceptance for the reform and not as a necessary economic part of the price reform. But as the cash transfer should not discriminate according to usage, even if the cash transfers are substantial, the price reform is likely to have its opponents. This is because there will inevitably be some losers under the market price scheme – heavy users of electricity and water – who cannot be compensated by cash transfers for their greater loss. The losers are likely to be distinguished by their occupation or place of living, while winners are more likely to be dispersed among society. As the group of losers is easily superimposed over existing demarcations – such as trade unions, societies, or constituencies – they could easily cohere into a lobby or a protest group. The natural emergence of an opposition explains why subsidy price reforms have been reversed in several parts of the world. The key question facing Kuwaiti policymakers is then: how can the cash transfer be designed to minimize the opposition to energy pricing reform?

The authors' study was recently published by the Oxford Institute for Energy Studies under the title 'Price Reform in Kuwait's Electricity and Water: Assessing the Net Benefits in the Presence of Congestion', and is available to download from the OIES website.

Simulating impacts of reducing subsidies to Kuwait's electricity sector

Ayele Gelan

Kuwait's electricity is among the cheapest in the world, and it is the most highly subsidized sector in the country. Indeed, it is so highly subsidized that the sector generates electricity and almost distributes it to users for free. The extremely generous subsidy is intended to serve as a means of allocating welfare transfers to resident businesses and households. The government owns a vertically integrated monopoly – managing the entire supply chain from electricity generation to retail.

'KUWAIT'S ELECTRICITY … IS SO HIGHLY SUBSIDIZED THAT THE SECTOR GENERATES ELECTRICITY AND ALMOST DISTRIBUTES IT TO USERS FOR FREE.

In recent years, however, it has become increasingly clear that this welfare-oriented electricity production and distribution has had adverse economy-wide effects, specifically conflicting with other policy priorities such as environmental protection and appropriate resource allocation. There is growing awareness among policy makers and researchers that the existing policy is not sustainable. The necessity for economic reforms in wider areas of public utilities management is rooted in recent shifts in economic development strategies, as well as in initiatives related to regional integration among GCC member countries.

Given mixed results from public utility reforms in many countries, uncertainties surrounding the effects of regulating the Kuwaiti electricity sector have caused some apprehension among the public. This article will shed some light on the likely impacts of the envisaged reform and summarizes some of our main conclusions from a forthcoming study, whose objective is to quantify economy-wide impacts of public utility reform that may start by targeting the reduction of electricity subsidies. The study is based on a computable general equilibrium (CGE) model which simulates the possible economy-wide impacts of reducing electricity subsidies.

Electricity tariffs and consumption

All GCC member countries are known for charging extremely low electricity

tariffs compared to the rest of the world. Generally, electricity tariffs range from between 2.2 US cents/kWh in Qatar to an average (with a range of differentiated tariff bands for different types of users) of around 4.1 US cents/kWh in Saudi Arabia. By contrast, most electricity users in Kuwait pay a nominal tariff of 2 fils (about 0.7 US cents/kWh, about a third even of Qatar's low electricity prices), which means that Kuwait has the lowest electricity tariff of the GCC member countries. Kuwait's 2 fils/kWh rate was introduced in 1966 and has been retained, with some modification, at that level. The cost of generating electricity, on the other hand, has risen sharply over the years. Between 2000 and 2010 alone the cost of production per kWh doubled from 20 fils (7 US cents)/kWh to about 40 fils (14 US cents), suggesting a subsidization rate for Kuwait's electricity of 95 per cent in 2010.

These extremely generous subsidies have given rise to a pattern of unsustainable behaviour in electricity use, which is reflected in a number of key aggregate indicators. In terms of its economic use of electricity, not only does Kuwait's efficiency (measured in terms of GDP generated per kWh used) stand among the lowest in the world but the situation has been worsening over the years. In 1990, the GDP/kWh ratio was US$1.4 but this fell to US$1.2 in 2005. This contrasts poorly with experience across most other parts of the world, including emerging economies. Kuwait's per capita electricity consumption is now amongst the highest in the world, more than doubling between 1985 and 2005, at which point Kuwait ranked second only to Norway. However, unlike the case of Norway, whose electricity needs are primarily met by renewable (mostly hydro) sources, Kuwait's electricity is generated entirely using fossil fuels.

Prospects for reform

Pressure to reduce electricity sector subsidies in Kuwait comes from various sources. One is Kuwait's latest medium-term development plan, which expressed the government's commitment to implement far-reaching liberalization of the country's economy. This plan is expected to be implemented through two firmly interrelated strategies: (a) diversifying the structure of the economy by reducing the dominance of the oil sector and encouraging the growth of non-oil sectors; and (b) promoting private sector development and reducing the dominance of the public sector. Liberalization of public utilities including electricity and water are prime targets in achieving these goals.

There is also regional pressure, related to the processes of interconnecting the GCC electricity grid. The primary goal of this initiative is to provide power supply stability and reliability by integrating the high voltage transmission systems of all GCC member countries. The economic rationale for this lies in the need to improve competitiveness in generation and distribution capacity, which each country badly needs in in the medium to long term. This interconnection of transmission systems encourages countries to engage in trading electricity with each other, on the basis of each country's comparative marginal costs. Cross-border electrical energy trading started in summer 2010, although information on quantities traded has not yet been made available.

The relevance of the GCC electricity grid connection to reform and regulation in each country lies in the pressure felt by each country to improve its efficiency, in order that its marginal cost of production and distribution would be competitive relative to that of its neighbours. In this regard, Kuwait is already at a relative disadvantage, since its marginal cost is relatively high compared to other GCC member countries. For instance, Qatar's marginal cost of electricity production at peak is less than half that of Kuwait ($88/MWh and $188/MWh respectively). These differences are largely explained by types of fuels (mostly natural gas in Qatar and heavy oil in Kuwait) together with the types of turbines used to fire electricity generating plants.

The model

The model used for this study was adapted from the International Food Policy Research Institute's (IFPRI) standard CGE model. A social accounting matrix (SAM) was constructed for Kuwait with 2010 as its base year. The 2010 Kuwait input–output table, and related system of national accounts obtained from the Central Statistical Bureau (CSB), provided the core data required to construct a SAM with 17 production sectors. This was supplemented with other satellite accounts such as employment, demographic, and capital stock, which are separately estimated in line with flow variables in the SAM.

The model was implemented using a comparative static framework. This simply implies instantaneous movement of the economy from the current status to another without tracing the path through which the economy passes during the adjustment period, which would require a fully dynamic model. The long-run outcomes of both a fully dynamic model and the comparative static long-run model are about the same, since each involves full adjustment of the economy to the shock caused by the policy change.

The focus of this study, while designing the simulation experiments, was on labour market conditions in order that the highly segmented nature of

the labour market in Kuwait could be captured. Expatriates constitute the bulk (about 83 per cent) of Kuwait's workforce, with Kuwaitis accounting for the remaining proportion. Critically, the national labour force is highly concentrated in the public sector, which includes the electricity sector. The average wage level for Kuwaitis is substantially higher than that of expatriate salaries and wages, which is highly relevant in the context of this study. Economic reform in Kuwait is bound to be implemented in conditions of inflexible wages and limited sectoral mobility among Kuwaitis. However, labour market conditions for expatriates are likely to be characterized by flexible wages and free mobility between sectors. The simulation experiments were conducted taking these conditions into account.

Results

The model was used to conduct three simulation experiments. The first run replicated the base year situation –the baseline scenario – which represents the status quo. The second and third runs each imposed a policy shock under different conditions. These yielded results which were different from the base run. The differences between the base scenario and the policy shocks highlighted the effects of the policy change.

A 25 per cent reduction in electricity subsidy was applied and the economy-wide impact of this change was evaluated. This rate of subsidy reduction was chosen arbitrarily, it can be set at a lower or higher rate. However, it is not feasible to implement much larger shocks – such as abolishing electricity subsidy altogether – in a CGE modelling context, particularly when the rate of subsidy in the baseline scenario is as high as 95 per cent. In such cases, policy shocks can be evaluated by applying relatively small changes to get a sense of magnitude regarding impacts.

For this policy experiment, the 25 per cent subsidy reduction was simulated in two scenarios. Scenario 1 was run without compensating households for any welfare loss resulting from rises in electricity prices due to the partial withdrawal of subsidy. Scenario 2 simulates the case where the government compensates households by an amount relative to the size of the increased government budget surplus (induced by the partial withdrawal of subsidy). The two scenarios are separately discussed below.

Scenario 1: Subsidy reduction without compensation

We begin with intra-sectoral impacts. Gross value added in the electricity sector fell by 34 per cent while the electricity tariff rose by 260 per cent (this means a rise from 2.0 to 5.2 fils/kWh). The policy shock revealed interesting macroeconomic and sectoral impacts. The inter-sectoral effects were more or less in inverse proportion to sectoral electricity use intensity – the more intensive users experienced relatively larger contractions, while the less intensive electricity users experienced some expansion. The variety of impacts at sectoral level led to negligible macroeconomic effects: aggregate GDP (value added measure) declined by less than 1 per cent; government surplus increased by about 3 per cent, as we had expected; and household welfare, measured in terms of equivalent variation, declined but only by 0.5 per cent. In this modelling framework, the net impacts of this policy shock were negligible but the distributional impacts were probably significant. We have shown this in terms of distributional effects across sectors, but distributional effects by households groups are beyond the scope of this analysis, since this study is based on a highly aggregated SAM which does not distinguish between households by income or expenditure sizes. This is left for future research.

Scenario 2: Subsidy reduction with compensation

In this scenario households were compensated for the welfare loss they experienced due to the policy change. It should be noted that the reduction in welfare reported above is negligible. However, if the subsidy reduction was much larger, say 50 per cent or more, then we would expect that the welfare loss to households would be much larger as well. The policy shock would increase the government budget surplus. However, unlike other countries with large budget deficits, current economic reforms in Kuwait are motivated more by the need to adjust the structure of the economy and to improve efficient resource allocation than by budgetary considerations. In that context, if economic reform can help with achieving the objectives of improving the efficiency of resource allocation, then compensating households for welfare loss may be necessary, particularly if public resistance to expected reform of public utilities, including the electricity sector, is to be reduced. It was with this policy context in mind that scenario 2 policy experiment was conducted.

The additional simulation shock was effected by compensating households by the full amount of budget surplus gained by the government as a result of the policy change. In other words, government transfer to households was scaled up by the full amount of the difference between government budget surplus resulting from the policy shock in scenario 1 and the corresponding figure in the base year. This yielded a much higher expansionary effect. In scenario 2, the only sector experiencing

contraction in terms of gross value added was the electricity sector, the sector that received the shock, but it only contracted by about 32 per cent which was smaller than the contraction it experienced in scenario 1. The rates of positive stimulus to the other sectors ranged from 0.41 per cent in government services to 6 per cent in the construction sector. Aggregate GDP increased by 2.2 per cent and the compensation caused household welfare to improve by 3.4 per cent compared to the baseline level. The positive impacts resulted from the stimulus created by the reform, in terms of resource allocation and expansion of economic activities.

Conclusion

The simulation experiments indicate that subsidy reduction does not necessarily cause any substantial contraction in economic activities or decline in household welfare. The differences between the two policy scenarios indicated that the adverse demand-side effect of the subsidy reform dominates. Specifically, when households were compensated for the welfare loss, then this made the effects of the policy reform positive and hence aggregate GDP and household welfare effects also became positive.

However, the results of the simulation experiments reported in this study should be interpreted with caution. First, the model used for this analysis is highly aggregated, and hence it does not account for distributional effects, particularly for differential impacts on households in different income brackets. Second, a comparative static framework gives the long-run effects of the policy change but it does not explicitly show the length of time it will take to reach the long-term outcome.

'… SUBSIDY REDUCTION DOES NOT NECESSARILY CAUSE ANY SUBSTANTIAL CONTRACTION IN ECONOMIC ACTIVITIES …'

Policy reforms, such as a reduction of subsidy to Kuwait's electricity sector, can realize positive and desired results if accompanying measures are implemented in addition to the actual change to the policy instruments. The accompanying measures may include organizational or technological changes, both of which imply innovations which are not quantifiable in a modelling framework. This means depending on whether or not these innovations accompany the policy change; the results reported in this study can overestimate or underestimate the effects of reducing subsidy. Similarly, the applications of packages of reform measures can influence the speed with which the economy will realize potential benefits from reducing or abolishing subsidies to public utilities.

For instance, the 32 per cent contraction in the electricity sector was likely to overstate the adverse effects since the reform package would not be confined to just reducing or removing the subsidy but would also involve partial or full privatization of the public utility. This in turn would lead to substantial efficiency gains through organizational changes and introduction of the latest technology in the process of electricity generation. If this is the case, then the economy-wide positive stimulus of the reform could be much greater, or the adverse effects much smaller, than the reported simulation results.

Ayele Gelan's study 'Quantifying economy-wide impacts reducing subsidy to the electricity sector' is forthcoming and is to be presented at the International Conference on Economic Modelling, 201, Bali, Indonesia, 16–18 July 2014.

Dubai's energy efficiency drive

Faisal Ali Rashid and Katarina Uherova Hasbani

The Gulf region has been known traditionally as the centre of the global oil and gas industry, and indeed its production has been supplying international markets reliably for decades. However, the region has increasingly been focusing on the policy debate around the Gulf states' own energy demand and, in particular, on sustainability and clean energy solutions. Diversifying the region's energy sources, for instance via several GCC states' ambitious programmes to harness the Gulf's abundant solar resources, has been one policy response. The United Arab Emirates is home to one such scheme, where Dubai is working towards the production of 1000 MW at its Sheikh Mohammed bin Rashid Al Maktoum solar park. However, another area – demand side management – has also been emerging; this could be critical in ensuring the Gulf region's sustainable growth over the years to come. Demand side management, together with the related topic of energy efficiency, offers multiple benefits to the economies of Gulf countries.

Compelling reasons

The growing interest in demand side management stems from two main

motivations. One is the continuing pattern of high economic growth, which has been pushing energy consumption in the region. This consumption almost tripled during the period 1990–2010, putting pressure on the energy systems and finances of individual countries in terms of both fuel supply and the required capacities for electricity generation, transmission, and distribution. Another issue is the pattern of high energy intensity in the region. The energy intensity level in the GCC has been growing, while other regions, such as OECD or Asia, have encountered a downward trend during the period 1980–2010. These factors have important implications for future economic development, especially against the background of policies for economic diversification which are being pursued in the region. Energy is perceived as a cost of doing business and this cost is compared to that in other global trade centres. There is an increasing awareness that energy intensity is a critical factor of competitiveness, along with economic and environmental sustainability.

'THE ENERGY INTENSITY LEVEL IN THE GCC HAS BEEN GROWING, WHILE OTHER REGIONS … HAVE ENCOUNTERED A DOWNWARD TREND DURING THE PERIOD 1980–2010.'

Dubai is at the forefront of new energy policy thinking in the region. This stems from the already diverse nature of its economy which is based on trade, logistics, manufacturing, and tourism. It also due to the fact that Dubai is a net importer of energy; this implies its use of different policy approaches – in terms of both supply and demand side energy management – from countries such as Abu Dhabi and other GCC states with significant own oil and natural gas resources. Therefore, the need for increased efficiency in the use of energy was identified by the Dubai Supreme Council of Energy as a key part of Dubai's drive to increase the competitiveness and sustainability of its economy.

At the strategic level, a 30 per cent reduction in Dubai's energy demand by 2030 (in comparison to the business as usual scenario), was set as one of the objectives of the Dubai Integrated Energy Strategy, which sets out key energy priorities for the period 2010–30 and is the first of its kind in the GCC. The Strategy was developed and mandated in 2010 by Dubai's Supreme Council of Energy, which is responsible for energy policy, governance, and planning in the Emirate. Apart from demand side management, the Strategy sets policy initiatives for diversification of energy mix, ensuring security of gas supply, and enhancing the overall regulatory framework, funding, and capabilities in Dubai's energy sector. At the federal level, demand management is also positioned as a critical contribution towards achieving the aims of the UAE-wide initiatives: Green Economy for Sustainable Development and Green Growth. These look at the wider picture of economic development in the UAE and set out initiatives in support of UAE's sustainability beyond the energy sector.

In this context, energy efficiency is considered as an inexpensive way to reduce energy consumption and drive emission of greenhouse gases to a low level. Through appropriate policy and regulatory mechanisms, considerable savings can be achieved in terms of electricity and water consumption, which also brings financial benefits for the Government, businesses, and final consumers. In return, this creates new economic opportunities, which the Emirate of Dubai is keen to promote, enabling it to position itself as a global business hub and as a centre of sustainable and clean energy development.

Dubai's demand side management strategy

In order to achieve its target of 30 per cent energy demand reduction by 2030, Dubai's Supreme Council of Energy endorsed a detailed Demand Side Management (DSM) Strategy in June 2013. Its scope covers electricity and water and it is the first of its kind in the region. Implementation of the DSM Strategy opens new opportunities for sustainable and efficient businesses by setting out initiatives for implementation up to 2030 and by outlining policies, regulations, awareness schemes, technology, and financing mechanisms. The strategy is based on eight DSM programmes encompassing critical areas where electricity and water savings can be realized.

New building regulations are translated into the Dubai Green Building Code, which covers overall resource efficiency and building vitality, in addition to energy and water performance. The Code (available in full on the Dubai Municipality's website) entered into full application across Dubai in March 2014, and is based on internationally recognized performance standards. Existing buildings are also targeted by the DSM Strategy. The objective is to have 30,000 buildings retrofitted in Dubai by 2030, representing an expected investment of AED3 billion and achieving electricity and water savings. To drive this initiative, a Super-ESCO (energy service company), Etihad Energy Services, was formed as a fully owned subsidiary of DEWA, the Dubai utility company which is a member of the Supreme Council of Energy. Etihad Energy Services is expected to lead project development, mobilize technical expertise and finance, and provide initial leads favouring the creation of an ESCO market in Dubai. Moreover, a regulatory framework has been put in place by Dubai's Regulatory and Supervisory Bureau for ESCOs, with a focus on

contracts, accreditation, measurement and verification, and dispute resolution.

'… ENERGY EFFICIENCY IS CONSIDERED AS AN INEXPENSIVE WAY TO REDUCE ENERGY CONSUMPTION AND DRIVE EMISSION OF GREENHOUSE GASES TO A LOW LEVEL.'

Bearing in mind the importance of water resources in the arid climate of Dubai a separate programme targets increasing the rate of water reuse and the efficiency of irrigation. The aim is to have 80 per cent of Dubai's green areas efficiently irrigated by 2030. Other initiatives include: promotion of district cooling, energy efficient standards and labels for appliances and equipment, efficient outdoor lighting, as well as demand response measures at the utility level. Dubai Carbon Center of Excellence was tasked with monitoring the impact of the implemented initiatives on Dubai's carbon footprint. Overall, implementation of the Strategy is expected to result in considerable savings: 19 terawatt hours of power and 47 billion imperial gallons of water consumption by 2030, and hence better value for Dubai customers.

Key enabling mechanisms

However, successful implementation of the Strategy will depend on the deployment of key enabling mechanisms, and the collaboration of concerned stakeholders. These mechanisms are aligned with the current international best practices found in the implementation of similar programmes worldwide. They will include adequate policy and regulatory frameworks, together with strengthening of institutions and capacities building. An effective implementation of the DSM Strategy will also require collaboration of key stakeholders and close cooperation between private and public actors in Dubai.

Therefore, the establishment of a dedicated DSM agency is planned in the near future as one of the key drivers and symbols of Dubai's commitment to its energy efficiency goals. By providing a platform and 'one-stop-shop' for improved energy use, this new centre of DSM-related expertise will assist Dubai's businesses in achieving better efficiency of their operations and will drive public–private collaborations. Awaiting its creation, a DSM Executive Committee with participation of key stakeholders is ensuring smooth uptake of the necessary regulation and measures, in cooperation with the concerned stakeholders. As an additional support to the Strategy, series of actions are being put in place in the areas of public awareness, DSM-adapted information systems, and measurement and verification.

The Government of Dubai is committed to leading by example in setting high standards of energy efficiency. In 2011, Dubai's Supreme Council of Energy embarked on a series of practical initiatives which improved energy efficiency across key energy companies in Dubai. These included: Dubai Electricity and Water Authority, Dubai Aluminium, Emirates National Oil Company, Dubai Supply Authority, and Dubai Petroleum. In addition, more than 40 government entities have been mobilized to deploy simple practices such as: setting the thermostat at 24 °C during the day, switching off lights after working hours, and using energy-efficient lighting and solar water heating where applicable. These inexpensive measures are expected to result in significant electricity and water savings – estimated for 2012 alone at a reduction of 30 gigawatt hours and 306 million imperial gallons. These efforts will continue as the Government of Dubai is keen to show the way for the implementation of DSM Strategy. As an example, Dubai's Green Building Code was mandated first for a compulsory application with government entities.

'… THE STRATEGY IS EXPECTED TO RESULT IN CONSIDERABLE SAVINGS: 19 TERAWATT HOURS OF POWER AND 47 BILLION IMPERIAL GALLONS OF WATER CONSUMPTION BY 2030 …'

The DSM Strategy spans a period of 17 years, targeting the horizon of 2030. However, Expo 2020, which will take place in Dubai in 2020, is already expected to be a great platform for showcasing the results of the initiatives. In the meantime, Dubai's DSM Strategy will continue its leadership role, and build a more sustainable, better future for the generations to come.

Climate change and CCS in the GCC

Robin Mills

The year 2014 was recently described by Imperial College London as 'a pivotal year; one which, in time, we will look back on as being the dawn of the age of sustainable fossil fuels', based on major advances in carbon capture and storage. This comment was inspired by progress on power plants with carbon capture in Canada, the USA, and the UK, but it could also have applied to the Gulf Cooperation Council (GCC) countries.

In November 2013, the Abu Dhabi National Oil Company (ADNOC) and the Emirate's clean energy vehicle Masdar announced the formation of a joint venture, whose operations will commence with the world's first commercial-scale carbon capture and storage (CCS) project on an industrial source, in this case a steel plant.

'GCC IS ONE OF THE MOST FAVOURABLE AREAS IN THE WORLD FOR DEVELOPMENT OF A CCS INDUSTRY. ITS CARBON DIOXIDE EMISSIONS ARE AMONGST THE WORLD'S HIGHEST.'

In many ways, the GCC is one of the most favourable areas in the world for development of a CCS industry. Its carbon dioxide (CO_2) emissions are amongst the world's highest: Qatar being at an unwanted number one with 44 tonnes per capita, and Kuwait, the UAE, and Bahrain also in the top ten.

A large fraction of this CO_2 comes from big stationary sources amenable to capture – power plants, waste streams from gas processing, and industrial facilities. In Qatar, as much as 86.5 per cent of total emissions come from such sources: 50 per cent from the oil and gas sector (the giant LNG and gas-to-liquids plants), 27 per cent from power generation, 8.5 per cent from industry, and 1 per cent from oil refining. In Abu Dhabi, the leading oil producing emirate of the UAE, 44 per cent of greenhouse gases come from stationary fuel combustion (mostly power generation), 5 per cent from industry, and 2 per cent from cement. Abu Dhabi is also increasingly developing 'contaminated' gas fields with high contents of natural CO_2.

A high-potential technology

Carbon dioxide sources are in close proximity to many of the world's giant oilfields (making them suitable for enhanced oil recovery (EOR)), and to well-characterized and extensive saline aquifers. Thick shale and evaporite seals have held huge oil and gas columns over geological time – 500 million years or more in the case of some fields in Oman – with little sign of leakage. Carbon dioxide enhanced oil recovery (CO_2-EOR) provides the economic rationale missing in many other CCS projects worldwide. Giant fields with high-quality reservoirs and low production costs make EOR more feasible than in the expensive North Sea, for instance.

GCC-level figures are not available, but the Global Carbon Capture and Storage Institute estimated in 2009 that the Middle East and North Africa as a whole could store 96 gigatonnes of CO_2 in EOR projects, releasing 316 billion barrels of additional oil in the process. This would represent a 60 per cent increase on current reserves (already the world's largest), while the storage capacity represents at least 40 years of the region's emissions from all fossil fuels. Of course, it is probable that a much larger capacity is available from storage in saline aquifers and depleted gas reservoirs.

Local populations are familiar with the oil and gas industry, and environmental lobbies are unlikely to oppose CCS as they have done in Europe. In any case, the oil-fields are generally in sparsely populated deserts or offshore, easing community and safety concerns.

Environmental awareness is growing, although still lagging behind many other countries. The 2006 launch of Abu Dhabi's clean energy vehicle, Masdar, was a particularly notable step. Last year, both Abu Dhabi and Dubai released their first greenhouse gas inventories. And in this wealthy area, government funding is readily available for strategic projects.

Abu Dhabi is by far the most advanced of the Gulf states in advancing carbon capture. The first project for the ADNOC–Masdar joint venture will be to capture 0.8 million tonnes per year of CO_2 emitted from the Emirates Steel plant and to use it for EOR. This $120 million project builds on several years of trials at the Rumaitha field. The Emirates Steel Plant has the advantage that its Direct Reduced Iron process already produces a stream of relatively pure CO_2.

Although a major step forward, this project is smaller and later than was originally planned at Masdar's launch. Originally, three projects were to capture 5 million tonnes of CO_2 annually: a hydrogen power plant in partnership with BP; the Taweelah aluminium smelter; and the Emirates Steel project. Other CCS plans have been advanced: for example, ADNOC has a roadmap for progressively moving to CO_2-EOR, including from natural (contaminated gas) sources, while Maersk has been advocating its TriGen technology, an oxyfuel gas combustion process which produces

electricity, high-purity CO_2, and potable water.

Various applications in the GCC context

Dubai, amongst other emirates of the UAE, has considered building a coal-fired power plant with CCS, but it now seems that the project, if it goes ahead, will simply be a standard plant, albeit with pollution controls. The small northern emirate of Ras Al Khaimah plans a $1.5 billion, 270 MW coal-fired power station with carbon capture, the CO_2 to be used for industrial uses and EOR, although in which fields is not clear.

Saudi Arabia's state oil firm Saudi Aramco plans the injection of 0.8 million tonnes of CO_2 from gas processing into the Uthmaniyah section of the world's largest oilfield, Ghawar, over a three-year period starting in 2015. The Kingdom maintains that it will not need CO_2-EOR to meet its oil production goals for many years to come, and that this is a pilot project to build expertise. Linde will construct a 0.5 million tonne per year CO_2 capture plant at two ethylene glycol plants in the petrochemical centre of Jubail, with the CO_2 used for methanol, urea, and food processing.

Research institutions such as the King Abdulaziz City for Science and Technology and the King Abdullah Petroleum Studies and Research Centre have also been carrying out studies.

By autumn 2014, the Qatar Fuel Additives Company plans to install a 180,000 tonne per year CO_2 recovery unit at its methanol plant, at a cost of $80 million. Qatar's maturing oilfields and giant high-purity CO_2 source at Shell's Pearl gas-to-liquids plant make it theoretically an ideal candidate for CO_2-EOR. But otherwise, apart from studies on the Dukhan and Al Shaheen fields, and the establishment of a joint CCS research centre with Shell, there has been little progress.

Bahrain has a carbon capture unit at its Sitra petrochemical complex, which extracts about 160,000 tonnes of CO_2 per year for urea and methanol synthesis. Kuwait's petrochemical company Equate also captures some CO_2 for sale to industrial users.

Oman has done least in CCS amongst the GCC members, perhaps surprisingly given its use of a range of other EOR techniques. However, it does have very large deposits of peridotite, which can be used in mineral carbonation to lock up CO_2 in solid form, a potential long-term option to reduce the amounts of CO_2 that have to be injected underground. Other long-term technologies that might be applicable in the GCC include: calcium looping for carbon capture from cement plants; and using CO_2 for enhanced growth of algae for biofuels, which is being researched at the Masdar Institute.

Incentives vary

The incentives to advance CCS vary between the various Gulf countries. Possible motivations are economic, environmental, technological, strategic, and reputational.

Economic drivers include the value of additional hydrocarbons recovered or saved from reinjection. Abu Dhabi injects some 2 Bcf (billion cubic feet) per day of gas for enhanced oil and condensate recovery. With an increasing 'gas crunch' over the next few years – being faced with the development of more costly sour gas resources and plans for LNG imports late in the decade – replacement of re-injected gas with CO_2 can be seen as highly cost effective. A simple calculation suggests that avoided LNG imports could be equivalent to a CO_2 price of more than $250 per tonne, far above likely capture costs. Full replacement of all re-injected gas suggests the potential for some 40 million tonnes per year of CO_2 injection, about a third of the country's total emissions from gas combustion.

Mature oilfields in Oman, Bahrain, and Qatar, now in a phase of decline, could also benefit from CO_2-EOR. Saudi Arabia and Kuwait will require EOR in the future, though large-scale application may be one or two decades away. As noted, four of the GCC states are already using captured CO_2 in industrial processes, albeit on a relatively small scale.

The environmental goal – reducing CO_2 emissions – is accepted as a useful side benefit but is not a core driver of policy. Technological objectives, stressed by Saudi Arabia, include the creation of new skills and industries.

Strategic goals include: the ability to play a constructive role in international climate negotiations, to establish gas as a long-term sustainable energy source, and to create 'carbon space' for continued oil exports. With a gas reserves life of 160 years at current production rates, Qatar is particularly exposed to a more stringent climate policy regime towards mid-century. This is analogous to the interest in CCS from major coal producers and exporters such as the USA, Australia, and China.

Reputational benefits include: bolstering an image of technological progress, and reducing embarrassingly high CO_2 footprints at a time when the UAE and Qatar, in particular, are seeking to become global centres of business and tourism.

These various goals are mostly congruent with other clean energy approaches being adopted by the GCC – energy efficiency initiatives, solar power, and (in the UAE and perhaps Saudi Arabia) nuclear power.

Lagging progress

Given all these advantages, why has the GCC not made more progress in CCS?

Some of the reasons are common to most carbon capture initiatives worldwide: the lack of a commercial rationale in the absence of strict emissions limits or carbon pricing; the challenge of matching utility and oil company business models; and the high cost and perceived technical risk of the capture process. The UAE put its support behind efforts, successful in late 2011 at the UN Climate Change Conference in Durban, South Africa, to include CCS in the Clean Development Mechanism and so make it eligible for carbon credits.

But carbon prices around the world have collapsed because of: oversupply as emissions plunged during the financial crisis, competing policies on renewable energy targets, and failures to agree stricter climate targets. EU carbon prices reached a record €32 per tonne in 2006 but have now fallen to about €5 per tonne. The collapse in carbon prices makes it only a minor contributor to the economics of CCS projects – a problem for putting carbon capture on an equal footing with mandated renewables.

National oil companies (NOCs) and (usually monopoly) utilities tend to be technically conservative and risk-averse. They have to work together to advance CCS projects, but commercial coordination has proved problematic – just as it has in many Western countries. The Masdar–ADNOC joint venture is important in this regard, but it is notable that it does not yet include the emirate's power generation utility ADWEC. The national oil companies' priority is to achieve oil production targets at minimum cost; that of the utilities, to provide reliable, low-cost electricity. The government has to set a strategic goal for carbon capture to be compatible with these considerations.

Subsidies and non-commercial pricing of gas and electricity are also problematic, as in other areas of GCC clean energy policy. With gas priced cheaply or even free to oilfield operators, they have no incentive to replace it with CO_2 – which has to be purchased – for EOR. A single monopoly NOC and utility engage in a zero-sum negotiation over CO_2 pricing. Although environmental awareness in the GCC is rising, it is still not high enough to overcome the historical and political bias towards heavy energy subsidies – unfavourable for clean but relatively costly generation technologies.

'CARBON DIOXIDE ENHANCED OIL RECOVERY PROVIDES THE ECONOMIC RATIONALE MISSING IN MANY OTHER CCS PROJECTS WORLDWIDE.'

There are also specific GCC political challenges. The six nations have relatively limited economic integration, and have neither common energy policies, nor a shared gas grid (the Dolphin pipeline from Qatar to the UAE and Oman being the only exception). This makes plans for CO_2 pipelines between states appear rather unlikely at the moment, although given ample storage space within national boundaries this may not be a problem. However, it does inhibit cross-border learning; this is unfortunate as the geological, economic, and regulatory challenges are very similar throughout the bloc.

However, the Masdar–ADNOC project and the Saudi Uthmaniyah scheme will make the GCC into one of the world's leading areas for CCS. Specific experience here can be applied to other giant fields in the MENA region, and worldwide. Together with the new CCS projects in Canada, the USA, and the UK, within a few years there should be a full spectrum – coal and gas; pre-combustion, post-combustion and oxyfuel; and industry – of demonstration plants worldwide. Real cost benchmarks and operational experience should enable the next generation of projects to go forward faster and with more confidence. It will no longer be possible for opponents to write off CCS as an 'unproved' technology.

Carbon capture has seen several false dawns since its birth in 1996. It may still encounter new obstacles. But the GCC, more than any other region, needs the age of 'sustainable fossil fuels' to emerge soon.

Robin Mills has published the books The Myth of the Oil Crisis *(2008 Greenwood Press), and* Capturing Carbon *(2011, Columbia/Hurst).*

The GCC states need to focus on green actions, not climate vulnerabilities

Mari Luomi

In terms of sustainable energy, the Gulf has come a long way since 2008. Resource efficiency programmes, alternative energy projects, clean technology research, sustainable building codes, public transport systems, and green economy strategies are now part of everyday news in the United Arab Emirates (UAE), Qatar, and Saudi Arabia. Given their hydrocarbon resources, the Gulf states have a large stake in the ongoing global sustainable energy transition, in which they are currently playing a number of different roles: as 'movers', 'clingers', and 'sufferers'. However, only the first of these roles constitutes a tangible option for sustainable development in the region.

Start of a transition

Over the past six years, the pace of global negotiations in the process leading to a universal agreement to avoid dangerous climate change has been glacial: the last round of UN negotiations in March 2014 reconfirmed the lack of trust and leadership, together with the existence of deep divisions between countries over responsibility for cutting national greenhouse gas emissions and financing actions in developing countries. The willingness of major emitters, like the USA and China, to commit will ultimately determine whether a robust agreement will be reached in Paris in 2015. So far, key players have been intransigent and disappointing in this respect in the positions they have put forward.

Meanwhile, a slow but consistent transition to greener economies is already ongoing in most countries of the world. Doubts remain, however, whether this bottom-up action can be scaled up to reverse global emissions growth in time to avoid a dangerous warming of the climate system (represented by an increase of 1.5–2 °C from pre-industrial times).

'GIVEN THEIR HYDROCARBON RESOURCES, THE GULF STATES HAVE A LARGE STAKE IN THE ONGOING GLOBAL SUSTAINABLE ENERGY TRANSITION …'

Regardless of whether or not global climate action will come in time, present and future actions elsewhere will critically impinge on the Gulf Cooperation Council (GCC) economies. In a low-carbon world, 'GCC business-as-usual' will not stand a chance given the carbon-intensive industries and societies and the inefficiency-inducing energy pricing policies that underpin these. But these states still have the choice of positioning themselves as winners.

The Gulf is moving

The year 2008 saw both record oil prices and the onset of the current global economic slowdown. It was also the year when the emirate of Abu Dhabi (UAE) began the construction of its sustainable community, Masdar City. Albeit repeatedly downsized since, this particular endeavour symbolizes the breakthrough of sustainable energy thinking in at least three of the GCC states. Abu Dhabi now hosts the International Renewable Energy Agency, Qatar has presided a major UN climate conference, and Saudi Arabia is embarking on a massive solar energy deployment programme – three testimonies to the broadening regional energy agenda. Research and development into clean energy technologies is a key focus for the governments of all these states, and improving energy efficiency is becoming a key policy goal across economic sectors.

As argued in detail in my recent working paper 'Mainstreaming Climate Policy in the GCC States' (OIES, February 2014), the GCC states have already embarked on a number of policy, project, and sector-wide efforts that, if implemented, will result in deviations from business-as-usual emission trajectories. These explicit or implicit mitigation actions are largely in line with the states' broader development priorities, the most important here being economic diversification and efficient resource use. Many of them, however, still mostly exist only on paper, and consist of fragmented actions with low transformative impact. The national solar targets and green building codes, respectively, are emblematic.

What is still missing in most cases is a strategic approach to low-emission development that integrates emission reduction goals with broader resource efficiency, economic sustainability, and resource security goals. Cross-sectoral sustainable energy and climate policy frameworks, complete with monitoring, reporting, and verification mechanisms for implementation, are also needed. This spring a pioneer in the bloc, the UAE, is expected to approve a federal green growth strategy with medium- and long-term environmental objectives for seven economic sectors.

Many are still clinging

Taking place amidst the global financial crisis, the most high-profile global climate event to date, the Copenhagen Climate Summit in 2009,

confirmed that the world is currently not ready to commit internationally to a fundamental economic transition, despite alarming news from the scientific community and profoundly changing patterns of global emissions: in 2010, developing countries' cumulative (historical) emissions already amounted to 48 per cent of the global total.

Copenhagen also demonstrated that key alignments no longer followed the North–South division. Today, one side of the debate is represented by a loose alliance of progressive action-oriented countries which includes the European Union, small-island states, and the least developed countries, among others. Interestingly, the UAE today identifies itself more with this group, as demonstrated by its participation in the Cartagena Dialogue for Progressive Action. On the 'opposing' side, there is the coalition of Like-Minded Developing Countries, which includes countries as different as China, Venezuela, the Philippines, Saudi Arabia, and Qatar.

Most recently, in a submission of views on the 2015 outcome in March this year, the Like-Minded Group called for the maintenance of a 'firewall' between developed and developing countries, based on a classification from 1992. There would be differentiated types of contributions from each group, and any enhanced action by developing countries should be supported by financing and technology transfer by the developed countries.

Although simplistic and harsh, the Like-Minded Group has been characterized by many as a group that, over the past decade or two, has seen rapid economic and emission growth and is now reluctant to recognize the new global reality in which a substantial share of future emission reductions against baseline trajectories will need to come from these countries. Lack of leadership by industrialized countries, principally the USA, together with low ambition in climate finance pledges are, no doubt, strengthening this reluctance.

However, for the GCC states, external climate finance is not a prerequisite for action, and they can afford to pay for technology transfer and capacity building. Income levels are high and, as a result, emissions profiles have changed. There is no obvious reason for the GCC states to cling to the old rhetoric on this issue. The UAE's carefully balanced stance in the negotiations, as part of the GCC and the 'progressive bloc', stands as a successful example of reconciling an oil-exporting country's past with its present, and re-branding its future in the international energy economy.

Will the Gulf suffer?

A parallel theme to that of insisting on a binary division of the world has been the 'dual vulnerability' of the GCC states. Since the 1990s, representatives of these states in the UN negotiations have portrayed their countries as being highly vulnerable to both the physical impacts of climate change and the economic impacts resulting from international actions to restrict emissions. Adaptation has been characterized by Saudi Arabia, in particular, as the most important priority vis-à-vis climate action.

'IN A LOW-CARBON WORLD, "GCC BUSINESS-AS-USUAL" WILL NOT STAND A CHANCE …'

Although mitigation takes second place, over the past two years the GCC states have moved towards a more constructive approach to it, and now recognize the 'win–wins' of aligning key development goals with action to reduce emissions. In 2012, upon the proposal of Saudi Arabia, the UAE, Qatar, and Bahrain, parties to the UN climate convention agreed that hydrocarbon-dependent economies could present their mitigation and other climate actions to the international level, under the umbrella of economic diversification and sustainable development strategies. Such actions would be subject to international verification but could also be eligible for financial support. The GCC states are yet to register any actions under this concept, but may do so in the near future.

Economic diversification is not just the best way to increase economic resilience in the GCC. It is the only way for these states to 'survive' in a low-carbon economy. For enhanced competitiveness, policies should focus on increasing the efficiency of the economy and diversifying into green sectors and jobs, such as solar and clean tech industry, energy service companies, and buildings, waste, and public transport sectors.

The Gulf states will 'suffer', but only they if keep perpetuating current vulnerabilities.

Fundamental changes required

The current global economic development model is an anachronism, and cannot continue with business-as-usual. It stands in fundamental contradiction to contemporary climate science and environmental economics. The latest assessment report by the Intergovernmental Panel on Climate Change (AR5) concluded that, should we wish to live in a <2 °C world, we have already spent over half of the available 'budget' for CO_2 emissions. Some have calculated that this budget would be exhausted in three decades, or even in as little as two, if non-CO_2 emissions are included and emission growth continues.

Given this timeframe, the GCC states' hydrocarbon-dependent economies, in their essence, cannot claim to be sustainable. Given future oil and natural gas demand estimates, the GCC states appear to have no pressing medium-term incentive to embark on a fundamental economic transformation. However, continuing to base economic planning on global oil demand and price projections that imagine a future world where climate policies fail is not only morally wrong, but it is also short-sighted.

'THE INCREASING NUMBER AND SCOPE OF "GREEN" AND CLIMATE ACTIONS IN KEY GCC STATES IS A GOOD START.'

Attention in the Gulf energy ministries and in hydrocarbon companies worldwide should be turning to 'unburnable carbon' – fossil fuels that must be left in the ground to avoid a >2°C warming of the climate system. The best-known estimate, by Meinshausen and others in 2009, places this share at more than half of global proven economically recoverable fossil fuel reserves. A recent study by McGlade and Ekins finds that even a broad deployment of carbon capture and storage would not noticeably alter the levels of unburnable carbon in the Middle East.

More 'greening' needed

Together with crises come opportunities. The global financial crisis drew attention to, among other systemic failures, the disconnect between economic growth and its impacts on the environment. This realization brought about the re-emergence of the concept of 'green economy', currently promoted by a number of UN organizations and by the Global Green Growth Institute (the latter through a regional office in Abu Dhabi) as a broad toolkit for enabling economic growth whilst improving environmental and human wellbeing. Indeed, one way of framing the required transition in the Gulf is through the lens of green economy.

The increasing number and scope of 'green' and climate actions in key GCC states is a good start, and this trend is set to intensify over the coming years and decades. However, the current actions and plans of GCC states will not take them to a low-carbon, climate-resilient future. Similarly, as warned by the World Bank in 2012, the bottom-up pledges made so far by individual countries globally will take the world to 4 °C of warming, or more. In both cases, more ambitious action is needed, faster.

Climate science and the reality of unburnable carbon are the decisive reasons why the GCC states must rethink their economic priorities and embark on building truly sustainable and resilient economies that will last beyond oil and natural gas.

A global failure to tackle climate change will not be a win–win scenario for the Gulf: the more the global community fails in its efforts to curb greenhouse gas emissions, the worse will be the physical impacts of climate change, and the higher the cost of inaction, worldwide, including in the Gulf.

The Gulf oil exporters' vulnerability to climate change is real but should not constitute an excuse for procrastination on low-carbon development and green growth on their part. On the contrary, it should serve as reason for action.

The author has recently published a study for the Oxford Institute for Energy Studies under the title 'Mainstreaming Climate Policy in the GCC States' MEP7, available on the OIES website.

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