EU-GCC Clean Energy Network II

O.1.6 Report
Background Paper on Areas of Potential EU GCC Clean Energy Cooperation

July 2016

A report compiled within the EU GCC Clean Energy Network II
European Commission – FPIS (No. PI/2015/370817)

EU Consortium
KOMIS (Project coordinator), ICCS-NTUA/ EPU-NTUA, Fichtner, ECN - Energy Research Centre of the Netherlands, CEPS - Centre for European Policy Studies, CENER - National Renewable Energy Centre of Spain
Key Authors (in alphabetical order):

Haris Doukas, Assist.Professor, ICCS-NTUA
Charikleia Karakosta, Energy Expert, ICCS-NTUA
Ioanna Makarouni, Communication Manager, CENII
Mustapha Taoumi, Energy Technology Expert, CENII
Frank Wouters, CENII Director

Note: This report is taking stock of best practices, obstacles or gaps that have emerged from the Network discussions during the previous phase (2010-2013) and reviews the EU GCC clean energy cooperation areas and potential in view of what is relevant to date. In addition the analysis takes into consideration the results of the eConsultation process carried out in April and May 2016 as well as the recommendations that have emerged from the 1st Working Groups’ Consultation Workshop (24 May 2016, Dubai) in the fields of Renewable Energy Sources, Electricity Interconnections and Market Integration.

The authors’ team would like to express its appreciation to and to acknowledge the valuable contribution of:

- the key Network stakeholders during the first phase of its operation (2010-2013) that have carried out extensive analysis per country/region and per working group topic, coming up with a set of background papers, recommendations, etc:
  - EU consortium during the first phase: ICCS-NTUA Co-ordinator, (Greece); GRC Foundation; DLR (Germany); CENER (Spain); CEPS (Belgium); ESBI (Ireland); University of Stavanger (Norway).
  - GCC Consortium during the first phase: Masdar Institute - Co-ordinator, (UAE); Arabian Gulf University (Bahrain); King Abdulaziz City of Science and Technology KACST (Kingdom of Saudi Arabia); Kuwait Institute for Scientific Research KISR (Kuwait); Sultan Qaboos University (Oman); Qatar Environment and Energy Research Institute QEERI (Qatar)

- a number of stakeholders and experts in the EU and in the GCC that were consulted during the first six months of 2016.

This report is intended to be a living document, subject to annual updating as appropriate in order to support the prioritisation and planning of the Network activities.

Disclaimer: This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of its authors and can in no way be taken to reflect the views of the European Union.

Copyright © Key Authors
Table of Contents

ABBREVIATIONS ....................................................................................................................................................... 2

1 Introduction .......................................................................................................................................................... 4

2 The Concerned Regions ....................................................................................................................................... 5

3 Overview of EU-GCC Cooperation Initiatives ................................................................................................. 6

4 Potential Areas for cooperation .............................................................................................................................. 7

  4.1 Renewable Energy Sources .............................................................................................................................. 8

  4.2 Energy Efficiency – Demand Side Management ............................................................................................. 12

  4.3 Clean Natural Gas and Related Technologies ................................................................................................. 15

  4.4 Carbon Capture, Storage and Usage ................................................................................................................ 18

  4.5 Electricity interconnections & market integration ............................................................................................ 20

5 Current State of GCC- EU Policies on Climate Change ......................................................................................... 23

Bibliography ............................................................................................................................................................... 27

ANNEX: EU Strategic Energy Technology (SET) Plan ................................................................................................. 30
## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU</td>
<td>Business-as-usual</td>
</tr>
<tr>
<td>BEMS</td>
<td>Building Energy Management Systems</td>
</tr>
<tr>
<td>CCS</td>
<td>Carbon Capture and Storage</td>
</tr>
<tr>
<td>CCU</td>
<td>Carbon Capture and Use</td>
</tr>
<tr>
<td>CEN</td>
<td>EU-GCC Clean Energy Network (Phase 1 Project: 2010-2013)</td>
</tr>
<tr>
<td>CENII</td>
<td>EU GCC Clean Energy Network II (Phase 2 Project: 2015 – 2018)</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>CSP</td>
<td>Concentrated Solar Power</td>
</tr>
<tr>
<td>DEWA</td>
<td>Dubai Electricity and Water Authority</td>
</tr>
<tr>
<td>DHI</td>
<td>Diffuse horizontal irradiance</td>
</tr>
<tr>
<td>DIES</td>
<td>Dubai Integrated Energy Strategy</td>
</tr>
<tr>
<td>DNI</td>
<td>Direct normal irradiance</td>
</tr>
<tr>
<td>DSCE</td>
<td>Dubai Supreme Council of Energy</td>
</tr>
<tr>
<td>DSM</td>
<td>Demand Side Management</td>
</tr>
<tr>
<td>ECCP</td>
<td>European Climate Change Programme</td>
</tr>
<tr>
<td>EEOs</td>
<td>Energy efficiency obligation scheme</td>
</tr>
<tr>
<td>ESCO</td>
<td>Energy services companies</td>
</tr>
<tr>
<td>ESI</td>
<td>Emirates Steel Industries</td>
</tr>
<tr>
<td>FIT</td>
<td>Feed in Tariff</td>
</tr>
<tr>
<td>GCC</td>
<td>Gulf Cooperation Council</td>
</tr>
<tr>
<td>GCCIA</td>
<td>Gulf Cooperation Council Interconnection Authority</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gases</td>
</tr>
<tr>
<td>GHI</td>
<td>Global horizontal irradiance</td>
</tr>
<tr>
<td>GTL</td>
<td>Gas-to-Liquids</td>
</tr>
<tr>
<td>INDC</td>
<td>Intended Nationally Determined Contributions</td>
</tr>
<tr>
<td>JICA</td>
<td>Japan International Cooperation Agency</td>
</tr>
<tr>
<td>KACARE</td>
<td>King Abdullah City for Atomic and Renewable Energy</td>
</tr>
<tr>
<td>KEEP</td>
<td>Kingdom of Bahrain Energy Efficiency Programme</td>
</tr>
<tr>
<td>KSA</td>
<td>Kingdom of Saudi Arabia</td>
</tr>
</tbody>
</table>
LCOE  Levelised costs of electricity
LNG  Liquefied Natural Gas
PPA  Power Purchase Agreement
PSI  Projects of Common Interest
PV  Photovoltaic
QGBC  Qatar Green Building Council
ReCREMA  Research Center for Renewable Energy Mapping and Assessment
RES  Renewable energy source
SEEC  Saudi Energy Efficiency Center
SEEP  Saudi Energy Efficiency Program
SET  Strategic Energy Technology
SOE’s  State owned enterprises
UAE  United Arab Emirates
UPC  Urban Planning Council
ZEP  Zero Emission Fossil Fuel Power Plants
1 Introduction

The EU-GCC Clean Energy Network (CEN) was launched in 2010 with European Union funding, as a response to the common EU GCC interest for strategic clean energy cooperation. The Network is designed to catalyse and coordinate joint EU GCC clean energy initiatives, including policy and technology aspects involving a broad range of stakeholders in the EU and GCC countries. The Network aims to become permanent over the mid-term. With these objectives in mind, the European Union has recently launched the “EU GCC Clean Energy Network II” (CENII) project. Building on the achievements of the EU-GCC Clean Energy Network since 2010, the project aims to boost the Network and explore the opportunities for cooperation in the energy sector.

The new Project aims at widening the participation in the Network, ensuring its sustainability in the longer term and strengthening its capability to increase EU-GCC cooperation in the field of clean energy. The main instruments for the Network to promote cooperation activities such as policy discussions, joint research or technology implementation projects are a system of Working Groups and an advanced web based cooperation platform. Dissemination of information about the existing cooperation and relevant funding opportunities and the Network itself is a third pillar of the project content.

The Project covers all EU member states and the countries of the Gulf Cooperation Council (GCC), namely: Bahrain, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia (KSA) and United Arab Emirates (UAE). All GCC members are also members of the Arab League and Qatar, KSA, Kuwait and the UAE are prominent members of OPEC.

The targeted Network stakeholders include: industry, energy-related research entities, universities, government entities and policy makers, utilities, and others from the energy and climate change sectors. Of particular importance in the GCC Region are state owned enterprises (SOE’s) who are often major consumers of power and in a number of cases owners of generation assets.

The Network can promote cooperation activities that are both regional and bilateral and will include the exchange of ideas, sharing best practices, development of common research co-operations etc. The Network aims to bring the stakeholders together, providing the means for the development of better and more efficient ways of cooperation and helping identify new fields and areas of cooperation among the Network’s stakeholders. It provides a platform for debate and exchange of information, a bridge between the EU and GCC regions and a source of information on clean energy and climate change.

This background paper builds upon the discussions that took place in what were previously called Discussion Groups from 2010 to 2013. The analysis is taking stock of best practices, obstacles or gaps that have emerged from the existing Network and will review the Network cooperation areas and potential in view of what is relevant to date. It has greatly befitted from consultation with many stakeholders. In addition it takes into consideration the recommendations that have emerged from the 1st Working Groups’ Consultation Workshop that has been held in Dubai on 24 May 2016. The workshop discussed among experts the two regions’ cooperation potential in the fields of Renewable Energy Sources, Electricity Interconnections and Market Integration. The EU-funded workshop was organised with the support of the Dubai Supreme Council of Energy (DSCE) and in association with the Clean Energy Business Council.
A mapping of the current state of clean energy in each GCC country is also presented, identifying the countries’ level of progress on policies, technologies, research, capacity and strategy. This is done based on previous work realised by the Network, as well as on papers, publications, industry and policy news and other reliable information released.

The main aim of this background paper is to support a discussion on updating areas for potential EU-GCC clean energy cooperation.

This paper describes the current state of play in the GCC and EU regions, the desire for cooperation, and potential areas for EU-GCC clean energy cooperation.

2 The Concerned Regions

The GCC countries are among the world leading oil and gas producing and exporting countries. This is in particular the case for the Kingdom of Saudi Arabia, Kuwait, the United Arab Emirates and Qatar, which jointly contain 40% of world oil reserves and 20% of world gas reserves, and account for production of 23% of world oil and 9% of gas. Oman and Bahrain are smaller producers. But even the KSA, with 21% of world oil reserves and 13% of world oil production, has a reserve to production ratio of 66 years, which means that, assuming no new oil is found and that oil production levels remain at the present level, the KSA has oil for less than 70 years, i.e. three generations.

The GCC countries are also among the highest energy and water consumers worldwide and domestic energy consumption continues to increase fast. Electricity demand is increasing particularly fast, at average growth rates of 7%, which implies a doubling of the needed power generation capacity every 10 years. This strong electricity demand growth is also driven by artificially low energy prices. Low returns for the power utilities results in insufficient capacity additions and reserve margins falling to dangerously low levels, with increased risk of outages and black-outs. In the GCC all power generation is largely oil and gas based. The CO$_2$ footprint of GCC countries is among the highest in the world.$^1$

Engaging in a more sustainable development path and thus curbing domestic oil and gas demand will allow hydrocarbon reserves to last longer, enable higher revenues through export and make more hydrocarbons available for other use, such as the petrochemical industry. However, efforts towards rational use of energy, energy efficiency, renewable energy sources and sustainable energy in general have been limited so far in the GCC and there has also been limited interest in these issues until recently.

Recent developments and our experience from the previous project (EU GCC Clean Energy Network phase I) indicate that past attitudes have started to change rapidly. Interest in renewable energy source (RES) technologies (predominantly solar) is growing fast in various GCC countries, as a number of projects are already implemented or underway, local and regional actors are developing impressive RES plans and activities and local capacity is growing. In this framework, a number of technological, policy, as well as research challenges in developing and applying RES projects in the region are the basis for cooperation that the Network can build on. There is also intense interest in Carbon Capture and Storage (CCS) technologies, notably because CO$_2$ injection into oil reservoirs not only reduces

---

atmospheric greenhouse gases (GHG), but can also enhance oil recovery. In addition, there is growing interest in technologies related to the transportation of gas into Liquefied Natural Gas (LNG) or Compressed Natural Gas (CNG) form, as well as in transformation of gas into clean liquid fuels and other petrochemical derivatives.

On the other hand, there has been so far little progress in the GCC in the fields of Demand Side Management (DSM) and Energy Efficiency. However, interest through intervention processes and policies is gaining ground as demand continues to put pressure on the provision of capacity in terms of primary fuel and generation and in recent years several GCC countries have been launching various DSM and Energy Efficiency initiatives. Consequently, there is large potential for cooperation on energy efficiency as well, starting potentially with energy efficiency in the building sector, targeting GCC countries that appear more advanced and ready to consider adopting relevant policies.

Additional areas which address demand and capacity provision include initiatives such as, integration of the region’s electricity systems, which bring a whole raft of benefits to participating countries including the promotion of capacity sharing, stability and reliability to electricity supply, has already begun with the operationalization of the first stage of the GCC power grid. It should also be noted that GCC countries on many occasions have declared climate change as key strategic priority and seek to develop international cooperation on these grounds.

On the other hand, the EU, as the world’s major importer of hydrocarbons and the leading world proponent of climate change prevention has a well-founded interest to cooperate with the GCC countries and support them in addressing and successfully tackling clean energy issues. The multiple benefits to this approach include reduction of the greenhouse effect, prolongation of the duration of the hydrocarbon fuel reserves, the potential for diversification of gas supply to Europe (through the supply of gas or gas derivatives from the region), the promotion of EU policies, the development of a market for the EU clean energy industry and, in the long run, even the potential for import of solar electricity from the GCC. The Project at hand is a manifestation of the European Commission’s desire to catalyse developments in the GCC in the field of clean energy, through the reinforcement of cooperation (at the level of research, policy, technology and industry), dissemination of information and advice on clean energy policies, capacity building and exchange of know-how, and exploration of possibilities for joint projects (both technological research and pilot industrial scale projects).

3 Overview of EU-GCC Cooperation Initiatives

Energy has always been a central element of EU-GCC relations. Having the features presented before, the EU has a sound interest to cooperate with the GCC countries and support them in successfully addressing clean energy issues. Conversely, the GCC countries, as hydrocarbon exporters, have an interest in Europe, to strengthen international relations and in this context, the EU and the GCC countries have established and are further enhancing a long term regional strategic relationship in many sectors and policy areas including the energy sector. This development is fully reflected by the on-going contacts, underpinned by the growing interest of the GCC countries to work more closely with the EU on clean energy.

In the political context, the EU has established bilateral relations with the GCC countries through the 1988 Cooperation Agreement, intended to strengthen stability in a region of strategic importance, facilitate political and economic relations, broaden economic and technical cooperation, broaden
cooperation on energy, industry, trade and services, agriculture, fisheries, investment, science, technology and environment. The Agreement allowed for the development of closer cooperation on issues such as energy, transport, research and innovation, and the economy. Nowadays, the rationale for having close relations with the GCC countries is different and perhaps stronger, as trade and investment relations have grown.

Current EU-GCC relations are based on this Cooperation Agreement, putting into place a regular high level framework of dialogue. The Cooperation Agreement has established an annual Joint Council/Ministerial Meeting between the EU and the GCC foreign ministers, as well as between senior officials at a Joint Cooperation Committee.

Furthermore, an Energy Experts Group was initiated, which started working at the beginning of the 1990s' and currently constitutes one of the longest standing cooperation mechanisms between the EU and the GCC partners. Exchanges within this group are being complemented by the activities of the EU-GCC Climate Change Experts’ Group that has met on a regular basis since 2007.

At the 19th EU-GCC Joint Cooperation Committee meeting on the 18th March 2009 in Brussels, the EU and GCC partners agreed on extending energy cooperation and more specifically on establishing an EU-GCC clean energy network. The European Commission initially seeded the network with funding for three years, which ended in 2013. In December 2015, the EU initiated the second phase of the EU-GCC Clean Energy Network, with funding covering the period 2016-2018.

4 Potential Areas for cooperation

An essential element of the EU-GCC Clean Energy Network project are the five (5) Working Groups (previously called Discussion Groups) that focus on areas of common interest for the stakeholders of the two regions (EU, GCC):

- Renewable Energy Sources
- Energy Demand Side Management and Energy Efficiency
- Clean Natural Gas and Related Technologies
- Electricity Interconnections and Market Integration
- Carbon Capture and Storage.

The expanded Network will also address climate change.

The CEN supports EU GCC cooperation in clean energy fields through:

- Networking and Partnership development, with a wide range of stakeholders, including policy-making bodies, research institutes and industry players.
- Organisation of experts’ events, thematic discussions, seminars, webinars, training sessions and high-level conferences.
- Operation of Working Groups to facilitate collaboration among EU and GCC experts.
- Dissemination of information on EU-GCC clean energy co-operation opportunities and policy frameworks:
  - Information on possibilities for cooperation and joint projects, including through Horizon 2020, the European Framework Programme for Research and Innovation.
- Detailed information and better understanding of EU and GCC policies and frameworks related to clean energy and climate change.
- Advanced Web-Area to facilitate discussion, dialogue and collaboration among EU and GCC stakeholders on technology, research and policy aspects of clean energy and climate change.
  - Promotion and facilitation of a number of joint demonstration and pilot projects, as well as research activities, being implemented with participation of EU and GCC entities in the area of clean energy and climate change.
  - Support for the publication of articles in scientific journals.
  - Coordination with other networks/instruments, such as platforms for international scientific cooperation established under Horizon 2020.
  - Closely liaising with initiatives in the region in related fields, e.g. waste, with a view to coordinating efforts and benefiting from synergies.

This section presents the highlights and the cooperation potential of the five thematic areas of cooperation of the current Network (as per the results/experience of the previous project and the analysis of the current state of clean energy in the GCC region). In addition, there is the thematic area of climate change, which is a cross cutting topic among the five thematic areas mentioned above.

### 4.1. Renewable Energy Sources

**In the EU**: As a net importer of hydrocarbons, renewables will build on their key role in helping the EU meet its energy needs beyond 2020. EU countries have agreed on a renewable energy target of at least 27% of final energy consumption in the EU as a whole by 2030\(^2\).\(^3\). However, as the current legislation is not sufficient for this purpose\(^4\), there is a need to modify the legislative framework to ensure a timely and cost effective achievement of the EU level binding target on renewables by 2030.

One of the aims of the European Commission’s 2020 Climate and Energy Package is to reach a 20% share of renewable energy generation in EU energy consumption by 2020 in a cost-effective and economically efficient manner. The Renewable Energy Directive adopted in 2009 sets binding targets for renewable energy. Individual Member States have targets set in EU legislation\(^5\) and some have set additional objectives nationally.

All EU countries have adopted national renewable energy action plans showing what actions they intend to take to meet their renewables targets. These plans include sectorial targets for electricity, heating and cooling, and transport; planned policy measures; the different mix of renewables technologies they expect to employ; and the planned use of cooperation mechanisms. The member states are free to select and implement mechanisms that are best suited to their national situation. Such mechanisms and instruments include investment grants, net-metering, feed-in tariffs, feed-in premiums, green certificates and auctions.

---

\(^2\) European Council, October 2014  
\(^3\) COM(2014) 15 final of 22 January 2014  
\(^4\) As highlighted in the baseline scenario of the 2030 climate and energy framework (COM(2014) 15 final)  
\(^5\) DIRECTIVE 2009/28/EC
Apart from this policy based know how, the EU also possesses a wide range of experiences on technologies including:

- Wind energy, including constructing and maintenance of on and off shore parks,
- Solar energy, including photovoltaic and concentrated solar power and
- geothermal energy sources.
- waste management energy

**In the GCC:** All countries now have clean energy project plans or targets in place and there are several conservation initiatives that include RES targets in almost all GCC countries. The main drivers are increasing demand for energy, the desire to diversify the energy mix and reduce the impact on the climate. In this context, new technologies including for RES are also seen as solutions to increase competitiveness, as well as create employment opportunities in the region. RE manufacturing could help transforming the GCC economies, while ensuring their future sustainability.

The Dubai Integrated Energy Strategy 2030 aims to have a 15% share of renewable energy capacity in Dubai’s energy mix by 2030. Abu Dhabi has published a capacity target of 7% renewable energy by 2020, which is equivalent to 1,500MW of solar energy, wind energy and waste to energy. Lastly, there is the contribution of nuclear power. Abu Dhabi’s Masdar built the 100 MW Shams I concentrated solar power plant near Madinet Zayed, in the Emirate’s Western Region, which was inaugurated in 2013.

Dubai Electricity and Water Authority (DEWA), has signed a Power Purchase Agreement (PPA) and a Shareholder Agreement for the second phase of the Mohammed bin Rashid Al Maktoum Solar Park with ACWA Power to construct a 200MW photovoltaic solar power plant, and a 800MW plant is underway. It is worth noting that the Mohammed bin Rashid Al Maktoum Solar Park is the largest single-site strategic renewable energy project of its kind in the world, based on the IPP model. The first phase of 13MW has been operational since 2013. The 200MW second phase of the Solar Park will be operational by 2017, and the 800MW third phase is planned to be operational by 2020. Recently opened bids for the levelised costs of electricity (LCOE) at just under 3 US cents/unit, the cheapest in the world to date.

GCC countries have established some type of policy support scheme to reach the established RES objectives (Table 1) and promote RES power generation. The KSA is discussing a proposed Feed in Tariff (FIT) for small-scale projects that would include a number of renewable technologies, as an important mechanism to meet the country’s new targets, while the Emirate of Dubai has introduced a net metering scheme for roof top PV. The UAE has so far adopted RES auctions in the region, followed by Kuwait, Saudi Arabia and Qatar, while Oman, which is planning to develop seven small scale solar and wind projects for rural areas, is considering auctions to attract developers for these projects.6

---

**Table 1: RES Policy Support Scheme in the GCC**

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulatory Policies</th>
<th>Fiscal Incentives</th>
<th>Public Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

The King Abdullah City for Atomic and Renewable Energy (KACARE) in the KSA, the governmental department so far responsible for the clean energy programme, published its vision for a long-term energy mix that relied on large contributions from solar and nuclear energy. By 2032, Saudi Arabia plans to add 41 GW of solar power, and 4 GW from other renewable sources (geothermal, waste and wind) to expand electricity supply which would make Saudi Arabia one of the world’s main producers of renewable electricity. In the same direction, K.A.CARE has published in 2013 a draft Renewable Energy Competitive Procurement paper (White Paper), which outlines the institutional structure for the promotion of RES in line with the national RES strategy. However, in 2014 Saudi Arabia delayed its target to complete this clean energy program by eight years. More recently as part of a wide-ranging economic and social policy vision for the Kingdom of Saudi Arabia, deputy crown prince Mohammed bin Salman, on April 25th, 2016 announced the first cornerstones for the deployment of renewable energy in the country.

The “Saudi Arabia Vision 2030” paper states an “initial” target of 9.5 gigawatts (GW) of renewable energy.

The program will be implemented under the umbrella of a new “King Salman Renewable Energy Initiative”. Legal and regulatory frameworks and the involvement of the private sector are expected to be set up to scale up the deployment of renewable energy. The paper also hints at encouraging distributed renewable energy deployment encouraged through “the gradual liberalization of the fuels market”. A first step into this direction has already been taken with the steep increase in electricity tariffs at the beginning of 2016.

Overall the renewable energy targets in the GCC countries are constantly increasing and there is hence a growing interest in local production of renewable energy components and systems. The European renewable energy industry could definitely support in such efforts.

---

While targets and national strategies constitute an important first step in national renewable energy planning, these elements need to be supported by an appropriate legal framework (such as a renewable energy law) in order to be effective. Without such framework, governments will find it difficult to translate their long-term visions into concrete, actionable plans.

Apart from missing or inadequate policies and regulations, other barriers hindering their wider deployment exist, such as a lack of detailed resource assessment, lack of awareness, lack of standards and inadequate technology adaptation. Not all GCC countries have carried out a multi-annual detailed assessment of the renewable energy resources on their territory, most notably solar and wind. Furthermore, the harsh climate (high temperatures and humidity, dust and sand storms) may necessitate long term outdoor testing of equipment such as solar panels. Not all GCC countries have quality control systems for renewable energy technologies, involving testing and standards and related institutions, in place. There is generally limited support for testing and R&D activities.

### SOLAR POTENTIAL ASSESSMENT

Solar radiation and wind potential are variable in time and space, dependent on multiple factors, and due to these reasons they are difficult to predict.

In order to obtain relatively reliable information about wind and solar parameters, many years of observations are needed at specific spots, with good renewable energy resources. The existing methods of measuring solar and wind potential are basically using meteorological stations measurements, geographical and satellites observations, airplane observations and probes.

The data is gathered and compiled to develop solar and wind maps, estimate the market potential and determine projects’ initial feasibility. Although these data have a certain level of reliability, they should be used tentatively and specific measurement campaigns in the project selected site should be undertaken to correlate the available data.

In the case of UAE, the Research Center for Renewable Energy Mapping and Assessment (ReCREMA) - Masdar Institute, in response to UAE’s renewable energy drive, has developed a solar mapping tool to meet the country’s prospecting and resource assessment needs.

The developed tool utilises a robust satellite-based model to map the solar potential across the country. Most of the existing models, developed elsewhere, typically overestimate solar irradiance in this region. The bias is primarily due to the models’ inability to adequately account for the attenuation and scattering of solar irradiance by predominantly airborne dust. The UAE solar mapping tool was specifically developed considering the local conditions and upon validation is revealed to be reasonably accurate for UAE climate and has the potential to be reliably used for similar arid environments.

The model produces direct normal irradiance (DNI), diffuse horizontal irradiance (DHI) and global horizontal irradiance (GHI) maps at a 3 km spatial resolution and in a near real-time manner, i.e., updated each 15 min. While DNI is used as a key input in all Concentrated Solar Power (CSP) applications, the latter two components are of immediate interest in PV simulations. Hourly, daily, monthly and yearly irradiation values for all three components can also be derived. One of the primary objectives of the solar atlas project is to bridge the gap between restricted number of existing ground measurement sites and regional demand for rapid solar technology deployment by providing reliable

---

8 M. Taoumi and all, Renewables Readiness Assessment, Sultanate of Oman, IRENA, 2014
and readily available solar irradiance data. The UAE Solar Atlas is accessible here: http://atlas.masdar.ac.ae

Furthermore, it is to be noted that technical knowledge in the region is limited and industrial chains are relatively weak and non-integrated.

A number of applications hold great promise for the cost-effective introduction of renewable energy. And due to the ever-growing population there are many opportunities in the cities and city areas for as district cooling (in combination with e.g. geothermal heat sources) and energy storage. Lastly, the combination of desalination and renewable energies could greatly reduce the CO₂ footprint of water in the GCC, most of which comes from thermal desalination facilities powered by fossil fuels.

Table 2: Potential areas of Cooperation in RES

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Cooperation Areas of common Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy Sources</td>
<td>• Policies and regulations: RES policy and institutional/regulatory environment for the greater deployment of RES.</td>
</tr>
<tr>
<td>RES can play an important role in addressing climate change, environmental, geopolitical and economic issues in the GCC region.</td>
<td>• Encourage the establishment of institutional, legislative and governance frameworks enabling environment for clean energy investments and implementing innovative and flexible funding mechanisms.</td>
</tr>
<tr>
<td>High potential for solar thermal and photovoltaic electricity generation in the GCC region.</td>
<td>• RE resource assessment (solar, wind and geothermal), zoning and planning.</td>
</tr>
<tr>
<td>Wind and Geothermal as underutilised RE sources</td>
<td>• Technology adaptation to GCC climate conditions (high moisture, dust, sand storms, high temperatures); Quality control infrastructure related to standards, testing and certification.</td>
</tr>
<tr>
<td></td>
<td>• Distributed PV systems (i.e. PV Rooftop systems); policies, regulations and best practices.</td>
</tr>
<tr>
<td></td>
<td>• Cooling applications; district cooling.</td>
</tr>
<tr>
<td></td>
<td>• Energy Storage (Thermal and Electrical).</td>
</tr>
<tr>
<td></td>
<td>• Expanding RES integration linked to water desalination including exploring possibilities for efficient decoupling energy and water by using new technologies e.g. Reverse Osmosis.</td>
</tr>
<tr>
<td></td>
<td>• The promotion of energy services companies using solar rooftop as an economic driver for lower energy costs.</td>
</tr>
<tr>
<td></td>
<td>• Assessment of local manufacturing potential of renewable energy components and systems.</td>
</tr>
<tr>
<td></td>
<td>• Capacity building and awareness raising particularly in the residential segment.</td>
</tr>
<tr>
<td></td>
<td>• Certification and quality control for RE equipments.</td>
</tr>
</tbody>
</table>

4.2. Energy Efficiency – Demand Side Management

In the EU: The EU has adopted a series of targets to cope with climate change and secure the supply of energy, quantified as the 20-20-20 target set, with 20% improvement of energy efficiency by 2020.
(EC 2008). Recently, the Directive on Energy Efficiency\(^9\) requires each member state to apply an energy efficiency obligation scheme (EEOs) or alternative policy measures that would deliver a certain amount of end-use energy savings over the 2014-2020 obligation period.

The Energy Efficiency Plan\(^10\), issued in 2011, proposes several directions for a transition towards a more efficient economy regarding the use of energy resources, covering targets, public sector measures, buildings, energy supply obligations, cogeneration and industry. The Plan also went into financing issues, promoting smart meters and smart grids, expanding the National Energy Efficiency Action Plans to cover the entire energy chain and not just energy demand.

The most recent policy document on energy efficiency was published in July 2014\(^11\). It was a Commission Communication on Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy\(^12\) calling for a 30% energy efficiency target by 2030. Energy efficiency policy is also guided by an indicative target for 20% energy savings by 2020 and many policy reports and directives related to energy efficiency.

Demand Side Management (DSM) in electricity markets could improve energy efficiency and achieve environmental targets through controlled consumption. DSM would enable consumers to optimize consumption, while giving network operators greater flexibility in the management of the system. European agencies and companies have already studied DSM for many years and have achieved great results, in particular through energy management, public and cooperative technology procurement, energy efficient buildings, energy efficient household appliances and other end-use equipment, smart energy metering, third party financing, guarantee of results and other innovative financing schemes.

In the GCC: Energy efficiency activities and policies are also gradually gaining traction in the region. The Dubai Integrated Energy Strategy 2030 (DIES) aims to reduce electricity demand by 30% compared to business as usual through the promotion of green buildings, building retrofiting, district cooling and other energy efficiency policies. Furthermore, as part of the Dubai Smart City program and DIES, Dubai’s DEWA is introducing policies and measures that include the following\(^13\):

- The Distributed Renewable Resources Programme, containing the regulatory framework related to licensing, finance and technical standards.
- The introduction of smart meters, enabling demand side management.
- The introduction and promotion of the ESCO model.

In 2010, Abu Dhabi’s Urban Planning Council (UPC) introduced the Estidama rating system, requiring communities, buildings and villas to comply with energy performance standards. Under the leadership of Abu Dhabi’s Executive Affairs Authority, a task force was set up to devise a Comprehensive Cooling Plan, tackling the energy consumption of Abu Dhabi’s 200,000 buildings. Dubai’s government has been working on a similar initiative as part of the DIES. Both Abu Dhabi and Dubai have recently introduced


\(^10\) COM(2011) 109 final

\(^11\) COM(2014) 520 final

\(^12\) COM(2014) 15 final

appliance standards covering AC units and light bulbs. Also, Dubai and Abu Dhabi have recently reduced energy subsidies, leading to higher prices for water and electricity, and similar announcements have been made in the KSA, Oman and Bahrain. The UAE also placing efforts on the appliance efficiency standards; the UAE introduced the region’s first efficiency standards for air-conditioning units, eliminating the lowest performing 20% of the units the market, and is introducing efficiency standards for refrigeration and other appliances.\(^{14}\)

Kuwait’s initiatives have been mainly focused on the building sector, with a code of practice for energy conservation in buildings being developed and adopted. Moreover, Kuwait was the first country in the GCC to implement energy-conservation measures in air-conditioned buildings.

Saudi Arabia has implemented measures to conserve energy and to reduce peak load demand, while the Saudi Arabian Standards Organization has adopted several standards aiming to limit the penetration of inefficient electrical appliances into the KSA market (although they have not been put into effect so far). In this context, the Saudi Energy Efficiency Center (SEEC) was established in 2010 and since then, SEEC has been responsible for the demand-side energy efficiency effort in the KSA, with the mission to improve domestic energy consumption efficiency, and coordinate all related activities between governmental and non-governmental stakeholders. In 2012, SEEC launched the Saudi Energy Efficiency Program (SEEP) with the objectives of improving the KSA’s energy efficiency by designing and implementing initiatives and their enablers.

Green buildings and sustainable development are also a priority for Qatar. The related initiatives realized in the country include the National Vision 2030 on sustainable development, as well as the establishment of the Qatar Green Building Council (QGBC).\(^ {15}\)

In Oman, the first DSM study was conducted by Japan International Cooperation Agency (JICA), which identified several strategies for potential load management and shifting load from peak time to off-peak time in the industrial and commercial sectors.\(^ {16}\)

Bahrain promotes energy efficiency activities and programs such as the Kingdom of Bahrain Energy Efficiency Programme (KEEP), which promotes energy efficiency by 2030 in the public, residential, commercial buildings and the industrial sector. Moreover, it has adopted the Motor Vehicles Standards and technical regulations to reduce energy consumption and emissions from gasoline and diesel engine vehicles, and it also supports the Energy Efficient Lighting Initiative.\(^ {17}\)

Given the growth of the population and corresponding expanding cities, there are ample opportunities for smart energy city approaches, combining energy efficiency, DSM and renewable energy technologies, all linked with modern information and communication technology. The fact that electricity markets are not yet fully liberalised, makes the introduction of such smart energy cities somewhat less complicated.

---

14 UNFCCC, UAE INDCs
17 UNFCCC, Bahrain INDCs.
Many industrial complexes, most notably in the oil and gas sector, have great potential for efficiency improvements, but could also serve as sources of waste heat, that could be used for local or district cooling.

The expansive experience with energy efficiency policies and measures in Europe offers lessons that can potentially be applied to the situation in the GCC cities\(^8\), \(^9\), \(^3\). The table below provides an overview (not exhaustive) of those options, and also suggests some sectoral and technology options that could be useful.

Table 3: Potential Cooperation Areas in Energy Efficiency and DSM

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Potential Cooperation Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>High potential for energy efficiency in both the built environment and the industrial sector.</td>
<td>• Building retrofitting and building codes.</td>
</tr>
<tr>
<td>The GCC regions are actively involved in the pilot/demonstration or large scale implementation of emerging technological opportunities, such as smart energy meters.</td>
<td>• Passive building design, reduction of cooling and heating requirement by appropriate initial design, thermal mass, orientation, passive cooling techniques etc.</td>
</tr>
<tr>
<td>Low energy prices that don’t give incentives for the consumers to save energy.</td>
<td>• Use of “cool” materials in buildings, Building Energy Management Systems (BEMS), efficient lighting options.</td>
</tr>
<tr>
<td>Political will to introduce changes in the energy market and practices.</td>
<td>• Industrial heat management, including upgrading waste heat;</td>
</tr>
<tr>
<td>Many options to increase industrial energy efficiency in the production and treatment of natural resources.</td>
<td>• District cooling and options for coolth storage.</td>
</tr>
<tr>
<td></td>
<td>• Advanced industrial processes to increase resource and energy efficiency.</td>
</tr>
<tr>
<td></td>
<td>• Upgrading industrial auxiliary streams.</td>
</tr>
<tr>
<td></td>
<td>• Labels and standards: AC highly efficient appliances, building envelop material, lighting.</td>
</tr>
<tr>
<td></td>
<td>• Market based mechanisms to promote energy efficiency.</td>
</tr>
<tr>
<td></td>
<td>• Promotion of best existing and best future practice and exchange of EU/GCC success stories.</td>
</tr>
<tr>
<td></td>
<td>• Smart grids, shifting peak cooling loads in metropolitan areas</td>
</tr>
<tr>
<td></td>
<td>• The promotion of energy services companies (ESCO’s) using advanced, viable and affordable processes /technologies to increase energy efficiency.</td>
</tr>
<tr>
<td></td>
<td>• Encourage the establishment of institutional, legislative and governance frameworks enabling environment for clean energy investments and implementing innovative and flexible funding mechanisms.</td>
</tr>
<tr>
<td></td>
<td>• The Introduction of regulations at domestic and commercial demand sides and small industries by introducing capped consumption, incentive tariffs and building insulation etc.</td>
</tr>
<tr>
<td></td>
<td>• Capacity building and awareness raising.</td>
</tr>
</tbody>
</table>

4.3. Clean Natural Gas and Related Technologies

---


\(^9\) Monitor Deloitte, 2015. “Smart cities...Not just the sum of its parts”.

In the EU: The EU has taken significant steps towards reaching its energy and climate objectives for 2020 and integrating the fragmented electricity and natural gas markets into a single energy market. The 2004 and 2010 Gas Security Directive aimed to improve security of supply in the natural gas sector.

Although reluctantly in many countries, Europe is studying the feasibility of exploring shale gas. In January 2014, the Commission issued a recommendation aimed at ensuring that those EU countries undertaking fracking implement proper safety and environmental safeguards to improve transparency for citizens, establish a clearer framework for investors and a level playing field regarding the industry's regulation.

Within the EU extensive experience is available at both natural gas sweetening and purification as well as the production of substitute natural gas. Especially the first topic may be of interest to the GCC countries. due to large volumes of sour gas in the region. A broad combination of knowledge on proven technologies is available that can be applied today for existing economically viable wells as well as on breakthrough technologies for future fields, which can currently not be operated in a profitable fashion. Examples of these breakthrough processes include membrane and solid sorbent based separation processes. Substitutes for natural gas are often based on biomass and on hydrogen that has been produced in a renewable way.

Europe has been leading the global development of concentrated solar power collectors, a technology that can be used to hybridize fossil fuel power plants. Gas is also considered as the main back-up fuel to renewables when the weather hampers the production of renewable energy.

In the GCC: The six countries are among the world leading oil and NG producing and exporting countries. Fundamental changes in the global gas market have created a significant global supply overhang and provide GCC countries with a unique opportunity to address their gas shortage in the short term. At the same time, the European experience in its pursuit of a single, transparent and competitive gas market may be of interest to the GCC countries, which can learn from it.

Natural gas related policy measures differ depending on the supply/demand situation of a particular country in the GCC region. Moreover, there is an opportunity for National Oil Companies, regulators, and utilities in the region to develop an integrated, GCC-wide approach.

The following table highlights key issues concerning natural gas in the GCC countries.

Table 4: GCC National Context for Collaboration

<table>
<thead>
<tr>
<th>Country</th>
<th>Key Issues</th>
</tr>
</thead>
</table>

---


22 Regulation (EU) No 994/2010

23 Regulation (EU) No 994/2010

Bahrain
- Newly formed Natural Oil and Gas Authority aiming to restructure the country’s offshore.
- Current growing demand for electric power forces Bahrain to become a net NG importer in the coming years.
- Difficulty for large scale investment projects due to fiscal constraints.

Kuwait
- A number of collaborative agreements with other countries from the region and internationally (e.g. with Esso, GE and Pertamina).

Oman
- The government is following an aggressive exploration campaign for NG leading to a recent significant increase in reserves.
- The government enlists foreign companies in new exploration and production projects, requiring the sophisticated technology and expertise of the private sector.

Qatar
- In the field of NG, the country follows an aggressive exploration tactic.
- Important cooperation agreements have already taken place with EU countries.
- Moratorium imposed on new gas development projects in the North Field (decision on lifting the moratorium would likely be made in 2016-17) constrains production capability.

Saudi Arabia
- The government is investing heavily in research to improve production in order to meet with soaring demands.
- Extended existing gas transmission system with planned additional large NG gas pipeline capacity to meet domestic demand.
- Pricing regime for Natural Gas, which are not cost-reflective.

UAE
- 95% of the fossil fuel reserves in the UAE are inside the emirate of Abu Dhabi.
- Most important domestic issues are mainly dealt with on an emirate level.
- Although ADNOC is committed to reducing the flaring of natural gas, more can be done.
- Full legal control over oil and natural gas reserves is with the local governments with apparent limited intervention by the federal government.
- The country is facing shortage problems which is mainly due to slow growth in gas infrastructure as compared to increase in demand for gas.
- Abu Dhabi has started the production of sour gas, requiring the removal of large amounts of sulphur with a net output around 500 mm Btus/day
- Any gas that is produced is prioritized for re-injection to maximize oil production associated gas production growth is limited by legislation such as the OPEC quotas on oil production.
- Due to the heavy subsidization of domestic energy prices within the region, upstream gas players have received around US$2-2.5/mmbtu currently insufficient to stimulate exploration and development of more challenging gas reserves, given the associated costs and rate of return on investment that investors would receive.

Source: Doukas et al., 2013\textsuperscript{25}, Fuel gauge report, 2016, Gulf Times, 2014,

Table 5: Potential areas of Cooperation in Clean Natural Gas

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Cooperation Areas of High Interest</th>
</tr>
</thead>
</table>

Clean Natural Gas and Related Technologies

Many aspects of clean natural gas technologies have been the subject of close cooperation between Gulf entities and specialized companies. The whole value chain is important, i.e. natural gas production, processing, transportation and end use.

- Norms and standards; Advanced processes to remove and treat contaminants from natural gas fields.
- In the transport sector: compressed natural gas (CNG), LNG, Gas-to-Liquids (GTL, as diesel and jet fuel), production of oxygenated fuel additives etc.
- In the power sector: ways to further improve the efficiency of gas turbines; Solar-Gas combined cycle and its related technologies.
- Potential development of unconventional natural gas in GCC countries, following similar development in some EU countries (Austria, Germany, Poland, etc.).
- Manage national and regional gas networks, based on the EU experience. Exchange of know-how and capacity building.
- Development of novel technologies that would enable the profitable operation of natural gas fields that are currently not within reach, because of too high energy utilisation costs because of the required purification process.

4.4. Carbon Capture, Storage and Usage

In the EU: The technology of Carbon Capture and geological Storage (CCS) has significant potential to help mitigate climate change both in Europe and internationally, particularly in countries with large reserves of fossil fuels and a fast increasing energy consumption. The European Commission’s proposal for a “2030 climate and energy policy framework” acknowledges the role of CCS in reaching the EU’s long-term emissions reduction goal. However, to ensure that CCS can be deployed in the 2030 timeframe, increased R&D efforts and commercial demonstration are essential over the next decade, while a supportive EU framework will be necessary through continued and strengthened use of auctioning revenues.

Research and innovation should support carbon and energy intensive industries to explore the feasibility of CCS, focusing primarily on sectors with high-purity sources of CO₂ to minimise capture costs. CCU options, such as transforming CO₂ into fuels, chemicals and material, could further improve the economic case for CCS²⁶.

The environmental integrity of CCS is the Commission’s overriding concern. Although the components of CCS are all known and deployed at commercial scale, integrated systems and the applications are new creating new challenges beyond the current state of the art. Different boundary conditions are also likely to result in different optimal operation conditions and in turn completely different preferred technological solution. A clear regulatory framework is required, and the EU’s Directive on the geological storage of CO₂ (so-called “CCS Directive”) provides this²⁷. It establishes a legal framework for the environmentally safe geological storage of CO₂ to contribute to the fight against climate change (ZEP, 2011).

²⁷ DIRECTIVE 2009/31/EC.
According to the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP Platform, created out of the EU’s recognition of CCS as a key component of any future sustainable energy system), without CCS, the cost of decarbonising European power is 20-50% higher by 2050.28

In addition, enhanced efforts by Member States, in the implementation of large-scale integrated chain CCS demonstration projects in both power and industrial sectors, are necessary to gain experience, bring down costs and demonstrate safe and reliable underground storage of CO₂. At the EU level, apart from the support planned under Horizon 2020, future CCS projects may be able to benefit from the proposed Innovation Fund to support highly innovative, low-carbon first-of-a-kind projects; and the Modernisation Fund, to support modernisation of energy systems in 10 lower-income Member States.

Despite major setbacks in especially the UK in setting up a large demonstration project purely for sequestration purposes, interest in CCS is on the increase again. Especially, the ROAD project29 (Rotterdam capture and Storage Demonstration) looks promising in this respect. Here CO₂ from a coal fired power plant is planned to be stored in a depleted gas reservoir under the North Sea.

In addition, major steps are being taken to maximise CO₂ utilization. In this vision, CO₂ is seen as a low cost carbon source, that can be used to produce fuels, chemicals and as to store electricity in the form of chemical energy. The presence of affordable renewably produced hydrogen is essential for these concepts. The Phoenix initiative is one of the more prominent examples in this field.

In the GCC: levels of public awareness and positivity towards key CCS processes such as pipeline transportation of high pressure CO₂ and CO₂ injection and storage, may be assumed to be more favourable than those in the European countries. This is mainly attributable to public confidence in the safety and robustness of existing similar practices in the oil and gas industry, such as high pressure natural gas transportation and gas injection.

Masdar and ADNOC are presently constructing a carbon capture, utilization and storage project using an off stream from the Emirates Steel Industries (ESI) iron making process from their plant in Musaffah, Abu Dhabi. The current Project is the first in a planned series of CCS projects in the emirate of Abu Dhabi, potentially involving the power sector. The captured and pressurized CO₂ is transported by pipeline to ADNOC reservoirs, approximately 45 km southwest of Abu Dhabi City30.

The use of CO₂ as a chemical feedstock is also studied with the GCC countries, such as at the Qatar University.

Recently KSA Aramco’s commissioned the first successful use of CO₂ to replace hydraulic fracturing to enhance oil recovery31. The project aims to enhance oil recovery beyond the more common method of water flooding, and is the largest of its kind in the Middle East.

In this pilot project, 40 million standard cubic feet per day of CO₂ will be captured at Hawiyah NGL plant and then piped 85 kilometres to the ‘Uthmaniyah field. At ‘Uthmaniyah, it will be injected — and

sequestered, or stored — into flooded oil reservoirs under high pressure to enhance oil recovery, making it a win-win solution.

The pilot project is the latest in the company’s list of efforts, injecting 800,000 tons of CO2 every year into flooded oil reservoirs. The project includes an elaborate monitoring and surveillance program that will collect data to evaluate its performance and build public confidence in the Kingdom’s — and the GCC’s — first CO2 sequestration project.

Table 6: Potential areas of Cooperation in Carbon Capture, Storage and Usage

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Cooperation Areas of High Interest</th>
</tr>
</thead>
</table>
| Carbon Capture, Storage and Usage | • Advanced CO2 capture technologies  
| | • Integrated approaches in natural gas treatment and hydrogen production facilities.  
| Lift from individual projects to knowledge or action networks | Other CO2 uses:  
| | - CO2 for Enhanced Gas and Oil Recovery;  
| Legislation may be an issue | - Mineral Carbonation;  
| | - Production of solar fuels and chemical energy storage;  
| | - Pilot permanent storage.  
| | • Participating in existing - as well as establishing new - pilot and test plants and laboratory scale test equipment.  
| | • Create networks and partnership for projects on either the application of advanced and integrated capture technologies or the identification of storage sites can be initiated in the context of an EU-GCC cooperation.  
| | • Step up research and innovation activities on the application of CCS and the commercial viability of carbon capture usage (CCU).  
| | • Legislation  

4.5. Electricity interconnections & market integration

In the EU: The European Council of October 2014 called for all Member States to achieve interconnection of at least 10% of their installed electricity production capacity by 2020. This means that each Member State should have in place electricity connections that allow at least 10% of the electricity that is produced by their power plants to be transported across its borders to its neighbouring countries. The necessary measures to achieve this 10% target are set out in the Commission Communication presented with the Energy Union Strategic Framework.

As underlined by the European Council, the interconnection target should mainly be reached through implementation of the Projects of Common Interest (PCI). The first list of PCIs was adopted in 2013; it consists of 248 projects, of which 137 are in electricity, including 52 electricity interconnections and

---

33 COM(2015) 80 final
one project with anticipatory investments enabling future interconnections, out of which 37 projects are involving Member States that currently have an interconnection level below 10%\textsuperscript{34}.

Interconnections between Member States and neighbouring countries are also foreseen through the EU RES Directive\textsuperscript{35}, since a prerequisite for the implementation of Joint projects between Member States and third countries is that the electricity should be exported to the EU.

### Increase the Resilience, Security and Smartness of the Energy System

The core objectives of the EU Energy Union Framework Strategy\textsuperscript{36} are to develop a long-term, secure, sustainable and competitive energy system in the EU.

With the next generation of smart energy-system solutions, the EU needs to develop and demonstrate innovative power electronics, flexible thermal generation, demand response and storage, as well as efficient heating and cooling technologies (such as heat pumps and combined heat and power) to use synergies between energy vectors, new transmission technologies, new techniques for physical and cyber security of networks, and demand analysis including exploitation of Big Data\textsuperscript{37}.

Connecting the different networks in an integrated energy system, will be particularly important for ensuring the stability and security of the electricity system, as well as the protection and privacy of consumer data. This requires the development of new methodologies for optimisation across networks and for protocols of data exchange, including testing and demonstration. This will require a collaborative effort between the Commission and Member States, as well as the energy, transport, and information and communication technology sectors and regulators.

**In the GCC:** Electricity remains to a large extent national business in the GCC. However in 2011, the GCC countries have moved a step closer towards linking their electricity sectors with the formal completion of a regional GCC grid interconnection system (GCCIA-Gulf Cooperation Council Interconnection Authority). With a total installed size of two times 1,200MW on average, the interconnector currently maintains a relatively small capacity, primarily as a result of the grid’s design reaching back to the 1990s when demand volumes differed significantly from today’s consumption patterns across the GCC. For current purposes the capacity appears to be sufficient, as the grid’s primary function to date is to act as an emergency backup system that allows flexible ad hoc transfers of electricity between GCC members at time of need\textsuperscript{38}. However, it is recommended to construct a 400 kV double circuit corridor to increase the sustainability of the import/export of electricity between GCC countries.


\textsuperscript{38} Laura El-Katiri, Interlinking the Arab Gulf: Opportunities and Challenges of GCC Electricity Market Cooperation, Oxford Institute for Energy Studies, July 2011
The GCC countries, while actively participating in the GCC Interconnection project, have been equally active on the national level; each GCC country has its own strategy when it comes to national interconnection, organisational model, private sector’s involvement and the pace of evolution.

GCCIA is progressing a feasibility study to assess the option of the interconnector expansion options within GCCIA and other countries outside the GCC, with the aim to enhance supply reliability and security in the GCC countries in sharing their generation spinning reserve, reduce maintenance cost and defer investment in new added generation capacities.

While the GCC region has strengths and attractive conditions to achieve a high rate of integration and a wide deployment of renewable energy, the adoption of a regional approach and strategy is essential to support and coordinate the efforts of the six countries in achieving their stated objectives. Indeed, the existing electricity interconnections between the GCC countries currently built for back-up support in spinning reserve and limited load transfer, could be used for larger trades between countries and expanded to link it to the other Arab countries and later on to the Mediterranean networks through the existing frameworks, e.g. MEDRING, MED REG and the European Network of Transmission System Operators for electricity (ENTSO-E). It should also promote economies of scale and reduced production costs.

In addition, as the national markets are being developed, a regional strategy is necessary to avoid imbalances between countries and distortion of energy markets. However, regional energy integration requires a clearly articulated common policy that promotes the harmonisation of policies, regulatory frameworks, norms/standards and procedures and the establishment of fair trading conditions, addressing both private and public interests and rallying more funds for investment.

A larger-scale application of the grid, by extending its capacity and creating a wholesale market similar to those of several European neighbourhood systems and Latin America, is technically possible, though currently not feasible given the absence of competitive markets for electricity and price controls in each of the GCC countries. There are also technical caveats to consider: The KSA operates on a different frequency than the rest of the GCC, requiring a separate back-to-back HVDC interconnector.

The physical infrastructure is not the only work progressing. The GCC Interconnection Authority (GCCIA) is gradually putting together the regulatory framework that will facilitate region-wide electricity trading. Key to this is the formation of an Advisory and Regulatory Committee consisting of two representatives from each member state. The GCCIA, through the Regulatory & Advisory Committee in which all States are represented, will act as the regulator and manage the flows of electricity through the network once two states negotiate a deal. Member states have to ensure they manage their networks so that trading can happen. The Regulatory Committee has convened for the first time in April 2014 and started working on a trading agreement framework. GCCIA has an ambitious plan within GCCIA to go for effective power trading between GCC member states.

The Regulatory Committee will have to regulate the use of the Interconnection and the behaviour of the players during steady state, commercial trading times and emergency situations. It must ensure the GCC Interconnection is available for all countries for immediate response and mutual support. Besides its regulatory role, this Committee has an advisory role on improvement of the ‘system’ and

---

strategic directions to be endorsed appropriately for further development. Pricing is an inevitable part of the set up and the GCCIA is also working, with the Member States, on a tariff study.

GCCIA would require more resources to perform the following tasks in cooperation with the GCC member states: Work with GCC countries to make sure they exert full determination in transferring RES plans into a time-stage projects. The long term benefits of such implementation will overlay the invested CAPEX considering the NPV over 25 years. The implementation shall consider high quality and efficient RES adapting to the GCC climatic conditions (heat, humidity, dust, storms)).

Table 7: Potential areas of cooperation in Electricity Interconnections and Market Integration

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Cooperation Areas of High Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Interconnections and Market Integration</td>
<td>• Regulation of electricity markets in the GCC - learning from the EU experience. How has the phased approach employed in the European Target Model worked in the EU? Electricity Market Aspects: How to introduce market mechanisms in the realities of the GCC on a national and regional level.</td>
</tr>
<tr>
<td></td>
<td>• The role of Transmission System Operators who confirm the transfer capacity available on each border and how such a model could be developed in the Middle East</td>
</tr>
<tr>
<td></td>
<td>• Work on intra-country connection, especially relevant in the UAE and Oman.</td>
</tr>
<tr>
<td></td>
<td>• Integrating RES into the grid:</td>
</tr>
<tr>
<td></td>
<td>- Grid Operation issues: due to variability/ non-dispatchability;</td>
</tr>
<tr>
<td></td>
<td>- Forecasting: Is becoming an important tool for improving operational integration of varying RES sources;</td>
</tr>
<tr>
<td></td>
<td>- The role of advantaged storage technologies;</td>
</tr>
<tr>
<td></td>
<td>- Grid connection issues: RES are often distributed and located away from load centres or grid infrastructure;</td>
</tr>
<tr>
<td></td>
<td>- Reinforce the interconnections among GCC countries and with neighbouring countries</td>
</tr>
<tr>
<td></td>
<td>• Interconnection expandability – High Voltage Interconnection (primarily for emergency support) vision for use and expansion Technical Aspects of RE integration:</td>
</tr>
<tr>
<td></td>
<td>- Promote interconnections GCC ➔ MEDRING ➔ ENTSO-E and MED Reg</td>
</tr>
<tr>
<td></td>
<td>- Pursue development of effective wholesale GCC power market.</td>
</tr>
<tr>
<td></td>
<td>- Energy only regional markets or with market coupling</td>
</tr>
<tr>
<td></td>
<td>- Quantifying the impact on CO2 emissions by the introduction of integrated markets.</td>
</tr>
<tr>
<td></td>
<td>• Capacity building</td>
</tr>
</tbody>
</table>

5 Current State of GCC- EU Policies on Climate Change

In the EU: The EU has long been committed to international efforts to tackle climate change. The European Commission has taken many climate-related initiatives since 1991, when it issued the first Community strategy to limit carbon dioxide (CO₂) emissions and improve energy efficiency. Agreed in
1997, the UNFCCC's Kyoto Protocol\textsuperscript{40} was a first step towards achieving more substantial global emission reductions. The goal of the European Climate Change Programme (ECCP)\textsuperscript{41}, launched in June 2000 by EC is to identify, develop and implement all the necessary elements of an EU strategy to implement the Kyoto Protocol avoiding dangerous climate change.

Towards this direction, European Commission published a green paper in 2007 (Adapting to climate change in Europe - options for EU action) and a white paper in 2009 (Adapting to climate change: Towards a European framework for action)\textsuperscript{42}. Consequently, the 20-20-20 target set for 2020 placed very ambitious goals for the reduction by 20% of EU’s GHG emissions and primary energy consumption, only to be surpassed by the agreement of the 2030 Framework for climate and energy for the period between 2020 and 2030. The 2030 goals include a 40% cut in EU’s greenhouse gas emissions compared to 1990 levels and at least a 27% share of renewable energy consumption and an additional 27% energy savings compared with the business-as-usual (BAU) scenario.

The goal for 2050\textsuperscript{43} stands for reducing greenhouse gas emissions to 80-95% below 1990 in the context of necessary reductions by developed countries as a group\textsuperscript{44}. The Commission analysed the implications of this in its “Roadmap for moving to a competitive low-carbon economy in 2050\textsuperscript{45}.

In the GCC: Although the region accounts for less than 2.4 percent of global greenhouse gas emissions\textsuperscript{46}, global climate change will have a severe negative environmental impact on the region, which in turn will have implications for the economic and other development gains achieved by the region.

Rising sea levels on the Red Sea, the Arabian Gulf, and the Indian Ocean and the associated risk of salinization of soil and coastal groundwater aquifers pose a growing threat; besides, countries like Bahrain, Qatar and the UAE may lose a large part of their populated coastal area to the sea should sea levels rise substantially.

In the coming decade, the GCC countries will face pressure to use their energy resources more efficiently, in order to supply their rapidly growing populations, free up resources for export, and address concerns about climate change and pollution. The countries of the region will seek to manage energy in new ways, focusing not just on the export of oil and gas, but on increasing the proportion of downstream value-added products and the utilization of renewable energy. The focus on high-value-added energy exports will also add to the opportunity cost of wasting energy through inefficient domestic uses. Although the GCC economies will remain energy-intensive because of the harsh climate, they have a broad scope for making energy use more efficient, whether by changing consumer behaviour, reforming subsidies, and/or by introducing new ideas in building and transport design. The region will also need to focus more intensively on conserving its scarce water supply, as growing populations and wasteful use of water increasingly strain supply. As with electricity, reforms of the tariff subsidy system present political obstacles. However, water shortages create opportunities to

\textsuperscript{40} COM (1999) 230
\textsuperscript{41} COM (2001) 580 final
\textsuperscript{42} COM (2009) 147 final
\textsuperscript{43} COM (2011) 885 final
\textsuperscript{44} European Council, October 2009
\textsuperscript{45} COM(2011) 112 of 8 March 2011
\textsuperscript{46} http://trendsinstitution.org/?p=1590
develop new water-producing technologies and industries, including new and more energy-efficient desalination technologies.

### INDCs: From Intentions to Implementation

Intended Nationally Determined Contributions (INDCs) are the key vehicle for governments to communicate internationally how they will cut emissions for the post-2020 period. They also help countries demonstrate leadership on addressing climate change. While climate change is a global challenge, each country faces unique circumstances, with a different emissions profile and emissions-reduction opportunities. INDCs allow contributions to be tailored to national priorities, capabilities and responsibilities. These individual measures can be the basis for collective action, and, if they are ambitious enough, set a path toward a low-carbon, climate-resilient future.

COP21 has concluded in an historic climate agreement. However, in order to implement the Agreement and reach its overall objective to limit global temperature increase to well below 2°C significant effort is needed at the international level and more so at country level.

In fact, the implementation of the INDC framework will require significant resources, public and private, domestic and international, to continue and scale up immediate mitigation action and to support the necessary long term decarbonisation.

Beyond the provision of financial resources, capacities will need to continue to be built at the country level to enable Parties to carry out the range of activities needed to reach the INDCs targets. Although, over the INDC preparation process it has been highlighted that many capacity and knowledge gaps exist. These relate in particular to the identification of technical options for increased mitigation effort, the understanding finance and investment needs as well as more generally to the need to build institutional capacities. International bilateral and multilateral cooperation can play a key role in supporting the different activities related to INDC review and implementation and the associated processes. Beyond direct country support, knowledge sharing activities, peer to peer learning as well as the facilitation of dialogues and constructive expert reviews can also be helpful. These can build on the existing EU GCC cooperation frameworks to mobilize all relevant stakeholders and ensure effective transfer of knowledge and experience.

Taking into account the similar nature of the GCC’s economies and climate and considering the fact that in the GCC the vast majority of CO₂ emissions are related to energy, it makes sense for the GCC countries to coordinate mitigation and adaptation efforts. Regional cooperation and exchange of knowledge and lessons learned are essential to enrich the discussion on the best policy and technology options that will maximize clean energy deployment and climate change mitigation and adaptation.

<table>
<thead>
<tr>
<th>Status Highlights</th>
<th>Cooperation Areas of High Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate Change</strong></td>
<td></td>
</tr>
<tr>
<td>New area of cooperation – activities of the network are expected to be</td>
<td>• Building capacity – in order to achieve climate objectives and ensuring that climate actions are entirely compatible with national energy policies’ objectives.</td>
</tr>
</tbody>
</table>

---


---

*Background Paper on Areas of Potential EU GCC Clean Energy Cooperation*
enhanced to this specific area of interest.

| • Knowledge sharing on technological needs assessments and priorities related to INDCs’ implementation and coordination among local and regional stakeholders |
| • Measures and practices to tackle increased CO\textsubscript{2} emissions through RES, EE and CCS/U. |
Bibliography


13. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Roadmap for moving to a competitive low carbon economy in 2050, COM(2011) 112 final, 8 March 2011. Retrieved from


ANNEX: EU Strategic Energy Technology (SET) Plan

In the autumn of 2015 the European Commission has communicated an updated and targeted version of the Strategic Energy Technology (SET) Plan. Ten actions, listed beneath, have been designed to accelerate the energy system transformation and to create jobs and stimulate growth. The EU-GCC Clean Energy Network underlines these actions as starting points.

- Core priority 1: Number 1 in renewable energy:
  - Action 1: Sustain technological leadership by developing highly performant renewable technologies and their integration in the EU’s energy system;
  - Action 2: Reduce the cost of key technologies.

- Core priority 2: The future smart EU energy system, with the consumer at the centre:
  - Action 3: Create technologies and services for smart homes that provide smart solutions to energy consumers;
  - Action 4: Increase the resilience, security and smartness of the energy system.

- Core priority 3: Develop and strengthen energy-efficient systems:
  - Action 5: Develop new materials and technologies for, and the market uptake of energy efficiency solutions for buildings;
  - Action 6: Continue efforts to make EU industry less energy intensive and more competitive.

- Core priority 4: Diversify and strengthen energy options for sustainable transport:
  - Action 7: Become competitive in the global battery sector to drive e-mobility forward;
  - Action 8: Strengthen market take-up of renewable fuels needed for sustainable transport solutions.

- Additional priority 1: Driving ambition in carbon capture storage and use deployment:
  - Action 9: Step up research and innovation activities on the application of carbon capture and storage (CCS) and the commercial viability of carbon capture and use (CCU).

- Additional priority 2: Increase safety in the use of nuclear energy:
  - Action 10: Maintaining a high level of safety of nuclear reactors and associated fuel cycles during operation and decommissioning, while improving their efficiency.