Burning Oil to Keep Cool

The Hidden Energy Crisis in Saudi Arabia

Glada Lahn and Paul Stevens

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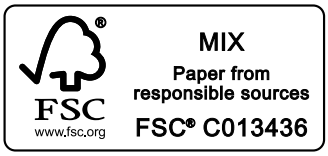

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Acknowledgments

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G.L.
P.S.

Executive Summary

Saudi Arabia's place in the world oil market is threatened by unrestrained domestic fuel consumption. In an economy dominated by fossil fuels and dependent on the export of oil, current patterns of energy demand are not only wasting valuable resources and causing excessive pollution, but also rendering the country vulnerable to economic and social crises. This report explains why the need for change is urgent, and what options and challenges the Saudi government faces in trying to address the politically sensitive issue of domestic energy prices.

The report begins by examining the causes for concern. Chatham House simulations reveal that, on the current trajectory, Saudi Arabia's domestic energy consumption could limit its exports of oil within a decade. This would have a severe effect on government spending, over 80% of which is dependent on oil revenues.[1] Ultimately, it may reduce Saudi Arabia's spare production capacity, causing greater volatility in the world oil markets.

Next, the report considers the role of historically low energy prices in the kingdom in both driving these unsustainable consumption trends and inhibiting measures to correct them. Internationally, this issue is receiving increasing attention, with several multilateral bodies calling for the elimination of fossil fuel subsidies. Saudi Arabia is a member of some of these bodies, including the G20 and the World Trade Organization. In 1992 it was one of the signatories of the UN's Agenda 21, which committed countries to developing policies to address unsustainable patterns of consumption, including energy. It is also among the members of the G20, all of which committed themselves to phasing out 'inefficient fossil fuel subsidies' in the medium term in September 2009. Yet Saudi Arabia does not have an overarching policy on energy consumption and claims it has no inefficient fossil fuel subsidies. This report argues that there are compelling domestic reasons for Saudi Arabia to act on both energy consumption and price. These include the looming constraint on oil export capacity, the need to develop a post-oil economy, and threats to the health of inhabitants resulting from power outages and from increasing industrial and traffic pollution.

The report examines the Saudi government's current approach and demonstrates that this will not be enough to head off an economic crisis in the kingdom. So far, the focus has been on adding new energy supply. Chatham House simulations show that adding renewable and nuclear power based on current estimates will only delay the onset of an intractable fiscal deficit by a couple of years. An ambitious effort to increase energy efficiency is also essential. Our simulations show that this could buy the government more time in which to lower the economy's dependence on income from oil exports. Ideally, efficiency drives would be supported by higher prices for energy.

However, several factors make raising the price of energy a daunting task for the Saudi government – not least the role of cheap energy in Saudi Arabia's social contract and in its industrial development policy. Powerful groups within the country as well as the poor currently benefit from the status quo, so opposition to price rises would be strong. The report discusses this and the associated challenges. It then suggests possible ways forward with reference to several international examples. Experience in other countries shows that to achieve their goals, the authorities would have to prepare Saudi society for price rises. Public education campaigns and mechanisms to offset the higher costs for the most affected consumers need to be well thought out and planned for the long term. This will involve the coordination of a wide range of agencies and action on legal, regulatory and administrative fronts. Under the Saudi

1 Calculated as the average over 10 years, 2000–09. SAMA (2011), Sheet 5-2, Table 2.

bureaucracy, this would appear more painful than investing in new, large-scale energy supplies, but would ultimately pay back greater dividends for future generations.

The report concludes that huge economic, social and environmental gains in energy conservation are possible in Saudi Arabia. International experience can help although design and implementation would need to be adapted to the country's industrial and social context. Key recommendations for the Saudi government are as follows:

- Develop ambitious but realistic energy intensity targets and a programme of measures to achieve them. This would provide a useful overarching policy goal, over which the various ministries and sectors could coalesce.
- Mandate and enforce regulation such as building and appliance standards for existing as well as new construction and installation – even in the absence of price reforms, this would both rapidly conserve oil and reduce peak electricity demand.
- Prepare society for energy pricing reforms through investment in a range of efficiency, educational and infrastructure adaptation measures to smooth the transition. This may include innovative technology applications to ensure affordable energy is still available to those who need it most.
- Implement a package of measures that increase private-sector employment for Saudi nationals, such as public–private partnerships to adapt infrastructure, and introduce efficiency-enhancing technologies.

1 Introduction

The world's largest exporter of oil is consuming so much energy at home that its ability to play a stabilizing role in world oil markets is at stake. Saudi Arabia's demand for its own oil and gas is growing at around 7% per year. At this rate of growth, national consumption will have doubled in a decade. On a 'business as usual' projection, this would jeopardize the country's ability to export to global markets. Given its dependence on oil export revenues, the inability to expand exports would have a dramatic effect on the economy and the government's ability to spend on domestic welfare and services.

Following the political unrest in the Middle East since the start of 2011, the impulse of the Saudi authorities has been to give out more social benefits – including cheap energy. Yet the negligible cost of fuel to consumers is encouraging wasteful consumption and deterring investment in efficiency and alternative energy supplies. In a country powered entirely by domestically produced oil and gas, this is using up precious natural resources as well as having long-term environmental impacts. One indicator of the problem has been the rise in the burning of heavy fuel oil and crude oil to generate electricity when gas cannot meet the surge in demand for cooling during the summer months. At a local level, electricity shortages caused by demand outpacing infrastructure have already triggered rare protests in at least one province.

This report outlines the evidence for an energy crisis in Saudi Arabia and examines the role of low energy prices in fuelling many negative trends. With reference to the failures and successes of other countries in attempting to reduce fossil fuel consumption, it offers recommendations for tackling this urgent issue.

The report concludes that Saudi Arabia must develop an energy policy based on achieving a long-term sustainable consumption pattern in line with its transition to a less oil-dependent (and, eventually, post-oil) economy. This will not only involve sourcing new supply – as is the government's current emphasis – but also, and more urgently, addressing efficiency. Conserving precious oil and gas resources through improving efficiency will allow more time to effect essential economic diversification and the introduction of new energy technologies. This can be achieved by using a range of coordinated policy, regulatory and technical tools which would ideally be underpinned by higher energy prices.

However, Saudi Arabia will face specific challenges, given its political and economic context; these include:

- reversing a history of low energy prices and vested interests in low prices;
- managing the transition to higher prices, especially for low-income groups;
- making energy conservation policy coherent and effective, given the vertical structure of government and lack of channels for societal feedback;
- convincing the public that such measures are necessary when oil and gas reserves are so abundant.

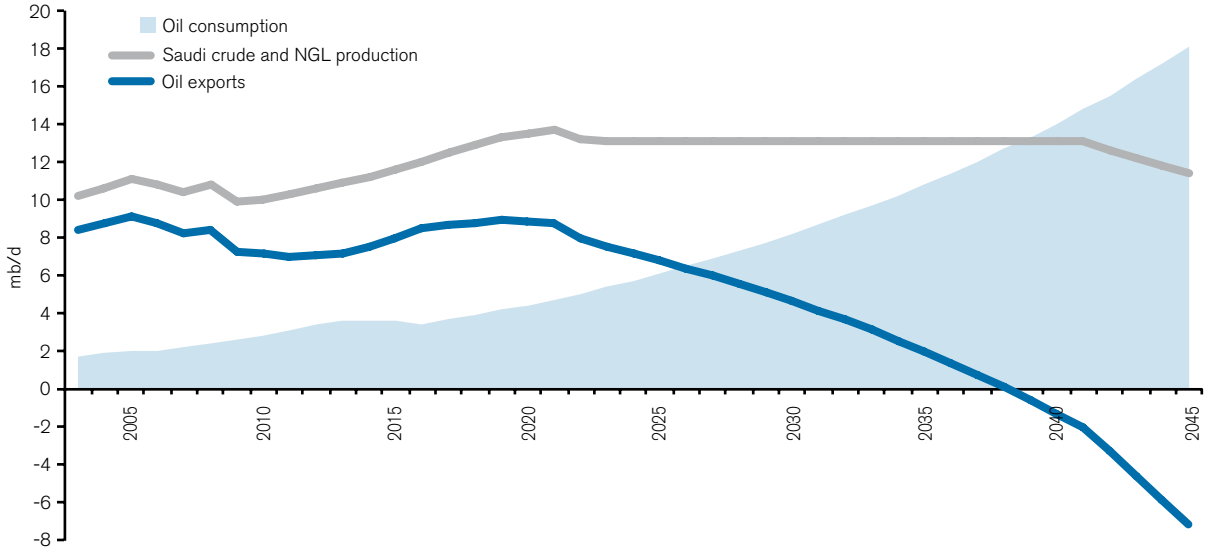
In view of these issues, the report recommends the setting of an overarching energy intensity goal for which each sector could be set practical targets, and outlines a number of measures to smooth the transition to higher energy prices.

2 Saudi Arabia's Consumption Problem

Economic vulnerabilities

Saudi Arabia's energy consumption pattern is unsustainable. The country currently consumes over one-quarter of its total oil production – some 2.8 million barrels a day.[2] This means that on a 'business as usual' trajectory it would become a net oil importer in 2038 (see Figure 1). No one is suggesting this is the most likely outcome but the possibility does signal the urgency of the need for change. More oil reserves may be discovered and production raised, population growth may decline and new policies and technology may change consumption patterns, but in the absence of such events and with the country's high dependence on oil revenues the economy would collapse before that point. The Ministry of Petroleum considers between $70/b and $80/b to be a fair international price for oil.[3] With the price at $77/b Saudi Arabia could begin to fall into intractable deficit in its fiscal and current accounts from as early as 2022 (see Figure 2).

Figure 1: Saudi Arabia's oil balance on a business-as-usual trajectory



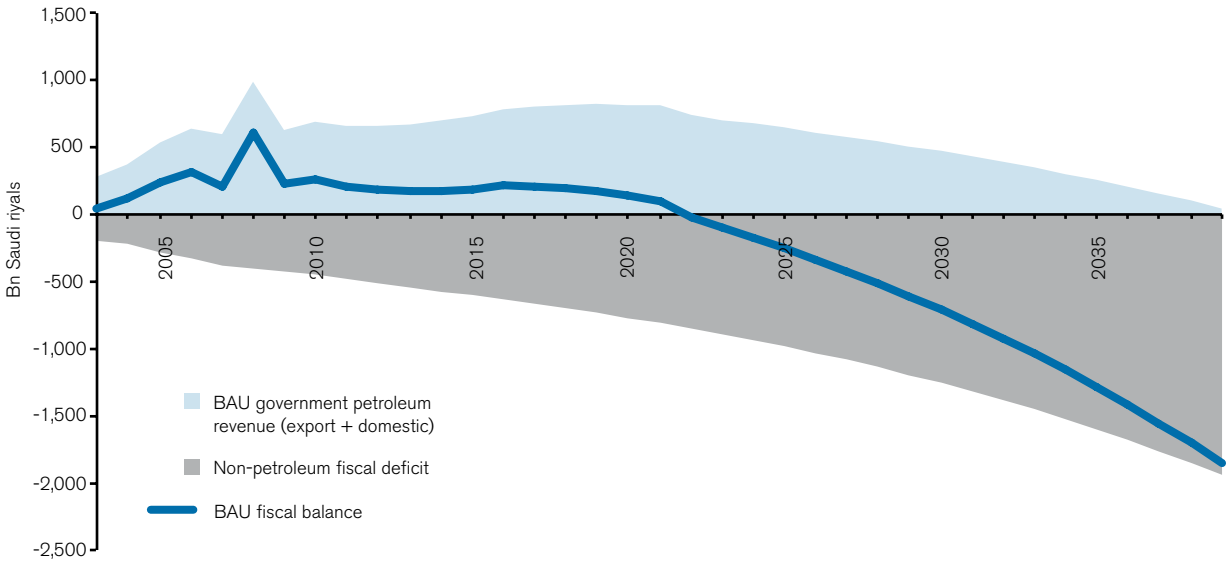
Source: Chatham House research 2010. See Appendix 1 for assumptions and key sources.
NGL = natural gas liquids

2 See Appendix 1 for our definition of 'apparent consumption'. This is the figure given in BP (2011). It includes natural gas liquids (NGLs), international aviation fuel and marine bunker fuel. It differs from the figure given by Saudi Aramco, which would suggest around one-fifth of oil production is consumed domestically.

3 This is the range that Saudi government figures suggested for 2010–11 but what is considered a 'fair price' by Saudi Arabia tends to rise over time along with the budgetary needs. It was $35/b in 2004–05, for example. In February 2011, King Abdullah announced a $37bn handout including a 16% increase in all public-sector salaries. This $37bn is equivalent to an additional $14/b on the price of Saudi exports for 2010. A report from the Institute of International Finance estimated that the breakeven price for oil needed to balance the Saudi budget for 2011 would be $88/b, as opposed to $68/b in 2010 (IIF 2011).

This would mean the kingdom becoming increasingly dependent on debt to support government spending at home and to pay for imports – or having to make some drastic spending cuts. Facing a rapidly growing population of 27 million (including some eight million expatriates), a third of the population under the age of 14 and high unemployment (officially 10.5–11% of the Saudi labour force, unofficially anything between 20% and 30%),[4] the need to diversify the economy and create jobs is paramount. If this is not done fast enough – and the signs are it is not – the subsequent fiscal squeeze would have serious political consequences.

Figure 2: Saudi Arabia's fiscal deficit on a business-as-usual trajectory



Source: Chatham House research 2010. See Appendix 1 for assumptions and key sources.

Impacts on the international oil market

International trends signal more havoc for the oil markets. Saudi Arabia currently has a production capacity of 12.5 million barrels per day (mb/d) and produces 9–10mb/d of crude oil and natural gas liquids (NGLs). It exports 6–7mb/d of crude oil, refined products and NGLs. According to the International Energy Agency (IEA), the global market will rely on OPEC to meet increasing global oil demand with the greatest expectation on Iraq and Saudi Arabia. A rough estimate shows that current consumption trends in Saudi Arabia could deprive the world market of up to 2 mb/d by 2020 compared with the IEA's supply scenario.[5] The national oil company, Saudi Aramco, has warned that Saudi Arabia's crude export capacity would fall by about 3 mb/d to under 7 mb/d by 2028 unless the domestic energy demand growth is checked.[6]

Saudi Arabia's ability to stabilize the international oil market by turning export volumes up or down would be damaged, with spare capacity used up to maintain export volumes. As this spare capacity is eroded, and if other oil reserve holders such as Iran and Iraq fail to invest adequately in upstream capacity,

4 This is for males and females of working age. Aissaoui (2010) gives the 2009 estimate for the proportion of working-age Saudi males in employment as 45.3% (ILO and local sources).

5 The IEA's New Policy Scenario expects Saudi Arabia to produce 10.9 mb/d of oil and NGLs by 2020 and 11.6 mb/d by 2025 (IEA 2011, Table 3.6). Although it does not specify how much of this would need to be exported, the projection of net trade (Fig. 3.19 and p. 600) assumes that the whole of the Middle East would only be consuming around 7.7 mb/d in 2020 and 8.2 mb/d in 2025, which seems conservative given current rates of growth. If Saudi Arabia's share of Middle East consumption remained at its average historical level of 33%, it would consume only 2.5mb/d in 2020 – similar to current levels – and 2.7mb/d by 2025; our BAU simulation puts it at 4.5 mb/d in 2020 and 6.1mb/d in 2025. For a more detailed discussion of underestimation of demand growth in oil consumption projections for Saudi Arabia, see Gately et. al. (2011), pp.10–14.

6 Al-Falih (2010).

an oil supply crunch leading to major price spikes on the world market is likely.[7] While this may help oil producers balance budgets in the short term, in the longer term a dip in the oil price would be likely, followed by decline as new production comes on-stream and responsive national policies move even emerging markets away from oil. This would be even more damaging for the Saudi economy than our simulation suggests.

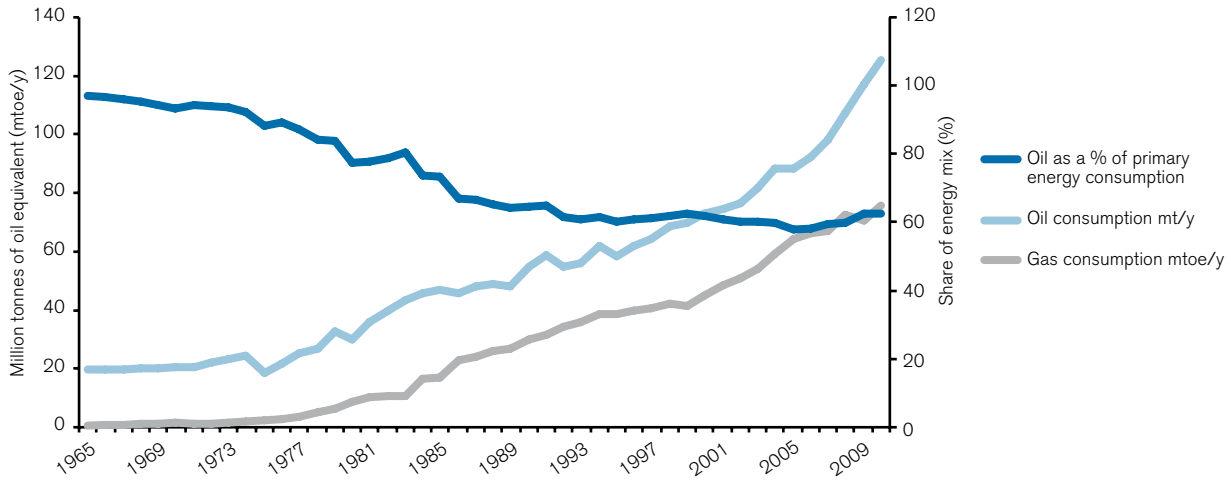
What's eating Saudi Arabia's oil?

Saudi Arabia's energy consumption pattern

Saudi Arabia's historical energy consumption pattern is shown in Figure 3. Looking at its evolution since 1970, four things are clear:

- Energy consumption has been rising since the early 1970s and shows no response to subsequent dips in the oil price;
- Oil and gas continue to account for all of Saudi Arabia's energy production, with oil continuing to dominate the energy mix;
- Progressive diversification into gas began in the early 1970s;
- Oil's share in the energy mix has nevertheless begun to rise again in the last six years.

Figure 3: Saudi Arabia's historical energy consumption pattern



Source: BP (2011).

These trends can be explained by Saudi Arabia's rise as an oil-exporting nation since the formation of the Organization of Petroleum Exporting Countries (OPEC) in 1960, and its rapid development since the oil-price boom of the early 1970s. Once oil increased in value as an export and as the associated gas became usable as the Saudi Master Gas System developed, there were efforts to use more gas domestically, chiefly in power generation. The cost of producing a barrel of oil is low (an estimated $2 in the 1990s and around $5 today), as is the cost of associated gas. Domestically produced oil and gas have therefore been the preferred fuels, both as the rational economic choice for the country's energy services, and as a competitive advantage on which to develop industry.

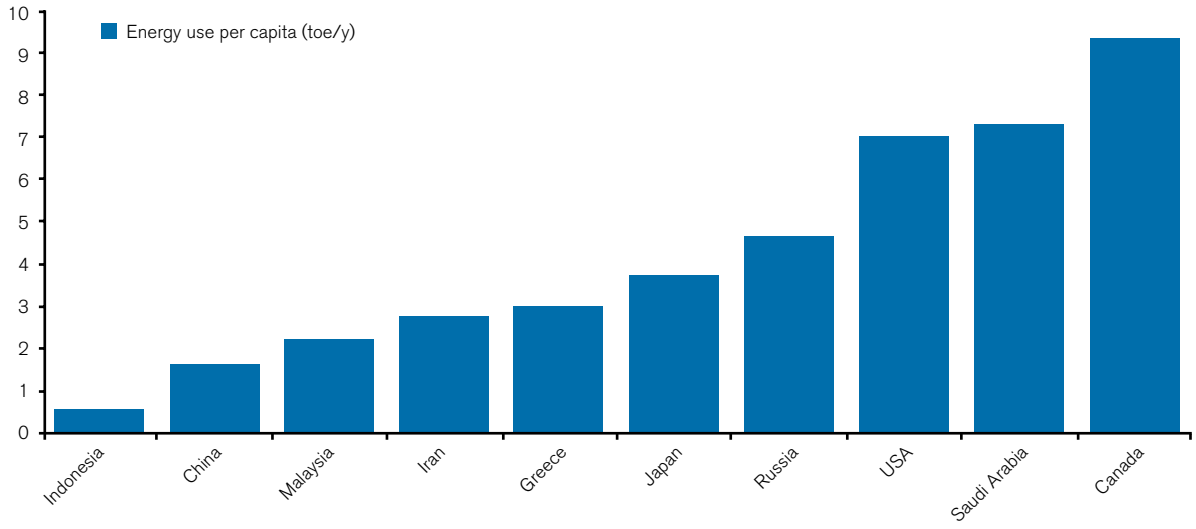
7 Stevens (2009).

By 2005, oil as a share of total primary energy consumption (TPEC) had decreased to 58%.[8] Further diversification into gas has been limited, however, partly because most of the gas produced has been associated and therefore dependent on oil production, and partly because Saudi Arabia – as the world's fourth largest holder of proven gas reserves – is reluctant to import gas. The establishment of gas-fired power plants and a petrochemicals industry has locked in demand for gas, which has risen with electricity demand and industrial growth.

In the last decade, gas shortages have prompted oil substitution, so the trend has reversed. All natural gas produced in the country is consumed domestically. Gas currently fuels around 35% of power generation, with the remainder coming from a mix of diesel, heavy fuel oil and crude oil. When gas shortages occur in summer – mainly owing to the high demand for power for air-conditioning – more oil is burned in its place.[9] A 2006 royal decree mandated that all coastal power stations burn oil in order to save gas.[10] Demand for gas in power plants has also left the petrochemical industries short on occasion and new petrochemical projects are required to be based on liquid feedstock. The national energy mix now stands at around 62% oil (including LPG) and 38% gas.

Since the 1970s, most importing countries have introduced long-term policies and measures to diversify the energy mix and to moderate consumption. These were prompted first by the high costs of imports and concerns about import disruption, and later by local pollution and efforts to mitigate climate change. Exporters have generally been slower to formulate this kind of energy policy given the low cost and availability of domestically produced fossil fuels. Saudi Arabia appeared to have even less need than most to address domestic consumption because its exceptional place in the international market meant that exporting more oil (saved by not consuming it at home) would not necessarily make economic sense.

Figure 4: Energy consumption per capita in selected countries, 2010



Sources: BP (2011); UN Population Division Data.

Saudi Arabia's TPEC amounted to around four million barrels of oil equivalent per day (201 million tonnes of oil equivalent per year (mtoe/y)) in 2010.[11] This is similar to consumption in the United Kingdom, which has well over double the population. Per capita, Saudi Arabia consumes a little more than the United States and around twice as much as Japan (see Figure 4). Cross-country comparisons can

8 We include in this some non-energy use of crude oil and natural gas products, namely as industrial feedstock.

9 This practice is less efficient, more polluting and damaging to the turbines in dual-fuel plants.

10 Although this is likely to change as Saudi Aramco develops more non-associated gas.

11 BP (2011) figure for primary energy consumption. Saudi Aramco (2011) figures for non-exported oil and gas sales suggest the slightly lower 3.9 mboe/d.

be misleading. Different stages of development, structures of energy production and consumption, and different geographic and climatic factors all affect a country's needs.[12] The question is whether the value generated is commensurate with the volume of natural resources being burned. The next section explores this question, which is a valid one for all countries.

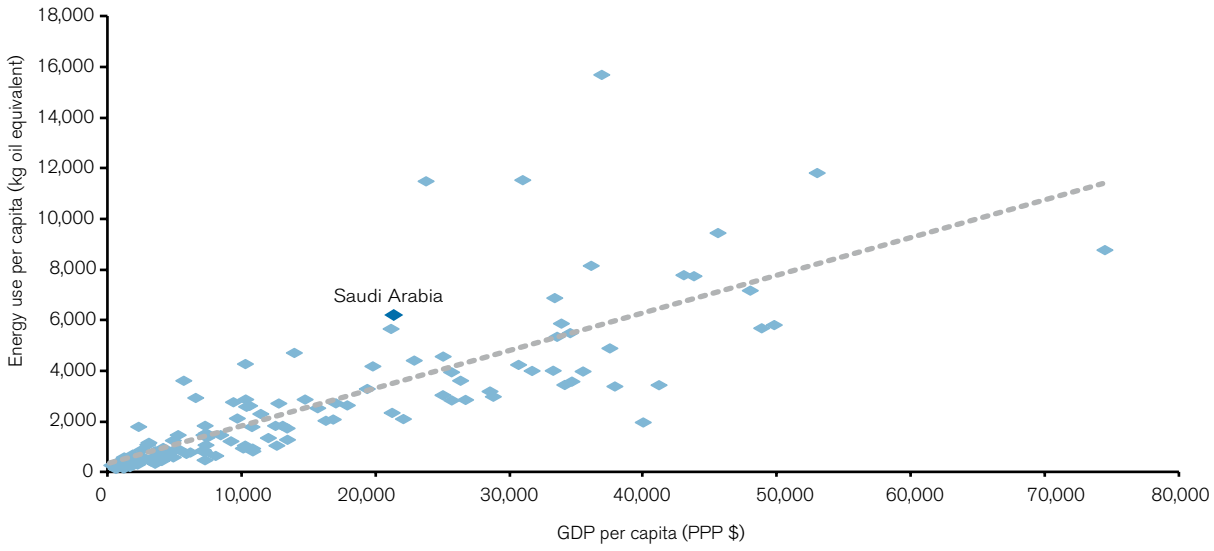
How much is energy contributing to society?

Energy is a key input into both the productive processes generating a country's output and the services that improve people's standard of living. On these criteria, using more energy may be considered a good thing. However, using more energy resources than is necessary to produce certain outcomes over time results in wasted resources, and therefore misses an opportunity to deploy them or invest their value elsewhere. For countries whose economies are dependent on the export of hydrocarbon and mineral resources this issue has additional resonance. The economic logic for using revenues generated by extracting and exporting exhaustible wealth *below* ground is to create more sustainable wealth *above* ground.[13]

Output can be measured by GDP. Figures 5a and 5b plot energy use against GDP, showing 'energy intensity', which can give an idea of a country's efficiency.[14] Figure 5a shows that Saudi Arabia is an outlier by world standards on a purchasing power parity (PPP) basis. Figure 5b zooms in, giving selected country comparisons using official 2000 exchange rates. This shows that in 2007, Saudi Arabia's energy intensity was nearly double that of Malaysia, which is of a comparable population size and level of development.

As noted above, country-specific conditions may account for some of the disparities, but only up to a point. For example, Russia has a similar output level to that of many developing countries, yet uses three times as much energy per unit of output. Long driving distances and extreme cold are clearly factors, as is the dependence upon heavy industry as a mainstay of exports. However, these can only partially account for such a discrepancy.

Figure 5a: Commercial energy intensity, all countries, 2007 (PPP $)



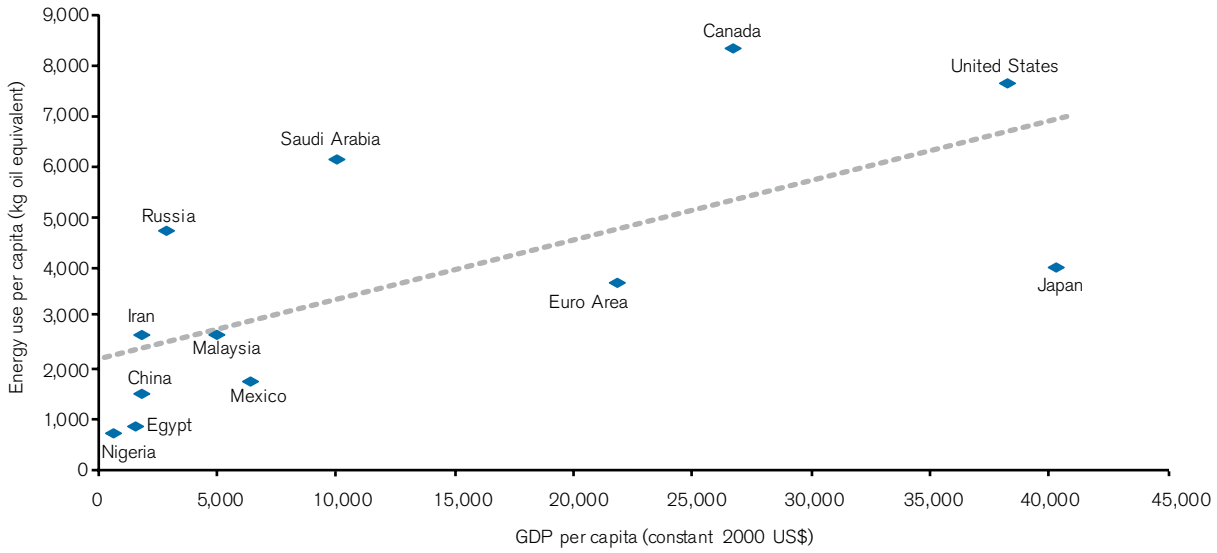
Source: World Bank Development Indicators (WDI)

12 Contrary to popular belief in the West, Saudi Arabia is not a fabulously wealthy country. In terms of per capita income (based on purchasing power parity) it is ranked 142nd out of 176 countries (World Development Indicators 2010).

13 Oil revenues are not income. They simply represent a reshuffling of the national portfolio of assets. Thus oil revenues mean swapping barrels of crude oil below the ground for dollars above the ground. Sustainability requires the dollars to be used to create new forms of wealth to replace the depleted hydrocarbons.

14 Such measurement is not without complexity and controversy. For example, when making cross-section comparisons it is not clear which exchange rate should be used – i.e. official (which is pegged to the US dollar) or PPP.

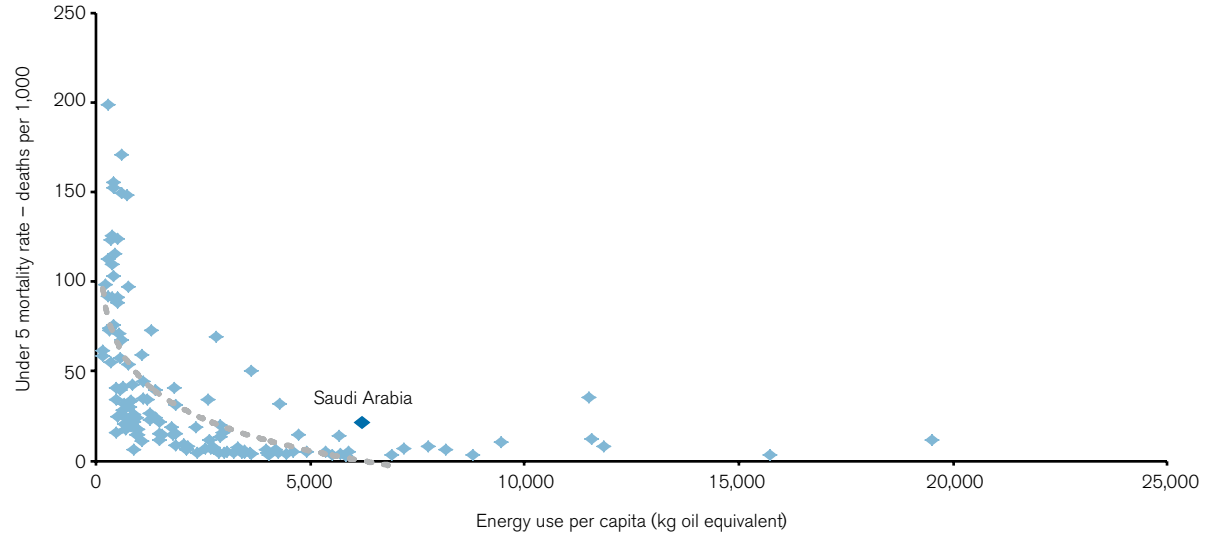
Figure 5b: Commercial energy intensity, specific countries, 2007 (constant 2000 $)



Source: WDI

Measuring the standard of living is more complex but child mortality is a good proxy measure.[15] Figures 6a and 6b show the relationship between energy inputs and output and the under-five mortality rate. Saudi Arabia does not do well on this measure either. Figure 6a shows the general relationship between energy use per capita and infant mortality – the trend line suggests that higher energy use per capita is associated with lower infant mortality. Figure 6b shows that other countries achieve similar infant mortality rates to Saudi Arabia's with much lower per capita energy inputs.

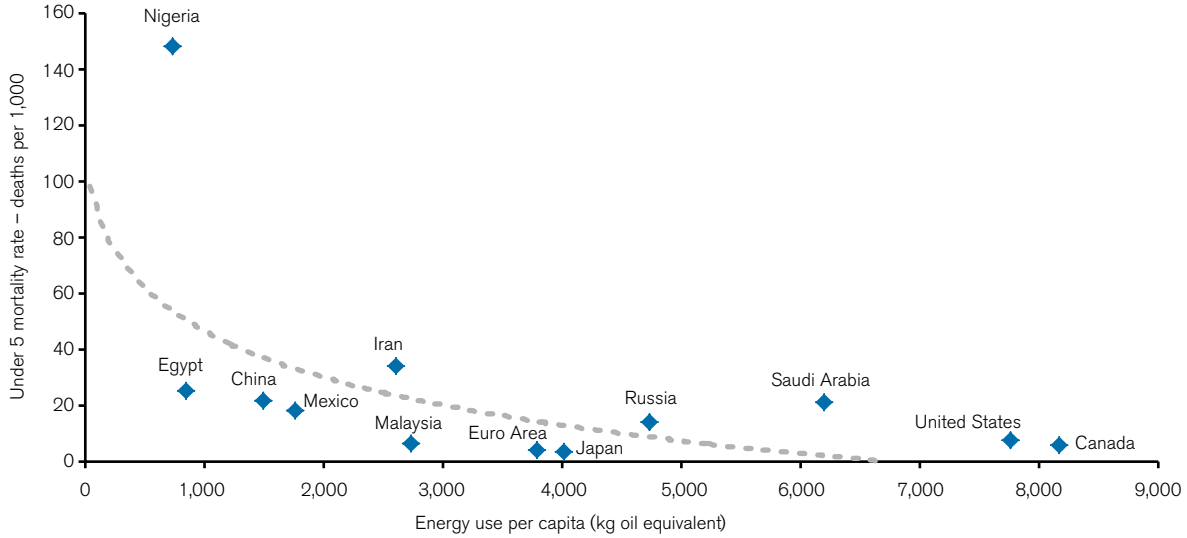
Figure 6a: Energy as a key input into people's standard of living (using child mortality as a proxy), all countries, 2007



Source: WDI

15 This can be considered a reasonable reflection of the quality of nutrition, access to clean water, sanitation and health care and many other measures of wellbeing at the foundation of any society.

Figure 6b: Energy as a key input into people's standard of living (using child mortality as a proxy), specific countries, 2007



Source: WDI

Even if a country is justified in using more energy per capita and more energy per unit of output than others on the basis of the conditions described above, one would still expect its efficiency to improve over time. Figure 7 shows that this is not the case for Saudi Arabia. Between the oil price hikes of the 1970s and the global financial crisis in 2008–09, GDP per unit of energy increased in the oil-importing countries, but declined or stayed level in the oil-exporting ones: Saudi Arabia, Iran, Malaysia and Nigeria. On this measure, Saudi Arabia's decline in energy efficiency is dramatic. Because the international price of oil has a distorting effect on the GDP of countries that depend on oil exports, we have also included a calculation based on Saudi Arabia's non-oil sector GDP, which shows that the efficiency of this sector was roughly the same as for the United States in 1975 but has declined in almost inverse proportion to that of the US ever since.[16]

In fact this is in line with a regional trend. A World Bank report estimates that energy consumption has risen faster in the Middle East and North Africa (MENA) than in any other region since 1980.[17] Between 1990 and 2005 MENA's energy intensity increased by 14%, which was 60% above the OECD average and 40% above the global average. The report concludes that 'high energy intensity is used, cautiously, as a sign of possible energy inefficiency'.[18]

Moreover, in the ideal resource-dependent development model, earnings from the depletable resources are directed towards sustainable investment, so that by the time the resources themselves are exhausted (or no longer have value on global markets) the country has compensated for any environmental damage and derives its standard of living and growth from other economic activities.

Oil money has stimulated other areas of the economy in Saudi Arabia, with remarkable growth in the petrochemicals, construction and financial sectors. Yet dependence on oil and gas revenues to pay for state spending in society and the economy has hardly shifted. In fact it increased during the last period of unusually high oil prices (2005–08).[19] It is also debatable how much vertical integration of the petroleum sector (integrated refining, petrochemicals, plastics etc.) contributes to diversification. Just under a fifth of the oil and gas consumed in Saudi Arabia is used for feedstock and power for

16 Energy efficiency and conservation policies and measures affecting the US trajectory began when the United States became a net oil importer from around 1970 and in response to the 1973 oil price hike.

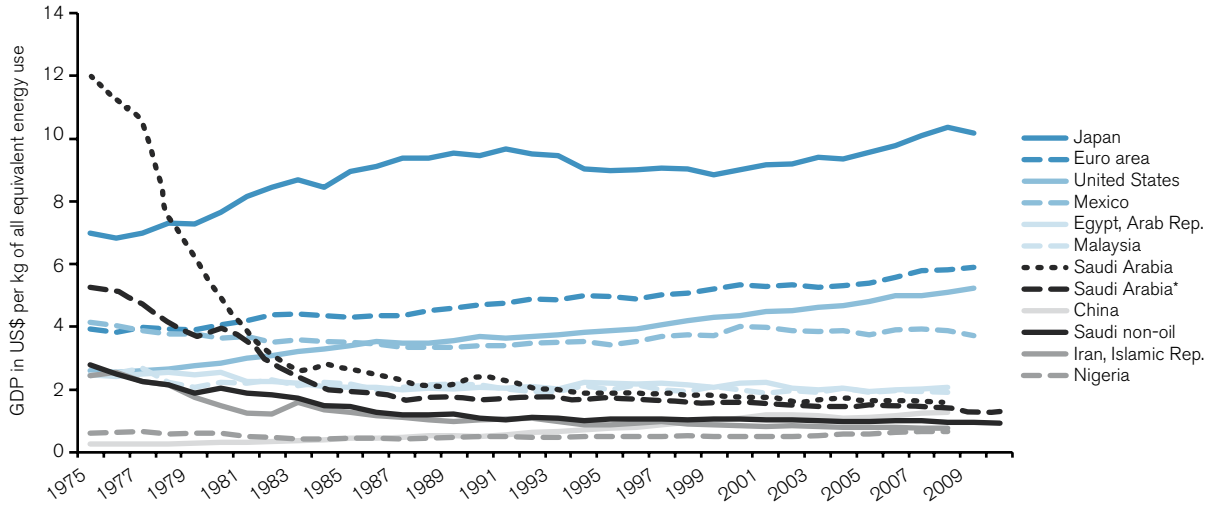
17 Energy Sector Management Assistance Program (ESMAP)(2009).

18 ESMAP (2009), p. 6.

19 Dependence of expenditure on oil revenues increased from 42% in 2003 to 50% in 2007 (Mitchell and Schmidt, 2008).

industry (e.g. petrochemicals, plastics and fertilizer).[20] In principle, these capitalize on Saudi Arabia's 'competitive advantage' as a producer of low-cost energy to generate national value through jobs, exports and economic diversification. But as Aissaoui (2010) argues, the petrochemicals industry encourages dependence on low-cost feedstock, does little to reduce the economy's vulnerability to global oil-price cycles as its processes are closely correlated to these, and provides few jobs relative to productivity.[21]

Figure 7: Output per unit of energy over time – selected countries



Sources: WDI, SAMA, BP.

Note: Saudi Arabia* uses BP data for energy consumption rather than WDI.

This graph uses WDI data drawn from IEA statistics for primary energy use and IMF data for GDP (constant 2000 US$) except in the case of the Saudi Arabia 'non-hydrocarbon' series and the Saudi Arabia* series. The former uses SAMA data for non-oil GDP (constant 2000 US$) and BP (2011) for primary energy use minus estimated hydrocarbons-sector consumption at 9.4% based on Al-Yousef (2011). The latter uses WDI data for GDP and BP (2011) data for the energy consumption because IEA data and BP data for total primary energy consumption differ and there is a significant variation in the pre-1980 numbers, e.g. for 1975 – 9.2bn tonnes and 20.7bn tonnes respectively.

Escalating demand and social insecurity

Saudi Arabia's annual energy consumption is growing at double the rate of GDP growth. With high population growth and planned industrial development, growth in power demand will remain high under current policy conditions. Oil products have particular demand growth potential given that '[v]ehicle ownership, currently at 230 vehicles per 1000 people, is only half the levels in Europe and Japan, and only 30% of that in the USA, and hence far from saturation'.[22]

Escalating demand for power is already causing insecurity in some parts of society. Electricity generation capacity has doubled in the last decade to around 50,000MW[23] but still struggles to keep up with demand in summer, which rises by as much as 50%. Air-conditioning is the crucial factor in this peak, accounting for around 52% of the country's total consumption during these periods.[24] This has led to some regions suffering power outages – a serious health issue when temperatures reach 40–50 degrees

20 According to Saudi data, about 17% of this total oil and gas consumption is used as industrial feedstock, and 12% of power (accounting for around 2% of total oil and gas consumption) goes to the industrial sector (Al-Yousef, 2011). However, as far as the authors know, there are no data on how much oil and gas could be accounted for by exports produced outside the energy sector.

21 Aissaoui (2010), p. 17. Aissoui also argues that the prevailing energy pricing system encourages rent-seeking behaviour as investors crowd in at the primary processing stage, neglecting projects further downstream in the oil and gas value chain as a result.

22 Gately et al. (2011).

23 Around 86% of this is operated by the Saudi Electricity Company (SEC); the rest includes some 9,165 MW from leased diesel units, desalination plants and large industrial producers (SEC, 2011, p. 16).

24 This is a rough calculation given that air-conditioning accounts for 70% of the power demand from buildings during peak demand and the residential, commercial and governmental sectors account for 75% of total national power demand.

Celsius. It also triggered a rare public protest: in September 2008 hundreds of citizens were reported to have gathered outside the state-owned electricity company offices in the northern town of Qubba to demand action to end frequent power cuts.[25]

Water is another security concern. As with other Gulf Cooperation Council (GCC) countries, Saudi Arabia will require an increasing amount of energy to produce water. At present, almost all residential and commercial water needs are met by desalination while agriculture absorbs the bulk of depleting groundwater resources.

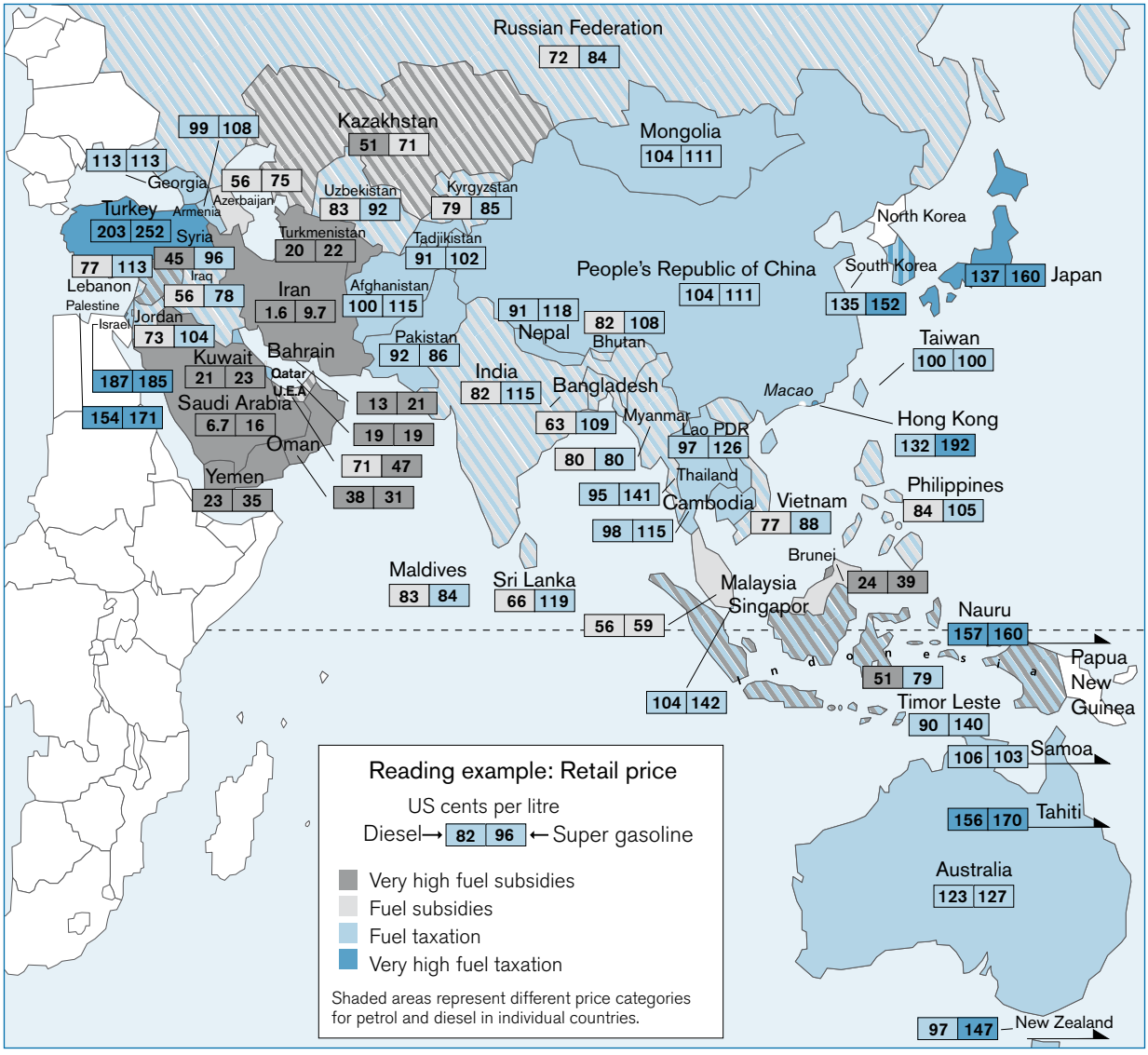
The combination of the inflexible energy mix and low domestic resource prices is fundamental to these insecurities. The next section examines the issue of price in more detail.

25 Al-Jazirah Newspaper (2008). The treatment of the local journalist who filed the report suggests that similar protests may not be publicized: see Human Rights Watch (2010).

3 The Role of Energy Prices

Prices are central to the story of energy consumption in Saudi Arabia. However, they are also extremely controversial. One issue is whether the low prices charged are subsidized or simply low prices.[26] In its negotiations for accession to the World Trade Organization (WTO), Saudi Arabia was able to justify having domestic energy prices at sub-international levels on the basis of its status as global price-maker for oil, arguing that the correct reference price for calculating subsidies would be the long-run marginal cost of oil and not its international price. The successful outcome of the negotiations for Saudi Arabia meant it could continue to provide energy inputs to the rest of its economy at levels below international prices.

Figure 8: A regional comparison of diesel and gasoline retail prices, 2010



Source: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), *GIZ International Fuel Prices 2010/2011*, forthcoming. GIZ assumes subsidies for fuel prices below the cost of crude oil on the world market.

26 The argument is extremely complex and is outlined in detail in Al-Yousef and Stevens (2011).

The lowest oil prices in the GCC

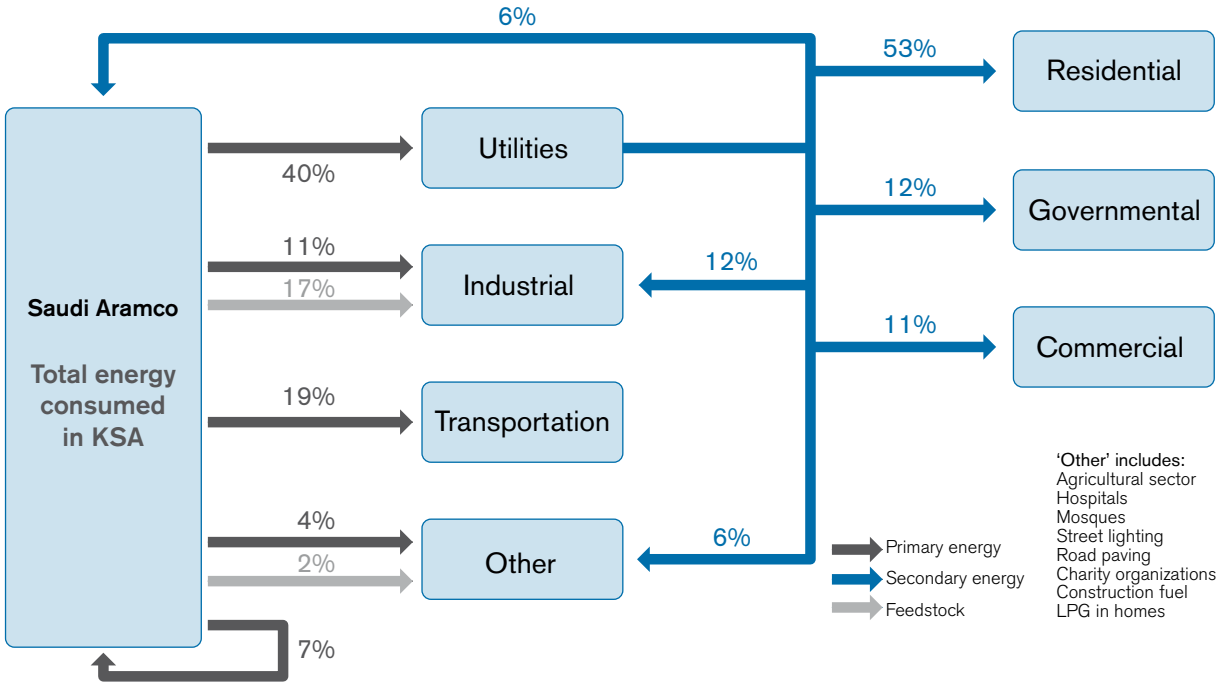
Saudi Arabia has the cheapest prices for transport fuel in the GCC (see Figure 8). They were actually lowered during the period of high oil prices to demonstrate the shared benefits of windfall export income and to offset the negative impact of the 2006 Saudi stock market crash on citizens' living standards. It now stands at 12–16 US cents a litre for gasoline and 6.7 US cents a litre for diesel.

A gas price too low to bring on new production

Saudi Arabia claims to have gas reserves equivalent to 51.5bn barrels of oil and produces about 1.4 mboe/d (7.5 bcfd). All of this is consumed domestically. The associated gas produced along with oil was initially considered a nuisance, but now forms a vital pillar of the economy. Saudi Aramco has prioritized exploration and production of non-associated gas over oil. The petroleum ministry and Saudi Aramco have announced a $9bn strategy to add 50 trillion cubic feet (tcf) of non-associated reserves by 2016 through new discoveries. Yet exploitation of gas from the new non-associated gas projects will be more expensive because of the special processes and technology needed to extract gas in more difficult – offshore, and 'tight' (embedded in rock) – geological conditions and to treat sour gas (i.e. with high hydrogen sulphide content). This could cost between $3.50 and $6.00/million British thermal unit (mmBtu), making the current domestic price for gas – $0.75/mmbtu – highly unprofitable. Global market prices are currently at least $4/mmBtu. Indeed, part of the reason for the historically slow exploration for non-associated gas in Saudi Arabia is the low domestic price, which offers little incentive to either Saudi Aramco or foreign investors.

The breakdown for oil and gas consumption in Saudi Arabia is shown in Figure 9.

Figure 9: Distribution of domestic oil and gas consumption by sector



Source: Adapted from Al-Yousef 2011.

The Saudi government has until very recently avoided addressing the issue of energy prices, chiefly because they form a key part of the country's social contract. In September 2009 G20 members agreed in principle to phase out 'inefficient fossil fuel subsidies'.[27] As Saudi Arabia was one of the signatories

27 The Leaders' Statement from the Pittsburgh 2009 G20 Summit expressed the commitment to 'Rationalize and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption' (G20, 2009, p. 14).

there was curiosity for a time as to what kind of strategy it would come up with. But instead of delivering a report on current subsidies and policy proposals to eliminate them, officials continued to claim that in Saudi Arabia's case, prices for fossil fuels that are below world prices do not constitute an inefficient subsidy.[28]

Box 1: The international focus on fuel subsidies

The issue of unsustainable fossil fuel consumption is rising up the policy agenda of transition economies and developing countries in connection with import insecurity, pollution and modernization. In addition, most of the oil exporters among these countries are effectively burning up potential revenue. Several multilateral bodies including the G20, the International Energy Agency (IEA) and the World Trade Organization (WTO) have emphasized the need to eliminate fuel subsidies in the last few years. Objectives are various and include moderating global oil prices (given that cheap domestic fuel diverts oil from international markets), reducing dangerous levels of greenhouse gas emissions and creating a more level playing field for cleaner energy and energy-saving technologies. But the debate over how to tackle the problem is still fraught with sensitivities about equity and political anxieties.

Calls to remove fuel subsidies arouse suspicion in many quarters. There is also a history of failure among countries trying to reform a system of very low energy prices. Critics claim that subsidizing goods such as fuel leads to inefficiency, unfairness and wasted resources. Advocates of subsidies insist that energy prices must be kept low to tackle poverty, promote economic development and, in the case of owners of energy resources, to share national wealth. Much of this debate has been coloured by North-South inequality, charges of neo-imperialism and hypocrisy; in other words, there is a strong argument that the term 'subsidy' is used as a stick to beat developing countries with while the prescribed discipline is not applied to advanced economies. Saudi Arabia and others would have liked the G20 agreement to have used the term 'energy subsidies' (rather than 'fossil fuel subsidies'), thus also targeting, for example, subsidies for biofuels in the United States.

The cost to society

Although cheap fuel and electricity have helped to alleviate poverty and incentivize development of the non-oil economy in Saudi Arabia, the negative consequences are outweighing the positive ones. The low pricing is indiscriminate so the rich benefit more from it than the poor. Inefficiency is entrenched.[29] For example, the low prices of gasoline and diesel relative to average incomes have encouraged the emergence of a US-style driving culture and poor public transport systems. Maintaining the provision of cheap energy diverts or forgoes money that could be spent more effectively on development and tackling poverty in the country.[30] And that cost is rising year after year as the low prices of fuel and electricity relative to higher incomes and turnovers encourage wasteful practices and investment decisions that lock in higher than necessary energy demand.

28 Little progress has been made on the G20 promise in general. Those major importers already intent on reducing demand (e.g. China, Germany, the United States) have proposed only pre-existing policies. The oil, coal and gas exporters for which energy pricing is politically sensitive (Indonesia, Mexico, Russia) only discussed subsidies in general and did not specify policies. Some energy exporters (Australia, Saudi Arabia and South Africa) denied the use of inefficient subsidies altogether. See Koplow (2010).

29 This is generally the case with subsidized energy. For example, ESMAP (2009) estimated that in Egypt in 2004, individuals in the highest quintile received 2.5 times the household electricity subsidy received by the poor and the richest 20% got 93% of the gasoline subsidy. The IEA (2011) estimates that only 8% of the $409 billion spent globally on fossil fuel subsidies in 2010 went to the poorest 20% of the population.

30 As with domestic prices for oil products, there is a debate as to whether the low prices for electricity are subsidized or not. The issue is the cost of fuel to the generators. However, as outlined below, the view of the electricity sector itself is that elements of subsidy do exist.

The rising demand for power in Saudi Arabia is affecting other resources and industries, as explained above, with regard to the substitution of oil for gas in power generation. This is not only a waste of oil but also more polluting. In addition, low prices deter individual or private-sector investment in efficiency improvements and cleaner power generation. For example, solar and wind power plants would not be commercially viable under the current pricing system.

Whether subsidized or not, the low prices of energy in the kingdom are not at all benign. First, as Figure 1 shows, current growth rates in oil and gas demand are unsustainable and could eventually eat into Saudi Arabia's export capacity, threatening its ability to remain the global market stabilizer. The country remains vulnerable to changes in international prices and, as Figure 2 shows, its fiscal account could slide into intractable deficit from as early as 2022 with the combination of rising consumption and costs of welfare and state employment.

Second, Saudi Arabia is also effectively subsidizing foreign consumption. Figure 8 shows that the cost of diesel is almost seven times higher in neighbouring United Arab Emirates (UAE), making smuggling a highly profitable business. Officials at the Ministry of Petroleum and Mineral Resources estimate that 10% of domestic oil purchased in Saudi Arabia finds its way to neighbouring countries, mostly through truckers filling up their tanks at the border. This is exacerbating the looming fiscal and current account problems.

Third, even if the current prices for oil products are not subsidized, the government is forgoing sales tax revenue. Energy is an ideal target for taxation because it has a large tax base, an inelastic demand to allow the application of taxes without reducing consumption and a low collection cost. It also means that those who are wealthy enough to afford to use more energy effectively pay more tax.

Fourth, as mentioned before, there are local health risks associated with heavy traffic in urban areas, and emissions and water pollution from the burning of oil for heat, power and energy-intensive industries. Traffic congestion also significantly increases the transaction costs of doing business. These are problems that will gain increasing attention in industrializing countries like Saudi Arabia, as is evident from current debates and political concerns in China.

Fifth, as mentioned above, the low prices act as a disincentive for potentially more efficient or less polluting alternatives. In the case of oil, for example, this might include the consumer demand for more energy-efficient vehicles and the private-sector investment in electric vehicles.

4 Current Approaches to Addressing the Energy Challenge

The elements of the Saudi government that deal with energy are well aware of the above issues but have found them difficult to tackle given the political sensitivity of energy prices and the lack of coordination between the relevant ministries and agencies.

Saudi Arabia does not have an overarching energy policy.[31] Oil policy is directed by the Ministry of Petroleum and Mineral Resources and has traditionally focused on oil and gas exploration, production, management of oil production quotas and spare capacity through OPEC and external relations with importing countries. The ministry sets prices for domestic supplies of oil, gas and refined products to the power sector, as industry feedstock, and for sale through gas stations. The Ministry of Water and Electricity deals with the management of the power sector, including planning and ensuring adequate investment in the provision of power to meet demand and desalination. Until recently, as in many other oil-exporting countries, there has been no attempt at a comprehensive policy to manage *consumption*.

The government appears to be following four main tracks at the time of writing – reforming electricity pricing; regulating and helping industry to increase efficiency; planning to introduce renewable energy sources and infrastructure; and planning to add nuclear power. While pricing is on the agenda, it is pursued with extreme caution and, given the ongoing political upheavals in the Arab world, the leadership's impulse is to stress increases in benefits for the people rather than reductions – that is, the promise of new forms of power to meet demand rather than any measures to reduce that demand.

Energy price reform

As noted in the previous section, the Saudi government has managed to exempt itself from acting on international calls to remove energy subsidies and has no public plans to raise domestic oil and gas prices. The electric power sector offers more possibilities for price reform because of the potential for using 'lifeline' rates.[32] Abdullah al-Shehri, Governor of the Saudi Electricity and Cogeneration Regulatory Authority (ECRA), has made strong public statements about the unsustainable use of oil in electricity generation and identified a large government subsidy.[33]

Gradual price increases are planned for electricity, which is currently sold at an average of 12.5 halalas/Kwh ($0.03). In June 2010, the partially privatized Saudi Electricity Company (SEC) announced tariff rises for the government, commercial and industrial sectors.[34] These are expected eventually to average a 25–30% increase on previous per kilowatt hour prices.[35] Facing the prospect of unrestrained demand growth, a first-stage rise to 13.8 halalas/kWh ($0.04) for residential customers is being discussed in government.[36] Oil and gas fuels and feedstock prices remain unaddressed.

31 In this respect it is very little different from a great many other countries where a coordinated and coherent energy policy is lacking.

32 The metering of electricity allows the use of lifeline rates whereby different tariffs are applicable to differing consumption levels. So the poor, who use little, pay little per unit.

33 Al-Shehri was quoted by AFP from his presentation at the Saudi Water and Power Forum in Jeddah, October 2010. 'Saudi subsidies incur huge costs, threaten oil exports', AFP, 4 October 2010. He claimed that the government subsidizes power consumption to the tune of 50 billion riyals ($13.3bn) a year – the equivalent of 9% of government expenditure – although it was not clear if this number had been derived from the income forgone by not selling the oil on the international market.

34 SEC is a joint stock company in which the Saudi government owns 74.3% of the stock and Saudi Aramco 6.9%.

35 See NCB Capital (2010).

36 Utilities-ME (2010). For more on Saudi Electricity Company reforms and tariffs, see http://www.meed.com/supplements/2009/engines-of-growth/saudi-electricity-company/3000232.article.

Regulating for increased efficiency

A National Energy Efficiency Programme (NEEP) was launched in Saudi Arabia in 2002 to devise and run national programmes in coordination with key ministries, industry and commerce. The stated goal of NEEP was to 'induce lasting structural and behavioral changes in the marketplace, resulting in increased adoption of energy-efficient technologies'.[37] To this end, NEEP conducted energy audits for selected buildings and facilities, and initiated some energy efficiency training and awareness programmes. It also issued energy efficiency standards for selected household appliances and developed a labelling programme for these appliances. It began developing energy efficiency codes for new buildings and established a benchmarking system for buildings and building services. Interestingly, its work with nascent energy service companies showed energy efficiency improvements to be viable even under the current pricing regime, but not bankable owing to unfamiliarity with the appropriate financing models.

At present, with the exception of appliance labelling, these initiatives have mainly been in pilot form and have yet to be rolled out nationally. NEEP became the Saudi Energy Efficiency Center (SEEC) under the umbrella of the King Abdullaziz City of Science and Technology (KACST) in 2011 and is currently working on the potential for overarching policy goals such as an energy intensity target. This change in status reflects the government's growing concern about domestic energy consumption.

A June 2011 report from the SEC on the problem of rising consumption proposes for the first time reducing government office hours (from 06.00 to 12.00) and limiting opening times at large commercial centres such as shopping malls to seven hours (12.00 to 19.00).[38] This is more likely to be a shock tactic to drive home the message about overconsumption than a realistic proposal.

Adding renewable sources of energy

Saudi Arabia does not currently have any major operating renewable facilities, but recent announcements by senior public officials, including the minister of petroleum, clearly indicate that the country sees its future as a significant producer of solar energy. Policy is driven by the desire to reduce growth in domestic fossil fuel consumption (which on its current trajectory would eventually constrain crude oil export capacity and the growth of the petrochemicals industry), and to create new industries and employment for Saudis.

Things have moved pretty fast in the last two years. In September 2009, Petroleum Minister Ali Al-Naimi said that 'Saudi Arabia aspires to export as much solar energy in the future as it exports oil now'.[39] In early 2010, work began on a solar-powered desalination plant outside Jeddah, and soon afterwards the king announced the new King Abdullah City for Atomic and Renewable Energy (K.A.CARE). K.A.CARE is intended to be the overarching entity with authority to oversee the country's renewables and nuclear drive. The country's first grid-connected solar power station[40] – a 500kW plant built by a Saudi–Japanese joint venture on Farasan Island and connected to the Jizan regional grid – was inaugurated in October 2011.[41]

The government is also promoting 'laboratories' for innovation. The King Abdullah University for Science and Technology – set up by national oil company Saudi Aramco – is pioneering several clean energy technologies and building solar generation on campus.

The government has not yet officially set targets for the generation of renewables but Saudi Aramco – until recently the effective authority over renewable energy – put this at 7–10% of electricity from renewable sources by 2020.[42]

37 NEEP website: http://www.neep.org.sa.
38 Saudi Gazette (2011).
39 Reuters (2009).
40 Saudi Arabia's first solar power station was a 350kW plant at the Solar Village just outside Riyadh, launched in 1981 as part of the Saudi–US Soleras project. This project, although successful, remained a singular experiment.
41 Al-Arabia (2011).
42 CSP Today (2010).

At the time of writing, the Saudi government had yet to formulate a comprehensive national incentive package that makes investments in alternative energy production commercially feasible. ECRA has made the case for eliminating electricity subsidies and incentivizing renewable generation. Al-Shehri was reported as saying that the government hopes to approve a regulatory framework for investment in renewables in 2011 and that without this the sector would not progress.[43]

Nuclear power ambitions

Nuclear power appears to have moved rapidly up the Saudi agenda in the last couple of years, perhaps spurred by the UAE's contracts for four nuclear power stations and Iran's advances in this field. In August 2009, Saudi Arabia announced that it was considering a nuclear power programme, and in April 2010 the royal decree establishing K.A.CARE stated that 'The development of atomic energy is essential to meet the country's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources.'[44]

K.A.CARE is mandated with advancing this agenda. In June 2010 it appointed Swedish consultancy firm Pöyry to help define its energy and desalination strategy. A year later, K.A.CARE announced that it would construct Saudi Arabia's first fleet of 16 nuclear reactors by 2030 and that these would satisfy around 20% of the country's electricity demand.

43 ArabianBusiness.com (2010).

44 Royal Decree No. A/35, Date: 3/5/1431 AH (17 April 2010).

5 Reform Challenges

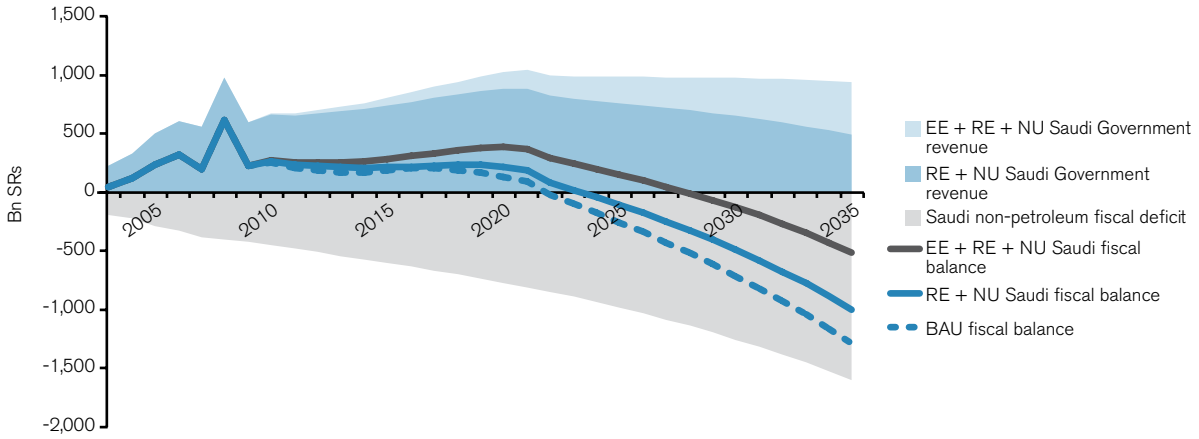
The approaches outlined above might be too little and come too late to allow Saudi Arabia to shift its economy away from dependence on oil revenues and onto a sustainable track. The government's focus is on adding more supply rather than on reining in demand. But in the decade it will take to develop new forms of energy, oil production may have reached a plateau (this happens in 2021 in our BAU simulation) while overall energy demand continues to rise. With consumption some 50% higher than it is today (if it grows at a rate of 4.5–5.5% per year) the additional supplies will have little impact on the decline in oil exports.

The simulation in Figure 10 factors nuclear and renewable energy additions into the business-as-usual scenario whereby government expenditure expands by 5–6% per year. This would save some $5.4bn worth of oil (if calculated at $77/b) per year by 2021, but would only stave off a fiscal deficit for an extra two years compared with the business-as-usual simulation shown in Figure 2. In fact, expenditure may well grow faster in order to maintain political stability, bringing forward the economic crunch point.

Current targets and policy approaches are not proportionate to the urgency of curbing growth in domestic energy demand. International experience and local analysis suggest that Saudi Arabia could and must go further and faster.

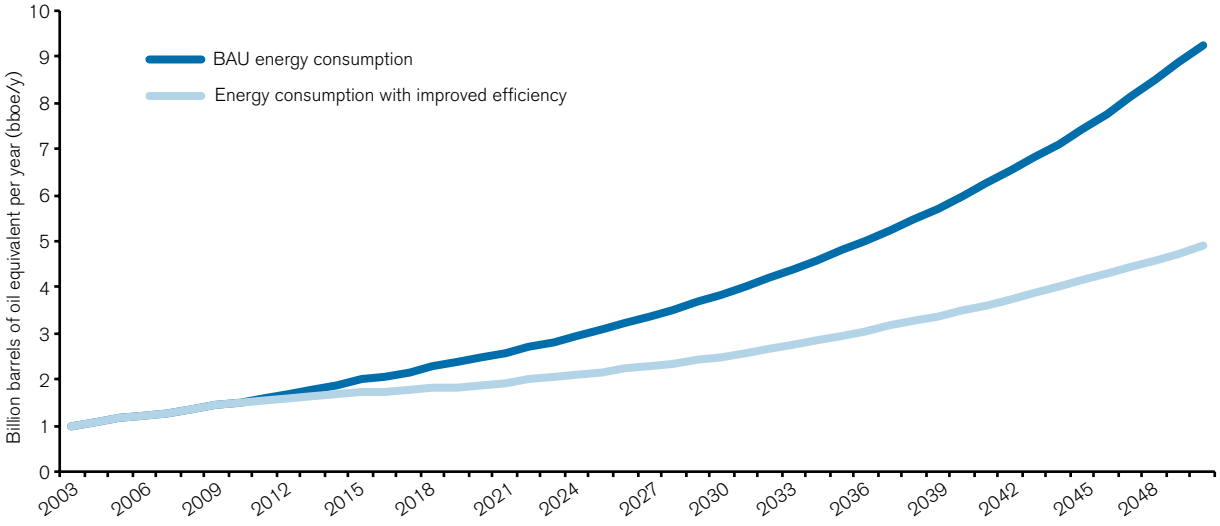
An economy-wide energy intensity target would provide an imperative for demand-side management across sectors. Results from other countries with energy-intensive industries are encouraging. For example, China has achieved an average 3% improvement over the last 20 years that will be carried forward in its 12th Five Year Plan. Poland is projected to achieve a 2.7% improvement per year from now until 2030. On the basis of what has proved feasible elsewhere, Chatham House ran a further simulation factoring in similar energy intensity improvements for Saudi Arabia. These suppose an initial reduction of 3% year on year between 2010 and 2020 as Saudi Arabia picked the low-hanging fruit, slowing to improvements of 2% year on year from 2021 to 2030 and 1.5% year on year from 2031 to 2050. This would alter the domestic energy consumption trajectory shown in Figure 1, delaying the end of oil exports by around ten years. Figure 11 shows the amount of oil that could be saved purely through increasing efficiency on this basis.

Figure 10: The effect on the Saudi fiscal account of renewable and nuclear energy additions with and without energy efficiency



Source: Chatham House 2011. See Appendix 1 for assumptions.
RE = Renewable energy additions; NU = Nuclear power additions; EE = Energy efficiency improvements.

Figure 11: Saudi domestic energy consumption – BAU vs energy efficiency improvements



Source: Authors' simulation

The increased government revenue would allow a further four to five years (on top of the renewable energy scenario) in which to set the economy on a more sustainable path. This is shown by the black line in Figure 10.

The addition of nuclear power, although factored into the scenario according to government targets, would have no impact on fiscal crunch points during this period because of the time it would take to bring on significant supply additions, in the face of rapidly growing power demand.

While many governments would like to reduce energy consumption growth, the difficult question is how to achieve this when current politics, markets, infrastructure and mindsets are geared so strongly towards consuming more. Below, we outline the main challenges that Saudi Arabia faces in effecting faster rates of progress on energy conservation with reference to some examples from other countries trying to do the same. (See Appendix 2 for more details.)

Box 2: Cool at the peak

Our simulation only takes into account annual power demand, projected at current rates and averaged out into fuel consumption per day. As mentioned above, in summer the peak demand can be 50% higher than the rest of the year. This presents a serious problem for power supply additions as these must have the capacity to provide for peak demand (often in the form of specially constructed peaking generation plants) even though this will not be used for most of the year. To tackle gas shortages and the recourse to burning oil to meet demand, the government will need to introduce strong demand-management-side policies to reduce this peak. These would be included in a comprehensive plan to reduce energy intensity and prepare people for higher electricity tariffs. Given that cooling is largely responsible for the summer peak, necessary measures include not only efficiency standards for new air-conditioning appliances but also measures to replace inefficient models and regulation on maintenance. In terms of building standards, these should apply not only to new construction but also to existing buildings. The latter will require special schemes to 'weatherize' homes and commercial and public buildings against the heat – see section on 'Managing the transition to higher prices' below.

Reversing the long period of low prices and vested interests

The longer the problem of low prices is allowed to continue unchecked, the harder it becomes to solve; there is an exponential correlation. This is evident in other countries that have a long history of holding prices low – Iran, Mexico and Nigeria, for example. Although Saudi Arabia does not have workers' unions, which have been a strong force for opposition in Mexico and Nigeria, powerful commercial and industrial entities currently benefit from low prices that increase profits – particularly for exports – and those in lower income groups, such as taxi drivers and small agricultural producers, whose livelihoods depend on a high volume of fuel, would be adversely affected. The energy used in lower-income households for basic needs including cooking and cooling take up a larger proportion of income than in richer households, meaning that price rises may affect their ability to pay for other necessities.

Moreover, cheap energy forms an important part of the social contract in Saudi Arabia as a hydrocarbons-rich country without the institutions of representative democracy. These issues would have to be tackled before or in tandem with price rises. This would mean consultation with potentially obstructive groups and individuals and a thorough plan for financial transfers (using the money saved/gained through charging higher prices for energy) or other offsets to ease the transition.

It also appears there are a significant number among Saudi Arabia's extended ruling family who simply refuse to pay energy bills and who are protected from the consequences because the suppliers are unable to seek redress. Thus even before considering higher prices, enforcement of payment by these elements would be required. This would also give some comfort to those already paying their bills and facing higher prices.

The question of electricity is related to issues of access and poverty. Given the nature of the social contract within Saudi Arabia, this is an emotive and important subject. Exclusion from access to electricity is very sensitive, whether it is the result of lack of physical supply because the absence of grid supplies is not offset by small-scale generation, or the result of prices that are too high for certain groups of consumers.

By far the best way to manage reform of electricity price is to start by establishing the 'correct' price based upon long-run marginal costs.[45] Once this has been agreed, it is feasible to adjust the price to the consumer to take account of other objectives ranging from equity issues to the financing of the sector.[46] The main benefit of this approach is that it makes explicit to the relevant authorities the true cost to a country of deviating from efficient prices. The 'reference price' would not be the recommended end-user price. Rather, it can be used to estimate the cost of subsidy to the end-use sector.

Managing the transition to higher prices

Some interesting approaches to energy price reform have been rolled out in Iran and Egypt.

In 2007 Iran attempted a gasoline rationing scheme which allowed individuals to buy a certain volume of fuel at the old subsidized price and anything above that at the higher price – an initial increase of 400%. The government intended this to continue to enable poorer people to meet their basic needs cheaply. The allocations were higher for those in certain occupations, such as taxi drivers and truckers. The Iranian scheme issued people with smart cards – which have been trialled in a number of other countries including Syria and Turkmenistan – to determine the price paid at filling stations. There were a number of serious teething problems such as the propensity of taxi drivers to sell their allowance on the black market and stay at home. However, the scheme appears to have had success in reducing gasoline demand – official figures in 2010 cited an initial reduction of over 20% since rationing began and slower year-on-year growth.

In December 2010, the Iranian government went further with the 'Targeted Subsidies Reform' to bring prices of fuel, electricity, water and food in line with market or cost levels over a five-year period. This involved payments to households, ready for withdrawal on the day of the price rises. A special fund administers the revenues from the higher-priced goods, initially allocating 50% in direct cash transfers to

45 'Correct' as defined in terms of economic efficiency.

46 Siddayao (1985).

families, 20% to businesses affected by price rises and 20% to the treasury to assist with implementation costs.[47] It is too early to assess the effectiveness of these reforms but so far prices have risen without the expected rioting.[48]

In Egypt, the government rolled out a scheme to convert public transport and taxis in Cairo to compressed natural gas (CNG), both to make the most of declining domestic oil production and to reduce urban pollution. It raised the price of diesel gradually while providing affordable financing schemes as an incentive to drivers and companies to make the necessary conversions, and to pay for the initially more expensive fuel. The interesting feature of this scheme was the public–private partnership that ensured the necessary investment in infrastructure (CNG conversion centres and filling stations).

Although CNG is not necessarily an answer for Saudi Arabia, whose demand for gas is already outstripping domestic production, the government could introduce similar public–private financing mechanisms to encourage and enable individuals and businesses to convert to a different kind of energy or a more efficient practice to offset the eventual higher costs of fossil fuels. This has the added benefit of creating a new market for services and products, and creating more jobs. In the United Kingdom, for example, where over a fifth of households are officially 'fuel poor' with respect to gas and electric power, new business models are being applied to the utilities sector.[49] The idea is to provide grants for investments that would not otherwise take place, such as home insulation, which are then paid back through lower fuel bills.[50]

Simple and usually cost-effective demand-side measures such as promoting better energy management, monitoring and maintenance can result in significant improvements in efficiency, especially in large energy-consuming industries. Yet they are often overlooked in favour of larger-scale supply-side solutions that may require much higher capital and running costs relative to fossil-fuel savings. Examples of efficiency standards success such as CAFÉ standards for vehicles in the United States or the industry Top Runner programme in Japan demonstrate the ways in which efficiency standards might be rolled out in industrialized countries with high energy intensities. Japan's scheme has the added benefit of progressive improvement of energy-using appliances – the best available energy efficiency standard currently in the market is set as the mandatory minimum within a fixed period of time.

Many countries, including oil exporters such as the UAE, are now legislating for more stringent energy efficiency standards for buildings, which – if properly enforced – will lock in lower growth in power demand. Currently available technology and practices can reduce heating and cooling energy bills in new buildings to close to zero. Industrial planning also needs to take on board the best global practice in efficiency and situating plants to reduce transport and energy costs, e.g. through clustering and the use of combined heat and power.

Schemes to weatherize existing buildings against heat are essential. These can help to offset higher electricity tariffs and can include measures to assist the poor. In the US, for example, the Department of Energy has run a weatherization assistance programme since 1976 to assist low-income families lacking the resources to invest in energy efficiency. Today this involves trained 'weatherization crews' with computerized energy audits and diagnostic equipment to determine the most effective measures for each home. The DoE claims that this reduces national energy demand by the equivalent of 24.1 million barrels of oil per year and creates around 75 jobs for every $1 million invested.[51]

Adapting passive infrastructure and adding small-scale power generation nationwide is one obvious way to prepare people for higher prices and conserve fuel. In Saudi Arabia, electricity is used to heat water

47 This has since been changed to a 80-20-0 division of funds and the idea of a utilities smart card is being discussed as an alternative to direct cash transfers.

48 The cost of rationed gasoline went up from around 38 cents to 144 cents overnight on 18 December 2010. For a thorough evaluation of this reform, see Gillaume et al. (2011).

49 A household is considered "fuel poor' in the UK if it spends more than 10% of its income on fuel for adequate heating – usually 21 degrees Celsius in the main living area, 18 degrees in other occupied rooms (UK Department of Energy and Climate Change (DECC) on 'Fuel Poverty', http://www.decc.gov.uk/en/content/cms/funding/fuel_poverty/fuel_poverty.aspx).

50 This is part of the government's 'Green Deal' scheduled to be launched in 2012. See DECC, http://www.decc.gov.uk/en/content/cms/legislation/energy_bill/energy_bill.aspx.

51 Weatherization Assistance Program Technical Assistance Center, www.waptac.org.

in many homes and businesses when rooftop solar water heaters (SWHs) could do the same at virtually no cost. As the experience of Egypt shows, new building legislation, regulation of equipment standards and a strategy to communicate the incentive schemes and benefits are all essential. For example, the poor quality of equipment and lack of financing schemes (or poor communication of financing schemes to potential users) in Egypt deterred both commercial and residential installation of SWHs.

A strategy would need to include local training in the necessary skills to install and maintain equipment such as SWHs and solar photovoltaic (PV) panels. Several schemes to introduce solar PV to buildings in developing countries have failed because the panels fell into disrepair and no one in the community was able to carry out the repairs or buy new components for them.[52]

Schemes such as these that affect the local built environment would benefit from a prior assessment of how best to make energy audits and the new infrastructure and adaptations attractive to businesses and communities. In urban areas of Egypt, for example, where there are many families inhabiting multi-storey buildings, satellite dishes compete for space with SWHs. In Saudi Arabia, there may be a different problem as SWHs might be considered primitive by wealthier households.

A similar perception problem could affect the case for public transport. However, although this had been one of the concerns about the Dubai metro system, this is proving popular, avoiding congestion and enhancing a modern city.[53]

Making energy policy coherent and effective

As is evident from the above examples, some of the cheapest and most effective efficiency improvements require the involvement and coordination of a range of existing agencies – ministries, legislatures, regulators, private and public companies, and municipal authorities.

One of the major challenges that Saudi Arabia faces is setting and implementing energy policy under its current bureaucratic structure, which has been described as 'hub and spoke' with little connection between ministries and agencies. There is also a general disconnect between government and business sectors when it comes to policy-making, with a lack of formal channels through which to engage sector forums.[54]

Saudi Arabia's government has protected or created 'islands of efficiency' such as the central bank and the KACST, but it is also hobbled by multiple agencies and semi-fiefdoms, with little coordination between them when it comes to implementing nationwide reforms.[55] K.A.CARE is intended to overcome some of these problems. Indeed, it is effectively a ministry of energy, superseding the authority of the ministries of petroleum and of electricity and water when it comes to new sources of power.[56] K.A.CARE and SEEC both include representatives of these and the relevant range of government and private-sector stakeholders on their boards. It is not clear at present how far K.A.CARE's remit will involve its rolling out energy strategies beyond introducing new sources of power.

Convincing the public

Addressing fuel consumption is part of a much larger effort in Saudi Arabia to raise awareness about the impacts of human consumption – particularly of water. The Saudi press often raises the problem of rapid domestic consumption of the country's oil wealth and quotes leaders on plans to introduce renewable and nuclear fuels to meet the power supply gap. But only recently has the need for energy *conservation* gained prominence. The issue is difficult for the government to articulate because it would appear at odds with

52 A major problem with using solar voltaic panels in Saudi Arabia has been the impact on them of dust accumulation and mud rains, which reduce their operating efficiency. A casual observation of new buildings in Riyadh incorporating solar panels suggests the architects have overlooked this problem. There has been a breakthrough in self-dusting panels – originally designed for use on Mars and lunar missions – which detect dust and use an electrical charge to repel it (New York Times, 2010). The mud is more of a problem as it sticks to the panels.

53 Gulf Today (2011). It is worth noting, however, that the system is still mainly used by expatriate workers rather than Emiratis.

54 See, for instance, Steffen Hertog's analysis of the debates and consultation that took place in the run-up to Saudi Arabia's accession to the WTO in 2005, 'The Fragmented Domestic Negotiations over WTO Adaptation', in Hertog (2010) particularly pp. 233–34 and pp. 244–45.

55 For more on this, see Hertog (2010), pp. 92–98.

56 See Article 3 of the Bylaws of the King Abdullah City for Atomic and Renewable Energy, in the Royal Decree for establishing the King Abdullah City for Atomic and Renewable Energy, 3/5/1431 AH (17 April 2010), http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf.

Saudi Arabia's image as an affluent oil and gas producer and the House of Saud's legitimacy as a provider of social goods. There is no civic 'duty to conserve' in the unwritten social contract between the royal family and its subjects.

One of the problems often cited by Saudis engaging with this problem is the lack of understanding of the concept of sustainability. The word in Arabic (*istidaama*) has only been applied in this context in the region for a few years. Since public education campaigns must be context- and culture-specific, tapping into people's core values or grievances, a Saudi campaign would have to make the case that a new system of pricing would raise standards of living among the poor and create more jobs.

Environmental awareness is culturally new in the country although there are some nascent attempts to promote it through Islam and local community improvement projects.[57] Concern about climate change is not high up the agenda in Saudi Arabia or indeed elsewhere in the GCC countries. Although the phenomenon is widely accepted, many still regard the multilateral agenda to mitigate it by reducing CO_2 emissions as a 'plot' to undermine the oil-exporting countries. By contrast, local air pollution is an issue of public concern, not least because its impacts are tangible and immediate. As in most other developing countries, the argument for greater efforts to reduce fuel use is more likely to be won through appeals to concerns about the effects on health than to concerns about climate change.

57 Bagader et al. (1983/1994), written by a group of scholars at King Abdullaziz University in Jeddah, sets out an Islamic perspective on these issues. Clerics in Saudi Arabia have shown little or no interest in the environment, unlike their counterparts in Indonesia and Malaysia, but there are some local initiatives, particularly in the Hijaz region, that are promoting environmental conservation through Islamic principles and teachings. See Lahn (2011).

6 The Relevance of International Experience

There is considerable international experience on how to use prices and regulation to improve energy efficiency and reduce energy intensities, which holds relevance for Saudi Arabia. (See Appendix 2 for country case studies.)

Overall, reforms appear to have a greater chance of success if they are undertaken as part of a coherent energy policy that aims at setting the country on a sustainable consumption path over time. This would take into account the environmental impacts of resource consumption and be closely linked with the economic vision for the country (as has been the case in Japan and Malaysia). This aspect is particularly relevant to Saudi Arabia because, as demonstrated above, its energy profile is so closely linked to its economic sustainability. If it can successfully reduce growth in domestic oil demand, it will effectively buy itself more time in which to lessen the economy's dependence on oil exports. As our simulations show, unless the government is banking on an ever-increasing international oil price, the next few years will be critical. The lessons that can be learned from the experience of different countries are listed below.

Lessons learned: raising the price

- Education campaigns and strong coherent government messaging are needed before reforms are introduced, explaining why price rises are necessary.
- Early consultation with affected groups – e.g. industrialists, workers unions, private transport companies – and clear explanation of provisions are necessary to minimize potential actions to sabotage reforms.
- There should be clear plans for robust compensation and transfers to the poorer sections of society and those whose livelihoods depend on high energy inputs (e.g. taxi drivers).
- Effective alternatives to replace energy-intensive practices must be installed in advance or in tandem with price rises – e.g. affordable public transport, adaptation to increase energy efficiency of existing buildings, specifically weatherization against high temperatures.
- There should be a period of assistance for the main stakeholders (e.g. energy-sector actors, energy-intensive industry) in preparing for the restructured price system.
- It is possible to protect the poor from the consequences of the removal of subsidies by applying 'lifeline rates', with a low price charged for a certain amount of energy above which the market price is charged.
- Some technical solutions such as smart cards can help facilitate pricing schemes. This would also be crucial if a system of price discrimination in favour of nationals were to be used. Such schemes and mechanisms must be accompanied by the adequate administration, legal framework and public education to explain why they are necessary and how they work. Thorough research into how a scheme will be received and how to avoid abuses (such as a black market) will improve its chances of success.

Lessons learned: regulatory solutions

- While individual industries will gain economically from measures to improve energy efficiency (especially where energy price increases are taking place) and therefore have an incentive to achieve them, governments can provide further incentives to progressive improvements by mandating energy monitoring and facilitating information exchange on best practice.

- Audits and voluntary pilot schemes to identify potential areas for improving efficiency in industry and commercial sectors can be an essential starting point, but these will not be maintained and spread without enforceable regulation, benchmarking, standards setting and labelling, and commitment to eventual higher energy prices over a fixed period.
- There is potential for capitalizing on climatic advantage by adapting passive infrastructure, often with low-cost technology – e.g. widespread installation of solar water heaters. Such measures can save a huge amount of energy over the long term but require a more thorough institutional approach than is necessary for adding new supply on a large scale. A public and industry education drive coupled with changes in building/planning laws and quality assurance for equipment are necessary for large-scale roll-out.
- Improving energy efficiency in the building sector is crucial to short- and long-term energy conservation. This will require tight regulation, monitoring and the authority to impose penalties where standards are not met.
- Clear short- and medium-term targets can assist building designers and constructors to achieve higher energy efficiency standards.

7 Conclusions and Recommendations

This report has examined the problem of excessive consumption of fossil fuel in Saudi Arabia. As it is the world's largest exporter of oil and the only one capable of using its spare capacity to stabilize global oil markets, this problem has global as well as domestic ramifications. Business-as-usual simulations show that the country's current trajectory is unsustainable, economically and politically. They also signal problems for the wider global economy, which, still being largely oil-dependent, will suffer if Saudi Arabia ceases to maintain a sufficient amount of export capacity. That a growing share of the country's own hydrocarbons production is being devoted to domestic needs is largely due to a history of very low energy prices. As noted with reference to international examples, any effort to conserve fossil fuels is severely constrained while prices remain so low.

Our analysis has shown that current government policies and targets are not enough. The addition of planned nuclear and renewables will not fill the demand gap in time. Raising the price of energy is the most obvious means of restraining consumption, but this risks being stalled or undermined by lack of public support or by powerful opposition from key groups that benefit from the status quo. Several countries have attempted price rises and other measures to smooth these reforms, particularly during the oil price spike of 2008 when countries that have to import oil products suffered from higher bills. Their experiences might be useful for Saudi Arabia, which is just beginning to address these issues, especially as it has no time to lose by making the same mistakes.

The key findings of our research are:

1. The rate of growth of domestic energy consumption in Saudi Arabia is a sign of inefficient energy use rather than of economic development and improved living standards.
2. Economic and social pressures caused by excessive energy consumption will appear in Saudi Arabia long before its oil exports end – within a decade if nothing changes.
3. Current policies are not enough. Announcements for renewable power supply additions would help maintain the fiscal balance for an additional two to three years; nuclear power, given the long lead times and high rates of consumption, would have little or no impact.
4. Huge economic, social and environmental gains in energy conservation are possible in Saudi Arabia but the long period of low prices and the bureaucratic structure of the state present several challenges to implementing effective pricing policy and regulatory measures. Fear of confronting these challenges has tended to deter meaningful government action in the past.

Messages and recommendations for the Saudi government are:

1. Early action is critical given the lead times necessary for economic diversification and the introduction of new technology. As a guide, our simulation showed that a national energy intensity improvement goal of a 3% reduction year on year between 2010 and 2020 and a 2% reduction between 2021 and 2030 could buy an extra five years to enable the transition to lower dependence on oil exports. International experience can offer help and guidance to the government in pursuit of ambitious but practical targets for individual sectors.
2. Some immediate, targeted investments could produce effective results even in the absence of price reforms. Given that air conditioning can produce a peak of up to 50% higher power demand in summer when it accounts for up to 52% of total demand, the government could make savings and increase social welfare through large-scale home weatherization programmes and installation of

energy-efficient air-conditioning units. Using regulation such as building standards and mandated appliance standards to slow the growth in energy demand would offer one of the most effective options for Saudi Arabia, if it could be implemented effectively.

3. Raising domestic energy prices is politically difficult but preparing society through a range of efficiency, educational and infrastructure adaptation measures can smooth the transition. Technology can help in providing affordable energy to those who need it most.
4. Any attempt to reform energy prices should be carried out within a package of measures that increase private-sector employment for Saudi nationals, such as public–private partnerships to adapt infrastructure and introduce energy-saving technologies.
5. In order to develop the right package of policies and win public support for energy reform, the economic costs of the domestic energy system should be unpacked and understood in the context of Saudi Arabia's vision for development. This should also form the basis of a public campaign and debate to encourage citizens to be aware of the issues and why action is essential, not least for the benefit of future generations of Saudis.

Appendix 1: Assumptions for Saudi Oil and Gas, and Economy Simulations

We have calculated domestic consumption as the difference between oil and gas produced in the country and oil, gas and refined products exported from the country. This is a simple measure of 'apparent consumption'. We have not separated out energy and non-energy consumption in the simulation, so oil and gas used as industrial feedstock are included. It is important to note that this is only one possible measure of consumption. Some of the oil, gas and refined products will be used as energy and feedstock in the refining and petrochemicals industries to produce non-energy goods, some of which will be exported. The figures for these inputs are not available so for the purposes of the Chatham House study they were treated as domestic consumption.

Assumptions

The Business-as-Usual Scenario (BAU)

Oil

- Non-hydrocarbon (NH) GDP grows at 6.3% per annum between 2010 and 2014, then by 5% per annum from 2015 onwards.
- Oil price held at $77/barrel.
- Domestic energy consumption grows at 90% of NH GDP.
- No new reserves of oil are added; these remain at 264.1bn barrels (2008).
- Oil production follows national depletion policy. Crude production does not exceed 12.5mb/d (13.1 if NGLs are included) and maintains plateau production for 30 years before allowing a depletion rate of 3% per annum.
- A minimum of 1.5mb/d of crude spare capacity is maintained.

Gas

Because gas can alleviate the demand for oil in the power sector, the scenarios are sensitive to gas assumptions. The gas assumptions used in the BAU scenario are as follows:

- Gas reserves follow Saudi Aramco's stated aim, which is to discover 3–7tcf/y of non-associated gas, adding the oil equivalent of 5tcf/y in barrels (0.95 billion bbls/y) to 2020.
- Gas consumption is only met by domestic production – this follows Saudi Aramco's aims to 2015, then holds steady with no reserves-to-production constraint.
- Additional associated gas is projected at 43% of additional oil and NGL production.
- Oil makes up the additional energy requirement, when gas production ceases to grow.

Fiscal account

- From 2009, government non-petroleum revenue equals previous year's figure multiplied by the NH GDP growth rate.
- Government expenditure from 2009, previous year multiplied by the NH GDP's growth rate.
- The model does not factor in inflation.
- Foreign reserves are 'total reserve assets' held by the central bank to 2009, and projected by simply adding to the previous year's figure the surpluses from the current account balances for the current year (when there are surpluses).

- Foreign income is calculated at 3% of total foreign reserves.
- Foreign reserves are not drawn down (although we include income from them in the fiscal account balance and could easily adapt a scenario to show reserves being run down).
- Petroleum export earnings are given as oil exports and bunker sales to 2004, when the central bank changed its reporting categories and stopped disaggregating bunker sales. Only 'oil exports' are included to 2009.
- No revenue is assumed from domestic oil or gas sales.

Current account

Although the modelling for the current account is not discussed in this paper, the deficits follow a similar pattern, affecting Saudi Arabia's ability to pay for imports. Assumptions and projections are as below.

- Non-petroleum exports grow by 10% between 2010 and 2014, as projected by the 9th five-year development plan, and then at NH GDP growth rate.
- Total imported goods are increased at the NH GDP growth rate.
- Non-petroleum imports (goods) are total imports minus 'oil-sector payments'.
- 'Oil-sector payments' are held steady at $4bn per year.
- NH imports (services) include private services plus freight and insurance, and is projected at the average of 7.7% annual growth (the same as that projected for 2010–14 in the 9th five-year development plan).
- Non-hydrocarbon employee compensation debits are projected out at $1bn per year.
- Private transfer payments (including workers' remittances) are held steady at 2009 levels of $25.3bn per year.
- Government service payments are held constant at $28 bn per year from 2010.
- Government transfer payments are held constant at $2 bn per year from 2010 – just over the 2009 level of $1.92bn.

Data used

The main economic data used are from the Saudi Arabian Monetary Agency (the central bank) report 2010 and go up to 2008 or 2009.

For oil, we have used BP data for the consumption and production numbers (relying on data from the US Energy Information Agency to separate out NGLs). For gas production we have used Saudi Aramco data, given that future gas production in the simulation is based on Saudi Aramco projections.

We acknowledge that there is variation in the data sets for oil and gas consumption depending on which accounting method is used (e.g. data for petroleum consumption for 2010 is given variously as 2.3 mb/d (Saudi Aramco *2010 Annual Review*), 2.5 mb/d (IEF 2011 JODI Database) and 2.8 mb/d (BP *Statistical Review of World Energy 2011*). Using data from different sources would alter the simulations and therefore the country's timeframe available for transition. We used BP's statistics because they attempt to reflect total oil demand including crude burnt directly as fuel and refinery fuel and loss.

The Renewable Energy and Nuclear Power Scenario (RE + NU)

- Renewable sources used to generate an increasing share in the national electricity mix: 10% by 2020, and 30% by 2030, remaining at this level thereafter. Official sources in Saudi Arabia have indicated a target of 10% by 2020 and these are arbitrary estimates up to 2030.
- Nuclear power comes on-stream in 2021, initially meeting 2% of electricity demand. This share increases at 2% per year to reach 20% in 2030 and remains at this level. This is based on the 2011 K.A.CARE announcement that Saudi Arabia will have two nuclear power stations established in 10 years, and two more each year until the total reaches 16, and that these will eventually provide for 20% of electricity demand.

- Renewable and nuclear sources displace only oil in the electricity mix.
- Oil-fired electricity generation uses an average of 1.8mb to generate 1 Terawatt hour (TwH) – this is based on International Energy Agency data for 2007 and 2008.
- Gas increases in the national energy mix follow the scenario in the BAU Scenario above.

The Energy Efficiency Scenario (EE)

- Energy efficiency is calculated at an annual improvement rate of 3% between 2010 and 2020, of 2% between 2021 and 2030, and of 1.5% between 2031 and 2050. This is based on a feasible level of improvement for Saudi Arabia based on the experience of industrializing countries.

Appendix 2: International Examples of Attempts to Conserve Fuel

Urgency versus political limits – Malaysia

Malaysia is unusual among oil exporters in having operated energy policies since 1979. These initially focused on oil- and gas-sector management and diversifying the fuel mix, but energy conservation has moved up the political agenda in the last decade. The country's success in diversifying its economy and developing a strong export-led manufacturing sector has been largely accomplished through the provision of subsidized energy and tax breaks to industry. But as demand outpaced national refining capacity (Malaysia spent around $12.4bn on imported oil products in 2010), this began to threaten the economy with rising subsidy costs, adding to the country's 5–6% fiscal deficit.[58]

In the wake of the 2008 oil price spike the government raised fuel prices four times.[59] Subsequently, there was a restructuring of the fuel subsidy, with prices controlled by government but linked to the world market. Cash rebates were made available to vehicle owners based on engine capacity.[60] The government's poor performance in the 2008 general election was largely attributed to the fuel price rises and eventually forced Prime Minister Abdullah Ahmad Badawi's resignation.[61] Peaceful protests took place when the petrol price went up by 41% in June 2008 and there was strong public feeling that subsidies should be paid from state oil company Petronas' profits while the international price of fuel was high.

In January 2010, the government announced a dual price structure for fuel, based on citizenship. Foreigners are expected to pay market price while citizens will have subsidy allocations based on engine capacity.[62] Prime Minister Najib Razak's New Economic Model (March 2010) aimed to remove distortions in the economy, including subsidies. Opposition parties criticized the proposed reform package as an example of double standards, citing the favourable treatment of big corporations over citizens facing subsidy cuts. The opposition is not against raising energy prices but calls for this to be done in tandem with restructuring concessionary systems to reduce gains for corporates. The government has had some success with raising the price incrementally – the price of the popular RON95 gasoline blend has gone up three times in the last two years (from 57 to 62 US cents per litre), in tandem with measures to cushion the impact such as increasing the salaries of low-ranking civil servants. With oil prices again breaching the $100/b mark in 2011 and the fuel subsidy bill set to rise by almost 50%, the government is under pressure to apply more price rises but remains cautious of the impact on voters.[63]

In Malaysia the argument for removing subsidies has largely been won. The main challenge is the perception of unfairness. Ordinary voters see the big companies – especially the private and foreign ones – receiving substantial benefits from the subsidies (e.g. financial transfers to power companies or levies collected by road toll concessionaires) while they are being asked to pay more for energy.

Entrenched interest groups – Nigeria

The Nigerian experience illustrates the classic problem that the longer the problem of low prices is allowed to continue unchecked, the more difficult it is to solve – a problem that increases at an exponential rate. Nigeria's situation is particularly desperate; in spite of being the world's eighth largest oil exporter, it must meet around 85% of the domestic demand for fuel through imports as it lacks the necessary refining

58 Malaysia, Department of Statistics (2010).
59 Reuters (2010a).
60 New Straits Times (2008).
61 Reuters (2010b).
62 The Star (2010).
63 Reuters (2011).

capacity. The subsidized price of fuel in turn deters investment in refining, while encouraging growing consumption.

The national oil company's subsidiary, Pipelines and Products Marketing Company, has the monopoly on imports of petroleum products but private marketing companies sell the products at local prices and are compensated through the state's Petroleum Support Fund, which pays the difference between the fixed price and the international price.[64]

Government reform plans followed by U-turns on subsidy removal have been a regular feature of Nigerian politics. For example, in June 2003 the price of regular gasoline was raised from 26 to 40 Naira. There was an immediate general strike and the increase was eventually reduced to 36 Naira. Nigeria appears to be stuck in a bind on the fuel pricing side. According to the Nigerian Extractive Industries Transparency Initiative (NEITI) Director of Services Stan Rerri,

> *[s]uccessive governments have also tried to fully deregulate the downstream market by allowing open price competition but labour groups maintain that removal of the subsidy for petroleum products, particularly petrol used by taxis and buses and kerosene for cooking, would impact negatively on low income earners and have a dire effect on consumer prices and industrial production costs through fuel inflation.*[65]

A major problem in trying to reform the Nigerian energy sector is that the system, in existence for many years, has become extremely complex and therefore requires complex reforms. In addition, the system has created a very large set of interest groups that as a diverse coalition have the desire and the power to block reform. In the words of the Governor of the Central Bank in June 2010, 'Subsidy is creating a pool of funds for a cabal. These are the same people who borrow from banks and do not pay … the same people who are rigging elections'.[66]

Rationing and smart cards – Iran

In 2005, President Mahmoud Ahmadinejad was elected on a platform of increased social services and aid to the poor, implying the continuation of subsidies. By 2007, consumption and imported petrol prices were so out of control that the government introduced petrol rationing and raised the price by 25%. This was introduced with only two hours' notice to the public and resulted in widespread protests with 12 service stations in Tehran burnt down.

Planning for the rationing system based on electronic smart cards began in 2004 and cost $100m over two years. The scheme initially involved adapting 1,500 service stations and distributing 12 million cards.[67] However, there were serious problems in the early stages. First, there were lengthy queues (often over 30 minutes). Also there were no passwords on the cards and no audible reminder for them to be removed once the transaction was completed. The result was many cards were inadvertently 'recycled' by others. Cards were also widely available on the black market.[68]

The quantity of subsidized gasoline was increased to 120 litres per month in 2008 but that was reduced to 80 litres in early 2009, and 55 litres in October 2009. The official line was that the rationing had reduced consumption by 20 million litres per day. However, by mid-2008 concerns about the effectiveness of the policy were being raised. First, an active black market had developed, but more important was that government organizations and certain individuals were exempt. There were in fact 45 different categories of exemption. There were also claims that taxi drivers were simply re-selling their ration allocation and staying at home, making more money than by working.[69] Nevertheless, by July 2010 the National Iranian Oil Distribution Company claimed that rationing had saved some $11bn in imported fuel costs since

64 Rerri (2008). Those who are actually importing the products are allegedly making huge profits.
65 Rerri (2008).
66 NEXT (2010); AllAfrica.com (2010).
67 Wolfensberger (2007).
68 Safavi (2008).
69 Tahmassebi (2007).

2007.[70] The government further raised prices in December 2010 as part of a much wider subsidy reform plan and registered a per capita reduction of 3.5m litres/d in the Iranian year 2010–11 compared with the previous year.[71]

Changing the vehicle fuel mix – Egypt

Egypt is in the process of dealing both with the transition to reduced oil dependence and with the country's poverty levels through a variety of measures that affect energy production and consumption. Total fuel subsidies for 2007–08 cost the government $10.95bn, or the equivalent of 7.1% of GDP (compared with public spending on health of only 4.5%).[72] Of this, about one-third went on gas subsidies to energy-intensive companies.[73]

Egypt has been a pioneer in the region in terms of the replacement of diesel by compressed natural gas (CNG) for taxis and microbuses in Cairo. The government introduced this policy in 1995 as an answer to heavy air pollution and to help cut dependence on gasoline. CNG is both cleaner in terms of tailpipe emissions (about 85% fewer harmful pollutants than diesel) and a domestic resource more abundant than oil. The policy appears to have been remarkably successful owing to strong support from key influential individuals and groups within government, private-sector engagement from the beginning and public acceptance given the urgency of the pollution problem.

The petroleum ministry was the driving force behind the policy and before rolling out the scheme it directed two pilot projects to ensure good performance of CNG as a fuel and the viability of the support infrastructure. This involved two public–private joint ventures, Gulf of Suez Petroleum Company and Petrobel, which set up fuelling stations and conducted 180 vehicle conversions. The ministry then promoted the formation of two companies including local and international partners to commercialize the scheme. The market 'chicken and egg' problem was overcome by a ministerial decree that requires all approved CNG companies to build and operate CNG fuelling stations, and construct and operate vehicle conversion centres, thus developing a self-reinforcing market.

Owners of taxis were encouraged to convert by the cost savings they could make based on a 55 piastre difference between a litre of gasoline and the equivalent CNG unit. But because most potential customers did not have the capital to pay the 5,000 Egyptian pounds for the conversion, the two companies offered financing programmes that took a small initial payment and then monthly instalments for up to three years. High-use vehicles could recover their costs in just six months. To facilitate payment further, in 2002 the industry introduced a 'Gas Card' system which allows customers to pay the (higher) gasoline price each time they refuel with CNG, with the extra money then credited against their loan.[74] More than 122,000 vehicles were estimated to be operating on natural gas by 2010.[75]

The sustainability and upscaling of CNG is dependent on several costs being covered, including the implementation of new infrastructure (CNG fuelling stations), conversion of vehicles to natural gas engines and specialized CNG fuel tanks, and the operating and maintenance costs of vehicles, which required training for mechanics in a new skills set.[76] Initially there was no cost advantage for the ordinary driver choosing CNG gas over diesel. This situation would have made investment in CNG conversion illogical without government support as the cost of diesel was heavily subsidized (around five piastres lower than the equivalent volume of CNG). This is being addressed as part of fuel price reforms and the diesel price is now around double that of CNG.

70 IMRA (2010).
71 Mehr News Agency (2011).
72 Oxford Business Group (2010), p. 12; USAID Egypt; Egyptian Ministry of Health and Health Systems 20/20 (2010).
73 Reuters (2010c).
74 Chapel (2002).
75 Egypt State Information Service (2010)
76 Chemonics International Inc./USAID (2004).

Promoting progressive appliance efficiency standards – Japan

Japan has one of the most energy-efficient economies in the world. Its almost total dependency on oil and gas imports has encouraged it to seek both diversification of supply and demand-side solutions. Japan's energy efficiency and demand programme, begun in the 1970s, is considered to be a world leader, having resulted in lower energy intensity and brought the benefits of greater security of supply and improved balance of payments.

Between 1973 and 2003, Japan cut its energy intensity by approximately 37%.[77] Most of the effective measures were taken early on and the pace of improvement has slowed since the mid-1980s.[78] Some of the most significant improvements were in the industrial sector. Between 1973 and 2005, energy efficiency improved by 20% in the steel sector, by 52% in the pulp and paper sector, and by 29% in the chemical sector.[79] These improvements have been largely achieved through the implementation of the provisions of the Energy Conservation Law, which required companies that consumed over 3,000 kilojoules (kj) of energy to appoint energy managers and submit mid- and long-term energy reduction plans and reports on energy usage. While companies with smaller energy usage were also required to take action, they only had to appoint energy officers and make reports on energy usage. In addition, subsidies were made available for energy-management systems and high-performance equipment.[80] These simple measures bought significant initial benefits and captured the 'low-hanging' fruit of better energy management and good housekeeping.

Japan's Top Runner programme has been one of the most successful innovations in stimulating long-term, progressive efficiency. It is a regulatory scheme designed to stimulate the continuous improvement of energy-efficient products within selected segments of markets for household and office appliances and vehicles.

The key feature of the programme is its focus on the supply side, not the demand side, of product markets, with the obligation to comply with regulations resting entirely with manufacturers and importers. The Top Runner programme is designed to undergo regular revisions, allowing its scope to be continuously improved. The best available energy efficiency standard currently in the market is set as the mandatory minimum within a fixed period of time. At the end of this period the process is repeated. This encourages manufacturers to introduce innovations as quickly as possible in the knowledge that all their competitors must also do so. If they go further than the minimum they gain a competitive advantage, knowing that their rivals will have to follow suit.

To date eighteen product categories have been brought into the programme, including passenger vehicles, air conditioners, fluorescent lights, cathode-ray TV sets, copy machines, computers, magnetic disk units, diesel and gasoline freight vehicles, video cassette recorders, fridges and freezers, gas and oil heaters, gas cooking appliances, gas water heaters, electric toilet seats and vending machines. Further consideration is also being given to electric rice cookers, microwave ovens and heavy vehicles and industrial processes.[81]

Capitalizing on passive infrastructure – Egypt

The installation of about 200,000 domestic passive solar water heating units (SWHs) is estimated to save Egypt the equivalent of around 85,000 tonnes of oil annually. However, much more could be done. Much of the fossil fuel burnt in Egypt for heating water or generating steam could be replaced by using this relatively simple existing solar technology. Heating for industrial processes such as sterilization, laundering fabric and pasteurizing milk is the largest untapped potential application for solar energy in Egypt. But there are several obstacles to overcome, including the perception of risk and examples of malfunctioning poor-quality SWHs provided by the government and used by state contractors.

77 Mori (2008).
78 Surprisingly, Japan has one of the worst records on improving the energy efficiency of its economy if 1990 is taken as the baseline.
79 IEA (2008).
80 Kodaka (2008).
81 Ibid.

The government issued a ministerial decree in the mid-1980s requiring all homes in new communities outside the cities to use solar water heating. However, the scheme has not had the scale-up expected. One report said that 'most are believed to be inoperable or disconnected'.[82] It also found a lack of awareness of the potential financial incentives available. Factories that apply clean energy solutions are eligible for a grant from the Cairo-based Industrial Modernization Centre equivalent to 15% of the conversion cost.

At a residential level, it is estimated that it will take only five years, even at current subsidized energy prices, for a family to realize a saving from a SWH. The problem is the high initial cost (about $1,200 for a 360-litre model) and competition for roof space in a country in which most urban residential buildings are multi-occupancy apartment blocks of at least five storeys.

There are no government financing incentives for residential customers/landlords at present. However, the subsidized oil and gas prices further mask the benefits of converting to solar water heating. One estimate by a solar technology firm puts the payback period at about ten years for converting from gasoil and at about six years from natural gas with subsidies, whereas in the absence of subsidies an investment in conversion from natural gas would pay back in less than four years. There are also strong calls for sticks as well as carrots. 'We need legislation establishing that building permits will not be issued to investors unless they install solar water heaters on the roofs of their buildings,' said Hisham El-Agamawy, head of energy projects at the Egyptian Environmental Affairs Agency.[83]

82 Inter Press Service (2009).
83 Ibid.

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