

availability, as high gas supply will mean more gas-fired capacity.

**The solution may lie in a gradual approach**

We use the overall economic gain to gauge the efficacy of the alternative policy scenarios. This measure is defined as the discounted sum of the annual differences between aggregate revenue and social cost relative to a policy where current industrial fuel prices are unchanged. Immediate deregulation of prices generates the largest economic gain for the Kingdom and serves as a benchmark against which other policy options are assessed. When decisions are made based on deregulated prices, the higher economic value of oil leads the sectors to forgo its use, resulting in economic gains from its potential export.

Our results suggest that a more gradual transition, such as that in the second and third alternative policies, can achieve the vast majority of the benchmark economic benefits, without the shock of immediate deregulation. Furthermore, we find that most of the gains of immediate deregulation can be attained by raising fuel prices slightly (to well below their deregulated values) and offering financial support to the utilities for constructing renewable and nuclear capacity. The introduction of investment credits reduces the cash outflows that would be incurred by the utilities in a deregulated setting.

The observed overall economic gain does not necessarily mean that no additional costs are sustained if the analysed policies are implemented. But the incremental revenue of the aggregate system, which is mainly driven by the value of the oil saved, is higher in magnitude in all alternative scenarios than the corresponding additional costs. While the energy system as whole enjoys a substantial economic gain, the power and water utilities will experience higher costs by increasing fuel prices, since the prices of their products are unchanged. Manufacturing sectors that can export are able to alter the mix of exported products to gain increased revenue. The additional costs experienced by the petrochemicals sector are, however, alleviated by honouring existing long-term contracts that keep feedstock prices at the current values. The utilities' costs are mitigated in an investment credit policy in which the government bears a proportion of new capacity cost. The resulting lower net revenues in the alternative policy scenarios may either be absorbed by the sectors themselves or covered by financial transfers from the government.

**Transitioning into a more efficient Saudi energy economy**

Policies targeting industrial sectors such as petrochemicals, cement, and the power sector may be viewed as a first step in achieving a more efficient

.....  
**'... LARGE REDUCTIONS IN DOMESTIC FOSSIL FUEL USE CAN BE REALIZED BY THE ALTERNATIVE INDUSTRIAL FUEL PRICING POLICIES.'**  
 .....

Saudi energy system. We show that large reductions in domestic fossil fuel use can be realized by the alternative industrial fuel pricing policies. The higher prices and/or financial incentives induce investment in more efficient industrial production technologies. While efficiency improvements are made over time under a business-as-usual scenario, the current prices would not encourage investment in renewable and nuclear power generation; also, crude oil would still be burned in large quantities to satisfy electricity demand. Although deregulated fuel prices induce the deployment of renewables and nuclear and achieve the highest economic benefits, the drastic increase in prices may not be politically tenable. Instead, our analysis shows that a large part of these economic benefits can be attained without a drastic surge in prices. Therefore, policies comprising a moderate increase in fuel prices, coupled with investment credits for non-hydrocarbon technologies, would facilitate the construction of renewable and nuclear plants in the Saudi power system, and attain most of the benefits of deregulation. Investment credits also alleviate the power sector's expenditure requirements.

**Reforming end-user energy prices could rationalize GCC energy demand**

Jim Krane

The six GCC economies – Saudi Arabia, the UAE, Oman, Kuwait, Qatar, and Bahrain – are some of the world's most profligate consumers of energy and emitters of greenhouse

gases, relative to their size. Other hydrocarbon exporters in the region, notably Iran and Algeria, are beset by similar circumstances. Observers have attributed this state of affairs to

the very low prices at which energy is sold in these countries. However, there have been few attempts to quantify the effects of subsidies on domestic consumption.





This article takes a simplified approach to a complex topic by posing the following questions: What would happen if fuel and electricity prices in the Gulf monarchies were increased to world market levels? How would consumers respond? More specifically, would electricity demand in Abu Dhabi adjust to look more like that in unsubsidized, but otherwise similar, Arizona?

.....

**'SOCIAL CONTRACTS ... REQUIRE REGIMES TO GIVE SUBSIDIZED ENERGY AND OTHER BENEFITS TO CITIZENS IN RETURN FOR POLITICAL SUPPORT.'**

.....

To regional experts and policymakers, these questions might sound overly hypothetical, even radical. Social contracts in the Gulf are understood to require regimes to give subsidized energy and other benefits to citizens in return for political support. In this context, subsidy removal could provoke social unrest. Despite the risks, the Gulf states have attempted reforms of subsidized energy prices, with varying degrees of success. The UAE's lifting of transport fuel subsidies in August 2015, if sustained, may offer some incentives for neighbouring states. Reforms have been catalysed by ominous projections that rising domestic energy consumption will bring about premature declines in oil exports.

Across the Gulf, Iran's ongoing subsidy reform, in which citizens are compensated with cash for acquiescing to higher prices, has been touted as a model for raising prices without inducing a backlash on the streets. My own survey work suggests that a majority of Saudi citizens would, like Iranians, agree to higher prices on electricity if compensated. The gathering momentum toward subsidy reform in the Gulf makes it worthwhile to consider whether increased prices on transportation fuel and electricity

would significantly reduce the region's runaway energy demand.

**Low prices inflate demand**

Price is just one determinant of energy demand, alongside income, population, technology, and climate. Price affects demand in two ways: directly, by influencing choices in consumption of fuel and electricity; and indirectly, through choices of energy-consuming equipment and its efficiency, as well as how often it is used. In the Gulf, low prices relative to income offer little incentive for conservation, compared with the effects of pricing in unsubsidized markets.

Several authors have reached similar conclusions. Alyousef and Stevens describe low and subsidized prices in Saudi Arabia as *'the single most obvious explanation for the extremely high levels of energy use'*. Mehrara finds that subsidies in oil exporting countries explain their otherwise *'implausibly high energy intensity'*. Bourland and Gamble show that the kingdom uses ten times the global average of oil per unit of GDP, and argue that the *'key reason for the rise in consumption is very low energy prices'*.

**How would energy consumption change if prices were dramatically increased?**

In the short run, energy demand is understood to be inelastic; meaning that it is unlikely to respond in a dramatic fashion to an increase in price. In the longer run, energy demand is more elastic. Over time, consumers will change their behaviour and upgrade technology and building envelopes, thus reducing exposure to higher prices.

Here, I provide results of two series of calculations that focus on the long run. The first uses price elasticity to demonstrate that a hypothetical

subsidy removal would *significantly* reduce energy demand in the GCC states. The results infer that a large portion of the region's outsized energy demand is indeed due to very low prices.

The second calculation uses a less hypothetical comparison of subsidized electricity demand in Abu Dhabi with unsubsidized consumption in Arizona. This exercise offers a way of controlling for income and climate effects, since both places are similarly hot and wealthy. By raising Abu Dhabi prices to Arizona levels, demand in Abu Dhabi falls sharply, but average consumption still remains higher than that in Arizona.

**How sensitive is consumer behaviour to price?**

Some scholars argue that energy demand in the wealthy Gulf is probably not very sensitive to price, and that a US\$1 increase in price would have a smaller corresponding effect on demand than in an unsubsidized market. This argument is probably correct, but it overlooks the magnitude of the differences in energy prices between the Gulf and unsubsidized markets. Therefore, even at the relatively low estimates of price elasticity that circulate in literature on the Gulf, the price increases required to cover the full cost of energy products are so large that the resulting reductions in demand become significant.

A price elasticity of  $-1$  implies a one-to-one relationship between price and demand. Here, I use a modest but plausible estimate of  $-0.3$ , meaning that a 1-point increase in price would produce a 0.3-point reduction in demand. This figure lies within the range covered in the literature, and represents the lower of two price elasticity estimates used by the IMF in a 2012 paper on Kuwait.

Effect of price increases on energy consumption in Gulf states				
	Price (US\$)	Unsubsidized price (US\$)	% price increase to displace subsidy	% decrease in long-run demand at -0.3
Kuwait: electricity	0.007	0.135	1,829	-59
Kuwait: gasoline	0.23	0.65	183	-27
Saudi Arabia: gasoline	0.16	0.65	306	-34
Abu Dhabi: electricity (expatriates)	0.041	0.089	117	-20
Abu Dhabi: electricity (citizens)	0.014	0.089	536	-43
Oman: electricity	0.026	0.1	285	-33
Oman: gasoline	0.31	0.65	110	-20

**Note:** Electricity prices are in kWh and gasoline is priced per litre. Current prices and estimates of unsubsidized prices compiled by author. Price elasticity estimate is based on the lower figure used in the document 'Fuel Subsidies and Energy Consumption: A Cross-Country Analysis', Rodriguez, P., J. Charap, and A. Ribeiro da Silva, *Kuwait Selected Issues and Statistical Appendix, IMF Country Report*. Washington: International Monetary Fund. 2012. Demand effect calculations are based on energy demand formula in the same document, which uses a non-linear function that reflects effects of large price increases. Expatriates receive smaller energy subsidies in some countries.

Using a non-linear equation for price elasticity – due to the very large price increases needed to rationalize prices – the IMF found that Kuwait would have to raise its gasoline price by 183 per cent (from US\$23 to US\$65 per litre) to eliminate the implied subsidy. Faced with such an increase in gasoline prices, Kuwaiti consumers would reduce consumption by about 27 per cent (see the table *Effect of price increases on energy consumption in Gulf states*).

However, Kuwait's electricity pricing is distorted by a much larger subsidy relative to that on gasoline. Government figures show that the electric power subsidy covers about 95 per cent of the total cost. An increase of 1829 per cent would be required for a full rationalization of electricity prices. Such a massive price increase implies that long-run demand would respond by decreasing by 59 per cent, even when using the IMF's non-linear formula.

It is probably unrealistic to expect such a huge increase in price or decrease in demand. Regardless, the calculation remains useful in quantifying the outcome of the government's policy which has left

electricity prices untouched since 1966.

The table *Effect of price increases on energy consumption in Gulf states* extends this method across various energy products in the Gulf. It shows reductions in long-run demand that would occur from price rationalizations, using a price elasticity estimate of -0.3 and the adapted IMF demand formula. Results show significant decreases across the board. These range from a 20 per cent reduction in electricity consumption by expatriates in Abu Dhabi (who pay higher electricity prices than citizens), and of gasoline in Oman; to reductions of about a third in demand for gasoline in Saudi Arabia and for electricity in Oman; to a drop of 43 per cent in citizen power consumption in Abu Dhabi and, as mentioned, a 59 per cent reduction in Kuwait. Of course, short-run effects would be smaller.

Regardless of whether one regards such price increases as a political possibility, these results suggest that price exerts strong encouragement of energy demand in the Gulf. The results also imply that a full reform of subsidies, all else being constant, would palpably reduce demand.

### Comparing consumption in Abu Dhabi and Arizona

Moving to a less hypothetical example, to what extent is electricity consumption explained by price when comparing subsidized and unsubsidized markets that exhibit otherwise similar characteristics? In other words, what happens to consumption when controlling for income and climate?

The UAE emirate of Abu Dhabi and the US state of Arizona exhibit many similarities; these include a hot climate (average temperature 27 °C in Abu Dhabi and 24 °C in Phoenix), and high incomes (2007 GDP per capita US\$76,000 in Abu Dhabi and US\$42,000 in Arizona). But electricity prices are very different. Arizonans paid an unsubsidized average tariff of US\$9.7/kWh, while Abu Dhabi nationals (until prices were increased slightly in 2015) paid just US\$1.4 and expatriate residents paid US\$4.1. Comparing these cases offers a 'natural experiment' with most variables held constant, while prices vary.

As the table *Comparison of electricity consumption in Abu Dhabi and Arizona* shows, the two markets



exhibit major differences in household electricity consumption, with Arizonans consuming just a fifth as much electricity as Abu Dhabi nationals and just over half as much as expatriates in the emirate. Despite consuming so much less electricity, the average Arizona household still paid significantly more, on average, than households in Abu Dhabi.

How important a factor is price in determining the differences in electricity consumption between these two markets? Using the same price elasticity formula, would equalized prices lead Abu Dhabi's consumption to resemble that in unsubsidized Arizona?

For Abu Dhabi nationals, raising prices to match those of Arizona leads to a drop in long-run demand from 71,000 kWh/year to 40,000 kWh/y. This revised consumption figure, while remaining far larger than the 14,000 kWh/y per capita consumption in Arizona, suggests that price contributes considerably to demand. The remaining difference implies that other factors – such as higher average temperatures and incomes in Abu Dhabi, and the characteristically larger size of Emirati households and homes – remain important. Low prices also encourage path-dependent long-term structural effects which skew consumption patterns over time, and which cannot be undone to the same extent through price increases.

For Abu Dhabi expatriates, with typically smaller families and homes, rationalized prices adjust their consumption closer to that of Arizona. Using the price elasticity estimate of –0.3, long-run demand drops to 20,400 kWh/y, about 45 per cent above that of Arizona.

**Reforming end-user prices could help rationalize demand**

These calculations are intended to be simple illustrations of the role of price in energy demand in the Gulf, rather than an econometric disaggregation of all components of demand. Taken together, these two sets of estimates show that subsidized prices in the Gulf account for a significant share of energy consumption, which might be plausibly estimated at *between one fifth and one half of total demand* for electricity and transportation fuel.

.....  
**'REFORMING END-USER SUBSIDIES BY RAISING PRICES WOULD GO A LONG WAY TOWARD RATIONALIZING DEMAND.'**  
 .....

Reforming end-user subsidies by raising prices would go a long way toward rationalizing demand. But price reform would not, by itself, be sufficient to permanently halt increases in energy demand in countries where growth in population, wealth, and industrialization continues.

Besides the benefits in reduced energy consumption, reforms would ease public spending and provide governments with increased revenue, since subsidies impose a cost, in fiscal terms and in lost opportunities to earn the full market value of natural resources. Reduced demand would also allow these countries to maintain hydrocarbon exports for a longer period.

However, one must view estimates for very large savings with some scepticism. Today's consumption is based on prices and development decisions made in a previous era. This means there is path-dependence on higher levels of demand based upon structural factors that cannot be changed as easily as prices. These include the patterns and density of human settlement, the prevailing characteristics of the built environment, and the available transportation alternatives. One cannot be certain whether the extent of this path-dependence is fully captured in the price elasticity calculation, an area where further research would be useful.

Finally, while these hypothetical reforms provide another important demonstration that low prices carry much of the blame for high energy demand in the Gulf, they also suggest that undoing damaging subsidies cannot transform all of the structures that encourage demand.

<b>Comparison of electricity consumption in Abu Dhabi and Arizona</b>				
	<b>Avg. consumption (kWh/yr)</b>	<b>Tariff per kWh (US¢)</b>	<b>Avg. yearly bill (US\$)</b>	<b>Arizona demand as a factor of Abu Dhabi</b>
Abu Dhabi nationals	71,000 (2006)	1.4	967	20%
Abu Dhabi expatriates	26,500 (2006)	4	1,082	53%
Arizona residents	14,000 (2009)	9.7*	1,600	–

**Note:** consumption is per household; \* = average tariff  
 Sources: Abu Dhabi Regulation and Supervision Bureau; US Energy Information Administration

