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RESEARCH PAPERS

EU-GCC Cooperation on Energy - Technical Report

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Acronyms

ADWEC	Abu Dhabi Water and Electricity Company (UAE)
AER	Authority for Electricity Regulation (Oman)
AUE	Arab Union of Electricity
BOT	Build, Operate and Transfer
BP	British Petroleum
CDM	Clean Development Mechanism
CPF	Country Program Framework
CPP	Competitive Procurement Process
CSP	Concentrated Solar Power
DEWA	Dubai Electricity and Water Authority (UAE)
DLR	German Aerospace Centre
DNI	Direct Normal Irradiance
DPC	Dhofar Power Company (Oman)
DSM	Demand Side Management
ECRA	Electricity and Cogeneration Regulatory Authority (Saudi Arabia)
EHC	Electricity Holding Company (Oman)
EIJLLPST	Egypt, Iraq, Jordan, Lebanon, Libya, Palestine, Syria, and Turkey
EMMS	Energy Market Management System
ENEC	Emirates Nuclear Energy Corporation (UAE)
ENTSO-E	European Network of Transmission System Operators for Electricity
EOR	Enhanced Oil Recovery
EPIA	European Photovoltaic Industry Association
ERRA	Energy Regulators Regional Association
ESMA	Emirates Authority for Standardization and Metrology (UAE)
EU	European Union
EWA	Electricity and Water Authority (Bahrain)
FANR	Federal Authority for Nuclear Regulation (UAE)
FEWA	Federal Electricity and Water Authority (UAE)
GCC	Gulf Cooperation Council
GCCIA	Gulf Cooperation Council Interconnection Authority
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GORD	Gulf Organization for Research and Development
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IWPP	Independent Water and Power Producer
JICA	Japan International Cooperation Agency

K.A.CARE	King Abdullah City for Atomic and Renewable Energy (Saudi Arabia)
KAHRAMAA	Qatar General Electricity and Water Corporation
KAUST	King Abdullah University of Science and Technology (Saudi Arabia)
KEPCO	Korea Electric Power Company
KISR	Kuwait Institute for Scientific Research
KNNEC	Kuwait National Nuclear Energy Committee
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied Natural Gas
MED	Multi-effect distillation
MEDENER	Mediterranean Association of National Agencies of Energy Conservation
MEDREG	Mediterranean Regulators for Electricity and Gas
MENA	Middle East and North Africa
MEW	Ministry of Electricity and Water
MIS	Main Interconnection System
MOWE	Ministry of Water and Electricity
MSF	Multi-stage flash
NEEP	National Energy Efficiency Program
NREP	National Renewable Energy Plan
OETC	Oman Electricity Transmission Company
OME	Observatoire méditerranéen de l'énergie
OPEC	Organization of the Petroleum Exporting Countries
OPWP	Oman Power and Water Procurement Company
PAEW	Public Authority for Electricity and Water (Oman)
PPP	Public-Private Partnership
PST	Poly-Silicon Technology
PV	Photovoltaic
QEWC	Qatar Electricity and Water Company
QNFSP	Qatar National Food Security Programme
QP	Qatar Petroleum
QPEERU	Qatar National Plan for Energy Efficiency, Optimization and Resource Utilization
QSAS	Qatar Sustainability Assessment System
QSTec	Qatar Solar Technologies
QSTP	Qatar Science and Technology Park
RAECO	Rural Areas Electricity Company (Oman)
RE	Renewable Energy
RO	Reverse Osmosis
SEC	Saudi Electricity Company
SEEC	Saudi Energy Efficiency Center
SEPC	Sustainable Energy Procurement Company (Saudi Arabia)
SEWA	Sharjah Electricity and Water Authority (UAE)
TPES	Total Primary Energy Supply
TREC	Trans-Mediterranean Renewable Energy Cooperation
UAE	United Arab Emirates

UNFCCC	United Nations Framework Convention on Climate Change
UN-ESCWA	United Nations Economic and Social Commission for Western Asia

Units

bcm	Billion standard cubic metres
bn b	Billion barrels
GW	Giga Watt
kWh	kilo watt-hours
MCM	Million cubic metres
Mtoe	Million tonnes oil equivalent
MW	Megawatt
TWh	Tera watt-hours

Executive Summary

Introduction

The Cooperation Council for the Arab States of the Gulf (also known as the Gulf Cooperation Council, or GCC) is a regional political and economic union created in May 1981 to promote stability and economic cooperation among its members. The Union consists of the six Arab States of the Gulf, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE). The GCC countries show some common characteristics and are among the world's leading oil and gas producing and exporting countries. They are also prominent members of the Organization of the Petroleum Exporting Countries (OPEC).

The economies of the GCC countries are heavily dependent on the fossil fuel resources which have contributed to the rapid socio-economic growth in the region over the past couple of decades. Indeed, energy remains central to relations between the GCC and the EU. In fact, fossil fuels remain the most traded product between the two regions. This is mainly due to the proximity of the regions and the complementarity of their energy production and consumption patterns, which create favourable exchange conditions between the EU and the GCC.

This report aims to identify areas of potential cooperation in the fields of energy, the environment and climate change. It is based on analysis of primary and secondary data emerging from the contributions and knowledge of EU/GCC stakeholders.

The current position

Relations between the EU and the GCC are not recent. Economic cooperation started in 1981 following the creation of the GCC. On 22 July 1985, the Council of Ministers of the then EEC expressed its deep-seated interest in developing economic and political links with the GCC, and decided in principle on a meeting between the Community and the Gulf states.

More recently, on the occasion of the 20th session of the Joint Council held in Luxembourg on 14 June 2010, officials of the EU and the GCC states endorsed the EU-GCC Joint Action Programme 2010-2013, which had been negotiated during the senior officials meeting held in Riyadh on 9-10 February 2010. The Joint Action Programme has the aim of strengthening cooperation in areas of strategic mutual interest over the 2010-2013 period. It specifically includes energy, electricity and water, and nuclear safety among the main topics for cooperation between the EU and the GCC. In particular, regarding energy, the programme foresees:

- exchanging views, information and experience on oil and gas market developments, energy policies, and policies, frameworks, best practices and techniques in the upstream, midstream and downstream fields;
- cooperation in the field of energy equipment, machinery and spare parts manufacturing, especially those used in the oil and gas industries;
- cooperation on clean and renewable energy technologies, on energy efficiency policy and measures, and on solar energy technologies and policy frameworks.

In the field of electricity and water, the programme foresees:

- technical cooperation in all stages of electricity and water production (generation, transport, energy transfer distribution and service providers), including technology transfer;
- benefit to the GCC from the EU's experience in power interconnection, load management, the regulatory framework and the creation and development of regional markets for the trade in, and exchange of, electricity;
- exchange of best practices in RDT (research, development and technology) regarding the integrated management and sustainable development of water in order to achieve water security in the GCC states, and of best practices and techniques in the efficient use of power and water consumption.

Finally, in the field of nuclear safety, the programme foresees:

- cooperation in the field of atomic energy as well as nuclear safety and security;
- exchange of information and experience in matters such as the legal framework for protection against radiation, nuclear security and safety, radioactive waste, warranties and appropriate systems and surveillance.

Within the Joint Action Programme, particular attention is paid to the issue of energy diversification through the development of alternative energy technologies (such as renewable energy technologies and the development of energy efficiency for conventional

energy technologies), as well as the issue of the development of energy infrastructure. Indeed, since the beginning of the cooperation, the Joint Councils and Joint Cooperation Committee meetings have stressed the need for policy support for the promotion of renewable and energy efficiency options in the GCC countries.

The follow-up to the Joint Action Programme has, however, not been complete. At the 22nd session of the Joint Council and Ministerial Meeting held in Luxembourg on 25 June 2012, delegates evaluated progress achieved so far, and agreed to prepare a joint work programme for the next period (2013-2016) and to identify priorities and objectives.

Several EU-GCC expert meetings' conclusions have underlined the importance of enhancing cooperation in energy, with particular focus on energy efficiency and conservation, clean energy, climate change, and technology transfer. The rapid socio-economic growth experienced by the GCC countries has led to a high level of demand for energy, thus making the GCC countries large consumers of fossil fuels. The rising local energy demand is stimulated by several factors, including the population increase, higher urbanization rates, the industrialization of the economies, changes in transportation modes, and water scarcity. Water scarcity has forced the GCC countries to develop energy-intensive water desalination processes.

Having a third of the world's oil reserves, the GCC countries have had little incentive to pay attention to their energy domestic consumption. However, the rising cost of electricity production and the relative shortage in gas production are changing the governments' strategies. Today, the GCC countries are embarking on establishing a sustainable energy mix that is able to meet the needs of their energy consumers without damaging their economic development.

The energy mix of the GCC is much less diversified when compared to that of the EU-27. Indeed, almost 80% of the GCC's energy production is based on oil, with the remaining 20% based on gas. The GCC is also seeing a continuing increase in its energy production, which reached 1,000 Mtoe in 2009. Most of the energy produced is exported, while roughly 300 Mtoe is consumed locally.

The GCC economies are among the most energy intensive, with all of them (except Oman) having energy intensity twice the global rate. Electricity demand is increasing particularly fast, having grown at an average annual rate of 6.6% over the period from 1999 to 2009 (IEA 2011a). This appears to be the case with water demand as well. Being among the most water-scare and arid regions in the world, water desalination is commonly used to meet national water demand. Energy-intensive desalination technologies remain the most feasible alternative to increase or meet domestic supply requirements. This implies massive investment in power generation and seawater desalination capacities.

The GCC countries are looking at several technologies, including nuclear power and renewable energy, to be able to supply part of the extra capacity needed. In addition, in

recent years, the GCC countries have implemented the GCC interconnection grid, which would, in theory, allow savings in the construction of new power plants, and provide standby backup capacity.

Soaring energy demand is parallel to electricity and water demand, mainly driven by the basic needs of the population, such as air-conditioning in buildings and potable water (desalinated water). Further analysis of these consumption patterns reveals that the GCC countries' electricity and water consumption are driven largely by the residential sector, followed by the commercial and public services sectors.

Soaring energy consumption in the GCC is accentuated by pricing policy for energy, which is heavily subsidized. Per capita energy consumption is among the highest in the world, making GCC citizens among the highest consumers of energy. While energy subsidies are aimed at ensuring access for all residents of the GCC, the economic consequences are massive. According to the IMF (2013), energy subsidies result in distorted resource allocation by encouraging excessive energy consumption, artificially promoting capital-intensive industries, reducing incentives for investment in renewable energy, and accelerating the depletion of natural resources.

The utilities sector in the GCC has historically been dominated by state-owned power companies supplied with low-priced oil and natural gas by mostly government-owned oil and gas companies. The market distortion created by this subsidy undermines the growth potential of renewable energy in the region.

The GCC governments are aware of the burden on the state budget that results from energy subsidies, and some countries are already reviewing their energy tariffs. Oman was the first GCC country to review its energy tariffs, followed by Saudi Arabia and the UAE. However, the current political climate in the region tends to challenge such initiatives. One of the reasons is that subsidies are seen as a mechanism to distribute the benefits of the endowment in natural resources to the population.

When it comes to electricity and water, top-down initiatives with low political cost may be more feasible than subsidy removal. The GCC countries have not yet undertaken concrete measures to promote energy efficiency and water conservation. A study of energy policies and relevant initiatives in the GCC countries (Reiche 2010a) shows that the GCC countries have recently adopted a more proactive approach towards environmental sustainability, pointing out also that despite some relevant initiatives, no consistent or coordinated strategies or policies have been established up to now.

Recently, Bahrain has looked at energy efficiency strategies as a way of meeting local energy needs due to the accelerated depletion of its indigenous hydrocarbon reserves. Several market drivers are being introduced to facilitate the inclusion of energy efficiency strategies and measures, but progress remains relatively slow. Kuwait, where domestic buildings are

estimated to consume more than 60% of electrical power, revised its 30 year-old energy conservation code back in 2010. The country's Medium Term Development Plan 2010-2014 aimed at achieving long-term economic sustainability, targeted sectoral development and focused in particular on transport, water and energy resources efficiency.

Additionally, in cooperation with Japan International Cooperation Agency (JICA), Oman is currently drafting its master plan for promotion of energy conservation in the electricity sector (JICA 2012:109). Qatar has already developed a strategy to address several sustainability issues, mainly regarding water conservation, but this strategy has not yet been translated into concrete measures. In 2005, the United Nations Economic and Social Commission for Western Asia (UN-ESCWA) signed an agreement with the Qatar General Electricity and Water Corporation (KAHRAMAA)[1] to support energy efficiency in the power sector. Furthermore, the Gulf Organization for Research and Development (GORD) is working on establishing the Qatar Sustainability Assessment System (QSAS) as a customized regional sustainability rating system. Saudi Arabia's National Energy Efficiency Program (NEEP) and the Saudi Energy Efficiency Center (SEEC) are working toward applying measures to improve energy efficiency in buildings. Similarly, in the UAE, the Emirates Authority for Standardization and Metrology is implementing a labelling program and rating system tailored to the UAE's conditions.

The current trend across the GCC countries is to reform the power sector by enabling IPPs (Independent Power Producers) and IWPPs (Independent Water and Power Producers) to compete at the stage of generation. Furthermore, several GCC countries are attempting to unbundle the generation, transmission and distribution segments in order to facilitate and encourage private investment.

As market reform progresses and a competitive market is established, the electricity interconnection between the GCC countries will start playing an important role going beyond emergency support. The existence of the GCC interconnection will provide opportunities for the establishment of power and desalination plants close to resources, thus giving the freedom to IPPs and IWPPs to select strategic locations which will allow them to operate in a larger market with reduced risks. In the long-term, it is also envisioned that the GCC grid system could be expanded to trade energy with other regions having interconnections.

Diversification of the fuel mix for electricity generation is essential in order to create a competitive advantage between GCC countries and to reduce their over-reliance on hydrocarbon resources. Most GCC countries are exploring RE options, while others are also looking at developing nuclear energy. In December 2006, the six GCC Member States announced that the Council was commissioning a study on the peaceful use of nuclear energy. In 2007, the GCC countries agreed to cooperate with the IAEA on a feasibility study for a regional nuclear power and desalination programme.

1 *KAHRAMAA website: http://www.km.com.qa.*

Saudi Arabia was leading the work, and thought that a programme might emerge in about 2009. In March 2009, Kuwait established its National Nuclear Energy Committee (KNNEC) on the basis of an Amiri decree. In addition, all countries are signatories to the Non-Proliferation Treaty, and the UAE ratified a Safeguards Agreement with the IAEA in 2003. Beside the regional programme, each country has looked at the nuclear option with more or less interest. In 2010, a Saudi Royal decree established the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) to contribute to sustainable development in Saudi industries related to renewable and atomic energy. In May 2012, K.A.CARE foresaw 17 GW of nuclear capacity to be installed by 2032 in the Kingdom, and a National Atomic Regulatory Authority has been set up. Furthermore, the UAE is pursuing a target of producing 25% of its electricity from nuclear energy by 2020. The Fukushima Daiichi nuclear incident sparked fears among GCC citizens, and the pursuit of the nuclear option has been slowed in some countries in the region. In Kuwait for instance, another Amiri decree was issued in July 2011 which cancelled KNNEC and transferred its programme to the Kuwait Institute for Scientific Research (KISR). The UAE however is still continuing with its nuclear programme.

On the other hand, renewable energy technologies are offering promising opportunities in the GCC countries, particularly solar energy technologies. The GCC countries lie in the so-called sunbelt, and are one of the regions in the world with the best solar energy potential, with global horizontal irradiance (GHI) values ranging from 1,900 kWh/m^2/y to 2,160 kWh/m^2/y, and direct normal irradiance (DNI) varying from 2,000 kWh/m^2/y to 2,500 kWh/m^2/y. Wind energy shows lower potential than solar energy, while geothermal and wave-energy have limited potential.

Several studies have investigated the potential of different renewable energy technologies in the GCC, and in a wider context the MENA region, to supply a significant share of European energy needs through interconnected systems. Within the framework of Trans-Mediterranean Renewable Energy Cooperation (TREC), the MED-CSP study carried out by the German Aerospace Centre (DLR) (Trieb et al. 2005), the study by the IEA of the long-term potential of renewable energy technologies (Müller, Marmion and Beerepoot 2011) and the study by the European Photovoltaic Industry Association (EPIA 2011), among others, have reported on the favourable potential and conditions for solar technologies in the GCC region.

Despite the above, the current level of development and deployment of renewable energies in the GCC is below expectations. The GCC countries still lack specific frameworks for RE, but that does not imply that the region is inactive in the field. In fact, all GCC countries have established RE targets and promote renewable energies through resource assessment, pilot demonstration plants and feasibility studies.

In 2011, Kuwait announced its aim to produce 10% of its electricity from renewable sources by 2030, but it has not yet established the required legislative and regulatory frameworks to reach this target. A national renewable energy policy is being drafted to fill the emerging gaps between electric energy demand and supply. In Oman, the Public Authority for

Electricity and Water (PAEW) is taking steps to implement solar and wind projects where the grid is not available. A regulation adopted in 2013 requires the inclusion of a component of renewable energy technology (solar or wind) in each new power project in rural areas. Furthermore, large-scale solar projects with a capacity of 50 to 200 MW are planned for the coming years.

In Qatar, the National Energy Strategy 2011-2016 states that RE technologies should help to save gas and reduce carbon emissions. In 2013, an Amiri declaration set a 2% (640 MW) target for electricity generation by solar energy by 2020. Several projects have been announced, such as the construction of a 3.5 GW integrated solar combined cycle plant (500 MW of CSP) by 2013. Another tender is planned to be launched in 2014 for a 1,800 MW PV plant, which is expected to be completed by 2018. The Qatar Science and Technology Park (QSTP) has announced a 100 MW PV power plant to be implemented by 2014. Qatar Solar Technologies (QSTec) was established in 2012 and aims to produce 8,000 metric tonnes per year of polysilicon, which would provide enough solar energy to power around 240,000 homes for an entire year.

In 2009, the Electricity and Cogeneration Regulatory Authority (ECRA)[2] of Saudi Arabia produced a National Renewable Energy Plan (NREP)[3]. The K.A.CARE programme which oversees renewable energy development in the Kingdom has suggested 54 GW of power generation capacity from renewable energy by 2032, and is currently developing the tools necessary to achieve this target (K.A.CARE 2013:15).

In the United Arab Emirates, Dubai set a target of producing 5% of its electricity from solar energy by 2030, while Abu Dhabi announced that 7% of its total energy would come from RE technologies by 2020, but no specific regulatory framework has been put in place. The UAE is active in the RE field, most particularly through the Masdar initiative. Masdar has announced plans to develop the Sir Bani Yas wind farm with a target capacity of 25 MW, the Shams 1 CSP plant with a capacity of 100 MW, and the Noor 1 PV plant with a planned capacity of 100 MW. Masdar will continue to help the UAE to find new ways to diversify its energy mix.

Identified areas of cooperation

All of the above shows the high potential of EU-GCC partnership in the energy field. To date, energy flows between the EU and the GCC have been very much focused on fossil fuels, mainly oil and gas. The OPEC 2012 report underlines that Saudi Arabia exports to Europe 12.3% of its crude oil exports, Kuwait 4.4% and the UAE only 0.1%. Saudi Arabia therefore remains the biggest GCC exporter of oil to Europe, with 890 thousand barrels per day transferred in 2011 alone. According to BP (2012), 42% of Qatar's total Liquefied Natural Gas (LNG) exports go to Europe, representing 43 billion cubic metres, while for Oman this figure is 2%.

2 *ECRA website: http://www.ecra.gov.sa.*

3 *See Al-Shehri 2010*

There are also clear opportunities to improve cooperation between the two regions, as well as scope for possible projects of common interest, in the natural gas sector, bearing in mind the possibility of linking the natural gas markets of the two regions, which would require the development of adequate infrastructure. Indeed, the EU is expected increasingly to rely on gas to cover its energy needs. Diversifying the sources of the supply of gas is of paramount importance in order to ensure energy security.

In the electricity sector, EU-GCC cooperation is quite advanced as a result of regular exchanges and meetings at the technical level organized by producers, transmission system operators, distributors and their associations. This could of course be enhanced by complementing the activities that the EU is already carrying out with many neighbouring countries in the framework of its external energy policy. For instance, within the Mediterranean region and in the framework of Euro-Mediterranean cooperation, MEDREG (Mediterranean Regulators for Electricity and Gas) offers relevant examples, best practices and lessons to be learnt for fostering market integration and infrastructure investment.

As far as electricity interconnection is concerned, the completion of the GCC regional power grid opens new perspectives for the establishment of a wider electricity market. The EU has a long experience in the establishment of a common electricity market, and there is clear room for cooperation between the EU and the GCC in terms of knowledge transfer in this field. In addition, through the Pan-Arab interconnection study, common research could be carried out in order to examine the benefits and challenges of the interconnection of multiple regional power grids.

Prospects for cooperation could also be explored in the field of nuclear energy. While most of the GCC countries have confirmed their commitment to developing nuclear power over the medium-term, the implementation of nuclear technology remains challenging. Five essential issues have to be addressed in order to consider nuclear energy as a source of sustainable energy, namely nuclear safety, proliferation resistance, a minimal production of radioactive waste, the availability of natural resources, and economic competitiveness (Koning and Rochman 2008). Several EU Member States have longstanding experience of nuclear power. EU-GCC cooperation could build on best practices to enable the transfer of this knowledge from EU to GCC countries.

Renewable energy technologies offer perhaps one of the greatest opportunities for enhanced cooperation between the EU and the GCC, given the high potential for RE in the region, the prominent role of the EU in the development of renewables at the global level, the substantial industrial capacity and degree of innovativeness displayed by EU companies in the field, and the availability of capital in the GCC countries for profitable RE investments.

Within RE technologies, solar is one key option, given the abundance of the resource, which means that the development of both PV and CSP technologies is a concrete opportunity. The development of solar is also being encouraged by several ongoing initiatives in the Euro-Mediterranean and the EU-MENA regions, such as the Desertec concept and the

Mediterranean Solar Plan. However, in addition to solving market integration and system interconnection issues, the implementation of such ambitious projects needs to take into account and overcome a series of technical aspects, mostly related to the intermittent nature of the resource and the harsh climate conditions, which reduce the efficiency of systems.

In addition to the study of these technical aspects, the GCC countries could particularly benefit from the experience of the EU in the development of effective policy and regulatory frameworks for renewables. An impact assessment of incentive mechanisms and of the main technical and non-technical barriers which need to be addressed when designing RE policies would certainly be of benefit to the GCC countries in order to allow them to learn from previous experience and to avoid repeating the same mistakes.

The advanced EU institutional and regulatory framework could also be of benefit to the GCC in the field of energy efficiency. The GCC countries would benefit from cooperation with the EU in several ways, such as:

- institutionally, by taking advantage of the experience accumulated in the EU in the preparation of several directives on energy efficiency (covering for example ecodesign and energy labelling, and energy building codes), as well as in the preparation of the National Energy Efficiency Action Plans (NEEAPs);
- as regards demand-side management, through the development of models for energy service companies (ESCos) and market-based mechanisms to support energy efficiency.

In addition, the establishment of national agencies for energy efficiency would represent a significant step towards the implementation and monitoring of concrete energy savings measures in the GCC countries. This could be further developed by complementing the activities that the EU is already carrying out in the Mediterranean region, such as in the context of the Mediterranean Association of National Agencies of Energy Conservation (MEDENER). Last but not least, capacity building is of the utmost importance both for RE and energy efficiency. Cooperation in this regard can only be beneficial to all parties.

Conclusion

The GCC countries show good potential for cooperation and partnership with the EU over a vast and diversified range of issues. Renewable energy and energy efficiency present excellent opportunities for cooperation and partnership. Despite the slow development in the region, interest is increasing among the governments of different GCC countries. The level of interest varies from one country to another, as does the type of targeted investment. In general, interest is motivated by the desire to achieve both a sustainable energy mix and economic development.

Despite the similarities between the GCC Member States, there are also significant differences between them on a variety of issues. Energy security is a subject of common

interest between all six Gulf states. However, the approach towards the subject varies from one country to another.

Having a third of the world's oil reserves, the GCC countries have paid little attention to their domestic energy consumption. However, the rising cost of electricity production and the relative shortage in gas production are changing the governments' strategies.

The GCC countries are indeed facing important energy challenges, and only recently have their governments acknowledged this. No common approach is in place to deal with electricity and water security issues. In fact, effort fragmentation is common at country level, with most GCC countries splitting the work between research institutes, government agencies and the private sector. Nevertheless, it can be observed that some GCC countries are already taking measures to consolidate their efforts.

The GCC governments recognize the importance of diversifying local energy supplies, and are moving towards market reform and a sustainable energy mix. This move is beset by many challenges. These challenges can be traced back to the size of the demand for electricity. It is argued that electricity and water subsidies have exacerbated rapid demand growth; as a consequence, both sectors have experienced little progress in terms of efficiency improvement and conservation. The current political atmosphere and the constraints this atmosphere imposes on GCC governments make putting in place some of the foundations for market reform rather challenging. However, it is unlikely that subsidies will undergo any significant change. When it comes to electricity and water, top-down initiatives with low political cost (such as building codes) may be more feasible than subsidy removal. Most GCC countries are still at an early stage in the development of their building codes.

The GCC countries are actively working on expanding existing production capacities in order to meet current and future electricity and water demands. Finding secure non-fossil fuel alternatives, developing a regional energy market and creating conditions which stimulate energy saving are essential. Delaying investment in this field could undermine the sustainability and security of supply. In addition, a clearly-defined strategy is key to achieving sustainable and secure electric and water supplies. Yet it is evident that most GCC countries need to intensify their efforts and define clear strategies for achieving these targets.

Plans to develop nuclear energy met with public concern in at least one GCC country following the Fukushima accident, which eventually led to the cancelation of the nuclear programme in that country. However, nuclear energy may still be a viable alternative for some GCC countries. Additionally, nuclear energy could contribute to the GCC interconnection to the benefit of countries where nuclear energy is not feasible. The contribution of nuclear energy to the future GCC energy mix must be addressed openly and objectively. With the exception of Dubai, nuclear energy plans are not being moved forward at the moment at the same pace as RE.

Renewable energy technologies and energy efficiency offer some of the greatest opportunities for enhanced cooperation between the EU and the GCC. The prominent role of the EU in the development of RE at the global level and the substantial industrial capacity and degree of innovativeness displayed by EU companies, together with the availability of capital in the GCC countries, represent a profitable RE investment opportunity which could contribute to energy security for both sides. Furthermore, the EU has long experience of dealing with energy market reform and establishing transparency and accessibility. This has contributed to the security of energy supply by allowing electricity companies to grow beyond national borders.

The EU is already carrying out activities with many countries neighboring the GCC in the framework of its external energy policy. The EU-Mediterranean partnership provides a good example of how EU-GCC cooperation and partnership could be developed. The incorporation of energy efficiency, clean technologies and safe and sustainable low-carbon energy in EU-GCC cooperation and partnership plans will emphasize the global role of the EU in a low-carbon energy future.

Introduction

The Cooperation Council for the Arab States of the Gulf (also known as the Gulf Cooperation Council, or GCC) is a regional political and economic union created in May 1981 to promote stability and economic cooperation among its members. The union consists of the six Arab States of the Gulf, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE). The GCC countries show some common characteristics and are among the world's leading oil and gas producing and exporting countries. They also constitute prominent members of the Organization of the Petroleum Exporting Countries (OPEC).

The economies of the GCC countries are heavily dependent on the fossil fuel resources which have contributed to the rapid socio-economic growth in the region over the past couple of decades. Indeed, energy remains central to relations between the GCC and the EU. In fact, fossil fuels remain the most traded product between the two regions. This is mainly due to the proximity of the regions and the complementarity of their energy production and consumption patterns, which create favourable exchange conditions between the EU and the GCC.

Relations between the EU and the GCC are not recent. Economic cooperation started from the very beginning after the creation of the GCC. On 22 July 1985, the Council of Ministers of the then EEC expressed its deep-seated interest in developing economic and political links with the GCC, and decided in principle on a meeting between the Community and the Gulf states.

More recently, on the occasion of the 20th session of the Joint Council held in Luxembourg on 14 June 2010, officials of the EU and the GCC states endorsed the EU-GCC Joint Action Programme 2010-2013, which had been negotiated during the senior officials meeting held in Riyadh on 9-10 February 2010. The Joint Action Programme has the aim of strengthening cooperation in areas of strategic mutual interest over the 2010-2013 period. It specifically includes energy, electricity and water, and nuclear safety among the main topics for cooperation between the EU and the GCC. In particular, regarding energy, the programme foresees:

- exchanging views, information and experience on oil and gas market developments, energy policies, and policies, frameworks, best practices and techniques in the upstream, midstream and downstream fields;
- cooperation in the field of energy equipment, machinery and spare parts manufacturing, especially those used in the oil and gas industries;
- cooperation on clean and renewable energy technologies, on energy efficiency policy and measures, and on solar energy technologies and policy frameworks.

In the field of electricity and water, the programme foresees:

- technical cooperation in all stages of electricity and water production (generation, transport, energy transfer distribution and service providers), including technology transfer;
- benefit to the GCC from the EU's experience in power interconnection, load management, the regulatory framework and the creation and development of regional markets for the trade in, and exchange of, electricity;
- exchange of best practices in RDT (research, development and technology) regarding the integrated management and sustainable development of water in order to achieve water security in the GCC states, and of best practices and techniques in the efficient use of power and water consumption.

Finally, in the field of nuclear safety, the programme foresees:

- cooperation in the field of atomic energy as well as nuclear safety and security;
- exchange of information and experience in matters such as the legal framework for protection against radiation, nuclear security and safety, radioactive waste, warranties and appropriate systems and surveillance.

Within the Joint Action Programme, particular attention is paid to the issue of energy diversification through the development of alternative energy technologies (such as renewable energy technologies and the development of energy efficiency for conventional energy technologies), as well as the issue of the development of energy infrastructure. Indeed, since the beginning of the cooperation, the Joint Councils and Joint Cooperation Committee meetings have stressed the need for policy support for the promotion of renewable and energy efficiency options in the GCC countries.

The follow-up to the Joint Action Programme has, however, not been complete. At the 22nd session of the Joint Council and Ministerial Meeting held in Luxembourg on 25 June 2012,

delegates evaluated progress achieved so far, and agreed to prepare a joint work programme for the next period (2013-2016) and to identify priorities and objectives.

Several EU-GCC expert meetings' conclusions have underlined the importance of enhancing cooperation in energy, with particular focus on energy efficiency and conservation, clean energy, climate change, and technology transfer. This report aims to identify areas of potential cooperation in the fields of energy, the environment and climate change. The research is based on analysis of primary and secondary data emerging from the contributions and knowledge of EU/GCC stakeholders.

Energy in the GCC

The rapid socio-economic growth experienced by the GCC countries over the past couple of decades has led to higher local demand for energy, thus making the GCC countries large consumers of fossil fuels. The rising local energy demand is stimulated by several factors, including the population increase, higher urbanization rates, the industrialization of the economies, changes in transportation modes, and water scarcity. Water scarcity has forced the GCC countries to develop energy-intensive water desalination processes.

Electricity demand is increasing particularly fast, having grown at an average rate of 6.6%per year from 1999 to 2009 (IEA 2011a), which implies massive investment in power generation capacity to meet requirements. The GCC countries are looking at several technologies, among which are nuclear power and renewable energy, in order to be able to supply part of the extra capacity needed. In the last few years, the GCC countries have implemented the GCC interconnection grid, which would, in theory, allow for a reduction in the amount of new power plant construction needed, and provide standby backup capacity.

The GCC countries are ranked among the world's highest carbon footprint countries. Greenhouse gas (GHG) emissions increased by more than 75%over the period from 2000 to 2010, and by more than 200% over the period from 1990 to 2010 (IEA 2012a). Per capita CO2 emissions and energy intensities in the GCC countries are higher than the world and EU-27 averages (IEA 2011b). These patterns of fossil energy use and related CO2 emissions are encouraged by the fact that GCC governments heavily subsidize energy, especially electricity, leading to wasteful practices on both the demand and the supply sides.

These patterns give rise to an unsustainable energy system across the GCC. All the patterns described show the non-sustainability of the GCC countries' energy systems. This increases the necessity of moving towards sustainable energy solutions, as the region cannot depend on non-renewable resources forever. Despite the high exploitable potential, till now, only pilot, research and some small-scale activities related to renewable energy and energy efficiency have been conducted in the GCC countries. Nevertheless, the GCC countries have recently adopted a more pro-active approach towards the sustainable development of their economies, looking at solutions to switch towards a more efficient use of fossil fuels, combined with an increased development of both renewable energies and energy efficiency.

EU-GCC relations

Relations between the EU and the GCC date back to the Cooperation Agreement, which was signed in 1988 and entered into force in 1989. The Cooperation Agreement encouraged trade and economic cooperation in the sectors of energy, industry, trade, investment, agriculture, science, technology and the environment. The objective of the Agreement was to bolster stability in a strategic region for the EU, and to facilitate political and economic relations. In 2010, the EU and the GCC agreed on a Joint Action Programme 2010-2013 for the implementation of the Cooperation Agreement. The Joint Action Programme devoted a specific section to energy, focusing on one hand on oil and gas issues, and on the other on the issue of renewable energy and energy efficiency. A main tool of cooperation in this field is the establishment of the Clean Energy Network, a framework in which GCC institutions can access European Commission partnerships and participate in discussion groups and pilot projects:[4]

The EU has a well-founded interest to cooperate with the GCC countries and support them in addressing and successfully tackling energy issues. EU-GCC cooperation makes particular sense when one considers that the EU is on the one hand one of the world's major importers of hydrocarbons, and on the other the leading global proponent of sustainable development. On-going EU-GCC cooperation on energy highlights the paramount importance of the producer-consumer dialogue, which is currently focused on the identification of prospects and opportunities for the development of a sustainable energy economy in order to move from the current carbon-constrained economy to new and prosperous sustainable development paths (Papadopoulou et al. 2011).

Structure of the report

The first part of this report focuses on the energy sector in the GCC countries. It includes an analysis of the latest energy trends in the EU-27 and the GCC, and their respective roles on the global energy stage. Additionally, it includes an in-depth analysis of the energy sector in the GCC countries, examining issues ranging from the importance of fossil fuels to electrical interconnections, and focusing on the latest developments in relation to renewable energy and energy efficiency in the region.

The second part looks at the historical relationship in terms of energy between the EU and the GCC, and outlines the main areas of possible in-depth cooperation between the two regional organizations.

4 *EU-GCC Clean Energy Network, Network Activities and Offering, http://www.eugcc-cleanenergy.net/TheNetwork/NetworkActivitiesOffering.aspx*

1. Overview of the energy sector in the GCC

Although the GCC countries represent a small proportion of the global population compared to the EU-27[5] (0.6% compared to 7.4%, with 26 out of 38 million people living in Saudi Arabia), they are very important actors on the global energy scene.

1.1. Fossil fuel reserves

Past and current trends in energy within the GCC countries have been driven by their large hydrocarbon endowments, on which they have relied to support and develop their economies. Indeed, the GCC countries hold approximately one third of the world's proven crude oil reserves (Figure 1), with more than half being held by Saudi Arabia, and around one fifth of global proven natural gas reserves, with around 60% in Qatar (Figure 2).

Fig. 1. Global proven crude oil reserves by region, 2011

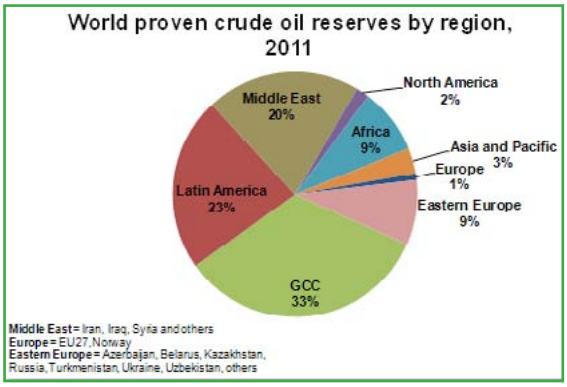
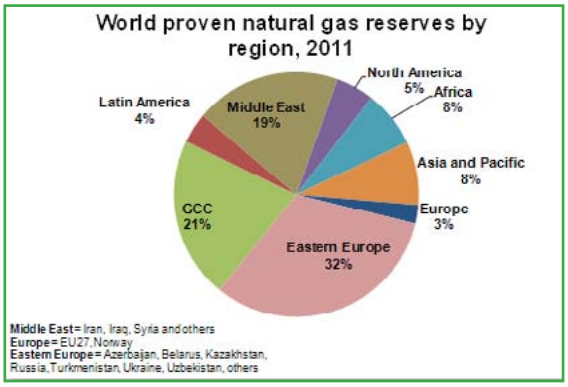


Fig. 2. Global proven natural gas reserves by region, 2011



Source: OPEC 2012.

Four of the GCC countries are among the 15 countries holding the highest proven crude oil reserves (Saudi Arabia with 265 bn b, Kuwait with 101.5 bn b, UAE with 97.8 bn b and Qatar with 25.4 bn b), and four GCC countries are among the 20 countries holding the highest proven natural gas reserves (Qatar with 25,110 bcm, Saudi Arabia with 8,151 bcm, UAE with 6,091 bcm and Kuwait with 1,700 bcm) (Figures 3 and 4).

5 Please note that in the interests of having comparable data, all 27 Member States are included since 1990, despite their different dates of accession to the European Union.

Fig. 3. Top 15 global proven crude oil reserves by country, 2011

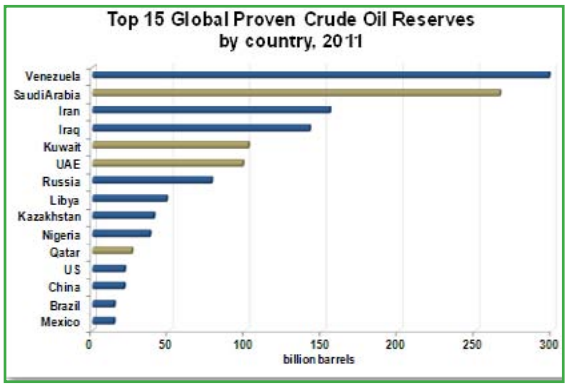
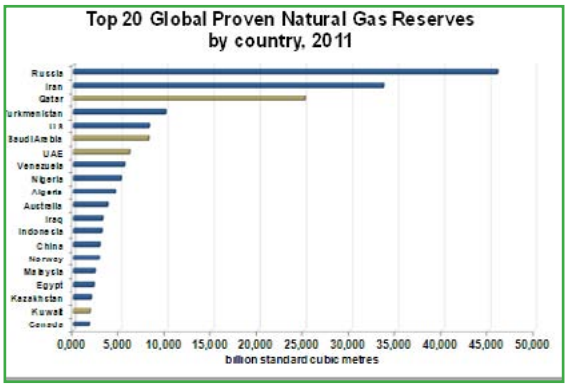


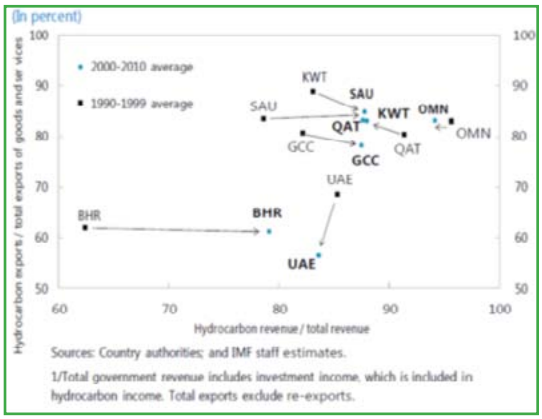
Fig. 4. Top 20 global proven natural gas reserves by country, 2011



Source: OME based on OPEC 2012.

Given these extraordinary hydrocarbons resources, the GCC countries have developed their economies in almost exclusively reliance on hydrocarbons, and thus are highly dependent on revenues coming from that sector (Figure 5).

Fig. 5. Hydrocarbon dependency in GCC countries



Source: US Energy Information Administration 2013.

In all the GCC countries, 80% of total government revenue depends on revenues coming from hydrocarbons-related activities (Figure 5), and hydrocarbon exports account for more than 50% of total exports of goods and services (around 80% for most of the GCC countries).

1.2. Energy production

According to the IEA (2011c), in 2009, the GCC countries' energy production represented 8% of the world's energy production, while the EU-27's energy production represented around 7% (Figure 6). In other words, in 2009 the GCC countries produced more than 1,000 Mtoe of energy thanks to their reserves of crude oil and natural gas, while the EU-27 produced just over 800 Mtoe. More than half of the GCC countries' production was supplied by Saudi Arabia (mainly crude oil). It is also observed that the GCC's energy production has increased

over the period 1990 to 2009, while the opposite is true of the EU-27, raising concerns as to security of energy supply among the EU-27 Member States (Figure 7).

Fig. 6. Worldwide energy production, 2009

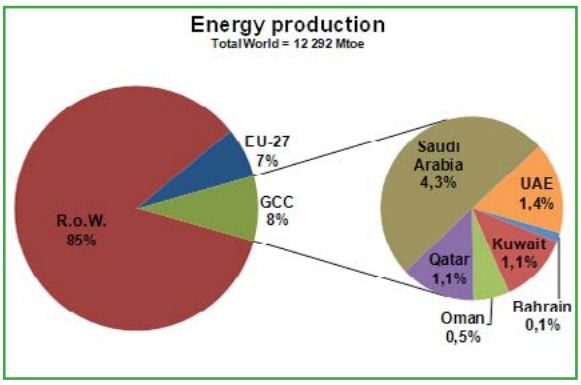
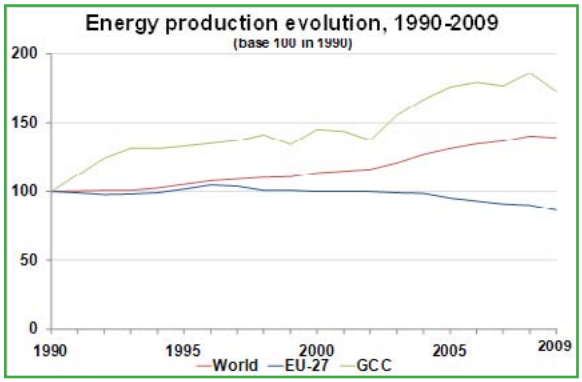


Fig. 7. Energy production evolution in the EU-27 and the GCC, 1990-2009



Source: OME based on IEA 2011a.

The breakdown of the energy production mix is widely different between the EU-27 and the GCC. The EU-27 energy production mix is relatively diversified, with half of production based on fossil fuels (coal, oil and gas), 29% based on nuclear, and 19% based on renewable energy sources (including hydro). The energy production mix of the GCC is much less diversified, with almost 80% of production based on oil, and the remainder based on gas (Figures 8 and 9).

Fig. 8. Energy production in the GCC, 2009

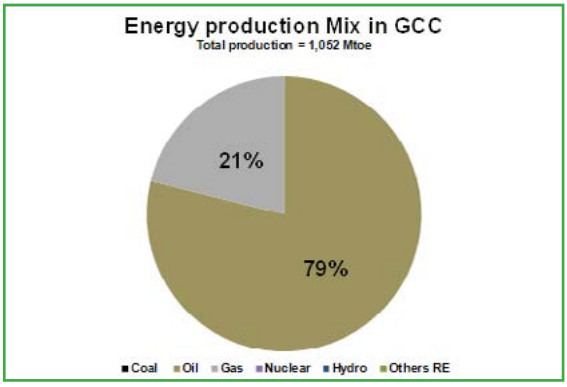
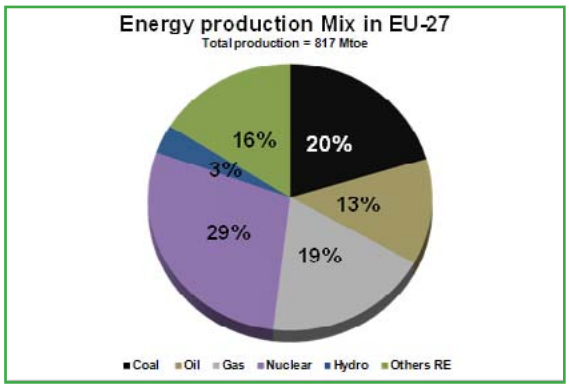


Fig. 9. The energy production mix in the EU-27, 2009



Source: OME based on IEA 2011a.

Among the GCC countries, Qatar, Bahrain and, to a lesser extent, Oman are the countries with the highest share of gas in their production mixes (Figure 10). However, in terms of absolute value, Qatar is the main producer of gas, followed by Saudi Arabia and the United Arab Emirates (Figure 13). The GCC's energy production has tended slightly to increase from 1990 onwards, except for Qatar and Kuwait, whose production has multiplied by 5 and 3 respectively (Figure 11).

Fig. 10. The energy production mix in GCC countries, 2009

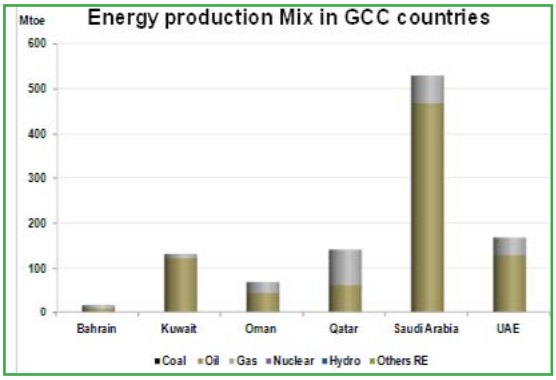
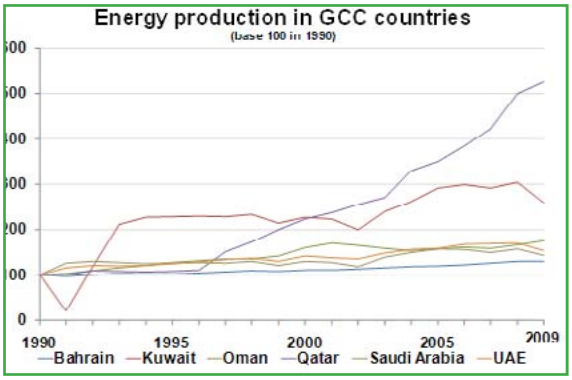


Fig. 11. Energy production evolution in GCC countries, 1990-2009



Source: OME based on IEA 2011a.

Saudi Arabia is the biggest producer of oil in the region, with more than 450 Mtoe, followed by the United Arab Emirates (around 130 Mtoe) and Kuwait (120 Mtoe) (Figure 13). As for energy production from gas, Qatar is the leading producer with 80 Mtoe, followed by Saudi Arabia (61 Mtoe) and the United Arab Emirates (40 Mtoe) (Figure 13).

Fig. 12. Energy production from oil in GCC countries, 2009

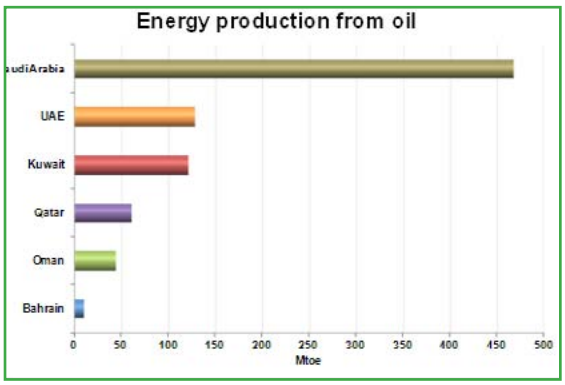
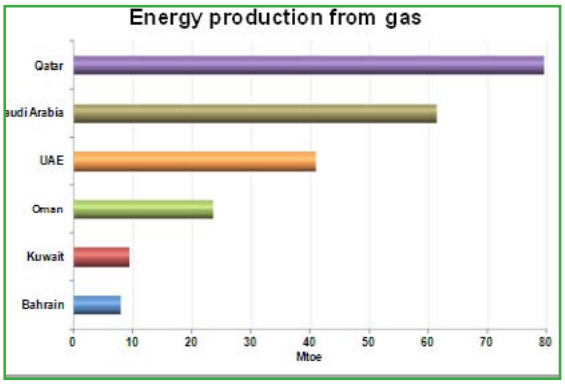


Fig. 13. Energy production from gas in GCC countries, 2009



Source: OME based on IEA 2011a.

1.3. Energy consumption

In terms of energy demand, in 2009, the GCC countries consumed roughly 300 Mtoe, i.e. 2% of the world's total, while the Total Primary Energy Supply (TPES) to the EU-27 represented 14% of the worldwide TPES (Figure 14). Saudi Arabia alone consumes more than half of the TPES to the GCC countries (158 Mtoe). It is followed by the UAE (60 Mtoe) and Kuwait (30 Mtoe). While the GCC countries' energy production systems are largely dominated by oil (except for Qatar), their energy consumption is more equally shared between oil and gas, mainly due to the use of gas for electricity and heating purposes (Figure 15).

Fig. 14. Worldwide TPES, 2009

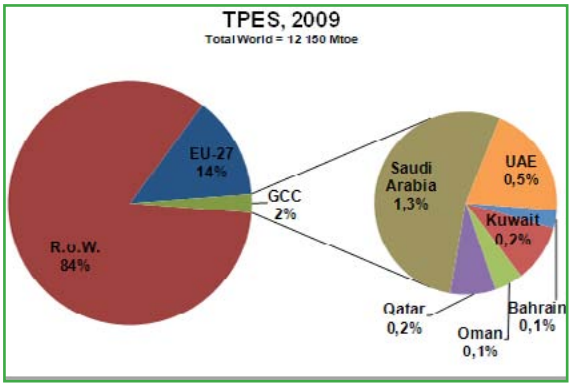
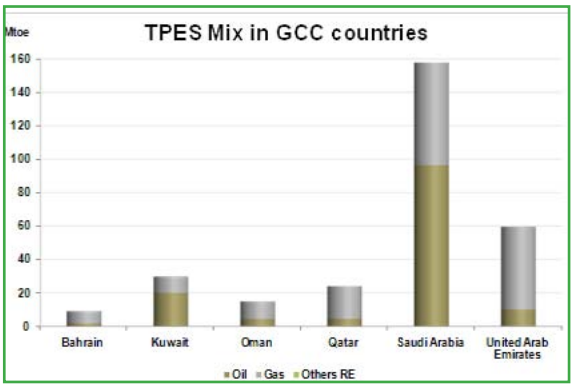


Fig. 15. The TPES mix in the GCC, 2009



Source: OME based on IEA 2011a.

The GCC countries are facing rapid socio-economic growth (increasing population, high rates of urbanization, substantial industrialization), which forces them to consume more and more energy. As a result, energy consumption for all GCC countries has strongly increased from 1990 to today. Bahrain's energy consumption has doubled from 4 Mtoe to 9 Mtoe. Saudi Arabia, the UAE and Kuwait have almost tripled their consumption, from 60 Mtoe, 20 Mtoe and 9 Mtoe to 160 Mtoe, 60 Mtoe and 30 Mtoe respectively. Finally, Qatar and Oman are the countries which have most increased their energy consumption, from 6 Mtoe and 4 Mtoe to 24 Mtoe and 15 Mtoe respectively (Figure 17).

Fig. 16. TPES evolution, 1990-2009

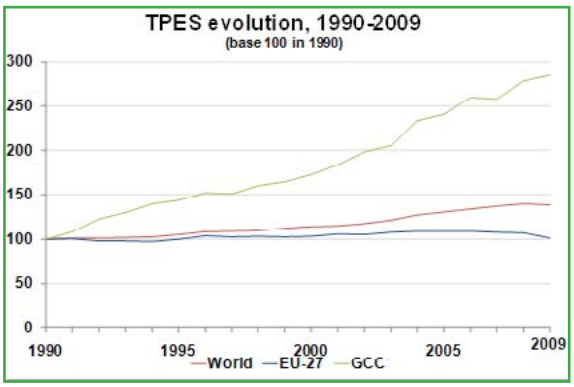
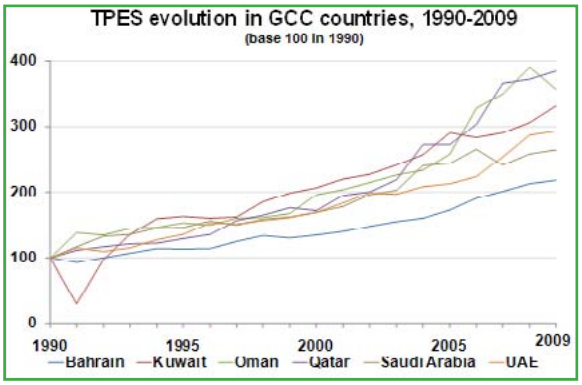


Fig. 17. TPES evolution in GCC countries, 1990-2009



Source: OME based on IEA 2011a.

Soaring energy consumption in the GCC is accentuated by pricing policy for energy, which is heavily subsidized (see 1.5 Energy tariffs/subsidies). GGC citizens are among the highest consumers of energy, with per capita energy consumption being among the highest in the world. Qataris are the greatest consumers, with an average exceeding 16 toe per capita, more than eight times global average per capita consumption (Figure 18).

Fig. 18. Per capita energy consumption in GCC countries, 2009

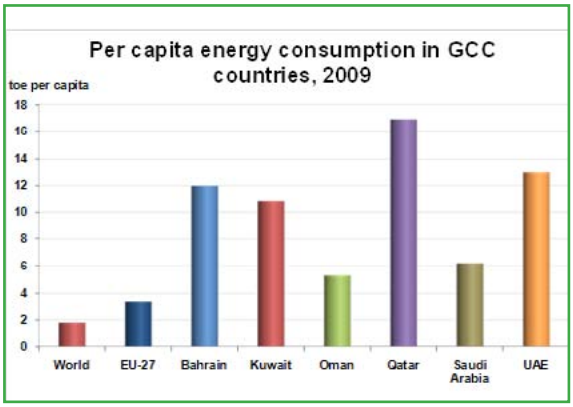
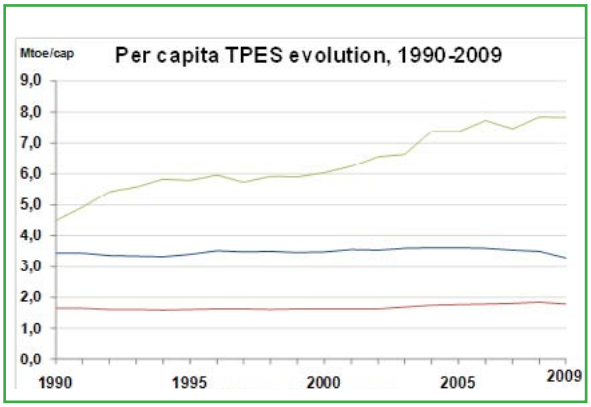


Fig. 19. Per capita energy consumption evolution, 1990-2009



Source: OME based on IEA 2011a.

GCC economies are among the most energy intensive, all of them (except Oman) having energy intensity twice the global rate (Figure 20). While energy intensity has been decreasing in Bahrain and Qatar from the 1990s onwards, other GCC countries have seen their energy intensity increase, particularly Saudi Arabia (Figure 21).

Fig. 20. Energy intensity in GCC countries, 2009

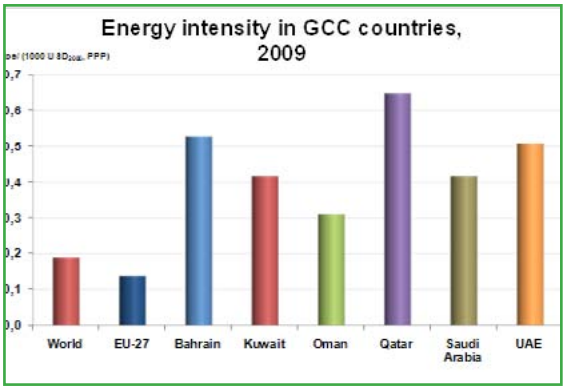
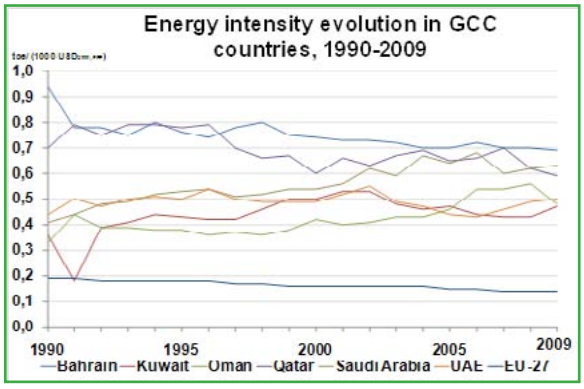


Fig. 21. Energy intensity evolution in GCC countries



Source: OME based on IEA 2011a.

1.4. Energy exports/imports

All GCC countries are net exporters of energy (Figure 22). Despite their large endowments of hydrocarbon resources, soaring energy demand, driven by the increasing population and resulting increased energy needs, has led some of the GCC countries to import energy (notably natural gas) in order to meet local energy demand. For instance, the UAE recently became a net importer of natural gas for two main reasons: (i) nearly 30 percent of natural gas produced in recent years was re-injected into existing fields as part of enhanced oil recovery (EOR) techniques; and (ii) the country's inefficient and rapidly-expanding electricity grid relies on natural gas for the majority of its feedstock.

Fig. 22. Imports/exports in GCC countries, 2009

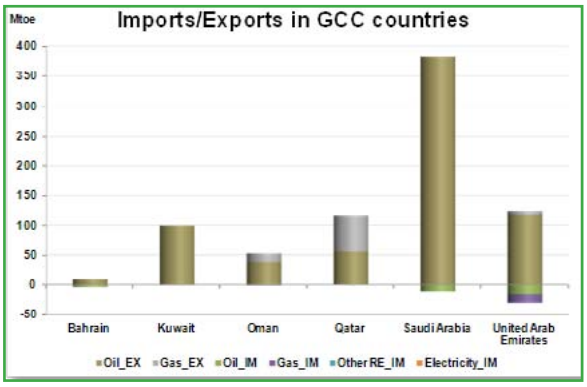
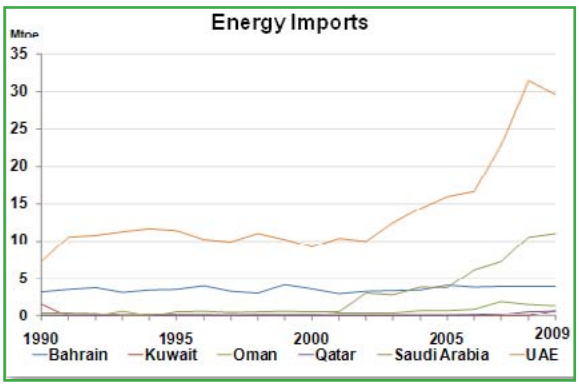


Fig. 23. Evolution of energy imports in GCC countries, 1990-2009



Source: OME based on IEA 2011a.

According to OPEC (2012), in 2011 Saudi Arabia supplied 13.2% of the world's total crude oil production, and was also the main exporter, with 7,218 thousand barrels per day . Kuwait and the United Arab Emirates are also major worldwide suppliers, with 3.8% and 3.6% respectively of the world's total crude oil production, and exporting respectively 1,816 and 2,330 thousand barrels per day (Figures 24 and 25).

Fig. 24. Worldwide crude oil production, 2011

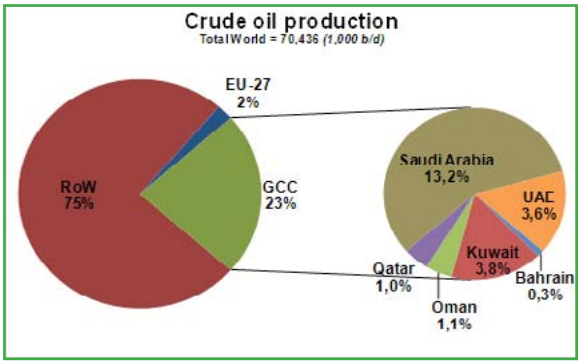
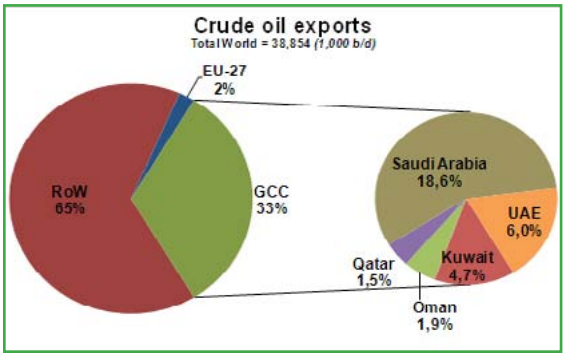


Fig. 25. Worldwide crude oil exports, 2011



Source: OME based on OPEC 2012.

In total, the GCC countries account for 33% of global crude oil exports (Figure 25). The EU's share of the crude oil exports of the GCC has decreased from 11% in 2005 to 8% in 2011, as a result on the one hand of the emerging and energy-intensive Asian economies, which are playing an increasing role in the oil trade with the GCC countries, and on the other of the stagnant/declining demand in Europe (Figures 26 and 27).

Fig. 26. The destination of GCC crude oil exports, 2005

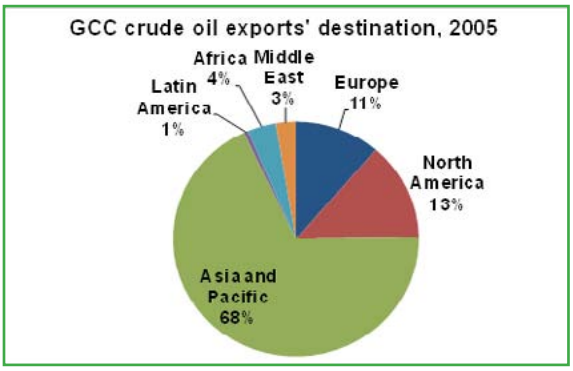
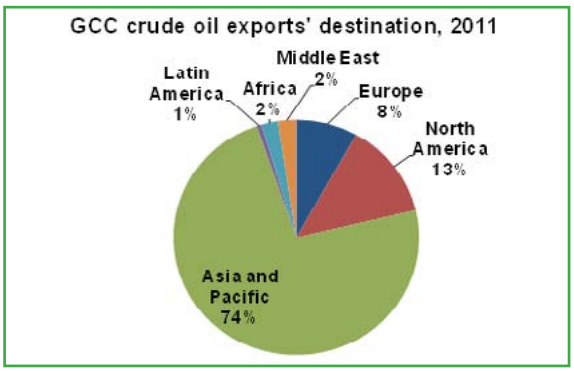


Fig. 27. The destination of GCC crude oil exports, 2011



Source: OME based on OPEC 2012.

The GCC countries remain among the biggest energy exporters, with five of them ranked among the top 15 global crude oil exporting countries (Figures 28 and 29). Saudi Arabia is the main worldwide exporter of crude oil with more than 7.2 bn b exported in 2011. In relation to natural gas exports, Qatar is ranked second in the world with 113 bcm exported in 2011, and Oman 19th with 12 bcm. In addition, Qatar exports one third of total global exports of liquefied natural gas (BP 2012).

Fig. 28. Top 15 crude oil exporters by country, 2011

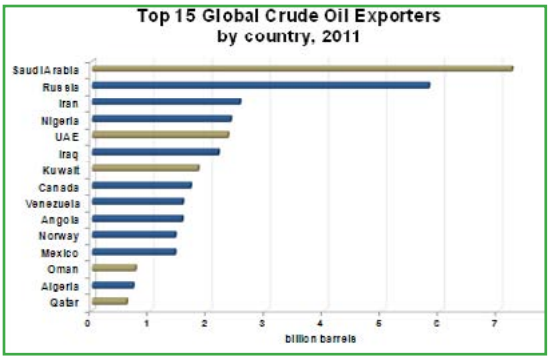
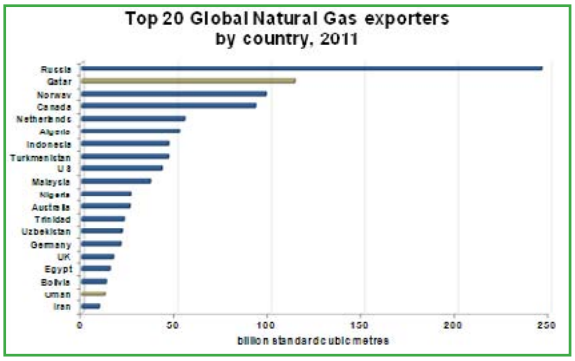


Fig. 29. Top 20 natural gas exporters by country, 2011



Source: OME based on OPEC 2012.

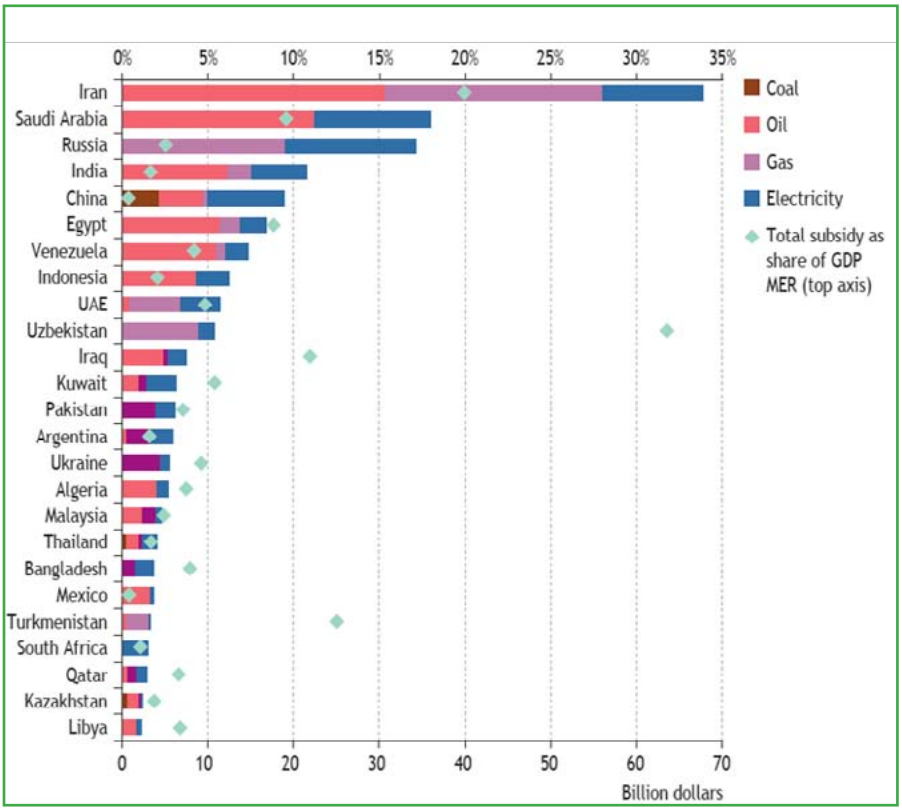
1.5. Energy tariffs/subsidies

Low energy prices are often conceived of as being part of a subsidy. In the case of crude oil, the marked reference price for domestic pricing is often the marginal cost of production rather than the achievable export price to the international market. This represents an issue in regions where electricity generation is exclusively dependant on fossil fuels. While energy subsidies are aimed at ensuring access for all GCC residents, the economic consequences are significant. According to the IMF (2013), energy subsidies result in distorted resource allocation by encouraging excessive energy consumption, artificially

promoting capital-intensive industries, reducing incentives for investment in renewable energy, and accelerating the depletion of natural resources.

In 2010, the IEA established a ranking of the top 25 countries in terms of subsidies to their energy sector. Four GCC countries appear in this rankng. Saudi Arabia was ranked second, behind Iran (Figure 30).

Fig. 30. Economic value of fossil-fuel consumption subsidies by country and type, 2009



Source: IEA 2010.

Table 1 summarizes the subsidies given to energy in 2011 in some of the GCC countries. The Kuwaiti Government spent $11.1 billion in 2011 on energy subsidies, representing 6.3% of GDP. Qatar devoted $5.98 billion to energy subsidies, of which $2.1 billion were for electricity. Overall, subsidies in Qatar represented 3.4% of GDP in 2011. Saudi Arabia spent $87.94 billion (almost half on electricity), which represents 10.6% of GDP. Finally, the UAE spent $21.82 billion (half on natural gas), i.e. 6.1% of GDP.

The UAE, with $4,172/cap, is the country which spent the most on its citizens in terms of yearly energy subsidies. Kuwait and Qatar follow with $3,729/cap and $3,622/cap respectively. Saudi Arabia "only" spends $2,291/cap.

Table 1. Energy subsidies in some GCC countries, 2011

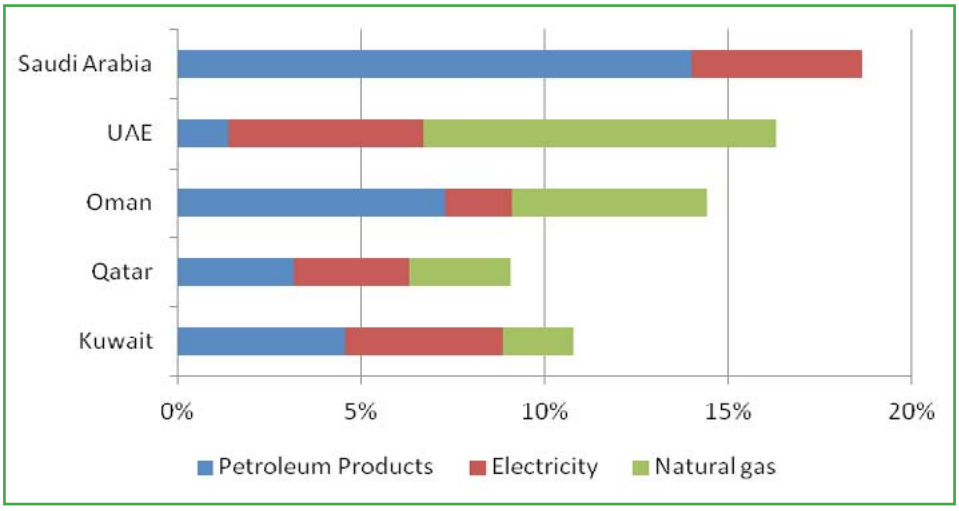
	Kuwait	Qatar	Saudi Arabia	UAE
Average subsidisation rate*	87.8%	78.6%	79.5%	69.1%
Oil (billion $)	4.34	2.03	46.12	3.93
Natural Gas (billion $)	2.08	1.86	0	11.52
Electricity (billion $)	4.68	2.09	41.82	6.37
Total (billion $)	11.1	5.98	87.94	21.82
Total subsidy as share of GDP	6.3%	3.4%	10.6%	6.1%
Subsidy ($/person)	3 729.3	3 622	2 291.2	4 172.1

* Fossil-fuel consumption subsidy rate as a proportion of the full cost of supply

Source: IEA 2012b.

The GCC governments are aware of the burden on the state budget that results from energy subsidies (Figure 31). Oman was the first GCC country to review its energy tariffs, followed by Saudi Arabia and the UAE. However, the current political climate in the region tends to challenge such initiatives. One of the reasons is that subsidies are seen as a mechanism to distribute the benefits of the endowment in natural resources to the population.

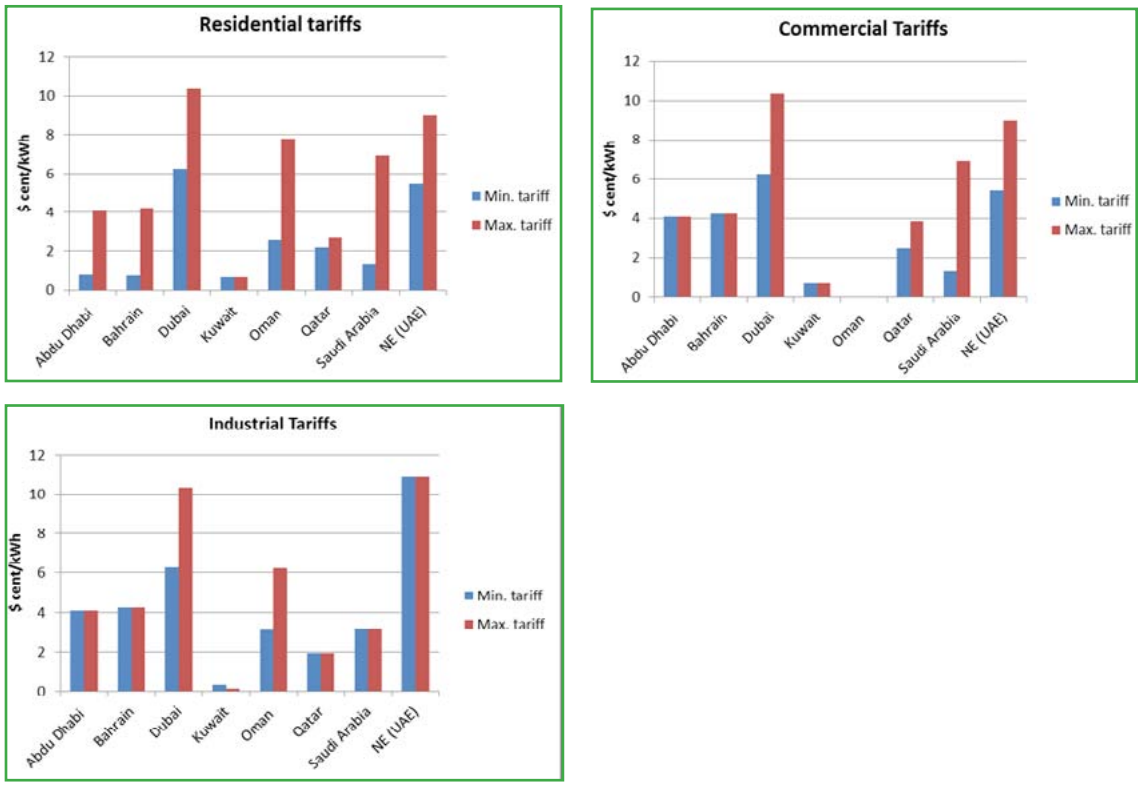
Fig. 31. Total subsidies as a share of government revenue, 2011



Source: OME based on IMF 2013.

The utilities sector in the GCC has historically been dominated by state-owned power companies supplied with low-priced oil and natural gas by mostly government-owned oil and gas companies. When electricity is supplied to the final consumer, an additional subsidy is often applied. GCC residents enjoy some of the world's lowest energy prices, particularly as regards electricity (Figure 32). The market distortion created by this subsidy undermines the growth potential of renewable energy in the region.

Fig. 32. Retail electricity prices in GCC countries by sector



Source: OME based on national sources 2013.

The current move toward the liberalization of the utility markets in the GCC has not influenced electricity pricing (El-Katiri 2011). According to the IEA (2012c), some GCC countries are on the way to reducing energy subsidies. In that respect, Qatar increased gasoline, diesel and kerosene prices by 25% in January 2011, and the UAE increased gasoline prices in 2010 to the highest level in the GCC. These prices were still below international prices, and despite the higher international prices seen in 2011, there have been no further increases. In Kuwait, the Ministry of Finance started reviewing government service tariffs in 2011. Though no further details have been published, the desire to move this forward in 2013 is being met with parliamentary opposition, and has been described as unconstitutional (Kuwait Times 2013).

1.6. Electricity

1.6.1. Electricity consumption

Soaring energy demand is parallel to electricity demand, mainly driven by the basic needs of the population, such as air-conditioning in buildings and potable water (desalinated water), and the low electricity tariff policies resulting from subsidies (see above). In all GCC countries, electricity consumption has greatly increased over the past 20 years, leading to a significant development in power capacities (see annex 3). Qatar and the UAE are the countries which have seen the greatest increase (Figure 34).

Fig. 33. Electricity consumption evolution in GCC countries, 1990-2009

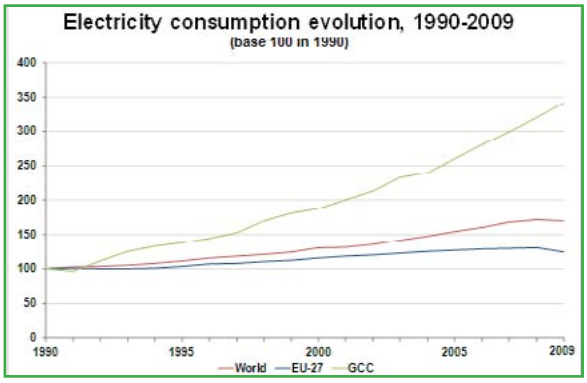
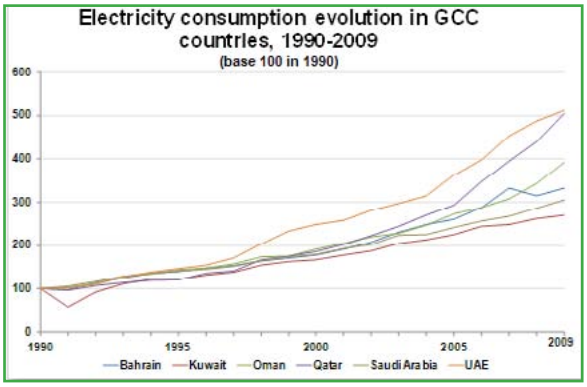


Fig. 34. Per capita electricity consumption evolution in GCC countries, 1990-2009



Source: OME based on IEA 2011a.

On a per capita basis, the GCC countries show fast growth, increasing on average from 4,700 kWh/cap in 1990 to 9,900 kWh/cap in 2009. UAE inhabitants are the greatest consumers of electricity with more than 17,000 kWh/cap, more than six times global average per capita electricity consumption (Figure 35).

Fig. 35. Per capita electricity consumption evolution, 1990-2009

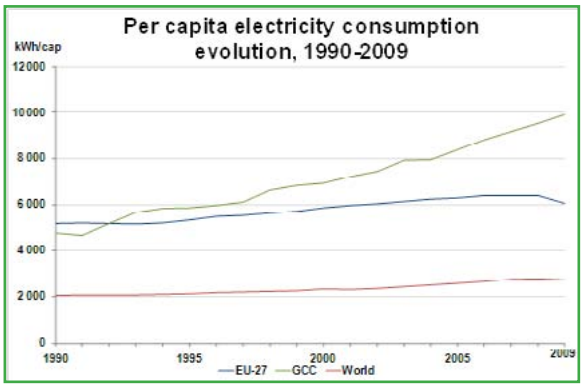
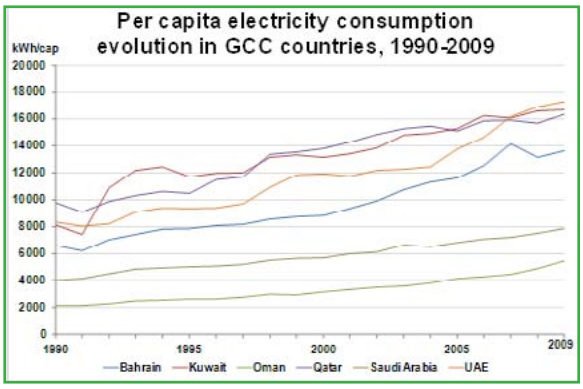


Fig. 36. Per capita electricity consumption evolution in GCC countries, 1990-2009



Source: OME based on IEA 2011a.

Further analysis of electricity consumption in the GCC countries reveals that in most of them (except Qatar), the residential sector is the highest consumer of electricity, followed by the commercial and public services sectors (Figure 36). Consumption is indeed very high in buildings, which is mainly due to the use of air conditioning systems (Deloitte 2011). Given that electricity is heavily subsidized, GCC residents are not incentivized to change their habits, which should evolve from being wasteful to being more sustainable.

The GCC economies are among the most electricity-intensive in the world. The economies of Bahrain and Saudi Arabia are the most intensive in the region, with electricity intensity of around 0.8 kWh/thousand $2,000 in 2009 (Figure 38).

Fig. 37. Total final electricity consumption by sector, 2009

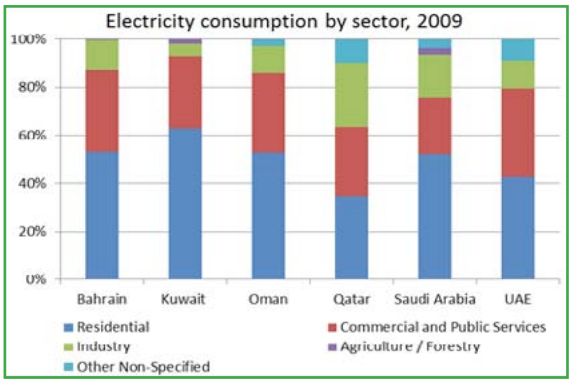
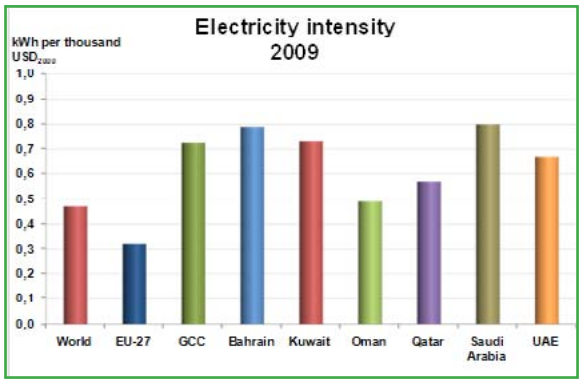


Fig. 38. Electricity intensity in GCC countries, 2009



Source: OME based on IEA 2011a and national sources.

1.6.2. Electricity market structure

The GCC countries have been experiencing increased demand for electricity due to rapid population growth and economic development. In order to shoulder the financial burden, most GCC governments have restructured their electric power markets in order to involve the private sector in power generation, transmission and distribution. The current trend across the GCC countries is to reform the power sector by enabling IPPs (Independent Power Producers) and IWPPs (Independent Water and Power Producers) to compete at the stage of generation. A summary of the market structure is set out in Table 2.

Bahrain

In previous years, the Ministry of Electricity and Water (MEW) was responsible for electricity generation, transmission and distribution. However, recent reform of the electric power sector has enabled the private sector to participate in electricity generation. Today, the Electricity and Water Authority (EWA)[6] acts as regulator for the private sector. The Government has encouraged IPPs to undertake projects, and allowed the privatization of some state-owned power sector assets. The Kingdom's first IPP is Al-Ezzel Power Company, which began operations in 2006. Today, there are three privatized power companies (IPPs and IWPPs). The EWA owns the transmission and distribution mechanisms and participates in electricity generation.

Kuwait

The entire energy market of Kuwait is solely owned by the Government. Kuwait's electric power system is no exception, and is vertically integrated. The MEW generates, transmits and distributes electric power. Several studies have proposed restructuring the electric power sector in the country. Until 2008, the MEW had taken responsibility for the planning, procurement, operation and maintenance of the entire production, transmission and distribution supply chain and for demand control, the latter by means of both approval

6 *EWA website: http://www.mew.gov.bh.*

of consumers' installations and conservation outreach initiatives. In 2008, a legislative framework, including means of privatization, was introduced by the Public-Private Partnership Law No. 7/2008. It involved competition and the award of contracts to private developers/investors under Build Operate and Transfer (BOT) arrangements, as well as the subsequent formation of PPPs. The process is so far considered to be in its infancy. Implementation of the first IPP tender for Az Zour North power station Phase 1 is now in progress. Currently, IPP tenders apply only to new generation projects of more than 500 MW.

Oman

In 2005, a law decree passed operational responsibility for the electricity sector from the Ministry of Housing, Electricity and Water to the newly-created generation, transmission and distribution companies. Today, the Public Authority for Electricity and Water oversees the electricity sector in the Sultanate. The government still owns approximately 99% of the shares in each of the companies, but privatization is nevertheless expected to occur in the coming years in the generation, transmission and distribution sectors. According to Al-Asaad et al, the procurement company will however remain under government ownership.

The Oman Power and Water Procurement Company (OPWP) is the single buyer of power and water for all IPP and IWPP projects in Oman. The Ministry of Finance owns 99.9% of the shares in OPWP. The Ministry also owns 98.1% of the shares in the Dhofar Power Company (DPC). The power system in Oman is not fully interconnected. The largest part of the system, known as the Main Interconnection System (MIS), covers the northern part of the Sultanate. A smaller system owned by DPC serves the Salalah area in the south of the Sultanate. The rest of the country is supplied by the Rural Areas Electricity Company (RAECO).

Generation and privatization of the electricity sector falls under the responsibility of the Electricity Holding Company (EHC). Established in 2002, the EHC is wholly-owned by the Ministry of Finance. The EHC also holds the shares of the Government in nine companies engaged in the generation, transmission and distribution of electricity and related water services. Transmission activities are the responsibility of the Oman Electricity Transmission Company (OETC).

Other entities such as the Ministry of Defense, the Oman Cement Company and the Oman Mining Company have their own dedicated power systems. Petroleum Development Oman (PDO), which is responsible for oil and gas exploration and production, owns and operates its own power system, which is also interconnected with the MIS and Salalah systems.[7]

Qatar

Until 1990, all electrical power generation, transmission and distribution services were carried out by the MEW. The rapid increase in electricity demand in Qatar has led the

7 OPWP, Oman Power & Water Procurement (OPWP) Co. SAOC, http://www.linkedin.com/company/oman-power-&-water-procurement-opwp-co-saoc.

government to encourage foreign investment in IPP projects. By 2000, the power sector had undergone a restructuring that led to the separation of power generation and water production services and their privatization. The Qatar Electricity and Water Company (QEWC), which had already been founded in 1990 as a company limited by shares with the purpose of acquiring and managing power generation and water desalination plants, took over. Approximately 43% of the company's shares are held by the government, while the remaining 57% are held by individuals and private companies. The company owns and operates power plants to meet consumption needs, and sells its output to the Qatar General Electricity and Water Corporation (KAHRAMAA), a government entity. Transmission and distribution of electricity remains a government service carried out by KAHRAMAA. Qatar Petroleum (QP) remains the sole source of natural gas as fuel for power production facilities run by IPPs.

Saudi Arabia

The Ministry of Water and Electricity (MOWE) is responsible for setting electricity sector policy and long-term energy plans. MOWE also oversees private investment in the energy sector. The Saudi government restructured the electricity industry to unbundle the sector into separate generation, transmission and distribution functions. In 2001, the Saudi Electricity Company (SEC) was established by a decision of the Council of Ministers issued in 1998. The decision was to merge ten electric companies, as well as projects run by the General Electricity Company which covered most parts of Saudi Arabia, into one company forming the SEC. Part of the restructuring process was the establishment of the Electricity and Cogeneration Regulatory Authority (ECRA) in 2001. The role of the ECRA is to regulate the electricity sector in order to maintain the lowest price for electricity at the highest standard and quality of service. Today, the electricity market in the kingdom is open to IPPs, and some large electricity consumers have on-site generation, with which some of them supply the SEC.

UAE

The national grid of the UAE is managed by the Ministry of Energy, and consists of four utilities covering different Emirates. Each utility is responsible for maintaining the quality, security and control of its own power system. The four utilities are:

- the Federal Electricity and Water Authority (FEWA),[8] which was established in 2008 to provide electricity and water services to the Northern Emirates (Ajman, Oum AQuain, Fujairah and Ra'as Al Khaima);
- the Sharjah Electricity and Water Authority (SEWA),[9] which was established in 2007 to provide electricity and water services to Sharjah;
- the Dubai Electricity and Water Authority (DEWA),[10] established in 1992 to replace the Dubai Electric Company. There are as yet no plans to privatize the electricity and water sector (Bitar 2013);

8 *FEWA website: http://www.fewa.gov.ae.*

9 *SEWA website: http://www.sewa.gov.ae/english.*

10 *DEWA website: http://www.dewa.gov.ae.*

- the Abu Dhabi Water and Electricity Authority (ADWEA),[11] established in 1998. It is wholly owned by Abu Dhabi government and supplies electricity and water to the Emirate of Abu Dhabi. It has five wholly-owned subsidiaries and holds 60% of the shares in nine independent power and water producers. The vertical and horizontal organizational system of the water and electricity sector was dissolved upon the establishment of ADWEA. The new structure of the electricity and water sector came into effect in 1999. The electricity sector in Abu Dhabi is currently under a single-buyer model, where all production capacity is purchased by Abu Dhabi Water and Electricity Company (ADWEC).

See Table 2 on "Electricity market structure in GTCC countries" at page 84.

1.6.3. Electricity shortage

It has become evident over the past several years that there is a significant shortage in the electric power capacities of some of the GCC countries. However, this shortage is felt only during peak demand periods. Electricity consumption peaks in the GCC during summer as a result of the high demand for air conditioning. Maximum peak loads occur in the afternoon periods between 12hr and 16hr, depending on the temperature and humidity. Peak loads can be as twice off-peak summer rates and three times winter rates. Sustained high loads and inadequate capacity at peak hours have caused recurring electricity outages in several major cities across the GCC (mainly in Kuwait, Bahrain, Jeddah and Sharjah).

The power outages and load shedding have affected not only the residential sector, but have also raised concerns among the business and industrial sectors, which are often left with no other option than to shut down operations during power outages. The economic loss due to power cuts in Sharjah in 2009 was estimated at more than $19 million. Saudi Arabia had to shut down its most important petrochemical complexes in 2010 due to power outages. In recent years, the Saudi Electric Company had to shut down parts of the industrial zone in south Jeddah during afternoon hours in order to avoid larger power outages. This has led some businesses to install their own generation capacities, while other projects have been delayed or in some cases cancelled (El-Katiri 2011).

1.6.4. Interconnections

Realizing the urgent need to meet growing energy needs and the resulting power requirements, the GCC countries have jointly thought about areas of cooperation, one of which being the development and interconnection of their power systems. The GCC regional power grid interconnection scheme was formally inaugurated in 1981 with a signed agreement between the GGC countries. This agreement was followed by a series of feasibility studies, but the project stalled for over two decades. It really got concrete with the establishment, through a Royal Decree issued in 2001,[12] of the Gulf Cooperation Council

11 ADWEA website: http://www.adwea.ae/en

12 See GCCIA , CEO Statement, http://www.gccia.com.sa/ceo_message.html.

Interconnection Authority (GCCIA), which aims at constructing, operating and maintaining a GGC regional power grid (Figure 39). In 2003, an update of the previous feasibility studies was carried out, and in 2004, and GCC states agreed to implement and finance the project.

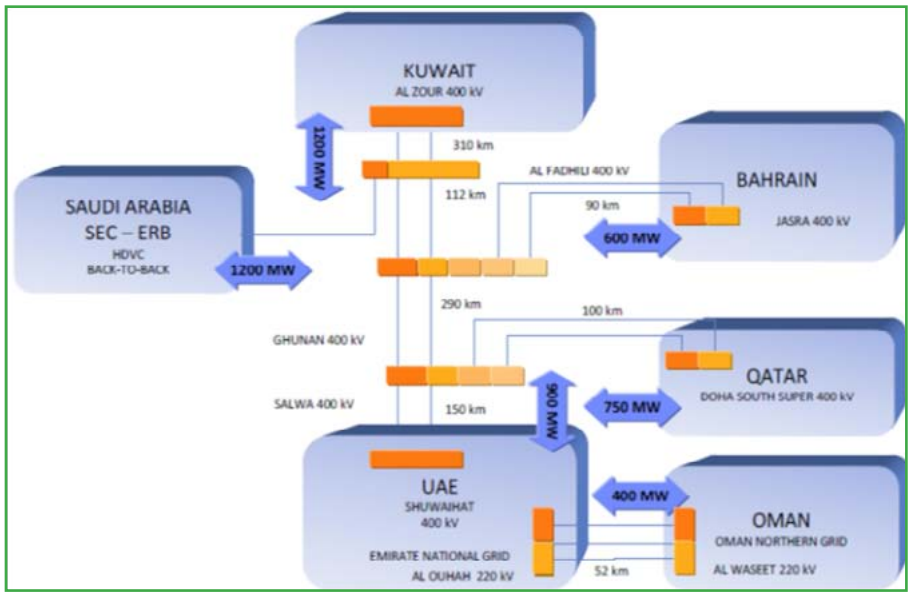
Fig. 39. The interconnection of the GCC regional power grid (GCCIA)

The benefits expected from integrating the GCC power systems are among others: (i) to reduce the investment costs required for new generation by reducing the level of reserves needed in each country; (ii) to improve the economic efficiency of the electricity power systems of each country; (iii) to provide mutual support in case of national power system failure; (iv) to enable energy trading.

The project has been implemented in three phases:

- Phase I: Interconnection of the power systems of Kuwait, Saudi Arabia, Bahrain, and Qatar, including HVDC back-to-back converter stations between the Saudi 380 kV 60-Hz system and the 400 kV 50-Hz system of the other GCC countries. This is the GCCNorth Grid.
- Phase II: The internal interconnection of the independent systems in the UAE and Oman. This is the GCC South Grid. The GCCIA was not involved in this phase.
- Phase III: Interconnection of the Northern and Southern Grids, forming the "Hybrid Link".

Fig. 40. Block diagram of the GCC interconnection system (GCCIA)



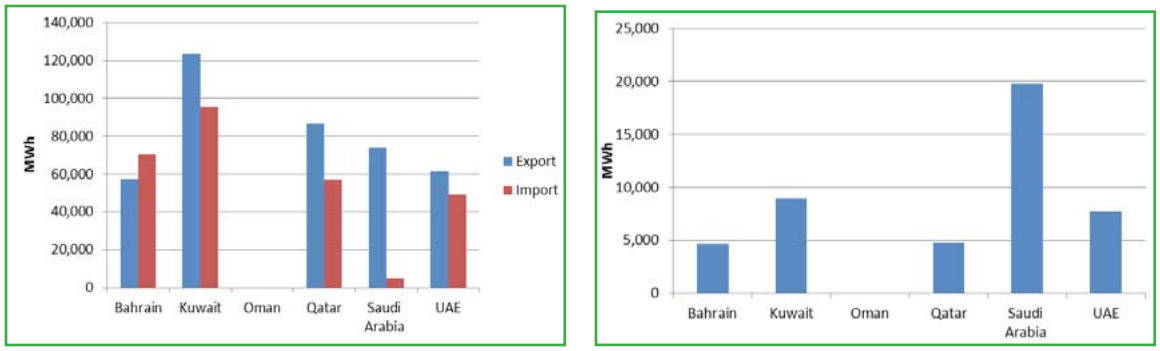
The first phase was completed in 2009, and phases II and III were completed during 2012 (King Saud University 2012). The GGC electricity grid allows for the possibility of exchange between countries following the technical specificities described in Figure 40. Thus, Kuwait and Saudi Arabia are both able to export or import up to 1,200 MW from the grid. Bahrain, Qatar and the UAE are able to trade 600 MW, 750 MW and 900 MW respectively. Oman has the lowest interconnector capacity at 400 MW. The GCC control center is located in Ghunan in Saudi Arabia.

In parallel to this regional power grid development, the GCC countries have been undertaking transformational changes within their power sectors, mainly in order to overcome the financial burdens involved in constructing utility projects to meet growing demand. Thus several GCC countries intend to unbundle the generation, transmission and distribution functions in order to facilitate and encourage private investment. The GCC countries are thus on the way to reforming their electricity sectors and to initiating the gradual development of a competitive market. The GCCIA's role in this is to enhance cooperation between Member States' utilities in order to establish a common market in the region. Furthermore, the existence of the GCC interconnection will provide opportunities for the establishment of power and desalination plants close to resources, thus giving the freedom to IPPs and IWPPs to select strategic locations which will allow them to operate in a larger market with reduced risks.

The completion of the GCC regional power grid has already allowed significant progress in both power trading and emergency support. According to the GCCIA, in 2011, before completion of the entire grid, the volume of electricity exchanged between the interconnected countries had already multiplied by 150. The GCCIA also observed that simultaneous trading occurred among up to three Member States at once. Between July 2009 and the end of 2011, there were some 450 incidents of sudden loss of generation units

connected to the network in various Member States, but thanks to the GCC interconnection, the systems managed to avoid supply interruption, and the need for programmed shutdown was avoided. In 2011 alone, the GCCIA observed around 180 incidents within local GCC grids which did not require load shedding, as a result of the compensation of the interconnection. This clearly highlights that the establishment of the regional power grid allows GCC countries to rely on the interconnector in case of emergency or unaccounted load increase. Electricity trading between GCC countries across the GCCIA interconnection increased from 308 MWh in 2010 to 46 GWh in 2011. In August 2011 alone, around 20 GWh were exchanged. The volume of electricity exchanged during emergencies and the size of the electric trade are described in Figure 41.

Fig. 41. Electricity dispatched between the GCC countries during emergencies in 2011 and the size of the electric trade in 2011



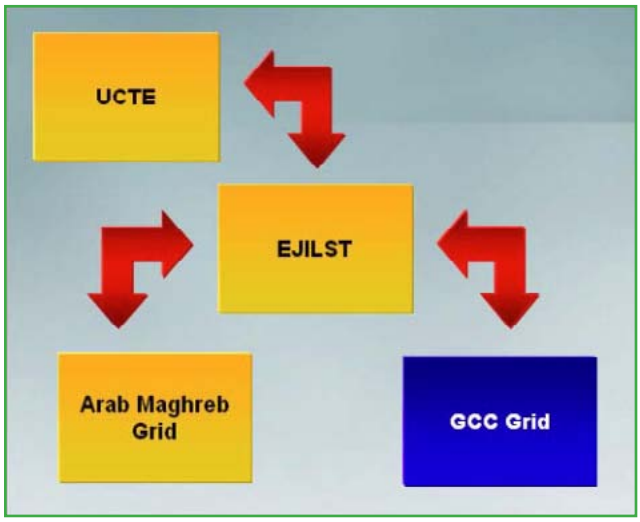
Source: OME based on GCCIA.

The GCCIA is now focusing on the development of simple trading tools in order to facilitate and promote power trading between the GCC countries (e.g. the GCCIA e-auction system), as well as the acceleration of the establishment of a competitive regional market. The GCCIA is also working on the development of an integrated Energy Market Management System (EMMS) to handle transactions.

In the long-term, the GCCIA envisages expanding the GCC grid system to trade energy not only within the GCC, but also with other interconnected regions (Figure 42). The GCCIA is also involved in the Pan-Arab interconnection study. This study is looking at the feasibility of the interconnection of the regional power grids of the Arab countries, including the EIJLLPST grid (Egypt, Iraq, Jordan, Lebanon, Libya, Palestine, Syria, and Turkey) and the Arab Maghreb grid (Morocco, Algeria, Tunisia). Extending the GCC grid to other grids such as EJILST or the Arab Maghreb Grid would provide an opportunity for the export of surplus power to other regions. For instance, during the winter, when demand for power is low in the GCC, it would be advantageous to export power to regions in Europe, where demand is high during the same period. The market will also encourage energy interchange at other times of seasonal diversity, for example when demand for power in the GCC region during the hot summer season is high and this high demand can be met by importing from regions where demand is low during the same period. Such a scheme would provide new opportunities in terms

of regional markets and power exchange, given the complementarities of these different electricity markets. The GCC grid and the idea of a regional electricity market is a long-term project whose potential benefits will evolve over decades.

Fig. 42. Potential regional interconnections (GCCIA)



Box 1 | **Electrical Interconnection of Three Continents Project**

The Electrical Interconnection of Three Continents or EITC (formerly EIJLLPST) Project has the purpose of interconnecting the electric power system networks of the countries participating in the EIJLLPST project. From the beginning of this project in 1989 until now, Turkey-Syria, Syria-Jordan, Jordan-Egypt, and Egypt-Libya interconnection lines have been built. Syria-Lebanon and Syria-Iraq interconnections lines are to be built, and the planning of a Jordan-Palestine line and upgrades to some existing interconnection lines are in progress. Some studies looking at the interconnection of all the EIJLLPST countries have been conducted, but due to the extraordinary situation in the region some of the work has been delayed. If the studies are successful, the ring created will enable EIJLLPST, Europe and the Gulf countries to cooperate on technical issues and renewable energy and trading.

The project began on 17 January 1989 with a document signed at ministerial level entitled "Interconnection of Egypt, Syria, Jordan, Iraq and Turkey Electricity Transmission Networks". The purpose of the document was to establish the synchronous parallel connection of the electrical transmission systems of the countries involved. The study was also known as the "Five Countries Interconnection Project". It became the "Six Countries Interconnection Project" after Lebanon's involvement in 2001. The last participant, Palestine, joined at the time of the Technical Committee and Ministerial Meeting held in Jordan on 22-28 October 2008, when the project acquired the name of the "Eight Country Interconnection Project (EIJLLPST)".

Box 1 (continues)

Within the framework of the project, Turkey has signed Installation Agreements with Syria and Iraq for 400 kV electricity interconnection lines. The Turkish section of the Turkey-Syria interconnection line was finished at the end of 1997, the Syrian section was completed at the beginning of 2003, and the interconnection line became operational in mid-2003. At the Technical Committee meeting held in Damascus on 1 November 2003, the parties agreed to accelerate the construction of the Syria-Iraq and Iraq-Turkey lines.

The European Network of Transmission System Operators for Electricity (ENTSO-E), formerly the European Union for the Coordination of the Transmission of Electricity, to which Turkey is currently in a trial period of parallel connection and which aims at the establishment of a possible Mediterranean ring, has always been taken an interest in EIJLLPST. For this reason, examining the structure of ENTSO-E is a priority of EIJLLPST. In June 2010, a General Meeting of the Planning Committee changed the name of the Eight Country Interconnection Project to the "EITC/Electrical Interconnection of Three Continents". The studies for the Eight Countries Interconnection Project are carried out by the General Planning Committee, the Operation Committee and the Transit Fees Committee.

1.6.5. CO_2 emissions

Due to the structure of the energy sector in the GCC countries, CO_2 emissions are among the highest in the world. Indeed, whereas the total volume of CO_2 emitted is not as high as the one in the EU-27, the GCC's per capita CO_2 emissions are three times higher than those of the EU-27. Qatar's rate, the highest rate of per capita CO_2 emissions among the GCC countries (40 tCO_2/cap), is six times higher than that of the EU-27. The electricity sector across the GCC is inseparably linked to the water sector due to the use of desalination plants for the production of potable water. Thus the electricity and water sectors are by far the largest single producers of CO_2 emissions in the region. On average, the sector contributes to 40% of the region's total CO_2 emissions. In some GCC countries, emissions from the sector surpass 50% (Bachellerie 2012).

Fig. 43. CO_2 emissions in EU-27 and GCC countries, 2009

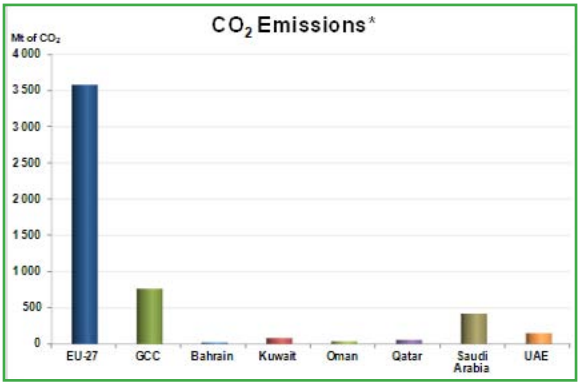
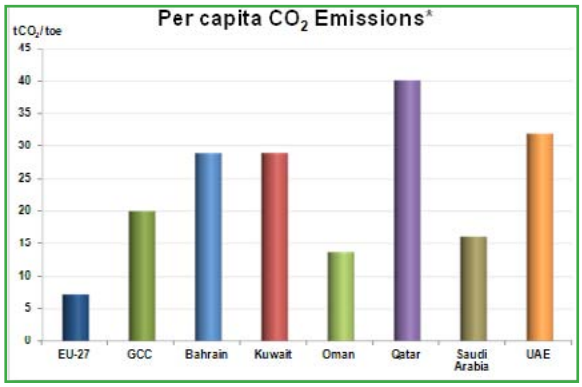


Fig. 44. Per capita CO_2 emissions in EU-27 and GCC countries, 2009



** CO_2 emissions from fuel combustion only. Emissions are calculated using IEA's energy balances and the Revised 1996 IPCC Guidelines*

More recently, the GCC countries have adopted a proactive approach to environmental issues. Legislation and medium- and long-term targets are being developed in the field of renewable energy. However, there are as yet no consistent strategies or policies (Reiche 2010).

1.7. Non-fossil resources

1.7.1. Nuclear

The GCC countries are also looking at developing nuclear energy in order to diversify their energy mix and to reduce their over-reliance on hydrocarbon resources. In December 2006, the six Member States of the GCC announced that the Council was commissioning a study on the peaceful use of nuclear energy. In 2007, the GCC countries agreed to cooperate with the IAEA on a feasibility study for a regional nuclear power and desalination programme. Saudi Arabia led the work, and thought that a programme might emerge in about 2009. In addition, all countries are signatories to the Non-Proliferation Treaty, and the UAE ratified a Safeguards Agreement with the IAEA in 2003. Beside the regional programme, each country has looked at the implementation of nuclear energy with greater or lesser degrees of interest.

Bahrain

In Bahrain, the Minister for Electricity and Water Affairs announced in December 2010 that Bahrain intended to have nuclear power by 2017 (Reuters 2010). The implementation of this plan, however, faced several problems, and in October 2012 it was announced that Bahrain's plans to adopt nuclear energy as source of power by 2017 had been postponed.

Kuwait

Kuwait has investigated the possibility of having its own nuclear programme for electricity generation and freshwater production as an alternative to fossil fuel. In March 2009, the Kuwait National Nuclear Energy Committee (KNNEC) was established by Amiri decree. The committee was headed by the Prime Minister and 10 distinguished members. It implemented the country's nuclear energy programme, working through roadmap programmes to form an official organizational structure (covering regulation, operations, and safety organizations). In December 2009, Kuwait signed its first Country Programme Framework (CPF) with the IAEA. The CPF served as a frame of reference for the medium-term planning of technical cooperation between Kuwait and the IAEA in order to identify priority areas where the transfer of nuclear technology and technical cooperation resources would be directed to support national development goals. KNNEC conducted an economic feasibility study which showed that the establishment of a nuclear plant with capacity ranging from 4 to 6 GW was the optimum level of generation under various assumptions (oil/gas prices, demand, technology costs, etc.). After the Fukushima Daiichi nuclear accident in Japan in March 2011, an Amiri decree was issued in July 2011 cancelling the Kuwaiti nuclear energy programme for electric power generation. The Amiri decree transferred KNNEC's programme to the Kuwait Institute for Scientific Research (KISR).

Oman

Oman has also investigated nuclear power. In June 2009, Oman signed a nuclear cooperation agreement with Russia. However, earlier in 2008 it said that since most of its demand was peak load, nuclear did not seem appropriate, though investment in a nuclear plant in a neighbouring GCC country was possible (World Nuclear Association 2013a).

Qatar

Qatar has undertaken its own investigation regarding the viability of nuclear power, and late in 2008 announced that there was not yet a strong case for proceeding. Nevertheless, in 2010 Qatar raised the possibility of a regional project. In the same year it signed a nuclear cooperation agreement with Russia's Rosatom (World Nuclear Association 2013a).

Saudi Arabia

Saudi Arabia announced in 2009 that it was considering a nuclear power programme. In April 2010 a royal decree stated that "the development of atomic energy is essential to meet the Kingdom's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources" and the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) was created to oversee nuclear and renewable energy development within the kingdom. In June 2011, the coordinator of scientific collaboration at K.A.CARE announced a plan to construct 16 nuclear power reactors over the next 20 years. In May 2012, K.A.CARE foresaw the generation of 17 GW of nuclear capacity by 2032. A National Atomic Regulatory Authority has also been set up (World Nuclear Association 2012).

UAE

The UAE has the most advanced nuclear energy plans of all the GCC countries. In 2008, it published a comprehensive policy on nuclear energy. Nuclear power was described as a "proven, environmentally promising and commercially competitive option which could make a significant base-load contribution to the UAE's economy and future energy security". 20 GW of nuclear power is foreseen, which implies the construction of 14 plants, with nearly one quarter to be built by 2020. At the recommendation of the IAEA, a Nuclear Energy Program Implementation Organization, namely the Emirates Nuclear Energy Corporation (ENEC), was set up as public entity to evaluate and implement these plans. In 2009, a federal law regarding the peaceful uses of nuclear energy was adopted which set up the independent Federal Authority for Nuclear Regulation (FANR) to oversee the entire nuclear energy sector of the UAE. In December 2009, ENEC announced that the Korea Electric Power Company (KEPCO) would construct four nuclear reactors, and in July 2012 licenses were approved for KEPCO to begin construction of the first two 1,400 MW reactors. The first reactor is scheduled to be operational by 2017, while the others are expected to be completed by 2020. To avoid concerns about its use of nuclear technologies, the UAE committed itself to forgoing the domestic enrichment and processing of nuclear fuel by adopting a law that banned its practice within the country (World Nuclear Association 2013c).

1.7.2. Renewable energy

a) The current state of development and potential of renewable energy technologies in the GCC countries

In general, renewable energy (RE) applications are still not very well developed in the GCC countries. Nevertheless, renewable energy technologies offer promising opportunities in the GCC, particularly solar energy technologies. The GCC countries lie in the so-called sunbelt, with global horizontal irradiance (GHI) values ranging from 1,900 kWh/m^2/y in Kuwait to 2,160 kWh/m^2/y in Bahrain, and direct normal irradiance (DNI) varying from 2,000 kWh/m^2/y in Qatar to 2,500 kWh/m^2/y in Saudi Arabia. This is one of the areas of the world best endowed with solar energy (Table 3). The wind potential is more moderate, with full load hours per year of wind power ranging from 1,176 in the United Arab Emirates to 2,463 in Oman.

Table 3. Solar resources and wind energy potential in GCC countries

	DNI (kWh/m^2/y)	GHI (kWh/m^2/y)	Full load hours per year (h/y)
Bahrain	2,050	2,160	1,360
Kuwait	2,100	1,900	1,605
Oman	2,200	2,050	2,463
Qatar	2,000	2,140	1,421
Saudi Arabia	2,500	2,130	1,789
UAE	2,200	2,120	1,176

Source: Al-Karaghouli et al. 2007.

Several studies have investigated the potential of different renewable energy technologies in the GCC, and in a wider context the MENA region, to supply a significant share of European energy needs through interconnected systems.

Within the framework of the Trans-Mediterranean Renewable Energy Cooperation (TREC),[13] the MED-CSP study carried out by the German Aerospace Centre (DLR) (Trieb et al. 2005) has emphasised that the biggest resource in the MENA region is solar irradiance, with a potential that is by several orders of magnitude larger than the total world electricity demand. In fact, every 10 km^2 in the MENA region could yield the equivalent of 15 million barrels of oil fuel per year in the form of solar energy. Such solar resources could be used both in distributed photovoltaic systems and in large central solar thermal power stations. Thus both distributed rural and centralised urban demand could be met by renewable energy technologies.

13 TREC was established in 2003 by The Club of Rome, the Jordanian NERC and the Hamburg Climate Protection Foundation. Its aim is to achieve fast climate, energy and water security by means of a joint effort undertaken by the EU-MENA regions, and it has laid the foundations of the DESERTEC concept.

Moreover, the IEA has started looking at the MENA region to investigate the potential of several energy technologies. In a 2011 information paper (Müller, Marmion and Beerepoot 2011), the IEA looked at the long-term potential of several renewable energy technologies in selected MENA countries, including some GCC countries such as Saudi Arabia and the United Arab Emirates. The study's results show a high potential for RE technologies, especially for both PV and CSP technologies, particularly in Saudi Arabia (Figures 45 and 46).

Fig. 45. 2030 renewable electricity potentials in MENA-7 countries

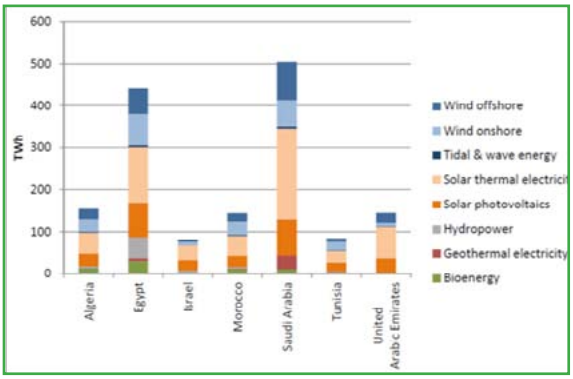
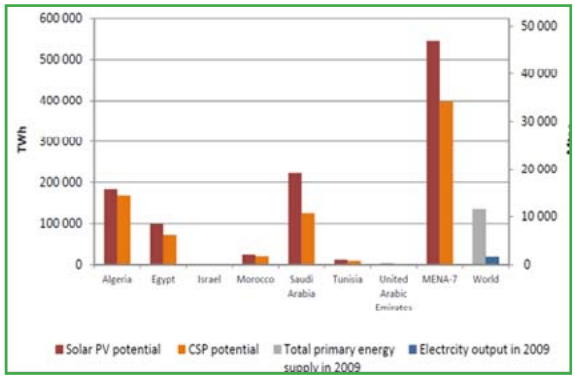


Fig. 46. The long-term potential of CSP and PV in MENA-7 countries



Source: Müller, Marmion and Beerepoot 2011, p. 71 and 72.

Other sources (Al Masah Capital 2011) report the very favourable framework conditions for solar technologies in the GCC, with three GCC countries (Oman, Saudi Arabia and the UAE) ranked among the top five countries in the MENA region in terms of ideal solar energy potential for both CSP and PV applications (Table 4). In particular, Saudi Arabia combines very high DNI and GHI values (2,500 kWh/m^2/y and 2,130 kWh/m^2/y respectively) with high availability of non-arable land (98.2%) and 9.3 daily hours of sunshine. Oman has a DNI of 2,200 kWh/m^2/y, a GHI of 2,050 kWh/m^2/y, 99.7% of non-arable land and 9.6 daily hours of sunshine. The UAE has a DNI of 2,200 kWh/m^2/y, a GHI of 2,120 kWh/m^2/y, 97% of non-arable land and 9.5 daily hours of sunshine.

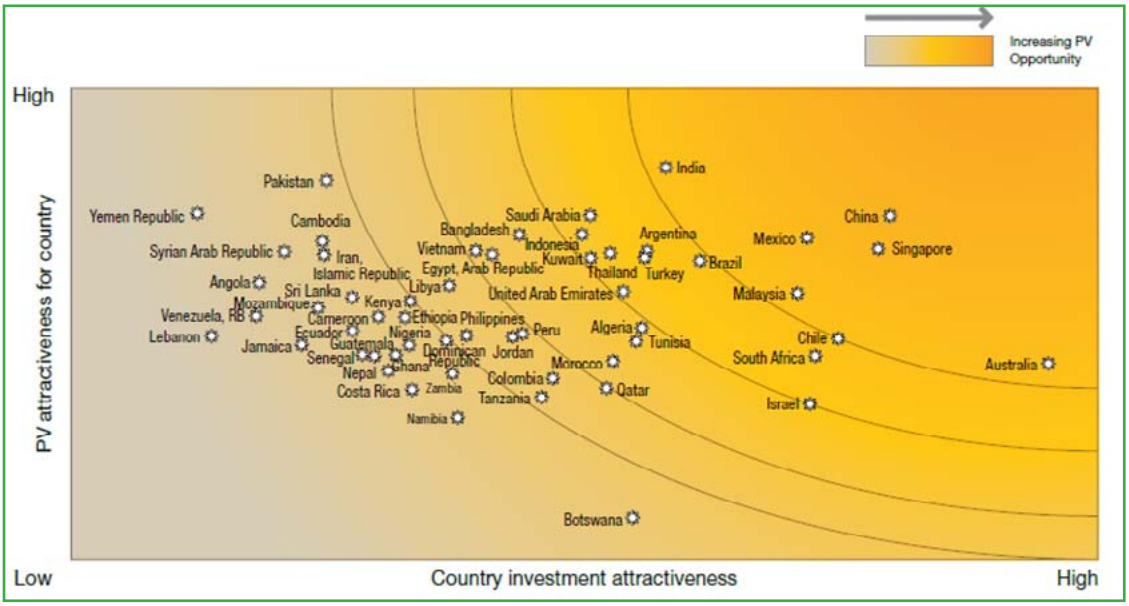
Table 4. Top five countries in MENA with ideal physical resources for solar energy generation

	Direct normal irradiance KWh/m²/y (for CSP)	**Global horizontal irradiance KWh/m²/y (for PV)**	**Non-arable land (%)**	**Daily hours of sunshine**
Egypt	2,800	2,450	96.6%	9.3
Oman	2,200	2,050	99.7%	9.6
Saudi Arabia	2,500	2,130	98.2%	9.3
Jordan	2,700	2,310	95.5%	9.3
UAE	2,200	2,120	97.0%	9.5

Source: Al Masah Capital 2011:16.

A study by the European Photovoltaic Industry Association (EPIA 2011) presents an assessment of the opportunities for investing in PV technologies in selected sunbelt countries, based on a ranking of several factors affecting the likelihood of investing in the country, as well as of specific factors affecting the attractiveness of the PV industry. As shown in Figure 47, several GCC countries are clustered in the medium to higher categories for PV investment. There is a clear role for EU industry to play in establishing important industrial partnerships with the GCC countries, thus expanding their businesses in the GCC region. The report points to the contribution PV can make to the sunbelt countries' energy supply, and provides guidance on how existing barriers can be overcome.

Fig. 47. PV opportunities in sunbelt countries



Source: EPIA 2011.

Against this general framework, the current level of development and deployment of renewable energies in the GCC is below expectations. The GCC countries still lack specific frameworks for RE, but that does not imply that the region is inactive in the field. In fact, all GCC countries promote renewable energies through resource assessment, pilot demonstration plants and feasibility studies.

As Non-Annex I parties, the GCC countries are potential locations for Clean Development Mechanism (CDM) projects, but these projects are still overlooked in the GCC region, despite the enormous potential they present for energy efficiency, solar development, waste management and other CO_2 abatement solutions. As of 1 December 2012, only 6 CDM projects had been registered by the CDM Executive Board (Table 5), for a total CO_2-eq saving of about 3.3 million tonnes through to 2020. Some 20 further projects are currently being validated. The United Arab Emirates is taking the lead in the implementation of CDM projects, followed by Saudi Arabia, Qatar and Oman. There are no CDM projects on the horizon in either Bahrain or Kuwait (Menichetti 2012).

Table 5. CDM projects in GCC countries

ID	Ref.	Title	Host country	Status	Sub-type	Credit start	Credit start to 2020 $ktCO_2e$	MWel
CDM09424*	7198	Sir Bani Yas Wind Farm Project	UAE	Request review	Wind	1 Jul 14	280	25,0
CDM03990**	2444	ADFEC 10 MW Solar Power Plant	UAE	Registered	Solar PV	8 Jun 09	174	10,0
CDM03644**	2534	Abu Dhabi solar thermal power project, Masdar	UAE	Registered	Solar thermal	1 Sep 11	1633	100,0
CDM08635**	6964	10MW Photovoltaic Plant in Dubai	UAE	Registered	Solar PV	1 Jul 13	96	10,0
CDM09427		Nour 1 PV Project	UAE	At Validation	Solar PV	1 Jan 14	997	99,8
CDM10973		Solar Power Project at North Park Building	Saudi Arabia	At Validation	Solar PV	1 Jul 12	92	10,5

* means has requested registration
** means registered
Source: OME on UNFCCC CDM projects database.

Another positive signal of the involvement of the GCC countries in the RE field is the fact that five countries (Bahrain, Oman, Qatar, Saudi Arabia and the UAE) are already members of the inter-governmental organization dedicated to renewable energy, namely the International Renewable Energy Agency (IRENA) based in Abu Dhabi, while Kuwait is currently applying for membership.

b) Main programmes by country

Bahrain

There is no formal policy framework in place to support the development of RE in Bahrain, although it has been announced that Bahrain aims to produce 5 to 7% of its energy from renewable sources by 2030. Bahrain has been active in developing mobile solar water desalination units as part of small-scale research and development projects, and in carrying out assessment studies for solar and wind. However, as of today, the only renewable source project remains the installation of wind turbines at the Bahrain World Trade Centre. In early 2010, an official from Bahrain's Ministry of Finance stated that the priority of Bahrain's government was to focus on developing clean technology projects (using mature technologies), rather than to develop a specific RE scheme to support the deployment of new technologies (Bachellerie 2012). In this context, a waste-to-energy plant of 25 MW is

due to be commissioned in 2013, which will use domestic waste to produce electricity that will feed into Bahrain's electricity grid. In addition, during the Petrotech 2012 conference, Bahrain's Minister of Energy announced the implementation of two renewable projects of 5 MW each.

Kuwait

In 2011, Kuwait announced its aim of producing 10% of its electricity from renewable sources by 2030, with target values of 1.1 GW from CSP, 3.5 GW from PV, and 3.1 GW from wind, but neither legislative nor regulatory frameworks have been put in place. Although the government has repeatedly financed research in the RE field (mainly wind and solar), current RE installed capacity does not exceed 400 kW. Besides the target announced in 2011, a 70 MW RE complex is expected to be set up by KISR for the MEW (10 MW PV, 10 MW wind and 50 MW CSP).

A study conducted by KISR focused on developing a strategy for introducing renewable energy as a primary energy source to meet the future needs of the country for electrical power generation and water desalination. The study included an assessment of electricity and fresh water demand and the potential primary energy supplies that can be made available to meet electricity production requirements up to 2030. Build-up scenarios for the generation system were used to draft a national renewable energy policy that is expected to fill the emerging gaps between electric energy demand and supply.

Oman

In 2008, the Authority for Electricity Regulation (AER) was commissioned to investigate the potential for renewable energy projects in electricity generation. The study identified significant potential for solar and wind generation. However, limited potential was identified for generation from biogas, geothermal and wave-energy (AER 2008).

The Public Authority for Electricity and Water (PAEW) is taking steps to implement solar and wind projects where the grid is not available. Five pilot projects with a total maximum capacity of 8 MW were planned for the period from 2009 to 2012. A mix of PV, hybrid, and wind technologies were planned to be put on trial by RAECO under the supervision of the AER. However, recent changes in the government resulted in a delay to the implementation of these projects until 2014/2015. Nevertheless, in March 2013 the AER adopted a new requirement for the promotion of renewable energy in rural areas. Under this scheme, a component of renewable energy technology (solar or wind) must be included in each new power project in rural areas. If no renewable energy component is included in a funding application, RAECO is required to explain why, and to provide the AER with supporting analysis to confirm that renewable technologies are either not technically feasible, or not economic for that particular project.

Furthermore, larger scale solar projects were planned for the period from 2011 to 2014, but also delayed. A feasibility study was conducted for grid-connected solar plant with capacity of 50 to 200 MW. The detailed study, led by the PAEW and supported by a leading

international consultant, identified the best locations for building solar power plants in the Sultanate from a total of 23 reviewed sites. The study confirmed that the Sultanate has many potential solar energy resources which could be used to produce large-capacity electric power, and shortlisted Adam, Manah and Ibri as sites for future solar power plants (Oman Daily Observer 2012). Adam and Manah have been reserved for such projects, and preliminary environmental approval has already been granted. Both locations have also been used to establish, in cooperation with OPWP, meteorological stations to measure the necessary solar energy data and other factors that affect the design of plants, such as dust levels and temperature. The construction of the power plants is on hold pending completion of the National Energy Strategy, which is expected in early 2015.

The government's position towards renewable energy has been positive to some extent. Implementation of renewable energy initiatives has gained support at different levels in the Sultanate. Support for renewable energy is reflected by the formulation of a ministerial committee to oversee and coordinate efforts in the field. A technical committee has also been formed, which is chaired by the PAEW. However, this support is most visible when it comes to powering rural areas that are highly dependent on diesel for electricity generation and in the development of local skills and expertise. The government seems to be less ambitious about pursuing grid-connected large scale RE projects or solar manufacturing. A steering committee is currently being formed to set out an overall RE generation strategy for the Sultanate. The committee consists of the Ministry of Oil and Gas, the PAEW, the Ministry of Environment and Climate Affairs, and the Ministry of Planning, and is expected to submit its findings by the end of 2014.

The government is active in engaging with stakeholders and in developing programmes for the education and training of local manpower and expertise. A policy framework is being developed to encourage the involvement of medium and small-sized businesses in RE projects. The decision-makers in the Sultanate are taking cautious but steady steps towards RE. They hope that RE penetration will add a sustainable value to the Sultanate. This does not necessarily mean that it will become a hub for research and development or manufacturing in RE. The human development aspect of RE investment in the Sultanate appears to be the main concern. One of the goals of investment in RE in Oman is for the country to become a supplier of manpower in the field of RE to the entire GCC region.

Qatar

The Qatar National Food Security Programme (QNFSP) is the body coordinating energy and water security, as well as food security, across all different sectors. Through the Qatar Science and Technology Park (QSTP), the QNFSP aims to become a leading exporter of solar technology and knowledge both in the MENA region and internationally by establishing a solar technology industry in the country. Furthermore, there are plans to establish institutes of higher education, along with research and development centres, in order to keep up with developments in the sector. Moreover, the QNFSP will develop CDM projects to achieve its

goals. These projects are planned to cover solar power generation, solar desalination, wind power generation, waste heat recovery and CO2 usage in farming and food production.
The National Energy Strategy 2011-2016 states that RE technologies should help to conserve gas and reduce carbon emissions. In 2012, an Amiri declaration set a 2% (640 MW) target for electricity generation by means of solar energy by 2020.[14] Several projects have been announced, such as the construction of a 3.5 GW integrated solar combined cycle plant (500 MW of CSP) by 2013. Another tender is scheduled for launch in 2014 for a 1,800 MW PV plant, which is expected to be completed by 2018 (Chan 2012). Activities are being developed at the QSTP, among which is the construction of a testing facility of about 35,000 m2 for all types of solar technology. The aim is to test the suitability of different solar technologies under local conditions, in particular dust and wind conditions. It was also announced in 2009 that a PV power plant of 100 MW would be built by 2014. The key components of this solar power plant will come from the Qatar-based polycrystalline silicon production facility to be constructed in 2012 by Qatar Solar Technologies (QSTec). Located in Ras Laffan Industrial City, the QSTec plant will initially produce 8,000 metric tonnes per year of polysilicon, which is sufficient to produce enough solar energy to power around 240,000 homes for an entire year (Choudhury 2012). In July 2012, QStec signed a Memorandum of Understanding with KAHRAMAA for the distribution of solar energy in Qatar.

Saudi Arabia

In Saudi Arabia, the ECRA produced a National Renewable Energy Plan (NREP) in 2009, which included recommendations to promote the growth of RE, and which stated that if the conditions are put in place, RE could account for between 7% to 10% of electricity by 2020 (Goulding and Bush 2009). In 2010, a royal decree established K.A.CARE, which was intended to contribute to the sustainable development of Saudi industries related to renewable and atomic energy. K.A.CARE is the designated lead organisation for the energy diversification process. The overall target is to generate a third of the Kingdom's electricity from renewable sources by 2032. The K.A.CARE programme promises 54 GW of power generation capacity from renewable energy by 2032 (K.A.CARE 2013:15).

Currently, K.A.CARE is developing the tools necessary to enable the achievement of its targets, such as the Competitive Procurement Process (CPP). Furthermore, the Sustainable Energy Procurement Company (SEPC) has been established as a stand-alone government-guaranteed entity that will be responsible for administering the procurement of power purchase agreements, as well as executing and managing them.

During the Saudi Solar forum week held in May 2012, officials from K.A.CARE announced a programme, to be adopted by the government, for the generation of 41 GW of solar by 2032 (16 GW PV and 25 GW CSP), plus 4 GW from geothermal and waste. The solar programme is expected to cost $109 billion, almost as much as the $136 billion invested worldwide in solar energy in 2011 (Steyn and Norman 2012). Saudi Arabia was planning to launch

14 Statement by Emir of Qatar at the opening ceremony of the High-Level Segment of COP 18 / CMP 8, Doha, 4 December 2012, http://unfccc.int/meetings/doha_nov_2012/statements/items/7324.php.

its first solar tender early this year, covering 1.1 GW of PV and 900 MW of CSP (K.A.CARE 2013:17), with a second tender to follow in 2014. However, K.A.CARE is still drafting the CPP programme, which is expected to be the gateway into the Saudi market in RE. The CPP programme is expected to be completed by the end of this year.

Many solar pilot plants have been installed within the latest year, either in remote areas or connected to the grid. In addition, a solar manufacturing plant (Poly-Silicon Technology, PST) has been set up in Jubail II. In addition, the King Abdullah University of Science and Technology (KAUST) is currently constructing a sustainable campus which incorporates solar thermal and PV systems on the roof to provide hot water and power to the campus buildings.

UAE

In the United Arab Emirates, Dubai set a target of producing 5% of its electricity from solar energy by 2030, and Abu Dhabi announced that 7% of its total energy would come from RE technologies by 2020, but no specific regulatory framework has been put in place. The UAE is active in the RE field, most particularly through the Masdar initiative. Established in 2006, Masdar is a subsidiary of Abu Dhabi's state-owned Mubadala Development Company, and is focused on being a leader in the development of renewable and sustainable energy technologies. Masdar City is the flagship project of the initiative, and aims to be the world's first zero-carbon city. It already houses the Masdar Institute, a joint undertaking between the Massachusetts Institute of Technology and Masdar, and there are plans to bring hundreds of other high-technology and renewable energy businesses into the city over the coming years. Masdar city currently houses a 10 MW PV plant. Masdar has announced plans to develop the Sir Bani Yas wind farm with a target capacity of 25 MW, the Shams 1 CSP plant with a capacity of 100 MW, and the Noor 1 PV plant with a planned capacity of 100 MW. Masdar will continue to help the UAE to find new ways to diversify its energy mix. Furthermore, Masdar is developing a regional tool for solar resource mapping in desert and dusty environments, launching the UAE Solar Atlas and developing a solar resource forecasting tool adapted to the desert environment.

1.8. Energy efficiency

The GCC countries have as yet not undertaken any concrete measures for the promotion of energy efficiency. A study of the energy policies and relevant initiatives in the GCC countries (Reiche 2010) shows that they have recently adopted a more proactive approach towards environmental sustainability, but it also points out that despite some relevant initiatives, no consistent or coordinated strategies or policies have yet been established.

Bahrain

Due to the accelerated depletion of its indigenous hydrocarbon reserves, Bahrain has moved its focus towards energy efficiency strategies as a way to meet local energy needs. Several market drivers are being introduced to facilitate the inclusion of energy efficiency strategies and measures in the Kingdom. The National Economic Strategy 2009-2014

promotes sustainability by implementing green solutions and by addressing key priority areas and identifying actions. It aims at reducing energy consumption, developing clean energy technology, enforcing pollution control laws, and improving water resources management and the conservation of biodiversity. It is estimated that 60-70% of total energy consumption in Bahrain is for building and construction, which in turn generates 55% of CO2 emissions in Bahrain. In May 2010, the Bahraini Minister of Housing announced a Green Building initiative, with the development of an updated building code. In October 2012, the World Bank signed an agreement with the Bahraini Government to provide technical support in the field of energy consumption reduction. The support will help replace traditional bulbs with the low energy lighting technology Compact Fluorescent Lighting (CFL).

Kuwait

Kuwait, where domestic buildings are estimated to consume more than 60% of electrical power, issued an energy conservation code in 1983 for new buildings, which however lacked certain technical guidance. A revised version of the code was issued in 2010. In 2007, Kuwait witnessed its largest electricity shortage. As a response, the Emir of Kuwait announced a $150 million grant for energy research and development. Additionally, in August of that year, the MEW initiated a $35 million media campaign entitled Tarsheed to reduce electricity and water consumption. The campaign attempted to deliver its message through printed materials, television and radio advertisements, phone messages, and billboards. The campaign was initiated in six languages and attempted to reach the country's whole population. The campaign has raised a debate about the effectiveness of such an approach. Nevertheless, Tarsheed spinoffs have also been implemented in Saudi Arabia, UAE and Qatar, under the same name but with adjusted goals and targets. Among other measures, the MEW also planned to improve the efficiency of power generation by introducing combined cycle power generating systems for new installations or system upgradings. Finally, the Medium Term Development Plan 2010-2014 aimed at achieving long-term economic sustainability, targeted sectoral development and focused in particular on transport, water and energy resources efficiency.

Oman

In Oman, electricity companies have been trying to implement certain demand side management (DSM) programmes over recent years, but are facing difficulties (Papadopoulou et al. 2011). However, during the Oman Power and Water Summit 2012, the chairman of the PAEW stated that enhancing energy efficiency is one of the major goals of the organization (Chai 2012). As demand for electricity in the Sultanate is expected to increase, in 2012 the government agreed with the Japan International Cooperation Agency (JICA) to create a master plan for the promotion of energy conservation in the electricity sector. The PAEW requested Japan's support in improving the balance between the supply and demand for electricity by promoting energy conservation among users. The project started in February 2012 and is currently at the final drafting stage (JICA 2012:109).

Qatar

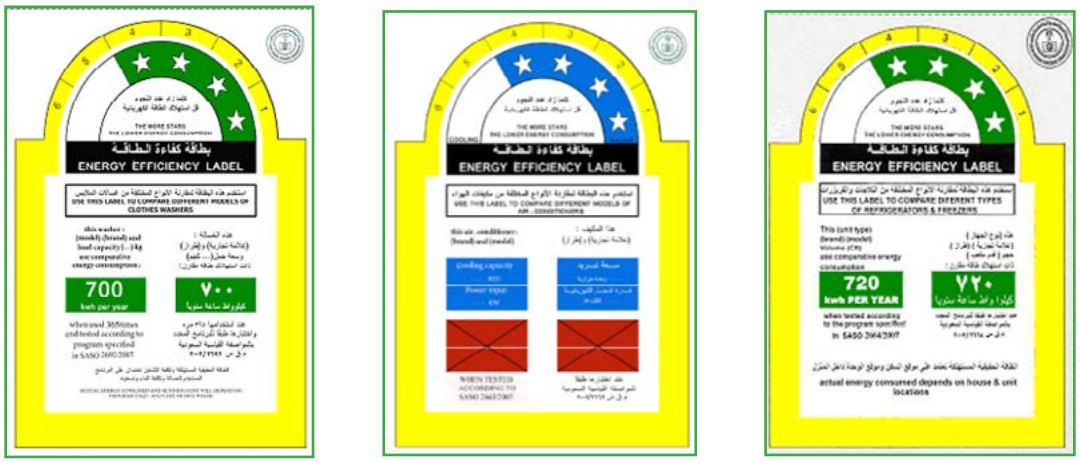
Qatar has developed a strategy to address several sustainability issues, mainly regarding water conservation, but it has not yet been translated into concrete measures. The strategy has, however, promoted research on sustainable development through the construction of the "Energy City", which aims at incorporating the latest green energy technologies and solutions for energy efficiency and pollution reduction. In 2005, the United Nations Economic and Social Commission for Western Asia (UN-ESCWA) signed an agreement with KAHRAMAA to support energy efficiency in the power sector. The agreement also aimed at establishing a Cooperation Programme on Energy Efficiency for the Qatari Electricity Sector. Other initiatives in favour of energy efficiency are currently being implemented, such as for example in the aviation industry, where Qatar Airways is implementing its Oryx Flies Green programme, which includes among other components fuel optimization, a recycling programme, and sustainable development. In 2009, Qatar Airways carried out the world's first commercial flight from London to Doha fuelled by a gas-to-liquid (GTL) 50/50 fuel blend with kerosene. Furthermore, the Gulf Organization for Research and Development (GORD) is working on creating the Qatar Sustainability Assessment System (QSAS). QSAS is a customized regional sustainability rating system based on rating systems from the UK, US, Canada, Hong Kong and Japan, in addition to European and American energy standards.

The Qatar National Plan for Energy Efficiency, Optimization and Resource Utilization (QPEERU) is currently being developed to serve as a driver for energy efficiency projects within the framework of the United Nations Framework Convention on Climate Change (UNFCCC). The objectives of QPEERU are to establish policies and regulations to manage energy conservation, assist in energy efficiency improvement, and adjust the value structure of society in terms of energy use and utilization. The objectives are to be achieved by inviting investments in CDM projects (Qatar Ministry of Environment 2011).

Saudi Arabia

Established in 2000, Saudi Arabia's National Energy Efficiency Program (NEEP) defined in 2008 eight priority objectives to be achieved through the implementation of among other things energy audit services, the efficient use of oil and gas, energy efficiency labels and standards for appliances (Figure 48), constructions codes, training and public awareness. The NEEP focuses on four outcomes: regulation (the drafting of the first energy conservation law and national and regional regulations), information (a new database on energy supply and demand), capacity development of energy efficiency managers and public awareness.

Fig. 48. Energy efficiency labels for home appliances in Saudi Arabia



Source: Saudi Arabia Standard Organization.

The NEEP also contained a master plan for energy conservation in the power sector, which aims at cutting electricity intensity by 30& between 2005 and 2030 and at cutting the growth in peak demand by 50% compared with the average 2000-2005 increase. In October 2010, the Saudi Energy Efficiency Center (SEEC) was created, which is responsible for the development of energy efficient technologies and conservation policies. Among the proposed measures are the replacement of low-efficiency air conditioning units and the insulation of new buildings for residential customers, which would lead to significant energy savings.

UAE

In addition to the so-called Masdar City, based in Abu Dhabi, which aims at being one of the most sustainable cities in the world, the UAE has been developing a new green building code to save energy and reduce the environmental impact of construction. In 2007, Dubai adopted a new resolution on the implementation of green building specifications and standards. The Dubai Green Building Code came into force early 2009, and was based on the Leadership in Energy and Environmental Design (LEED)[15] rating system and tailored to conditions in the UAE. In addition, the Emirates Authority for Standardization and Metrology (ESMA) has been implementing an energy efficiency appliance labelling programme since the end of 2010. Other initiatives have been put in place in the transport sector, such as for example in Dubai, which has adopted a policy encouraging sustainable transportation in order to reduce vehicle pollution in the Emirate. Abu Dhabi is also carrying out studies on urban transport systems. DEWA is running an awareness campaign at schools, hotels, and public departments in order to encourage greater electricity and water conservation.

15 LEED consists of a suite of rating systems for the design, construction and operation of high performance green buildings, homes and neighborhoods, and was developed by the U.S. Green Building Councils.

1.9. Water desalination

In the GCC countries, which are among the most water-scarce and arid regions in the world, water desalination is commonly used to cover national water demand. Indeed, improving the water supply is constantly at the forefront of the policy-making process in the GCC countries. Water demand is increasing rapidly, driven by a high population increase and rapid urbanization, with a high share coming from the agricultural and municipal sectors (Figure 49). Desalination remains the most feasible alternative to meet domestic supply requirements as a result of the relatively low cost, which is due to existing energy subsidies in most of the GCC countries. In response to shortages in naturally renewable water supplies, the GCC countries continue to develop desalination facilities. In consequence, the dependence of the GCC countries on the supply of desalinated water is very high (Figure 50).

Fig. 49. Water withdrawal share by sector in GCC countries

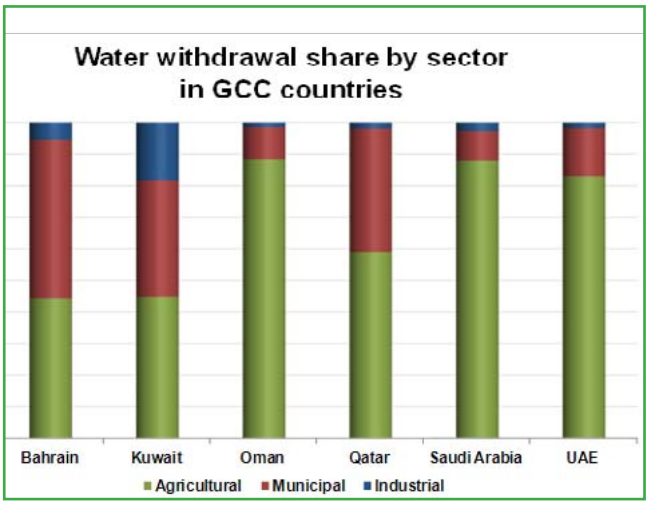
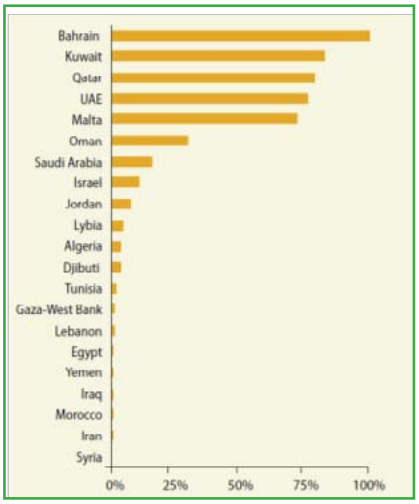


Fig. 50. The share of potable water in MENA countries provided by desalination, 2010 [%]



Sources: OME based on FAO AquaStat data (fig. 50); Fichtner and DLR 2011 (fig. 51.).

By 2007, 48% of the world's water desalination capacity was installed in Middle East, and mainly in the Gulf region (Latteman 2010). In 2010, 199 desalination plants were operating in the GCC countries (Dawoud and Al Mulla 2012), of which 50% are installed in Saudi Arabia and 25% in the UAE.

In most of the GCC countries, the authorities have foreseen plans to develop water desalination capacity in the coming years in order to cover water demand, which is expected to increase dramatically over the coming decades. For instance, Kuwait is planning to develop its water desalination capacity within the framework of its 2010-2014 development plan from around 1.9 million cubic meters per day (MCM/d) in 2008 to reach around 3.1 MCM/d by 2016. In Oman, the total production of desalinated water reached 129 million cubic meters per year (MCM/y) in 2010. In early 2000, assessments of water availability versus

future water demand pushed the government to adopt a National Water Resources Master Plan 2001-2020, which stated that to cover the increased demand, an additional capacity of about 330 MCM/y will be required. In Qatar, desalination covers 50% of water demand in the country, representing in 2008 a total production of 312 MCM. It is expected that water production will rise yearly by 9% up to 2015. The Qatar National Development Strategy 2011-2016 developed by the General Secretariat for Development and Planning identifies a range of initiatives in the water sector to tackle technical and economic inefficiencies in the production, distribution and use of water. By 2014, Qatar will enact a National Water Act in order to develop a set of policies and regulations aiming at covering future needs. Saudi Arabia, which is the world's biggest producer of desalinated water, produced 1,013 MCM in 2009 and, according to the Saline Water Conversion Corporation (SWCC), the main Saudi desalinated water provider, an additional capacity of 5.9 MCM/d will be required by 2024 in order to meet the growing demand. In 2011, the UAE's water demand reached 4,500 MCM and is expected to be twice that figure by 2030, with a large part supplied by desalination. According to ADWEC, in 2010 Abu Dhabi produced 3 MCM of desalinated water, and it is expected that desalinated water demand will reach more than 4.5 MCM by 2020. It is estimated than 95% of the demand for potable water will be met by desalination in 2010. In the other Emirates, the importance of desalination in the water supply is likely to be the same as in Abu Dhabi, i.e. 95%, covering most of the demand.

Water desalination is also related to the food security issue in the region. Most of the GCC countries are from 45 to 90%reliant on non-renewable brackish groundwater resources for the agricultural sector along with desalinated water (Lee et al. 2012). In 2008, Saudi Arabia abandoned its 30-year policy of large-scale irrigated wheat cultivation after decades of unsustainable water withdrawals. As a result, domestic wheat production declined by over half between 2005 and 2006, and is expected to be completely depleted by 2016.

Given the above, one can see that the GCC countries are, and will remain, among the world's biggest desalination markets during the period 2007-2016, offering great business opportunities. Indeed, five GCC countries (Saudi Arabia, the UAE, Kuwait, Oman and Qatar) are ranked within the top 15 desalination markets for the period up to 2016 (Figure 51).

Fig. 51. Top 15 desalination markets, 2007-2016

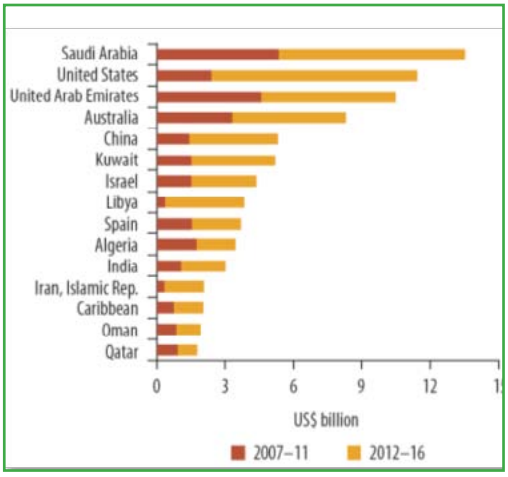
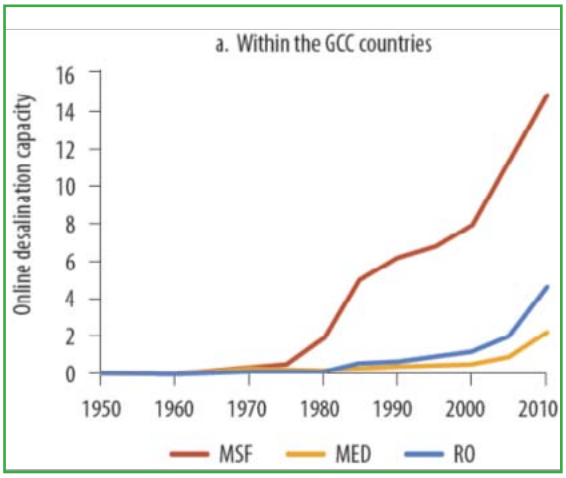


Fig. 52. The growth of on-line desalination capacity in the GCC, 1950-2010



Source: World Bank 2012.

Whereas in the 1960s-80s, Multi-Stage Flash units (MSF, a thermal process) were the only commercially viable large-scale technology for desalination, later, Multi Effect Distillation (MED, a thermal process) and Reverse Osmosis (RO, an electrical process) technologies became viable for large-scale units thanks to major technological improvements. Thermal desalination plants use heat sources as the driving force. These heat sources can be hot water or steam from a turbine. Therefore, thermal desalination is ideal for co-generation with power plants. Given that the power and water sectors of most of the GCC countries have the same regulators and utilities, and that Gulf water has high salinity and a high temperature, thermal processes suit such conditions better than RO. Thus, MSF has historically been the privileged technology in the GCC (Figure 52).

Table 6. Main characteristics of desalination technologies

Desalination technology	**MSF**	**MED (Plain)**	**MED-TVC**	**RO**	**UF/MF/NF**	**Electro-dialysis reversal (EDR)**
Energy source/type	Thermal	Thermal	Thermal	Electricity	Electricity	Electricity
Typical energy consumption (kWh/m^3) electricity	3-5	1.5-2.5	<1.0	3-5	3-5	3-5
(MJ/m3) heat	233-258	233-258	233-258	No heat energy needed	No heat	No heat
Capacity range	Current modular capacity up to 90,000 m^3/day	Current modular capacity up to 38,000 m^3/day	Current modular capacity up to 68,000 m^3/day	Current modular capacity up to 10,000 m^3/day	Current modular capacity up to 10,000 m^3/day	Current modular capacity up to 34,000 m^3/day

Source: World Bank 2012.

Desalination processes, either thermal or electrical, require a significant amount of energy (Table 6). The impact of the expansion plans of desalination units in the GCC countries will be important for both the power sector and the fossil fuels balance. Hence, sustainability of power and water are closely-linked challenges in the GCC countries. Several research studies are currently being carried out to look at the feasibility of renewable energy desalination. Technologies such as CSP can provide steam to be used either for electricity generation or water desalination. Future desalination capacity expansions will be heavily determined by how energy policy is developed. At the moment, there are considerable inefficiencies in the water sector. These inefficiencies can be observed all along the production, distribution and consumption chain. They range from energy-inefficient production methods to inefficient water consumption. Just as with electricity consumption, water consumption conservation is politically difficult, but offers development opportunities. As a result of the water subsidies offered to consumers (residential, agricultural and industrial), customers have little incentive to conserve water.

2. Identification of hot spots and implications for EU-GCC cooperation

2.1. The EU-GCC partnership in energy

Relations between the EU and the GCC are not recent. Economic cooperation was started from the very beginning after the creation of the GCC in 1981. On 22 July 1985, the Council of Ministers of the then EEC expressed its deep-seated interest in developing economic and political links with the GCC, and decided in principle on a meeting between the Community and the Gulf states.

The meeting, described by both parties as a historic landmark in their relations, took place in Luxembourg on 14 October 1985. The two parties decided to speed up discussions for the conclusion of a comprehensive agreement aimed at stepping up economic and trade cooperation between the Gulf States and the Community. The EU-GCC cooperation agreement, which encouraged trade and economic cooperation, was signed in 1988.[16] It established various important bodies: on the strategic level, an annual Joint Council and Ministerial Meeting between EU and GCC foreign ministers, and a meeting of senior officials at the Joint Cooperation Committee; and on the operational level, an Energy Experts Group that started its work early in the 1990s.

Since the signing of the Cooperation Agreement, the partnership between the two regional alliances has laid a greater emphasis on economic aspects, since the Gulf countries are major oil and gas producers. During the subsequent Joint Councils and Joint Cooperation Committee meetings, leaders agreed to reinforce cooperation in the field of energy and on the conclusion of a Memorandum of Understanding on energy cooperation.

16 *EU-GCC Cooperation Agreement, Official Journal L 054 of 25/02/1989, p. 3-15, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1989:054:0003:0010:EN:PDF.*

More recently, on the occasion of the 20th session of the Joint Council held in Luxembourg on 14 June 2010, officials of the EU and the GCC states endorsed the EU-GCC Joint Action Programme 2010-2013,[17] which had been negotiated during the senior officials' meeting held in Riyadh on 9-10 February 2010. The Joint Action Programme has the aim of strengthening cooperation in areas of strategic mutual interest over the 2010-2013 period. It specifically includes energy, electricity and water, and nuclear safety among the main topics for cooperation between the EU and the GCC. In particular, regarding energy, the programme foresees:

- exchanging views, information and experience on oil and gas market developments, energy policies, and policies, frameworks, best practices and techniques in the upstream, midstream and downstream fields;
- cooperation in the field of energy equipment, machinery and spare parts manufacturing, especially those used in the oil and gas industries;
- cooperation on clean and renewable energy technologies, on energy efficiency policy and measures, and on solar energy technologies and policy frameworks.

In the field of electricity and water, the programme foresees:

- technical cooperation in all stages of electricity and water production (generation, transport, energy transfer distribution and service providers), including technology transfer;
- benefit to the GCC from the EU's experience in power interconnection, load management, the regulatory framework and the creation and development of regional markets for the trade in, and exchange of, electricity;
- exchange of best practices in RDT (research, development and technology) regarding the integrated management and sustainable development of water in order to achieve water security in the GCC states, and of best practices and techniques in the efficient use of power and water consumption.

Finally, in the field of nuclear safety, the programme foresees:

- Cooperation in the field of atomic energy as well as nuclear safety and security;
- Exchange of information and experience in matters such as the legal framework for protection against radiation, nuclear security and safety, radioactive waste, warranties and appropriate systems and surveillance.

Three main mechanisms to carry out such activities are put forward, namely ad-hoc working groups, events such as seminars, workshops, and exhibits, and training and capacity building.

The follow-up to the Joint Action Programme has, however, not been complete. At the 22nd session of the Joint Council and Ministerial Meeting held in Luxembourg on 25 June

17 Joint Action Programme for Implementation of the GCC-EU Cooperation Agreement of 1988, 2010-2013, http://eeas.europa.eu/gulf_cooperation/docs/joint_action_programme_en.pdf

2012, delegates evaluated progress achieved so far, and agreed to prepare a joint work programme for the next period (2013-2016) and to identify priorities and objectives.[18]

Nowadays, energy remains central to relations between the GCC and the EU. In fact, fossil fuels remain the most traded product between the two regions. This is mainly due to regional proximity and the complementarity of the regions' energy production and consumption patterns, which create favourable conditions for exchange between the EU and the GCC. These exchanges are regulated chiefly by Article 6 of the GCC-EU Cooperation Agreement, which states that "[i]n the field of energy, the Contracting Parties shall strive to encourage and facilitate, inter alia: cooperation in the two regions by energy undertakings [… and] exchanges of views and information on matters relating to energy in general and respective energy policies, without prejudice to the parties' international obligations".

Within the Joint Action Programme, particular attention is paid to the issue of energy diversification through the development of alternative energy technologies (such as renewable energy technologies and the development of energy efficiency for conventional energy technologies), as well as the issue of the development of energy infrastructure. Indeed, since the beginning of the cooperation, the Joint Councils and Joint Cooperation Committee meetings have stressed the need for policy support for the promotion of renewable and energy efficiency options in the GCC countries. Several EU-GCC expert meetings' conclusions have underlined the importance of enhancing cooperation in energy, with particular focus on energy efficiency and conservation, clean energy, climate change, and technology transfer. More particularly, the workshop entitled Enhancing the EU-GCC Relations within the New Climate Regime: Prospects and Opportunities for Cooperation, held in Brussels on 26 February 2009,[19] underlined the importance of EU-GCC cooperation on issues related to energy and the environment.

Taking into consideration the conclusions of the expert meetings, the Directorate-General of the European Commission responsible for external relations commissioned a project entitled Creation and Operation of an EU-GCC Clean Energy Network. The project aimed at creating and facilitating the operation of an EU-GCC network so as to act as a catalyst and element of coordination for the development of cooperation on clean energy, including the related policy, research and technology aspects, among various stakeholders in the EU and GCC countries. The overall objective of this initiative is to enhance EU-GCC energy relations by developing the appropriate structures and instruments for practical cooperation activities of common interest in the area of clean energy technologies.

The Network's current objectives are: i) exchange of experience and know-how; ii) coordination and promotion of joint actions between EU and GCC stakeholders; iii) the

18 Co-Chairs' statement, 22nd GCC-EU Joint Council and Ministerial Meeting, Luxembourg, 25 June 2012, http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/er/131196.pdf.

19 See more in the Al-Jisr Project website: http://aljisr.ae/?q=node/42

facilitation of joint research; iv) demonstration and development of clean energy in the GCC through joint projects; and v) policy support to promote the above.[20]

The Network's activities target: i) knowledge sharing; ii) training programmes; iii) research articles; iv) technical visits; and v) discussion group meetings.

The Network is organized around the following five thematic discussion groups, which contribute to enhancing EU-GCC clean energy cooperation:

- renewable energy sources;
- energy demand side management;
- clean natural gas and related clean technologies;
- electricity interconnections and market integration;
- carbon capture and storage.

These discussion groups meet on a regular basis to exchange views, best practices, and experience on the different related topics. In addition, the discussion groups cover most of the topics identified by the Joint Action Programme, as they deal not only with cooperation in natural gas and electricity interconnection, but also with water as sub-topic.

The 2nd Annual Conference of the EU-GCC Clean Energy Network was held in Abu Dhabi, UAE from 17 to 19 January 2012, as a side event of the World Future Energy Summit 2012. During the 2nd Plenary Meeting of the EU-GCC Clean Energy Network, held on 18 January 2012, the European Commission highlighted the importance of making every effort to guarantee the transformation of the Network into a sustainable entity that will continue to catalyze EU-GCC cooperation in the field of sustainable energy.[21] Network stakeholders had the opportunity to discuss the structure and organization of the Network, as well as to elaborate on the Network's sustainability strategy and activity plan, thus enhancing stakeholders' ownership and commitment to creating a useful and viable mechanism for supporting clean energy cooperation between the two regions.

2.2. Identified area of cooperation: fossil fuels

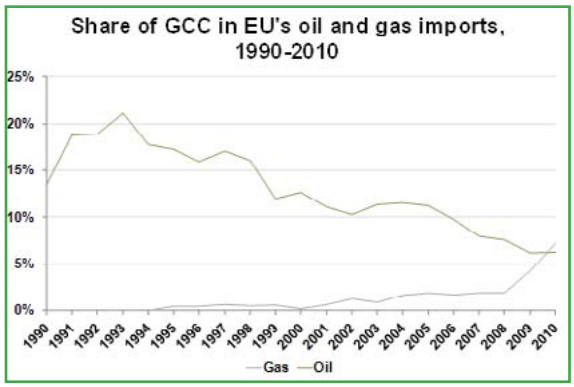
Energy flows between the EU and the GCC are still very much focused on fossil fuels, mainly petroleum and gas. The OPEC 2012 report underlines that 12.3% of Saudi Arabia's crude oil exports go to Europe. In the case of Kuwait, this figure is 4.4%, while for the UAE it is just 0.1%. Saudi Arabia therefore remains the biggest GCC exporter of oil towards Europe, with 890 thousand barrels per day transferred in 2011 alone. According to BP (2012), 42% of Qatar's Liquefied Natural Gas (LNG) exports go to Europe, representing 43 billion cubic metres, while for Oman the figure is 2%.

20 See the EU-GCC Clean Energy Network website: http://www.eugcc-cleanergy.net/TheNetwork.aspx.

21 EU-GCC Clean Energy Network 2nd Annual Conference Press Release, http://www.eugcc-cleanergy.net/LinkClick.aspx?fileticket=rbV2PuL_WKw%3d&tabid=253.

Statistics on the EU's fossil fuels imports from 1990 to 2010 show that the EU maintains a privileged relationship with the former Soviet Union; imports from this region increased from 35.7% in 2005 to more than 41% in 2011. Another main supplier is Africa, with Algeria and Libya in the leading positions. Imports from the African region grew from 18% in 2005 to 20.6% in 2010 (with a slight decline in 2011 due to political instability). According to EUROSTAT, the share of EU's oil imports coming from the GCC countries decreased from 13.5% in 1990 to 6.2% in 2010 (Figure 53). The share was near 20% in the middle of the 1990s. Gas imports from the GCC have shown the opposite trend, growing from 0% in 1990 to 7.2%, mainly due to the increase of the Qatari share in LNG imports. According to BP, the share of LNG coming from Qatar has reached 50% of total LNG imports to Europe in 2011.

Fig. 53. The GCC's share in the EU's oil and gas imports, 2005-2010



Source: OME based on EUROSTAT.

There are clear opportunities for improving cooperation between the two regions in the natural gas sector. There is also scope for possible projects of common interest, bearing in mind the future possibilities for linking the natural gas markets of the two regions, which would require the development of adequate infrastructures. Indeed, the EU is expected to increasingly rely on gas to cover its energy needs. Diversifying the sources of the supply of gas is of paramount importance in order to ensure energy security.

To enhance cooperation in this field, the Joint Action Programme focuses on information exchange on oil and gas markets; policies, frameworks and best practices; and techniques for upstream, midstream and downstream infrastructure development. The Joint Action Programme foresees that ad hoc groups should address the various areas of cooperation, holding seminars and workshops, as well as organising training and capacity building programmes when appropriate.

In addition, issues related to natural gas have been fully integrated into the Clean Energy Network as one of the themes of the discussion groups. During the discussion group meeting dedicated to natural gas held in Abu Dhabi in January 2012, several areas of cooperation in the natural gas field in the EU-GCC context were identified (Assadi 2012), as follows:

- cooperation and research on more economic, effective and environmentally-friendly means of transporting gas, either piped or in liquid form;
- emphasis on new and innovative technologies for LNG regasification;
- cooperation and research on the potential development of unconventional natural gas in the GCC countries, following similar developments in some European countries;
- emphasis on new and innovative technologies for dealing with sour gas reserves found in some GCC countries;
- exchange of information on a research and development project aiming at enhancing the environmental-friendly use of natural gas in the different economic sectors, such as the transport sector (LNG, Gas-To-Liquid, Compressed Natural Gas), the power sector and the residential and commercial sectors.

Furthermore, the development of Integrated Solar Combined Cycle (ISCC) electric generation plants might be an interesting option for the GCC countries, both those which are net gas importers and those which are net gas exporters.

2.3. Identified area of cooperation: electricity

EU and GCC cooperation in the electricity field is already quite advanced, as a result of regular exchanges and meetings at the technical level organized by producers, transmission system operators, distributors and their associations.

The Arab Union of Electricity (AUE), which includes members from GCC countries, has established relationships with the European Network of Transmission System Operators for Electricity (ENTSO-E). The establishment of the GCCIA is also a step towards the creation of more effective, harmonized and stable systems, which should be able to meet the growing demand for electricity.

The knowledge exchange between these organizations is very beneficial both for the EU and for the GCC, particularly within the framework of recent strategies highlighting the need for more closely interconnected electricity systems to support increased exchange of power, with a significant role to be played by renewable energy.

The development of big infrastructure projects requires addressing a series of issues related to a variety of technical, institutional and market aspects, which should accompany the current process of liberalization of electricity markets in the GCC countries. Over the last decade, most Gulf countries have launched reform programmes to create independent power production, decentralisation, privatisation and the unbundling of generation from transmission and distribution.

Such enhanced cooperation would complement the activities that the EU is already carrying out with many neighbouring countries in the framework of its external energy policy, which offer relevant examples, best practices and lessons to be learned.

For example, within the Mediterranean region and in the framework of Euro-Mediterranean cooperation, MEDREG (Mediterranean Regulators for Electricity and Gas) was established in 2007 to promote a transparent, stable and harmonized regulatory framework in the Mediterranean region, fostering market integration and infrastructure investment through a permanent exchange of know-how, data collection and expertise. MEDREG carries out its activities through collaboration with energy stakeholders in the Mediterranean basin with the objective of creating the conditions for the establishment of a future Mediterranean Energy Community, based on a bottom-up approach. MEDREG has five main missions:

- ensure greater harmonization of energy markets and legislation, and to seek progressive market integration in the Euro-Mediterranean region;
- foster sustainable development in the energy sector through greater efficiency and integration of energy markets based on secure, safe, cost-effective and environmentally sustainable energy systems;
- support initiatives of common interest in key areas such as infrastructure development, investment financing and research;
- provide capacity building activities such as training, seminars and working groups;
- foster co-operation, information exchange and mutual assistance among members by providing a permanent discussion framework.

More recently, METSO (Mediterranean Transmission System Operators) was established as an association gathering the electricity transmission system operators of the Mediterranean region. METSO aims to build a link between market regulation functions and electrical system operations, thus facilitating dialogue and cooperation between transport system operators and the institutions in order to promote the coordinated and proactive development of electricity grids and connections in the Mediterranean.

Similarly, the Energy Regulators Regional Association (ERRA) is a voluntary organization comprised of independent energy regulatory bodies primarily from the Central European and Eurasian region, with affiliates from Africa, Asia, the Middle East and the USA. The UAE and Saudi Arabia are members of ERRA.[22]

As far as electricity interconnection is concerned, the completion of the GCC regional power grid opens new perspectives for the establishment of a wider electricity market. The EU has a long experience in the establishment of a common electricity market, and there is clear room for cooperation between the EU and the GCC in terms of knowledge transfer in this field. In addition, through the Pan-Arab interconnection study, common research could be carried out in order to examine the benefits and challenges of the interconnection of multiple regional power grids.

22 *See ERRA website: http://www.erranet.org.*

2.4. Identified area of cooperation: nuclear

While most of the GCC countries have confirmed their commitment to develop nuclear power over the medium-term, the implementation of nuclear technology remains challenging. Five essential issues have to be addressed in order to consider nuclear energy as a source of sustainable energy, namely nuclear safety, proliferation resistance, a minimal production of radioactive waste, the availability of natural resources, and economic competitiveness (Koning and Rochman 2008).

Several EU Member States have longstanding experience of nuclear power. EU-GCC cooperation could build on best practices to enable the transfer of this knowledge from EU to GCC countries. The following measures are as much prerequisites as areas for EU-GCC cooperation in the promotion of nuclear power (Psarras, Flamos and Patlitzianas 2009):

- training of highly technically skilled personnel;
- development of a strategy for future investment in the exploration of uranium and relevant processes in the nuclear fuel cycle;
- development of a strategy for nuclear waste;establishment of effective research and development infrastructure;
- development of a regulatory, safety and licensing board, with government oversight and assistance from the IAEA.

Nuclear energy could contribute to the GCC electric system interconnection for the benefit of Member States where the production of nuclear energy is not feasible.

2.5. Identified area of cooperation: renewable energy

RE technologies offer perhaps one of the greatest opportunities for enhanced cooperation between the EU and the GCC, given the high potential for RE in the region, the prominent role of the EU in the development of renewables at the global level, the substantial industrial capacity and degree of innovativeness displayed by EU companies in the field, and the availability of capital in the GCC countries for profitable RE investments.

Within RE technologies, solar is one key option, given the abundance of the resource, which means that the development of both PV and CSP technologies is a concrete opportunity. The development of solar is also being encouraged by several ongoing initiatives in the Euro-Mediterranean and the EU-MENA regions, such as the Desertec concept and the Mediterranean Solar Plan.

However, in addition to solving market integration and system interconnection issues, the implementation of such ambitious projects needs to take into account and overcome a series of technical aspects, mostly related to the intermittent nature of the resource and the harsh climate conditions, which reduce the efficiency of systems.

Joint cooperation should focus on technology development and innovation, as well as research and development, including the development of new materials.

In addition, the business plans for the various RE projects should be evaluated, taking into account in particular the structure of the electricity market in the GCC countries, and the amount of subsidies granted to fossil-generated electricity.

Resource assessment is another area which deserves further investigation. Whereas for solar and wind, estimates and maps have been produced, much less information is available on other sources, such as geothermal and waste-to-energy.
In addition to the study of these technical aspects, the GCC countries could particularly benefit from the experience of the EU in the development of effective policy and regulatory frameworks for renewables. An impact assessment of incentive mechanisms and of the main technical and non-technical barriers which need to be addressed when designing RE policies would certainly be of benefit to the GCC countries in order to allow them to learn from previous experience and to avoid repeating the same mistakes.

Finally, knowledge sharing is a fundamental aspect which would encourage increased investment in renewables, both in the GCC and in the EU, through new business opportunities and joint ventures. In this regard, in September 2012, a consortium led by ACWA Power International, the Saudi Water and Power giant, in partnership with Aries Ingeniería y Sistemas SA and TSK Electrónica y Electricidad (Spain), was announced as preferred bidder to develop the 160 MW Ouarzazate CSP Independent Power Project, valued at $1 billion.

This is a significant example of the possibility to pull together financial and technical expertise from different actors from the EU and the GCC to work on renewable energy development.

2.6. Identified area of cooperation: energy efficiency

On 25 October 2012, the EU adopted Directive 2012/27/EU on energy efficiency.[23] This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020.

In the GCC, the institutional and regulatory framework is less developed, and efforts have been undertaken in a rather fragmented way. The GCC countries would benefit from

23 Directive 2012/27/EU on energy efficiency …, 25 October 2012, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=celex:32012l0027:en:not.

cooperation with the EU in several ways:

- institutionally, by taking advantage of the experience accumulated in the EU in the preparation of several directives on energy efficiency (covering for example ecodesign and energy labeling, and energy building codes), as well as in the preparation of the National Energy Efficiency Action Plans (NEEAPs);
- as regards demand-side management, through the development of models for energy service companies (ESCos) and market-based mechanisms to support energy efficiency.

In addition, the establishment of national agencies for energy efficiency would represent a significant step towards the implementation and monitoring of concrete energy savings measures in the GCC countries.

EU-GCC cooperation on energy efficiency would benefit from the establishment of a regional association, along the lines of the experience gained in the Euro-Mediterranean area, where the Mediterranean Association of National Agencies of Energy Conservation (MEDENER) was created in 1997. MEDENER brings together 12 organizations in charge of energy efficiency and renewable energy development policies from both shores of the Mediterranean. It aims at exchanging experience, know-how and best practices. The development of synergies between its members allows for the strengthening of the regional partnership on issues of energy conservation specific to the Mediterranean.

2.7. Identified area of cooperation: water

The impact of climate change will contribute to increased pressure on water resources in both regions. Desalination processes will therefore become essential for providing water in southern EU countries, as is already the case in the GCC. For instance, several regions in Spain are facing dramatic water shortages.

In the GCC, the cost of thermal desalination has increased rapidly as result of global oil price rises in recent years, which means that the cost of water subsidies for the GCC governments has increased substantially and is now considered uneconomic. This has led to the expansion of reverse osmosis seawater desalination on a larger scale, since they are grid-connected and often run on gas-fired turbines.

However, the lower gas-to-coal price ratio has led to a global increase in gas consumption. This increase has been stimulated by global investment in gas-fired power plants, whose role may further expand due to the current public perception of nuclear power.

At the moment, and due to demand for electricity and water, the UAE has become a net gas importer, as has Kuwait. Furthermore, according to a recent Citigroup report, Saudi Arabia is at risk of becoming a net oil importer in the next 20 years due to local levels of demand for energy (Daya and El Baltaji 2012).

Based on these considerations, it becomes evident that there is clear room for cooperation as regards desalination, mainly in terms of research and development which could be conducted in order to find ways to reduce the energy intensity of such processes. In particular, desalination powered by renewable energy (and specifically solar) is an area which deserves further investigation, given the high potential of solar energy in the GCC countries. A number of EU research projects have been carried out in this field. They highlight some fundamental barriers to solar desalination, both for decentralized systems and large-scale plants. As for the former, the main obstacle is the fact that the main technology which is commercially available today for capacities below 1,000 m^3/day (photovoltaic reverse osmosis) is limited when it comes to treating high-salinity water. Alternative technologies existing in the region are not energy efficient and are insufficiently developed. Therefore, novel technologies must be deployed which are capable of working with high salinity and sufficient energy efficiency to be coupled with solar energy.
On the other hand, large-scale solar desalination is constrained by the intensive energy consumption associated with desalination and the high investment costs associated with solar energy. To improve the financial picture, synergies can be exploited by coupling desalination with power generation. There are different ways of combining CSP generation with desalination. Several scenarios have been compared which consider the two main industrial technologies for large-scale desalination, i.e. RO and MED. However, the studies have been made on a theoretical basis using thermodynamic analysis, and further investigation is needed of the engineering to identify the most suitable case for each framework condition.

Given the proximity of the water and power sectors in the GCC countries and the growing tensions regarding these two essential commodities, implementation of pilot projects (such as combined CSP desalination plants) would enhance the development of these promising technologies.

Another area of study is nuclear desalination. According to the World Nuclear Association (2013b), the BN-350 fast reactor at Aktau (Kazakhstan) successfully produced up to 135 MW of electricity and 80,000 m3/day of potable water for some 27 years until it was closed down in mid-1999. About 60% of its power was used for heat and desalination and it established the feasibility and reliability of cogeneration plants of this type. There are also combined plants operating in Japan, India, Pakistan, and China.

Nuclear desalination could be another option worth developing. However, public concerns expressed after the Fukushima accident have led to delayed development plans in the GCC region.

Conclusion

The GCC countries show good potential for cooperation and partnership with the EU over a vast and diversified range of issues. The renewable energy sector presents an excellent opportunity for cooperation and partnership given the current perception of RE in the region. Despite its slow development in the GCC countries, interest in RE is increasing among the governments of different GCC countries. The level of interest varies from one country to another, and the type of targeted investment also varies. In general, interest is motivated by the desire to achieve both a sustainable energy mix and economic development.

Despite the similarities between the Gulf states, there are also significant differences between them on a variety of issues. Energy security is a subject of common interest between all six Gulf states. However, the approach towards the subject varies from one country to another. This is particularly true of RE. Having a third of the world's oil reserves, the GCC countries have had little incentive to review their local consumption of energy. However, the rising cost of electricity production and the relative shortage in gas production are changing the governments' strategies.
The GCC countries are indeed facing great energy challenges, and only recently have GCC governments acknowledged this. There is no common approach to electricity and water security issues. In fact, effort fragmentation is common at country level, with most GCC countries splitting the work between research institutes, government agencies and the private sector. Nevertheless, it can be observed that some GCC countries are already taking measures to consolidate their efforts.

The GCC governments recognize the importance of diversifying local energy supplies, and are moving towards market reform and a sustainable energy mix. This move is beset by many challenges. These challenges can be traced back to the size of the demand for electricity. It is argued that electricity and water subsidies have resulted in rapid demand growth in a sector which has, as a consequence, experienced little progress in terms of efficiency improvement and conservation. The current political atmosphere and the constraints this atmosphere imposes on GCC governments make putting in place some of the foundations for market reform rather challenging. It is unlikely that subsidies will undergo any significant change. When it comes to electricity and water, top-down initiatives with low political cost (such as building codes) may be more feasible than subsidy removal. Most GCC countries are still at an early stage in the development of their building codes.

The GCC countries are working actively on expanding existing production capacities in order to meet current and future electricity and water demands. Finding secure non-fossil fuel alternatives, developing a regional energy market and creating conditions which stimulate energy saving are essential. Delaying investment in this field can undermine the sustainability and security of supply. In addition, a clearly-defined strategy is key to achieving sustainable and secure electric and water supplies. Yet it is evident that most GCC countries still lack clear strategies in this regard. Plans to develop nuclear energy met with public

concern in at least one GCC country following the Fukushima incident, which eventually led to the cancelation of the nuclear programme in that country. However, nuclear energy may still be a viable alternative for some GCC countries, with their different social and political systems. Additionally, nuclear energy could contribute to the GCC interconnection to the benefit of countries where nuclear energy is not feasible. The contribution of nuclear energy to the future GCC energy mix must be addressed openly and objectively. With the exception of Dubai, nuclear energy plans are not being moved forward at the moment at the same pace as RE.

Renewable energy technologies offer one of the greatest opportunities for enhanced cooperation between the EU and the GCC. The prominent role of the EU in the development of renewables at the global level and the substantial industrial capacity and degree of innovativeness displayed by EU companies, together with the availability of capital in the GCC countries, represent a profitable RE investment opportunity which could contribute to energy security for both sides. Furthermore, the EU has long experience of dealing with energy market reform and establishing transparency and accessibility. This has contributed to the security of energy supply by allowing electricity companies to grow beyond national borders.

The EU is already carrying out activities with many countries neighboring the GCC in the framework of its external energy policy. The EU-Mediterranean partnership provides a good example of how EU-GCC cooperation and partnership could be developed. The incorporation of energy efficiency, clean technologies and safe and sustainable low-carbon energy in EU-GCC cooperation and partnership plans will emphasize the global role of the EU in a low-carbon energy future.

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Annex 1. Key indicators and compound indicators for GCC countries, EU-27 and the world, 2009

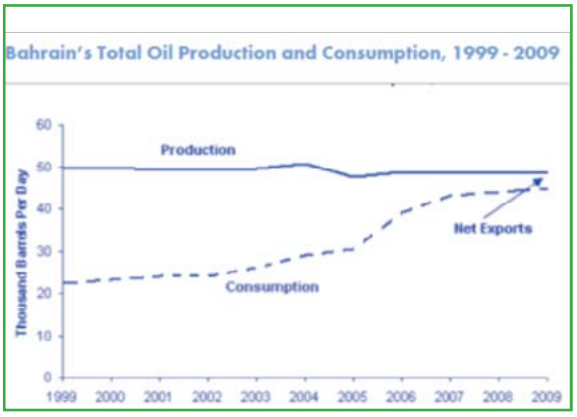
Table 7. Key and compound indicators in GCC countries

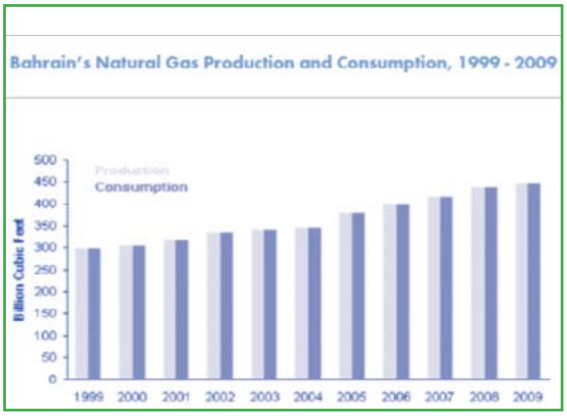
Key indicators	Units	EU-27	GCC	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	World
Population	Million	500,37	37,84	9,79	2,80	2,85	1,41	25,39	4,60	6 760,75
GDP	Billion 2000 USD	9 841,59	517,24	13,67	63,63	31,63	40,71	249,54	118,06	39 674,41
GDP (PPP)	Billion 2000 USD	12 007,61	664,36	17,91	72,41	49,02	36,47	371,91	116,64	64 244,43
Energy production	Mtoe	817,29	1 052,12	17,55	130,24	67,20	139,95	528,38	168,80	12 291,68
Net imports	Mtoe	941,46	-735,27	-5,58	-98,58	-51,03	-115,07	-371,80	-93,21	0,00
TPES	Mtoe	1 655,79	295,96	9,47	30,17	15,06	23,82	157,85	59,59	12 149,85
Electricity consumption*	TWh	3 037,15	374,60	10,78	46,60	15,52	23,04	199,12	79,54	18 451,50
CO_2 emissions**	Mt of CO_2	3 577	757	23	81	39	57	410	147	28 999

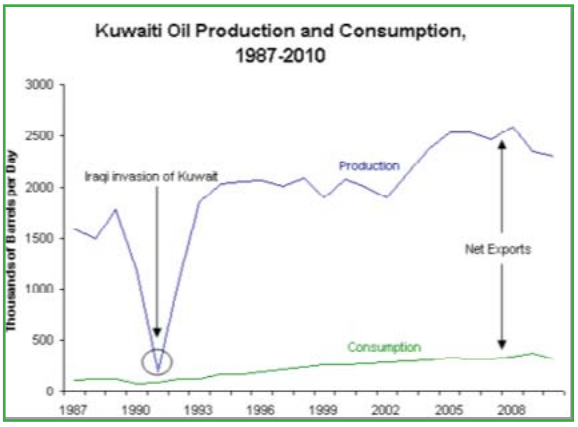
Coumpound indicators	Units	EU-27	GCC	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	World
TPES/ population	toe/ capita	3,31	7,82	11,97	10,8	5,29	16,91	6,22	12,96	1,8
TPES/GDP	toe/ thousand 2000 USD	0,17	0,57	0,69	0,47	0,48	0,59	0,63	0,5	0,31
TPES/GDP (PPP)	toe/ thousand 2000 USD	0,14	0,45	0,53	0,42	0,31	0,65	0,42	0,51	0,19
Electricity consumption/ population	kWh/capita	6 070	9 900	13 625	16 673	5 457	16 353	7 842	17 296	2 729
CO_2/TPES	tCO_2/toe	2,16	2,56	2,41	2,68	2,59	2,37	2,6	2,47	2,39
CO_2/population	tCO_2/capita	7,15	19,99	28,86	28,88	13,69	40,12	16,17	31,97	4,29
CO_2/GDP	kg CO_2/ 2000 USD	0,38	1,46	1,67	1,27	1,23	1,39	1,64	1,25	0,73
CO_2/GDP (PPP)	kg CO_2/ 2000 USD	0,30	1,14	1,27	1,11	0,79	1,55	1,1	1,26	0,45

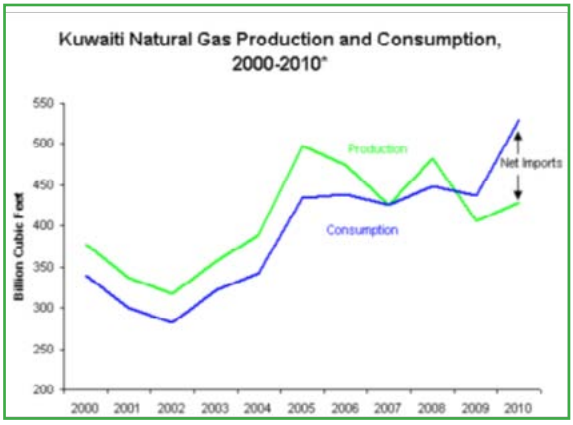
Source: IEA 2011b.

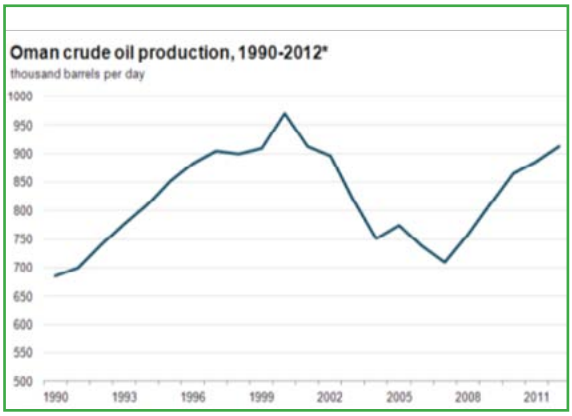
Annex 2. Crude oil and natural gas production and consumption in some GCC countries

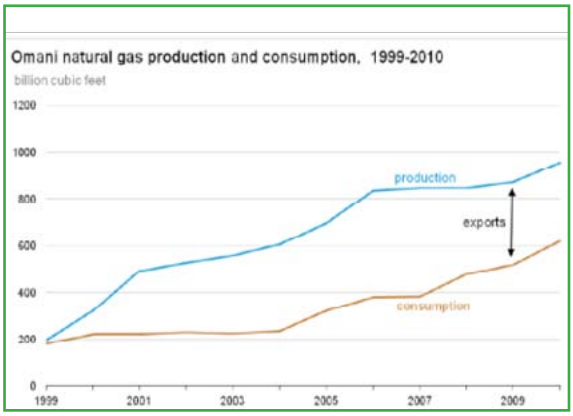


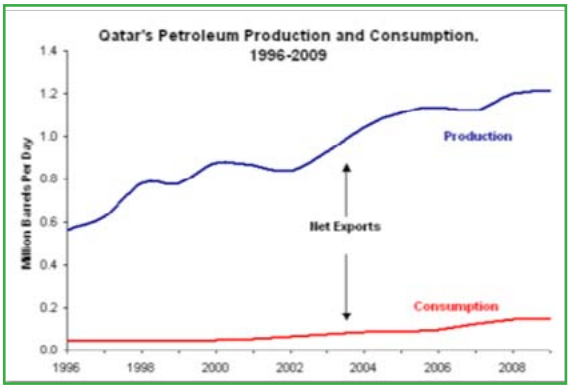


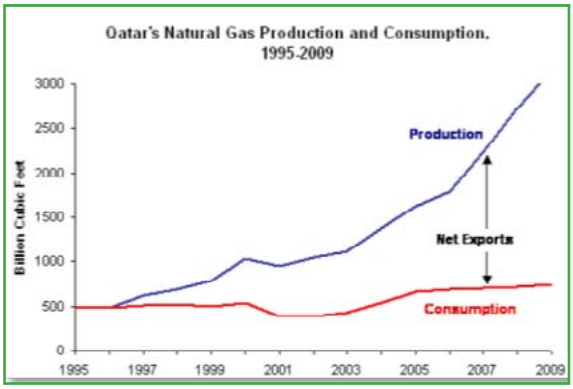


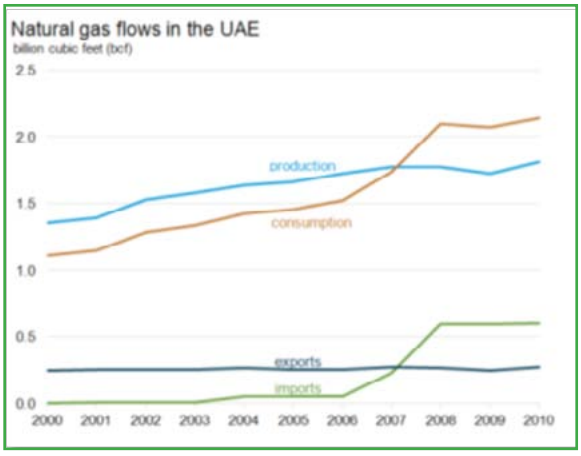






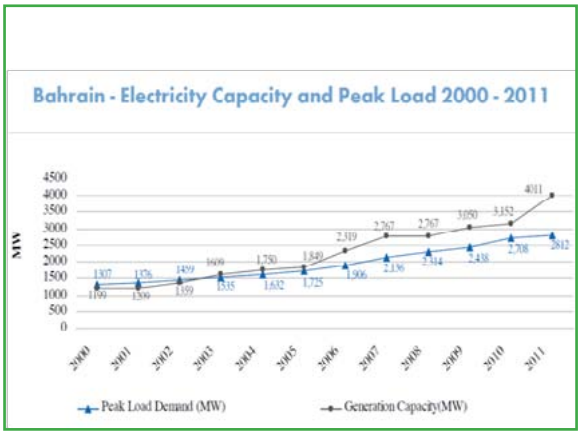


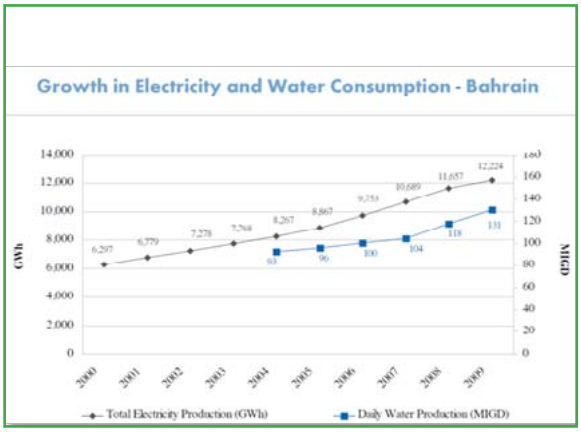


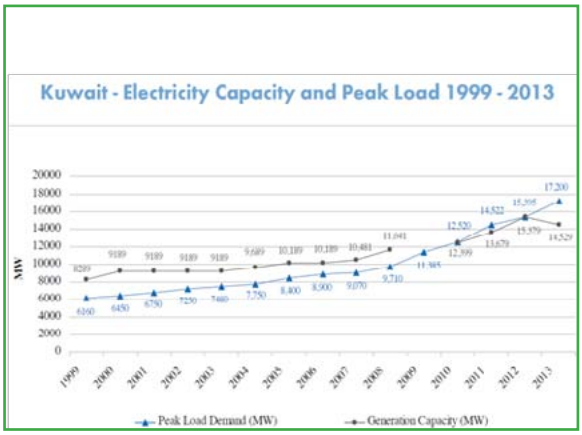


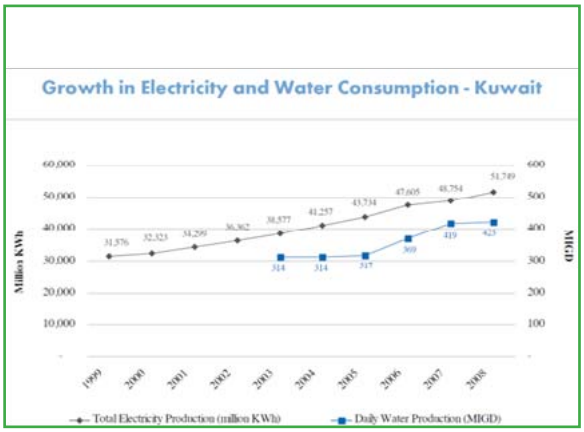
Sources: US Energy Information Administration 2013; Bachellerie 2012.

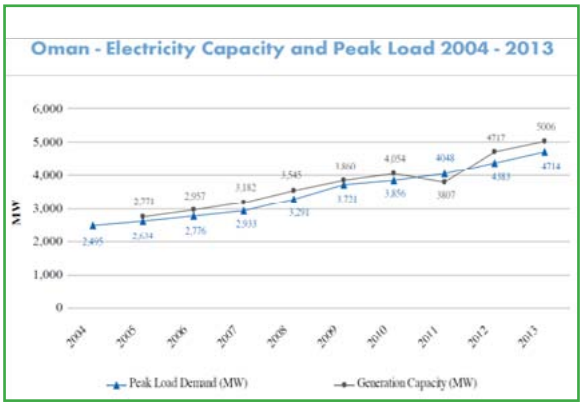
Annex 3. Electricity and water consumption growth in GCC countries

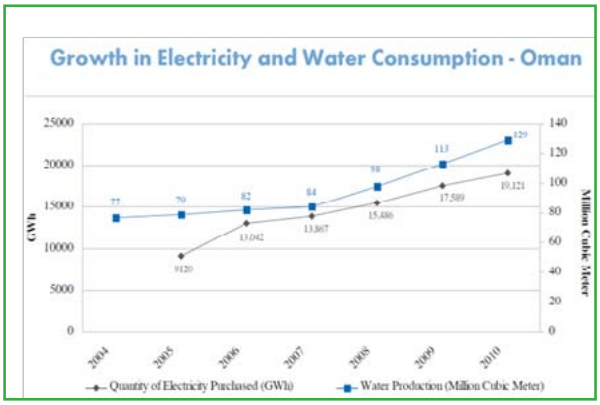


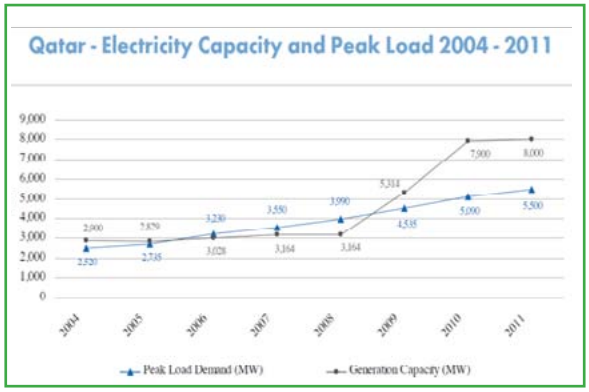


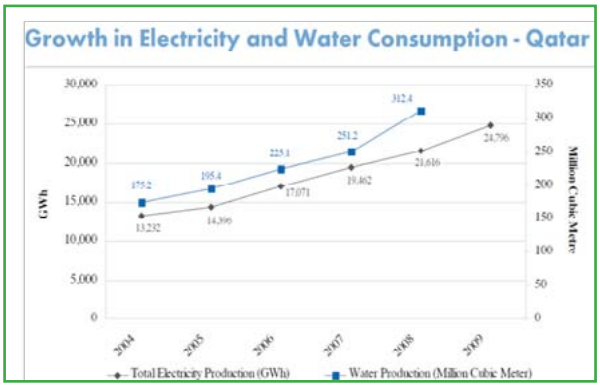


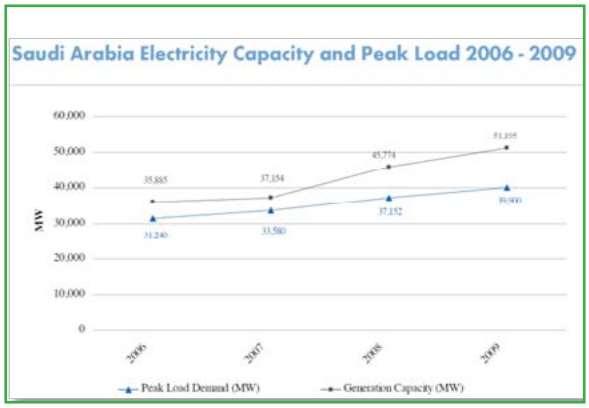


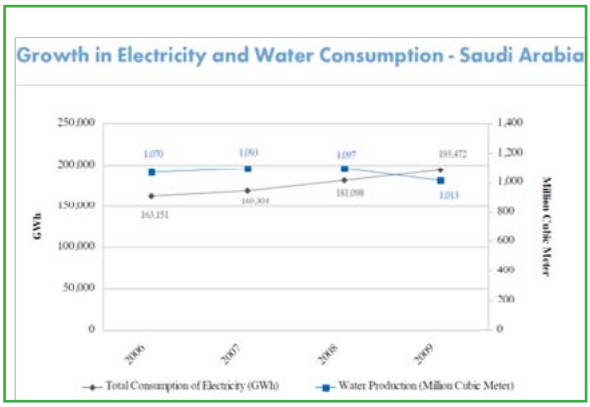

Oman - Electricity Capacity and Peak Load 2004 - 2013
MW
Peak Load Demand (MW)
Generation Capacity (MW)

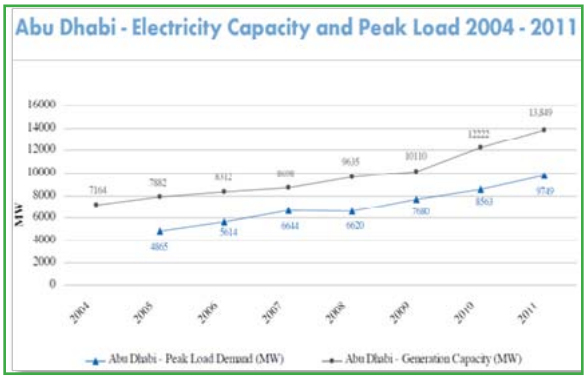

Growth in Electricity and Water Consumption - Oman
GWh
Million Cubic Meter
Quantity of Electricity Purchased (GWh)
Water Production (Million Cubic Meter)

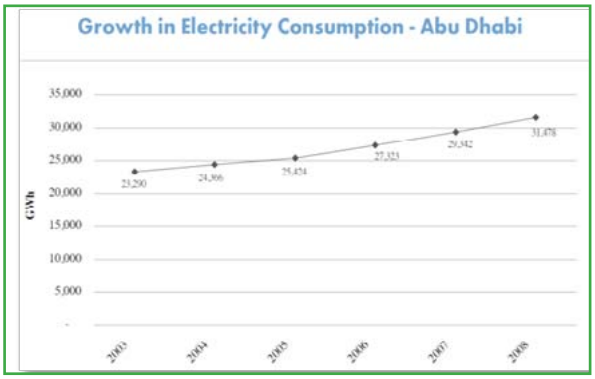

Qatar - Electricity Capacity and Peak Load 2004 - 2011
Peak Load Demand (MW)
Generation Capacity (MW)

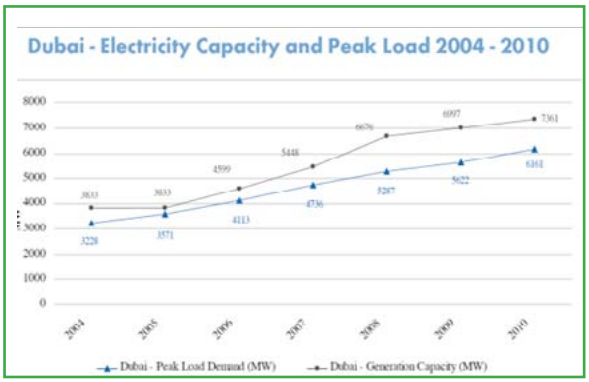

Growth in Electricity and Water Consumption - Qatar
GWh
Million Cubic Meter
Total Electricity Production (GWh)
Water Production (Million Cubic Meter)

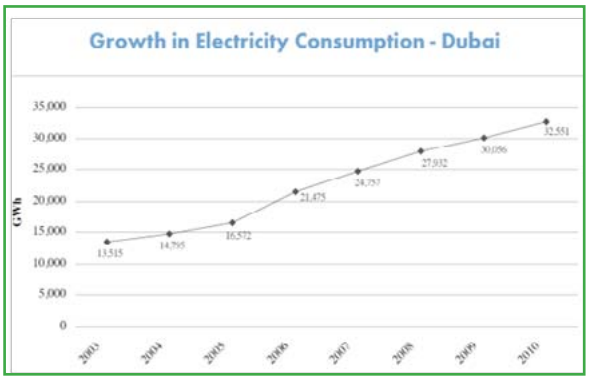

Saudi Arabia Electricity Capacity and Peak Load 2006 - 2009
MW
Peak Load Demand (MW)
Generation Capacity (MW)

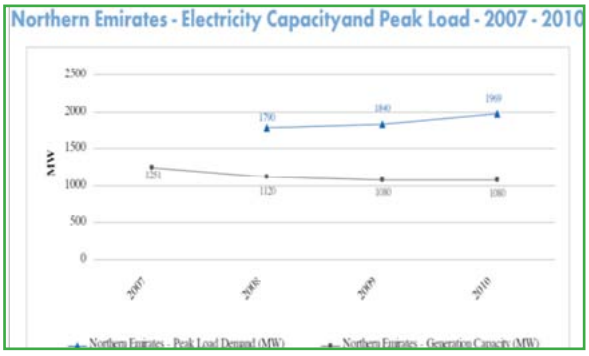

Growth in Electricity and Water Consumption - Saudi Arabia
GWh
Million Cubic Meter
Total Consumption of Electricity (GWh)
Water Production (Million Cubic Meter)

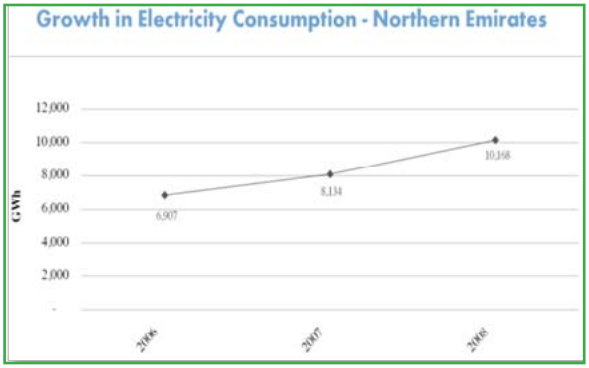

Abu Dhabi - Electricity Capacity and Peak Load 2004 - 2011
MW
Abu Dhabi - Peak Load Demand (MW)
Abu Dhabi - Generation Capacity (MW)

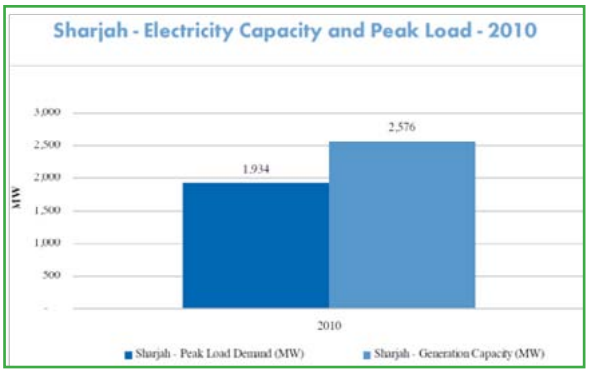

Growth in Electricity Consumption - Abu Dhabi
GWh

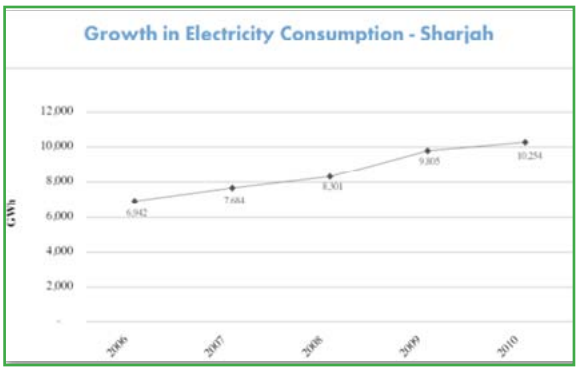












Source: Bachellerie 2012.

Annex 4. Electricity tariffs in GCC countries

Table 8. Electricity tariffs in GCC countries

Abu Dhabi			Bahrain		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1 (Remote areas - UAE national)	3	0.82	1 - 3,000 3,001 - 5,000 >5,001	3 9 16	0.80 2.39 4.24
1 (other areas - UAE national)	5	1.36			
1 (Non-UAE national)	15	4.08			

Dubai			Kuwait		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
0 - 2,000	23	6.26	1	2	0.70
2,001 - 4,000	28	7.62			
4,001 - 6,000	32	8.71			
>6,001	38	10.35			

Oman			Qatar		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC Dh/kWh**	**USD $ cent/kWh**
1 - 3,000	10	2.60	1 - 4,000	8	2.20
3,001 - 5,000	15	3.90	>4,001	10	2.75
5,001 - 7000	20	5.19			
7,001 - 10,000	25	6.49			
>10,000	30	7.79			

Saudi Arabia			Northern Emirates (UAE)		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1 - 2,000	5	1.33	0 - 2,000	20	5.45
2,001 - 4,000	10	2.67	2,001 - 4,000	24	6.54
4,001 - 6,000	12	3.20	4,001 - 6,000	28	7.62
6,001 - 7,000	15	4.00	>6,001	33	8.99
7,001 - 8,000	20	5.33			
8,001 - 9,000	22	5.87			
9,001 - 10,000	24	6.40			
>10,000	26	6.93			

Source: OME based on national sources 2013.

Table 9. Electricity tariffs in the commercial sector

Abu Dhabi			Bahrain		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1	15	4.08	any	16	4.24

Dubai			Kuwait		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
0 - 2,000	23	6.26	1	2	0.70
2,001 - 4,000	28	7.62			
4,001 - 6,000	32	8.71			
>6,001	38	10.35			

Oman			Qatar		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC Dh/kWh**	**USD $ cent/kWh**
NA			1 - 4,000 4,001 - 15,000 >15,001	9 12 14	2.47 3.30 3.84

Saudi Arabia			Northern Emirates (UAE)		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1 - 2,000	5	1.33	0 - 2,000	20	5.45
2,001 - 4,000	10	2.67	2,001 - 4,000	24	6.54
4,001 - 6,000	12	3.20	4,001 - 6,000	28	7.62
6,001 - 7,000	15	4.00	>6,001	33	8.99
7,001 - 8,000	20	5.33			
8,001 - 9,000	22	5.87			
9,001 - 10,000	24	6.40			
>10,000	26	6.93			

Source: OME based on national sources 2013.

Table 10. Electricity tariffs in the industrial sector

Abu Dhabi			Bahrain		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1	15	4.08	any	16	4.24

Dubai			Kuwait		
Consumption slab (kWh)	**LC fils/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
0 - 10,000	23	6.26	1	1	0.35
>10,001	28	10.35			

Oman			Qatar		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC Dh/kWh**	**USD $ cent/kWh**
From Sept to April	12	3.12	1	7	1.92
From May to August	24	6.23			

Saudi Arabia			Northern Emirates (UAE)		
Consumption slab (kWh)	**LC Bz/kWh**	**USD $ cent/kWh**	**Consumption slab (kWh)**	**LC fils/kWh**	**USD $ cent/kWh**
1	12	3.20	1	40	10.89

Source: OME based on national sources 2013.

Table 2. Electricity market structure in GCC countries

	Regulator	Generation	Transmission	Distribution	Procurement
Bahrain	Electricity and water Authority (EWA)	Electricity and Water Authority (EWA) Al-Ezzel Power Company (Al-Ezzel PC) Hidd Power Company (HPC) Al Dur Power and Water Company (Aldur)	Electricity and Water Aughority (EWA)		
Kuwait	Ministry of Electricity and Water (MEW)				
Oman	Authority for Electricity Regulation (AER)	SMN Barka Power Company Al Rusail Power Company Sohar Power Company ACWA Power Barka United Power Company Al Kamil Power Company Al Ghubrah Power and Desalination Al Rusail Power Company Wadi Al Jizzi Power Company Rural Areas Electricity Company Ministry of Defense (generates electricity and sells it to OPWP) Petroleum Development Oman (PDO)	Oman Electricity Transmission Company Rural Areas Electricity Company	Rural Areas Electricity Company Muscat Electricity Distribution Company Mazoon Electricity Company Majan Electricity Company	Oman Power and Water Procurement Company (OPWP)
Qatar	Companies are self-regulated	Qatar Electricity and Water Company (QEWC) Ras Lafflan Power Company (RLPC) 1. Ras Girtas Power Company 2. Q Power Mesaieed Power Company	Qatar General Electricity and Water Corporation (KAHRAMAA)		
Saudi Arabia	Electricity and cogeneration Regulatory authority (ECRA)	Saudi Electricity Company (SEC)			Sustainable Energy Procurement Company (SEPC)
UAE					
The Northern Emirates	Federal Electricity and Water Authority (FEWA)				
Sharjah	Sharjah Electricity and Water Authority (SEWA)				
Dubai	Dubai Electricity and Water Authority (DEWA)				
Abu Dhabi	Abu Dhabi Water and Electricity Aughority (ADWEA) Regulation and Supervision Bureau (RSB) Federal Authority for Nuclear Regulation (FANR)	Al Mirfa Power Company (AMPC) Emirates CMS Power Company Gulf Total Tractebel Power Shuweihat CMS International Power Company Arabian Power Company Taweelah Asia Power Company Emirates SembCorp Water and Power Company Fujairah Asia Power Company Ruwais Power Company Shuwaeihat Asia Power Company	Abu Dhabi Transmission and Dispatch (TRANSCO)	Abu Dhabi Distribution Company (ADDC) Al Ain Distribution Company(AADC)	Abu Dhabi Water and Electricity Company (ADWEC)

Source: OME based on national sources 2013.

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Mireia Zamora, Tawasul

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ABOUT SHARAKA

Sharaka is a two-year project implemented by a consortium led by Istituto Affari Internazionali (IAI).

The project, partially funded by the European Commission, explores ways to promote relations between the EU and the Gulf Cooperation Council (GCC), through the implementation of policy-oriented research, outreach, training and dissemination activities. The overall project aim is to strengthen understanding and cooperation between the EU and the GCC, with particular attention to the strategic areas identified in the Joint Action Programme of 2010, such as trade and finance, energy, maritime security, media and higher education.

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