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Energy and Sustainability Policies in the GCC

Research Paper, Kuwait Programme on Development, Governance and Globalisation in the Gulf States

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Abstract
Per capita oil and gas consumption and, by implication, CO_2 emissions in the GCC countries are uniquely high. This paper will argue that under current global market conditions, fossil fuel conservation is a rational strategy for the Gulf monarchies; in electricity production, in particular, there are large-scale opportunities for introducing non-carbon energy sources. Many of the Gulf regimes' current sustainability-oriented energy policies can be pursued on a project basis, building on efficient technocratic enclaves under the direct patronage of rulers. These are more likely to be successful than broader regulatory strategies aimed at changing consumer and business behaviour in general. There is considerable potential to build up local technology clusters, but spillover into society and business at large is likely to remain limited.

Per capita oil and gas consumption and, by implication, CO_2 emissions in the GCC countries are uniquely high. This paper will argue that under current global market conditions, fossil fuel conservation is a rational strategy for the Gulf monarchies. In electricity production in particular, there are large-scale opportunities for introducing non-carbon energy sources. Gulf industrial and upstream structures also offer strong opportunities for carbon capture and storage.

The Gulf regimes' commitment to sustainable energy policies appears increasingly serious, reflecting their ambition to be taken seriously as international actors. Much of the policies currently under way can be pursued on a project basis, building on technocratic enclaves under the direct patronage of rulers. These are more likely to be successful than broader regulatory policies aimed at changing consumer and business behaviour in general. There is considerable potential to build up local technology clusters; but spillover into society and business at large is likely to remain limited.

The paper consists of two parts, the first expounding the economic rationale for specific types of sustainable energy policies, the second analysing the institutional embedding of these policies.

1. THE RATIONALE FOR SUSTAINABLE ENERGY IN THE GULF

As the Gulf is expected to be the incremental supplier of oil and gas for the entire world for decades to come, the simplistic assumption is frequently made that the region enjoys

an abundant supply of cheap energy. This, however, is not the case and, indeed, the Gulf countries face their own 'energy crisis', which will become more and more apparent in the years and decades to come. The Gulf energy crisis is the consequence of rapidly growing domestic demand for energy and, specifically, for electric power.

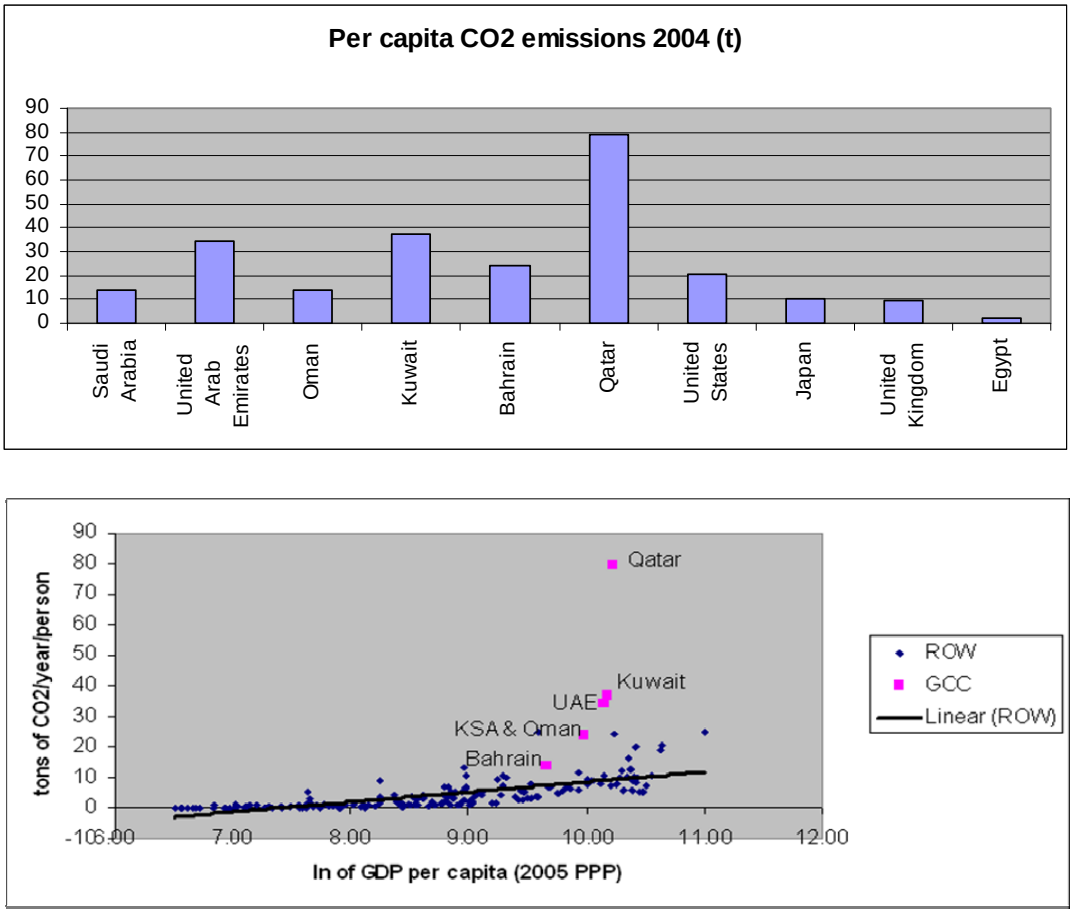
The sustainability of the Gulf Cooperation Council (GCC) energy systems and their interest in diversification into renewable and nuclear energy deserve an in-depth critical analysis. In discussing sustainability we should very clearly distinguish between the consumption of liquid fuels and that of electricity. Consumption of liquid fuels has grown very rapidly in all GCC countries, thanks to low, politically motivated domestic prices. The high level of consumption constitutes a problem, and it is a bit of a paradox that some of the GCC countries are forced to be net importers of refined products. There is no economic logic in selling petroleum products domestically at prices way below what the same can fetch on the international market, and even the national oil companies complain about this practice. However, the political logic is very strong, and the probability that prices might be significantly realigned is low (see below). Besides containing consumption through higher prices, there is little the GCC countries can do to improve sustainability of liquid fuel supply. There is certainly no reasonable alternative to producing liquid fuels from oil in these countries: biomass is obviously a non-starter.

Electricity is different, because alternative means for producing electricity that make sense in the region are available. Both renewable sources – meaning primarily solar and to some extent wind – and nuclear energy are valid options. Coal, too, has been considered, but would not help in the direction of reducing greenhouse gas (GHG) emissions.

The GCC countries have per capita emissions of carbon dioxide (CO_2) that are among the highest on the planet (figure 1). This is, of course, partly due to the tiny population of some of them, but energy intensity is an undeniable feature.

The discussion in this paper concentrates on electricity as the most critical area for the future of the Gulf countries' sustainability. We begin by framing the current 'electricity crisis' of the GCC countries and then consider the prospects and rationale for reliance on carbon capture and sequestration (CCS), for rational use of energy and for the use of alternative sources of power generation, notably solar, wind and nuclear.

Figure 1. GCC CO_2 emissions relative to GDP, 2004 (based on UNDP and World Bank data)



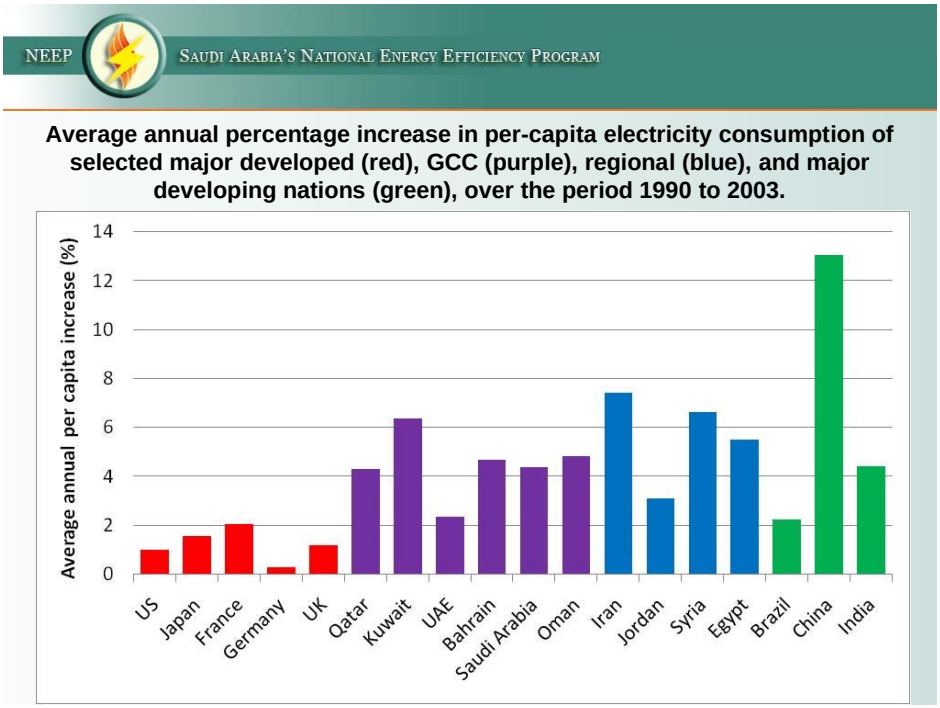
1.1. Causes of growth in electricity demand

Economic growth is always accompanied by growth in energy demand, but the elasticity may vary greatly; the Gulf countries have experienced high rates of per-capita electricity consumption growth, although they are not outliers in the context of emerging economies (figure 2).

The per capita electricity consumption of the GCC countries has by now surpassed the level of the major industrial countries, and dwarfs the level of other developing countries. Qatar and Kuwait have per capita electricity consumption levels above that of the United States (figure 3).

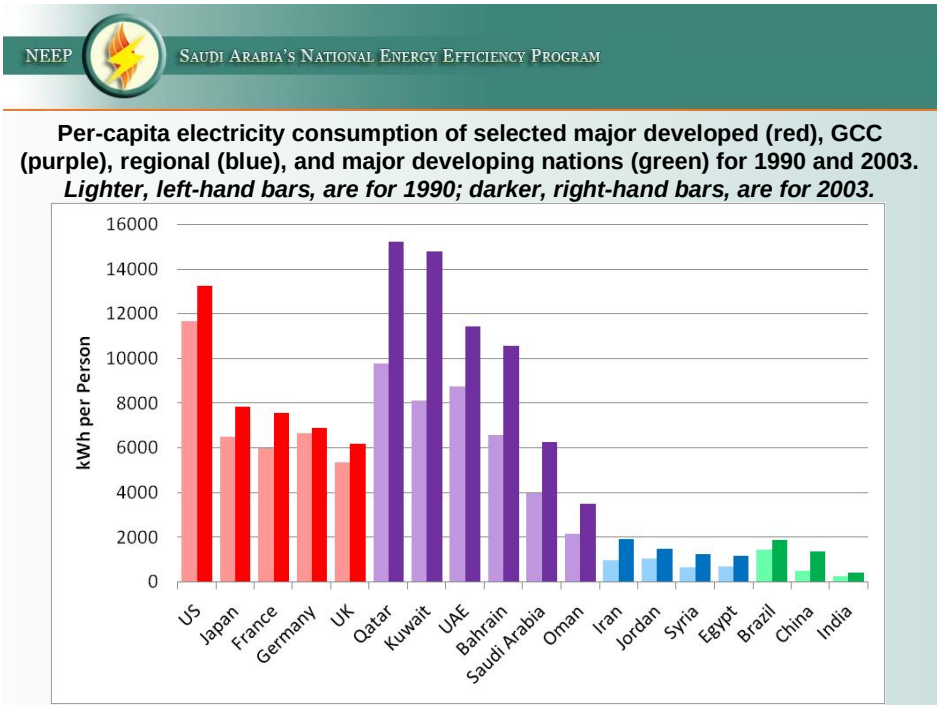
The rapid growth in energy demand may be attributed to three main concomitant causes.

Figure 2



Source: Al-Ibrahim 2009.

Figure 3



Source: Al-Ibrahim 2009.

1.1.1. Demographic changes

The first and most important cause is the rapid increase in the numbers and purchasing power of the urban population. The national population in all Gulf countries increases relatively rapidly by international standards, although the rate of growth has been declining in recent years. National population growth is reinforced by the continuous inflow of expatriate workers. Internal population movements have led to increasing concentration in urban areas, and a portion at least of the population has enjoyed significant improvement in living standards, leading to an increase in the size of the average dwelling, universal reliance on ambient air conditioning, and very widespread use of household appliances.

The effect of some of these phenomena may become less important in the future – national population growth is slowing down, and the process of urbanization is almost complete – but others may continue to be felt for quite some time; in particular there are still numerous nationals and expatriates living in less than optimal conditions, whose energy consumption patterns are waiting to evolve towards significantly higher levels.

1.1.2. Industrialization

The second important cause is the process of economic diversification, and the concentration on energy-intensive industries.

Here one should distinguish industries that use oil and/or natural gas as feedstock (petroleum refining, petrochemicals) and industries that use the same as sources of heat (again, petroleum refining and petrochemicals, but also cement, iron and steel, building materials, glass, etc.). Although some of these activities are important consumers of electricity in addition to heat, they also offer the opportunity of recovering waste heat on a much larger scale bigger than is done already, and use the same to produce electricity more efficiently. Combined heat and power (CHP) offers significant potential for the improved efficiency of energy use. Water desalination, which is an absolute necessity in the arid climate and a prerequisite for the survival of all urban centres in the region, is now normally combined with power generation and may thus be viewed as contributing more to the supply of electricity than to its demand.[1]

[1] Desalination plants in the GCC are predominantly the multi-stage flash type (MSF), which generate heat that can be recovered to produce electricity. Where reverse osmosis (RO) technology is used, the plant absorbs electricity and contributes to demand.

But the industrialization process has also led to the growth of industries that specifically require electricity rather than other forms of energy – notably aluminium smelting. This industry has long since been part of the diversification strategy of Bahrain (ALBA) and Dubai (DUBAL), and the success of these pioneering ventures is motivating major expansion projects in various GCC countries.

1.1.3. Low prices

The third fundamental determinant of energy consumption is price. The cost of energy to industry as well as to the final consumer has been kept low, whether in the form of liquid fuels (primarily for transportation) or in the form of electricity.

Access to energy at prices that are unrelated to the opportunity cost of the primary source on international markets has been a key component of the political compact between the Gulf rulers and their people, and prices have not been raised and have even been lowered, even at times of increasing international prices, in order to compensate for the increasing cost of imported goods.[2] It may not be appropriate to speak of subsidization, because even at the low domestic prices the energy companies can cover their costs and make a profit. However, it is very clear that the same primary sources if sold internationally would fetch a much higher price. In cases in which the primary source is not exported at all – such as that of natural gas in Saudi Arabia – the low price has discouraged exploration and increasing production capacity, and has induced wasteful consumption.

In the case of electricity, which is the main form of energy consumption in households and in the commercial sector, the wasteful pattern of consumption is very obvious. It is also deeply rooted, in the sense that building codes and standards have paid little attention to containing power requirements. On top of large and badly insulated homes, the region is characterized by wasteful consumer habits, with ambient temperature kept exceedingly low, abundant illumination based primarily on traditional incandescent bulbs, and unrestrained running of appliances (the television set switched on for twenty-four hours a day).

[2] For example, Saudi Arabia lowered the domestic price of petrol in 2006, when oil prices were exploding, to compensate for the high rate of inflation. With respect to electricity, practices range from providing electricity for free for all national households in Qatar, to a level of tariff in Saudi Arabia that is considered to be high enough to encourage some savings – of which there are few signs, however.

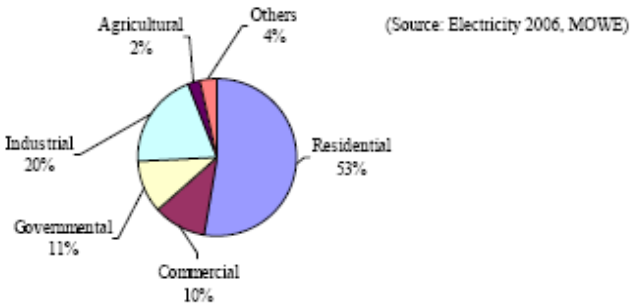
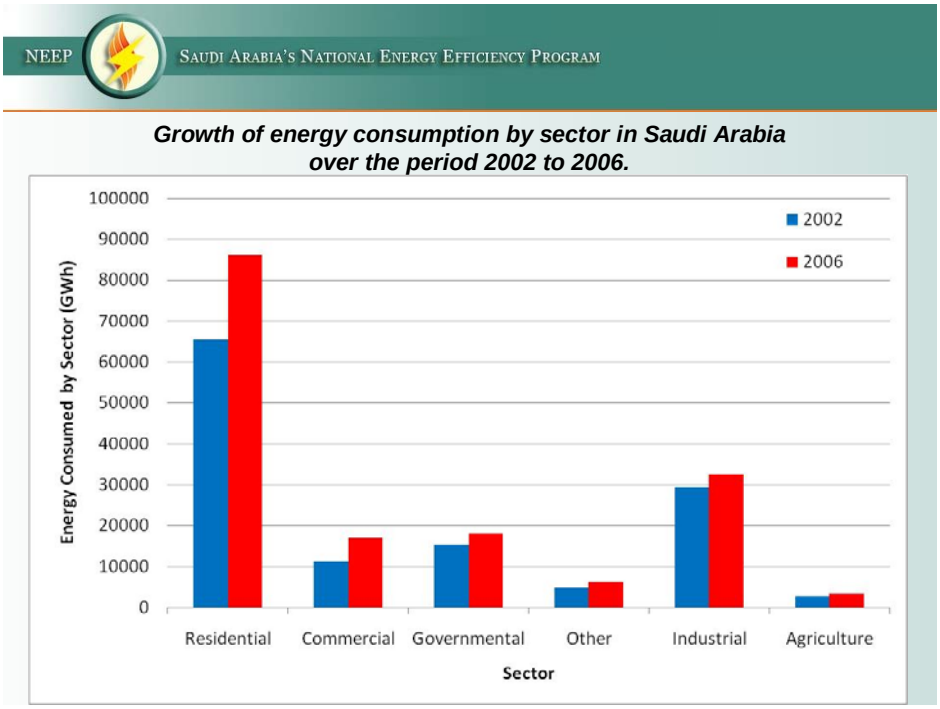


Figure 4. Electricity consumption by sector (JICA 2008)

Households constitute by far the most important component of electricity demand, accounting for 53 per cent of total consumption in Saudi Arabia (figure 4).

Households constitute the segment of demand that has grown more rapidly. Encouraging them to change their electricity consumption pattern is much more difficult than pursuing a more rational use of energy in industry, and it is especially difficult if the price lever cannot be used. It is therefore to be expected that emphasis will be on increasing electricity production rather than reining in consumption and, if anything, savings efforts will be focused on industry rather than the residential sector (figure 5).

Figure 5



Source: Al-Ibrahim 2009.

1.2. Investment requirements and the choice of primary source

It has been estimated that meeting the electricity demand of the GCC countries will require investment of the order of US$50 billion from now to 2015 – that is, $7 billion per year. Capacity would need to be increased by 60,000 MW, which is equivalent to 80 per cent of currently installed capacity.[3]

Such almost doubling in barely seven years represents a challenge not just from the point of view of finance, but also from the point of view of project management and procurement.

The cost and complexity of implementing new power generation facilities depends to some extent on the technology which is chosen. Power plants utilizing primarily gas as fuel – in so-called combined cycles or in simple gas turbines – are the easiest and cheapest to build. From this point of view, they would be the first best choice for power generation in the GCC. As gas is much more expensive to transport than oil, netback returns on exported liquefied natural gas (LNG) are many times lower than for oil. Even Qatar, by far the largest gas exporter in the GCC and a relatively minor exporter of oil, still derives the bulk of its government revenue from sales of oil rather than from LNG exports. This means that it is rational for the GCC countries – as indeed for all oil producers – to devote gas to domestic uses and maximize the share of oil production which is available for export.

It is not surprising, therefore, that gas is used in all power plants in the UAE and Qatar. Kuwait makes extensive use of crude oil for power generation because of limited gas availability. Saudi Arabia also uses fuel oil and crude oil for power generation, but 56per cent of electricity is produced from gas. Gas turbine plants are normally utilized to meet the variable load, while the base load is met from desalination, Independent Power Producers projects or combined cycle gas plants (table 1).

However, gas is in short supply in most GCC countries. The only country that enjoys an absolute abundance of gas is Qatar, and it has declared a moratorium on new projects – at least until 2012. All other GCC countries, although they might be exporters of LNG, like Abu Dhabi or Oman, face a shortage of gas for domestic purposes.

[3] These estimates were included in a report from Moody's Investor Services published in October 2008.

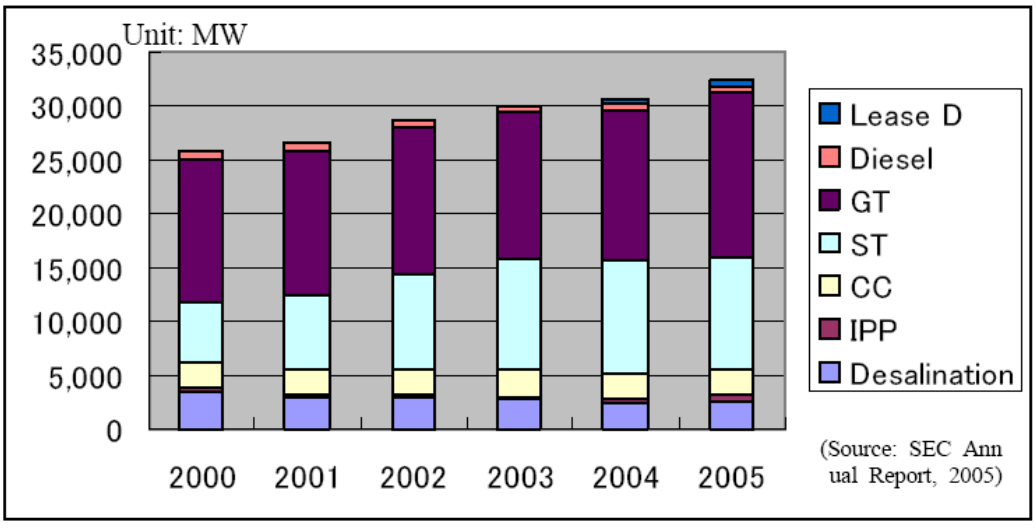
Table 1. Fuel consumption structure in the electricity sector

		1999	2004
Crude oil and NGL	ktoe	10344	6182
Petroleum Products	ktoe	10345	13927
Natural gas	ktoe	14556	25502
Total	ktoe	35344	45611
Power generation	GWh	119015	159875

Source: JICA 2008.

Saudi Arabia has declared a moratorium on new gas power plants, and additional demand for electricity will need to be satisfied by plants burning either heavy fuel oil or crude oil. But the upgrading of the kingdom's refineries will improve the product slate and reduce the share of undesirable heavy fuel oil, thereby reducing the supply available for power generation. As for crude oil, the opportunity cost of burning it in power plants is equal to the price that it would fetch if sold on the global market (figure 6).

Figure 6. Available generation capacity in Saudi Arabia



Source: JICA 2008.

In the past the GCC countries enjoyed (or suffered from, depending on one's point of view) excess production capacity for oil and gas. One could therefore argue with reason that the cost of producing one marginal barrel to be burned in a power plant was close to nil. It was, therefore, logical and justified to provide fuel to power plants at very low cost, allowing for the generation of very cheap electricity.

But conditions have changed. Since 2004 the GCC countries have been producing at a level very close to capacity, when consideration is made of the desired 'cushion' of unutilized capacity to be activated only at times of crisis. The current global crisis has again created a margin of unutilized capacity, but this is not expected to last for long. Therefore the marginal barrel sent to a power plant has a very real opportunity cost: creating the additional capacity to produce that marginal barrel requires substantial investment in projects whose cost has greatly increased. The same marginal barrel could be sold on the international markets and yield a substantially higher return than if sold to domestic power producers. Whichever way one looks at it, there is significant cost attached to producing electricity out of oil.

In the light of the above, one can understand that the GCC countries are showing increasing interest in other primary sources for power generation, notably renewable sources and nuclear energy. At the same time, the steep investment requirements will act as a factor to discourage sources necessitating relatively high initial investment, which is the case for both renewable sources and nuclear.

1.3. Climate change and renewable sources of energy

The position of the Arab Gulf countries with respect to global environment issues and alternative sources of energy has evolved considerably in recent years. Throughout the 1990s, when global demand still was short of global production capacity, and some of the latter had to be shut in – notably in the Gulf – calls to contain emissions and the use of fossil fuel were viewed as a ruse by the industrial countries to undermine the future of the Organization of the Petroleum Exporting Countries (OPEC). Today this is no longer the case; a genuine appreciation of the danger and the disastrous potential consequences of climate change, coupled with the wish not to increase much further oil production and investment in additional capacity, have opened the door to a substantial change in the

rhetoric. All GCC member countries signed and ratified the Kyoto Protocol in 2005 or 2006.[4]

In recent months the Saudi Minister of Petroleum and Mineral Resources, Ali Naimi, has repeatedly spoken in favour of alternative sources of energy. In an interview published in the French oil newsletter *Petrostrategies*, he stated, 'For a country like Saudi Arabia ... one of the most important sources of energy to look at and to develop is solar energy.' He added, 'One of the research efforts that we are going to undertake is to see how we make Saudi Arabia a centre for solar energy research, and hopefully over the next 30 to 50 years we will be a major megawatt exporter. In the same way we are an oil exporter, we can also be an exporter of power.'

More recently, speaking in Beijing on 7–8 November, the minister underlined the important role of technology in addressing climate change.

> I firmly believe that when it comes to technologies aimed at mitigating climate change, the world has barely scratched the surface and the research, development and innovation in this area need much greater attention than is presently the case. The list of what we can do includes, but is not limited to, multiple ways of greatly enhancing the efficiency of energy use in a variety of applications, cleaner and futuristic forms of conventional and unconventional fuels, and numerous ways of carbon capture and sequestration, besides many breakthrough technologies that are not even on the horizon today.[5]

Solar and other alternative energy sources figure prominently in the research agenda of such Saudi institutions as the King Abdulaziz City for Science and Technology and the King Abdullah University for Science and Technology, and Saudi Aramco is interested in carbon capture and sequestration.

In Abu Dhabi the Masdar Initiative, launched in April 2006, is presented as 'a bold and historic decision to embrace renewable and sustainable energy technologies'. Abu Dhabi claims that 'as the first major hydrocarbon-producing nation to take such a step, it has established its leadership position by launching the Masdar Initiative, a global cooperative platform for open engagement in the search for solutions to some of mankind's most pressing issues: energy security, climate change and truly sustainable

[4] Depledge (2008) gives a vivid account of what she terms obstructionist tactics on the part of the kingdom in global climate negotiations. She believes that the kingdom's and other GCC countries' acceptance of the Kyoto Protocol is instrumental. But at the end of the article she recognizes that there has been a change of tack in the GCC countries' posture.

[5] Excerpts from the speech were published by the Middle East Economic Survey on 17 November 2008.

human development'.[6] Masdar has initiated the Masdar City project, which intends to create a carbon-emissions-free community (see below).

1.4 Renewable sources of energy

The Gulf countries (as well as North Africa) also enjoy a clear advantage for the development of two key renewable sources of energy, namely solar and wind.

With respect to solar energy, the availability of the resource is not in doubt. The average annual solar radiation falling on the Arabian Peninsula is about 2200 kWh (th)/m^2, and the vast expanses of uninhabited land offer huge potential for harnessing the energy of the sun. The region enjoys 40 per cent more sun than Spain.

Interest in solar energy has existed for decades. In Saudi Arabia the King Abdulaziz City for Science and Technology (KACST) has engaged in solar energy research since its establishment in 1977. Initially it signed two major cooperation agreements, one with the United States (SOLERAS) and the second with Germany (HYSOLAR). The major achievement to date has been the establishment of a solar village in which all power is generated from the sun.[7] The village has mainly served as a testing ground, demonstrating the inadequacy of early photovoltaic equipment under harsh desert conditions. Recently, KACST has signed an agreement with IBM Research to establish jointly a Nanotechnology Center of Excellence. In this context, production capacity at the solar village is to be increased five times, with KACST and IBM working together to use nanotechnology to develop the village and improve its performance, focusing on new materials for converting solar energy into electricity.[8]

In the context of its first round of research grants, the new King Abdullah University of Science and Technology, has awarded a scientist at Stanford University a grant of $25 million to start a centre of research into how the cost of solar power can be made competitive with that of coal.[9] Initiatives of this kind may go a long way to speed up the pace of innovation in the field.

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[6] www.masdaruae.com/.

[7] On solar energy research activities in Saudi Arabia see Saleh A. Al-Athel 'Solar Energy in the Kingdom of Saudi Arabia', available at www.un.int/saudiarabia/solar2; Fahad Huraib, 'Saudi Arabia R&D effort in the field of Solar Energy', available at www.un.int/saudiarabia/solar3; F. S. Huraib, S. M. Hasnain and S. H. Alawaji, 'Solar Energy Projects in Saudi Arabia', available at www.un.int/saudiarabia/solar1.

[8] *Saudi Gazette*, 27 October 2008.

[9] 'Gulf Oil States Seeking a Lead in Clean Energy', *New York Times*, 13 January 2009.

In Abu Dhabi research in the field of solar energy is again led by Masdar. In May 2008, Masdar invested in a new company, Masdar PV, in Erfurt, Germany. Masdar PV is constructing a thin-film photovoltaic (PV) manufacturing facility, which is expected to produce more affordable panels. A similar facility will also be created in Abu Dhabi.

Masdar also invests in thermal solar energy, based on concentrators (mirrors) of various shapes. It has established Torresol Energy, a joint venture between Masdar and the Spanish engineering group Sener, which has three solar power plants under construction in Spain with an approximate combined investment cost of $800 million. It also has a project for concentrated solar power (CSP) in Abu Dhabi, called Shams 1: a tender has been issued to invite companies to participate in this project, but the original deadline was later delayed, and no firm progress has been made at the time of writing.

Saudi Arabia and Abu Dhabi have been the most active among the GCC countries in the field of solar energy, although smaller initiatives are also registered in the rest of the group.[10] One Bahraini expert[11] has estimated that Bahrain alone will have to invest an estimated $900 million in wind and solar power in the next decade to meet the growing demand for energy. Similarly, he estimated that Kuwait would need to spend $2.5 billion (BD 945 million), Oman $800 million (BD 302 million), Qatar $600 million (BD 226.8 million), Saudi Arabia $15 billion (BD 5.67 billion) and the UAE $5.1 billion (BD 1.9 billion). Against this investment new solar and wind electricity may reach 5 GW by 2015 (a minuscule contribution: Saudi Arabia alone consumed 160 GW in 2004 …).

Clearly, actual progress in the direction of implementing major solar energy projects will be conditional on further decreases in the cost of the required equipment. One notes that the Gulf countries are pragmatically leveraging their financial resources to engage in international scientific cooperation and ‘import’ the best available technology, with a very long-term approach. They expect eventually to be able to reap the benefit because of favourable local conditions, also with respect to the production of the required equipment (photovoltaic panels).

In a recent study, Yasser Al-Saleh, Paul Upham and Khaleel Malik have explored several renewable energy scenarios for Saudi Arabia, based on a Delphi panel of thirty-

[10] For a detailed analysis of these initiatives see EPU-NTUA 2009.
[11] Professor Waheeb Alnaser, chairman of the Bahrain chapter of the International Solar Energy Society (ISES), speaking at a conference organized by UNIDO in Bahrain in February 2009.

five Saudi and foreign experts (Al-Saleh et al. 2008). Among a total of eight scenarios, differentiated by the availability of fossil fuel reserves, the intensity of action on environmental protection and the positive or negative attitude towards the use of renewable sources, the authors explore two 'green scenarios' (low availability of fossil fuels, intense action on environmental protection) in which the contribution of renewable sources to total electricity supply would be 45 per cent and 30 per cent respectively by 2050, depending on a positive or negative attitude towards renewable sources. These are rather extreme assumptions, of course, but they may be worth exploring. In these two scenarios total GHG emission reductions are at or slightly above 2,500 million tonnes of CO_2 equivalent; total savings of oil are at or slightly above 5 billion barrels; total land occupation requirement is around 4,000 sq km (although the authors caution that this estimate does not take into account the possibility of mounting solar panels on rooftops); and estimated annual life-cycle savings are of the order of $2.5 billion.

1.5. Nuclear energy

The other possible means by which the GCC countries could diversify power generation away from exclusive dependence on oil and gas is nuclear energy. As shown above, the potential for significant diversification based on renewable sources is insufficient to solve the sustainability issue for the GCC countries – indeed, the same is true at the global level. A nuclear energy component is therefore probably a necessary ingredient to achieve sustainability.

In the international context, the GCC countries happen to be very favourably positioned to develop quickly a nuclear power generation component while at the same time actively pursuing the adoption of CCS technologies to contain their carbon emissions.

For most countries, the main drawback of nuclear energy is the high initial investment requirement. In most cases, utilities are short of investment funds and must rely heavily on debt or other outside financing; nuclear energy is considered as risky and offering returns only in the very long term.

However, the GCC countries have large liquid balances which might grow further in the mid-term. This has led to the accumulation of sovereign wealth funds as tools for international investment in equities and other assets classes that are not appropriate for

central bank reserve holdings. The visibility of some of the deals concluded by large state-owned GCC investors has already created a backlash and multiple calls for regulation and limitations.

Obviously the GCC countries will continue to engage in international investment, but it is already clear that this strategy has risks and limitations. This means that the opportunity discount rate for GCC official investment is very low or even negative. Rational behaviour in these conditions would tend to favour domestic investment – where risks are much reduced – and capital-intensive projects. Nuclear power plants conform to the desired profile very well, as they cater to an essential need and are especially competitive if the cost of capital is low.

Nuclear energy is capital intensive and an excellent store of value for the future: it is the kind of investment that a country with large financial resources and limited investment opportunities would logically find very attractive as a basis for long-run economic diversification and sustainability.

In fact, the development of nuclear energy should be viewed not purely from the point of view of rational financial placement, but also from the point of view of the strategy for longer-term economic and political sustainability. The long-term survival of the GCC countries requires a sustainable source of energy: this is true of all countries, but even more so of countries whose climate complicates human residence and working conditions.

Water desalination requirements are the most obvious aspect of vulnerability and potential non-sustainability of the Gulf economies. It is also a reason why these economies are structurally characterized by high-energy intensity. Essentially, all water in the Gulf region must be provided for through desalination,[12] and the growing population immediately translates into growing water requirements. If water desalination is insufficient or interrupted, living conditions in most GCC metropolises would quickly become unbearable. Finding a reliable and sustainable solution for water desalination is therefore an essential aspect of GCC security and sustainability.

[12] Desalination is almost exclusively the source of water for Qatar, the UAE and Bahrain. Saudi Arabia also makes considerable use of fossil (non-renewable) water sources, and enjoys limited rainfall in the western region. None of the major cities in the region could survive without desalination.

At the same time nuclear energy may also be developed to become complementary to fossil fuel production and optimal resource utilization. Nuclear energy may progressively substitute for fossil fuels in all stationary uses requiring heat, including for enhancing oil recovery (steam injection), in petroleum refining and in the production of petrochemicals. In this way, scarce fossil fuels use can increasingly be concentrated where they are not substitutable or are substitutable only with greater difficulty – that is, in transportation and as petrochemical feedstock.

It should be noted that the GCC countries, unlike many other emerging countries, have consistently built their development model on strong global integration and reliance on external sources of technology, know-how and manpower. Rather than aiming at total self reliance or technological independence early on, the GCC countries have banked on joint ventures, foreign direct investment and massive reliance on expatriate labour at all levels of skill to facilitate the absorption and implementation of technical know-how and managerial best practices.

This approach has been spectacularly successful in many areas, and is especially important in judging the prospects for nuclear energy development. In essence, it is certain that nuclear energy know-how will be imported lock, stock and barrel: this includes copying all required national and international legislation and regulation, including reliance on foreign experts for their implementation. Nationalization of personnel will take place only very gradually, while paying attention to maintaining the desirable standard of quality.

Along these lines, the GCC countries have initiated close cooperation with the International Atomic Energy Agency (IAEA) in Vienna. This is the main dimension of the collective GCC nuclear initiative, while at the bilateral level several cooperation agreements have been signed, notably by the UAE with France and by Saudi Arabia with the United States.

This strategic approach to reliance on outside sources of technology and specialized manpower means that, on the one hand, implementation can be greatly accelerated – to the extent that international providers will be available – and, on the other hand, that the international community will be able to maintain very close surveillance over the kinds of technology and equipment that are being transferred and

the use that is being made of them. The latter might not be a total guarantee against proliferation, but is more reassuring than the attitude of countries that would insist on extensive or total national control.

In fact, local conditions (social and environmental) for nuclear energy deployment in the GCC countries are ideal, and permit very rapid implementation. The complex authorization phase that is so long and cumbersome in most industrialized countries is likely to be greatly simplified in the GCC countries, especially the smaller ones. Construction times may well turn out to be shorter than in most other countries that are developing their nuclear energy capacity.

It is unfortunate that the Gulf countries' interest in nuclear energy is frequently interpreted as little more than a cover for – sooner or later – establishing a military capability. Obviously, the Iranian insistence on controlling fuel enrichment even before they have a single nuclear power plant functioning has created substantial distrust in the region. Similarly, Israel's covert nuclear weapons programme and overt hostility to any uptake of nuclear energy in neighbouring Arab countries complicate things. It is not difficult to see how the difficult political climate in the region might interfere with the logic of providing energy from a diversified array of sources, including nuclear. However, the Non-Proliferation Treaty (NPT) was designed not only to prevent proliferation, but also to offer, in exchange for renouncing proliferation, a guarantee of access to nuclear technology for civilian and peaceful purposes. The NPT regime will stand or fall as a whole: preventing proliferation is already such a difficult task that it cannot be pursued successfully if countries are denied access to nuclear technology for civilian uses. In this respect, the GCC interest in nuclear energy also has the potential of offering to the region and the world a model of civilian nuclear development which is accompanied by guarantees of non-proliferation. Abu Dhabi, indeed, has signed up to every conceivable non-proliferation and monitoring mechanism for its nuclear projects, arguably to offer a counter-example to its nuclearized neighbours. It is almost certain that Israel would object to Gulf nuclear energy nevertheless, but would probably find itself isolated in its opposition.

1.6. The rational use of energy

Technocratic opinion in the ministries and companies in charge of electricity supply is well aware of the issue of energy wastage, but implementation of rational use of energy measures requires the convergence of a very large number of independent decision makers, and becomes necessarily political.

We mentioned at the outset that residential consumption is the main component of total electricity demand, and no effort at curbing demand growth can be successful without attacking that component. Individual consumers respond primarily to prices, which range from zero for nationals in Qatar to levels that are believed to make a difference for the consumer in Saudi Arabia, but are in any case well below international norms.

Initiatives are under way to introduce green labelling and encourage consumers to buy more energy-efficient products. Saudi Arabia has introduced labels to distinguish more efficient equipment (figure 7 reproduces a label used for washing machines), and it is possible that the more affluent and environmentally conscious consumers may respond to such information. However, the vast majority of the Saudi population is not in a position to engage in such luxury, and will simply go for the cheapest product that does the job. This will be true across the board, influencing the choice of all appliances including air conditioners, which make the highest demand on energy.

Figure 7

However, in this respect, the issue of the rational use of energy is an important indicator, as it is one of the many manifestations of the

inevitable trade-off between quality and price in development strategy. Improving energy efficiency requires a modification of building codes to encourage greater insulation and higher quality of dwellings, inevitably increasing the cost of housing. If the increase in cost also encouraged a decrease in the standard size of homes, the energy benefit might be further increased. As we shall argue below, this probably runs counter to the ingrained preferences of the vast majority of the public.

The GCC countries face the quality/price trade-off dilemma in many areas. Whether it is with respect to expatriate labour (rely on fewer, more productive workers, and incentivize productivity increase by forcing a higher cost of labour, or keep relying on an ever growing number of unskilled labour from the lowest-wage source countries?), provision of public services (upgrade urban public transport to lure people away from using their cars, or leave it in such a condition that only the poorest will use it?), or the regulation of private investment (enforce tighter building codes, e.g. to ensure better insulation, or encourage the minimization of building costs?), the need to choose between speed and quality of growth is ubiquitous. So far, with the exception of industrial investment, the preference for cost minimization has almost always prevailed, but the current economic downturn and the subsequent, inevitable reappraisal of priorities may lead to a different attitude among technocrats. As will be argued below, however, the political and regulatory challenges of changing consumer and business behaviour in the Gulf are large.

1.7. Carbon capture and sequestration

It should be noted that the Gulf oil producers are very favourably positioned to make systematic use of carbon capture and sequestration, because of the concentration of carbon emission sources in their territory (oil refineries, petrochemical, steel and cement plants, power generation) and the potential for sequestration in oil and gas field using CO_2 injection as an enhanced oil recovery method. They have much to gain out of international schemes promoting CCS, for example through a form of revamped or extended Clean Development Mechanism.[13]

[13] The Kyoto Protocol expires in 2012 and a new regime is presently being negotiated for the aftermath. The critical issues for the future are whether the United States will participate and a new, global emission trading system (ETS) see the light of day on the basis of the experience of the EU ETS currently in place. How stringent the limits on emissions will be is crucially important, as the expected price for carbon

CCS has emerged as a necessary component of any global strategy aiming at reducing global emissions and stabilizing the CO_2 content in the atmosphere. The Blue scenarios[14] proposed by the International Energy Agency envisage a drastic reduction in the use of fossil fuels for power generation, which should be accompanied by systematic carbon capture and sequestration. It is estimated that the implementation of the Blue scenarios might require the price of carbon permits to climb to at least $200 and possibly up to $500 per ton.

If such prices were indeed offered for certificates issued under a new Clean Development Mechanism, CCS projects would become economically very attractive in the Gulf countries.

CCS costs depend on the technology to separate the CO_2 (the capture) and on the availability of adequate geological formations for sequestration. The latter may be close to or distant from the point of emission, and the cost of gathering CO_2 from several scattered sources and transporting it to the sequestration site adds to the total.

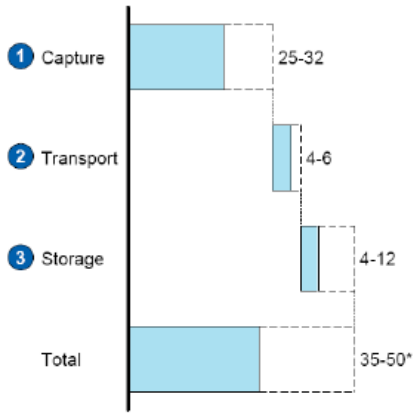


Figure 8. Total cost of early commercial project **(**McKinsey 2008).

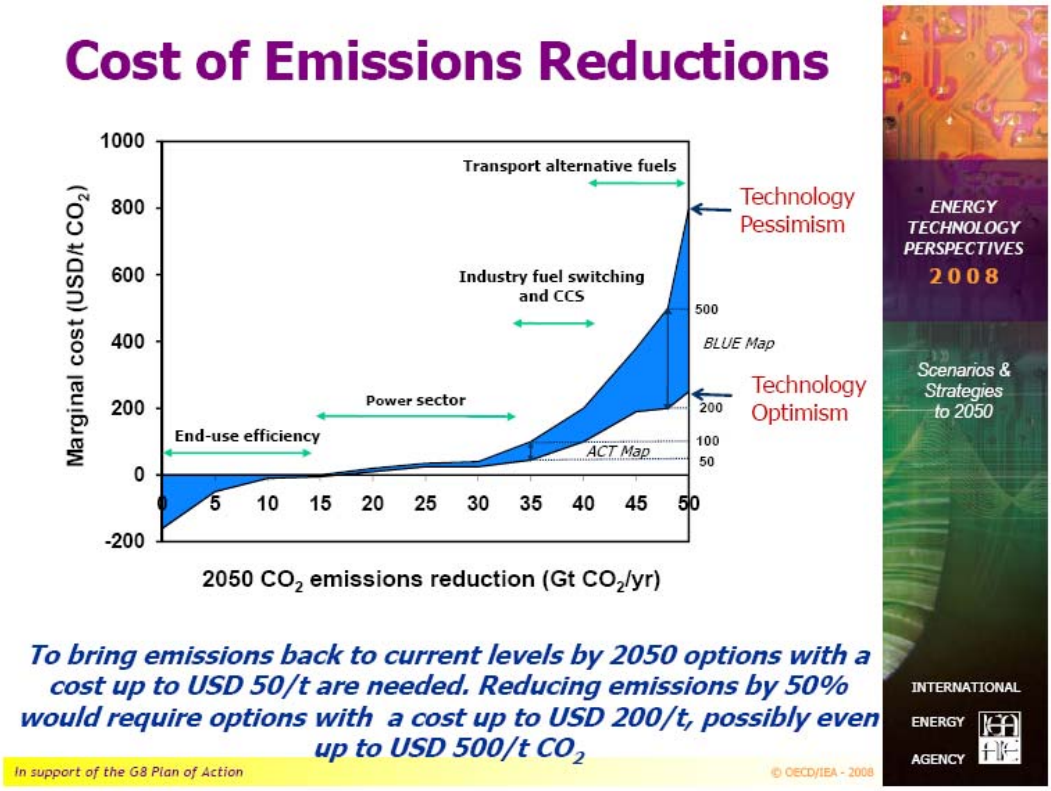
depends on them. Finally, from the point of view of the GCC countries it is strategically important that CCS be recognized as a legitimate form of carbon emissions abatement and source of tradable certificates; at the moment this is not the case, and no financial incentive is available for CCS under the CDM.

[14] The International Energy Agency established in 2008 two sets of scenarios alternative to business as usual; the first set is called ACT in the publication *Energy Technology Perspectives* and 550 in *World Energy Outlook 2008*, because they are compatible with stabilization of CO_2 in the atmosphere at 550 parts per million (PPM).The second set is called Blue Scenarios or 450 respectively, because they are compatible with stabilization of CO_2 at 450 ppm (which is the level compatible with climate stabilization).

The main cost component is the capture stage. Retrofitting an existing power plant that was not conceived with CO_2 capture in mind is more expensive than building a new plant equipped for CO_2 capture. The main cost of capture in a new plant is the investment cost and the loss in efficiency. McKinsey estimates the total cost of CSS for a new coal-fired plant at €35–50 per ton of CO_2 abated (McKinsey 2008; figure 8).

This is well above the current carbon price in the EU Emission Trading System, but well below the levels envisaged by the IEA in their Blue scenario, which reach to above $200 towards 2050 (see figure 9). The IEA envisages the generalized adoption of CCS from around 2030, and the challenge would be how to encourage early projects before that date. Obviously the Gulf countries, facing an already daunting investment effort to meeting growing electricity demand, would normally avoid incurring the additional cost of introducing CCS but, in the presence of determined global policies to reduce GHG emissions, their relative position would be very favourable.

Figure 9



In the Gulf countries, where significant new capacity is being built in power generation as well as in other energy-intensive and carbon-emitting industries, it would be easier to implement carbon capture before burning the fossil fuel. This in essence entails separating the hydrogen from the carbon in a process called reformation, and then burning hydrogen, a process that only generates steam. Implementing post-combustion capture of CO_2 is more complex and costly, although the technology exists. The pattern of concentrating industrial activity in special industrial cities or zones, in which multiple major sources of carbon emissions are concentrated in a relatively compact space, greatly facilitates the task of gathering the separated CO_2.

Tables 2a, 2b

CO_2 emissions in Mt by Sector (2006) [5]	Coal/peat	Oil	Gas	Other*	Total	% change 90-06
Sectoral Approach	-	**226.69**	**113.34**	-	**340.03**	**110.7**
Main Activity Producer Elec. and Heat	-	68.49	43.73	-	112.22	181.8
Unallocated Autoproducers	-	1.65	21.93	-	23.58	22.9
Other Energy Industries	-	16.94	23.37	-	40.31	82.9
Manufacturing Industries and Construction	-	54.87	24.31	-	79.19	175.1
Transport – Road	-	79.25	-	-	79.25	68.6
Other Sectors – Residential	-	3.67	-	-	3.67	46.1
Reference Approach	-	**224.22**	**113.34**	-	**337.56**	**137.8**

* other includes industrial waste and non-renewable municipal waste

Sector	Number of sites	Emissions CO_2 (kt)	$\%CO_2$ in flue	Production	
Cement	9	14'012	20%	19'886	kt clinker
Ethylene	4	12'914	12%	5'082	kt
Ethylene oxide	1	240	100%	523	kt
Hydrogen	2	476	100%	119	kt
Iron & steel	2	461	?%	3295	kt
Power	73	68'715	3% or 8%	150'200	GWh
Refineries	8	16'472	3%-13%	75'217	kt

Source: IEA (International Energy Agency), OECD (Organisation for Economic Co-Operation and Development), CO_2 emissions from *Fuel Combustion*, 2008.

The main stationary CO_2-emitting activities are power generation, cement, petroleum refining and large-scale petrochemical industries (ethylene crackers). Tables 2a and 2b provide information concerning Saudi Arabia specifically, but analogous results would pertain to the other GCC countries. In all cases these activities are mostly clustered in the proximity of major industrial cities.

The separated CO_2 could then be injected into oil or gas fields, which in most cases are not distant.[15] Injecting CO_2 in dry gas fields helps in maintaining pressure and enhances gas production. More importantly, injecting CO_2 in oilfields has a double positive effect: on the one hand, it helps to maintain pressure and, other things being equal, reduces the need for reinjection of associated gas, thus making more of the associated gas available for commercialization; on the other hand, it increases the fluidity of the oil and improves the rate of recovery – indeed CO_2 injection is a well-recognized method of enhanced oil recovery (EOR), and is implemented as such in numerous fields in the United States and Canada.

When all the above circumstances are considered, it is easy to see that in a global context of significantly higher prices per ton of carbon emitted, the Gulf countries are positioned to enjoy the enhanced competitiveness of their industry. Indeed, if in the future hydrogen becomes a significant fuel, and the difficulty of transporting it over long distances is overcome, the Gulf countries – as well as other oil producers, notably in North Africa – may become exporters of hydrogen and/or electricity produced from fossil fuels with complete carbon separation and sequestration.

For the time being, only one CCS project is planned in the Arabian peninsula, located in Abu Dhabi. Masdar and HydrogenEnergy10 have launched this project, called Hydrogen Power Abu Dhabi (HPAD). Originally planned to be in commercial operation in 2013, it has been delayed because of the complexity of project financing. It is expected that 1.7 million tonnes of CO_2 per year will be injected. This project could be the first industrial-scale installation of an integrated hydrogen power and CCS system. It will take natural gas from the grid and convert it to hydrogen and CO_2, using the pre-combustion

[15] This would be true for industrial cities along the Gulf coast. Saudi Arabia has industrial cities also in its Western region, along the Red Sea coast, and sequestration of CO_2 from those might be more of a challenge.

separation technology. The project requires a total capital investment (excluding CO_2 transportation and storage) of about US$2 billion.[16]

In Saudi Arabia, the King Abdullah University of Science and Technology (KAUST) is planning to invest funds in research into carbon capture. Its Global Research Partnership (GRP) announced a partnership with Cornell University which will focus on applications and fundamental studies of novel organic–inorganic hybrid nanomaterials. The centre will study these materials as new platforms for CCS. The KAUST-Cornell Center for Energy and Sustainability, with a $25 million budget, will focus on the potential of these new materials, named NIMS (nanoparticle ionic materials), for other applications, such as desalination of water, production of gas and oil, and solar energy conversion.[17]

Qatar has negotiated a partnership with London's Imperial College that involves Qatar Petroleum, the Qatar Sciences and Technology Park and Shell in a 10-year, $70 million research project on new CO_2 storage technologies that can be applied in Qatar. In November 2007, Gulf OPEC members have collectively pledged $750 million to fund research on clean technologies, focusing especially on carbon capture and storage in order to fight global warming.

It is possible that the global recession which began in 2008 may lead to a postponement of some of the more capital-intensive projects such as CCS, but this is unlikely to be a long-term phenomenon. Demand for oil and gas may be expected to recover very early in the cycle, and so will the region's revenues. The attitude of the international community towards global warming is likely to have a more significant impact. If attention to environmental problems were to diminish because of persistent economic woes, then obviously it would not be surprising if the Gulf countries lost some of their current interest for pushing hard on the CCS front. The fungibility of Gulf CCS will also depend on how exactly Gulf states are integrated into the international climate regime, which is yet to be decided and will involve difficult negotiations regarding local emissions caps.

[16] Hydrogen Energy, available at www.hydrogenenergy.com.
[17] Cornell University, available at www.research.cornell.edu/VPR/KAUST-Cornell/index.html.

1.8. Concluding remarks

The GCC electricity crisis is one of the major development challenges to which the region needs to respond in the coming decades and a fundamental dimension of the search for sustainability of the GCC economies. The GCC countries will need to reduce their reliance on fossil fuels, and are aggressively exploring the potential of renewable sources, primarily solar, as well as nuclear energy. By increasing their reliance on these alternatives, they may well persist in the pattern of economic diversification based on expansion of energy-intensive industrial transformations. Their relative specialization in these industries may be supported by their favourable position for engaging in CO_2 capture and sequestration. In a scenario of global consensus towards reducing GHG emissions and stabilizing CO_2 in the atmosphere, the GCC countries may emerge as significant providers of energy-intensive products to the rest of the world.

Today, the bulk of electricity is consumed in the residential rather than the industrial sector. Curbing the wasteful private habits of energy consumption is a clear technocratic priority but may represent more of a political challenge for the GCC countries. It should be viewed in the broader context of the need for the political leadership to find a new point of equilibrium in the trade-off between quality and cost, in which greater priority might be given to the former, even if to the detriment of short-term competitiveness and growth.

2. THE POLITICAL AND INSTITUTIONAL CONTEXT[18]

Although many technological and managerial intricacies still need to be sorted out, the broad economic rationale for pursuing sustainability policies in the GCC is clear. The new initiatives have been announced so rapidly and in such close succession, however, that further considerations must have been driving Gulf leaders. This section addresses the political motivations and the institutional framing of the new sustainability policies, and assesses their organizational and regulatory feasibility against this background.

2.1. The 'branding' of GCC states as technology leaders

One significant impetus for many of the recent high-profile project announcements in the Gulf has arguably been to recast the image of the GCC states on the international stage.

[18] Much of the following is based on personal interviews, and past archival and field research in the GCC countries, especially Saudi Arabia, Kuwait and the UAE. There is little written academic material about administrative and regulatory developments in the GCC.

Rhetoric and the scale of undertakings reflect a desire to 'brand' the Gulf monarchies as global leaders in new technology sectors and, more broadly, as responsible members of the international community. This would be difficult to deduce from energy-related policies alone, but there are ambitious projects in other policy fields – cultural endowments and museums, universities, internationally oriented charities and so on – which have recently been promoted in a very similar fashion. The motley ensemble of initiatives has one clear common denominator: the ambition to be taken seriously on the international stage. This is corroborated by the fact that many of the projects have only a very limited domestic audience, a mould into which the outward-oriented promotion of sustainability policies also fits. The branding component is also underlined by the speculative nature of at least some of the projects.

Gulf leaders clearly want themselves and their states to be seen as more than pure rentiers, quite similarly to newly rich families who after a couple of years of becoming wealthy or after the second generation takes the reins, start to invest in the arts and in charitable activities with a view to gaining more social respectability. There is a strong desire among Gulf elites to be taken seriously on the international stage, and not just as a source of energy and overseas capital. Qatar and Abu Dhabi in particular – two late developers even by Gulf standards – are trying to brand themselves as technological and cultural leaders in the international arena. Abu Dhabi campaigned vigorously to attract the headquarters of the newly established International Renewable Energy Agency (IRENA) to Masdar City, and saw its bid accepted in June 2009 – a first sign that its international ambitions are taken seriously.

The increasing pressure from the international climate change debate has contributed to the change of mind: GCC states would have found it hard to reinvent themselves as mature and responsible members of the international community if they had stuck to the unreconstructed obstructionism that at least some of them had pursued in the context of international climate negotiations. Their appropriation of the sustainability discourse as well as their integration into international regimes will bring them closer to Western powers, and nuclear cooperation in particular also provides an element of insurance, in that it increases the West's stake in protecting local partner regimes. It is

probably no coincidence that Abu Dhabi has been deepening nuclear and military cooperation with France at the same time.

In a regional context, the GCC's new ambition is furthered by the development failures of the Arab republics, which used to set the terms of regional political and, to some extent, developmental debates, but which have lost most of their credibility and leadership in the last three decades. GCC elites see a chance to become enlightened regional leaders by leveraging their own economic and technological – as opposed to military – strengths. In a related vein, the last years have also seen heightened competition within the GCC over better governance and who can pursue the most innovative and visible projects. The phenomenon of 'copy-cat' investment in real estate, heavy industry, and financial districts now seems to be mirrored to some degree in the field of sustainable energy.

The large fiscal surpluses since 2003 give the young ruling elites especially of the smaller GCC countries large-scale autonomy for institutional and technological experiments, and have awoken new ambitions of international leadership. Although some of the Gulf states' overseas assets have taken heavy hits in 2008, their overall value is still estimated at US$1.2 billion (Setser and Ziemba 2009). In particular, players like Abu Dhabi with small populations retain considerable resources for new ventures, even if surpluses might temporarily turn into deficits in 2009. Large, state-supported projects are fiscally grandfathered and with the project finance market having unfrozen, state-owned companies are forging ahead. Especially in the case of Masdar, there is too much prestige already invested, while the economic rationale for nuclear power remains undiminished in the long run.

It should be pointed out that the ambition to diversify into sustainable energy can build on a stronger competitive advantage and institutional track record than many of the other 'branding' policies mentioned above: the new technology sectors will dovetail with existing industrial structures in the Gulf, and in many cases will be managed by large public organizations with deep experience in project management. Moreover, some of the largest enterprises in the Gulf, both private and public, have managed to establish themselves as regional and even global exporters of specialized services, such as

telecoms, logistics or upstream energy. It is conceivable that a similar structure could be built up in sustainable energy technologies.

2.2. The institutional setting: who is in charge?

It is the institutional structures in which new projects will be embedded to which we now turn. The first thing that needs to be pointed out is that most of the successful large state enterprises in the Gulf are under the direct patronage of the ruling elite, and hence are shielded from much of the political interference and rent-seeking that happens in other sectors. Although much current expenditure is locked in for salaries and subsidies, Gulf regimes are highly centralized and largely autonomous in the use of their incremental fiscal surpluses, and hence are free in the creation and design of new organizations and policies. There are only two exceptions to this pattern, Kuwait (a full exception) and Bahrain (a partial one), and it is not coincidence that neither has seen new projects announced on the scale witnessed in other GCC monarchies. The country sections below will address these exceptions in more detail.

Ever since the first oil boom, GCC rulers have tended to delegate complex policy tasks in high-priority sectors in order to select technocratic clients who enjoyed special access to them and could cut through much of the sluggish national bureaucracy.[19] On this basis, the Gulf has witnessed a successful pattern of project-based and sector-specific development since the 1970s, be it the roll-out of national infrastructures in the 1970s and 1980s, the regulation of fledgling financial sectors in Bahrain or Saudi Arabia, or the creation of a competitive heavy industry sector in Saudi Arabia and, to a lesser extent, Qatar and Abu Dhabi. As pointed out above, GCC elites have been very effective at using international expertise in the process. Through cutting specific pockets of efficiency out of the state apparatus, they have managed to pursue priority projects while at the same time using much of the rest of the state for distributional purposes or, in some cases, for self-enrichment. As long as rents increased every year, the parallel building of institutions with very different purposes was a pain-free option enabling rulers to have their cake and eat it. They could build up an impressive national infrastructure – notably in energy and electricity – and at the same time pursue more political and patrimonial projects. This situation came to a close with the oil price collapse in the 1980s, which forced leaders

[19] For the Saudi case see Hertog 2008.

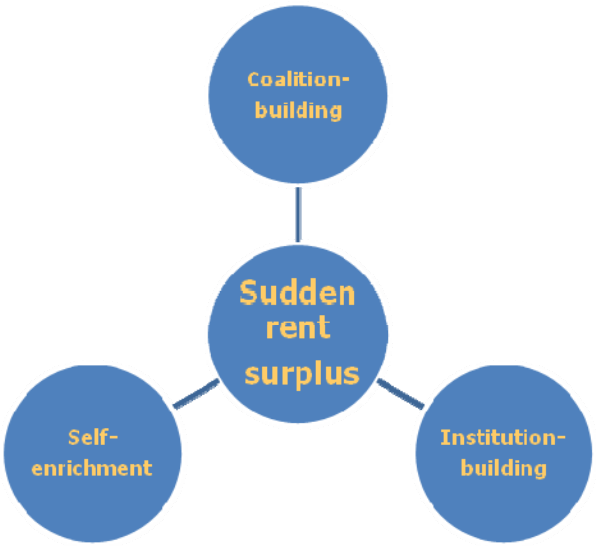
into fiscal retrenchment and into using most of the remaining resources for maintaining basic job guarantees and subsidies for nationals – removing options for the parallel building of efficient institutions. With the new boom, a new window of opportunity for institutional engineering has opened, and elites are using it once again to set up new organizations or expand existing pockets of efficiency – which play a pivotal role in the new wave of sustainability policies (figure 10).[20]

What are these enclaves of efficiency and how are they managed? They include both public enterprises and regulatory bodies, and the following are some of the most prominent examples:

Saudi Arabia: national oil champion Saudi Aramco, heavy industry conglomerate Saudi Arabian Basic Industries (SABIC), and central bank SAMA;
Dubai: Emirates Airlines, DP World, and various free zone authorities;
Bahrain: Aluminum Bahrain and Bahrain Monetary Agency; and
Qatar: Qatar Industries and, potentially, the Qatar Financial Center.

One might also add several of the national power companies and regulators, such as Saudi Electricity Company (parts of which used to be run by Aramco) or the Abu

Figure 10. Institutional choices of rentier autocrats in times of rent surpluses



[20] Some of these arguments are developed at much greater length in Hertog 2010.

Dhabi Water and Electricity Authority. All the enclaves of efficiency have in common that they are in charge of very specific sectors that can be separated relatively easily from the rest of business and bureaucracy. These institutions often operate on the basis of special regulations, allowing them to bypass the rest of the state. They usually have salary scales and recruitment mechanisms that are separate from the rest of the state, and they are insulated from political predation and rent-seeking through special protection by the ruler. Their leadership consists of handpicked, long-term technocratic clients. All the major state-owned enterprises mentioned above have been highly profitable in the recent boom, and some of them, such as SABIC and Emirates, have recorded a profit every year since the 1980s.

It should be noted that many, but not all, of the recently announced sustainability policies will be operated on a project basis that is quite similar to the large projects that the above bodies have been operating during the last decades. Power plants are typical enclave projects that can be managed by a relatively small, committed set of technocrats and technicians. Technocrats tend to have long planning horizons, even more so in the electricity sector than in the upstream oil sector. Due to the top-down nature of policymaking in the Gulf, the various components of GCC state apparatuses, whether patrimonial or technocratic, have been very stable and less subject to the vagaries of day to day politics than in many other countries – certainly than in most developing countries (see Geddes 1990).

Nuclear energy in particular requires very long-term planning and insulated technocratic management. Together with the GCC's above-mentioned openness to foreign technical assistance, the institutional setting seems to be highly amenable to large-scale sustainable energy projects with long planning horizons, be they nuclear, solar or CCS.

With most large-scale heavy industry in the Gulf located in separately managed 'industrial cities', point-source control of emissions is also facilitated spatially. One might also argue that nuclear policy has a natural affinity with authoritarianism, in the sense that it can be used to justify secrecy and top-down control, and increases the international premium on the stability of existing regimes.

2.3. Conditions for the emergence of islands of efficiency in the past

In the past, a number of conditions had to be fulfilled for pockets of efficiency to emerge:

- significant increments of state income over time, allowing for institutional experimentation;
- regime autonomy from societal demands, so that institutional decisions are made by a limited set of elite actors; and
- a non-populist development ideology that does not subject all economic and managerial decisions to distributional and nation-building considerations.

All the GCC states bar Kuwait, but very few other oil states, fulfilled these conditions during the oil boom from the early 1970s to the mid-1980s; it is in this period that most of the Gulf's impressive modern institutions were created. Despite further gradual growth of states after 1985, most money had to be used to sustain existing distributional clienteles, and few policy innovations happened during those times of austerity – until recently, when the second oil boom took off, creating new opportunities for large-scale infrastructure projects and the creation of new managerial structures.

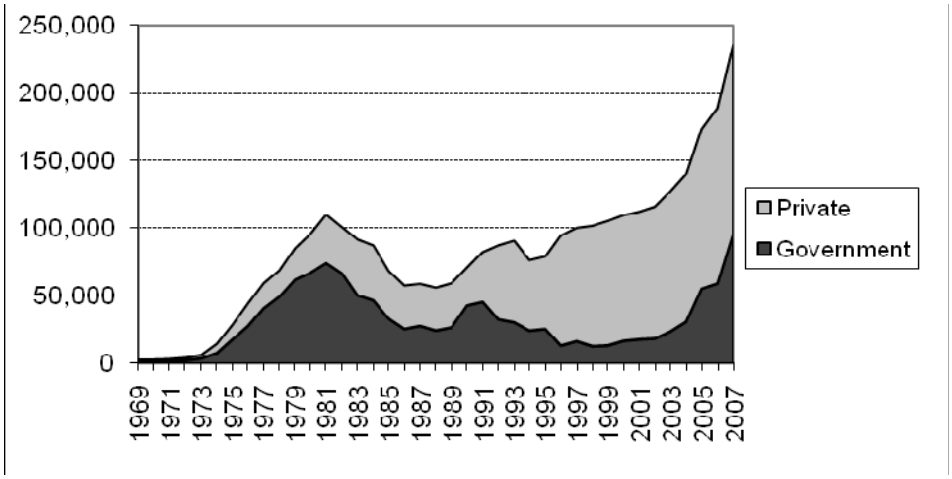
Even during lean times, however, existing islands of efficiency have continued to operate swiftly and coherently – increasing our confidence in stable long-term management of new sustainable energy projects. By contrast, the quality and coherence of the national bureaucracy at large has generally been limited, at least relative to other wealthy countries. Regulatory penetration of society and the economy at large has been only partial,[21] and non-project, non-enclave spending policies – public employment, pricing of public services and so on – have often followed political rather than economic rationales. This, as we shall see, limits the scope for more diffuse sustainability policies aimed at regulating social behaviour.

2.4 Sustainability policies as a new phase of enclave-oriented development?

The current fiscal surpluses have opened a new window of opportunity for institutional experiments, and at least the larger, project-oriented sustainability policies are well suited to be managed through expanded or newly created insulated islands of administrative efficiency. For the first time in twenty years, governments have returned to large-scale project spending (figure 11).

[21] While all GCC states, with the exception of Saudi Arabia, rank above the global median in terms of 'government efficiency' and all of them rank above the median on 'regulatory quality' in the World Bank's governance indicators, all rank clearly below similarly rich peers (measured in terms of GDP per capita).

Figure 11. Saudi gross fixed capital formation (million SR)



Source: Saudi Arabian Monetary Agency.

At the same time, they have embarked on the creation of new state-owned enterprises and sectoral regulators, recruiting a new generation of young technocrats and importing high-quality foreign manpower and expertise on a scale last seen in the early 1980s. But there are important differences between countries, both in terms of institutional conditions and the specific nature of sustainable energy projects, which warrant a country-by-country discussion.

2.5. Institutional outlook, country by country

2.5.1. Abu Dhabi

The rulers of Abu Dhabi enjoy very high regime autonomy, thanks to large fiscal surpluses and a small local population that is easily bought off without demanding a say in national-level policy issues. Abu Dhabi is one of the Gulf countries with the fewest accoutrements of formal democracy and a high level of institutional stability. Under Shaikh Zayed, who ruled between 1966 and 2004, however, it pursued a restrained development policy, preferring to leave many higher-profile initiatives to its neighbour Dubai, and stocking most of its riches abroad through the Abu Dhabi Investment Authority. With new oil surpluses and a new generation at the helm, much of this reticence has disappeared. Crown Prince Mohammad bin Zayed in particular is an avid modernizer who has initiated ambitious, large-scale projects.

The publicly owned Mubadala Development Company, set up in 2002, is the main promoter of Abu Dhabi's sustainability-related projects through its fully-owned subsidiary Abu Dhabi Future Energy Company or 'Masdar' (Arabic for 'source'), founded in 2006 (see above for its specific technology projects). The CEO of Mubadala, Khaldoon al Mubarak, is also the chairman of the Executive Affairs Authority of Abu Dhabi, serving the Abu Dhabi Executive Council, which is in turn chaired by Crown Prince Mohammed bin Zayed. The two leading figures in Masdar are Ahmed Ali Al Sayegh (chairman) and Sultan Al Jaber (CEO).

The leading figures in Mubadala/Masdar have worked with Mohammad bin Zayed on Abu Dhabi's military offsets project, in the national oil company ADNOC and the strategic Dolphin gas pipeline project. The Abu Dhabi national oil industry is generally considered to be well managed, even if heavily dependent on foreign expertise, and possibly the most efficient bit of the Abu Dhabi government. The Mubadala/Masdar leaders are long-term technocratic clients who have a close relationship to their patron and have been selected for managerial prowess. They are not from the highest-ranking indigenous Abu Dhabi tribes, but from respectable tribes which entered Abu Dhabi in the nineteenth century, reflecting some capacity to co-opt 'high potentials'.[22]

Recruiting from the existing pool of elite technocrats, Mohammed bin Zayed aims at building up another cluster of excellence. Mubarak in particular enjoys close access to the Crown Prince, and Masdar will be managed largely autonomously from the rest of Abu Dhabi's government. It appears well suited for managing capital-intensive, long-term projects.

Masdar's flagship project, Masdar City, is in fact an enclave in geographical terms also, and will function completely differently and separately from the rest of the emirate. A city of 6.5 sq km, it is supposed to become a 'carbon-free' home to 90,000 people, focused on investment, research and development in sustainable energy. The projected overall investment volume for Masdar City is US$22 billion, in addition to US$15 billion for Masdar's other renewable energy projects (CCS etc. – see above), reflecting Abu Dhabi's deep pockets. Some of its ventures are explicitly geared to future technology exports, and its acquisition of overseas assets in sustainable technology

[22] I should like to thank Christopher Davidson for helping me with these details.

combines, to some extent, sovereign wealth allocation and local capacity-building strategies – similar to the approach of its parent Mubadala.[23]

Mubadala and Masdar have entered an untested field, but their managerial structures are based on patterns that have been successful in the past: it is a typical enclave project, administered by trusted technocratic lieutenants with proven track records and special access to the leadership, who have in the past been successful at managing national oil and electricity sectors. The prospects for the physical implementation of the project hence are good, but its economics are yet unproven. While Masdar is likely to attract high-calibre international personnel – something Abu Dhabi has historically been good at – getting private investors involved in the projects could prove more difficult. In any case, however, Abu Dhabi is rich enough to bail the project out. Conversely, as it operates separately from Abu Dhabi's bureaucratic and social structures, even a successful Masdar City would probably have limited impact on local society.

2.5.2. Dubai

Historically, neighbouring Dubai has taken the lead over Abu Dhabi in terms of sectoral innovation and high-profile projects. Its leadership has been daring and highly autonomous from local society when it came to strategic project decisions. It does not, however, have the wherewithal seriously to engage in the GCC-wide competition for large-scale, sustainability-focused projects, as it simply lacks the capital resources. This is all the more true after the recent economic crash, which has made it politically and fiscally dependent on Abu Dhabi. Previous large-scale projects have drawn on large-scale project finance, and were based on an expectation of relatively quick returns – nothing that CCS or other big-ticket energy projects can promise. Dubai is not suited to very long-term projects that require deep fiscal reserves.

Dubai, however, could create the environment for smaller, private-service-sector service companies catering to the environmental technology sector at large, in particular if domestic energy regulations in the GCC should get stricter. It has itself recently made attempts to regulate business and consumer behaviour; it has started to introduce LEED

[23] Along similar lines, Abu Dhabi's majority state-owned National Energy Company (TAQA), which holds a large portfolio of overseas energy assets, has been working on a carbon sequestration project with the port of Rotterdam.

(Leadership in Energy and Environmental Design) building standards, and TECOM, the operator of Dubai's technology and media zones, has announced the aim of making its zones carbon neutral. Dubai's free-wheeling business environment has in the past not been very amenable to forceful regulatory intervention, and the recent bust calls the initiatives into question insofar as they impose costs on business. In general, Dubai is not leading the Gulf on sustainability issues the way it has in other sectors. Although Dubai has stable technocratic structures that are managed autonomously from social demands, richer states need to take the lead due to issues of scale and risk.

2.5.3. Saudi Arabia

Saudi Arabia is perhaps the prime candidate to do so. It is the country whose bureaucracy scores worst by most accounts,[24] and the government struggles to regulate local business and consumer behaviour. The kingdom, however, is also a player, with significant resources and, perhaps more important, the most impressive islands of efficiency, in the energy sector in particular. When it comes to the use of incremental oil surpluses, its leadership is autonomous from most interest groups, which are weakly organized.

The most impressive of the Saudi institutions is Saudi Aramco, probably the most efficient and technologically autonomous national oil company in any OPEC country (Hartley et al. 2008; Marcel 2006). It has managed to preserve the managerial structures of its foreign-owned predecessor Aramco, which was taken over by the Saudi government in 1980, and commands impressive in-house expertise and research capacities. It is by far the most competitive and attractive recruiter of high-potential young Saudis, and the royal leadership generally shields it from rent-seeking and other predation. Its senior management – as well as the current oil minister Ali Al-Naimi, who is its chairman – has been recruited in-house, and it is largely autonomous from the rest of the state in both managerial and infrastructural terms. Its senior management enjoys good access to the leadership. Its planning horizons are long and its ranks are stable.
As mentioned above, Aramco has declared its interest in sustainable energy technology in recent years, including carbon capture, clean fuels and combustion engines, and solar energy. It has already started several research projects in this regard and is probably the

[24] See World Bank governance indicators; Leaders in Dubai Business Forum 2006, *Doing Business in the GCC Survey*; interviews.

Gulf player that can bring not only much capital but also the most expertise to international joint ventures. Aramco has recently been entrusted with managing the new, above-mentioned King Abdullah University of Science and Technology (KAUST) in the Western Province, which has received a US$10 billion endowment from the king. The only Saudi university that is internationally competitive currently is the King Fahd University of Petroleum and Minerals (KFUPM) in the Eastern Province, which also enjoys close links to Aramco and has the authority to recruit much more selectively than other Saudi universities. KAUST has a good chance of emerging as a KFUPM-style island of meritocracy, but on a much larger scale, and could hence make Saudi Arabia the research and development leader on sustainable energy in the Gulf. Due to its size, Saudi Arabia has a much stronger national technocratic workforce than Abu Dhabi.

Foreigners are generally reluctant to move to Saudi Arabia because of its severe cultural restrictions. KAUST, however, will operate under what are referred to as 'Aramco rules': on its compound, genders will be allowed to mix and women will be allowed to drive. In managerial and geographic as well as cultural terms, it will be an enclave separate from the rest of state and society – but this might be a precondition for its success. As other international universities are cutting their funding, high-quality engineers and scientists will be attracted by KAUST's generous offers. Its close links to Aramco will allow direct exchange of corporate and university research.

The largest Saudi heavy industry and refining operations are managed by SABIC and Aramco and are located in specific industrial enclaves (some of which are managed by the Royal Commission for Jubail and Yanbu, another separate regulator with a good track record). This set-up could facilitate, among other things, future industrial CCS projects.

The Saudi electricity sector is regulated by a recently created body that has been spun off from the Ministry of Industry and Electricity, the Electricity and Cogeneration Regulation Authority. In its short history, it has managed to oversee the start-up of a number of successful private water and power projects with international involvement.

Nuclear research in Saudi Arabia is currently managed by the King Abdulaziz City for Sciences and Technology (KACST), which suffered more from budget cuts in the 1980s than did Aramco or SABIC. Yet with new resources, and thanks to its special

administrative status, it could be engineered into another large-scale island of efficiency, should the kingdom decide to engage in larger-scale nuclear research and power production on a commercial scale.

2.5.4. Qatar

Qatar is another country enjoying both significant surpluses and large regime autonomy. It has a shorter history of technocratic enclave-building, but its leadership is willing to take risks and keen to augment its international profile. It is the first Gulf country to have created a dedicated Ministry of Environment, in June 2008, and it is trying to make research into sustainable energy part of its international brand.

Two special institutions are in charge of a number of high-profile projects: the Qatar Investment Authority (QIA) and Qatar Petroleum, the national oil company. Both are managed through high-level clients of the emir: QIA's CEO is Sheikh Hamad bin Jassem, Prime Minister and Foreign Minister and the second most important man in the state, while Qatar Petroleum is chaired by Abdallah Al-Attiyah, Minister of Energy and Deputy Prime Minister, who is arguably the third most important figure in the Qatari government, and hails from an prominent clan.

In May 2007 Qatar Petroleum registered the first Gulf-based clean development mechanism project, an oilfield gas recovery and utilization venture, operated by Maersk Qatar Oil, that will prevent flaring of natural gas at the Al-Shaheen field. In November 2008, a QIA-sponsored £250 million Qatari-British fund was created, dedicated to clean energy technologies and research. The fund came together with a bilateral agreement on technology transfer for lowering carbon dioxide levels. Again, international cooperation is encouraged and projects are outward-oriented. Qatar also has been considering setting up a carbon credits exchange.

Qatar's leadership clearly has the ambition of putting the country on the map as a technology leader. Its layer of national technocrats is very thin, however, and it is not clear whether Qatar Petroleum can operate on the same scale as Aramco or even ADNOC in Abu Dhabi. On the upside, Qatar does not have to worry much about local consumers in its sustainability policies, as the country is very small. Most carbon emissions come from local industry, most of which is state-controlled, offering better opportunities for point-source carbon sequestration.

2.5.5. Oman

Oman is another country with a largely autonomous leadership and also a reasonably well-functioning bureaucracy, but its fiscal resources are limited. It will not lead in world-scale projects. It could operate in a number of niches, however; it has some experience with desalination driven by photovoltaic power. Its Electricity Regulation Authority has proposed a 750 MW solar plant.

2.5.6. Kuwait and Bahrain

The one country which would have most of the resources required for large-scale sustainable energy projects, but which has not seen any significant developments, is Kuwait. The main reason for its sluggishness – in many other economic policy fields also – is its parliament, which severely compromises the political autonomy of the leadership. Various groups in parliament have spent much energy on arranging free give-aways to the national population and on stalling any large, new state-financed projects (Herb 2008). Parliament occasionally teams up with well-organized public sector unions in preventing bureaucratic streamlining and the creation of independent, efficient bodies. Kuwait also lacks other islands of efficiency and autonomous state-owned enterprises on the scale of Aramco or Aluminum Bahrain. The Kuwaiti case demonstrates how rentier interest groups can undermine the capacity of ruling elites to shape state institutions.

In Bahrain, government is somewhat more autonomous, but still under much pressure to disburse funds to the population due to a very polarized and politically mobilized political scene. It is the one other Gulf country with a parliament that has at least some influence. Due to its dwindling oil resources, it is under stronger fiscal constraints.

2.6. Institutional context: summary

In sum, political autonomy and the scale of rents are the main constraints on sustainability projects in the Gulf. These two factors influence both the scale of projects under way and their future prospects. The main players on the big projects thus far have been special para-statal bodies and state-owned enterprises outside the regular state apparatus, with direct links to the leadership as driving agents. Most of the projects have been outward-oriented, following the GCC's tradition of relative economic openness and cooperation with international partners. So far, states have mainly taken the lead; the

private sector, if interested at all, will act only as a follower and policy-taker. Sustainable energy projects are driven by a small number of ambitious elite actors in a top-down fashion, with little resonance thus far in local society. While they are unlikely to have much impact on local consumers, they can also be managed more coherently and autonomously than policies in most other rentier states, thanks to long planning horizons and technocratic autonomy.

2.7. Enclaves and projects vs. consumer regulation

Not all sustainability policies are project-based, however. Some are regulatory in nature: they cannot be administered on a project basis, but require different types of state capacities. Influencing local consumption behaviour in particular requires more regulatory power and interaction with local business and society. Given the levels of per capita energy consumption in the Gulf, this is not a marginal issue.

The jury is still out on the LEED initiative in Dubai and on Istidama, a comparable building standard initiative in Abu Dhabi. Several governments have either introduced or enhanced their slab tariff systems, which charge higher rates for higher levels of household water and electricity consumption. GCC governments have also been working on energy-saving product and process standards and harsher sanctions for pollution. In many cases, however, they have to rely on rather weak ministries of commerce and industry or environmental regulators with a short and patchy track record.

Some consumer-related infrastructure can be managed on a project basis – for example, district cooling, which considerably lowers electricity use compared with conventional air conditioners. Dubai district cooling specialist Tabreed and Masdar have been reported as negotiating a district cooling joint venture. Similarly, public transport systems in larger conurbations, such as the Dubai Metro, can be managed on a project basis by specialized bodies.

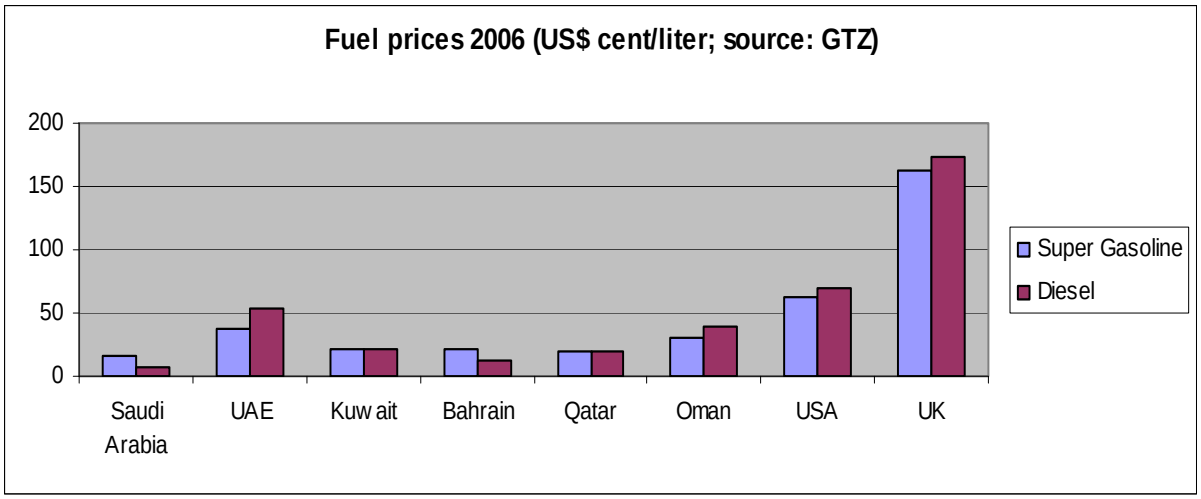
Apart from these large-scale, infrastructure-related initiatives, however, influencing domestic consumption patterns will be difficult. Past attempts at broader-based regulation in terms of national taxation systems, enforcement of intellectual property rights, information-gathering through censuses and business surveys, residency registration, or even just the enforcement of traffic rules, have proven difficult and have met considerable resistance. The GCC states have not gone through a conventional state-

building process in which such regulatory capacities are built up through taxation or military mobilization. Trust between bureaucracy and nationals tends to be low, as does rule-abidance. It has been much easier historically to build up efficient technocratic enclaves than to build up broad-based regulatory powers vis-à-vis societies which have been most of all distributional clients of the states. In some ways, one appears to be the result of the other: by clientelizing and 'buying off' large chunks of society, regimes could create political space for autonomous technocratic institution-building in other fields. But the co-optation of society has come at a cost that is both fiscal and regulatory.

The GCC states' rentier status makes price changes for utilities and petrol politically difficult. Reduced prices have traditionally been perceived as part of the ruling bargain and attempts to increase them have been repeatedly reversed. In a time when the governments are flush with cash but many nationals are struggling to adapt to rising prices and the socio-economic dislocations of the boom, significant increases in electricity or water tariffs appear unlikely. Only in April 2006, King Abdullah of Saudi Arabia significantly decreased domestic petroleum prices in Saudi Arabia to have the population partake in the boom and ease the strains of inflation (figure 12).

Such problems are more relevant for some states than for others. For sheikhdoms with a small national population, such as Abu Dhabi and Qatar, large-scale projects are much more important than the regulation of sustainability in local society. The few large industrial plants in these countries are fairly easy to regulate. The larger population and

Figure 12



more diffuse business activities of Saudi Arabia, by contrast, make local consumption patterns more important for both the country's global ecological footprint and for the sustainability of its hydrocarbon and energy-intensive exports.

This also raises the issue of whether the new sustainability initiatives will have any impact on domestic politics and the outlook of local society and business in general. As things stand now, linkage will be limited and local players are, indeed, not the main audience for the new policies. Some businesses might get involved in sustainable energy projects through support services, but they are unlikely to be leaders. Solar energy is the one field of electricity production in which the private sector might play a somewhat larger role, thanks to the (relative) scalability of solar plants. As far as regulatory change should have an impact on consumer behaviour, most of the sustainable technology in consumer durables, housing and so on will continue to be imported (with the partial exception of building materials).

Similarly, the spillover from new research units and universities to business and society at large is likely to be limited, as most of their output will not find local takers outside the large joint ventures and state-owned enterprises mentioned above. Impact on and interaction with local civil society interests will also remain limited for the time being: although there are environmental societies in a couple of countries, the general awareness of environmental issues is very low, even more than of other social and cultural issues, and enclave-style developments are not likely to change much about this. Civil society, including environmental groups, is only well organized in Bahrain and Kuwait, exactly the two countries with no great ambitions in sustainable development to date. This underlines the irrelevance of societal input in the decision-making process on sustainability policies. In Qatar, the UAE, Saudi Arabia and Oman, low civil-society capacity explains the regimes' extensive political autonomy, which is exactly what has allowed successful enclave-based development. Policy is decided by a few ruling family members under consultation with small groups of technocrats – and in this sense is very different from environmental decision-making in most Western countries.

3. Conclusion and Outlook

In many ways, the current boom is giving back to GCC states the economic and developmental leadership they had to some degree lost after the 1980s. Sustainable

energy is one of the niches in which the Gulf countries could attain real competitive advantage, based on a sound rationale of local energy conservation and use of its geo-economic position.

Prospects for a wide-reaching adoption of sustainability standards in society and the private sector are dim, but prospects for enclave-based, project-focused initiatives are much better – along the lines of the development successes of the 1970s oil boom. This is due to the favourable institutional and fiscal environment in at least three of the GCC states, and due to the substantial interest of nuclear power companies as well as international energy companies in partnering with national oil companies and host governments. Significant parts of local elites seem seriously committed to establishing the Gulf as an exporter of technology and of carbon certificates. Short of a major military conflagration, regional politics will change little of this outlook, which is driven by an economic rationale and an international ambition rather than regional strategic factors.

That being said, many technological and economic questions are still to be answered – but if CCS is feasible under the geological conditions of the Gulf, it is likely to be implemented successfully. Significant research and development will take place in Abu Dhabi, Saudi Arabia and probably Qatar, in enclave environments offering attractive conditions to footloose international scientists. The Gulf countries have deep experience in drawing on foreign manpower. By the same token, however, the spillover into local business will probably remain limited, as there is no diffuse research culture or history of venture capital in the Gulf.

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