CHAPTER 3: ENERGY EFFICIENCY

INTRODUCTION

This chapter discusses the need for energy efficiency measures in Qatar and the Gulf Cooperation Council (GCC) by providing an overview of energy intensity in the region; the benefits of energy efficiency measures including different types of technologies that can be applied; lessons learned at the international level by way of policies and obstacles; and financing for energy efficiency. The chapter also reviews existing energy efficiency measures in Qatar and the GCC, and concludes by providing recommendations for policy approaches and efficiency measures tailored to the region.

GULF COOPERATION COUNCIL REGION'S ENERGY INTENSITY

The GCC Energy Mix in a Global Context

The GCC region has the highest energy intensity in the world, and member states are expected to post robust growth in population, GDP and energy use over the next decade. Driven by economic expansion and development, many GCC countries are likely to see dramatic rises in the fraction of energy that is consumed domestically and unavailable for export. Rising living standards and increasing dependence on energy-intensive desalination processes compound the energy challenges for the GCC. For both economic and sociopolitical reasons, energy prices in GCC member states are well below international benchmarks. This has reduced incentives to invest in energy efficient infrastructure and equipment. For example, electricity is free to Qatari nationals. In Saudi Arabia, prices are only approximately 1.3 cents/kWh for residential customers up to 2,000 kWh per month, and 3.2 cents/kWh for industrial customers.[138] Bahrain, with relatively modest hydrocarbon resources, charges residential customers using less than 2,000 kWh per month only 0.8 cents/kWh.[139] In comparison, the average residential electricity prices are approximately 12 cents/kWh in the United States, 25 cents/kWh in the European Union, 9 cents/kWh in China, 28 cents/kWh in Brazil, and 8 cents/kWh in South Africa.[140]

Low energy and electricity prices are not only contributing to strong energy demand growth but also are encouraging investment in inefficient, long-lived infrastructure. In many cases, investment in inefficient transportation, buildings and industrial infrastructure has a lock-in effect that makes it difficult to reduce energy intensity and improve energy efficiency. This intensive use of fossil fuel energy contributes to greenhouse gas emissions and, as a consequence, to global climate change. Qatar, the United Arab Emirates (UAE), Kuwait and Bahrain have some of the highest per capita CO_2 emission rates in the world. Qatar's economy, for example, emits approximately 42 tons of CO_2 per capita per year, more than 10 times above the world average of 4.6 tons (see Table 1 in Chapter 1 for more information).[141]

A Changing Energy Landscape

Nevertheless, many world regions, including the GCC, are investing in alternative fuels and energy efficiency, as well as in unconventional resources such as shale gas. The natural gas boom has fueled additional energy efficiency opportunities: the replacement of existing industrial coal boilers and process heaters with new efficient natural gas boilers, as well as direct use of natural gas in residential heating, cooling and hot water systems all offer significant full-fuel-cycle efficiency improvements.

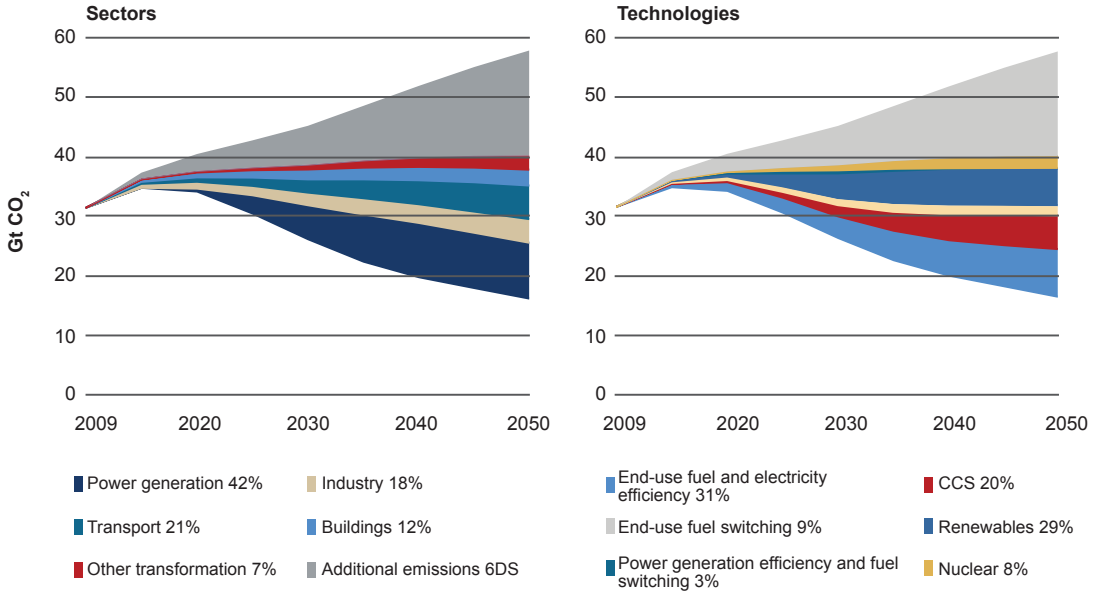
BENEFITS OF ENERGY EFFICIENCY MEASURES

Technology

New technologies, unconventional resources, increasing stringency of energy and environmental policies, and new transportation options will likely increase competition in energy markets. Efficiency improvements can reduce the need for energy imports, maximize fuel exports, increase supply reliability, improve industrial competitiveness, and reduce production and energy costs to consumers. In addition, energy efficiency options represent 40 percent of global greenhouse gas reduction potential that can be realized at a cost of less than $80 per metric ton of carbon dioxide equivalent (tCO_2e) (Figure 2).[142]

Figure 2: Global contributions to emissions reductions in the 2°C scenario, by sector and technology

Energy efficiency investments provide a large contribution to emissions savings—approximately 40 percent—due to their low cost and high returns.



Energy Technology Perspectives 2012: Global contributions to emissions reductions in the 2°C scenario, by sector and technology © OECD/IEA, 2012, fig. 1.9, p. 39.

Investments

Energy efficiency investments in buildings, industry and transport are, in many cases, economically beneficial. Most such investments have short payback periods (see Table 4) with annualized rates of return after 10 years ranging from 30 percent to over 100 percent, and even longer-term payback investments can be profitable because the fuel-cost savings over the lifetime of the capital stock often outweigh the additional capital cost of the efficiency measure. For example,

McKinsey projected that $170 billion a year invested in efforts to boost energy efficiency from 2008 to 2020 could halve projected global energy demand growth, and these investments would have an average internal rate of return (IRR) of 17 percent, with each of them generating an IRR of at least 10 percent.[143] Efficiency measures are also often most cost effective when new plants or buildings are being designed and built.[144] Nevertheless, a number of barriers can hamper the deployment of energy efficiency measures. Such barriers can arise from the inability to capture broadly dispersed benefits, uncertainties in quantifying benefits, price distortions in the market (including distortions arising from subsidies) and other causes.

Table 4: Internal rate of returns for 119 studied projects in developing countries

Payback period describes the number of years required to return the investment in full; thereafter, cost savings are essentially pure income. A more familiar method to evaluate investments is by using rates of return on invested capital, which are shown by the IRR columns. Efficiency investments can often have very high investment returns and are essentially risk-free.

Sector	Payback years	IRR 3 years (%)	IRR 4 years (%)	IRR 5 years (%)	IRR 10 years (%)
Automotive/autoparts	1.93	26	37	43	51
Cement/ceramics	2.19	18	29	36	45
Chemicals	2.90	2	14	21	32
Equipment manufacturing	2.10	20	32	38	47
Food and beverages	1.10	74	83	87	91
Metal	1.50	45	55	60	66
Paper	0.90	96	105	108	111

Alcorta et al. (2013) Return on Investment from Industrial Energy Efficiency: Evidence from Developing Countries.

Recent developments in efficient technologies such as LEDs and efficient turbines have increased the number of potentially profitable investments, even in environments with low prevailing energy prices. In cases where the barriers distort investments, governments can employ policies to overcome them. Of course, technological solutions must, at a minimum, be cost effective for societies and nations as a whole. Each of the GCC countries has unique social, political and cultural realities. As such, the solutions for each may be unique, but will be more effective when coordinated and integrated with other national and regional policies.

PROBLEMS AND POLICIES: INTERNATIONAL EXPERIENCE WITH ENERGY EFFICIENCY

Energy efficiency investments can be highly profitable because they can save money for companies or individuals by lowering energy costs. Nevertheless, many efficiency opportunities go untapped owing to obstacles that have historically reduced interest or profitability in such projects. This section describes some of those obstacles and policy options to address them.

Market Distortion through Energy Subsidies

Energy subsidies distort the cost-benefit calculations of individual investors and are therefore one of the biggest obstacles to efficiency investment. Subsidies are often rooted in a wide variety of well-meaning goals, such as protecting consumers, helping low-income groups gain access to energy, reducing the impacts of international price fluctuations, controlling inflation, distributing resource wealth to the population and helping domestic industries. On the other hand, recent international discussions have highlighted the costs as well. Many international organizations, such as the International Monetary Fund (IMF), World Bank, United Nations Development Programme (UNDP) and others have recently investigated some of the social costs of such subsidies and found that they can aggravate fiscal imbalances, crowd out priority public spending such as education and health, and distort pricing signals and resource allocation.[145] By artificially promoting capital-intensive industries, they depress investment in renewable energy and energy efficiency, and accelerate the depletion of energy resources and the rise in environmental pollution. They are regressive in nature, and most benefits are captured by higher-income households, therefore reinforcing inequality. By encouraging inefficient energy consumption, they also lead to additional greenhouse gas emissions: The IMF estimates that eliminating subsidies—which amount to more than $500 billion annually—would lead to a 13 percent reduction in greenhouse gas emissions below business as usual, or 4.2 billion tons by 2050.[146]

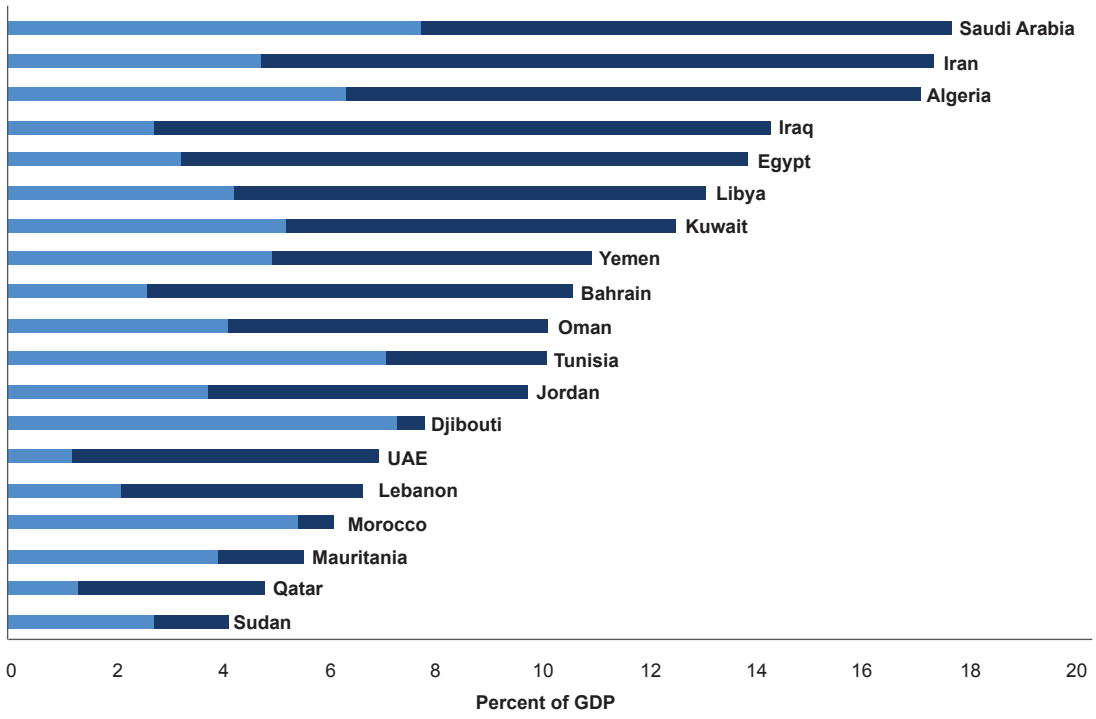
Because of these detrimental effects, there is currently a major international effort to identify and reduce distortionary energy subsidies at the national level.[147] Building on the commitment made at the Pittsburgh G-20 Summit in 2009 to phase out inefficient fossil fuel subsides, G-20 leaders agreed at the recent St. Petersburg Summit on the methodology for a new peer-review process of fossil fuel subsidies. Saudi Arabia's Economy and Planning Minister Mohammed al-Jasser recently said at the Euromoney conference in Riyadh that "[t]his has become an increasingly important issue as these subsidies have become increasingly distorting to our economy. This is something we are trying to address."[148] On July 30, 2013, Latvia's Cabinet of Ministers passed amendments that stipulate a significant reduction in natural gas plants subsidies.[149] Countries such as Turkey, Armenia, the Philippines, Brazil, Chile, Peru, Iran, South Africa, Kenya and Uganda have all attempted energy subsidy reforms.

The Middle East and North Africa (MENA) region accounts for about 50 percent of global pre-tax energy subsidies (see Figure 3). Energy subsidies amounted to over 8.5 percent of regional GDP or 22 percent of total government revenue in 2011. In Kuwait, Qatar, Saudi Arabia and the UAE, energy subsidies accounted for 15.10 percent, 15.39 percent, 31.99 percent, and 28.11 percent of respective government expenditures in 2010.[150] These four countries also have the highest per capita subsidies in the world: UAE, $4,172 per year; Kuwait, $3,729; Qatar, $2,622; and Saudi Arabia, $2,291.[151] Countries in emerging and developing Asia made up over 20 percent of global energy subsidies. They totaled nearly 1 percent of regional GDP or 4 percent of governance revenues.[152]

Non-Market Obstacles to Energy Efficiency

Even in investment contexts in which the price of energy is unsubsidized, some efficiency opportunities remain underdeveloped. Despite the vital role of energy efficiency in cutting energy demand and reducing GHG emissions, there sometimes arises an energy-efficiency gap, also known as the "energy

Figure 3: MENA pre-tax energy subsidies and spending on education [a, b] (in percent of GDP)



This image was taken from the IMF Middle East and Central Asia Department policy brief, "Energy Subsidies in the Middle East and North Africa: Lessons for Reform". Data in this figure has been generated from IMF staff estimates, national authorities, the Organisation for Economic Co-operation and Development, International Energy Agency, Deutsche Gessellschaft für Internationale Zusammenarbeit, IMF "World Economic Outlook", and World Bank.
[a] Includes petroleum, electricity, natural gas, and coal subsidies.
[b] Pre-tax subsidies refer to 2011, education refers to the latest available data.

paradox," whereby energy-efficient technologies with lower lifetime costs diffuse more slowly through the economy than expected given their cost advantages. Sometimes these differences arise from lack of information about savings, and other times result from institutional barriers, split incentives, or challenges in aggregating finance for smaller-scale technologies. Governments around the world have adopted a range of specific policy tools to overcome these obstacles, including targets, mandated standards, labeling programs, tax incentives and others. Some examples of these tools include:

- **Voluntary and information-based initiatives:** These initiatives entail providing information and encouraging consumers to reduce their emissions and can include awareness campaigns, labeling and training programs. Labeling initiatives involve the identification of products associated with low emissions in order to increase consumer knowledge and increase market demand. For example, the Energy Star program in the U.S. identifies energy-efficient products and buildings in order to reduce energy consumption, improve energy security, and reduce pollution through voluntary labeling of or other forms of communication about products and buildings that meet the highest energy efficiency standards.[153]

- **Minimum energy performance standards:** A complement to voluntary labeling is to establish required minimum efficiency standards for appliances, equipment, vehicles and other technologies. Over decades of experience in many countries, this method has proven to be a relatively low-cost way to realize large gains over time, particularly if the standards are periodically revisited and increased as technologies improve. These are increasingly being used in non-OECD economies. For example, in 2000, Ghana's Electrical Appliance Labeling and Standards Program (GEALSP) partnered with CLASP (an nongovernmental organization that helps countries develop and implement standards) and the Ghana Energy Foundation (a public-private partnership) to develop the first standards and labels in sub-Saharan Africa. Ghana first implemented a Minimum Energy Performance Standard (MEPS) for room air conditioners—the first MEPS in sub-Saharan Africa—because of their role in peak electricity demand and because a large part of the air conditioner market is new equipment. Over 30 years, Ghana's air conditioner MEPS is projected to save $64 million in annual energy bills and reduce CO_2 emissions by 2.8 million tons. In 2005, Ghana added a MEPS for compact fluorescent lights and a labeling program for air conditioners and lighting.[154]

- **Building energy codes:** Building energy codes are legal requirements regulating the energy performance of building designs and their compliance during construction. The enforcement of energy codes for new buildings and for alterations to existing buildings is an effective policy instrument to reduce the long-term energy use and potential emissions from buildings. For example, the city of Tianjin, China, has developed residential building energy efficiency codes and requires the use of energy-efficiency building technologies. Developed in 1997, compliance is now close to 100 percent with a payback period of between 5 and 11 years.[155]

- **Regulations for designated consumers:** Regulations for designated consumers are a way for governments to mandate that large energy consumers take steps to understand, monitor and plan their energy use. Examples of common mandated practices for designated consumers include energy audits, energy consumption reporting, the appointment of an energy manager and energy savings plans. These four regulations may be implemented as stand-alone approaches or a part of a comprehensive package. The Indian Energy Conservation Act of 2001 mandates energy audits, consumption reporting, and energy managers for firms in nine economic sectors: power, fertilizer, iron and steel, cement, pulp and paper, aluminum, chloralkali, textiles and railways.[156]

- **Regulations in the public sector:** Governments can establish credibility and bring awareness to energy efficiency through public-sector regulations, as well as build governmental capacity to understand and manage energy-efficiency programs. There are a range of viable, short-term, cost-effective regulations that can save government resources and deliver co-benefits. For example, Uruguay has defined a mandatory public-sector phase out of incandescent lamps, while Mexico is requiring mandatory energy planning and reporting.[157]

Energy Efficiency Finance

High upfront capital costs, high information costs and scale are also barriers to attracting finance. Many major economies have adopted financial and fiscal measures to tackle these hurdles. These steps include subsidies and grants, energy performance contracting (EPC), national/municipal loan/rebate programs for residential and/or commercial energy efficiency, energy utility obligations, mortgage-backed energy efficiency financing, preferential taxes or mortgage rates, utility on-bill financing, such as PAYS (pay as you save), revolving guarantee funds, green banks and climate funds. Some example policies include:

- **Local- or utility-scale efficiency programs:** In the United States, 52 state and 51 local government

energy-efficiency programs are now in operation, as well as 103 utility programs that provide financing for homeowners and business in their service territories.[158]

- **National level favorable financing:** China is investing $386.58 billion in key energy efficiency and emission reduction projects in the 12th Five-Year Plan period (2011-2015).[159] Energy efficiency projects with an annual energy savings of more than 5,000 tons of coal equivalent (tce, roughly 15 million KWh) are eligible for government rewards.[160] In addition, energy efficiency projects in China receive preferential treatment in interest rates when borrowing from banks. Moreover, the central government's push for the expansion of "green credit" business is leading banks to create new financial products for energy service companies (ESCOs) such as future receivables from energy efficiency project savings.[161]

- **Funding for efficiency implementation and research:** In Brazil, utilities are required to dedicate 0.5 percent of their income to energy efficiency projects or research. Together they have invested about $378.4 million on such initiatives since 2008, including public awareness campaigns. The national development bank Banco Nacional de Desenvolvimento Econômico e Social is offering an energy efficiency credit line (PROESCO) with an annual rate of 14 percent. About $16.5 million of financing has been approved at this line in 2011.

- **Preferential tax treatment:** In South Africa, the Income Tax Act allows for additional depreciation allowances up to 55 percent for greenfield projects over $19.42 million, where one of the rating criteria being energy efficiency savings. It provides a tax deduction to an energy efficiency taxpayer, with a focus on renewable energy. There are also other tax allowances that provide general depreciation of asset allowance that are applicable not only to ESCOs, but also to any business that meets the energy efficiency savings requirements. In addition, the National Treasury has envisaged a carbon tax that will be implemented in 2013/2014 at the rate of $11.65 per ton of CO_2 on direct emissions and will increase by 10 percent per annum until 2020, which would create an incentive for energy efficiency projects.[162]

- **Multilateral aid to provide lower-cost financing:** Early in 2013, the Inter-American Development Bank (IDB) approved $50 million for the Energy Efficiency Finance Facility to finance companies investing in energy efficiency and self-supply renewable energy projects in Latin America and the Caribbean.[163] In March 2013, development banks in the BRICS nations (Brazil, Russia, India, China and South Africa)—Brazilian Development Bank (BNDES), the Russian Bank of Development and Foreign Economic Affairs (Vnesheconombank), the Export-Import Bank of India, the China Development Bank (CDB) and the Development Bank of Southern Africa (DBSA)—agreed to finance projects connected to sustainability and the low-carbon economy, including investments in renewable energy and energy efficiency.

ENERGY EFFICIENCY POLICY

Recent Developments in Efficiency Policy in Qatar and Other GCC Countries

Many GCC countries have recognized the role for energy efficiency, and some have made substantial investments in this area. Table 5 shows a detailed breakdown of targets and standards for all six GCC countries. A few highlights are discussed in this section, and it should be noted that all GCC countries have begun to investigate and implement policies focused on efficiency.

- **Qatar**'s Vision 2030 and the Qatar National Development Strategy 2011-2016 aim at reducing the energy intensity of electricity consumption through awareness campaigns, standardization and seasonal shutdowns. The strategy seeks to cut total power generation by 7 percent by 2016.[164] Qatar implemented mandatory sustainable building criteria in December 2011. The Qatar Green

Building Council, established in 2009, aims at establishing best practice in sustainable building for Qatar and disseminating knowledge on sustainable living. Within industry, ExxonMobil has joined with Qatar Petroleum to conduct a thorough review of RasGas LNG trains and Al Khaleej Gas plants to monitor plant performance to identify plant and energy efficiency opportunities. ExxonMobil and Qatar Petroleum have also been working together on more efficient LNG ships (Q-Max and Q-Flex), an LNG facility and remote gas detection. Chevron's Center for Sustainable Energy Efficiency (CSEE) at Qatar Science & Technology Park, launched in March 2011, aims at supporting Qatar's sustainable development strategy. Its visitors' center includes training and demonstration of energy-efficient lighting and photovoltaic technologies. Qatar has also sought to halve flaring between 2008 and 2016 to improve energy efficiency and reduce emissions. The $1 billion Jetty Boil-Off Gas Recovery Project at Ras Laffan Industrial City has achieved over 65 percent reduction in flaring from on-plot LNG facilities since 2009. In addition, efforts are underway at the Qatar Sustainable Energy and Water Utilization Initiative, based at Texas A&M University at Qatar, to improve desalination technologies and promote public awareness of sustainable use of energy.

- In **Saudi Arabia**, the government established the Saudi Energy Efficiency Center (SEEC) in 2010 to focus on reducing power through audits, load management, regulation and education. The country is currently developing a Mandatory Energy Efficiency Plan that will include energy conservation targets. Saudi Arabia's Ministry of Water and Electricity created the Energy Conservation and Awareness Department to develop a comprehensive energy conservation plan, with a focus on building awareness among energy users and the general public, and is working with the Saudi Electricity Company to implement energy conservation and load management programs. The ministry rationalizes the use of electricity nationally, imposes limits on the maximum power that can be delivered to electricity consumers and establishes demand-side management actions. Industry in Saudi Arabia has also made efforts to maintain their own efficiency standards, for example, Aramco's energy management program achieved an energy savings of approximately 10,000 barrels of oil equivalent per day in 2011—which represents 3.5 percent of the company's total energy consumption for the year. Calls to revise electricity subsidies have also been raised by Mohammed al-Jasser, economy and planning minister, as well as the Saudi Electricity Company.
- In the **United Arab Emirates**, the Emirates Authority for Standardization and Metrology (ESMA) launched its National Energy Efficiency and Conservation Program in 2011, which seeks to promote energy efficiency in the residential section through massive education campaigns and a labeling system. The UAE continues to invest in energy efficient systems, such as the solar-powered hot water systems currently in use at the Dubai Abattoir in Al Qusais, the Al Quoz cemetery, the Al Fahidi Market and more. Furthermore, new UAE Energy Minister Suhail bin Mohammed Al Mazrouei has called for steps at the federal level to establish tougher building codes, stronger appliance standards, higher vehicle fuel standards and strategic management of water and desalination investment, and Dubai has set a target of a 30 percent cut in energy demand by 2030.
- **Kuwait** has begun the process of mapping a national energy efficiency strategy, supported by the Ministry of Electricity and Water (MEW) and Kuwait National Petroleum Company through the Kuwait Energy & Efficiency Conference.
- Energy efficiency initiatives are still in their infancy in both **Oman** and **Bahrain**, and Qatari initiatives are detailed in the following section.

The GCC region has a number of multilateral and regional institutions that support and promote energy efficiency and related research and development, most notably the GCC Interconnection Authority (GCCIA), a joint stock company subscribed to by all six GCC member states, which aims to become the driver of efficient markets through electricity trading in member states and other regional markets.

Table 5: Energy use targets and standards in GCC countries									
National Targets & Standards	**GCC**	**Saudi**	**UAE**	**Abu Dhabi**	**Dubai**	**Oman**	**Kuwait**	**Qatar**	**Bahrain**
Nationwide									
Low emissions development strategy									
GHG or CO_2 emmissions reduction target									
Energy efficiency/Conservation target		○							
Power and water									
Electricity sector conservation target		○		●	●	●			
Electricity sector peak demand reduction target		○		●		○			
Renewables deployment target		●		●	●		●	○	●
Nuclear introduction target		●	●	●	○				
Water intensity/Conservation target			○						
Transport									
Transport sector energy conservation target									
Vehicles efficiency standards									
Appliance and infrastructure									
Energy efficient labelling		●	○	●	●				
Appliance standards		●	●	●	●		●	●	●
Mandatory efficiency codes for new builds	○	●		●	○		●	●	
National retrofitting targets									
Industry intensity/Efficiency targets									
Oil and gas sector									
Efficiency/Conservation target		●							
Flaring reduction target				●		●	●	●	
Other sectoral efficiency/Conservation targets									

● Target or mandatory standard announced at official national level

○ Target or standard aspirational or under proposal

● Partial/Sector specific (in the case of Oil & Gas Sector = national oil company target)

○ Imported from Abu Dhabi

Lahn and Preston (2013) Targets to Promote Energy Savings in the Gulf Cooperation Council States.

RECOMMENDATIONS

As we have reviewed in this chapter, energy efficiency policies are in many cases justified because the social and financial benefits of efficiency are not being adequately captured. This situation can arise because of market distortions or other non-market (behavioral) obstacles. The large amount of experience with energy efficiency policy worldwide provides some lessons that can potentially be applied to the situation in Qatar and the GCC. This section will provide an overview of those options by policy area, and will also discuss some sectoral and technology options that could be useful.

Policy Approaches

Policy approaches for energy efficiency fall into three areas:

1. **Information and communication measures** focus on providing more transparent information to consumers and the private sector to encourage better decision-making. Such measures can include programs for labeling, either organized by governments or in public-private partnerships. They can also include public awareness and information campaigns.

2. **Regulations** can be established to encourage minimum levels of efficiency. These regulations are often effective at helping remove the very inefficient technologies from continued use in the economy at low cost. They help push the rate of modernization of technologies slightly forward and have the advantage of cumulative savings over years, as well as the possibility to increase stringency relatively painlessly as technologies improve. Such regulations can include minimum standards, such as for appliances, or building codes for new construction and existing infrastructure.

3. **Market-based instruments** are designed to correct or partially correct distorted price signals in the market, a goal that almost all economists would agree is beneficial to the overall economy and social well-being. Several policies could be said to contribute to this effort. A first step could be harmonizing the prices that consumers and industry pay for energy with the costs of the energy itself. This goal fits with the overall global move toward reducing fossil fuel subsidies that was discussed earlier. A second policy area is to incorporate market externalities into the cost of the energy. This can be done, for example, via a carbon tax or cap-and-trade type system that places a price on the externality.

Given these options, we review some possibilities for efficiency measures in the GCC region and Qatar. Not all policy options may be practical in all countries, but given the unique situation of this region there seem to be several promising areas for improvement.[165]

Efficiency Measures

1. **Lower-energy buildings**

Countries in the GCC region are building out their housing and commercial space very rapidly, and these buildings could turn into long-term heavy users of energy, particularly for space cooling. Moreover, the resulting savings would be shared not only by industry but also by individual citizens and residents: The share of the residential sector in total electricity consumption exceeds 50 percent in Kuwait, Saudi Arabia and Bahrain, and is about 40 percent in the UAE. This provides a huge opportunity to improve energy efficiency in the construction and management of buildings, for example, via:

- Construction codes or standards for new buildings.

- Building retrofits for improved efficiency.
- Incorporation of lower-energy passive measures such as natural ventilation, night ventilation, evaporative cooling, insulation, and solar control or shading; and active measures such as mechanical ventilation.
- Designing new urban and industrial clusters to minimize energy waste.

A necessary component of this transition toward efficient building stocks is to encourage the private sector to be able to make informed decisions about best practices. Rating systems and performance requirements for efficient building materials and accreditations programs such as LEED in the United States and BREEAM in the U.K. are a helpful component of this transition. In the GCC, the Qatar Sustainability Assessment System (QSAS) created by the BARWA and Qatari Diar Research Institute provides a template for region-specific building-sustainability programs. The QSAS program, which draws on lessons from a range of international frameworks for rating building sustainability and efficiency, offers an accreditation system for buildings that meet a prescribed set of criteria as well as training schemes for professionals in the construction sector. In 2011 portions of the QSAS criteria were incorporated into regulations by the State of Qatar. Abu Dhabi has also launched an initiative for building efficiency through Estidama, its sustainability program. The Estidama Pearl Rating System is a five-point ("pearl") system modeled on LEED system. According to an executive order, all new buildings in Abu Dhabi must meet the minimum "1-pearl" rating from September 2010; all government buildings must meet the "2-pearl" rating. Such programs could be officially incorporated in all GCC member states, and those countries that have already implemented them could investigate the possibility of requiring more broad based or ambitious efficiency targets for future projects.

2. Efficient appliances and industrial equipment

Improving efficiency for appliances, equipment and other technological devices can be supported by a combination of mandated minimum efficiency standards and voluntary labeling for "quality" products that satisfy certain criteria for excellent performance. Goals could be benchmarked domestically or relative to regional or international levels. Rating and labeling programs that provide information to the consumer at the point of purchase about the energy usage profiles and long-term energy costs of competing products are other means of improving efficiency. GCC countries have a number of nascent initiatives that can provide the basis for increased adoption of standards in both the building and appliance sectors. The Saudi Arabian Standards Organization (SASO), for example, oversees the implementation and standards of the national energy efficiency appliance labeling program, as well as mandates for appliance efficiency standards. Also, the UAE's Emirates Authority for Standardization and Metrology (ESMA) has launched an efficiency rating system for air conditioners: Systems are rated according to a star system (with five stars being the most efficient), and those that do not meet the minimum requirement are not allowed into the country. The system has been expanded to refrigerators and freezers in 2012 and to washing machines in 2013. The application of such systems by other countries in the GCC would be a major step toward increasing overall energy efficiency.

3. Energy efficiency as part of a broader clean energy R&D program

Many of the countries in the GCC have a stated aim to diversify their economies away from a reliance on hydrocarbon and petrochemical production through the establishment of educational centers and knowledge-based industries. Existing GCC research establishments (such as the Qatar Science & Technology

Park or Masdar in the UAE as well as the many technical departments in regional universities) have the opportunity to conduct scientific research into energy applications and systems specific to regional conditions—these include catalysts, lubricants, solar panels, hydrogen storage and optimal design of building "envelopes." GCC countries have the potential to serve as a development and demonstration base for efficiency technologies developed both inside and outside the region. There is also an encouraging precedent for public-private partnerships on R&D in Qatar, where Chevron and the Qatar Science & Technology Park have partnered to create the Center for Sustainable Energy Efficiency. The center will focus its research on lighting, cooling and solar technologies adapted for use in the climate of the Middle East. The center has the potential to serve as a venue for further public-private partnerships in the transfer of efficiency best practice within Qatar and as a model for other countries in the region looking to harness the expertise of their private-sector investors.

4. Energy prices

As discussed earlier, economic theory suggests that energy efficiency in the GCC could be significantly improved through a policy of greater market-based pricing and reduced subsidization of energy. In parallel with this is the possibility of a longer-term shift to a tax on emissions, which would provide additional incentives for investments in efficient technologies. Despite the well-known political challenges associated with pricing reform, there are means of enacting incremental pricing reform that are likely to have less of a disruptive impact than a wholesale move to market pricing. These include:

- A phased adoption of increased end-user pricing.
- "Recycling" the revenues from any price increase to improve efficiency of use.
- Differentiated pricing across different consumer groups.
- A mechanism for compensating the most economically vulnerable.

Given the nexus between energy and water use in the GCC, any pricing reform policy for electricity must also take into consideration water supplies and the wide-scale reliance on desalination plants. Before any implementation of large-scale pricing reform, countries of the GCC could consider conducting research into the consequences of a change in the pricing structure of energy, including the effects of a phase out of subsidies and other adjustments toward a more market-based approach.

5. Public-private partnerships in the energy industry

The GCC energy sector is unusually active and globalized, and there are significant opportunities for collaboration between private (international) companies, industry and government in the interests of increased efficiency. Much of the region's energy consumption occurs in the production and processing of hydrocarbons and other carbon-intensive industrial applications. Even without explicit requirements, the financial incentives to save energy are sometimes large: For example, the opportunity costs of wasting energy assets that could otherwise be sold have prompted many of the multinational companies in these industries to implement efficiency measurement and management processes. An example is ExxonMobil, a major joint-venture investor in the GCC, which had developed a Global Energy Management System (GEMS), a program comprising over 200 best practices and performance measures for process units, major equipment, and utility systems in the petrochemicals and petroleum refining operations. Other oil majors present in the GCC have similar institutionalized efficiency

programs. Total, also a major investor in the GCC, has a stated goal to improve the efficiency of its exploration and production and petrochemicals production by 2 percent per year over the period of 2007-2012. In 2008, the company published an Energy Performance Management Guide, aimed at getting its staff to deploy more efficient technologies and management practices. While many of the technical directives and guidelines used by energy companies may be specific to the hydrocarbon production sector, some of the efficiency management systems, data collection techniques and analysis tools may also be applicable to other sectors of the economy—such as power generation—that are currently under state management.

6. New government institutions to oversee efficiency

GCC countries could consider establishing energy efficiency authorities under their existing government energy agencies. Such institutions would be under the control of each government in the region and would have responsibility for managing domestic efficiency-related projects, promoting public-private partnerships and building capacity through the training of technicians and educators. They would also be responsible for coordinating with each other on trans-GCC partnerships. If desired, the role of the efficiency authority could also include responsibility for monitoring and analysis of water usage, including examination of the distribution and desalination systems. There is some foundation for such energy authorities in the region. Saudi Arabia's National Energy Efficiency Program (NEEP), for example, studies the possibility of implementation of energy efficiency measures in Saudi Arabia, and has set targets for reducing the country's energy intensity of 2030. Looking more broadly, India has implemented a successful Bureau of Energy Efficiency that could also serve as a model.

7. Utility-driven and utility-led efficiency programs

Because of their closer contact with consumers, utilities are in a potentially useful position with respect to encouraging residential and commercial energy efficiency. Moreover, energy efficiency is an important utility system resource that also reduces greenhouse gas emissions, achieves savings for customers and generates jobs. Utilities in the GCC could develop programs to encourage upgrades to more efficient appliances, to do energy audits on buildings, or to encourage peak load reductions through technological or behavioral incentives. Moreover, smart grids hold promise to enable improvements in energy efficiency within the utility sector through both gathering information on use and helping to manage demand and load. However, to harness the full efficiency and environmental benefits of smart grids would require careful program design and implementation, as well as targeted capital investment. In the U.S., for example, utilities are by far the largest driver of large-scale electricity efficiency programs, with customer-funded electric efficiency programs available in 44 states. Their budgets totaled over $6.8 billion in 2011.[166]

8. New energy management technologies

A final, cross-cutting approach to energy efficiency in the GCC region is to look at opportunities over all sectors to deploy new and more intelligent technologies to achieve energy services with less waste. Such information and communication technology (ICT)-based innovations—including ICT infrastructure and equipment, ICT-enabled buildings and construction, ICT-enabled transport, and ICT-enabled carbon/energy management and reporting—can deliver great energy savings. For instance, Mumbai's real-time, adaptive traffic control systems at 253 crossings, supervised by a central traffic management control center, resulted

in a 12 percent reduction in average traffic time in the city, along with an 85 percent reduction in energy usage from the city's traffic lights.[167] A computerized building management system (BMS) that manages and operates various pieces of equipment (usually air conditioning, heating, cooling, ventilation, lighting, maintenance management, security, access and fire systems, etc.) can save 10-40 percent of energy compared with the same building without such a system.[168]

ICT is also leading the evolution of energy infrastructure, where the nature of energy supply and demand is increasingly dynamic and distributed. For example, the number of plug-in electric vehicles has reached 120,000 units worldwide in 2012, and global electric vehicle sales are expected to hit 3.8 million annually by 2020.[169] Utilities are looking toward demand response technologies to shift consumption to lower-cost periods, and they need to be able to respond quickly to demand and supply, which is generated by distributed solar and wind energy, coming on and off the grid. In addition, smart grid and smart networks are generating huge volumes of data. A distribution company with 2 million meters, collecting 15-minute interval data four times a day, processes 35 GB of data every day.[170] Smart meter installation is expected to reach 602.7 million people worldwide by 2016.[171] Cities can leverage the maturing cloud computing and data management technologies that can harness large volumes of real-time data from diverse public and private sources, in order to monitor, measure, analyze, report on and control energy generation, distribution and use on a massive scale.