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An assessment of the sustainable energy investments in the framework of the EU–GCC cooperation

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Abstract

The cooperation between the European Union (EU) and the Gulf Cooperation Council (GCC) should be broadened, deepened and become more interactive due to GCC states' accession to the Kyoto protocol in 2005. Nowadays, the GCC states start putting climate change and its business opportunities on the top of their priorities' list towards the accomplishment of the sustainable development goals. However, the level of development of sustainable energy investments (renewable energy, CO_2 sequestration and rational use of energy) is low until now in the GCC. For the above reason, the assessment of appropriate investments needs to be taken into account both by the governments in order to design the appropriate framework for supporting them and the project investors to identify the commercially profitable ones. In this framework, the aim of this paper is the identification and assessment of sustainable energy investments in the framework of the EU–GCC co-operation.

Keywords: GCC; Sustainable energy investments; EU–GCC cooperation

1. Introduction

The Gulf Cooperation Council (GCC) is a regional organisation created in May 1981 by Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates [1]. The European Union (EU) has been linked with the six countries of the GCC in a non-

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preferential agreement till June 1988 [2]. The objective of this agreement was to facilitate trade relations, as well as more generally to contribute to strengthening stability in a strategic part of the world. Working groups were established in the fields of energy and environment. However, real progress towards a broader and more fruitful EU–GCC cooperation remains limited and the trade liberalization talks turned out to be a difficult undertaking in the above fields. According the international bibliography [3–6], the following factors acted as major constraints:

- The GCC states were not able to unify their widely differing tariff structures and thus fulfill the conditions that the European Community had set for engaging in free-trade negotiations.
- On the part of the EU, the main constraints that have to encounter, are the resistance of the strong petrochemical GCC lobby as well as the diminished interest of the GCC states till now regarding the EU environmental policies for CO_2 emission reductions.

Nowadays, oil markets and energy security need to be in the headlines. As a result, the cooperation between the EU and GCC should be broadened, deepened and become more interactive. Therefore, this producer–consumer cooperation should be purposefully based on greater mutual understanding and awareness of long-term common interests.

In the above context, the renewal EU–GCC partnership can be a matter of high priority as new opportunities occur. Specifically, the government, the financial organizations, the academics, the general public and the private sector of the GCC states start realizing the inevitability of putting climate change issues on the top of the priorities' list in the process of sustainable development. In this context, these states accessed (except of Bahrain) to the Kyoto Protocol in 2005 [7]. As a result, the possible use of the Kyoto flexible mechanisms could open up new avenues for the EU–GCC cooperation, taking into consideration the characteristics of the GCC member states and the status of EU commitments with respect to the Kyoto Protocol.

In particular, the emissions trading (ET) refers to the ability of countries to exchange part of their emission commitments and to redistribute in effect the division of allowed emissions between them [8]. This market-based instrument will allow countries to purchase the rights to emit greenhouse gases from other countries, which have reduced their GHG emissions below their assigned amounts. Intergovernmental emission trading or inter-source trading, where assigned amounts are allocated to sub-national entities, can also be possible.

In addition, through joint technology programmes, financial assistance and private investments, the EU can promote the development of renewable energy sources (RES) as well as CO_2 sequestration (CS) and support the improvement of the region's rational use of energy (RUE) in the GCC states. International organisations, governments and numerous of non-governmental organisations could facilitate the implementation of clean development mechanisms (CDM) investments in these countries [9]. Technology transfer will also contribute to strengthening security of supply by improving access to resources and by contributing to the diversity of fuel availability towards a sustainable energy system [10–11].

Furthermore, the price fluctuations, the rapid population growth and the increasing energy demand contribute to the increased necessity of the above sustainable energy investments, as the region cannot depend on conventional fuels forever.

Until now, the six member states of the GCC have not been really interested in the energy investment related to the RES, CS and RUE. The above fact is based on their huge conventional fuel resources, the lack of appropriate funds, the high risk as well as the lack of environmental awareness regarding the performance of these investments, as they were described by Patlitzianas et al. [12].

Indeed, these investments can save energy, improve air quality, provide social benefits and achieve the energy policy goals towards the sustainable development in the region. For the above reason, appropriate policy support is needed for the diffusion of these investments. The assessment of appropriate investments needs to be taken into account on behalf of the governments in order to design the appropriate framework for supporting the most promising ones. Furthermore, there is a need for participatory activities that allow these States to recognize different rationales for their intervention, taking also into account the specified characteristics of the gulf.

Kagiannas et al. [13] presented a marketing strategy for the enhancing EU–GCC oil and gas technology cooperation. In addition, Patlitzianas et al. [14] developed an overall review of bridging GCC needs in downstream oil and gas sector with EU technologies. To the best of our knowledge, an accomplished study that can help the GCC countries in identifying and assessing sustainable energy investments, under the umbrella of the EU–GCC cooperation, is not present in the literature until now. In the above framework, the aim of this paper is the identification and assessment of appropriate energy investments, towards the sustainable energy goals of the region.

The current analysis is largely based on the framework of the European Commission's programme "Synergy" that was implemented in the period 2003–2005. One of the projects under the umbrella of this programme aimed at the promotion of the cleaner fuels' use, notably natural gas and the development of RES, RUE and CS investments in the framework of the Kyoto Protocol in the GCC member states, in order to limit greenhouse gas emissions. Most of the information presented in this paper has been derived from the activities carried out within this project and the final deliverable produced [15]. In this project's context, a collective procedure was followed with the participation of the key relevant experts in these states for the implementation of short pre-feasibility studies for each investment.

In this framework, the remainder of this paper is organised as follows. Firstly, Section 2 presents the initial identification of appropriate sustainable investments in the GCC member states. Section 3 presents the assessment of sustainable investments, using an appropriately modified pre-feasibility study's approach and Section 4 discuses the results of the procedure and summarizes the main points drawn up from this paper.

2. Initial identification of the appropriate investments

2.1. Overview

The quantities of proved reserves of crude oil and natural gas were estimated in 2004 at around 478 billion barrels of crude oil and 41.920 billion cubic metres of natural gas, representing about 42% and 24% of the world's total reserves, respectively [16,17]. In addition, the greenhouse gas emissions have increased by more than approximately 50% in the last decade [18]. Till now, only pilot, research and some small-scale energy investment related to the sustainable development were conducted in the six member states of the GCC and as a result, some small and medium capacity projects were installed and tested.

Based on an analytical literature review, fifteen (15) RES, CS and RUE investment ideas were selected in total as they were described by Doukas et al. [19]. The selected investment ideas mainly aim to reduce green house gas emissions, the dependency on fossil fuels for energy production and the energy cost in the final demand sector (e.g., solar water heaters, solar cooling systems). In addition to this, GCC governments are fully aware that they cannot depend on oil and gas for their income forever, especially in the prevailing situation of price fluctuations, the rapid population and the increasing demand for electricity throughout the region and alternative energy systems have to be proposed for these country to maintain their share in the world energy market. In this context, the selection of the investment ideas also incorporated the regions capacity to export energy in a future "beyond oil" time frame, taking into consideration the recent study funded by the German Ministry for Environment, Natural Conservation and Nuclear Safety [20].

In particular, as concerns the renewable energy, the solar applications are regarded as the most appropriate, due to the regions' significant solar potential. In this context, the examined RES investment ideas that were investigated are the following:

- Solar power for electricity generation for desert communities throughout the region, aiming to reduce the need for conventional peak saving power plants.
- Solar power for thermal production, which can be applied as renewable backup capacity for fluctuating inputs as well as for providing regional freshwater from combined thermal desalination of sea water.
- Solar hydrogen energy for electricity generation for the exploitation of the increased hydrogen flexibility in order to meet the future energy needs of the electricity generation.
- Wind farm for electricity generation via small to medium-size wind energy turbine systems, which is proved to be both efficient and competitive in some remote locations.
- Fuel cells for electricity generation in remote areas for the promotion and use of fuel cells and the reduction of the energy cost in the electricity sector.
- Promotion of the utilization of biomass for electricity production in GCC, enhancing in long term the capability of GCC to manage and convert the municipal wastes to energy in a sustainable manner.
- Development of a geographical information system (GIS) for the identification of the technical and economical exploitable RES potential in each GCC state and especially the high-potential areas for RES applications.

In addition, the CO_2 sequestration technologies are drawing increasing interest from around the world, since they can be applied to each of the fossil energy industries. Taking into account the vast oil reserves and production capacity, the GCC region's potential for the application of these technologies is huge. Therefore, two CO_2 sequestration investments were selected, the following:

- Enhanced oil recovery (EOR) for the oil industry in order to substantially reduce emissions, and, in the case of EOR, to increase the recovery from oil fields.
- Reduce gas flaring, to maintain the pressure in the hydrocarbon reservoirs through the re-injection of the gas, thus enhancing their life, while eliminating the emissions not just on a local but on a global level.

Moreover, energy management and conservation and therefore promotion of energy efficiency will be a prerequisite for meeting the future energy demands. Accordingly, the

proposed RUE investment ideas that were examined are the following:

- Solar power for global system for mobile (GSM) Communications telecom towers in remote areas and therefore reduction of the energy cost in the tertiary sector using stand alone solar power systems.
- Energy efficiency in the lighting of roads, aiming at the development of RUE for the reduction of the energy cost in the tertiary sector, using solar energy systems for lighting.
- Solar power for small cash crop (vegetable/fruits, etc.) including integrated drip irrigation systems, which could help overcome water shortages and make small plots economically viable.
- Solar water heaters for domestic water heating purposes and therefore reduction of the energy cost in the final demand sectors.
- Solar cooling systems for the reduction of the annual electricity production and the implementation of energy conservation measures in air-conditioned buildings.
- Desalination with solar and wind power for the production of potable water from a solar desalination plant and wind for groundwater pumping.
- Know-how transfer for RUE for the promotion of mutually beneficial technological co-operation between organizations and professionals for innovative efficient technologies and transfer of the appropriate know-how in energy management and in particular energy auditing procedures in the GCC.

2.2. The emerging investments

Following the literature review's results, the development of a questionnaire was elaborated, which incorporated multiple choice and data gathering questions. In particular, the questionnaire was divided in five parts, where multiple choice questions were included in the first four parts, with their values being qualitative and representing the existence or not (yes (Y)/not (N) and existing (E)/lacking (L)) of the specific characteristics that were related to the examined energy investments, while tables to be completed were incorporated in the last part for the data collection procedure. Some indicative questions in each one of the above parts are presented as follows:

Part A—general energy policy information. Is there a concrete energy policy document of the state? (Y/N); Is this policy reflected in respective strategies (overall or per sub-sector)? (Y/N); Are there implementation plans for these strategies? (Y/N), etc.

Part B—strategy for sustainable energy investments. Subsidies for oil and gas fuels (Y/N); Renewables transaction costs (High–Normal–Low); Existence of renewable legal framework/agreements (E/L), etc.

Part C—environmental policy information. Was the Kyoto ratified? (Y/N); Is there a Designated National Authority—DNA (Y/N); Are there any policies regarding the CO_2? (E/L), etc.

Part D—energy cooperation with other countries. Existence of bilateral agreements with the EC (E/L); Existence of bilateral agreements with other countries (E/L), etc.

Part E—identification of sustainable energy investments. Category of investment, cost, revenues, financing sources, etc.

The developed questionnaire was dispatched, during the first Synergy project's workshop (April 2004 in Saudi Arabia), to the relevant experts from:

Governmental Organizations. Ministry of "Petroleum and Mineral Resources" and Ministry of "Communication" in Saudi Arabia, Ministry of "Electricity" in UAE, Ministry of "Energy" and Ministry of "Finance" in Kuwait, Ministry of "Water Resources (MWR)" in Oman, Ministry of "Energy" in Qatar.

Universities. King Fahd University of Petroleum and Minerals, University of Bahrain, Sultan Qaboos University of Oman.

Significant Institutes and Research Centers. King Abdulaziz City for Science and Technology (KACST) of Saudi Arabia, Kuwait Institute for Scientific Research (KISR), Middle East Desalination Research Center (MEDRC).

Companies. BP Solar Arabia Ltd, Qatar Petroleum, Kuwait Petroleum Corporation (KPC), Saudi Aramco, Ecoenergy, Gas and Upstream Nexant Ltd.

International organizations. International Energy Agency (IEA), Organization of the Petroleum Exporting Countries (OPEC).

Afterwards, the completed questionnaires were collected and evaluated, resulting in investments, which are more likely to contribute to the sustainable development of the energy sector in the region of Gulf. The outputs of the questionnaires as well as the priorities and views of the regional operators have been presented, discussed and finalized during the second project's workshop (November 2004 in Florence, Italy). As a result, six (6) sustainable energy investments were selected in total as follows:

I.1 Solar power for GSM telecom towers.
I.2 Enhanced oil recovery (EOR).
I.3 Energy efficiency in the lighting of roads.
I.4 Know-how transfer for RUE.
I.5 Solar cooling systems.
I.6 Solar water heaters.

The above investment ideas can be described as promising, since they employ environmentally sound technologies and their implementation is commercially feasible with a view from the medium to longer term, in the context of the EU–GCC co-operation.

3. The assessment of sustainable investments

3.1. The adopted short pre-feasibility studies' approach

The main purpose of this short pre-feasibility study is to assist project investors and other potentially interested project participants to identify commercially profitable investments, which are also promoting the sustainable development goals of the GCC countries. The short pre-feasibility study is based on the general structure as it is described in the international literature [21–25] and contains two main parts, as illustrated in Fig. 1:

In particular, the short pre-feasibility study contains:

A. Background information regarding the GCC region context influencing the project activity (policy and legislation, technological and market current status and potential). Furthermore, the same factors are also investigated for the EU, since the technological know-how as well as the financial support will be derived from EU investors.

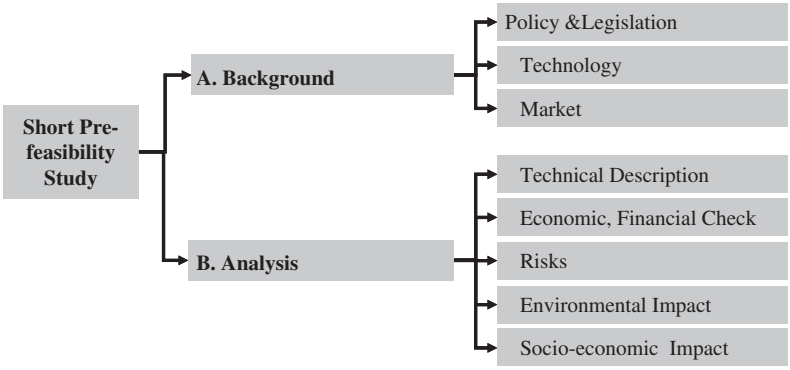

Fig. 1. The structure of the short pre-feasibility study.

B. Information regarding the investment analysis, such as:
- A description of the project objectives and a technical description.
- An estimation of the economic and financial data of the project and the elaboration of a short economic and financial check of the investment.
- The identification of the most important risks associated with the project idea, according to the severity of their impacts.
- A brief environmental impact analysis, without conducting an in-depth analysis, in order to check whether the investment has significantly harmful environmental impacts.
- The investment contribution to the socio-economic dimension of sustainable development, laying special emphasis on the regional communities' development and improvement of local people quality of life.

3.2. The results

Based on the above structure, the main outputs of the six short pre-feasibility studies (as they were presented in the final project conference in Kuwait, April 2005) are briefly presented as follows.

3.2.1. Solar power for GSM telecom towers
3.2.1.1. Background

- *Policy and legislation*: Many incentives exist in the EU for the PV promotion (e.g. Investment subsidies and Grants, feed-in and green tariffs), especially as concerns Telecom Towers' applications. On the other hand, legislative barriers are responsible for limited development of these technologies in the GCC region. Moreover, cost and pricing barriers are responsible for the greater competitiveness of conventional oil and gas technologies.
- *Technology*: Highly developed solar telecommunication systems exist in the EU, already considered as fully commercialized and vigorously pursued by many companies within the PV industry. Solar telecommunication investments have been developed in the GCC

for some specific applications, constituting of telecommunication sites, cathodic protection systems, GSM base stations and pay phones [26,27].
- *Market*: EU is one of the world's largest manufacturers of PVs for telecommunications. Moreover, universities, institutes and multinational companies in the GCC region are focused on PVs development and their potential applications.

3.2.1.2. Analysis

- *Objective*: This investment demonstrates the concept of a mobile, highly reliable and isolated PV system for GSM Telecom Towers in remote areas without grid connection.
- *Technical description*: Solar power systems for telecommunications typically supply power to continuous loads ranging from 1 W single terminal to multi-kW repeater stations located in places with no access to the electricity grid. These solar photo-voltaic panels are self draining and cleaning and have maximum reliability [28]. Such systems are extremely useful for remote locations where usage of conventional power (oil and gas) is difficult, since alternative options, such as batteries or diesel generators are expensive (maintenance, fuel supply) [29].
- *Economic and financial check*: Using typical borrowing costs and equipment life, the life-cycle cost of PV-generated energy generally ranges from 0.2 to 1.0 €/kWh. Moreover, for power system mentioned above, materials and installation cost approximately 150.000 €. These systems are attractive investments, with a short payback period, which can be reduced using financing mechanisms such as grants, TPF and leasing.
- *Risks*: There are some risks, which could affect the execution of the investment. However, most of them can be controlled during the implementation phase. The most important is the technical risk concerning the dust effect.
- *Environmental impact*: These systems are generally considered of benign environmental impact.
- *Socio-economic impact*: This investment can improve communication accessibility in all rural communities and strengthen the market for PV technologies.

3.2.2. Enhanced oil recovery

3.2.2.1. Background

- *Policy and legislation*: In the EU there is a regulatory framework to support carbon capture and storage (CCS) investment development. On the contrary, in the GCC region the correlated legislation and the awareness regarding climate change is limited.
- *Technology*: The R&D of the sequestration technologies in the EU has been a matter of high priority and a number of programmes and on-going investments exist, ensuring that the EU remains at the forefront of the international community's efforts to combat climate change [30,31]. On the contrary to the GCC countries' huge potential for the application of CCS technologies, the applied investments are very limited.
- *Market*: In Europe, a significant number of oil and gas power companies and suppliers and manufacturers exist, which have the knowledge on CS technologies. On the other hand, the GCC market for these technologies is still niche, since only a small number of project developers exist as regards CCS in the gulf region.

3.2.2.2. Analysis

- *Objective*: The specific investment aims to demonstrate the opportunities emerging for the oil industry to participate in activities that will substantially reduce emissions, and, in the case of EOR, increase the recovery from oil fields.
- *Technical description*: Technology to re-inject carbon dioxide into oil fields to enhance recovery is already deployed in more than 70 sites around the world. The injection of CO_2 into depleted oil reservoirs, in the context of EOR, improves recovery rates in oil and gas production [32].
- *Economic and financial check*: CCS costs can be considered in terms of four components: separation, compression, transport, and injection. These costs depend on many factors, including the source of the CO_2, transportation distance and the type and characteristics of the storage reservoir. For instance, for a typical base case, the cost is 9.39 €/l CO_2.
- Even though the current investment technology is proven, it is not fully commercialized yet. Mostly, demonstration and R&D investments have been developed and consequently, the proposed financial schemes cannot be very specific since the experience from real life investments is extremely limited.
- *Risks*: The most important is the technical risk, mainly depending on the natural settings, the integrity of the reservoirs, the quality of well and sealing package and the possibility of unforeseeable events.
- *Environmental impact*: CO_2-EOR technology may be one of the most important technology issues on reduction of CO_2 from fossil fuel usage in the future. However, there are some uncertainties, mainly due to the slow or sudden release of CO_2 to the atmosphere.
- *Socio-economic impact*: The current investment can provide affordable, clean energy to meet expanding energy demand and ease the economic costs of sustainable development.

3.2.3. Energy efficiency in the lighting of roads

3.2.3.1. Background

- *Policy and legislation*: EU has adopted energy efficiency legislation and directives, giving special attention to the lighting products. On the other hand, cost and pricing constraints due to the governmental subsidies for electricity generation are the main reasons explaining the relatively limited development of these investments in the GCC region.
- *Technology*: The use of PV lighting investments for streets and roads in the EU has been extended in the previous years and extensive off-grid applications exist in the streets and roads. In addition, stand alone lighting systems, solar powered pay phones and aviation obstruction warning lights have been specially adapted to the GCC region conditions [33,34].
- *Market*: The size of the EU's technological infrastructure is gigantic, thus it has a huge market for such systems. Furthermore, a few, mostly multinational, companies from the GCC region have developed a number of aviation warning or obstruction lights.

3.2.3.2. Analysis

- *Objective*: This investment will demonstrate the usability of reliable, self-contained solar power systems, used for street lighting in the GCC region.
- *Technical description*: These systems are independent of the grid thanks to the solar module and safety officials and can now be sure of autonomous and reliable operation without sacrificing safety [35].
- *Economic and financial check:* Such projects cost approximately 3.4 million € and their maintenance costs 1 million €. In case of a back-up diesel systems used, it costs approximately 2.2 million €. An indicative solar powered street lighting investment is an attractive investment with a short payback period. Such investments reduce the life-cycle costs of lighting systems.
- *Risks*: There are some risks, which could affect the execution of the investment, such as the risk of falling rocks or wild animals damaging PV systems.
- *Environmental impact:* These investments can play an important role in mitigating environmental problems.
- *Socio-economic impact*: The investment has a powerful social benefit, since road safety is a major issue throughout the GCC region.

3.2.4. Know-how transfer for RUE

3.2.4.1. Background

- *Policy and legislation*: In EU there are important networks of experts and supportive programmes for non-technical actions in the field of energy efficiency, especially for transferring know-how and exchanging experiences. However, in the GCC region there are no energy conservation programs for the promotion of such actions.
- *Technology*: A huge number of programmes exist in the EU to promote RUE actions. In the GCC region, a few technical studies have been conducted for energy efficient technologies, which have helped local energy actors to gain experience in the fields of instrumentation, calibration, data collection and monitoring and analysis [36–38].
- *Market*: Great emphasis has been given in EU regarding the building of scientific and political consensus. In this framework, EC has set up a number of communication channels on different policy-making and policy-drafting levels, such as websites, publications and workshops. On the other hand, significant market barriers still exist in the GCC region, such as the lack of database on such investments, inadequate demonstration experiences and insufficient training in the energy efficiency-related field.

3.2.4.2. Analysis

- *Objective*: The project aims to transfer appropriate know-how in energy management and in particular energy auditing procedures in the GCC. In addition, it promotes

mutually beneficial technological co-operation between organizations and professionals for innovative efficient technologies, addressed to the residential, tertiary and industrial sectors.

- *Technical description*: The main activities for the promotion of RUE in the context of the investment comprise newsletters and publications, training programmes—seminars, workshops, use of standards and labels, energy site educating on basic energy efficiency measures and informative material to a wide society range [39].
- *Economic and financial check*: The specific budget for an action plan raising public awareness regarding RUE, which consists of workshops, web sites and newsletters is affordable. In addition, grants can be provided from EC and international financing programmes (e.g. GEF), as well as governmental funds.
- *Risks*: Investment risks that can bring out some threats to the achievement of the investment's objectives are political, legislative, financial and technical. However, most of them can be controlled during the implementation phase.
- *Environmental impact*: Given the nature of the investment, there are no negative environmental impacts. On the other hand, the reduction of the consumed electricity amounts causes the reduction of GHG emissions and acid rain, thus improving the residents' living standards.
- *Socio-economic impact:* The current investment aims to stimulate the interest of decision makers and industry leaders for the adaptation of energy efficient technologies.

3.2.5. Solar cooling systems

3.2.5.1. Background

- *Policy and legislation*: The main EU drivers to reduce the level of energy consumed within buildings and to accelerate the growth of the market for solar-cooling systems are the recent directives on the buildings' energy performance and on the useful heat and electricity co-generation. In the GCC region, pricing and legislative constraints have blocked the wide spread implementation of solar cooling technologies.
- *Technology*: A significant number of solar-cooling investments were held in EU. In addition, solar heating and cooling technological development has been supported by multinational EU programmes. Research or pilot investments have been developed in the GCC countries, especially in Kuwait [40,41].
- *Market*: Many solar cooling companies exist in Europe. In addition, in some EU countries, solar cooling systems are supported by the government through subsidy programs, demonstrational investments and information campaigns (e.g., Germany). On the other hand, even though the GCC region offers massive market potential for such applications, not many manufacturers of solar cooling systems exist.

3.2.5.2. Analysis

- *Objective*: This investment aims to reduce the yearly electricity production and the implementation of energy conservation measures in air-conditioned buildings. Solar

space cooling is important in these countries, where nearly half of the total produced electricity is used for air conditioning.

- *Technical description*: Solar cooling is considered very interesting since the peak demand for power runs almost parallel with peak solar radiation. In this context, solar cooling based on the use of vapour absorption chillers fired by hot-water at less than 100 °C using flat plate collectors is an attractive proposition, which can achieve electrical energy savings of up to 40% [42,43]. In addition, these technologies are a very good solution for commercial applications, such as supermarkets, theatres and cinemas. The annual emission reductions are estimated to be approximately 450 tn CO_2.
- *Economic and financial check:* Taking into consideration the high initial capital cost (2 million €), this investment has a long payback period. However, a number of financing mechanisms have been designed to facilitate financing of such investments, such as grants, TPF and leasing.
- *Risks*: The most important risk is related to the very high initial capital cost of these systems, compared to conventional systems.
- *Environmental impact*: The current investment is generally considered of benign environmental impact, generating no noise or chemical pollutants during use.
- *Socio-economic impact:* The most important social benefits concern the improvement of the life quality through the delivery of modern social services. On the economical aspect, this investment will be helpful for the strengthening of the solar cooling market and the dispersion of the energy sources.

3.2.6. Solar water heaters

3.2.6.1. Background

- *Policy and legislation*: EC has released directives to promote SWHs. In addition, there exist initiatives to promote and enhance solar market at the European as well as the national and regional level.
  In the GCC region, various regulatory and awareness issues pose a barrier towards the wide scale adoption of this technology.
- *Technology*: The EU gives great emphasis to SWHs technology, since solar heating can make a significant contribution to meeting the EU's Kyoto targets for CO_2-emission reductions. EU companies have developed a range of high quality products and a significant level of expertise. In the GCC region, mostly the ERI of the KACST has completed technical studies on these systems and introduced individual SWHs [44,45].
- *Market*: In EU, the solar industry still consists of many small and medium enterprises, whereas in GCC only few SWHs local manufacturers exist.

3.2.6.2. Analysis

- *Objective*: The specific investment aims to develop the solar energy and to reduce the energy cost in the final demand sectors, successfully utilizing the regions significant solar potential.
- *Technical description*: Forced closed-type solar water heating systems, constituting of a special metallic absorber for flat plate collectors and a hydraulic press for bulk

manufacturing could provide sufficient hot water for a family of five persons living in a GCC state [46].

- *Economic and financial check:* The calculated cost of 1 kWh of useful heating energy from solar power is around 0.035 €. Generally, it is an attractive investment with a short payback period.
- *Risks*: The most important risk is the business, since most potential users still do not have motivation to consider investing in solar thermal systems.
- *Environmental impact*: This investment can play an important role in mitigating environmental problems, since it is generally considered of benign environmental impact.
- *Socio-economic impact:* The current investment can support the growth of the solar thermal market. In addition, it can improve the quality of life through the delivery of modern social services.

4. Conclusions

The implementation of sustainable investments in the gulf region can support the renewal EU–GCC partnership as well as play an important role in initiating a cleaner and environmentally sound energy market. Using the sustainable energy technologies that have already proven to be competitive, GCC companies can make a profit today, while creating a path for the future technological advantages. As GCC business becomes experienced with installation and maintenance on a large scale, new markets for these technologies will open up, creating even more competitive opportunities. In addition, the increased impact of the climate change on the energy sector, due to these states' recent accession to the Kyoto protocol, brings out these investments as key means for establishing conditions of security, stability and sustainability.

However, the development of the sustainable energy investments has to overcome many constraints in the GCC, based on the fact that these states are leading oil and natural gas producers. As a result, the presented approach can assist governments to design the appropriate framework for supporting the sustainable energy investments and the project investors to identify the commercially profitable ones. Based on the results of the six short pre-feasibility studies, the following points can be drawn up:

I.1 *Solar power for GSM telecom towers*: These applications are viable to particular power supply requirements and attractive for application in GCC's desert and remote areas to deliver modern services, stimulate investments and therefore create employment opportunities.

I.2 *EOR:* The potential for commercial-scale EOR provides the incentive for oil producers to become involved in CO_2 capture in order to meet the rising level of oil demand, to increase the efficiency of the oil extraction and to achieve huge emission reductions. Many have already recognized that this is a win-win situation for them.

I.3 *Energy efficiency in the lighting of roads*: The presumed EU–GCC co-operation in the framework of this investment can take advantage of the massive infrastructure development in EU regarding solar lighting and the huge market potential for energy efficiency improvement in the lighting sector of the GCC region.

I.4 *Know-how transfer for RUE*: There is a pressing need to renew commitment both at EU and GCC level to promote energy efficiency more actively. This investment constitutes

of a number of actions so as to convince local decision makers and industry leaders for the adaptation of energy efficient technologies, dissemination of know-how to local experts and facilitation links between the end users and equipment suppliers.

I.5 *Solar cooling systems*: A significant reduction of the yearly electricity production can be achieved through the implementation of energy conservation via solar cooling systems in air-conditioned buildings. Such investments can be considered of high priority in the context of the EU–GCC co-operation due to the EU significant level of expertise for such innovative and rationalistic investments and the significant solar potential in the GGC region.

I.6 *Solar water heaters*: It is an attractive solution in order to reduce electricity consumption in water-heating sectors for many hot water domestic and industrial applications and thus reducing future heating costs in the region.

The above investment ideas are only a small part of ''thinkable options'', in order to establish a discussion basis. In this context, other sustainable energy options (e.g., biomass co-firing and gasification, fuel cell/turbine hybrids, molten carbonate fuel cell, etc.) which are currently matured enough and commercialized in some EU countries, could become much more important in the region.

Finally, the outcomes obtained were judged as realistic and consistent from the participants of a recent meeting, organized in the context of the Synergy Programme (Belgium, October 2005) [47] and the presented procedure was appraised as appropriate, providing to GCC countries the flexibility to assess the suitability of promising solutions in the context of the EU–GCC cooperation.

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