Saving Oil and Gas in the Gulf

A Chatham House Report

Glada Lahn, Paul Stevens and Felix Preston

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G.L.
P.S.
F.P.

Executive Summary

The systemic waste of natural resources in the Gulf is eroding economic resilience to shocks and increasing security risks. The six Gulf Cooperation Council (GCC) countries now consume more primary energy than the whole of Africa. Yet they have just one-twentieth of that continent's population. Almost 100% of energy is produced from oil and gas without carbon dioxide abatement. If the region's fuel demand were to continue rising as it has over the last decade, it would double by 2024. This is a deeply undesirable prospect for both the national security of each state and the global environment. Output generated is not commensurate with energy used. Energy intensity regionally (units of energy per unit of GDP) is high and rising in contrast to other industrialized regions, and this is driven by systemic inefficiencies. The situation threatens sustainability on several levels, and is exacerbated by groundwater depletion and an increasing reliance on oil- or gas-fuelled desalination.

Between 2011 and 2013, Chatham House worked with partner institutions, policy-makers and technical experts in Saudi Arabia, the United Arab Emirates (UAE), Oman, Qatar and Kuwait to support practical strategies to reduce energy intensity. This report is based on the discussions at six workshops which included representatives of over 60 local institutions with a critical interest in and influence over domestic energy. To our knowledge, this is the first report to offer practical recommendations that address the key challenges of governance, political commitment and market incentives from a GCC-wide perspective.

Remarkable progress is evident in the clean energy targets and efficiency strategies that have sprung up across the region since 2009. Recognizing the risks in the current system and the economic potential from new sectors, GCC governments have dramatically scaled up plans that emphasize 'sustainable energy' transition. For Saudi Arabia securing future hydrocarbons export capacity is a priority. Across the region, remaining ahead in the energy industry and preparing for multiple resource stresses and price volatility are common drivers. The ballooning costs of subsidies – and in the case of the UAE and Kuwait, gas imports – make a clear business case for government-led efficiency interventions. Estimates by the International Monetary Fund of the energy subsidy burden on individual governments ranged between 9% and 28% of government revenue in 2011. This is more than is being spent on either health or education, and highlights a missed opportunity to improve the living standards of those who need it most.

All GCC countries now have clean energy plans or targets and there are several impressive steps towards conservation. These include Saudi Arabia's emerging efficiency master plan, Abu Dhabi's comprehensive cooling plan, the integration of energy strategy in Dubai, innovation in green buildings standards in the UAE and Qatar, and Oman's and Dubai's work towards cost-reflective utilities pricing. Comprehensive development strategies that aim at a 'low carbon pathway' or 'green growth' are also emerging (in Qatar and the UAE).

But in all GCC countries the effectiveness of plans hangs in the balance, chiefly owing to governance challenges, lack of market incentives and unpredictable political support. The GCC countries as a whole have an advantage over many other countries in their potential for financing efficiency and introducing renewable energy, the relevant infrastructure and communications technology. However, achieving this requires significant shifts in the way governments intervene in and regulate the energy sector. The GCC countries are in a position to benefit from the experiences of other countries, but their unique features – climate, political economy and administrative legacies – demand special attention to governance design.

A central challenge is that authority over the energy sector in all GCC member states is fragmented. The responsibility and the capacity to act effectively within the sector are scattered between different ministries and regional authorities. Government leaders are beginning to delegate authority to new or existing institutions to carry out studies and formulate plans for the sector. Often spurred by power crises, coordination in the electricity supply side is more advanced. Abu Dhabi, Saudi Arabia, Oman and Dubai have introduced an independent regulator for the power sector. The regulator has been instrumental in galvanizing the drive for greater energy conservation. New governance arrangements are also attempting to overcome sectoral barriers. Saudi Arabia has pioneered a coordinating body for energy efficiency and an agency for making policy on renewable and atomic energy. Qatar has evolved high-level inter-ministry coordination on climate policy, and Dubai was the first government to establish an entity for integrated energy policy.

Efficiency savings are urgent and practical and will build a bridge to renewables deployment. Ambitious green growth and clean energy strategies will take time to implement. In the meantime, power and water use is a challenge across the region that should be addressed as a priority. In fact, demand rationalization in these areas is vital if the vast renewable energy potential of the GCC countries is to be realized. Without it, power demand growth of more than 7% per year will swamp the effect of solar deployment over the next decade.

The size of the prize is significant. Our calculations show that planned clean energy introduction in Saudi Arabia, together with basic efficiency measures, could slow oil and gas demand growth from a conservatively projected 4% to an average of 2.8% per year between now and 2025. This would result in savings of between 1.5 and 2 million barrels of oil equivalent per day – a volume which roughly matches what the country needs to maintain the spare crude capacity so critical to global oil markets.

Changes to national building codes and air-conditioning standards represent the biggest proven savings potential for electricity. Pilot schemes and practice show that savings of up to 60% of energy demand can result from changes made to existing buildings, and 70% in new builds, against the existing average. In addition, urgent attention needs to be paid to transportation planning and addressing the ‘leakage’ of the fuel subsidy through smuggling.

Success or failure in meeting sustainable energy goals in the GCC will have global impact. It will affect not only local economies and therefore politics, but also the availability of oil and gas for export and the position of GCC countries in international climate change negotiations. It could also influence the policies of other countries in the region or with similar resource and climatic conditions. For example, in its latest report, the International Energy Agency underscores the dramatic rise in demand for air conditioning that will occur across Africa and the Asia-Pacific region as both incomes and temperatures rise. In the Gulf, where air-conditioning equipment frequently uses twice as much energy as the best available technology, standards and innovation to cool down using less energy will have global relevance.

Likewise, many countries are grappling with the challenge of pricing energy and water efficiently or creating renewables and energy service markets where fossil fuel prices do not reflect costs. If countries in which a tank of petrol costs the same as coffee for two and electricity bills are negligible can make these things work, it will serve as a powerful model.

Given their common aspirations and shared climatic, energy and market conditions, GCC countries could achieve more through cooperation. Alignment and support at the regional level could facilitate standard-setting for buildings, vehicles and appliances, as well as fuel price reform. Such measures could prevent cross-border trade undermining national efficiency regulations, and reduce the costs of materials and capacity-building by creating economies of scale. There is rich potential for collaboration over the best ways to introduce new sources of energy and technology in the region, especially given the common climate, employment challenges and the rapid urban and industrial development expected in all countries over the next decade. The GCC countries could foster regional integration and raise their international status and impact via the platform of energy cooperation. Through coordination of existing and scaled-up initiatives and targets, the GCC countries could then punch above their weight with joint CO_2 emissions reduction commitments.

Recommendations

Key recommendations for cooperation at the regional level or between GCC countries are as follows.

Establish a central resource for country planners

- Request a detailed sustainable energy strategy for each country to be submitted at the GCC Secretariat level to enable appropriate regional approaches.
- Centralize available country energy data on an open source website – this could be maintained by a GCC Secretariat team drawn from each of the countries.
- Share studies and methodologies to reveal total energy use in the water life-cycle, the costs of energy resources and the costs to the economy of wasted energy, the environment and human health.
- Share details of financial models that allow the commercial deployment of renewable energy under current low fuel price conditions.

Develop common standards and support their effective enforcement

- Develop and set common appliance efficiency standards – with air conditioning as a priority area.
- Establish a common progressive average vehicle fuel efficiency standard.
- Establish a common buildings code and buildings materials standards that will bring step changes in energy and water efficiency.
- Host an ongoing benchmarking programme for industrial efficiency for energy-intensive industries in the region.
- Organize joint training programmes for regulation and implementation of energy services.

Put in place the infrastructure and price mechanisms to overcome cross-border trade barriers

- Ensure the GCC-wide grid is flexible to allow inter-country and potentially inter-regional trading.
- Evaluate the potential to work towards common fuel prices.
- Develop the formula for a common trading price for electricity.

Increase cooperation on research and development and on technical planning to build national capacities faster

- Ramp up joint work on developing, piloting and evaluating low carbon forms of desalination.
- Develop common approaches to modelling and energy planning.

1. Introduction

The Gulf Cooperation Council (GCC) countries of Saudi Arabia, the United Arab Emirates (UAE), Kuwait, Oman, Qatar and Bahrain now together represent a formidable energy consumer. In 2011, the GCC countries, despite the relatively small size of their populations, consumed almost as much oil and gas as Indonesia and Japan combined, a quantity greater than the entire primary energy consumption of Africa. And demand is growing fast – at an average of 6% over the last 10 years, with electricity demand in Abu Dhabi and Qatar recently showing double-digit growth. While energy demand has mirrored GDP growth, it has also surpassed it in some cases and the GCC countries are global outliers in terms of levels of energy intensity. Year on year, the drawbacks of the energy- and water-intensive development model are becoming clearer than their advantages.

In the last two years, some GCC governments have publicly recognized the unsustainable nature of energy consumption patterns, or at least the tremendous waste they incur.[1] The resource stresses in these countries continue to brew, increasing both the well-known economic vulnerabilities of states that are dependent on rents from natural resources and the environmental vulnerabilities of a water-scarce region.

Alongside this, there is a concern among the region's private sector not to fall behind. Economies across the world are reorienting their growth strategies to delink energy demand growth from GDP growth and improving standards of living.[2] For different reasons, energy efficiency and energy diversification are rising up the policy agendas of both fuel importers and fuel exporters. The last few years have seen ambitious plans to reduce fuel consumption among large emerging economies including China, India and Indonesia through a combination of policies and finance mechanisms to incentivize efficiency and scale up energy from renewable sources. These are building on energy policies that for the large part began in the 1970s and 1980s.[3]

In the GCC, no state has a domestic energy policy as yet, but visions to harness climatic advantages and meet domestic energy and water challenges have progressed rapidly in the last five years. If implemented effectively, such strategies offer a win-win situation for both importers and exporters of traditional fuels, contributing to domestic energy security and long-term economic and environmental sustainability. Predictably, labour and security concerns – particularly in the wake of the Arab uprisings – have tended to postpone reforms aimed at long-term economic sustainability. There are also several well-known barriers to the implementation of energy management strategies in the GCC. These include the low price of fuels and electricity, the lack of integrated policy and targets to guide the demand side, poor availability and quality of data, and the lack of agency coordination and public awareness.

Given these shared challenges and the similarities in climate and energy market conditions, this report discusses common and cooperative approaches that could cut costs and catalyse oil and gas savings. There is clearly

1 See, for example, the words of Saudi Minister of Petroleum Dr Ali Al-Naimi, 'النعيمي: المملكة تواجه "تحديا" في استخدام الطاقة' ['Al-Naimi: The Kingdom faces a "challenge" in energy use'], *Al-Watan*, 25 November 2012, and the speech of the UAE Minister of Energy, Suhail bin Mohammed Al-Mazrouei, 'Energy will continue to be a central part of the UAE's economy and driver of development: Al Mazrouei', Emirates News Agency, 16 April 2013.

2 See, for example, World Bank/Development Research Center of the State Council, The People's Republic of China (2012), *China 2030: Building a Modern, Harmonious and Creative High-Income Society*, February. Available at http://www.worldbank.org/content/dam/Worldbank/document/China-2030-complete.pdf.

3 In 2011, the 21 Asia-Pacific Economic Cooperation (APEC) member countries resolved to reduce energy intensity by 45% by 2035. These account for over half of global GDP and there is clearly a collective push to progress measures to increase energy efficiency and emissions reductions. See, for example, *APEC Energy Demand and Supply Outlook – 5th Edition*, February 2013. Available at http://publications.apec.org/publication-detail.php?pub_id=1389.

scope to learn from international experience, and the closer the conditions are to those in the 'learning' country the more relevant the experience. Between 2011 and 2013, Chatham House worked with partner institutions, policy-makers and technical experts in Saudi Arabia, the UAE, Oman, Qatar and Kuwait to support practical strategies to reduce energy intensity. We held joint workshops with partners in Riyadh, Dubai, Doha, Abu Dhabi, Kuwait City and London, comprising representatives of over 60 institutions. Based on these discussions and critical feedback from participants, this report lays out the main challenges and makes recommendations for constructive inter-state

Box 1: What might energy sustainability mean for the Gulf?

The Bruntland Commission's definition of sustainable development – 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' – should have particular resonance for domestic energy management in the Gulf countries. There is, after all, a direct relationship between the energy that they consume at home and their future potential to export the commodity on which they depend. Groundwater resources are also being depleted and a number of processes (including desalination and rapid urban and industrial development) threaten marine ecosystems and other aspects of biodiversity. In addition, the ballooning cost of fuel and utilities subsidies is putting an increasing burden on countries' budgets and driving ministries of finance to take water and energy conservation seriously. As the tag line on a Saudi twitter feed @Save_Wealth puts it: 'Energy efficiency is one of the most important ways of conserving the country's oil and water resources … so let us take care of them for future generations.'[a]

Use of the term 'sustainability' is ubiquitous in the region. Abu Dhabi pioneered the use of the Arabic term '*Estidama*' for sustainability when naming its urban planning programme, which emphasizes energy and water efficiency. Saudi Arabia is rebranding itself as 'the Kingdom of Sustainable Energy'. In practice, governments will be giving priority to different objectives in pursuing 'sustainable' domestic energy policies. For some, the primary imperative is saving oil, which will mean an emphasis on displacing oil in power generation and introducing attractive public transport alternatives. For others it is reducing gas import and subsidy bills. Qatar and Abu Dhabi exhibit stronger emphasis on environmental footprint and emissions reduction.

However, for domestic populations in these countries sustainability will be framed less in terms of environmental sustainability and more in terms of economic and social sustainability. Scaling up renewable energy and efficiency initiatives will entail incorporating plans to diversify the economy and create jobs for the rapidly growing young population. This is clear from Saudi Arabia's roadmap for establishing new economic sectors through renewable and atomic energy deployment.[b] Going forward, environmental constraints and politics will converge – particularly where water is concerned. Urban traffic pollution may well rise up the agenda as health costs increase.

Certainly there is some tension between the idea of sustainability as a 'low carbon future' and the economic dependence of all GCC states on exports of hydrocarbons and/or hydrocarbon-intensive products. Country government planners expect and will act to secure a long-term future in these markets. There is little debate in the region about when the world market for their oil may begin to decline. GCC planners also expect to continue to rely on gas for power generation for decades to come. The emirates of Ajman and Dubai even see coal as a part of their future 'sustainable' energy mix because it would be cheaper than relying on imported gas or free up more gas for export. As elsewhere in the world, if fossil fuel use is to meet international sustainability criteria, significant resources will need to be dedicated to carbon abatement technology such as carbon capture and storage.

a This is rendered in Arabic 'كفاءة الطاقة من أهم وسائل حفظ ثروات البلد النفطية والمائية .. فلنحافظ عليها للأجيال القادمة'.

b See 'Saudi Arabia's Renewable Energy Strategy and Solar Energy Deployment Roadmap', Abdulrahman Al-Ghabban, Masdar (2013). Available at http: www.irena.org/DocumentDownloads/masdar/Abdulrahman%20Al%20Ghabban%20Presentation.pdf.

engagement within the GCC. It argues that faster progress on rationalizing fuel consumption in these countries could be achieved through action at the regional level. As with European Union efforts regarding regional energy and climate action, there are potential obstacles in terms of trust, enforcement and the tendency to dilute legislation. But the relatively small size of GCC populations, as well as the shared climate and energy challenges and existing border controls, offer the potential for overcoming these. The report concludes by summarizing which elements of the drive to reduce energy intensities might be best undertaken at the regional level.

2. Comparing Energy Use in the GCC

In order to better judge where unified or combined approaches to energy might be useful in the GCC, it is helpful to clarify what states have in common and where they differ.

Regional share of energy consumption

Figure 1 shows that energy consumption in the GCC has been rising inexorably over the last four decades. But the shares of each country differ. Saudi Arabia's is the largest by far, with the UAE and Kuwait second and third. This is not surprising given their relative population sizes.

Relative wealth

Qatar is exceptional in its high GDP per capita. Kuwait and the UAE would also fall into the high-income category while three states – Saudi Arabia, Oman and Bahrain – are closer to the upper-middle-income country average. Figure 2 illustrates this split with respect to energy use.

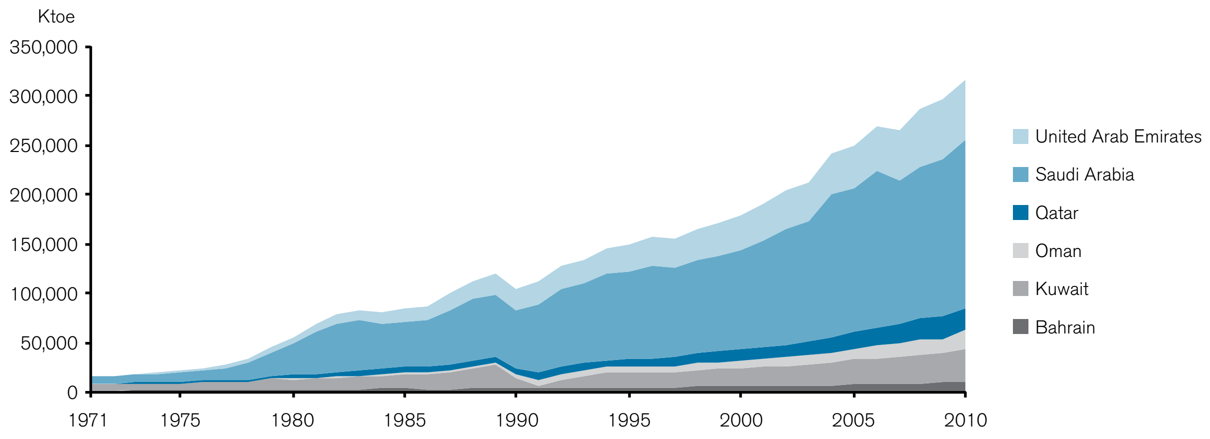
Energy use per capita

The height of the bubbles in Figure 2 illustrates countries' energy consumption per capita – all far higher than the world average and in general higher than their economic comparators. The bubble size for each country reflects the level of fossil fuel consumption per capita, which in all the GCC countries is equal to energy use.[4] Higher-income GCC countries – the UAE, Qatar and Kuwait – are notable outliers, but the similarity between the GCC states on this basis is nevertheless clear.

Energy intensity trends

Energy intensity as energy use per unit of GDP can give some indication of a country's overall direction in terms of generating

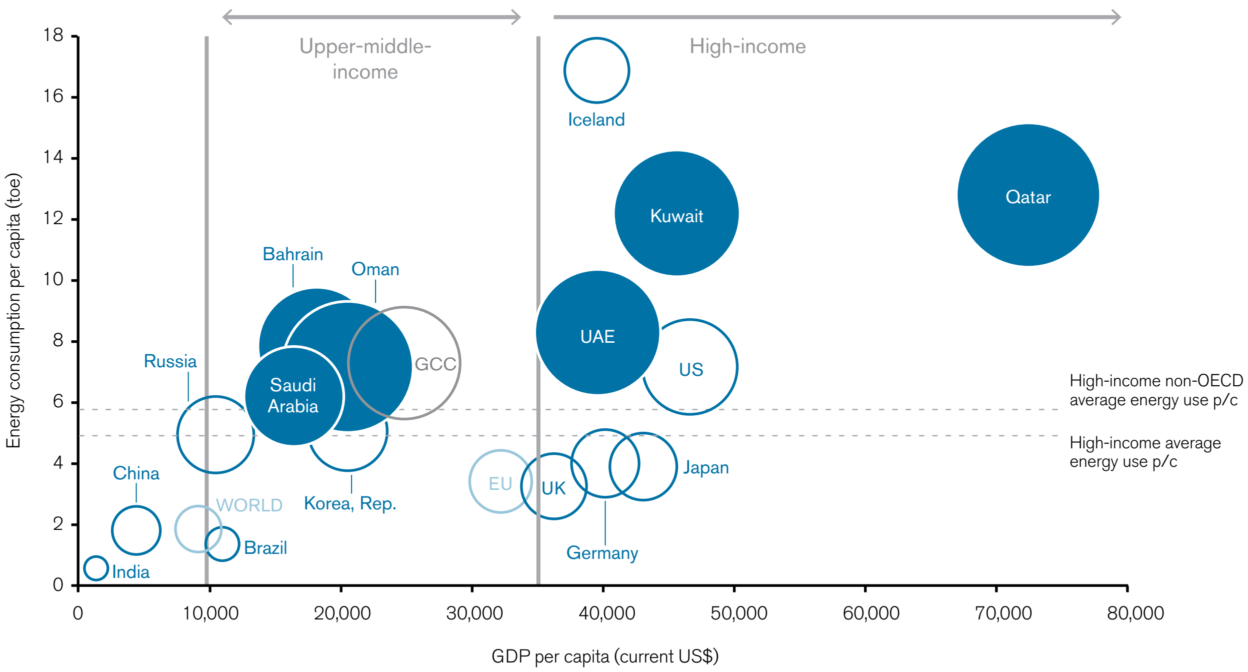
Figure 1: GCC energy consumption, 1971–2010 (ktoe)



Source: World Bank World Development Indicators 2012.

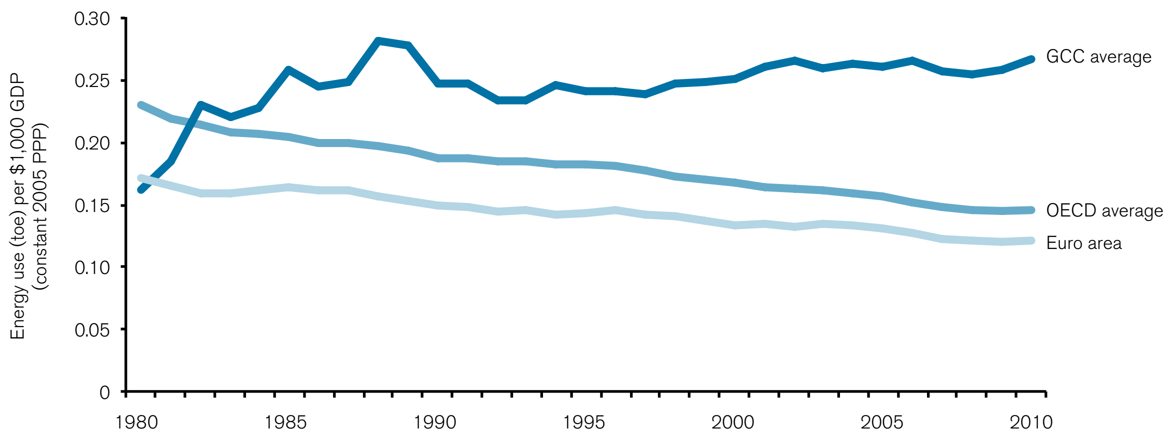
4 This just makes the point that a country such as Iceland may have high energy use per capita but less fossil fuel dependence (most of Iceland's energy comes from hydro and geothermal power) and therefore less concern about resource intensity.

Figure 2: Energy intensities in 2011: global per capita comparisons



Sources: World Development Indicators 2012, *BP Statistical Review of World Energy 2012*.
Note: Bubble size indicates size of fossil fuel consumption per capita.

Figure 3: Energy intensity trend in the GCC, 1980–2010 (PPP)

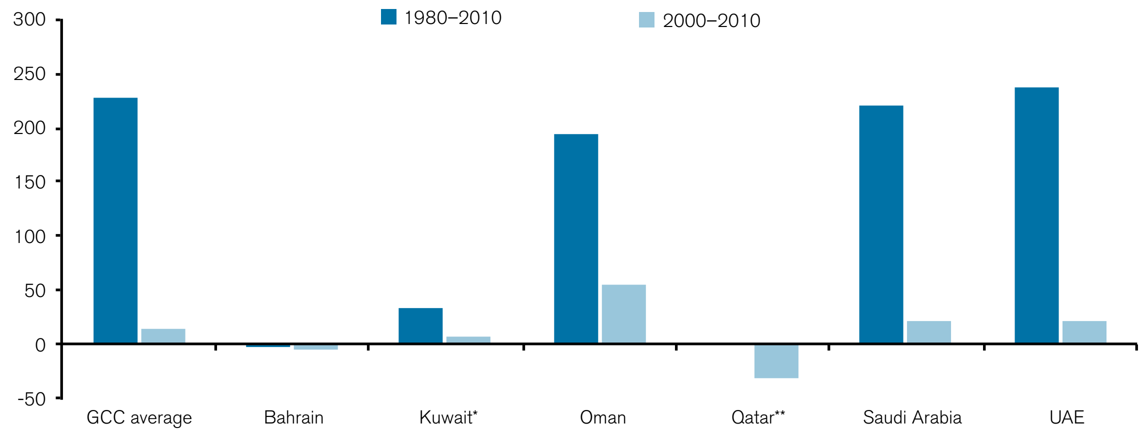


Source: World Development Indicators 2012.

value from its resources.[5] Figure 3 shows that the overall trend for the GCC is of high and rising energy intensity in comparison with many other industrialized regions including the United States, the European Union and China.

5 However, there are several important caveats regarding the extent to which energy carries externalities and GDP can be a proxy for 'national value generation'. For more details, see G. Lahn and F. Preston (2013): 'Targets to Promote Energy Savings in the Gulf Cooperation Council Countries' Energy Strategy Reviews, Vol. 2, Issue 1, June. Available at http://dx.doi.org/10.1016/j.esr.2013.03.003.

Figure 4: Percentage change in GCC energy intensities (energy use/GDP constant $2000)



Source: World Development Indicators 2012.
* The first bar for Kuwait is for 1992–2010 owing to lack of data.
**Qatar's data begin in 2000.
Note: A positive number indicates a rise in the energy intensity of the economy.

Energy intensity trends are volatile and differ among the GCC members. This raises some questions about the usefulness of the measure. Figure 4 shows that, between 1980 and 2011, energy intensities rose in Saudi Arabia, the UAE and Oman, but fell in Qatar, Bahrain and Kuwait.

However, two determinants affect these statistics. First, total primary energy consumption (which features in the conventional energy intensity measure) includes feedstock. Thus a country that has pursued a development strategy based upon petrochemicals will show high levels of energy consumption. In Saudi Arabia, for example, about 22% of energy consumed is in the form of industrial feedstock.[6] Second, GDP is influenced to a great extent by the international oil price; thus rising GDP does not necessarily reflect greater productivity in the economy.[7] Since 2000 all the GCC countries have registered slower or negative growth in energy intensity. This was also a time when the rising international price of oil brought them record windfalls, increasing the amount of capital spending and transactions throughout their economies.[8] So downward trends in energy intensity do not necessarily indicate increased energy efficiency. This is particularly relevant in the cases of Qatar and Kuwait where hydrocarbons revenues have soared but populations are small, limiting the growth in total energy use. Bahrain, the smallest and most energy-intensive of the GCC member states, should have witnessed some improvements as a result of service-sector growth.

The structure of energy use

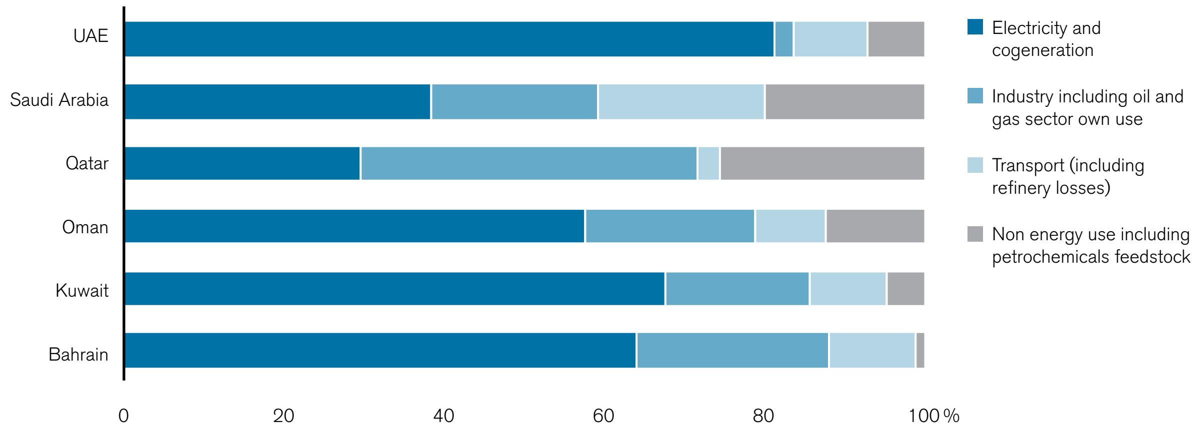
National projections, population growth, urban development and industry plans suggest that, without serious policy interventions, energy demand will continue to rise faster than real GDP growth. The way in which each country uses energy will inform the appropriate design of these interventions. Appendix 1 shows the basic sectoral breakdown of energy consumption in each country, with the four main segments represented in Figure 5.

6 Al-Ghabban (2013) from K.A. CARE energy flow diagram. The IEA data show that 18% went into petrochemicals in 2010.

7 Othman Al-Khowaiter, a former vice president at Saudi Aramco, has argued that oil export revenue should not be counted in GDP as it is not the result of productive labour. 'هل الدخل النفطي جزء من الناتج المحلي؟' ['Is oil income part of GDP?'], *Al-Eqtisadiah*. Available at http://www.aleqt.com/2011/01/02/article_486095.html. Available in English at http://www.kippreport.com/fcs/is-the-oil-revenue-part-of-the-gdp/.

8 For more on individual GCC states' energy intensity trajectories, see Lahn and Preston (2013).

Figure 5: Simplified energy resource use breakdown, 2010



Source: IEA data, 2012.

This shows that the relative priority given to addressing the consumption of industry, for example, would differ between Qatar, where the oil and gas sector and other industries account for at least half of total energy use, compared with just 9% in the UAE.[9] Transport's share of energy demand is highest in Saudi Arabia, where it is double that of most of the other countries. This is due partly to its larger landmass and distances between cities but also to the propensity for heavy vehicles in transit to fill up where diesel is cheapest. Buildings represent a high portion of electricity consumption for all countries, particularly when electricity generation losses are also accounted for. For all countries, with the possible exception of Qatar, these losses identify generation as a key area for improvement in energy efficiency.

Energy demand in water services more generally (pumping, desalination, delivery, treatment) is another shared concern across the GCC, although comparison is difficult as it is not currently available in national statistics. Afreen Siddiqi and Laura Anadon attempt some estimates. They suggest, for example, that 10% of total fuel use could be attributed to groundwater pumping in Saudi Arabia.[10] Recent estimates from local sources suggest that between one-tenth and one-third of fuel used in the power sector is used to produce desalinated water.[11] Getting the water to users also uses energy – electricity for pumping or diesel for tanker delivery – and regional authorities estimate distribution losses of between 10% and 40% across the GCC.

Future sectoral demand

In view of population growth rates, development plans and industrial scale-up, energy demand growth will be high across all sectors unless there are concerted and strategic policy interventions. Industrial use may be the most difficult to predict (and urgent domestic assessment is needed), since development plans are uncertain and growth is to some extent dictated by global economics.

9 In addition to the industry use bar, 31% of electricity use in Qatar is designated 'industry' in the statistics – see Appendix 1 for a more detailed breakdown. Country data based on the available International Energy Agency (IEA) figures.

10 A. Siddiqi and L.D. Anadon (2012), 'The Water–Energy Nexus in Middle East and North Africa', *Energy Policy* 39 (2011), p. 4535.

11 Estimates based on Saudi energy flows in Al-Ghabban (2013); S. Kennedy, S. Sgouridis, P.Y. Lin and A. Khalid (2012), *CO_2 Allocation for Power and Water Production in Abu Dhabi*, Masdar Institute Working Paper; H. Fath, A. Sadik and T. Mezher, 'Present and Future Trends in the Production and Energy Consumption of Desalinated Water in GCC Countries', *Int. J. of Thermal and Environmental Engineering* Vol. 5, No. 2 (2013), pp. 155–65, available at: http://www.iasks.org/sites/default/files/ijtee201305020155165.pdf; Abu Dhabi Electricity & Water Authority and Qatar Energy & Environment Institute estimates. There is no standard calculation for fuel allocation to desalinated water as it depends on the type of plant used, the formula used for allocating fuel in cogeneration plants and seasonal variation. See also the notes in Appendix 3.

While use of energy in industry may differ, there is similarity between GCC countries in the types of industry that are growing: the oil and gas downstream (refining, petrochemicals, fertilizers and plastics), and the energy-intensive manufacture of construction materials (steel, aluminium and cement). Here there is ample room for cross-sector analysis of efficiencies.

More analysis is available on the electricity sector, and numerous studies are improving the reliability of statistics. Those making projections face the problem of uncertainty about the impact on future demand of development plans and unscheduled expansions, as well as measures such as buildings efficiency codes. In the largest of the GCC countries, Saudi Arabia, we used available data on fuel use in transport per capita, past increases in vehicle use and population growth to project a rise of 167% in transportation fuel demand between 2010 and 2025. This is likely to be similarly high for Oman, where there is much room for growth of car ownership and use, but lower for other Gulf states given the near saturation of the car market.

Electricity and water are common areas of priority, generally noted by all governments. One area is particularly significant: rising peak power demand. This is driven by demand for cooling, which accounts for between 50% and 70% of electricity use across the region. Peak demand for electricity has more than doubled in the last decade in Saudi Arabia,[12] and is hitting double-digit growth in the UAE and Qatar. All GCC countries project peak demand growth of at least 7% per year in the next decade without intervention. This is an expensive issue. In Saudi Arabia, for example, 5% of total electricity generation capacity is used for just 48 hours a year. Inability to keep pace with growing peak demand is also responsible for outages and additional crude burn in summer in some areas.

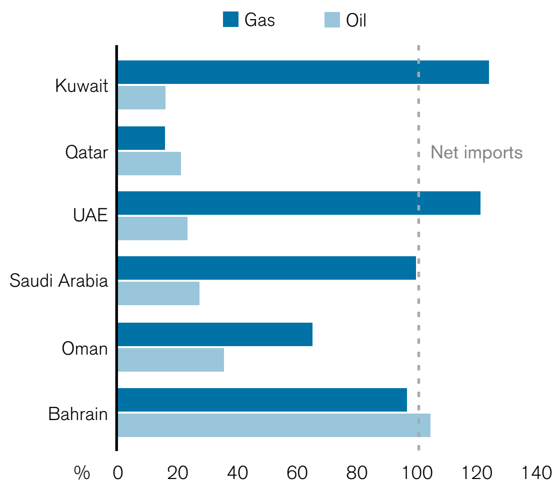
Given the linkages between energy and water described above, water is another area with major energy savings potential for all GCC countries through coordinated demand and supply side policies. For more on desalination technology options, see Chapter 5, Box 5.

Oil and gas balances and exposure to price shocks

Figure 6 shows the percentage of a country's oil and gas production consumed domestically. The vulnerability of countries to future export constraints or exposure to price volatility in imported energy products may influence the urgency with which governments pursue energy reforms and the policy case they make for pursuing reforms. Several factors will affect this vulnerability over time, including the level of economic dependence on hydrocarbon revenues, economically producible reserves and capacity to produce them, population size and growth, industrial development path and the international price for exports.

Dependence on hydrocarbon exports is high across the GCC, with receipts making up 80% or more of government revenues in all countries.[13] But they differ in terms of the size of the populations for which this revenue must provide, as shown in Figure 7. Saudi Arabia's hydrocarbons (crude

Figure 6: GCC countries oil and gas consumption as a percentage of production

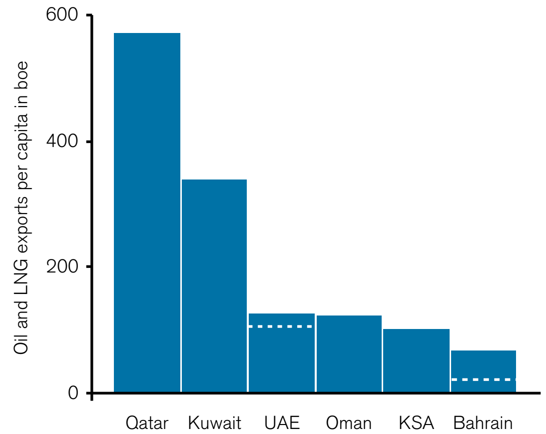


Sources: *BP Statistical Review of World Energy 2012,* Joint Oil Data initiative, OPEC, UN population data.

12 Electricity & Co-generation Regulatory Authority (ECRA), Saudi Arabia. Projections available at http://www.ecra.gov.sa/pdf/longtermgenerationplanningforsaudielectricitysectorstudy.pdf, p. 40.

13 This includes Bahrain, which exports refined products although it also imports oil to produce these.

Figure 7: Hydrocarbons export revenue per capita*



Sources: *BP Statistical Review of World Energy 2012,* Joint Oil Data initiative, OPEC, UN population data.
*This does not include Qatari gas supplied through the Dolphin pipeline.
Note: the white dotted line indicates share minus imports.

oil and refined products) export-to-population ratio, for example, is the second lowest after Bahrain's. Qatar and Kuwait stand out with their high revenues and relatively small populations. These factors, as well as individual countries' rigid budget costs (e.g. social spending and subsidies), affect future vulnerability. A recent study by the International Monetary Fund conducted a simulation based on a $30 drop in oil price in 2013, which found that all GCC countries would go into fiscal deficit by 2017, with Bahrain, Oman and Saudi Arabia most seriously affected.[14]

Common concerns

The analysis above gives a basic overview of the extent to which high energy consumption relative to national wealth creation presents a common challenge in the region. High energy intensity and high per capita consumption are concerns for all countries because all energy consumed is oil and gas. This suggests poor allocation of national resources – a particular issue for GCC economies which are all dependent on hydrocarbons export revenues.[15] Rising energy subsidy bills mean that governments in the region are forgoing potential funding for more urgent development needs. Estimates by the IMF of energy subsidy costs in GCC countries in 2011 range from 9% to 28% of government revenues. This is more than is being spent on either health or education.[16] While some countries have a bigger economic cushion than others, the interdependence of their economies means this 'loss of value' is a problem not only for individual states but for the GCC as a whole.

Effective strategies to address this will depend on the differing structure of energy use, expected patterns of demand growth and financial capacity in each country. As noted, there are key differences in population size, GDP per capita and consumption structure. And there are key commonalities: high and growing demand for cooling, water and transport, industrial development strategies based on hydrocarbon inputs and peak electricity demand issues. These suggest potential for shared approaches.

14 International Monetary Fund (2012), *Economic Prospects and Policy Challenges for the GCC Countries*, Gulf Cooperation Council Annual Meeting of Ministers of Finance and Central Bank Governors, Saudi Arabia, 5–6 October. Available at http://www.imf.org/external/pubs/ft/dp/2012/mcd1012.pdf.

15 For detailed arguments as to why this is the case for Saudi Arabia, see G. Lahn and P. Stevens, *Burning Oil to Keep Cool: The Hidden Energy Crisis in Saudi Arabia* (London: Chatham House, December 2011).

16 International Monetary Fund (2013), *Energy Subsidy Reform: Lessons and Implications*, IMF, 28 January. Available at http://www.imf.org/external/np/pp/eng/2013/012813.pdf.

3. The Status of Efforts to Manage Energy

This chapter looks at the status of GCC countries in seven key areas in which it will be essential to transform the energy system to achieve the efficient use of natural resources: policy coordination, target-setting, improving infrastructure efficiency, industrial efficiency, energy price reform, improving appliance efficiency, and bringing about behavioural change.

Policy coordination

The entities and individuals with the power to influence the energy system and consumption tend to be scattered and uncoordinated, with scant opportunity for communication. Often spurred by power crises, coordination in the electricity supply side is more advanced. All countries now have authorities responsible for both electricity and water – and several (Abu Dhabi, Saudi Arabia, Oman and Dubai) have introduced an independent regulator. In the last five years, there have been attempts at energy policy coordination taking the demand side into account. Table 1 shows four examples of such interagency cooperation in the GCC; the number of agencies involved shows the extent of the challenge.

Dubai was a first mover in this respect with the establishment of its Supreme Council of Energy (DSCE) in 2009. Its Chairman is the uncle of the ruler of Dubai, Sheikh Ahmed bin Saeed Al Maktoum, and its Vice Chairman is the CEO of the Dubai Electricity and Water Authority (DEWA). The DSCE launched the region's first 'integrated energy strategy' – a plan for energy diversification and efficiency to 2030. This covers electricity, water and transportation fuel, with specific targets set for electricity.

The Saudi Energy Efficiency Center, formally established in 2010, engages all the relevant ministries and industry partners and may be the most ambitious attempt to date at strategic coordination. It is not yet an independent entity and has no implementation authority, but its supervisory committee, led by the Deputy Minister of Petroleum, Prince Abdulaziz bin Salman, has ensured a high level of stakeholder engagement.

Abu Dhabi is attempting coordination through the Economics and Energy Committee of the Executive Affairs Authority (EAA), which has overseen an interagency working group of experts to devise strategy to address electricity demand-side management. This has benefited from clear channels of communication with the emirate's leadership through the EAA.

Targets

Figure 8 shows the picture of GCC country energy targets as of July 2013. Where there is an independent electricity regulator, this has been instrumental in promoting an energy conservation agenda. These regulators have tried to put in place incentives and specifications at the bidding and contractual stage to encourage efficiency investments. For example, Oman has specified loss reduction targets, while Saudi Arabia's Electricity & Co-generation Regulatory Authority (ECRA) requires all utilities bidding for power contracts to base their business plans on the Saudi Ministry of Petroleum's calculation of long-run marginal cost of oil – $25/b – not the actual cost of under $5/b.

Since 2009, countries have announced several official or aspirational clean energy targets which aim at replacing oil and gas in the generation mix. Some are highly ambitious. Saudi Arabia expects that by 2032 renewable energy with nuclear baseload will relegate fossil fuel generation to meeting peak demand during the summer months

Table 1: Coordinated institutional arrangements governing domestic energy policy in the GCC

Body	Role	Agencies involved
Abu Dhabi Demand Side management Working Group (2008) – now the Cooling Taskforce (2012)	To investigate and develop a comprehensive strategy to bring down electricity demand growth in Abu Dhabi	*Representation* Mubadala, Department of Municipal Affairs, Urban Planning Council (UPC), Masdar Institute, The Environment Agency, Abu Dhabi (EAD), RTI International, Abu Dhabi Distribution Company, Al Ain Distribution Company, Abu Dhabi Water and Electricity Authority (ADWEA), Regulation and Supervision Bureau (RSB), Abu Dhabi Quality and Conformity Council (QCC), Tabreed
Dubai Supreme Council of Energy (est. 2009)	To develop and implement sustainable energy policy for Dubai and provide for coordination between relevant agencies	*Members* Dubai Electricity and Water Authority (DEWA), Dubai Aluminium Company (DUBAL), Dubai Petroleum Affairs, Dubai Petroleum Establishment, Dubai Supply Authority (DUSUP), Dubai Municipality, Dubai Nuclear Energy Committee (DNEC), Emirates National Oil Company (ENOC)
Saudi Energy Efficiency Center (est. 2010) building on the former National Energy Efficiency Programme (2002)	To coordinate all the relevant stakeholders on efficiency and to develop a proposal for an energy conservation master plan for Saudi Arabia	*Supervisory Committee* Ministries of Petroleum and Minerals, Water and Electricity, Municipality and Rural Affairs, Commerce and Industry, Transportation, Culture and Information, Housing and Finance (Customs) Presidency of Meteorology and Environment, King Abdullah City for Atomic and Renewable Energy (K.A. CARE), Saudi Standards, Metrology and Quality Organization, Electricity & Co-generation Regulatory Authority, Royal Commission for Jubail and Yanbu, Designated National Authority for the Clean Development Mechanism, Saline Water Conversion Corporation, Committee, Saudi Aramco, Saudi Electricity Company, SABIC, and two private-sector representatives
National Climate Change Committee, Qatar (2007)	To establish a comprehensive national programme for climate change that includes policies to manage national greenhouse gas emissions; to develop and coordinate climate change policy advice to ministries and industries and ensure the integration and implementation of these policies within the national development plans	*Members* Ministry of Environment, Qatar University, Qatar Petroleum, the Office of HH Heir Apparent, the Civil Aviation General Authority, the Ministry of Municipal Affairs and Agriculture The Higher Organizing Committee for Qatar's hosting of COP 18/CMP 8 included ministers from the Administrative. Control and Transparency Authority and the Ministries of Foreign Affairs, Energy and Industry, Environment and the Qatar National Food Security Programme

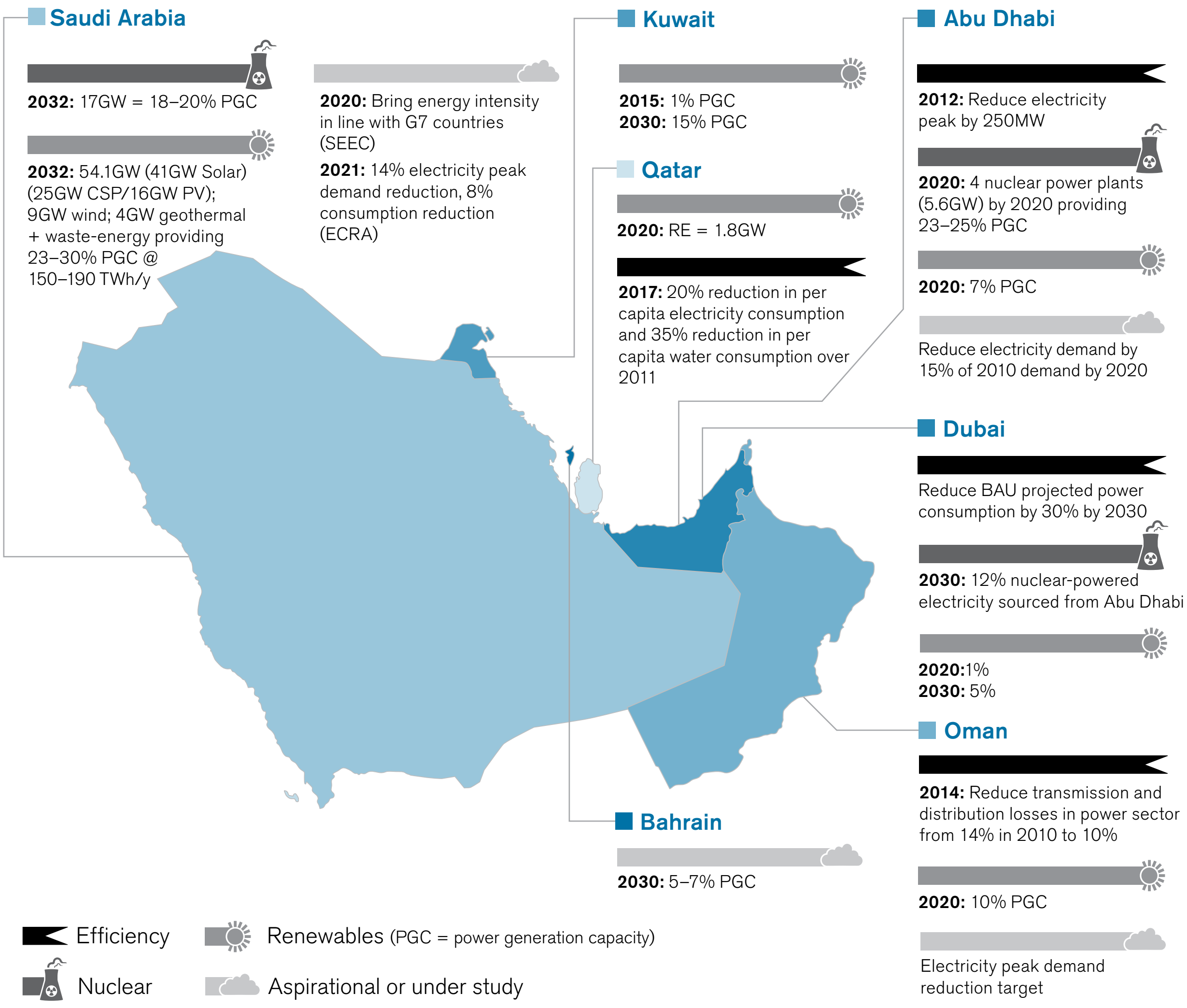
only.[17] Targets that address energy consumption are more recent and all concern the power sector. None yet have CO_2 emission reduction targets in spite of the neat fit for countries wishing to both conserve fossil fuels and harness renewable energy. However, the permanent location of the International Renewable Energy Agency (IRENA) headquarters in Abu Dhabi since 2011 and Qatar's hosting of the international climate negotiations (COP 18) in December 2012 helped raise awareness in the region of the linked issues of environmental sustainability, climate change and energy use. In the words of one local expert, COP 18 eroded 'the mystique of climate change' in a region where the carbon mitigation agenda had often been branded a plot to undermine states' economies.[18]

Only Dubai's Supreme Council of Energy (DSCE) has official targets for overall electricity diversification and conservation. However, 2012 was a watershed year for efficiency plans in the region. Abu Dhabi introduced

17 Dr Khalid Al-Suleiman, 'Solar Energy: A Pillar of the Sustainable Energy Kingdom', K.A.CARE, Fourth Saudi Solar Energy Forum, 8–9 May 2012, Riyadh.

18 For a detailed analysis of the response of Gulf monarchies to climate change, see M. Luomi (2012), *The Gulf Monarchies and Climate Change: Abu Dhabi and Qatar in an Era of Natural Unsustainability* (London: C. Hurst and Co.), particularly p. 47.

Figure 8: Energy targets in the GCC, mid-2013



Source: Chatham House workshops, stakeholder presentations, official announcements.

a Comprehensive Cooling Plan, devised and led by a multi-stakeholder taskforce. ECRA submitted detailed plans to achieve overall conservation and peak demand reduction targets to the Saudi government for approval. Qatar's KAHRAMAA launched its Tarsheed (meaning both 'guidance' and 'rationalization') campaign which aims to reduce per capita consumption of electricity and water. Oman's Authority for Electricity Regulation (AER) submitted plans to the government to reduce peak power demand and continues to pursue ongoing targets for reducing electricity losses in transmission and distribution. More detail on these plans is given in Table 2.

Improving infrastructure efficiency

Adapting the built environment to work with rather than against the Gulf's harsh climate, and tightening building codes to lock in efficiency, represent some of the largest proven savings in the GCC to date and an area of huge future promise. Pilots and practice show up to 60% reductions in energy demand as a result of changes to existing buildings, and 70% in new builds, against the existing average.

The most progressive buildings standards in the region are in Abu Dhabi, Dubai and Qatar, which are all taking the government 'lead by example' approach. Table 3 gives

Table 2: Examples of technical targets and measures to achieve them in GCC countries

Programme	Target	Measures include	Status
Reduction of losses in electricity transmission (AER, Oman)	Reducing total technical and non-technical transmission losses from 25% to 14% by 2010 (achieved) Reduce losses to 10% by 2014	*Supply side* Competitive tenders for utilities companies in PPPs promoting introduction of efficient technology Specifying 'losses targets' for utilities companies, linked to their share of dividends Better maintenance of the grid Prevention of electricity theft	First target introduced in 2004. Second target in progress
Electricity load management and demand side management (ECRA, Saudi Arabia)	Reduce peak by 14% by 2021 Reduce energy consumption (over projected increase) by 8% by 2021 Benefit to cost ratio of measures = 3.6 at 'shadow price' of $25/b oil. Saving in oil consumption: 175 million barrels (average of 17.5 million barrels per year)	*Existing buildings* Replacement of old air-conditioning units; building and roof insulation; lighting replacement (CFLs) *New buildings* Efficiency measures (high-efficiency A/C units and insulation). Public sector: Improved motor efficiency; street-lighting replacement *Load management and demand reduction programmes* Time-of-use tariff Direct load control Interruptible tariffs Curtailable load management	Piloting completed on LM/DR measures. Proposal for full package of measures submitted to Council of Ministers for approval Ministry of Transport and Ministry of Water and Electricity working on street-lighting replacement plan
Comprehensive Cooling Plan (Cooling Taskforce, Executive Affairs Committee, Abu Dhabi)	Reduce electricity demand by 15% of 2010 demand by 2020 (4,500 GWh/yr out of a total demand (excluding ADNOC) A saving of AED 2bn at current cost of production levels Savings achieved by introducing new building standards and appliances would be in addition to this	*Existing buildings* Chiller maintenance Monitoring control and analysis of consumption Thermostat settings Isolation and decommissioning of chillers Balancing and recommissioning of A/C systems	Approved and at stage of refinement with further surveys planned to map user behaviour, building's current energy use and pilots to test savings
Tarsheed campaign (KAHRAMAA, Qatar General Electricity & Water Authority), Qatar[a]	Reduce per capita electricity consumption by 20% and per capita water consumption by 35% over 2011 levels by 2017 Aims to rationalize consumption of water and electricity and promote the culture of conservation throughout society	*Existing buildings* Air conditioner energy efficiency labelling Power factor correction Phase-out of inefficient lamps Retrofitting to best-practice insulation and window-frame standards *Industry* Demand Side Management (DSM) – industrial sector Demand Side Management (DSM) – water conservation for major consumers *New buildings* KAHRAMAA building standards Regulations for Electricity & Water Conservation *Awareness & Support* Includes public campaign, competitions, events in mosques, schools, and provision of schools curricula *Law enforcement & Regulation* Developing amendments and regulation to enhance and enforce existing Electricity & Water Rationalization Law of 2008[b]	Awareness campaigns ongoing Drafted detailed plan for projects and strategies to meet targets

a For more detail on expected savings by measure, see *Tarsheed: Strategies & Projects*, KAHRAMAA Publications, 2013. Available at http://www.km.com.qa/Publications/webenglish.pdf.

b Regulations relating to these measures are planned to come into force over the next few years. Potential energy savings in existing single-storey villa using recommended measures estimated at around 60% reduction for energy, peak load and cooling load. For more information see 'Codes and Best Practices in Electricity & Water Conservation', KAHRAMAA, 2012.

some details. Abu Dhabi's Estidama Pearl Rating System, which began to be applied in 2010, was the first of its kind in the region to draw on international best practice but with adaptations to local climatic conditions and social needs – water conservation is given much higher priority, for example. Qatar has pioneered the Global Sustainability Assessment System (GSAS) in which energy and water efficiency are also benchmarked and attached to a six-star rating system. This is central to Qatar's 'national spatial strategy' which aims to achieve a 'low carbon, climate resilient development path'.[19]

Buildings efficiency is the one area where GCC countries have agreed to introduce a common GCC standard. This plans to take into account the existing standards through close cooperation between the standards authorities of each country and is likely to draw heavily on GSAS and the Pearl Rating System.

There are several plans, as noted in Table 2, that would affect existing buildings, and Appendix 2 notes more. At present, however, national or emirate-wide standards apply only to new buildings and are often voluntary or – according to local anecdote – poorly enforced.

The electricity grid is another essential aspect of infrastructure, where demand can be lowered through reducing transmission losses, enabling demand-side management and the penetration of renewables. The Abu Dhabi Water and Electricity Authority network now has almost full smart meter coverage, which enables better understanding of and response to customer energy demand. Dubai is piloting a similar scheme.

Industrial efficiency

Policy for industrial efficiency is largely absent, although proposed time-of-use and interruptible tariffs in Saudi Arabia and Oman focus on industry. The majority of industry in the Gulf is energy-intensive, so over time the most significant change in industrial energy use would come from economic restructuring. However, even in current conditions, there is room for greater efficiency. Savings of up to 30% in energy use and 80% in water use were noted during an industrial support programme introduced by the Gulf Organization Industrial Committee (GOIC) that was aimed at conserving power in 39 factories in the GCC.[20] Industry-specific data for benchmarking are lacking although the GOIC study may provide a starting point for targets.

Table 3: Progressive buildings sustainability standards

Programme/Standard	Regulation coverage	Estimations of effects on energy efficiency
Abu Dhabi's Pearl Rating System, part of programme Estidama	All government buildings must comply with '2 Pearl' standard. Since 2010, all new buildings must comply.	70% reduction in energy demand for new builds compared with existing average for building type; 30–50% savings in existing buildings.
Dubai Green Building Regulations and Specifications	Voluntary, planned to become law in 2014.	Estimated reduction of 15% water demand and 20% energy demand for new builds compared with existing average for building type.
Qatar's Global Sustainability Assessment System (GSAS)	GSAS incorporated into the Qatar Construction Standards in 2012. 3 stars to be achieved by all new civic buildings from 2012, new commercial buildings from 2016 and new residential buildings from 2020.	Implementing GSAS energy benchmarks to the minimum standard will achieve at least 30% savings compared with existing average for building type.

19 Qatar's Pathway to a Low Carbon Economy, 2012.

20 Major savings were found in metals and packaging manufacture. Gulf Organization for Industrial Consulting (2013), *An Energy Guide Book for Industries in the GCC*, February, as reported by Qatar News Agency, 21 February 2013. Available at http://www.qnaol.net/QNAEn/Local_News/Economics1/Pages/sf.aspx. Some results are summarized in an earlier GOIC website release: http://www.goic.org.qa/GOIC2011web/Arabic/images/New%20Folder/book3.pdf.

Energy price reform

Table 4 shows the extent to which electricity tariffs have been addressed, including those efforts to reflect real costs. The majority of these actions have been announced since 2010, and in those countries in which an independent regulator has driven reforms.

Oman was the first state to develop a cost-reflective pricing formula for its gas inputs to the power sector and the AER has submitted a proposal to government for the phased introduction of 'cost reflective tariffs' for industry, commercial and government consumers. The Saudi Arabian authorities are trying to publicize more effectively the real costs involved in its electricity and desalinated water production.[21] Dubai raised its electricity and water tariff rates in 2008 and 2011, in the latter adding a surcharge for imported liquefied natural gas (LNG).[22] This was the first emirate or state in the region to do so although the move was facilitated by its specific conditions as a city state with a majority expatriate population and import dependence.

Raising the efficiency of appliances

Appendix 2 gives an overview of evolving buildings and appliance standards which affect energy use. These are focused on new buildings insulation and raising the efficiency of imported air-conditioning. In Saudi Arabia, for example, the Saudi Energy Efficiency Center, working with the standards authority, introduced a mandatory labelling code for a range of appliances including a minimum efficiency standard for air-conditioning units in 2007. It now plans to raise the minimum efficiency performance standard (MEPS) for air-conditioning units allowed onto the market by about 25% to the current global average in 2013, and to increase this minimum steadily to international best-practice standards by 2015. In the UAE, the national standards authority raised the standard in 2013, and estimates this will take the least efficient 20% of models off the market. There is a clear economic case for such measures, as described in Box 2.

Table 4: Regional tariff reform and plans

	Saudi Arabia	Abu Dhabi	Dubai	UAE	Oman	Kuwait	Qatar	Bahrain
Link to market prices	No	No	Fuel surcharge reflecting imported LNG	N/A (each emirate sets tariff)	No	No	No	No
Cost of electricity made public	'Shadow price' for fuel to utilities established; subsidy public	Yes, electricity bills show subsidy	Yes	N/A	Not known	No	No	No
Time-of-use (TOU) or interruptible tariff (to reduce peak demand)	Voluntary TOU tariff for industry	Voluntary TOU tariff for large industry	No	N/A	No	No	No	No
Tariff reform plans	Considering interruptible tariffs; residential tariffs under study	Considering TOU residential tariffs	Last reformed in 2011 – effective 30–35% rise	N/A	Considering 'cost-reflective' TOU tariff for industrial/ commercial and government consumers	Not known	Aspiration to revise charges for water, power and fuel	Not known

21 See, for example, the ECRA Annual Report 2011, 'Activities and Achievements of the Authority in 2011', pp. 65–90. Available at http://ecra.gov.sa/documents/Annual%20Reports/engecra%20for%20internet.pdf.

22 For comment on the context and impacts of this, see Robin Mills, 'Economics drives Dubai's low-energy push', *Financial Times,* 12 September 2012.

Box 2: What kind of savings could enforcement of new standards achieve?

The average efficiency of air-conditioners in Saudi Arabia is estimated to be 18% below the current global average, so around one-fifth of total energy supply devoted to air conditioning could theoretically be cut through a mandatory replacement programme to bring units up to the global average.[a] Over time, the saving justifies significant investment in standards and well-thought-out replacement programmes. To give an idea of the potential savings that new technology and demand-side measures could have, we ran a simulation that compared the average efficiency of air-conditioners in Saudi Arabia at the current 2* (Energy Efficiency Rating 7.5–8.5 @ 35°C) rating with the 2015 planned minimum (EER 11.5). All things being equal, this would represent an overall 43% efficiency increase. We scaled up this saving under the assumptions outlined in Appendix 3 to see how much energy would be saved if all national stock were raised to this standard by 2025. Given the projected increases in population and therefore housing needs and associated power generation losses, this measure alone would save 130 million barrels of oil equivalent a year in 2025 against a 'current technology' trajectory. This is equivalent to a saving of $10 billion (SR37.5 bn) a year at $80/barrel, or some 5% of the projected Saudi government budget for 2013.[b]

a The average efficiency of current stock could be overestimated. A 2012 study by AMAD Consultation and Laboratories referenced in a presentation by the Korean company LG suggests the energy efficiency rating/MEPS is below the 1* at EER 7. 'HVAC and Energy Solution for KSA', presented at HVAC Conference and Exhibition, Riyadh, http://www.saudihvacconfex.com/uploadedFiles/day3/LGESR_Story_Line_v1.0.pdf.

b Ibid.

Transportation overhaul

There are no targets on vehicle efficiency or transport-sector fuel demand. The data needed to make decent projections are lacking and it is unclear which authority would be in a position to undertake such a strategy. However, plans for public transport, often overseen by municipal authorities, have developed rapidly in the last couple of years. Every GCC country now plans to introduce new metro systems following Dubai's example, and several have commissioned studies to look at how public transport can reduce emissions.

In 2003, the Gulf Standards Authority (GSO) established mandatory vehicle exhaust emissions standards[23] for new imported vehicles into GCC member states, although standards are only voluntary for imported second-hand vehicles. It is unclear how strictly these are enforced at the national level and they are only at the level of European standards in 1994 or 1996 – Europe has since introduced three sets of increasingly progressive standards halving carbon emissions and targeting lower nitrogen emissions.

The UAE and Qatar have introduced legislation beyond the GSO regulations to curb transport emissions, chiefly sulphur. The Abu Dhabi Air Quality Committee was established in 2007 to pursue the strategy of encouraging a switch to compressed natural gas (CNG) and cleaner diesel, with the objective of ensuring an average of 70% compliance with air quality standards by 2013.[24] Qatar appears to be the only state that has made an explicit commitment to a low carbon transport architecture (outlined in 2008 in its national development vision 2030) which includes the objectives of encouraging road-users to switch to rail travel, and switching public buses and taxis to CNG use in order to lower emissions and improve air quality.

23 Euro-II requirements for gasoline engine passenger cars, Euro I requirements for gasoline commercial LDVs and diesel passenger cars.

24 'Policies and Regulations of Abu Dhabi Emirate, United Arab Emirates'. Available at http://www.agedi.ae/pages/pdf/6%20pollution%20and%20regulations.pdf. Air quality standards as listed in the Council of Ministers Decree No. 12/2006.

Encouraging behaviour changes

There have been some dramatic findings regarding the achievable 'quick wins' from behaviour changes in buildings. For example, in one case of a large government office building whose management was working with the Estidama programme in Abu Dhabi, it was reported that the efforts of just one employee to change staff behaviour resulted in a saving of 30% of the building's electricity demand. In Dubai, the DSCE has set out regulations for government buildings including keeping the temperature at 24°C during working hours and 27°C at other times, and switching the lights off at the end of the day.

Several concerted efforts at awareness-raising began in 2012/13. These are happening on different levels, through top-down measures, via traditional channels of ministerial speeches, and through a variety of media and official and grassroots social media. For example, the Saudi @Save_Wealth Twitter account encourages a rich range of debate on energy conservation measures in the region and has a rapidly growing following. Qatar's 'Tarsheed' campaign uses public advertising campaigns and tweets energy-saving advice, including reminding people to limit use during peak time. In Saudi Arabia, the government has experimented with sending text messages to remind people to turn off the air conditioning when they go out. The Dubai Water and Electricity Authority will list carbon emissions for each customer on monthly bills, as well as detailing ways in which customers can reduce electricity consumption.

4. What is Holding Back Progress?

Lack of coordinated energy policy

The largest single barrier to effective domestic energy management in the GCC is lack of institutional coordination. This is of course a challenge for policy-making in the region more generally. Managing energy involves multiple authorities and agencies and needs to be strongly correlated with economic development plans and climate goals. Yet control of the sector is highly fragmented in each country, as illustrated by the problem with data cited below. For example, poor coordination of supply- and demand-side management may lead to excessive and expensive new power generation capacity being built without considering the demand-side alternatives. Likewise, far greater penetration of renewable energy will be possible with advances in efficiency and demand-side management technology, so it makes sense to consider the integration of strategies when planning renewable energy targets. This would involve not only the electricity and water authorities and companies but also major financial decisions about grid infrastructure, standards authorities, urban planning ministries, those in charge of the way housing subsidies are allocated and planning for long-term industrial development.

Integrated strategic planning on a range of resource issues is urgently needed. If the relevant authorities are not talking to one another, a government cannot formulate a realistic strategy. Furthermore, if those with the knowledge and capacity to develop energy and water strategies lack the authority to implement their plans, no strategy will achieve its potential at scale.

Poor reporting and centralization of data

The data upon which initial assessments, projections and the choice of the most practical interventions need to be based are highly imperfect and not yet (to our knowledge) collected and analysed by a single national policy-making body in any of the GCC states. This hampers efforts to make the case for new policy as well as the design of strategies and targets. Energy planning requires input from social and economic statistics as well as decent projections – such as for population, housing and sectoral growth of individual industries. In general, the energy statistics in GCC countries are haphazard, inconsistent and often either not collected or not available for public use. Different institutions hold them and there is no overarching ministry or agency responsible for collecting, standardizing and disseminating various energy-related statistics. Moreover there can be a tendency to secrecy and a lack of transparency when it comes to economic and commercial statistics generally.

Overcoming this barrier is a major challenge. Without reliable data to show baseline consumption and realistic scenarios, it is difficult to make a politically viable case for the institutional changes and investments that will enable progress. This is true at both macro and micro levels of analysis. Getting energy data and fostering the skills to be able to read, interrogate and analyse them is of paramount importance. This can be achieved if there is strong political support – as is evident when governments commit to a new project (such as a nuclear or renewables programme) and prioritize the necessary studies. Suddenly doors to data and resources to carry out the necessary research to improve information will be opened for the mandated agency.

Gaining political support will initially require a strong economic case. Authorities that can provide at least a rudimentary picture of wasted resources in the current system from the data available can champion this case. Table 5 gives an idea of the kind of initial data needed for this exercise, based on the Energy Saving Toolkit explained in Appendix 3.

Chatham House and the Saudi Energy Efficiency Center devised the toolkit to show potential energy

Table 5: Regional tariff reform plans

Total savings potential
- Non-oil GDP 2010 ($m)
- Annual non-oil GDP growth
- 2025 non-oil GDP ($m)
- 2009 population (m)
- Population growth to 2025 (%)
- 2025 population (m)

Refinery
- Sector growth 2010–25

Electricity sector
- Electricity growth factor for non-air-con applications
- Implied efficiency of oil generation plant
- Implied efficiency of gas generation plant
- %-point efficiency improvement of oil plant by 2025
- %-point efficiency improvement of gas plant by 2025
- % of generation from oil in 2025
- % of generation from gas in 2025
- % of generation from nuclear in 2025
- % of generation from renewables in 2025

Desalination
- Capacity growth 2010–25
- Water conservation (demand side) impact 2025
- Water conservation (distribution) impact 2025
- Retrofitting efficiency improvement potential 2025
- New technology efficiency improvement potential 2025

Buildings
- Average occupancy existing housing stock (person/home)
- Average floor space existing stock (m^2)
- Base case building energy use (kWh/m^2/year)
- Retrofit improved energy usage (kWh/m^2/year)
- % of existing stock retrofitted
- New homes built by 2025
- Average floor space new stock (m^2)
- Potential for non-electricity fuel savings
- New homes efficient building energy use (kWh/m^2/year)
- Growth in non-electricity fuel demand for buildings 2010–25

Air conditioning
- % of residential/commercial electricity used in air-con in 2009
- % of residential/commercial electricity used in air-con
- Growth in number of units 2010–25
- Energy savings potential per unit relative to current technology
- Potential savings from improved maintenance
- % of market reached by maintenance programme
- Energy use per unit 2010 (kWh/unit)
- Energy use per unit 2025 (kWh/unit)

Industry
- Fuel demand growth rate
- Electricity demand growth rate
- Average sector fuel savings potential
- Average sector electricity savings potential

Transport
- Increase in oil consumption per capita for transport 2010–25
- Oil consumption per person 2010 (boe/year)
- Oil consumption per person 2025 (boe/year)
- Potential savings for new cars (based on turnover of whole car parc)
- Typical replacement time for new cars (years)
- Behavioural change – reduction in energy consumption

Non-energy
- Sector growth 2010–25
- Total savings potential 2025

Other
- Sector growth 2010–25
- Total savings potential 2025

savings from various technology choices. Using available data and proxies, this compared a 'current technology' trajectory with the energy savings from new clean energy supplies and efficiency measures based on international technology, regional best practice and standards. A simplified methodology with assumptions can be found in Appendix 3. The basic simulation resulted in projected savings of about 1.7mboe/day by 2025, with new supply sources, measures to improve power plant and buildings efficiency contributing the bulk of this. Varying assumptions within the bounds of reason would give between 1.5–2.2mboe/day. The upshot under this scenario is that oil and gas demand grows at an average of just 2.8% per year between 2010 and 2025, significantly slower than our assumption of around 4% or Saudi Aramco's of almost 5%.[25] It also demonstrates the impact of efficiency

25 Based on the projection that total fuel consumption would rise from 3.4mboe/d in 2009 to 8.3 mboe/d in 2028 on current trends. 'Saudi Aramco and its Role in Saudi Arabia's Present and Future', speech given by Khalid A. Al-Falih, Saudi Aramco President and Chief Executive Officer, MIT Club of Saudi Arabia Dinner, Riyadh, Saudi Arabia, 19 April 2010. Available at http://www.mitsaudi.org/site/mr-alfalih%E2%80%99s-remarks-11th-annual-dinner-meeting/.

measures on the penetration of renewables, whose contribution to the energy mix could be swamped by escalating consumption.

With improved data, the results of such analyses will help governments explain to the various interest groups and public why there must be change.

Lack of 'performance measurement culture'

GCC countries' energy-sector professionals often refer to the lack of assessment and evaluation processes in government, which would inhibit target-setting. If there is an attempt to measure, there is often lack of expertise on how to do it. For example, in more detailed demand-side management/energy efficiency operations, the calculations are not straightforward. They rely on knowing what energy use would have been without the interventions. A measure of success would involve this calculation being compared with what is possible or what the original savings goal was as well as taking into account how the intervention affected other factors (such as cost, output or comfort levels).

Lack of awareness

Lack of awareness among consumers and some decision-makers that there is a problem is a major barrier to improving energy efficiency. Because energy is a factor in economic productivity and a key input into people's standard of living, rising energy consumption in the region is often associated with higher output and a better quality of life, and therefore seen as a sign of success.

There is some logic in this view. The decision to capitalize on the national 'competitive advantage' of low-cost domestically produced fossil fuels to develop income and job-generating activities is understandable. This has led to development strategies based upon the promotion of heavy industries – chiefly refining, petrochemicals, fertilizers, plastics, steel and cement. This choice will inevitably lead to higher energy consumption than one based on, say, services. Equally, the climate of the Arabian peninsula is harsh in terms of both heat and water scarcity. Economic success has encouraged rapid migrant population growth, while natural population growth has remained strong since the 1970s. Both of these factors put ever-higher pressure on energy sources to enable liveable conditions.

Even discounting these factors, a look at the design of buildings and modes of transportation in the Gulf shows that much energy in the GCC is consumed inefficiently. A culture of profligacy has developed whereby consumers are simply unaware that they are wasting energy and that this results in economic losses, if not to them then to the country. This is compounded by the lack of value conferred on energy resources by the market. But the 'illusion of abundance', as Luomi calls it,[26] has begun to crack in the last decade, with governments registering the soaring rates of power and water demand as a future threat to security.

Low energy prices

The prevalence of low energy prices relative to income gives consumers no incentive for moderation. For urban planners and commercial and industrial leaders, it also means there is little or no incentive to choose to invest in efficiency. At the time of writing, plans for municipal development and mega projects are getting the go-ahead without consideration of energy use or water footprint. It can be economically rational for the consumer to use excessive energy rather than investing in adapting the infrastructure itself. For instance, most villas are not built or fitted out to withstand high temperatures or humidity, hence it becomes cheaper to leave the air conditioning on while away for long periods over the summer than to replace the wallpaper afterwards.

Increasing energy prices would seem to be an obvious solution. But the political risks of this course of action are a strong disincentive to governments. International experience shows that energy prices that have been held low for many years cannot suddenly be allowed to

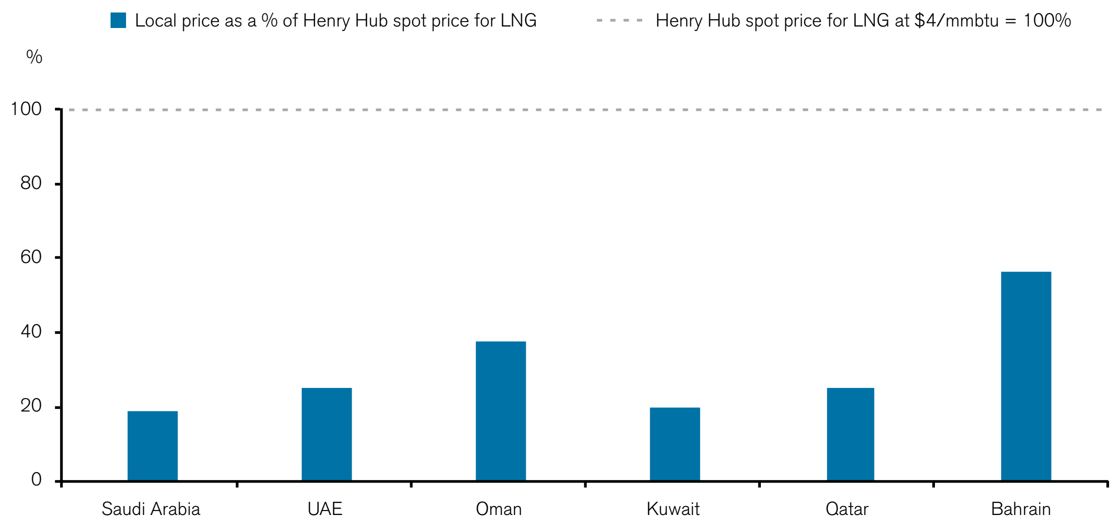
26 Luomi (2012), Chapters 1 and 2, particularly pp, 77–78.

rise without major repercussions for the poor, for businesses and often for social stability. Subsidies, explicit or implicit, are often a social safety net, however inefficient.[27] In the GCC countries, while citizens are not considered poor by international standards, there are some less developed regions and large income inequalities, particularly between citizens and low-skilled expatriate workers. A more serious political challenge is that low energy prices are seen as part of the current social contract between ruling elites and citizens. The popular perception is that as the countries are major producers of energy resources, low domestic energy prices are regarded almost as a birthright and a mechanism to spread the benefits of these resources to the mass of the population. For the governments, cheap power and feedstock have long been considered a way to encourage diversification away from hydrocarbons.

As global experience shows, low prices applied indiscriminately in a society do far more for the wealthy than for the poor.[28] For example, there is a wealth of evidence that when lifeline rates for electricity bills are set, the thresholds at which higher rates are charged are far too high, thereby benefiting the richer members of society. In Saudi Arabia, for example, only 1% of customers pay the highest rate of 26 halalah (7¢) per kWh, which is still well below the average cost in the United States (about 12¢/kWh). Similarly, those profiting from energy-intensive industry and long-distance transportation have strong vested interests in keeping domestic energy prices low. Leaders may perceive that these groups will act to derail any move to raise them.

Figure 9 shows local gas prices as a percentage of what gas would fetch on the US market. It is worth noting that the price to import from Sakhalin LNG (as Kuwait does) is much higher ($13–16/mmbtu) than the costs of importing gas through the Dolphin pipeline (around $1.50/mmbtu). Figure 10 gives local prices as a percentage of the average spot price of fuels to the Middle East. This gives an indication – albeit an imperfect one – of the opportunity cost of current pricing policies in the GCC.

Figure 9: Local natural gas prices as a percentage of US import price

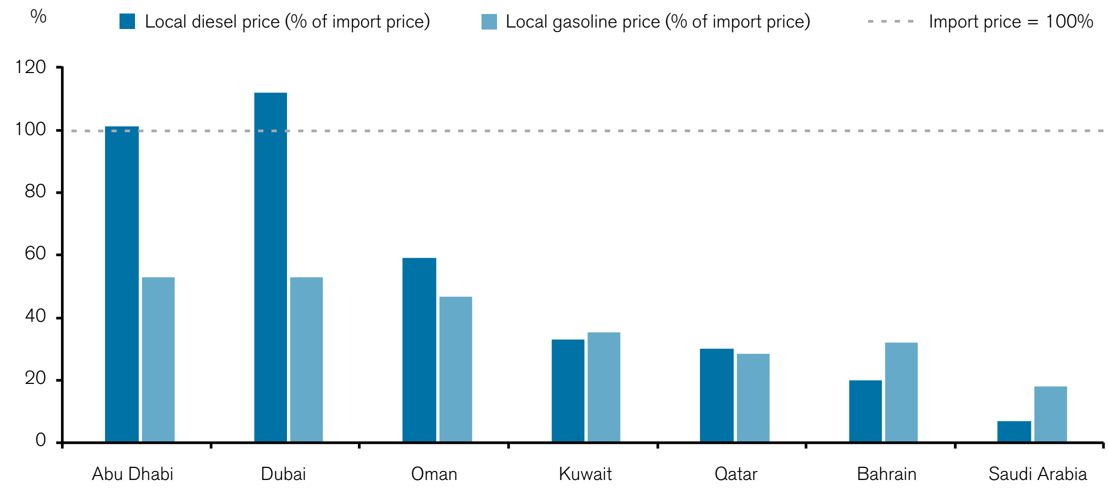


Source: H. Darbonche, 'Issues in the pricing of domestic and internationally-traded gas in MENA and Sub-Saharan Africa, *Oxford Institute of Energy Studies*, June 2012; various local sources.

27 B. Fattouh and L. El-Katiri, 'Energy Subsidies in the Arab World', *Arab Human Development Report*, United Nations Development Programme Research Paper Series, 2012. Available at: http://www.arab-hdr.org/publications/other/ahdrps/Energy%20Subsidies-Bassam%20Fattouh-Final.pdf. See also R. Yemtsov, 'Developing Effective Reform Strategies: Safety Nets to Protect the Poor and Vulnerable from Impacts of Subsidy Reform', World Bank presentation given at joint conference on 'Increasing the Momentum of Fossil Fuel Subsidy Reform', World Trade Organization, Geneva, 14–15 October 2010. Available at http://www.iisd.org/gsi/sites/default/files/ffs_gsiunepconf_sess4_ryemtsov.pdf.

28 *Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative*, IEA, OPEC, OECD, World Bank Joint Report, 16 June 2010; Fattouh and El-Katiri (2012).

Figure 10: GCC oil fuel prices as a percentage of spot market prices



Source: *OPEC Bulletin*, Vol. XLIII, August–September 2012. Local prices from World Bank and local press sources.

Infrastructure lock-in

The analysis in Box 3 of how energy should be viewed in terms of services rather than supplies sets the context for some of the misuse of energy in the GCC.

Infrastructure in the GCC, including power and water utilities and distribution, industrial choices, housing stock, town and city layouts and transportation routes, largely works against rather than with the climatic conditions or was originally built without taking into account energy efficiency considerations. For example, electricity generation from gas-fired power stations (all but one are open-cycle) in Saudi Arabia has only 28% to 30% efficiency,[29] compared with the global average of 35–42%, or 52–60% for closed-cycle gas turbines (CCGT). The skylines of Dubai and Doha teem with glass-covered skyscrapers which absorb rather than reflect sunlight. Roads and car use are expanding as there are few mass transport options.

Similarly, the stock of energy-using appliances in GCC homes and buildings is often old and poorly maintained – particularly in the all-important area of air conditioning. A classic example is the pilot study carried out in Abu Dhabi

Box 3: Points of intervention in energy demand

Energy is a ‘derived demand’. In other words, it is only meaningful in terms of the services it enables. Thus the focus should initially be on the services themselves – light, heat and motion – rather than on barrels of gasoline or cubic metres of gas. To provide these services requires first infrastructure (such as buildings or urban planning) and secondly appliances (such as vehicles and cooling, heating and lighting units) needed for the conversion of usable energy (such as fuel or electricity) into useful energy. Multiple consumer decisions are involved: in terms of infrastructure, decisions may be taken at national, regional and local government level, within the private sector and at the individual household level. Once these are in place, the consumer must decide on the efficiency level of appliance to buy, and only then how often and at what capacity to use the equipment.

29 Efficiency is 28% based on a division of Saudi Arabia's electricity input by output for 2010 given in the IEA Non-OPEC Energy Balances 2012. This may be misleading if it is also counting cogeneration whereby generation efficiency is be reduced owing to the use of heat for desalination. If our estimate of 10% of gas inputs is allocated to water production, it produces 30% efficiency.

in which the air-conditioning units of 29 large buildings were given routine maintenance. The result was an average 27% reduction in electricity consumption for cooling. The units had either never been cleaned or had suffered coil damaged as a result of abrasive cleaning.[30] The potential for savings implied in this study are immense, given that cooling accounts for 50–70% of electricity consumption in the region and almost all of the midday and summer peaks.

Poor enforcement of regulations

Another major problem is enforcement. Where regulations such as appliance and building standards do exist, lax enforcement often renders them ineffective. For example, the Saudi building code mandates thermal insulation against heat (since 2010) for all new buildings. This has proved to reduce energy demand for villas by 30–40%. However, new buildings continue to be erected without proper insulation. Some new approaches are emerging. The Estidama initiative in Abu Dhabi works closely with villa owners and office building managers when new buildings are being planned and constructed but also requires regular checks on buildings for operational compliance in order to maintain the Pearl rating. In Saudi Arabia, collaboration between ministries, municipal governments and electricity authorities strengthens the potential for enforcement. From mid-2013, all proposed buildings in Riyadh must be checked from the planning stage to the end of construction to verify installation of the correct thermal insulation before the building can be connected to the grid electricity supply. The plan is to extend this piece of regulation to the rest of the country by 2014.

Regional price and standard variation

Several of the strategies mentioned in Chapter 3 may be undermined by regional disparities. Policy-makers now recognize inefficient cooling as a major contributor to the rising demand and peak demand. However, tightening national import standards for air-conditioning equipment, for instance, could be rendered less effective in improving stock efficiency by the ease of obtaining cheaper, less efficient units from a neighbouring state.

Similarly, if fuel prices are raised to try to restrain consumption there is a temptation for consumers to smuggle from lower-price jurisdictions or, if crossing borders involves low costs, they will simply legitimately fill up in the lower-cost jurisdiction. This has been a serious concern for Saudi Arabia with respect to trucks crossing the border to the UAE, where diesel costs up to five times as much.

30 Abu Dhabi Inter-Agency Demand-Side Management Working Group under the Executive Affairs Authority, 2011.

5. The Potential for Regional Solutions

So far, the GCC Secretariat itself has had little involvement in attempts to improve energy efficiency among its member countries. However, there is strong evidence that a coordinated and unified effort by the GCC might produce considerable benefits. The arguments can be grouped under four measures: those involving **cross-border trade**, those **creating economies of scale** and those enabling **joint research and development** and **information-sharing and capacity-building** between the GCC members.

Measures involving cross-border trade

Common appliance and vehicle efficiency standards

The scope for cross-border trade is one of the key ideas behind the establishment of the GCC. Common standards for product safety are already in place; extending these to efficiency would have obvious advantages. The GCC has become a dumping ground for low-efficiency appliances – particularly for cooling – but has the import infrastructure in place for effective control. The GCC Standardization Organization could broaden its remit to setting common standards for appliances as well as overseeing the development of supportive materials for their procurement, installation and maintenance. Standards organizations already addressing these issues (as mentioned in Appendix 2) have transferable knowledge.

Setting a Corporate Average Fuel Efficiency (CAFÉ) standard for the region – later moving to the current European or Japanese standard – would require negotiation but not the amalgamation of existing standards, as none of the countries have such a standard in place at present.

Efforts to ensure building materials meet new energy efficiency standards could benefit from common standards and agreed regulatory approvals. The currently voluntary Estidama Villa Products Database could be extended.[31]

In general there are a number of advantages associated with developing a single market by lowering barriers to trade and agreeing common standards. Freer movement of factors of production increases their allocative efficiency, increasing productivity. It encourages greater competition by making it more difficult for monopolies to operate and therefore reduces prices for consumers. It also enhances enterprise and innovation.

A GCC fuel price

Working towards common fuel prices would be the obvious answer to border leakage. This would involve raising prices domestically for some, with all the necessary social safety nets that entails, and would therefore be a longer-term endeavour.

Measures creating economies of scale

In the energy sector, because of the presence of technical economies of scale, 'large is beautiful'. This can apply to both the energy-providing infrastructure – i.e. the grid – and the energy-using infrastructure – buildings and appliances. Extending the reach of the grid and the stock of efficient end-user appliances at GCC level will support national efforts to reduce energy intensity.

Common buildings standards

Improving the efficiency of the buildings stock can be a highly specific endeavour given the need to take into account the relevant operating conditions, in terms both of

31 See http://estidama.org/estidama-villa-products-database.aspx.

climate and of socio-cultural factors. In the GCC situation, similar climates and socio-cultural conditions mean there are huge opportunities for lowering costs and avoiding duplication through adopting common building standards. As noted, the GCC countries are already making progress on establishing a common buildings standard. If incorporated into national legislation in each country, this would create a substantial market for energy-efficient building materials, bringing down the cost of imports and potentially encouraging some local manufacture over time. Bulk buying would become possible. It could also open the door to tighter collaboration on training and effective regulation practices, as well as presenting opportunities for economies of scale in research and development (R&D), an issue developed below.

Extending and smartening the GCC grid

Development of power grids is an increasingly significant dimension of economies of scale in Europe. A major problem for the energy sector is the huge disparity between base-load and peak-load demand for power. This occurs on a daily and also a monthly basis. Planned GCC grid connections and *flexibility* to send electricity either way could address this problem, particularly as more renewable energy is brought into the mix. This is not a complete solution because peak load and base load tend to be similar across the region, but time differences between countries mean it could make a contribution on a daily basis. If developed, the plans for extension into Egypt could have a significant effect.

Equally there may be economies of scale in terms of storage and capacity possibilities. Some possible – if not yet politically acceptable – solutions exist within the GCC. For example, Qatar has around 30% surplus electricity capacity. It would not make commercial sense for it to sell electricity to Saudi Arabia during peak demand periods and therefore forgo the opportunity to sell the gas used to generate it on the international market. But Qatar may find advantage in renting out its unused spinning capacity during these times, thereby gaining additional revenue, while Saudi Arabia could avoid the expense of building and maintaining some planned peak-capacity plants.

Finding a formula for a common electricity trade price is a necessary step towards expansion of a flexible grid that would allow these kinds of transactions. The development of a smart grid that can connect beyond the region and eventually into Europe should be a long-term cooperative ambition.

Training

Although excellent experience in power- and desalination-sector regulation, sustainable building, urban planning, efficiency labelling and standards enforcement, and energy and carbon measurement is developing in different parts of the GCC, there is a lack of capacity in these areas overall. This presents an opportunity for joint or regional training and accreditation schemes.

Maintenance of air-conditioning units is one example. As the Abu Dhabi pilot proved, this can result in significant energy savings but building up the capacity for maintenance is a big job. It involves training maintenance engineers and ensuring they operate according to standards and regimes that are quality-assured. This involves initially bringing in enough trainers from overseas. Regional cooperation to build maintenance standards, establish training standards and create regional training programmes and an accreditation scheme would bring down costs for each country and increase effectiveness.

Common awareness campaigns and school curricula materials

Public awareness campaigns to encourage better use of energy could also benefit from economies of scale. Experience from the Estidama programme demonstrates the potential in behavioural change, as noted earlier. The Dubai police force managed to save around 3% of its electricity bills in 2012 through an awareness campaign and enforcement of energy-saving rules with its staff. Some innovative tools are specifically geared to the younger generation. For example, the Powerwise arm of Abu Dhabi's Regulation Supervisory Bureau is touring shopping malls with a video game whereby contestants win points by making energy-saving changes in a virtual villa. In Qatar, the mosques are participating in programmes to urge environmental responsibility, including care over energy and water consumption.

Given the commonality of language and culture within the GCC, taking some of the most successful elements of national education campaigns to the regional level makes sense. The development of a common set of television advertisements would be one option, especially if reinforced by curricula materials for schools.

Measures involving joint R&D

It makes sense to pool resources on innovation and technology deployment in the GCC. As indicated above, architecture and urban planning are critical areas for energy savings across the region. Pooling expertise and R&D funding to develop affordable buildings and retrofitting solutions suitable for a desert climate could bring several mutual benefits. In effect, it could involve cultivating a revival in traditional design and methods of building in the Gulf and exploring how these methods might be adapted alongside cutting-edge sustainability practices and technology.

Joint funding for prizes with shared patents

In each country there are already a number of separate initiatives that could contribute to a GCC-wide agenda. Pooled government funding for prizes, R&D and pilot schemes could incentivize solutions from the best minds working in this field, much as the Zayed Future Energy Prize currently does but with a more specific focus. This could avoid duplicating mistakes and increase the robustness of solutions. A framework that allowed funders rights to use designs and patents in their respective countries would lower the costs and barriers to widespread deployment of the most effective solutions.

'Solving solar'

The region's solar power potential is constrained by the nature of the dust, mud and humidity. Solving this problem would provide huge benefits and would best be done through a collective effort. Box 4 explains the possibilities for cooperation on renewable energy.

There is also inadequate understanding of the concrete benefits of incorporating renewable energy into the GCC

Box 4: Building a solid scientific foundation for the introduction of renewable energy

The specific climate of the Gulf region, including its heat levels, solar penetration, dust, humidity, sand storms and mud rains, means that existing tools for assessing renewable energy potential are not a sound basis for renewable energy strategy. Tests must be conducted on-site and a new body of knowledge and tools established. For example, the diffraction of solar radiation and whether the rays are horizontal or vertical would show which areas and which technology are most appropriate.

Several institutes are focusing on this kind of mapping, including the Qatar Environment and Energy Research Institute (QEERI) and K.A. CARE. The current Mapping Centre for Renewable Energy and Assessment at the Masdar Institute in the UAE (also working with K.A. CARE) is developing regional knowledge in renewable energy assessment and mapping for the Arabian peninsula and countries with similar climate. The potential offered for scale-up in the region through cooperation is clear: looking at the thermal pattern in, say, Abu Dhabi and Dubai may help show what is possible in Riyadh and other large cities in the region. The International Renewable Energy Agency (IRENA) is also playing a role. Many of its GCC members have committed to support the Global Renewable Energy Atlas which it hosts. This charts solar and wind resources and infrastructure across the world to help countries assess their renewable energy potential.

The Masdar Institute has developed methodologies to account for the impacts of dust and humidity on solar resource quality – one of the first new energy-related R&D breakthroughs in the region. The King Abdullah University of Science and Technology has developed a dry-brush technique for cleaning panels without water. K.A. CARE, Masdar Institute and QEERI are now working together to enhance their capabilities.

economies. This presents a significant obstacle to putting in place an ambitious policy to scale up its use.[32] For example, all governments want to avoid being dependent on expensive imported materials in the long term and want to use the renewables sector to create jobs, but there is little knowledge about how this could work.

'Solving solar' in the GCC will involve looking at all the possible applications – going beyond large-scale solar installations. There are opportunities, for example, in remote areas, especially where heavy fuel oil generators are used. If the costs of fuel and production are reflected in the electricity price, rooftop solar units could provide paybacks for individual customers and thus encourage commercial uptake.

A holistic strategic view would take into account the impact of introducing renewable energy and match it with an infrastructure plan that cuts across sectors. For example, many countries do not yet have a plan for a grid into which the energy can be fed. This will be essential to

Box 5: The potential for energy efficiency improvements in desalination technology

Table 5 shows the difference in energy use and associated CO_2 emissions using MSF alone, MSF in cogeneration power/desalting plants (CPDP), thermal vapour compression multi-effect desalination (TVC-MED) and sea water reverse osmosis (SWRO), which uses semi-permeable membrane technology to remove impurities. There are several options for both adapting current plants and changing the technology mix towards greater efficiency over time. MSF CPDP is currently the most common form of plant in the GCC and there are numerous efficiency improvements that could be applied to it. For example, Fath et al. (2013) estimate that efficiency retrofits could reduce energy consumption in desalination by up to 23% in some GCC countries by 2025. Switching from MSF in a cogeneration plant to SWRO can, under the right conditions, cut fuel use and emissions by over 75%. Sea water has to be of a certain quality to make SWRO effective at present. Most of the Arabian Gulf waters are unsuitable but the technology is likely to improve. Seasonal power demand also effects efficiency in cogeneration.[a] This, and electricity demand expectations, would need to be taken into account when planning the future desalination technology mix.

Ultimately, the fuel demand for desalination could be almost eliminated by using solar desalting plants. These are at an early stage of development in the region but small-scale solar desalination for remote areas already proves cost-effective given the high costs of delivery.[b]

Table 5: Efficiencies of desalination technologies

Technology	Thermal energy input (MJ/m^3)	Mechanical equivalent to thermal energy (kWh/m^3)	Pumping energy input, (kWh/m^3)	Consumed fuel (MJ/m^3)	Consumed fuel (CPDP kg/m^3)	CO_2 (kg/m^3)
MSF (boiler-operated)	270	27	4	344	7.5	27.48
MSF in CPDP	270	16	4	200	4.36	15.98
TVC-MED	270	18	2	200	4.36	15.98
SWRO	NA	NA	5	50	1.09	3.99

Source: Qatar Environment and Energy Research Institute (QEERI) (2012).

a Kennedy et al. (2012).

b See, for example, M. Shatat, M. Worrall and S. Riffat, 'Economic Study for an Affordable Small Scale Solar Water Desalination System in Remote and Semi-arid Regions', *Renewable and Sustainable Energy Review*, 25 (2013), pp. 543–51.

32 The EU–GCC Alternative Energy Network is actively engaged in this area. For example, Qatar is seeking to introduce 1.8GW by 2018 and the network is calculating how ready Qatar is to implement this and how it can achieve it.

allow the planned generation to be meaningfully utilized and incentivized in society. Following that, economic models can be devised to stimulate private-sector participation in the strategy for renewable energy. Financial models that allow its commercial deployment under current low fuel price conditions would be of use beyond the GCC, of course. Sharing of models at an early stage and working towards complementarity of models would facilitate investment.

Desalination technologies: producing more water with less energy

As an area of rising demand, desalination offers unique potential for energy and carbon savings in the region and would benefit from stronger cooperation on efficiency accounting and R&D. The majority of currently installed desalination plants in the region use multi-stage flash (MSF) technology – basically boiling sea water and collecting the purified condensate – often in cogeneration plants – and there are numerous options for both upgrading existing plants and choosing new plant technologies that would reduce energy intensity. Box 5 explains.

Measures involving information-sharing and capacity-building

Centralizing data-sharing

A central website and resource centre holding open-source information about GCC countries' energy profiles, policies and strategies would avoid duplication by each entity that attempted to conduct a baseline analysis, for example. This could be maintained by a GCC Secretariat team drawn from each of the countries and could encourage the submission of better data over time. The Joint Oil Data initiative (JODI) could also be developed and broadened to include other key energy data and by making it easier to use and compile personalized spreadsheets.

Sharing the results of studies to put a value on natural resources for domestic use

A potentially groundbreaking development could come from sharing national assessments of the value of national hydrocarbons wealth and the costs of burning it in domestic energy systems. There is widespread acknowledgment that if fuel is priced too low, it locks in far more wide-ranging patterns of unsustainable production and consumption (from water use to industrial development). The road towards value-reflective pricing in fossil fuel-exporting countries may be neither quick nor straightforward, but the realization of the need to put a value on national resources and build a consensus around that value is an essential first step.

In this regard, several oil exporters have developed formulas to evaluate costs of fuel inputs or electricity. This can open the way to reorienting business models and allowing cost-benefit analyses for investments in low carbon infrastructure, technology and energy supplies. For example, using either the opportunity cost (international export price) or a long-run marginal cost price, a country could calculate the price forgone over the coming 10 years with different power generation mixes. Making such studies public would help to generate debate and raise public awareness of the value of energy resources and current wastage as well as enabling better cost-benefit analyses.

Going further, GCC governments could identify a 'virtual' or shadow price to be obligatory when evaluating new investments in buildings or industrial installations. This is already the case for tenders for new power generation plants in Saudi Arabia, which, as noted, must base their business case on $25/barrel fuel inputs rather than the actual $4.50–5/b cost. Costs of inputs should be continually re-evaluated and include consideration of the whole life-cycle of the project.

Developing energy management expertise

Developing expertise and capacity to manage the energy sector would be aided via the above information-sharing measures but could be further catalysed through formalized cooperation.

Managing and directing an energy sector is a skilled activity that needs people of the highest calibre with considerable experience. The most obvious source of such expertise lies in the supplying utilities and national oil and gas companies. However, drawing on this too heavily will give energy policy a serious supply-side bias.

This trend was clear in the OECD countries following the first oil shock of 1973–74. At this point, energy policy rose to the top of the political agenda. Before then, it had at best consisted of a series of subsector policies. As supply-side people were drafted in, the policy orientation lacked direction or expertise in the ideas of demand-side management issues and conservation. This problem persists today.

The GCC countries will benefit from building a strong demand-side orientation as well as expertise in new forms of energy. For example, as new types of energy are introduced into a country, regulators will have to rethink demand management in order to maximize their effectiveness. Yet it takes time to train highly specialized teams and it will be expensive for each country to employ several consultancies for this purpose. Several GCC countries are pursuing government 'lead by example' strategies. The opportunity cost losses noted in Chapter 4 and the strong presence of government as an owner/operator of different entities and businesses give a strong incentive and potential for a government-driven approach to energy efficiency. Training and mandating of 'energy managers' – drawing on the successful Japanese example – to meet efficiency obligations for all large government, and later commercial, consumers would help institutionalize the conservation agenda.

It makes more economic sense to combine units of expertise into larger units serving more than a small country. This could take the form of an association under the umbrella of the GCC Secretariat or a more informal association championed by two or three member countries that would then organize and host strategy forums and technical workshops dedicated to networking and sharing experience.

This is reinforced where 'learning by doing' plays an important role in developing capacity. The larger the pool of experience from which to draw, the better the potential learning experience. There would be huge scope for developing specialist training courses if the target pool of trainees were large, i.e. drawn from all GCC states. There are considerable possibilities for exchanging practical experience through workshops and scientific papers, especially where these could be made available in Arabic. A number of projects are already under way in the GCC member states and could act as exemplars. These include the above-mentioned pilot for air-conditioning unit maintenance and the Estidama Pearl Buildings Rating system in Abu Dhabi, and ECRA's work developing cost-benefit analysis for conservation and peak-demand reduction measures in Saudi Arabia. One way of facilitating this would be for two or more countries to sign memoranda of understanding on practical demand-side cooperation for modelling and capacity-building.

6. The Limitations of a GCC-level Approach

There are a number of potential limitations to GCC-level action and approaches to managing domestic energy. These concern the extent to which policy could meaningfully be formulated and take effect at the regional level, and how far individual countries or emirates would be willing to engage and contribute.

Concerns about committing to regional-level targets

Any sensible programme to improve energy efficiency requires targets. Appropriate targets are those that are ambitious enough to make a difference, feasible to achieve and also affordable to implement. This raises several questions for GCC-level action.

First, how willing would GCC country leaders be to commit to target-setting within their own jurisdictions? Politicians all over the world are often reluctant to set targets simply because if they are not met there may be a loss of face or public criticism. Vague rhetorical statements feel safer.

Second, within the GCC, who would be responsible for setting these targets? Finding targets that every country could sign up to would have to allow for the differences in conditions and capacities noted in Chapters 2 and 3. There is always the danger that political expedience would favour the lowest common denominator, which would then obviate the other requirement of any target; namely 'to make a difference'. At present, the GCC Secretariat relies on members' voluntary adoption and enforcement of its standards at the national level. The energy sector may be seen by GCC member governments to be of such national strategic importance that they would refuse to allow it to be directed or even influenced by a supranational body.[33]

Third, what kind of targets could work for everyone, given the different sectoral priorities and range of conditions among the GCC countries as outlined in Chapter 2? Targets for energy intensity or carbon intensity would be the most obvious 'flexible' ones to adopt at the regional level, but as the analysis in Chapter 2 and the findings of Lahn and Preston (2013) show, this may not be appropriate for all GCC states without adjustment given the high dependence on variable hydrocarbons prices and their influence on GDP.

There are several examples of large country or regional groupings – Asia-Pacific Economic Cooperation (APEC) countries and the European Union in particular – that are benefiting from shared energy and climate goals and other, less formal channels for cooperation in these sectors. All are on a learning curve but they have been able to set targets that allow for countries designing context-specific ways to meet them. This model of a high-level goal with flexibility in how to achieve it will be increasingly important in China and India as they set energy and climate targets that will depend for their fulfilment on actions by provincial and state actors with varied characteristics.

With respect to appropriate targets, intensity targets with adjustment or fossil fuel conservation, CO_2 emissions reduction against a realistic 'no new policy' projection with negotiated contributions could be highly successful given the ongoing development of energy-sector targets in several countries.[34] The simplest starting place may be targeted reductions in per capita CO_2 emissions and water consumption, as Qatar is doing in electricity and water. In

33 This was and remains a consistent source of problems for the creation of an EU energy policy.

34 For a more detailed analysis, see Lahn and Preston (2013).

addition, improvements in fossil fuel or carbon intensity in key sectors based on physical output or comfort rather than financial outputs would appear a promising area for regional agreement. Essentially these could be reached through a bottom-up approach whereby countries submit their current national sustainable energy plans to the GCC Secretariat as the basis for setting practical common goals. These would build on what is already planned and help to maintain and increase momentum through regional reporting of progress and indicators.

Reluctance to 'copy' and preference for international partnerships

Relations between the GCC states are competitive and pressures to appear original or first may rule out copying exact forms adopted by neighbours. Their development of several sustainable building codes attests to this. Where GCC members have sought benchmarks, therefore, they have often been related to examples outside the GCC. For example, as a high-income 'city state', Dubai looked to the experience of Singapore when it came to electricity tariff reform. In similar vein, Abu Dhabi looked to South Korea for guidance on appliance labelling. There will be more rich potential for international partnerships on a range of energy policy issues. As international standards and best practices are adapted to local conditions in one country, there will be more opportunities to benefit from the regional similarities of circumstances.

Potential for lax enforcement among jurisdictions

GCC-level building and appliance standards alone could not solve the issue of enforcement at the national level. They will only work if the standards are enforced. The GCC lacks any effective enforcement agency of its own and it is likely that for reasons of sovereignty, enforcement would be left to state authorities. There would be opportunities to build regional best-practice guidelines and establish GCC-wide training programmes for assurance practices. However, lax application of the law in one jurisdiction within the GCC would undermine the effectiveness of the programme.

Bureaucracy and delays at the GCC Secretariat level

The slowness of GCC-level processes and lack of high-level, highly skilled engagement from each country is considered a barrier to more effective regional-level coordination more generally. The GCC power grid, for example, was proposed in the 1980s. It took 4–5 years to finance the initial study, which showed that every country would benefit. It then took 20 years to decide to implement it. Today all six governments consider the grid a positive and useful development but they do not have the luxury of that kind of timeframe for collaborative decision-making on such pressing issues as energy and water conservation.

Time and capacity constraints

The ideas for technical capacity-building between GCC countries that are at an earlier stage of energy policy development and their neighbours may be constrained by capacity. Even the authorities that are most advanced in building baseline energy consumption models and developing and piloting strategies tend to have small teams and limited budgets. These teams contrast sharply with the image of overstaffing and lack of work ethic in some Gulf civil service institutions, and the scale of the challenge demands a great deal of their time and attention. Therefore, countries may not be willing to lend expertise to regional teams or capacity-building elsewhere.

7. Conclusion and Recommendations

'We are going down a very dangerous road. Reactionary approaches are not feasible.' Experts in both technical and policy fields in the GCC frequently expressed this fear through the course of our conversations and workshops between 2011 and 2013. The fear relates to both the current business model with low- or no-cost water and energy inputs, and the rapid development of roads, new cities and large-scale industrial projects without consideration of future impact on demand for either of these resources. For many, the potential for diminishing government revenue from reduced oil exports and the vulnerability to a dip in international prices are serious and pressing concerns. Stakeholders often spoke of the tendency of their governments to act only in response to crises, whereas the current slow-burn challenge demands a comprehensive strategic approach firmly based on the interests of future generations.

This view is no longer confined to technical circles in the region and increasingly finds expression at the higher levels of leadership and in the media. This report testifies to the remarkable developments that have taken place in the last five years in terms of awareness, national commitment and practical strategy to save precious energy resources and reduce energy intensity. But more must be done, and faster, to change course towards a sustainable future.

The three loudest messages from the people working towards these aims are:

1. ***The importance of governance.*** Some countries, emirates and cities in the GCC are pursuing innovative pilots in efficiency, clean energy introduction, energy services, standards and pricing reform. Where inter-agency coordination, information, a degree of autonomy and resources (invariably conferred through some initial high-level support) have enabled initiatives, there is progress. But where one or more of these factors are missing, good plans are often stalled.

2. ***The need for integration of national energy strategy.*** To implement renewable energy ambitions will mean radically enhancing efficiency; business models to realize both will need to work with or address current energy and water prices, and create jobs for nationals. Most pressingly, the imperatives of conservation must take immediate effect on current and future development plans to avoid locking in resource-wasteful infrastructure. To galvanize and focus action across the energy sector, clear, well-thought-out targets should be introduced. Fossil fuel conservation or CO_2 emissions reduction targets and/or a number of per capita consumption reduction targets could be highly effective.

3. ***The potential for greater effectiveness through cooperation at the regional level.*** Experience in one country, emirate or city is not necessarily transferred and factored into approaches elsewhere, meaning opportunities to make faster progress are being missed. In addition, emerging product standards and pricing reforms may be undermined by cross-border 'leakage'. As an international relations issue, this has been the main focus of this report, the conclusions of which are laid out below.

There are clear advantages to pursuing GCC cooperation to improve energy efficiency. In spite of important differences, the GCC countries have established a regional grouping and identity because they share some common characteristics, particularly in terms of climatic conditions, hydrocarbons sector-based development and how energy is produced, priced and used. Specific advantages to joint approaches would be increased effectiveness of national policy measures, the time saved by avoiding duplication, and a reduction in the costs of capacity-building, public awareness-raising and developing new and more efficient materials and technologies. Some of this is already being realized through cooperation on a common building standard, for example.

There are problems with addressing policy at a regional level, particularly governments' fears about relinquishing any control over a 'strategic' sector, setting appropriate targets for all, enforcement issues and the lack of energy management capacity. Moreover, the current slowness of GCC-level processes and lack of high-level, highly skilled engagement from each country at the regional level may inhibit a proactive role on energy at the Secretariat level. Objections to regional target-setting at the macro level are likely at this stage. Regional regulation and enforcement of standards may also be politically impossible.

However, there will be opportunities for streamlining strategies as energy policy-making becomes more sophisticated in each state. This will work so long as provision is made for the principles of ambition at the regional level and flexibility at the national or emirate level. Centralizing energy information and efficiency benchmarks in areas specific to GCC production and consumption activities will help to raise the bar across the board and lay the groundwork for target-setting.

Domestic energy concerns suggest a strong area where cooperation itself would support integration and build trust between countries. In particular, the GCC countries will benefit from a strong demand-side orientation as well as expertise in new forms of energy. This is where sustainable energy policy is heading globally, and the GCC countries now have the opportunity to leapfrog others.

There are also international benefits in making the GCC more than the sum of its parts in terms of commitments to reduce greenhouse gas emissions. Already, agencies in Saudi Arabia, the UAE and Qatar are assessing CO_2 emissions reduction potential from existing strategies on both demand and supply sides. It is likely that some countries will package these as Nationally Appropriate Mitigation Actions (NAMAs) and the possibility of developing a GCC NAMA is worth exploring.

It may be possible to pursue some of the ideas in this report through cooperation initially between two or more states, as is already happening in the case of renewable energy mapping. Others, such as standard-setting and import controls, appear to be of overriding advantage for all countries concerned and should be supported at the GCC Secretariat level.

The following are areas where regional cooperation looks most promising:

Managing cross-border trade (leakage of fuel and inefficient products)

- Setting common appliance efficiency standards; prioritizing cooling appliances and formulating a common guide for the procurement, installation, maintenance and regulation mechanisms to support them.
- Setting a common progressive average vehicle fuel efficiency standard.
- Evaluating the potential to work towards common fuel prices.

Creating economies of scale

- Introducing buildings standards that take into account the regional climate, geography, water and waste constraints. The GCC countries have agreed to move towards a common standard in this area.
- Ensuring the GCC-wide grid is flexible to allow inter-country and potentially inter-regional trading.
- Establishing joint technical workshops to assist standards application, for example for the regional construction industry once a common standard is adopted.
- Developing an ongoing benchmarking programme for industrial efficiency for energy-intensive industries in the region.

Preparing for economies of scale

- Developing the formula for a common trading price for electricity.
- Instituting joint training programmes for regulation and promotion of the energy services/efficiency market. Air-conditioning maintenance and construction management to meet the (future) GCC buildings sustainability standard would be two opportunities.

- Launching a GCC-wide campaign to raise public awareness of energy and water efficiency and/or developing common school curricula materials.

Joint R&D opportunities

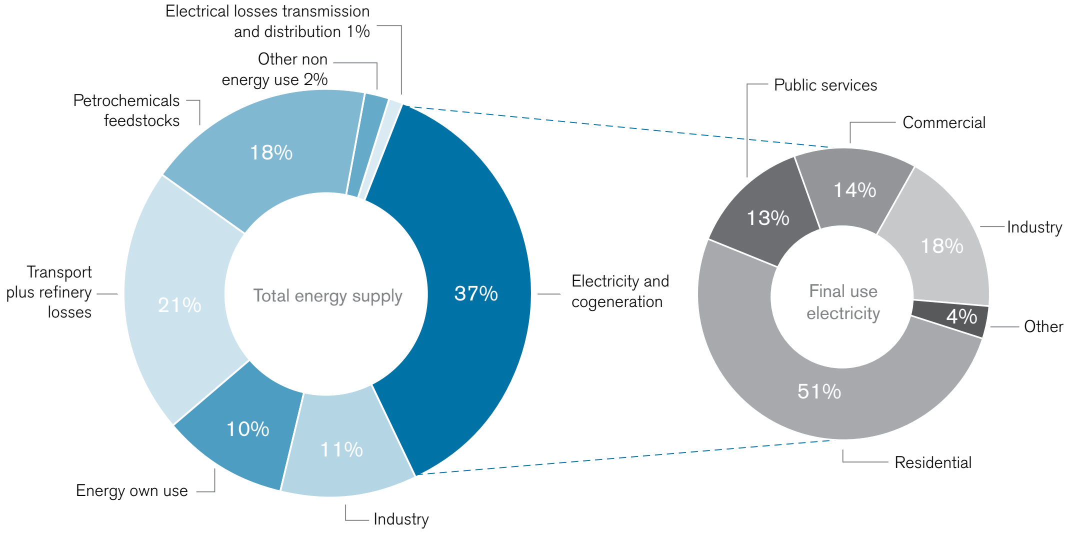
- Jointly funding prizes for energy-efficient and renewables adaptation and innovation to Gulf conditions, with provision for joint patents.
- Readjusting solar mapping for regional particularities. Collaboration has already begun between some research institutes. Once the tools for one country are established, these can easily be transferred to others in the region.
- Jointly developing, piloting and evaluating low carbon forms of desalination, sharing studies on potential and actual energy savings/emissions reductions and experience of pilots.
- Sharing details of financial models that allow the commercial deployment of renewable energy under current low fuel price conditions, and working towards complementarity of models.

Information-sharing and capacity-building

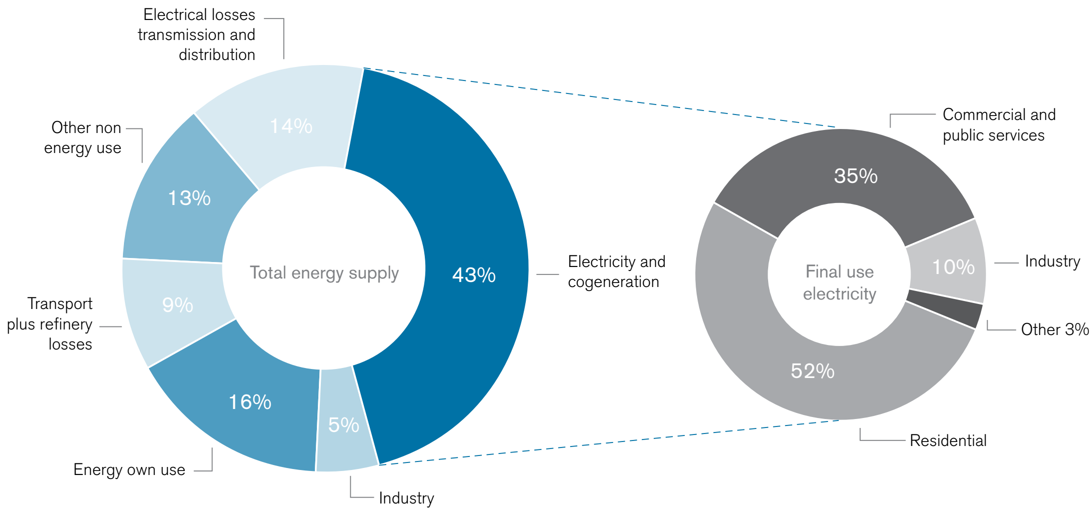
- Centralizing available country energy data on an open-source website. This could be maintained by a GCC Secretariat team drawn from each of the countries.
- Sharing studies and methodologies to reveal energy use in the water life-cycle, the costs of energy resources and the costs of wasted energy to the economy, the environment and human health.
- Developing common approaches to modelling and integrated energy and water planning. This should look at the economic and social implications of potential energy and water reforms (such as pricing) on other sectors of the economy.
- Drawing up Memoranda of Understanding between countries to help build capacity for strategic planning in the energy sector and share expertise on practical implementation of measures, particularly on the demand side.

Appendix 1: Total Energy Supply Breakdown for GCC Countries

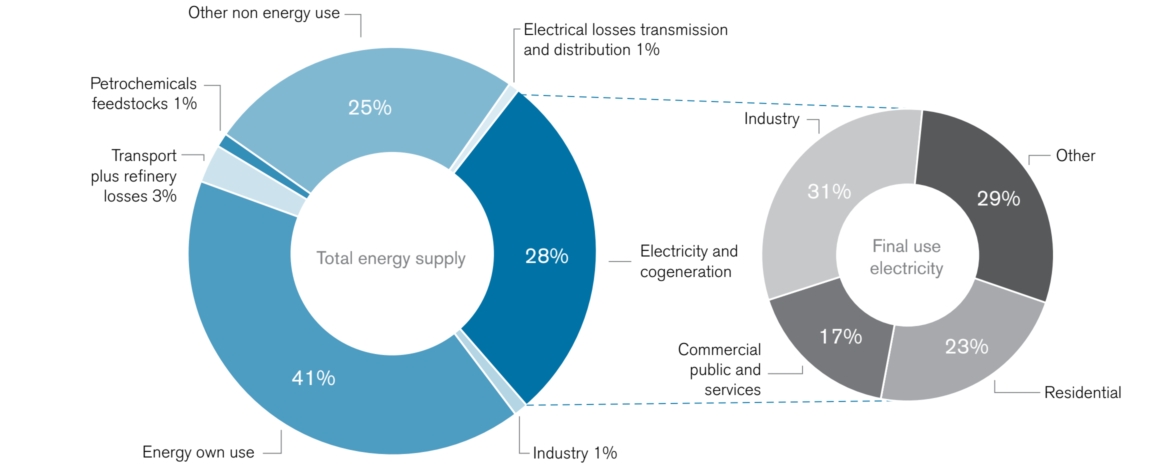
Saudi Arabia



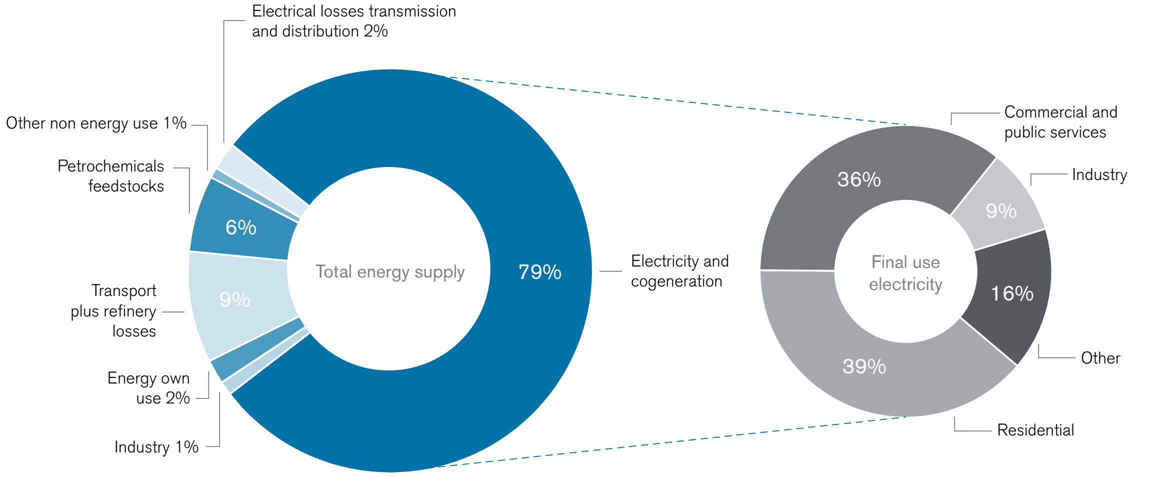
Oman



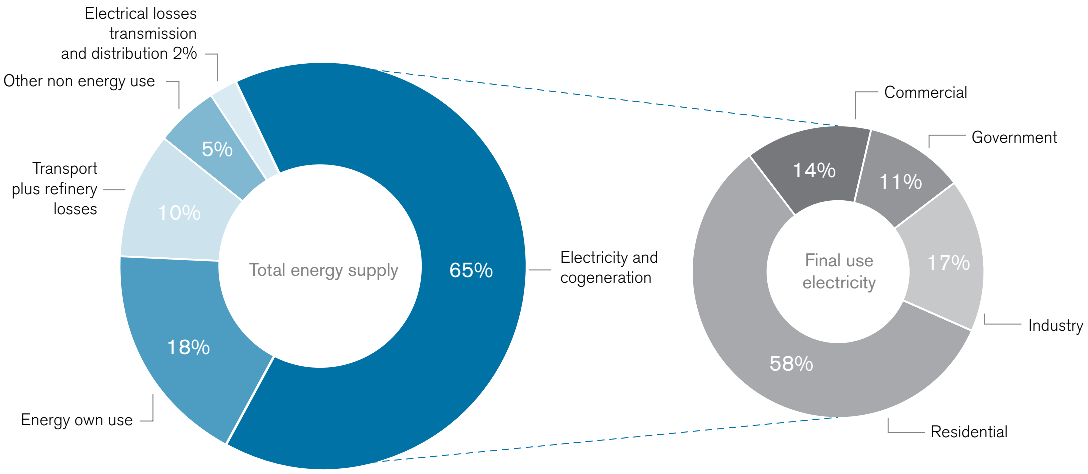
Qatar



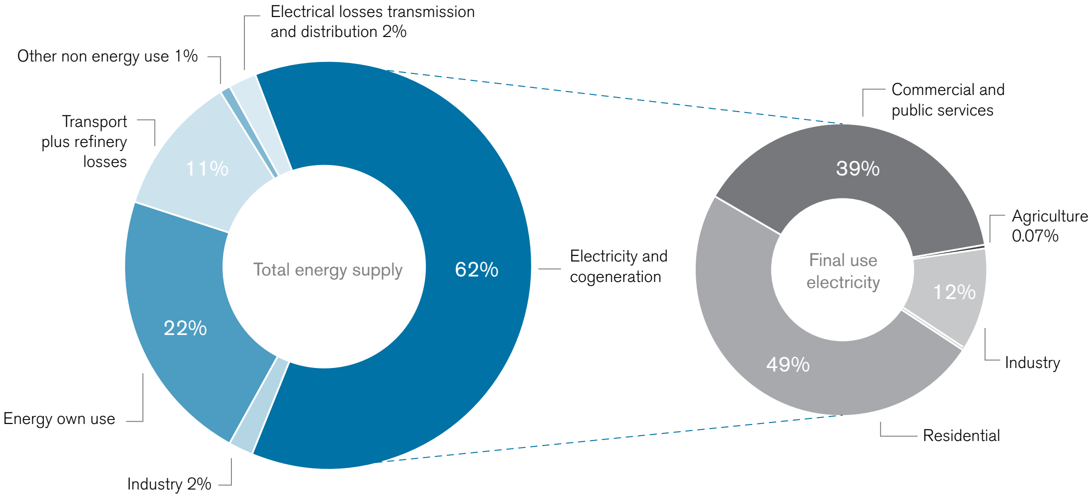
UAE



Kuwait



Bahrain



Notes:

1 These breakdowns have been compiled from data available from the International Energy Agency's 2012 non-OECD statistics for 2010 except for final use electricity for Saudi Arabia and Kuwait which are from ECRA Annual Report 2011 and Kuwait Ministry of Electricity and Water figures (2012) respectively. This enables some standardization but also simplification.

2 It is not clear how the different countries count electricity use in desalination. Because thermal cogeneration lowers inefficiency in electricity generation, the IEA data indicate extreme 'losses' in Kuwait and UAE, for example, without noting that the sector is also producing desalinated water. Therefore, we group the electricity fuel use as 'electricity and cogeneration'. Based on available figures and local estimates, we estimated allocations of fuel use to desalinated water production as follows: 10% in Saudi Arabia, 15% in Oman, 23% in Bahrain, 28% in the UAE and 30% in Qatar. Per capita fuel allocations for water appear highest in Qatar and UAE and lowest in Saudi Arabia and Oman. However, more robust estimates are needed.

3 Within the industry sections, some of the fuel will be used for self-generation, not captured in the 'final use electricity' pie. For transport-sector consumption, the refinery losses (when crude is converted to transport fuels) are also accounted for. The same applies to refined products used in electricity generation.

Appendix 2: Evolving Buildings and Appliance Standards in the GCC

	New buildings	Air conditioning	Other appliances
STANDARDS			
Saudi Arabia	Saudi building code 2007 + mandatory thermal insulation 2010.	Minimum efficiency Performance Standard (MEPS) for the energy efficiency ratio (btu/hour-watts of output) = 7.5 @35°C (since 2006).	Refrigerators, freezers and washing machines.
UAE		Voluntary energy efficiency labelling became mandatory for non-ducted A/C in January 2013. MEPS EER = 5.90 @ 52°C.	Voluntary energy efficiency labelling for lamps, washing machines, refrigerators.
Abu Dhabi	Estidama Pearl Rating System Since 2010, all new buildings must meet 1 Pearl requirements. New government buildings and Emirati villas must meet 2 Pearl requirements.	See UAE.	Trustmark for Environmental Performance given to 6 types of water-efficient equipment (2012).
Dubai	Voluntary 'Green Building Regulations and Specifications' 2009 adapted from Leadership in Energy and Environmental Design (LEED) rating system.	See UAE.	
Kuwait	Energy Conservation Code of Practice mandatory for new and retrofitted buildings (1983), revised 2010.	For new and retrofitted buildings in Energy Conservation Code of Practice (1983/2010).	
Oman			
Bahrain			
Qatar	Qatar/Global Sustainability Assessment System. In December 2011 it became mandatory for all government and large private-sector projects.		
FUTURE PLANS			
Saudi Arabia	Code under revision. SASO pursuing use of advanced insulation materials for commercial buildings. Regulation for enforcement of insulation through making it a requirement for grid connection.	Increase MEPS to 8.5 (window) 9.5 (split) by October 2013. Aim to reach ASHRAE standard (11.5) by 2015.	New standards being developed for electric motors and lighting.
UAE		Energy efficiency labelling mandatory for ducted air conditioners in 2014. Increasing import incentives, e.g. if 5-star rated units, no registration fee.	Lighting and other household electrical appliances.
Abu Dhabi	Moving towards passive buildings and operational checks on existing buildings.	See UAE.	
Dubai	Green Buildings Regulations and Specifications become mandatory 2014.	See UAE.	
Kuwait	Energy Conservation Code of Practice under revision to upgrade efficiency requirements.		
Oman	Developing 'green buildings code'.		
Bahrain	Updating buildings code to include green buildings code.		
Qatar	QSAS to become mandatory for all new buildings in 2014. New regulations expected as part of KAHRAMAA best-practice code – by 2016.	Window/split A/C (all capacities) MEPS EER: 8.5 @35°C, EER: 6 @46°C. Single Package Air Conditioners (MEP EER: 8.6–9 @35°C depending on size). All cooling systems to be controlled by time-clock. Air conditioners of capacity 5 tonnes and above used for large offices and commercial establishments to be controlled by programmable timers.	Various water efficiency standards including required installation of aerators in bathrooms and kitchen of all private and public buildings. The maximum flow rate from aerators shall not exceed 8.32 litres/minute.

Appendix 3: Methodology for the Energy Savings Calculations

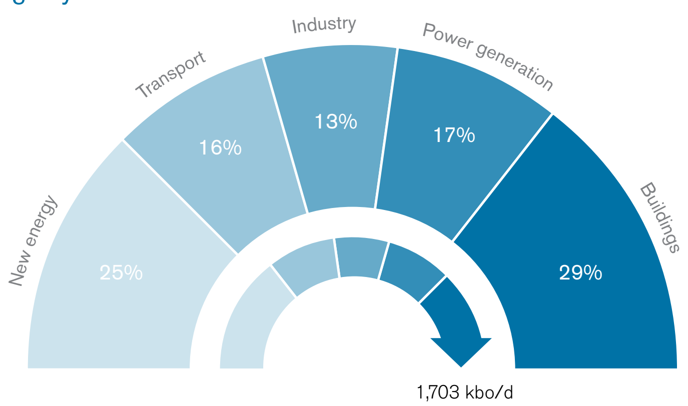
The Saudi Energy Efficiency Center and Chatham House developed an energy savings toolkit in 2011/12 to try to estimate potential energy savings through efficiency measures – chiefly upgrading or replacing technology – in Saudi Arabia. Chatham House reconfigured the calculation to enable data and assumptions to be input or altered for each GCC country. The result will calculate the energy saving possible by 2025 against the current technology projection. Once potential savings that would not undermine desired outputs can be identified, it is also possible to assess the most cost-effective investments to make. Thus, with reasonable scenarios for GDP growth and costs for the various energy-saving measures factored in, the tool could estimate a practical energy conservation or energy intensity target.

The results should of course be treated with caution as lack of disaggregated data and projections presents an obstacle to accuracy. In the simulation for Saudi Arabia referred to in this report, we tried to standardize data where possible and use regional or international proxies where necessary. Table 5 in Chapter 4 gives a summary of key data sets for current and projected energy consumption by sector that we gathered or made assumptions about for the toolkit. Behind each of the numbers is a more detailed set of calculations or proxies with projections either based on historical growth or publicly available data.

This appendix provides a summary methodology to explain the results that we draw upon in this report. More information is given here on the electricity and buildings scenarios, as these account for over 70% of projected savings and are based on a range of local data. A more detailed methodology is available online at http://www.chathamhouse.org/gcc_energy, or upon request to the authors.

What the basic efficiency scenario shows

Figure A1: Energy savings by 2025



- 75TWh/y of fossil fuel electricity is replaced with renewable and/or nuclear power. For example, this could be met with approximate capacities of 3GW nuclear power and 30GW renewable energy.
- This assumes fossil fuel efficiency standards and some behavioural change due to public transport. It covers fuel used in transport plus the avoided refinery losses to produce the fuel.
- This assumes technology upgrades in chemicals, steel, aluminium, cement and clinker production, which accounts for the majority of industrial energy demand.
- This assumes that new power plants are high-efficiency combined-cycle, pushing up average efficiency by 8 percentage points. This might also be partially achieved through retrofitting old plants as planned.
- This includes changes to the building envelope and air conditioning but not behavioural change. It accounts for both final-use electricity and avoided generation losses.

The current technology scenario and the efficiency scenario: assumptions and data gaps

The simulation makes various assumptions to show the breakdown of energy use under two scenarios for 2025: a 'current technology' scenario and an 'efficiency' scenario. The 2010 energy use data draw heavily on the IEA non-OPEC Statistical Balances for 2010, which offers a breakdown for energy use in the main sectors including petrochemical feedstocks but does not give details on energy use in desalination or in individual industries. In calculating potential future efficiencies, the study focused only on key sectors for energy use and efficiency improvement: **electricity generation, buildings, air-conditioning equipment, vehicles and energy-intensive industry** production (including refining). On the basis of nationally available data, we estimated these sectors to account for between 70% and 75% of total energy use (not including feedstocks) in the country.

The current technology projection for 2025 is not an ideal 'business as usual' baseline trajectory. For example, it assumes that efficiency of power generation remains the same. This is a controversial assumption as some open-cycle power plants will be replaced during this time with higher-efficiency combined-cycle plants, along with some efficiency retrofitting. However, data are uncertain on how much energy new desalination needs will require (this is not plotted on the simulation). As groundwater is depleted and urbanization increases, these needs are likely to take up an increasing share of fuel allocation and could counteract plant efficiency gains.

Energy demand is derived from various projections on growth in these key sectors, which are linked to population and not to GDP. On our assumptions, oil and gas consumption would be up from around 3.7mboe/d in 2010 (it was around 4mboe/d in 2012) to about 6.8mboe/d in 2025 with no new technology. Annual growth averages out at around 4.1% per year between 2010 and 2025, just over the projected GDP growth at 4%. Population growth slows down a little and averages out at 2.3% per year during the period.

Data gaps were particularly problematic in the areas of transportation and industry, for which we relied heavily on international proxies.

The energy-saving improvements by 2025 are almost all based on currently available technology or proven international standards. The only one that involves 'behavioural change' is the assumption of 10% reduction in energy use in vehicles due to widespread urban mass transport links. There are no assumptions that would foreseeably lower levels of comfort or entail 'doing' or producing less. Tables A1–A5 give the basic assumptions.

Table A1: Summary efficiency measures assumed in simulation

Sector	Efficiency measures in place by 2025 and energy reduction over 'current technology' projection
Buildings	4 million new homes built to average 115 kwh/m^2/year 20% of existing buildings retrofitted to 145kwh/m^2/y
Air conditioning	Stock of new air conditioners improves by 20% (from 2* to 5* rating) 20% of existing air-conditioning units maintained/cleaned, reducing their energy consumption by 27%
Transport	Car parc improves efficiency by 26% with US CAFÉ-style vehicle average fuel efficiency standards Vehicle use reduced by 10% through public transport introduction
Industry	Energy-intensive industries (petrochemicals, steel and aluminium, cement) install 2011 best available technology, saving 31% fuel and 19% electricity

Electricity overview

The scenario takes a conservative approach to electricity growth based on government announcements of planned housing unit additions, estimates of efficiency in industry and global industrial proxies for growth. A key factor is growth in electricity used in air conditioning, assumed to account for a yearly average of 62% of total electricity demand in 2010 and 58% in 2025. Electricity demand growth overall averages out at just under 5% per year during the 15-year period. In our projection, it would be between 7% and 8% growth up to 2013 and then begin to fall gradually to just under 4% by 2025 as certain growth areas became saturated.

Electricity generation

Current technology scenario

In 2010, oil and gas represented 55% and 45% of the electricity mix respectively. On the basis of the IEA figures for energy use in power generation and electricity output, we assume gas efficiency of 28% and oil efficiency of 30%. This appears very low and is likely to be due to a combination of factors including inefficient peak power generation as well as open-cycle plants. It is also unclear how much energy can be attributed to water production in cogeneration plants. Although the heat produced by thermal power generation is often considered a 'by-product', using it for desalination effectively makes the plant less efficient than it could otherwise be. See also note 2 in Appendix 1 and footnote 29.

Efficiency scenario

In the efficiency scenario, we assume that average gas-fired power generation improves by 8 percentage points owing to high-efficiency new plants. We assume that gas remains at 45% of the electricity mix but that some of oil's share is replaced by renewable and nuclear energy. By 2025 renewable energy provides 11.5% of total generation and nuclear energy 4.5% before any efficiency adjustments. That would equate to replacing (or actual) output of around 75 TWh/y fossil fuel-generated electricity based on the demand growth projection. This is a little over halfway to K.A. CARE's 2032 projection for renewable and nuclear energy although the relative weight of each may differ. Our calculation assumes 20% utilization for renewable energy and 80% utilization for nuclear. This saves in total 0.42 million barrels of oil per day based on current oil plant efficiency levels.

Buildings

Table A2: Current technology scenario

Key assumptions: current technology	Value	Source
Average occupancy existing housing stock (person/home)	5.5	Based on 5m homes divided by total population in Saudi Arabia in 2010
Average floor space existing stock (m^2)	300	
Base case building energy use ($kWh/m^2/year$)	169	Study of buildings in Dhahran & Riyadh in Al-Saadi and al-Budaiwi, 2007
Average occupancy new housing stock by 2025	3.0	Calibrated to give 4m new homes in Saudi Arabia
Average floor space new stock (m^2)	300	

Table A3: Basic efficiency scenario

Key assumptions	Value	Source
Retrofit improved energy usage (kWh/m²/year)	145	Insulation retrofitted to the International Energy Conservation Code (IECC) standard for Riyadh (Al-Saadi and al-Budaiwi 2007)
% existing homes retrofitted to this standard	20	
New homes efficient building energy use (kWh/m²/year)	115	New homes are built to the design envelope given as best case for Riyadh in Al-Saadi and al-Budaiwi 2007

Note: Building envelope assumptions: Ministry of Economy and Planning information in Global Property Guide, May 2012 http://www.globalpropertyguide.com/Middle-East/Saudi-Arabia/Price-History; Al-Saadi and al-Budaiwi (2007), 'Performance-based Building Envelope Design for Residential Buildings in Hot Climates', http://www.ibpsa.org/proceedings/BS2007/p104_final.pdf.

Table A4: Air-conditioning assumptions

Key assumptions	Value	Source reference
% of residential/commercial electricity used in air-con	62	Based on 50% of total Saudi electricity use in air-con – scaled to reflect share of Residential/Commercial in total
% growth in number of air-con units	186	Based on projections for Saudi Arabia in *In Focus: The Saudi Air-Conditioning Sector,* January – December 2008, National Commercial Bank, and BRSIA: *Air Conditioning Market in Saudi Arabia*, March 2010: http://www.bsria.co.uk/news/saudi-ac/
% energy-saving potential per unit relative to current technology	20	Increase from current 2* to 5* average energy performance rating
% improved maintenance efficiency potential	27	Air-conditioning maintenance programme 2010/11, Abu Dhabi pilot case (Demand Side Management Group of the Economic Affairs Committee, Abu Dhabi Executive Affairs Authority)
% of market reached by maintenance programme	20	

Savings potential through buildings envelope and air-conditioning standards

The simulation showed that applying the above efficiency improvements to buildings and air-conditioning would save 0.2mboe/d in final-use electricity. However, because it would be also be reducing the demand for fuel to generate this power – by 34% over the 'current technology' scenario' – it would save an additional 0.3mboe/d. In other words, 60% of the total energy savings from the assumed buildings and air-conditioning changes would come from avoiding additional power generation (which factors in the 8 percentage-point efficiency improvement in gas-powered generation).

Table A5 gives a breakdown of these savings translated into costs at different $/barrel oil prices. It also shows an alternative option for buildings, raising the average efficiency of all air-conditioning units to an average 43% improvement – the difference between the current 2* model at around EER:8 and the planned minimum energy performance in 2015 at EER:11.5.

Table A5: Basic efficiency scenario savings: buildings

Measure (as described in Tables A3 and A4)	Final use saving total in kboe/d	Avoided power generation losses if 15% = desalination*	Total kboe/d avoided	Total annual saving (mboe/y)	Savings @ $25/b	Savings @ $80/b	Savings @ $100/b
New builds meet code	105	155	260	94.9	2.4	7.6	9.5
Retrofitting insulation	12	18	31	11.2	0.3	0.9	1.1
Air-conditioner standard	67	99	166	60.8	1.5	4.9	6.1
Air-conditioning maintenance programme	15	21	36	13.1	0.3	1.0	1.3
Total savings	200	293	493	180	4.5	14.4	18
Alternative scenario: Air conditioning raised to 11.5EER minimum performance value nationally							
Alternative: Air-conditioning standard = 43% improvement	145	212	357	130.3	3.3	10.4	13

*This is simplistic calculation. We make an assumption that desalination accounts for 15% of fuel use in the power sector by 2025.

Note: not all numbers add up owing to rounding.

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