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A Strategic Investment Framework for Green Economy in Arab Countries from an Energy Perspective

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ACRONYMS

AF..... Adaptation Fund

BAU ..... Business As Usual

B/C ..... Benefit/Cost

BCA..... Benefit/Cost Analysis

BFT ..... Benefit Function Transfer

CAP ..... Climate-altering Pollutants

CAPEX..... Capital expenditure

CCG..... Combined cycle gas turbine

CCS ..... Carbon capture and sequestration

CH_4..... Methane

CIF ..... Climate Investment Fund

CO_2..... Carbon Dioxide

COED..... Cost of Environmental Degradation

CSP..... Concentrated Solar Power

CTF. ..... Clean Technology Fund

CV ..... Contingent valuation

DALYs ..... Disability-Adjusted Life Years

EPA ..... Environmental Protection Agency of the United States

EPI..... Environmental Performance Index

EU ..... European Union

FAO..... Food and Agriculture Organisation

GCF ..... Green Climate Fund

GCI..... Global Competitiveness Index

GDP..... Gross Domestic Product

GEF ..... Global Environmental Fund

GIS ..... Geographic Information System

GTF ..... GEF Trust Fund

GW/h..... Gigawatt per hour equivalent to 1,000,000 KW/h

IEA ..... International Energy Agency

IFC. ..... International Finance Corporation

IRENA..... International Renewable Energy Agency

Kg..... Kilogram

kTOE ..... Kiloton of oil equivalent

KW/h ..... kilowatt per hour equivalent to 1,000 W/h

LDC. ..... Less Developed Countries

LDCF ..... Least Developed Countries Fund

m^3 ..... Cubic meter

MW/h ..... Megawatt per hour equivalent to 1,000 KW/h

NAPA ..... National Adaptation Plan of Action

NDA ..... National Designated Authority

NIE ..... National Implementing Entity

NOx ..... Nitrogen Oxides

NPV ..... Net Present Value

OMEX ..... Operations and maintenance expenditure

O&M ..... Operations and Maintenance

$PM_{2.5}$ ..... Particulate matter equivalent to 2.5 $\mu g/m^3$ in size

PV ..... Present Value

RCREEE ..... Regional Center for Renewable Energy and Energy Efficiency

RET ..... Renewable Energy Technology

RR ..... Rate of Return

SCCF ..... Special Climate Change Fund

SCF ..... Strategic Climate Fund

SIDS. ..... Small Island Developing States

SOx ..... Sulphur Oxide and Dioxide

SO_2 ..... Sulphur Dioxide

SPCCF. ..... Special Climate Change Fund

SREP ..... Scaling up Renewable Energy in Low Income Countries Program

TOE ..... Ton of oil equivalent

TW/h ..... Terawatt per hour equivalent to 1,000,000,000 KW/h

UNFCCC ..... United Nations Framework Convention on Climate Change

UNDP ..... United Nations Development Programme

UNEP ..... United Nations Environment Programme

VAT ..... Value-added tax

VSL ..... Value of Statistical Life

WHO ..... World Health Organisation

WTP ..... Willingness to Pay

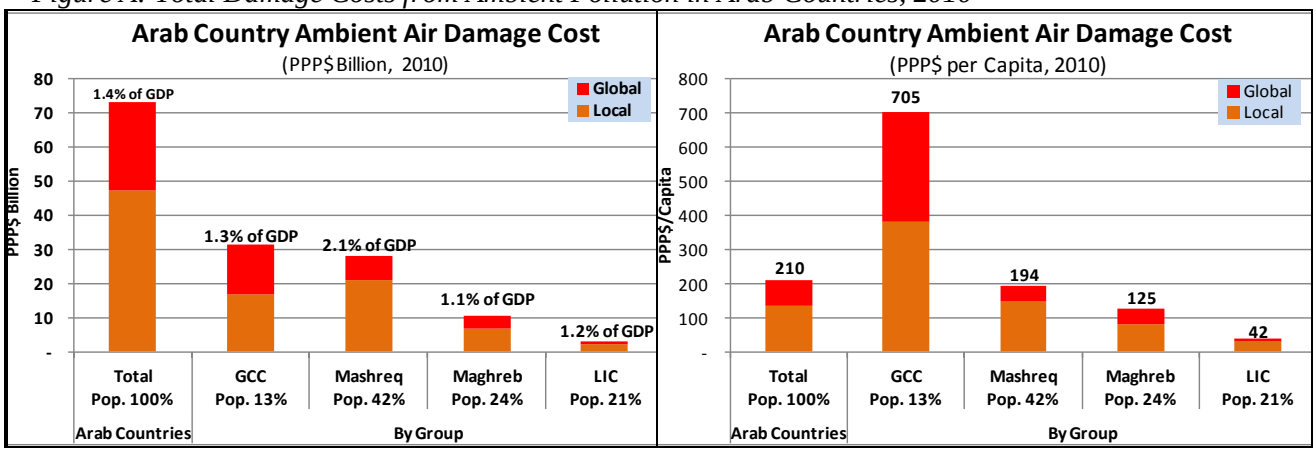
EXECUTIVE SUMMARY

The countries of the Arab Region face great challenges to improve the quality of life of their citizens. These countries are also committed to improve their energy efficiency and to mainstream global environmental concerns in their energy and environment policies. Qualitative and quantitative assessments of impacts of climate change are generally understood from a technical and engineering point of views, however, to the best of our knowledge, the economic assessments of these impacts, and the calibration of these impacts against the global and national degradation to determine cost effective and efficient policies are almost nonexistent in the countries of the Arab Region. This assessment will enable the decision makers at the national and regional levels to develop sectoral priorities and set trade-offs based in the cost and benefits of investments and the impact of the environmental externalities on these investments to move towards a green energy.

The objective of the "strategic investment framework" paper is to assist countries of the Arab Region in developing a resource-efficient and competitive economy that would lead to low carbon growth with economic, social and environmental benefits. The framework will address the role for ESCWA as facilitator for accessing Climate Finance sources and especially the Green Climate Fund by member countries. The approach for the Strategic Investment Framework for Green Energy starts from the premises that local and global pollutants generated from the energy sector is adversely affecting public health and natural resources.

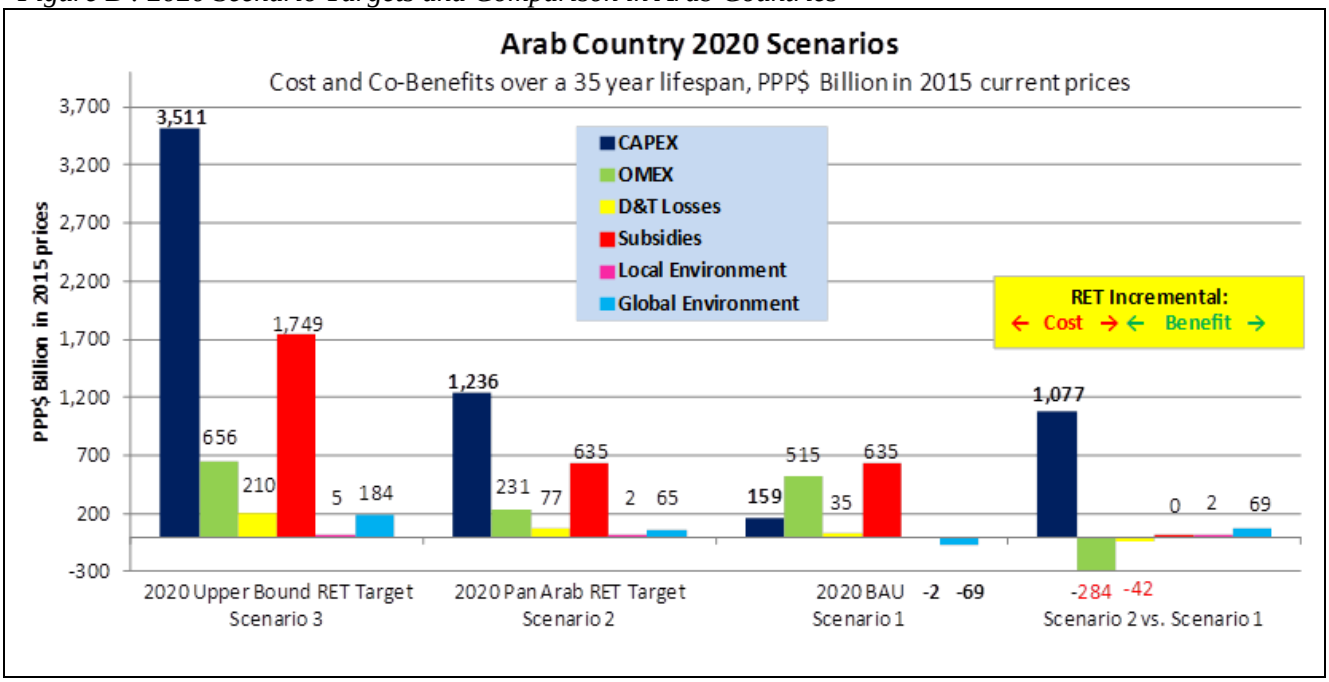
The total local and global damage costs from ambient air pollution as shown in Figure A set the total local and global damage costs at PPP$ 185 billion equivalent to 3.7% of GDP of the countries of the Arab Region in 2010.

Figure A: Total Damage Costs from Ambient Pollution in Arab Countries, 2010



The fossil fuel subsidies in Arab Countries amount to an opportunity cost of US$ 191 billion (8% of Arab Country GDP) equivalent to PPP$ 423 billion in 2011.

Figure B : 2020 Scenario Targets and Comparison in Arab Countries



Three scenarios were considered for the remediation costs using cost benefit analysis:

1. Scenario 1: The lower bound business as usual (BAU) scenario in 2020

2. Scenario 2: consists of the incremental RET power generation needed to comply with the RET Pan-Arab Strategy target (i.e., over and above the existing 4% in 2010).
3. Scenario 3; The upper bound where all the incremental energy demand between the 2010 baseline and 2020 is exclusively provided through RET sources increasing therefore the targets to 29% incremental RET energy generation

The results of the three scenarios reflected in Figure B below show extreme high capital costs for scenarios 2 and 3 coupled with high subsidies with low local and global benefits.

Based on the above, the diagnosis and analysis in the previous sections helped reach the following conclusions:

a) The path toward moving toward a green energy requires first a reduction of the environmental damages caused **by local and global pollutants**. These damages are extremely high and in the order of PPP$ 73.2 Billion in 2010 affecting both human health and the economy of the Arab countries.
b) Loss of opportunities due high subsidies are even higher (PPP$ 423 billion almost 6 fold the cost of environmental degradation.
c) The targets in the Pan Arab Renewable Energy strategy in 2030 are over ambitious and their financial and economic impacts have not been properly assessed.
d) The major culprit is the large subsidies which should be reduced by 14.2% over the RET investment period to be able to bridge the capital investment gap in order to comply with the 2020 Pan Arab Strategy Targets.
e) Grant financing and concessionary loans are already available worldwide by international financing institutions and from the forthcoming Green Climate Fund (GCF),

Based on the above general conclusions, the following recommendations are proposed for moving towards a green energy using the proposed the following four axes of intervention:

- **Focusing first on "the low hanging fruits" by: (a)** Financing high-profile demonstrations projects or pilot projects of green technologies specifically relevant to every country using existing climate funds and (b) Investing in energy efficiency through improving transmission and distribution losses.
- **Improving the planning and programming, investment efficiency in conventional and non-conventional energy** using the programmatic approach and the maximization of environmental and social benefits in the energy sector.
- **Creating favorable financial conditions for the banking and private sectors to finance green investments.**
- **Partnering with Climate and International Financing Institutions and Donors.**

The overall objective of ESCWA's green energy is to strengthen the momentum for policy reform and institution building for moving towards a low carbon economy in the energy sector by assisting counties in the Arab Region to better use their energy assets and resources. In order to achieve such objective, ESCWA should consider establishing a one-stop-office, as the first platform for knowledge generation, information dissemination, capacity building, technical support and advisory services in green energy.

In order to achieve the overall objective, the one-stop-office will focus on a capacity building program consisting of: (a) upstream analytical work to develop outcome-oriented strategies and programs in the energy sectors; (b) strengthening the institutional and legal framework, as well as stakeholders' participatory capabilities, (c) providing the technical and economic tools to ensure that strategies and policies that are considered by decision makers for a sustainable use of their energy assets and resources; and assisting countries in project preparation aimed at stimulating the role of the private sector in designing, financing and implementing priority projects based on Arab country priorities and/or in their MDGs and the SDGs.

(a) ESCWA has the flowing opportunities to assist the countries to move towards the path of green energy: Opportunities for cooperation with Regional Institutions and Partners as to act as a catalyst and facilitator for

generating business development and investments in collaboration with Regional Financing Institutions and Partners; (b) Opportunities for cooperation with the Private Sector. ESCWA could assist selected countries in studying private participation and assessing the possible contribution of the private sector to the achievement of potential investments in green energy technologies; and (c) Carbon Finance Business (CFB) Outreach Opportunities.

Irrespective as to whether ESCWA can be accredited and act as an intermediary for its Regional Partners and in view of the importance of the GCF mechanism for linking global to local benefits, ESCWA should play a major role in strengthening the GCF mechanism and its implementation through: (a) Capacity building in the form of workshops and training at the regional / local stakeholders for preparing, submitting and implementing GCF projects; and (b) Developing with the regional institutions and the Islamic Development Bank, the necessary Nationally Appropriate Mitigation Actions (NAMAs); Jordan and Tunisia prepared NAMAS for the municipal waste sector. Tunisia also prepared NAMAs for energy efficiency; and (c). Opportunities for ESCWA to implement stand -alone regional activities for removal of basic gaps in green energy technologies.

Five determinants will determine the effectiveness of this framework namely: (a) strong country commitment to regional cooperation; (b) realistic scope matched to national and regional capacities; (c) clear delineation and coordination of the roles of national and regional institutions; (d) accountable governance arrangements; and (e) planning for sustainability of outcomes and activities at both the national and regional level;

This framework should be a flexible mechanism that can adapt easily to the requirements and mandates of countries in the Arab region, potential donors and to the demands of the individual countries and the privates sector.

1. Introduction

1. Recent climate modeling undertaken for the Arab Countries projects temperature increases in the region of between 0-2°C over the period 2011-41, and between 1-4°C over the period 2041-70 across medium and high scenarios.[1] Projections for precipitation in the summer months show higher variability compared to temperature projections, with the change over the Arab region ranging from -0.5 to 0.5 mm/day.

2. In the context of water scarcity, dependency on shared resources and food security challenges, a warmer climate will bring greater climate variability including higher flood and drought risk, exacerbating the chronic water scarcity and other challenges in the Arab region. Therefore, low carbon, climate resilient and green economy approaches to national strategy development will provide an opportunity for countries in the Arab region to reinvigorate their national planning processes and potentially leverage significant financial assistance and partnerships through emerging green finance and global/regional institutions and coalitions.

3. Investing in low carbon and climate-resilient pathways in the Arab region for green economy transition is highly needed to safeguard natural assets. It holds the promise of achieving integrated or synergistic outcomes that simultaneously link socio-economic benefits with environmental sustainability. A key objective of a green economy strategic framework is to enable decision makers to assess and consider trade-offs and synergies of different investments and policy proposals in terms of their impact across a range of sectors and variables. Resilient-climate green economy strategies could provide further opportunities for climate finance mobilization and contribute to trace a low carbon pathway in the Arab region.

[1] UN-LAS Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR).

4. Indeed, Green Economy Investment refers to the change in mindsets, attitudes, values and principles that create the conditions for sustainable development. Green Economy Investment describes the economic, social and technical practices that improve the local and global environmental quality. It is also the strategy by which governments and businesses proactively make the transition to a future characterized by renewable energy and healthy environmental practices.

5. Green Economy Investment is inevitable as non-renewable resources become scarce and as more value is placed on the quality of life and on human health. The proposed Strategic Investment Framework on Green Economy will offer a regional umbrella to national policies with the perspective of horizontal solidarity, and increase their potential to mobilize climate finance for the implementation of their green economy strategic frameworks, notably through the Green Climate Fund. The reason for the selection the of energy sector is that: (a) energy is a key natural non-renewable asset (oil and natural gas reserves) both for the present and the future. However their utilization carries a "depletion cost" which is related to the question, what substitutes will be available after depletion, and at what cost? Energy is a source of local pollution that is affecting public health and is the major contributor of CO_2 emissions in the Arab Region that is considered to be the most vulnerable to climate change.

6. Furthermore, energy and climate change are part of the forthcoming Sustainable Goals[2] (which are still under negotiation) in which Goal 7 requires to ensure access to affordable, reliable, sustainable and modern energy for all which by 2030 and Goal No. 13 requires to take urgent action to combat climate change and its impacts. Finally this report can serve as an input for ESCWA reports at the forthcoming "Financing for Sustainable Development and UNFCCC COP consultations" as well at the "Global Forum on Financing for Sustainable Development" (Addis Ababa, July 2015).

[2] Report of the Open Working Group of the General Assembly on Sustainable Development Goals, United Nations General Assembly, A/68/970, August 12, 2014.

2. Objective, Scope, Approach, Methods and Limitations

7. This section sets the objective, scope, approach, methods and limitations of the study.

2.1 Objective of the Study

8. The objective of the "strategic investment framework" paper is to assist the Arab Countries in developing a resource-efficient and competitive economy that would lead to low carbon growth with economic, social and environmental benefits. The framework will use existing and potential climate finance mechanisms supporting low carbon growth and adaptation pathways. Moreover, this background paper will explore ways forward to acknowledge a role for ESCWA as facilitator for accessing Climate Finance sources and especially the Green Climate Fund by member countries.

2.2 Scope of the Study and Baseline

9. The analysis scope, which includes the cluster of 22 Arab countries although it does necessarily match the ESCWA member countries (22 Arab countries except Comoros, Djibouti, Mauritania and Somalia), hereby referenced as the Arab Region, is carried out to derive 4 country groups typology based on the Arab Millennium Development Goal aggregation that was also considered in the 2013 *An Investment and Financing Vision for Transitioning towards Green Economy in the Arab Region* report:

   - **Gulf Cooperation Council:** Bahrain; Kuwait; Oman; Qatar; Saudi Arabia; and United Arab Emirates (UAE).
   - **Mashreq Countries:** Egypt; Iraq; Jordan; Lebanon; Palestine; and Syria.
   - **Maghreb Countries:** Algeria; Libya; Morocco; and Tunisia.
   - **Low Income Countries:** Comoros; Djibouti; Mauritania; Somalia; Sudan; and Yemen.

10. The year 2010 was adopted as the baseline as the burden of disease is only available for 2010 and constrained the baseline selection although 2011 energy subsidies were used in the analysis unlike emission compound references that are available until 2013. Also, selecting 2010 as a baseline avoids

accounting for changes in country ranking in terms of income, output and oil/gas exports further to the unrest in a number of Arab countries since 2011.

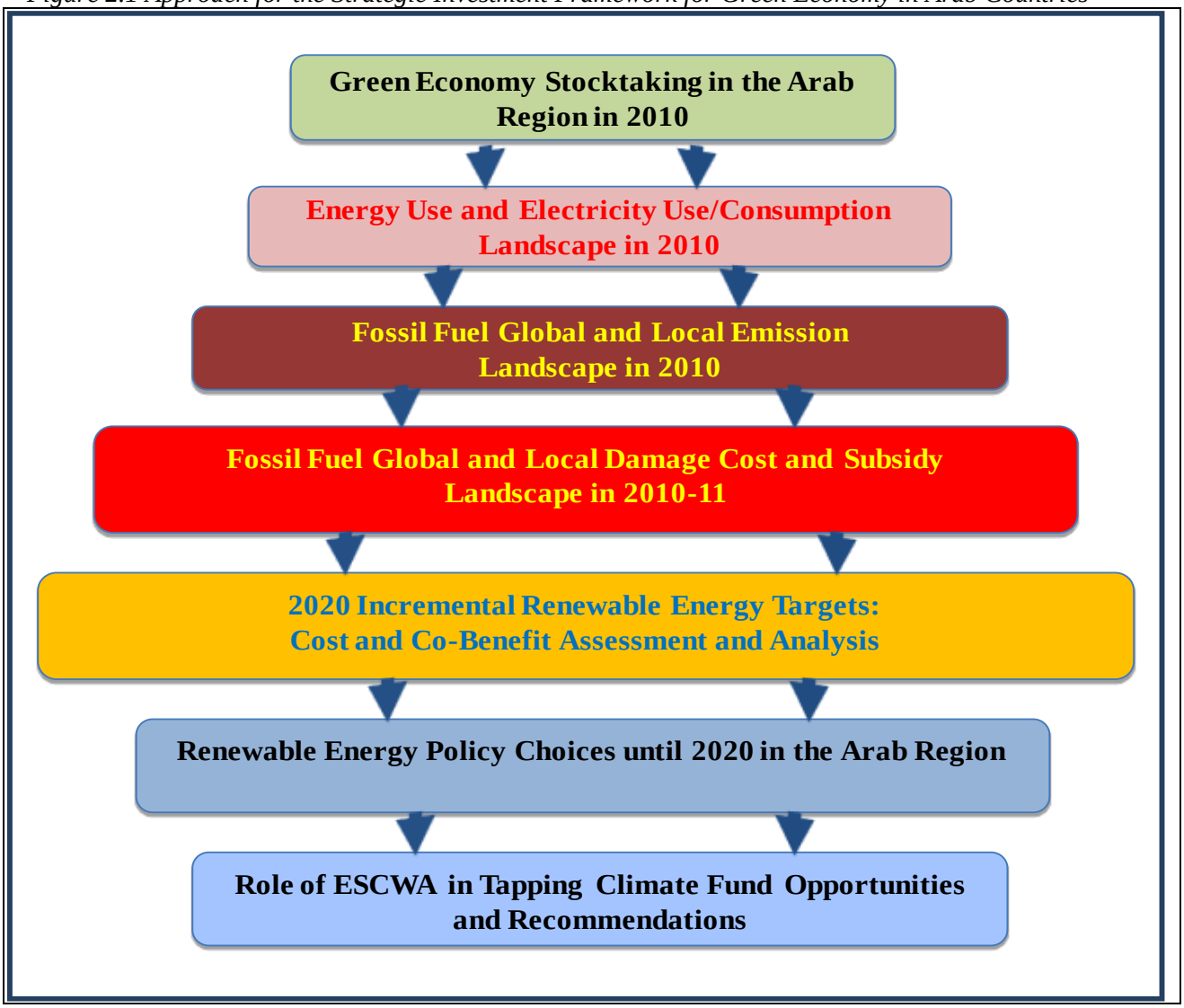
2.3 Approach

11. The approach *for the Strategic Investment Framework for Green Economy in Arab Countries* is different from past studies and strategies developed by a number of regional and international organizations. Qualitative and quantitative assessments ~~of impacts~~ of climate change impacts are generally understood from a technical point of view, however, to the best of our knowledge, the economic assessments of these impacts, and the calibration of these impacts against the global and national environmental damage caused by local and global pollutants are almost nonexistent in Arab Countries. Moreover, despite economic drivers, environmental pressures and climate vulnerability that occurred in these countries, energy is a vital natural resource that is not costed and valued according to well established general principles and therefore is not allocated efficiently.

12. It is in view of the lack of economic assessment of environment degradation due to the conventional energy that this present study has been developed. The economic assessment of environment degradation will enable an approximate quantification of orders of magnitude of the economic costs associated with environmental degradation. This assessment will enable the decision makers at the national and regional levels to develop sectoral priorities based in the cost and benefits of investments and the impact of the environmental externalities on these investments.

13. Figure 2.1 illustrates the approach adopted in this study. It consists of a green economy stocktaking, fossil fuel landscape analysis, fossil fuel co-benefit analysis, policy choices for climate fund tapping and concluded by recommendations.

Figure 2.1 Approach for the Strategic Investment Framework for Green Economy in Arab Countries



2.4 Methodological Process

14. Data was mainly extracted, compiled and aggregated from notably the EPA, EU, IEA, IMF, IPCC, IRENA, RCREEE, OECD, OPAEC, OPEC, UNCCC, UNDP, UNEP and the World Bank (notably World Development Indicators) Websites. Explanations on the methodological process are summarized below and detailed in Annexes I and II.

2.4.1 Local and Global Emission Loads and Damages

15. Damage costs, which are denominated in international dollar (purchasing power parity or PPP$) as it is a better cross-country comparator, are considered at the national and global levels for only ambient air pollution caused by fossil fuel combustions and processes as well natural (geological, construction dust, sand storm, etc.) causes. However, damages of fossil fuels sustained by other media (water, soil, and biodiversity in terms of fauna and flora as well as ecosystem services), cross-media and their effects on human health are not accounted for but cannot be discounted and require additional analyses. For local damages, only the health burden from ambient air pollution is considered in the analysis although ambient particulates impact ecosystem services, lead to infrastructure decaying overtime and reduced agricultural productivity. For global damages, a very conservative marginal cost of PPP$ 18 per extra ton of CO_2 emitted is considered (see Annex II).

2.4.2 Subsidies

16. IMF, UNDP and World Bank reports were used to develop the sub-sections on fossil fuel subsidies.

2.4.3 RET Cost and Co-Benefit Scenario Assessment

17. Cost and co-benefit scenarios based on 3 incremental RET power generation 2020 targets are assessed

2.4.4 RET Cost and Co-Benefit Analysis

18. Cost and co-benefit analysis is performed to help gauge scenarios and prioritize interventions (see Annex II).

2.5 Calibration and Limitations

19. In addition to resource constraints and binding time, the techniques used have their own methodological limitations. In the process of fact finding it became clear that availability, accessibility and topicality of information relevant for the assignment posed problems, especially for Comoros, Palestine and Somalia.

Information has been very scattered, not up-to-date and sometimes inconsistent. Inconsistencies have been experienced with similar types of information from different sources.

20. The results allow for a margin of error through sensitivity ranges (lower bound, upper bound) that were taken into account. In addition, marginal analysis has been attempted in some cases to assess the benefits and investment costs.

21. Most valuation techniques used have inherent limitations in terms of bias, Upper Bound premise, uncertainty especially when it comes to non-tradable goods. Moreover, the results are of course sensitive to the context. The use of benefits transfer could therefore exacerbate the results and uncertainties. Therefore, some results are described in the text and should be subject to further analysis when investments will be considered.

3. Review of the Green Economy in Arab Countries

22. This section assesses Arab Countries climate change vulnerability, energy production, green growth achievements and opportunities as well as overall environmental and competitiveness performance indices.

3.1 The Arab Region Vulnerability to Climate Change

23. With a hot and dry climate, and its limited and declining water resources and arable cropland, Arab Countries are witnessing serious climate-induced impacts capable of generating not only significant economic damages and social tensions, but also economy-wide repercussions. Climate change in these countries is expected to have adverse impacts on the environment causing: more heat waves, reduced rainfall, increased forest fires, lower agricultural yields resulting in food price increase, stress on water availability and quality and biodiversity all of which in turn will affect agriculture, tourism and other economic sectors with the brunt being borne the poorest segments of the population.

24. Climate change is affecting peoples livelihood as more than 100 million poor people out of 370 million Arab population in 2013 are already suffering from the negative impacts of climate change.3 The poor environment compounded by high poverty rates makes Arab Countries the most vulnerable to climate change.

25. Climate change has contributed to serious natural hazards in terms of severe droughts and flush floods which affected 50 million people over the last decades with a cost of at least US$ 11.5 billion and are increasing in frequency and intensity. For instance, in Jeddah, the 2009 flooding killed over 150 people, disrupted economic activities and damaged infrastructure as well as more than 800 homes and 700 vehicles. In Tunisia, repeated floods have exacerbated the Medjerda basin and destroyed villages. In

[3] World Bank. 2013. *Adaptation to a Changing Climate Change in the Arab Countries*. Washington, D.C.

Algiers, severe flooding occurred in Bab El Oued in 2001 resulting in 180 deaths and material losses of US$ 350 million. In 1990, 60 people died, 830,000 people were displaced, in the villages of Sidi Bouzid, Gafsa, Kairouan and Jeffara.[4]

26. Sea level rise will exacerbate coastal flooding especially when storm surges and flash floods occur simultaneously as major cities are located along the coastlines. Also, an Upper Bound sea level rise of 50 centimeters in Alexandria is likely to displace more than 2 million people resulting in a loss of 214,000 jobs and producing economic losses of US$ 25 billion.[5]

27. Arab Countries have already the highest level of water scarcity in the world and it is expected that it will worsen: the per capita water availability will be reduced by half in view of the expected raise on the population and the predicted reduced level of precipitation by 20-30% in parts of the region. It is expected that the demands will rise by about 25% in 2020-2030 and 60% in 2040-2050.[6] Unmet demand as compared to total demand will increase to 37% in 2020-2030 and to 51% in 2040-2050. A decrease of water availability will also lead to a groundwater table drawdown and an increase of water pollution resulting in water-borne diseases, and therefore affecting people's health.

3.2 Energy Production and Carbon Emission in Arab Countries

28. Arab Countries rely largely on fossil fuel for energy provisions. Arab countries possess about 69% of global oil reserves[7] and about 27% of gas reserves[8] in 2013. The crude oil production is 32.5% of the world production and its natural gas production is 16.5% in 2013 with proceeds of oil exports estimated at about US$ 500 billion in 2013. The region produces 7.8 million barrels per day for oil refining to meet oil refining capacity and export 2.9 million to international market. Energy demand in 2020 is expected to

[4] Leaders Website:<www.leaders.com.tn>
[5] El Raey, 1997.
[6] World Bank. 2013. *Adaptation to a Changing Climate Change in the Arab Countries*. Washington, D.C.
[7] OPEC Website: <www.opec.org>.
[8] OAPEC Website: <www.oapec.org>.

increase by 84% between 2010 and 2020 and could require 135 Giga Watt (GW) of generation capacity. This will require infrastructure investments of the order of US$ 450 billion.[9]

29. Energy intensity in this region is 60% higher than the OECD countries and 40% higher than the upper middle income countries. Unlike other part of the world, energy intensity is increasing[10] especially in the GCC countries. The region has high per capita green gas emissions (GHG) and is 60% higher than the average developing countries. However, in absolute terms, the region is a low carbon emitter representing 5-6% of the world emissions. Climate change will have an impact of both energy demand and supply. Refineries are large consumers of water and will be affected by renewable water shortages which in turn would have an impact on the global market. Refineries and power plants infrastructures are located on coastal areas and nearby water ways. Extreme weather conditions can have serious effects on energy infrastructure. Oil and gas pipelines that are running along many of the Arab countries could be affected by storms, floods and landslide.

3.3 Green Economy Achievements to Date in Selected Arab Countries

30. Arab country commitment to addressing climate change takes place in an atmosphere of political instability, an environment of finite resources, competing development challenges and recently a sharp drop in oil prices. In 2013, the 3rd Arab Economic and Social Development Summit adopted in January 2013 the Pan Arab Renewable Energy till 2030 which was commissioned by the International Renewable Energy Agency (IRENA) in collaboration with the League of the Arab States and produced by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE). This very comprehensive strategy calls for an increase of renewable technologies from 11 GW in 2010 to about 75 GW of installed capacity in the Arab countries by 2030 and is a road map of key actions and initiatives on a regional scale. It requires every country to prepare a National Renewable Energy Action Plans (NREAP) and a

[9] IRENA.2014. *Pan Arab Renewable Energy strategy 2030: A Road Map of Actions for Implementation*. Abu Dhabi..
[10] World Bank. 2007. *Seizing a Hidden Resource: Energy Efficiency in the Middle East and North Africa*. Washington, D.C.

concerted effort at the institutional policy and regulatory levels with additional technical and financial support.

31. Although the installed capacity in renewable energy does not exceed 0.5% of regional installed capacity for electricity; by the end of 2013, Arab Countries have installed 1,000 Mega Watts (MW) of wind energy capacity, of which 50% was installed in Egypt followed by Morocco (290 MW) and Tunisia (154 MW). The first Concentrated Solar Power (CSP) was installed in Kureimat Egypt, with an overall capacity of 140 MW of which 20 MW is from solar input.[11] In Morocco, the first phase of Noor Ouarzazate Complex consists of the construction of the first 160 MW, which will be followed with two other phases for a 150-200 MW parabolic through CSP and a 100-150 MW tower CSP plant[12] as Morocco is planning to become a renewable energy hub with the prospect of exporting clean energy to Europe in the future.

32. In the United Arab Emirates, Abu Dhabi has commissioned a 100 MW Shams CSP plant and Dubai has installed 13 MW of solar PV as part of Mohamed Ben Rashid Al Maktoum Solar Park[13] whose target was expanded from 1 GW by 2019 to 3 GW by 2030.[14] The Masdar City, a US$ 19 billion project that will cover 6 Km^2 and will house 50,000 people and 1,500 businesses, is relying entirely on solar energy and renewable energy sources[15] as Masdar City is the first large scale carbon neutral development.

33. Most of Arab Countries are planning to install renewable energy plants within the next ten years. At present 6.4 GW of renewable energy projects are being constructed or planned. The majority of these projects include wind power with an aggregate capacity of 2.4 GW and solar energy projects with an installed capacity of 1.8 GW. Morocco project pipeline is the highest with a planned capacity of 1.7 GW

[11] Dutch Government Website: <www.nrel.gov>.
[12] World Bank. 2014. *Noor Ouerzazate Concentrated Solar Power Project Appraisal Document* #1007. Washington, D.C.
[13] IRENA. 2015. *Renewable Energy Prospects*. United Arab Emirates.
[14] Clean Technica Website: <http://cleantechnica.com/2015/04/15/dubai-will-invest-3-billion-boost-solar-power-project-capacity-3-gw/>.
[15] Wikipedia Website: <www.wikipedia.org>.

followed by Egypt with over 1.2 GW.[16] Even the GCC countries are considering developing renewable energy projects as an alternative to ever increasing demand for electricity. Saudi Arabia alone announced a plan to develop 41 GWs, consisting of 25 GWs of CSP plants and 16 GWs of PV plants by 2032. The unprecedented oil price drop in the fourth quarter of 2014 from US$ 110 a barrel to below US$ 50 barrel in January 2015 will produce additional savings for most net oil and gas Arab Country importers to the detriment of GCC and other net oil and gas exporting countries, and may accelerate the adoption of win-win measures such as extending the use of natural gas, diversifying the energy mix and upgrading or rehabilitating the energy infrastructure[17] in parallel with reducing energy subsidies.

Table 3.1: Targets in Renewable Energy Production in Selected Arab Countries, 2007-30

Countries	Algeria	Egypt	Jordan	Libya	Morocco	Tunisia	Saudi Arabia	Yemen
Target	20% of electricity generation	20% of electricity generation	10% of electricity generation	10% of energy generation	42% of energy generation	10% of energy generation	20% of electricity generation	15% of energy generation
Start Year	2011	2008	2010	2007	2009	2008	2010	2009
End Year	2030	2020	2020	2020	2020	2010	2020	2025

Source: IEA Website: <www.iea.org>.

34. Concerning energy efficiency, Arab Countries have a low level of energy efficiency. Low energy efficiency raises the fiscal cost of energy subsidies, necessitates expensive energy sector investments, reduces economic competitiveness, lowers household welfare, contributes to local and global pollution and increases the perception of national energy insecurity. As for the use of renewable energy, while most of the Arab Countries have established specific targets (Table 3.1), these targets are not supported by a proper legal framework, and are not part of an integrated energy policy planning without which it will be difficult to prepare realistic action plans. However, the use of green energy in Arab Countries is becoming a priority issue, but for different reasons: the impact of the energy subsidies on their fiscal balance; the vulnerability of the economy given hydrocarbon price swings and the risk of losing

[16] IRENA. 2014. *Pan Arab Renewable Energy Strategy 2030:A Road Map of Actions for Implementation*. Abu Dhabi.
[17] World Bank. 2015. *MENA Quarterly Economic Brief: Pumping Oil*. Washington, D.C.

competitiveness; and the generation of enough financial resources for new energy investments to secure the ever growing energy demand of their growing economies.

3.4 Challenges and Opportunities of the Green Energy

35. However, Arab Countries are faced with serious financial, institutional, legal and technical challenges that are likely to delay or side track the use of green energy. Arab Countries are faced with the following major challenges which are summarized as follows:

a) *Energy pricing:* Energy subsidies are widespread. These have encouraged demand and hampered the adoption of green technologies, both for energy supply and industries. The subsidies estimated by IMF amount to be US$ 191 billion (US$ 423 billion in purchase power parity (PPP) representing 9% of regional GDP in 2011. Such level of subsidy inevitably leads to huge distortions in consumer choices and indirectly contributes towards high ambient air environmental damages which were estimated at PPP$ 73 billion, i.e., 18% of energy subsidies in relative terms (see Sections 4 and 5 below). The economic costs of these subsidies far outweigh the economic benefits. Such huge subsidies could hinder the adoption of renewable energy technologies and will hamper the competition with conventional energy resources especially at a time when oil prices have sharply decreased. Although some countries have started the reform process for reducing energy subsidies such as Egypt, Morocco, and Tunisia, Arab Countries will have to trade off between the painful economic reforms on one hand, and political consequences as well as unmet expectation of the young generation especially the poor on the other hand.[18] Protection of the poor is the argument most often used to justify energy subsidies. Oil and gas rich countries have argued that subsidies to energy consumers is an effective means to redistribute "oil rent". Net importing countries often argue that they must make energy affordable to all income groups. Energy subsidies and green

[18] Fattouh, B and L. El Katiri. 2012. *Energy Subsidies in the Arab World.* UNDP, Arab Human Development Report Research Paper Series. New York, N.Y.

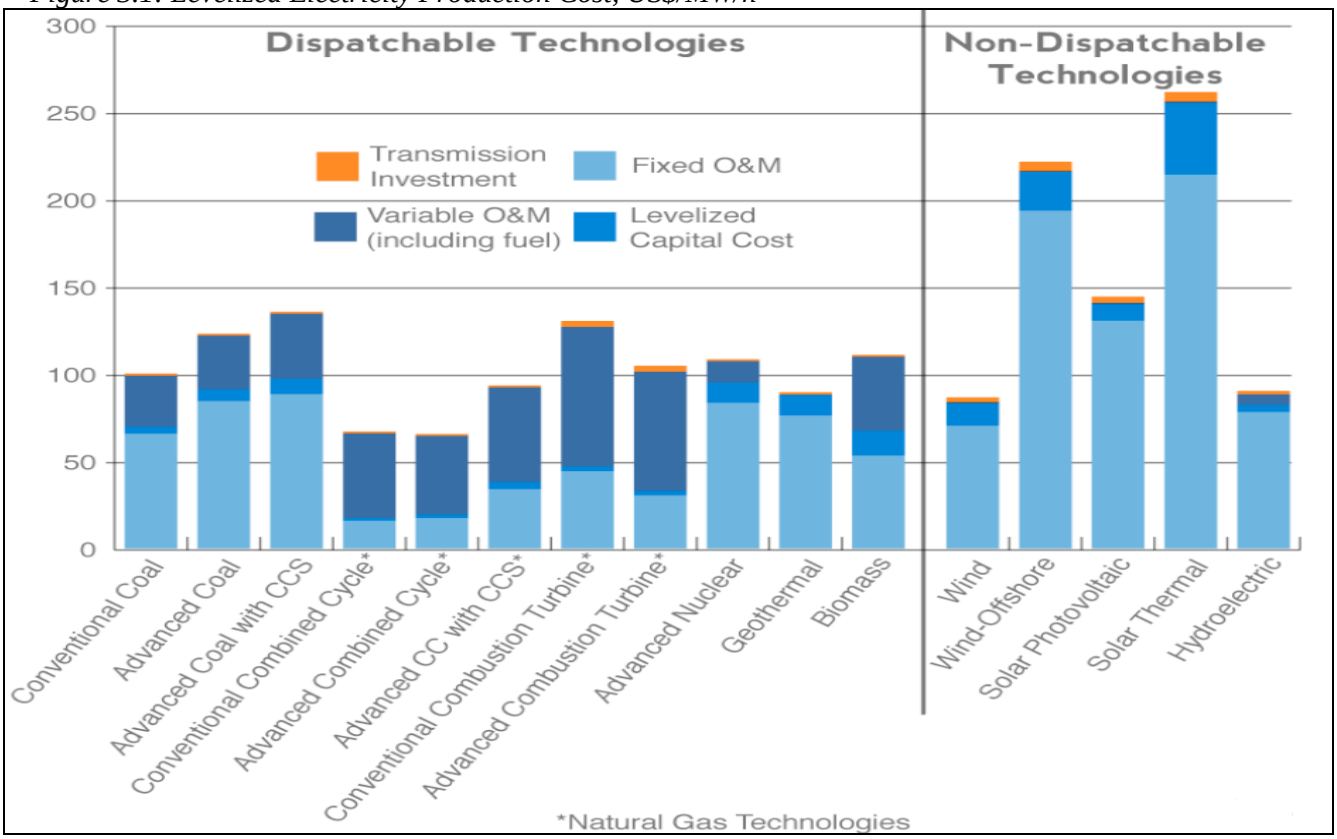
energy are however inter-related. On one hand, energy subsidies stimulate the inefficient use of energy and on the other hand, green energy could decrease the cost of energy subsidies because less conventional energy is used.[19]

b) *Institutional and Financing Framework for Green Energy*: The legal and regulatory framework for energy efficiency and renewable energy is not clear and the interrelationship between energy efficiency and the use of renewable energy has not been mandated legally and institutionally to implementing agencies. At present, there is a lack of a comprehensive strategy and long term plan for the horizon 2020-2030, that includes both clear visions, realistic targets with action plans for improving energy efficiency, using of renewable energy and reducing energy subsidies complemented by the effectiveness and cost of financial incentive mechanisms.

c) *Technical Solutions*. A wide range of technical solutions have already been introduced in the region, from building codes to appliance labelling, industry-specific measures, use of PVs, centralized solar power (CSP) and wind energy, though no quantitative analysis has been attempted. The renewable energy investment costs are still not competitive. The levelized cost allows for cost comparison among different generation types by linking initial capital, discount rate, and operations and maintenance to generation. The electricity generated with wind turbines in average conditions ranges between US$ 0.05 and 0.10 per kilowatt hour (kWh), followed by solar thermal (US$ 0.20 to 0.25) and biomass (greater than US$ 0.1) at slightly higher cost ranges. Solar PV currently levelized costs more than US$ 0.15 per kWh. The levelized cost of producing electricity from conventional sources is typically US$ 0.07 to 0.14 per kWh (Figure 3.1)**.** Financial support from government, international financial institutions as well as price incentive mechanisms are therefore required to improve the climate for RET investments.[20]

[19] Seizing a Hidden Resource: Energy Efficiency in the Middle and North Africa, the World Bank, 2007.
[20] IRENA: Pan Arab Renewable Energy Strategy 2030: A Road Map of Actions for Implementation, 2014.

Figure 3.1: Levelized Electricity Production Cost, US$/MW/h



Source: IER Website: <http://instituteforenergyresearch.org/wp-content/uploads/2009/05/2.15.13-IER-Web-LevelizedCost-MKM.pdf>.

36. Despite these major challenges, green energy will provide the following economic, entrepreneurial, social and environmental opportunities while helping to improve the competitiveness of the countries' industries:

a) *Economic opportunities.* Green energy will have a positive economic impact for all industries that are using conventional energy, trying to reduce waste or planning to compete on the basis of international environmental standards. It will also enable Arab Countries to compete in new growth industries related to renewable energy production and maintenance. Many Arab Countries such as Egypt, Morocco, Tunisia and the UAE have considerable comparative advantages in solar power and wind. Smart policies to encourage the transition to renewable energy technologies, even in advance of the immediate price signals coming from global markets, can facilitate this transition and enable Arab

firms to become important players in this future global industry. Also, Morocco is taking the lead in building a 350 MW Abdelmoumen pumped-storage dam with a capacity of 1.3 million m^3 on the Issen River capable of storing energy from the national 2,000 MW solar and 2,000 MW wind program.[21]

b) *Entrepreneurial opportunities*. Industries and investors in Arab Countries can benefit by being part of new global growth industries related to alternative energy, environmental controls and other technologies. Globally, renewable energy is increasing annually at a pace ranging between 15 and 30%. This growth occurs mostly in wind power, which has surpassed solar photovoltaic (PV) power and other technologies, and is followed directly by bio-diesel and central solar power.

c) *Social opportunities*. The green energy will allow the industrial sector to lower its production costs, guarantee future access to energy, and thereby compete globally**.** Currently, Arab Country non-petroleum exporters make up only 32% of the GDP in 2012. Non-oil exports can be an engine for economic growth and for the creation of good quality job for educated and for recent graduates as employment is also an important policy goal for all Arab governments.

d) *Environmental opportunities*. During the last 30 years, governments and businesses in many Arab Countries have played a major role in improving their environmental stewardship and the need to move towards economic and social sustainability. With climate change becoming an unequivocal global issue that is likely to stir significant economic damages and social tension in the Arab region, the broadening of the sustainable development concept now encompasses the protection and development of both local and global assets. Arab Countries are now confronted with two key principles that were essential for them to engage into the path of sustainable development: (i) the conservation and development of national and global assets; and (ii) an agreement on a new shared

[21] Hydro World Website: <www.hydroworld.com/articles/2014/11/morocco-pre-qualifies-builders-for-350-mw-abdelmoumen-pumped-storage.html>.

responsibilities between the State, the producers (or service providers) and beneficiaries in the conservation and development of these assets. Sustainability implies a need for a clear articulation between environmental policies and overall economic policy. Environmental benefits should accrue at the global and local levels thanks to an enabling environment based on better performing economies following gradual price and fiscal reforms, trade and foreign exchange liberalization, business innovation and technological development that will also help attract local and foreign investments.

e) *Competitiveness opportunities*. Most Arab Countries have adopted a market-based economy that aims to increase its competitiveness through its integration into the global economy. Businesses that wish to survive and thrive in a global economy must respond to major social and environmental trends that are reshaping markets. As such, these countries would need to reconcile their development needs with green transformation actions to stimulate growth and competitiveness, strengthen energy and water security and enhance the quality of life of their citizens. In environmental terms, it means improving efficiency in the use of energy and water, reducing pollution, changing societal behavior and reallocating savings from energy and water conservation and efficiency into social services and other welfare enhancements.

3.5 Competitiveness and Environmental Performance Indices

37. Environmental performance and competitiveness performance complete each other as they are mutually reinforcing. Empirical evidence shows that strong environmental performance is positively correlated with competitiveness. Esty and Porter, in their report on the National Environmental Regulation and Performance rankings,[22] demonstrated that countries with a strong environmental regulatory regime are also those that rank highest on the Global Competitiveness Index (GCI). The Environmental Performance

[22] Esty, D. C. and M. E. Porter. 2000. *Measuring National Environmental Performance and its Determinants*. In M.E. Porter and J. Sachs (eds.), The Global Competiveness Report, 2000, New York: Oxford University Press.

Index (EPI)[23] is a biennial ranking of countries to show how well the countries perform on high-priority environmental issues. It has two major objectives: environment health which measures protection of human health from environmental harm and ecosystem vitality measures ecosystem protection and resource management.

Table 3.2: Environmental Performance Index in Arab Countries, 2014

Arab Countries	Total EPI		Health Impacts		Air Quality Impact		Climate Change and Energy	
	Scores/100	Ranking/178 countries	Scores	Ranking	Scores	Ranking	Scores	Ranking
UAE	**72.91**	**25**	96.09	32	86.47	65	33.86	105
Saudi Arabia	**66.61**	**35**	94.68	38	84.45	73	46.63	74
Kuwait	**63.94**	**42**	80.71	71	61.54	167	42.23	90
Qatar	**63.03**	**44**	90.52	49	76.81	100	70.93	14
Egypt	**61.11**	**50**	66.83	97	67.99	144	61.05	37
Tunisia	**58.99**	**52**	89.95	51	99.04	12	54.38	55
Jordan	**55.78**	**60**	79.31	74	82.51	79	65.68	20
Syria	**54.50**	**68**	78.81	75	71.08	126	59.10	43
Morocco	**51.89**	**81**	64.96	81	98.85	14	49.40	67
Bahrain	**51.83**	**82**	81.63	67	74.63	113	39.57	97
Lebanon	**50.15**	**91**	91.77	45	77.34	98	40.43	94
Algeria	**50.08**	**92**	66.12	99	99.28	11	37.53	99
Oman	**47.75**	**99**	88.83	53	96.89	36	21.64	116
Libya	**42.72**	**120**	81.63	67	97.12	34	46.61	75
Iraq	**33.39**	**149**	71.73	91	67.42	148	36.03	101
Comoros	**31.39**	**153**	34.1	146	76.33	106	-	-
Yemen	**30.16**	**149**	38.98	138	81.65	84	23.59	147
Djibouti	**28.52**	**161**	31.37	151	93.39	51	-	-
Mauritania	**27.19**	**165**	26.73	158	80.67	88	-	-
Sudan	**24.61**	**171**	29.95	154	73.55	120	-	-
Somalia	**15.47**	**178**	18.55	166	66.89	158	-	-
Palestine	**NA**	**NA**						

Note: NA, Not Available
Source: EPI Website: <www.epi.org>.

38. The environment health consists of set of indicators related to health impacts (child mortality) air quality in terms of household air quality, air pollution exposure to $PM_{2.5}$, and water and sanitation. The ecosystem vitality indicators consist of water resources, forests, fisheries, biodiversity and habitats, climate change and energy in terms of trend in carbon intensity, change of trend in carbon intensity, access to electricity, and trend in CO_2 emission per kW/h.

[23] EPI Website: <http://epi.yale.edu//epi/country-rankings>.

39. Table 3.2 and Figure 3.2 illustrates the total EPI scores and ranking of Arab Countries along the three pertinent indicators, namely health impact, air quality and climate change and energy.

40. Only four countries, namely four GCC countries, i.e., UAE, Saudi Arabia, Kuwait and Qatar have an EPI ranking among the first fifty countries worldwide with a score above 63/100 and are considered to be good environmental performers. Eight countries (Egypt, Tunisia, Jordan, Syria, Morocco, Lebanon and Bahrain) have scores between 61 and 50/100 with a second-tiers ranking and are considered to be acceptable environmental performers. Oman, Iraq, Comoros island, Yemen, Djibouti, Sudan and Somalia, rank in the last third-tiers.

41. Global Competitiveness Index 2014-2015[24] assesses the competitiveness of 144 economies, reflecting the drivers of their productivity and prosperity. There are twelve indicators of competitiveness: 1. Institutions; 2. appropriate infrastructure; 3. a stable macroeconomic framework; 4. good health and primary education; 5. higher education and training; 6. efficient goods markets; 7. efficient labor markets; 8. developed financial markets; 9. the ability to harness the benefits of existing technologies; 10. its market size, both domestic and international; 11. by producing new and different goods using the most sophisticated production processes; and 12. Innovation.

42. Table 3.3 illustrates the Global Competitiveness Index of Arab countries. It is interesting to show that all GCC countries are among the first 50 countries worldwide in term of global competitiveness. The Maghreb countries and Jordan have scores between 4.3-4.0/7 and rank on the second tiers of global competiveness with ranking ranging from 64-87, whereas the third-tiers of Lebanon, Egypt, Libya and Yemen rank very low with ranking varying between 113 to 142 over the 147 countries surveyed.

43. It is also interesting to note in Figure 3.2 (which normalized the environment performance with global competitiveness) that for at least the GCC countries, there is a positive correlation between

[24] GCI Website: <http://reports.weforum.org/global-competitiveness-report-2014-2015/>.

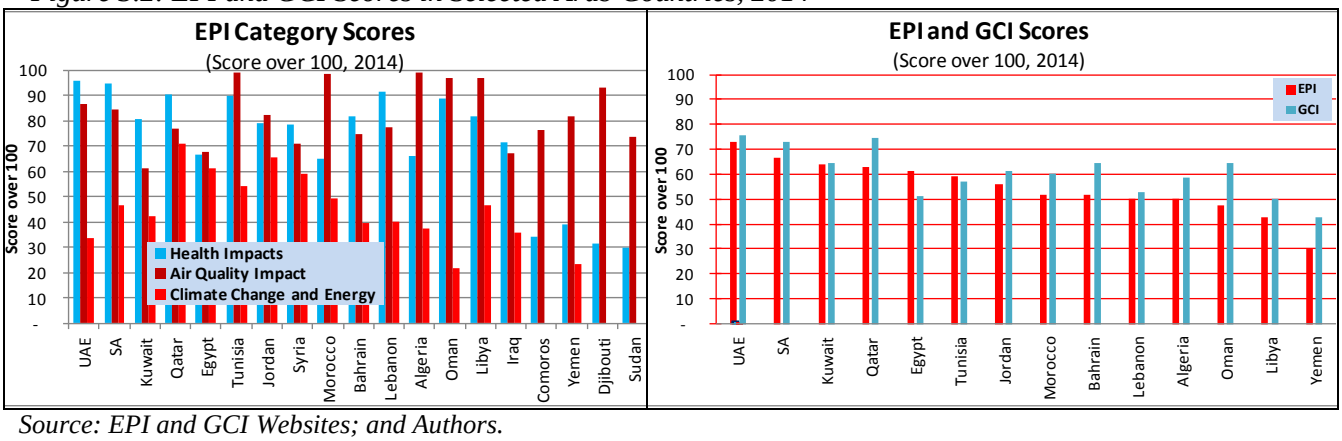
competitiveness and environmental performance. Such correlation is less evident for the other Arab Countries and particularly for the case of Iraq, Yemen and Sudan. International experience has proven that stronger and well-crafted environmental regulations reduce costs for business, create green markets, diminish business risk, drive innovation, increase confidence in the market and create competitive markets and job. Improved economic competitiveness such as in the case of the GCC, allows them to invest in better environmental protection. Improvements in the environment also build the underlying competitiveness of GCC industries. However, more data and research are required to verify and better understand this correlation.

Table 3.3: Global Competitiveness Index in Selected Arab Countries, 2014

Country	**GCI**		
	Scores over 7	Score rebased to 100	Ranking over 144 countries
United Arab Emirates	5.3	76	12
Qatar	5.2	74	16
Saudi Arabia	5.1	73	24
Kuwait	4.5	64	40
Bahrain	4.5	64	40
Oman	4.5	64	46
Jordan	4.3	61	64
Morocco	4.2	60	72
Algeria	4.1	59	79
Tunisia	4.0	57	87
Lebanon	3.7	53	113
Egypt	3.6	51	119
Libya	3.5	50	126
Yemen	3.0	43	142

Note: Only countries with GCI are considered
Source: GCI Website <http://reports.weforum.org/global-competitiveness-report-2014-2015/>; and Authors.

Figure 3.2: EPI and GCI Scores in Selected Arab Countries, 2014



Source: EPI and GCI Websites; and Authors.

4. Local and Global Fossil Fuel Landscape in Arab Countries

44. This section assesses Arab Country local and global fossil fuel landscape in terms of emissions, energy production and consumption, provides an order of magnitude of the local and global damages from ambient air pollution associated with the combustion of fossil fuels, and analyzes fossil fuel subsidies.

4.1 Energy Use, Electricity, and Carbon Emissions and Intensity Overview

45. With a population representing 5.1% of the world population in 2010, Arab Countries have an average per capita energy use close to the world benchmark (1.8 against 1.9 tons of oil equivalent per capita). Arab Country energy use reach 118 (with large variation from 148 in GCC to 76 in the Mashreq) against a global 139 kg of oil equivalent per PPP$ 1,000 GDP. Similarly, electric power consumption in Arab Countries is close to the world benchmark: 2.3 against 3.0 MW/h per capita (with large variation from 9.1 in GCC 0.15 MW/h in LIC). Table 4.1 and Figure 4.1 provide global comparisons, when available, to situate Arab Countries.

Table 4.1: Energy Use, Electricity, and Carbon Emission and Intensity Overview, 2010

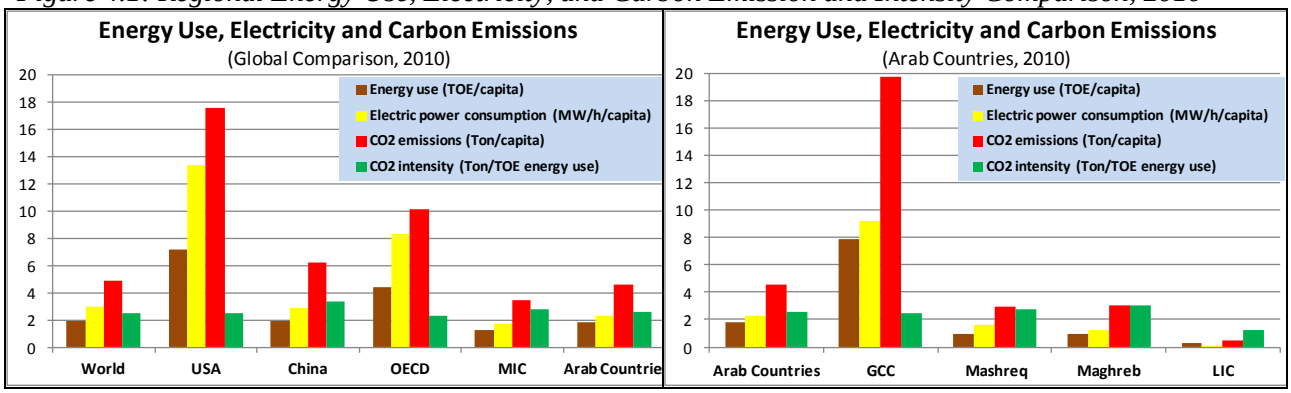
Energy use, Electricity and CO_2 emissions	**World**	**USA**	**China**	**OECD**	**MIC**	**Arab Countries**	**By Group**			
							GCC	**Mashreq**	**Maghreb**	**LIC**
Energy use (ton of oil equivalent per capita)	1.9	7.2	1.9	4.4	1.2	1.8	7.9	1.0	1.0	0.3
Energy use (kg of oil equivalent) per constant 2011 PPP$ 1,000 GDP	139	145	204	8.3	1.7	118	148	76	86	79
Electric power consumption (MW/h per capita)	3.0	13.4	2.9	8.3	1.7	2.3	9.2	1.6	1.2	0.1
CO_2 emissions (metric tons per capita)	4.9	17.6	6.2	10.2	3.4	4.6	19.7	2.9	3.0	0.5
CO_2 intensity (Ton per TOE equiv. energy use)	2.5	2.5	3.3	2.3	2.8	2.6	2.5	2.8	3.0	1.2

Note: Totals may not add up due to rounding. Energy use, Electricity and CO_2 are weighted by population.
Source: WDI (2015); and Authors' calculation.

46. As a result, Arab Countries (4.6 tons of CO_2 per capita) have an average per capita emissions also close to the world benchmark (4.9 tons of CO_2 per capita) and accounts for a small share of the world CO_2 emissions in 2010 (4.8%). However, these per capita indicators are significantly skewed towards the GCC groups (19.7 tons of CO_2 per capita) as the other groups are well below the world benchmarks (Table and Figure 4.1). Yet, GCC countries are more efficient in terms of intensity as their CO_2 emission of oil equivalent energy use is equivalent to the world benchmark (2.5 kg per kg of oil equivalent energy

use) and much lower than the Mashreq and Maghreb groups (2.8 and 3.0 kg per kg of oil equivalent energy use).

Figure 4.1: Regional Energy Use, Electricity, and Carbon Emission and Intensity Comparison, 2010



Source: WDI (2015); and Authors' calculation.

4.2 Energy and Electricity Landscape

47. Energy production in Arab Countries reached the equivalent of 1,683 million TOE in 2010 with GCC being responsible for more than half the production (66%) while the Mashreq (14%) and the Maghreb (15%) are responsible for almost the same share leaving LIC with 4%.

Table 4.2: Energy Production and Use in Arab Countries, 2010

Energy Production	**World**	**USA**	**China**	**OECD**	**MIC**	**Arab Countries**	**By Group**			
							GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	6,884	309	1,338	1,240	4,803	348	45	145	85	73
Energy Production (TOE million)	12,826	1,723	2,262	3,877	6,489	1,683	1,117	243	253	69
Energy Use (TOE million) *of which:*	12,516	2,216	2,517	4,359	5,906	614	349	147	88	31
- Industry						*103*	*66*	*22*	*11*	*3*
- Transport						*113*	*52*	*32*	*24*	*5*
- Residential, Public Buildings, Forestry						*91*	*31*	*31*	*19*	*10*
- Non-use *(associated with refinery processes)*						*76*	*61*	*9*	*6*	*0*

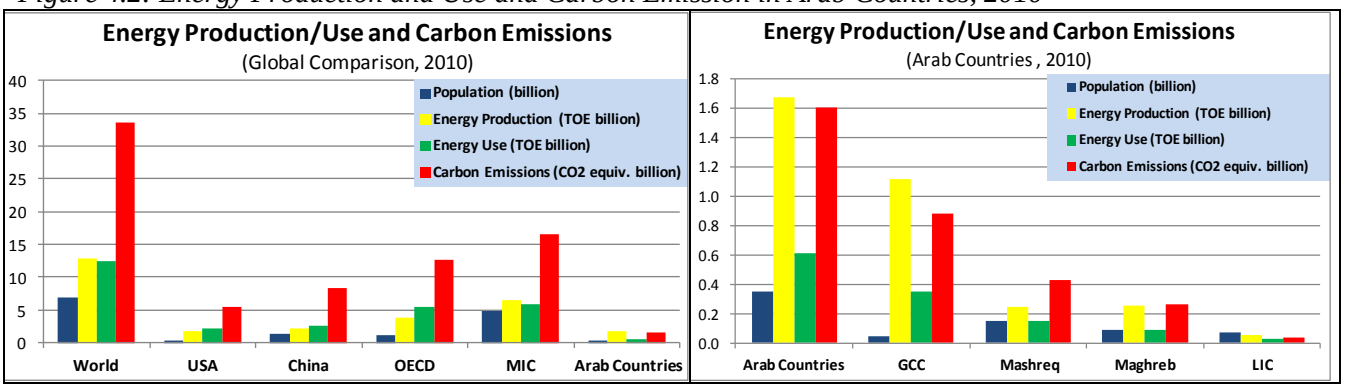
Note: Totals may not add up due to rounding. Energy use data for Palestine, Comoros, Djibouti, Mauritania and Somalia are not available.

Source: IEA Website <www.iea.org>; and WDI (2015).

48. Energy use in Arab Countries reached the equivalent of 614 million TOE in 2010, i.e., net exports represent 64% of production. Again, GCC is the highest consumer (57%) followed by the Mashreq (24%), the Maghreb (14%) and LIC with 5%. By sector, transportation is the highest energy user with 113 million TOE in 2010 followed by industry (103 million TOE), residential, public buildings and

forestry (91 million TOE), and non-use energy (76 million TOE) which is associated with refinery processes. Across groups, the relative ranking remains the same except for GCC that uses more energy for industrial processes than transportation (Table 4.2 and Figure 4.2).

Figure 4.2: Energy Production and Use and Carbon Emission in Arab Countries, 2010



Source: IEA Website <www.iea.org>; and WDI (2015).

49. The installed capacity of power generation reached about 221 GW in Arab Countries in 2010. However, the capacity is imbalanced across groups as: the GCC is home to 13% of the population and 55% for the power generation; the Mashreq is home to 42% and 29% of the capacity; the Maghreb is home to 24% and 14% of the capacity and Morocco is the only country still using coal to produce energy; and LIC is by far the worst off with 21% of the population and 2% of the installed capacity although Comoros, Djibouti, Mauritania and Somalia capacity is not included (Table 4.3 and Figure 4.3).

50. With regards to renewable energy installed capacity, it represents 11 GW or 5% of installed capacity. However, the highest installed capacity is indirectly related to the highest CO_2 emitters where LIC (38%) has the highest installed capacity followed by the Mashreq (11%), the Maghreb (8%) and GCC with a symbolic capacity of 0.1% (Table 4.3 and Figure 4.3).

51. There is a large deficit between power generation (868 TW/h) and consumption (758 TW/h) reaching 13% in Arab Countries in 2010. This is notably due to transmission and distribution losses whereas the benchmark losses do not exceed 8% worldwide and 6% in both the USA and China. Across groups, these losses are the highest in LIC (19%) followed by the Mashreq (16%), the Maghreb (15%) and GCC with

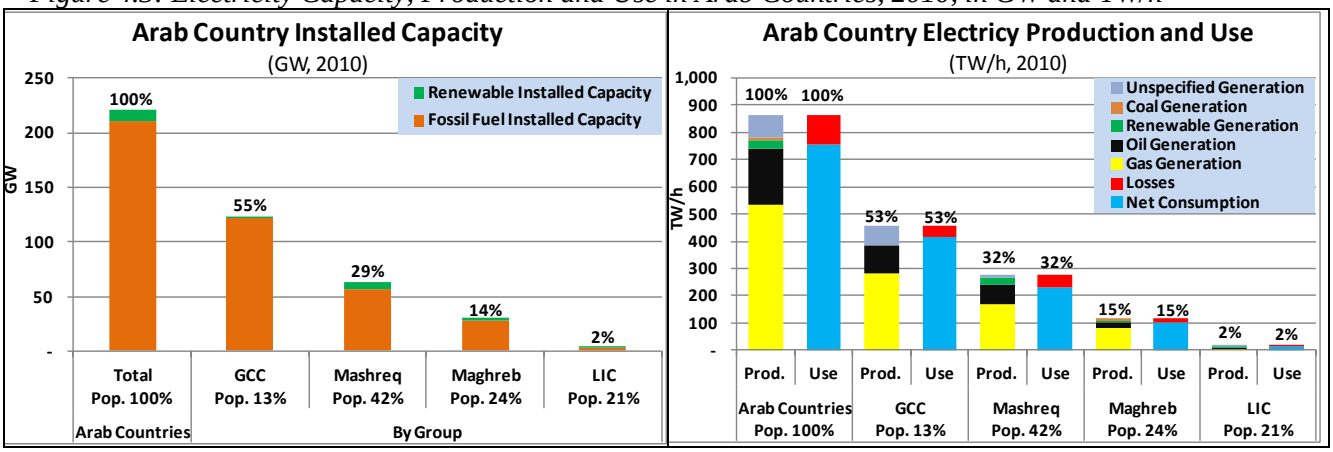
9% that is closer to the world benchmark. However, consumption does not include private generation through industrial, communal or individual power generators which explains the differential between the production/consumption (labeled unspecified generation in Table 4.3 and Figure 4.3).

Table 4.3: Electricity Capacity, Production and Use in Arab Countries, 2010, in GW and TW/h

Electricity Capacity and Production	**World**	**USA**	**China**	**Arab Countries**	**By Group**			
					GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	6,884	309	1,338	348	45	145	85	73
Electricity Installed Capacity (GW)	5,081.4	1,039.1	987.3	221.5	122.7	63.5	31.1	4.2
-Renewable installed Capacity (GW)	1,208.7	133.5	255.4	11.0	0.2	6.7	2.6	1.6
Electricity Production (TW/h) *of which:*	*21,470*	*4,354*	4,208	864	456	274	118	17
-Transmission and Distribution Losses	*1,745*	*261*	*257*	*109*	*42*	*45*	*18*	*3*
-Gas Generation	*4,777*	*1,018*	*69*	*532*	*284*	*166*	*79*	*2*
-Oil Generation	*808*	*48*	*13*	*207*	*100*	*75*	*24*	*7*
-Renewable Generation	*4,197*	*441*	*793*	*34*		*23*	*4*	*6*
-Unspecified Generation *(private, imports, etc.)*				*80*	*72*	*10*	*0*	*2*
- Nuclear Generation	*2,756*	*839*	*74*					
-Coal Generation	*8,640*	*1,994*	*3,250*	*11*			*11*	
Electricity Consumption (TW/h)	19,688	4,143	3,938	758	407	235	104	12

Note: Totals may not add up due to rounding. Installed capacity does not include Comoros, Djibouti, Mauritania and Somalia.
Source: WDI (2015).

Figure 4.3: Electricity Capacity, Production and Use in Arab Countries, 2010, in GW and TW/h



Source: RCREEE Website: <www.rcreee.org>; and WDI (2015).

52. With regards to the energy production breakdown, gas generation is the highest (532 TW/h) and represents 62% of the power generation in Arab Countries in 2010 followed by oil (207 TW/h) with 24%, renewables (34 TW/h) with about 5% and coal (11 TW/h) with 1% that is exclusively used in Morocco. Across groups, gas and oil share follow the region trend except in LIC. Moreover, the renewable energy

installed capacity does not reflect the renewable production as a large share of the energy, especially in the Mashreq (11% installed against 8% produced) and Maghreb (8% installed against 3% produced), is generated with hydropower which is sensitive to climate variability (Table 4.3 and Figure 4.3).

53. Regional power distribution network integration is well underway in each group of countries although it is not detailed in this context. For instance, Morocco is planning to export renewable energy to Europe in the future although it is encountering stiff competition from Spain (70 percent of its energy generation is from renewable and nuclear in 2014 with growing renewable targets in the future).

4.3 Local Emission Landscape

54. Regarding the 3 main criteria pollutants (NOx, SOx and $PM_{2.5}$), Arab Countries emit 5.5 million tons of NOx, 6.9 million tons of SOx and 0.7 million tons of $PM_{2.5}$. GCC and Mashreq countries are responsible for about half the SOx and NOx emissions whereas the largest emitter of $PM_{2.5}$ is the Mashreq, due mainly to Egypt, followed by LIC, Maghreb and GCC (Table 4.4).

Table 4.4: Local Damage Costs from Ambient Air Pollution in Arab Countries, 2010

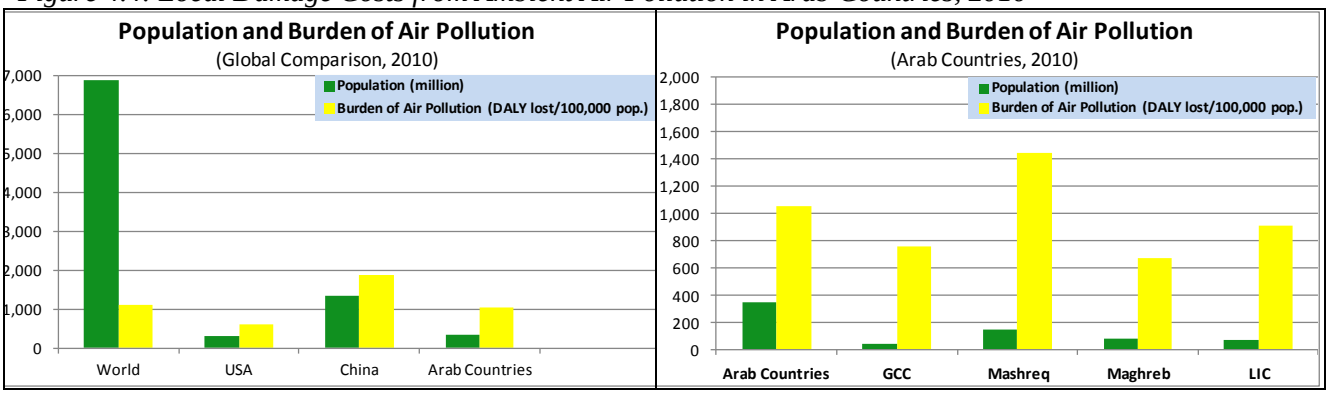
Population, Burden of Disease and Local Damages	**World**	**USA**	**China**	**Arab Countries**	**By Group**			
					GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	6,884	309	1,338	348	45	145	85	73
***Population** (%)*				*100%*	*13%*	*42%*	*24%*	*21%*
NOx Emissions (Ton million)				5.5	2.4	1.8	0.8	0.5
SOx Emissions (Ton million)				6.9	3.1	2.3	1.1	0.3
$PM_{2.5}$ Emissions (Ton million)				0.7	0.0	0.3	0.2	0.2
Burden of Air Pollution (DALY lost million)	76.0	1.8	25.2	3.7	0.4	2.1	0.6	0.7
***Burden of Air Pollution** (DALY lost %)*				*100%*	*11%*	*57%*	*16%*	*19%*
Burden of Air Pollution (DALY lost/100,000 pop.)	1,104	589	1,886	1,053	756	1,446	668	906
Local Damage Cost (PPP$ billion)				47.4	17.1	21.2	6.8	2.3
***Local Damage Cost** (%)*				*100%*	*36%*	*45%*	*14%*	*5%*
Local Damage Cost (% of GDP)				0.9%	0.7%	1.6%	0.7%	0.9%

Note: Totals may not add up due to rounding. Percentage local damage cost in terms of GDP considers the GDP denominated in international PPP$. Transboundary pollutant compounds are not considered. The 2005 EU EDGAR emissions were adjusted for 2010.

Source: IHME Website <www.healthdata.org>; EU EDGAR Website: <http://edgar.jrc.ec.europa.eu/>; WDI (2015); and Authors' calculation.

55. The burden of ambient air pollution from local environmental degradation is equivalent to 3.7 million DALYs lost (the DALY, which is equivalent to *one year lost of healthy life*, is the "currency of health" – see Annex I) in Arab Countries representing 4.8% of the world burden of disease from ambient air pollution just short of the population share (4.8%) in 2010 (Table 4.4 and Figure 4.4). When bringing the DALY lost to the same denominator, i.e., DALY lost per 100,000 population, Arab Countries' score (1,053 DALY lost per 100,000 population) is within the world benchmark (1,104 DALY lost per 100,000 population), is worse than the USA (589 DALY lost per 100,000 population) but fair much better than China (1,886 DALY lost per 100,000 population).

Figure 4.4: Local Damage Costs from Ambient Air Pollution in Arab Countries, 2010



Source: IHME Website <www.healthdata.org>; WHO Website: <www.who.ch>; IPCC Website: <www.ipcc.ch>; WDI (2015); and Authors' calculation.

56. By Arab Country group, GCC (13% of the population) bears less burden of disease from air pollution (11%) than other groups but GCC accounts for 36% (PPP$ 17.1 billion) of the damage cost. The Mashreq (42% of the population) bears the brunt of the burden of disease from ambient air pollution (57%), especially Egypt, and accounts for PPP$ 21.2 billion (45%) in damage cost. The Maghreb (42% of the population) bears 16% of the burden of disease from air pollution and accounts for PPP$ 6.8 billion (14%) in damage cost. With a 21% of total population, the LIC group bears 19% of the health burden, especially due to Sudan and Yemen, while only accounting for PPP$ 2.3 billion (5%) in damage cost.

57. The lower bound damage cost reach PPP$ 47.4 billion equivalent to 0.9% of the Arab Countries' GDP in 2010 (Table 4.4) of which roughly PPP$ 39.1 billion are attributable to fossil fuel combustion and the rest

being associated with natural causes, construction dust, etc. (see Annex I). Yet, the use of the value of statistical life for premature death significantly increases this figure by at least 5 fold (PPP$ 249.3 billion) and could be considered as an upper bound local damage cost.

4.4 Global Emission Landscape

58. Carbon emissions from fossil fuel combustion and process are equivalent to about 1.4 billion tons of CO_2 equiv. with damage costs reaching PPP$ 26.3 billion equivalent to 0.5% of the Arab Country GDP in 2010 (Table 4.5) when a conservative CO_2 social cost used is PPP$ 18 per ton (Nordhaus, 2011, see Annex I). Yet, if the United States Interagency Working Group on Social Cost of Carbon (IWGSC -- 2010) of PPP$ 33.6 per ton of CO_2 emitted is used, this figure increases by less than 2 fold (PPP$ 49.1) and could be considered as an upper bound global damage cost.

Table 4.5: Global Damage Costs from Ambient Air Pollution in Arab Countries, 2010

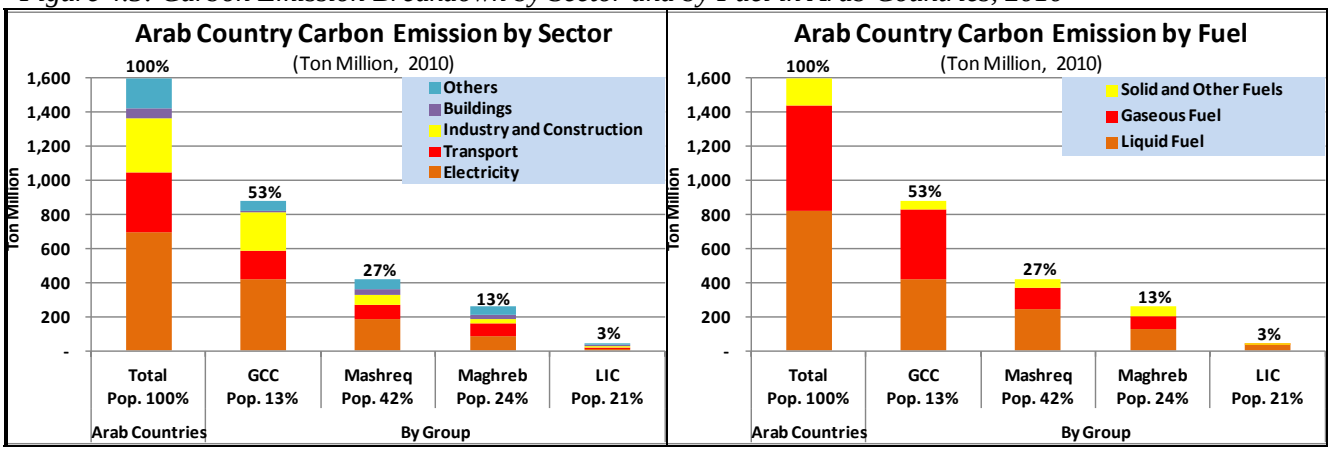
Population, Carbon Emission from Fossil Fuel Combustion and Global Damages	**Arab Countries**	**By Group**			
		GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	348	45	145	85	73
***Population** (%)*	*100%*	*13%*	*42%*	*24%*	*21%*
Carbon Emissions (Ton billion CO_2 equiv.) of which:	**1.4**	**0.8**	**0.4**	**0.2**	**0.04**
***Breakdown by Sector** (% by Group)*	*100%*	*53%*	*27%*	*13%*	*3%*
***-Electricity** (% by Category)*	*44%*	*48%*	*43%*	*34%*	*22%*
***-Transport** (% by Category)*	*22%*	*20%*	*21%*	*28%*	*36%*
***-Industry and Construction** (% by Category)*	*20%*	*25%*	*13%*	*12%*	*19%*
***-Public and Private Buildings** (% by Category)*	*4%*	*1%*	*8%*	*8%*	*7%*
***-Other Sectors** (% by Category)*	*10%*	*6%*	*15%*	*18%*	*16%*
***Breakdown by Fuel** (% by Group)*	*100%*	*53%*	*27%*	*13%*	*3%*
***-Liquid Fuel combustion** (% by Category)*	*52%*	*48%*	*57%*	*50%*	*90%*
***-Gaseous Fuel Combustion** (% by Category)*	*38%*	*47%*	*30%*	*30%*	*4%*
***-Solid (coal, peat, etc.) and Other Fuel Combustion** (% by Category)*	*10%*	*5%*	*13%*	*20%*	*6%*
Carbon Value (PPP$/$CO_2$ equiv.)	18	18	18	18	18
Global Damage Cost (PPP$ billion)	26.3	15.0	6.7	3.9	0.7
***Global Damage Cost** (%)*	*100%*	*57%*	*25%*	*15%*	*3%*
Global Damage Cost (% of GDP)	0.5%	0.6%	0.5%	0.4%	0.3%
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Totals may not add up due to rounding. International aviation and marine bunker CO_2 emissions are not considered.

Source: IPCC Website: <www.ipcc.ch>; WDI (2015); and Authors' calculation.

59. By Arab Country group, the GCC (13% of the population) is responsible for the highest CO_2 emission share (53%) and bears a damage cost of PPP$ 15 billion (0.6% of GDP). The Mashreq (42% of the population) is responsible for 27% of emissions bearing PPP$ 6.7 billion (0.5% of GDP) in damage cost. The Maghreb (24% of the population) is responsible for 13% of emissions bearing PPP$ 3.9 billion (0.4% of GDP) in damage cost. With an 21% of total population, LIC release 3% of the CO_2 emissions accounting PPP$ 0.7 billion (0.3% of GDP) in damage cost.

Figure 4.5: Carbon Emission Breakdown by Sector and by Fuel in Arab Countries, 2010



Note: International aviation and marine bunker CO_2 emissions are not considered.
Source: WDI (2015); and Authors' calculation.

60. By sector, CO_2 emissions are primarily attributable to electricity (44% of total with variation across group from 48% in GCC to 22% in LIC) followed by transport (22% of total with variation across group from 36% in LIC to 20% in GCC), industry and construction (20% of total with variation across group from 25% in GCC to 12% in Maghreb), public and private buildings (4% of total with variation across group from 8% in Machreq-Maghreb and 1% in GCC), and others (10% of total with variation across group from 18% in Maghreb to 6% in GCC) (Table 4.5 and Figure 4.5). Interestingly, GCC electricity and industry and construction mainly in terms of refineries and oil derivatives are the larger CO_2 emitters (68%) while electricity and transport are the largest emitters in LIC (59%).

61. By fuel, CO_2 emissions are primarily attributable to liquid fuel combustion (52% of total with large variation across group from 90% in LIC to 48% in GCC) followed by gaseous fuel combustion (38% of

total with variation across group from 47% in GCC to 4% in LIC), solid and other fuel combustion (10% of total with variation across group from 20% in Maghreb including 5% from coal powered electricity in Morocco to 5% in GCC) (Table 4.5 and Figure 4.5).

4.5 Damage Cost Results from Local and Global Ambient Air Pollution

4.5.1 Aggregate Damage Cost Results

62. The total local and global damage costs from ambient air pollution, which should be considered a lower bound figure, in Arab Countries amounts to PPP$ 73.2 billion equivalent to 1.4% of GDP in 2010 (Table 4.6 and Figure 4.6) of which roughly PPP$ 59 billion are attributable to fossil fuel combustion. The upper bound figure increases the total local and global damage costs by more than 5 fold: PPP$ 297 billion equivalent to 5.9% of GDP in 2010 and a midpoint between the lower and upper bounds would set the total local and global damage costs at PPP$ 185 billion equivalent to 3.7% of GDP in 2010.

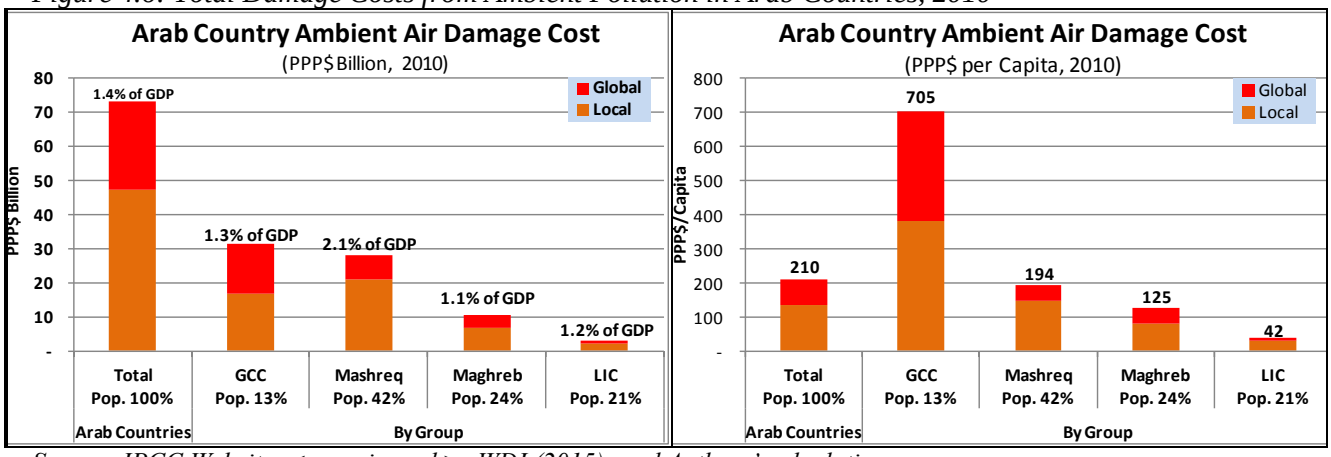
Table 4.6: Global Damage Costs from Ambient Air Pollution in Arab Countries, 2010

Population, Carbon Emission from Fossil Fuel Combustion and Global Damages	**Arab Countries**	**By Group**			
		GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	348	45	145	85	73
***Population** (%)*	*100%*	*13%*	*42%*	*24%*	*21%*
Local Damage Cost (PPP$ billion)	47.4	17.1	21.2	6.8	2.3
Global Damage Cost (PPP$ billion)	25.8	14.3	6.8	3.9	0.7
Total Damage Cost (PPP$ billion)	73.2	31.4	28.1	10.7	3.0
***Total Damage Cost** (%)*	*100%*	44%	38%	15%	4%
Total Damage Cost (% of GDP)	1.4%	1.3%	2.1%	1.1%	1.2%
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Totals may not add up due to rounding. Totals are not weighted.
Source: IPCC Website: <www.ipcc.ch>; WDI (2015); and Authors' calculation.

63. By group, the Mashreq and Maghreb bear the majority of the damage cost of PPP$ 38.8 billion (52% of total damage cost) equivalent to 2.1% and 1.1% of their GDP respectively.

Figure 4.6: Total Damage Costs from Ambient Pollution in Arab Countries, 2010



Source: IPCC Website: <www.ipcc.ch>; WDI (2015); and Authors' calculation.

4.5.2 Damage Cost Results per Capita

64. The results per capita produce a better picture on gaps among groups. Hence, the total local and damage cost from 3 criteria ambient pollutants and carbon emissions from fossil fuel amounts to PPP$ 210 per capita in 2010 (Table 4.7 and Figure 4.6).

65. There is a very large disparity (14 fold) between LIC and GCC with regards to total damage costs (PPP$ 42 and 705 per capita respectively) with Mashreq and the Maghreb countries reaching PPP$ 194 and 125 per capita respectively. On average, local and global damage costs represents 65% and 35% respectively of total damage with moderate variations (54% to 76% for local and 24% to 46% for global) across groups (Table 4.7 and Figure 4.6).

Table 4.7: Total Damage Costs per Capita from Fuel Combustion Emissions in Arab Countries, 2010

Population, Carbon Emission from Fossil Fuel Combustion and Global Damages	**Arab Countries**	**By Group**			
		GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	348	45	145	85	73
***Population** (%)*	*100%*	*13%*	*42%*	*24%*	*21%*
Local Damage Cost (PPP$ per capita)	136	384	147	79	32
Global Damage Cost (PPP$ per capita)	74	321	47	46	10
Total Damage Cost (PPP$ per capita)	210	705	194	125	42
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Totals may not add up due to rounding. Totals are weighted by population.
Source: IPCC Website: <www.ipcc.ch>; WDI (2015); and Authors' calculation.

4.6 Subsidy Landscape

4.6.1 Fossil Fuel Subsidies

66. Usually, the gap (also called the price gap approach) between subsidized price and benchmark price (the price paid by firms and households relative to supply and distribution costs without including environmental externalities) reflects the opportunity cost (see Annex I for subsidies distortions). The fossil fuel subsidies in Arab Countries amount to an opportunity cost of US$ 191 billion (8% of Arab Country GDP) equivalent to PPP$ 423 billion in 2011 (Table 4.8 and Figure 4.7). The bulk of the fossil fuel subsidies benefits GCC (58% of total Arab Country subsidies which is equivalent to 9% of GDP) followed by the Mashreq (26% equivalent to 11% of GDP), the Maghreb (15% equivalent to 7% of GDP) and LIC (2% equivalent to 3% of GDP).

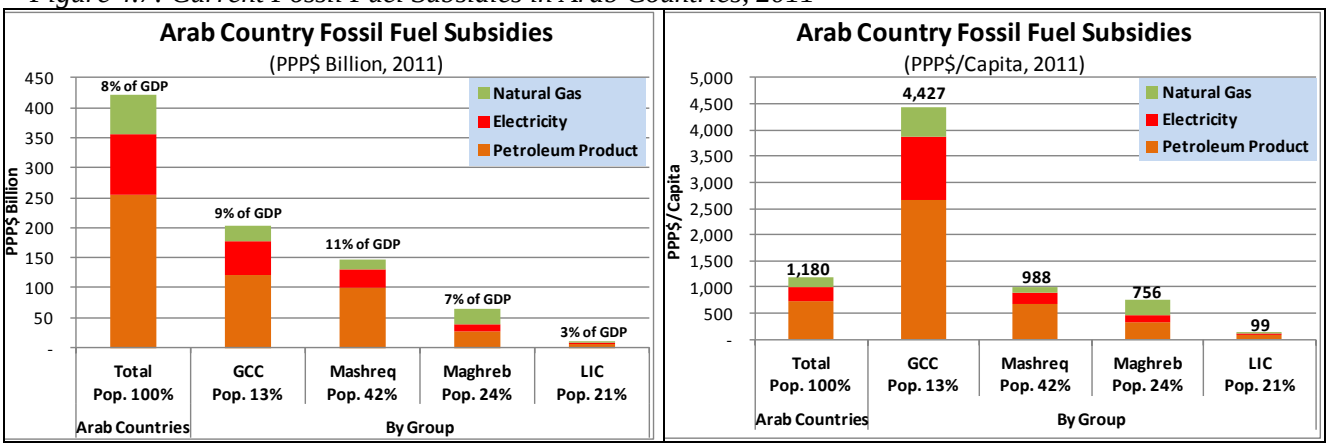
67. The fossil fuel subsidies per capita in Arab Countries reaches PPP$ 1,180 per capita with large variations across groups where GCC provides the highest subsidy with PPP$ 4,427 followed by a distant Mashreq with PPP$ 988 then Maghreb with PPP$ 716 and LIC with PPP$ 99.

Table 4.8: Current Fossil Fuel Subsidies in Arab Countries, 2011

Current Subsidies by Fossil Fuel	**Arab Countries**	**By Group**			
		GCC	**Mashreq**	**Maghreb**	**LIC**
Population (million)	348	45	145	85	73
Population *(%)*	*100%*	*13%*	*42%*	*24%*	*21%*
Petroleum Product, US$ billion	111	62	35	12	2
Electricity, US$ billion	46	31	11	5	0
Natural Gas, US$ billion	32	17	4	11	0
Coal, US$ billion	0	0	0	0	0
Current Fossil Fuel subsidies, US$ billion	191	110	50	28	3
Current Fossil Fuel subsidies, PPP$ billion	423	204	146	65	7
Electricity subsidy weighted average, US$ per KW/h	0.064	0.073	0.052	0.051	0.004
Electricity subsidy weighted average, PPP$ per KW/h	0.135	0.132	0.148	0.117	0.012
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Totals may not add up due to rounding. Energy subsidy includes petroleum, electricity, natural gas and coal subsidies. The subsidies for Palestine, Syria, Comoros and Somalia are not included. The Electricity subsidy per KW/h does not include Syria and Palestine for the Machreq and only includes Yemen for LIC. Only the GDP with subsidy data is considered.
Source: IMF (2014); WDI (2015); and Authors' calculation.

Figure 4.7: Current Fossil Fuel Subsidies in Arab Countries, 2011



Source: IMF (2014); WDI (2015); and Authors' calculation.

68. By subsidized categories, petroleum products rank first and represent 58% of the fossil fuel subsidies with variations across the groups (Table 4.8 and Figure 4.7): GCC, 56%, Mashreq, 70%; Maghreb, 43%; and LIC 67%. Natural gas subsidies rank second with 25% with the Maghreb (mainly Algeria and Libya) taking the lead with 39% followed by GCC (15%), the Mashreq (8%) and LIC (0%). Electricity subsidies rank third (24%) with GCC also taking the lead (28%) followed by the Mashreq (22%), the Maghreb (19%) and LIC (0%).

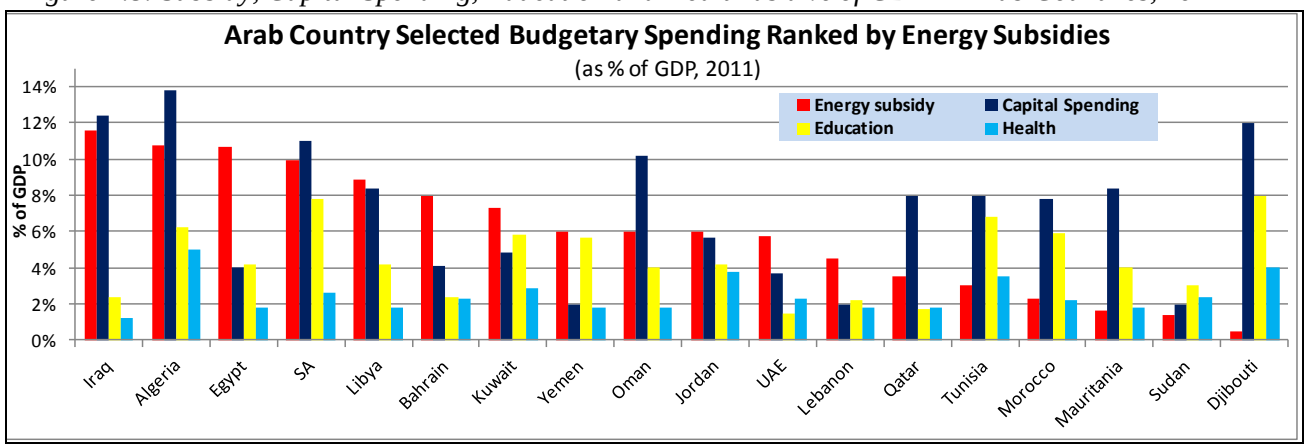
69. Electricity subsidy amounts to US$ 0.064 per KW/h equivalent to PPP$ 0.135 per KW/h in Arab Countries in 2011 with the following breakdown: 0.132 in GCC; 0.148 in Machreq; 0.117 in Maghreb; and 0.012 for LIC.

4.6.2 Opportunity Cost

70. To have a better grasp of the opportunity cost of fossil fuel subsidies in Arab Countries that could be allocated more efficiently, Figure 4.8 compares these subsidies to public capital spending, education and health as a percentage of GDP spending by country and illustrates the large subsidy variation as compared to other budgetary appropriations in 2011. Most GCC, Iraq, Algeria and Jordan subsidies exceed or almost match capital spending suggesting poor allocative efficiencies and disincentives to switch to cleaner energy. However, countries like Bahrain, Yemen, Lebanon and especially Egypt have

subsidies that are dwarfing other key budgetary allocations that are a growing drain on government budgets, a reduction of foreign exchange reserves for the net oil/gas importing countries as well as a threat to the debt repayment sustainability, e.g., Egypt's US$ 20.3 billion energy subsidies are greater than the US$ 19.2 billion fiscal deficit in 2010[25] although an effort by the government to increase energy prices for heavy industries, energy inputs for electricity producers, and household electricity use was initiated since early 2013. Conversely, Djibouti, Mauritania, Morocco, Sudan and to a certain extent Tunisia were able to significantly reduce their subsidies when compared to capital spending and social sector allocations (Figure 4.7). This could translate into better green investment prospects and a better stance towards green growth driving the economy.

Figure 4.8: Subsidy, Capital Spending, Education and Health as a % of GDP in Arab Countries, 2011



Note: Palestine, Syria, Comoros and Somalia are not included.
Source: IMF (2014).

71. Consensus is building among a number of governments to gradually reform the subsidy system by considering smart and targeted subsidies instead of across the board subsidies that are distorting market signals, benefiting middle to higher income brackets and putting increasing fiscal strain on government budgets, e.g., Morocco has one of the energy smallest subsidy (2.3% of GDP for fuel products) in Arab Countries when compared to GDP and is embarking on a green growth path.

[25] Fattouh, B and L. El Katiri. 2012. *Energy Subsidies in the Arab World*. UNDP, Arab Human Development Report Research Paper Series. New York, N.Y.

4.7 Landscape Results

72. The energy damage costs resulting from the local and global emissions are extremely high and represent 18% the amount of subsidies. The economy of all these countries will suffer from both the damage costs of PPP$ 73 billion and the loss of the opportunity costs of PPP$ 423 billion totaling PPP$ 496 billion for one year. Market penetration of RET will be limited in these circumstances as there capital and operations and maintenance will also be subsidized by governments. This will also worsen the countries financial deficits for the Arab countries other than the GCC. The later can afford these deficits given the large size of their sovereign funds. The penetration of the RET will be limited only to demonstrating or piloting the technology instead of substituting conventional energy unless more ambitious targets are considered in the future while tapping new sources of funding (see Section 7 below).

5. Renewable Energy Technology Cost-Benefit in Arab Countries

73. Based on the conclusions of the previous section, this Section will:

1. Take stock of Arab Country 2020 and 2030 cumulative renewable energy technology (RET) targets in terms of power generation.

2. Assess 3 energy demand cost and co-benefit scenarios in Arab Countries in 2020:

    a. Scenario 1: The lower bound business as usual (BAU) scenario in 2020. This scenario consists of an 11% increase in incremental energy demand in 2020 which will solely be produced by conventional energy (combined cycle gas) keeping the energy generated by the RET in 2020 unchanged and similar to the energy production by RET in 2010 of 4%. This is considered the worst case scenario for moving into green energy: Governments will not be investing in additional RET energy production.

    b. Scenario 2: The Pan Arab RET Target in 2020. Scenario 2 which consists of the incremental RET power generation needed to comply with the RET Pan-Arab Strategy target (i.e., over and above the existing 4% in 2010). This means that a certain percentage of future energy production as committed by every country will be converted to RETs, i.e., over and above the target of installed RET in 2010. This is the "anticipated bound" scenario that was politically committed the Arab Countries which could lead into green energy.

    c. Scenario 3; The Upper bound where all the incremental energy demand between the 2010 baseline and 2020 is exclusively provided through RET sources (refer to Table 5.2) increasing therefore the targets to 29% incremental RET energy generation which is the difference between the 2020 and 2010 baseline energy demand. This is considered an upper bound scenario in case Arab Countries decide to go over and above the targets that were

committed under Scenario 2 and therefore necessitate strong political commitment to effect RET market penetration. The scenarios are described in Table 5.2 below.

3. Carry out cost and co-benefit analysis scenarios to arbitrate between the first 2 scenarios to derive the breakeven point that will allow to balance the 2020 RET target incremental cost with the levels of incentives needed after accounting for the accrued environmental local and global co-benefits.

5.1 Cumulative Versus Incremental RET Power Generation Targets

74. In this report, incremental RET power generation targets are estimated instead of the cumulative power generation targets over 2020-2030, which were included in the RET Pan Arab Strategy power generation targets, to be able to derive the additional investments needed to reach these targets. Except for GCC that did not have any significant RET in 2010, the Mashreq, Maghreb and LIC 2010 RET power generation was therefore not considered in the incremental targets.

Table 5.1: Cumulative RET Power Generation Targets in Arab Countries, 2010-30

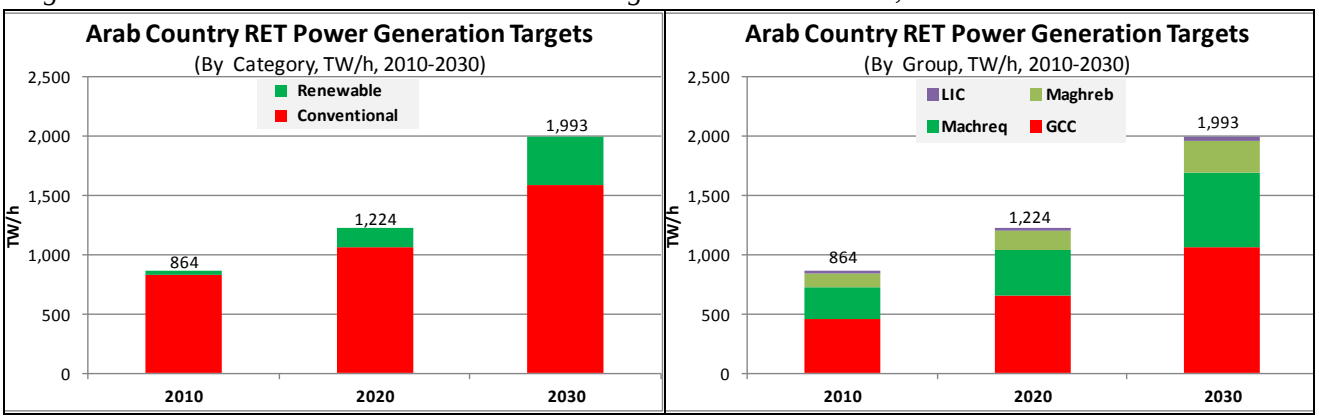
Cumulative Power Generation	Arab Countries	GCC	Mashreq	Maghreb	LIC
	(TW/h)	(TW/h)	(TW/h)	(TW/h)	(TW/h)
Baseline 2010	**4%**	**0%**	**8%**	**4%**	**38%**
Conventional	830	456	251	114	11
Renewable	34	0	23	4	6
Total	864	456	274	118	17
Cumulative Target 2020	**13%**	**13%**	**14%**	**10%**	**38%**
Conventional	1,061	572	330	147	12
Renewable	163	84	55	17	7
Total	1,224	656	385	164	19
Cumulative Target 2030	**20%**	**25%**	**10%**	**26%**	**26%**
Conventional	1,591	803	567	199	23
Renewable	402	265	60	68	8
Total	1,993	1,068	627	267	31

Note: Totals may not add up due to rounding. Figures were compiled and adjusted from various sources. Oman, Comoros and Somalia neither have detailed targets nor actual installed capacity. Target years that fall before or after the 3 landmarks are included in the closest landmark year, e.g., Sudan 2031 target is included in 2030.
Source: RCREEE 2012 Country Fact Sheets <www.rcreee.org>; Lins, C., L. Riahi and R. Zissler. 2013. Arab Environment Sustainable Energy, Chap. 3: Renewable Energy; AfDB. 2013. Djibouti Geothermal Exploration Project in the Lake Asal Appraisal Report. Abidjan; LAS-IRENA-RCREEE. 2014. Pan-Arab Renewable Energy Strategy. Abu Dhabi; ESCWA. 2015. Regional Coordination Mechanism, Issue Brief for the Arab Sustainable Development Report: Energy in the Arab Region. Beirut; IRENA Website <http://resourceirena.irena.org/gateway/index>; Clean Technica Website: <http://cleantechnica.com>; and Author's calculation.

75. Incremental power generation projections are based on a 5% annual increase across the board although some countries have more or less ambitious annual generation growth (see Annex II for power installed

capacity). Some countries had only installed capacity targets such as Morocco and were adjusted to electricity generation-based RET for comparison purposes. Also, some country targets were set for 2020 and/or 2030: in the absence of 2030 targets, the same 2020 targets were considered for 2030, therefore, RET cumulative targets are lower in 2030 than 2020 in Mashreq, Maghreb and LIC due to the fact that RET 2030 target shares were not available (Table 5.1 and Figure 5.1).

Figure 5.2: Cumulative RET Power Generation Targets in Arab Countries, 2010-30



Source: see Table 5.1.

76. Based on the above, the 3 scenarios for incremental RET power generation are summarized in Table 5.2.

Table 5.2: 2020 Incremental Power Generation Scenarios in Arab Countries

Incremental Power Generation	Arab Countries	GCC	Mashreq	Maghreb	LIC
2010 Power Generation Baseline (TW/h)	864	456	274	118	17
2020 Power Generation Projected Demand (TW/h) (+5%/year)	1,224	656	385	164	19
2020 BAU Scenario 1: incremental conventional demand	11%	13%	8%	7%	5%
2020 Pan Arab RET Target Scenario 2: incremental RET demand	11%	13%	8%	7%	5%
2020 Upper Bound RET Target Scenario 3: net 2020 over 2010 demand	29%	30%	29%	28%	13%

Source: Authors.

5.2 2020 Scenario Cost and Co-Benefit Assessment

77. The 3 scenarios were costed in terms of:

1. Power, distribution and transmission capital expenditure –CAPEX and operations and maintenance –OMEX.

2. Environmental local and global co-benefits are derived in terms of net quantity emitted (net reduction of CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$ and CO_2 load emissions) and value in 2020.

3. Subsidies where the 2011 rate is considered over the investment period (see Annex II for detailed Tables).

4. Cost of distribution and transmission losses (against a developed country benchmark of 6% for GCC and worldwide benchmark of 8% for other Country Groups) where the share of losses out of power generation is kept constant over the period.

78. All costs and benefits are denominated in PPP$ in 2015 prices. Investment lifespan is over 35 years, which is the average shelf life of the CCG and RET power plants. Some RET investments are already well under way but for consistency purposes in this analysis, all incremental RET investments will be initiated starting 2016 as 4 years are needed for feasibility, design and installation to have RETs operational by 2020. Table 5.3 summarizes the respective costs.

79. **2020 BAU Scenario 1.** In order to generate the incremental 129 TW/h from conventional (combined cycle gas plant) sources starting in 2020 and over a 35 year lifespan (4,523 TW/h in total over the period) in Arab Countries (Table 5.3):

1. The CAPEX and OMEX amount to PPP$ 20 billion in 2020 and PPP$ 674 billion over 35 years;

2. Local environmental benefits are negative and amount to PPP$ 52 million in 2020 and PPP$ 1.8 billion over the period with 0.1 billion tons of critical ambient air pollutants released in the air;

3. Global environmental damages are much more significant with PPP$ 1.9 billion in 2020 and PPP$ 69 billion over the period with 2.2 billion tons of CO_2 equiv. released in the atmosphere over the period;

4. Subsidies amount to PPP$ 635 billion over 35 years as based on 2011 subsidy rate;

5. Distribution and transmission losses amount to PPP$ 0.4 billion in 2020 and PPP$ 15.5 billion over the 2020-2055 period.

80. **2020 Pan Arab RET Target Scenario 2.** In order to generate incremental 129 TW/h from RET sources starting in 2020 and over a 35 year lifespan (4,523 TW/h in total over the period) in Arab Countries:

1. The CAPEX and OMEX amount to PPP$ 42 billion in 2020 and PPP$ 709 billion over 35 years;
2. Local environmental benefits amount to PPP$ 52 million in 2020 and PPP$ 1.8 billion over the period with 0.44 million tons of averted critical ambient air pollutants;
3. Global environmental benefits are much more significant with PPP$ 1.8 billion in 2020 and PPP$ 165 billion over the period with 2.1 billion tons of averted CO_2 equiv. over the period (Table 5.3);
4. Subsidies are the same as Scenario 1 amounting at PPP$ 635 billion; and
5. Distribution and transmission losses amount to PPP$ 1 billion in 2020 and PPP$ 34 billion over the period if they are kept at the same 2011 level.

81. **2020 Upper Bound RET Target Scenario 3.** In order to generate additional 359 TW/h from RET sources starting in 2020 and over 35 years (12,572 TW/h in total over the period) in Arab Countries:

1. The CAPEX and OMEX amount to PPP$ 119 billion in 2020 and PPP$ 4,167 billion over 35 years;
2. Local environmental benefits amount to PPP$ 136 million in 2020 and PPP$ 4.7 billion over the period with 1.2 billion tons of critical ambient air pollutants not being released into the atmosphere;
3. Global environmental benefits are much more significant with PPP$ 5.3 billion in 2020 and PPP$ 184 billion over the period with 5.8 billion tons of averted CO_2 equiv. over the period (Table 5.3);
4. Subsidies (using 2011 subsidy rate) over 35 years is $PPP of 1,749 billion, 2.7 times the energy subsidies on scenarios 1 and 2; and

5. Distribution and transmission losses amount to PPP$ 2.5 billion in 2020 and PPP$ 88 billion over the period.

Table 5.3: 2020 Incremental Power Generation Target Cost and Co-Benefit Scenarios in Arab Countries

Incremental Power Generation	**Arab Countries**	**GCC**	**Mashreq**	**Maghreb**	**LIC**
2020 BAU Scenario 1 with conventional sources (TW/h)					
Generation in 2020	**129.2**	**83.9**	**32.2**	**12.2**	**1.0**
Generation over 35 years	**4,523**	**2,937**	**1,125**	**427**	**34**
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	159	95	45	18	1
OMEX over 35 years	515	307	146	58	5
Distribution and Transmission Losses over 35 years	35	13	16	6	1
Subsidies (2011 subsidy rate) over 35 years	635	429	147	58	0.4
Environmental Benefit (PPP$ Million in 2015 prices)					
Local over 35 years	-1,818	-1,460	-249	-106	-2.7
Global over 35 years	-68,790	-41,018	-19,452	-7,709	-610
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	0.44	0.28	0.108	0.04	0.003
Global (CO_2) over 35 years	2,216	1,438	551	209	17
2020 Pan Arab RET Target Scenario 2 (TW/h)					
Generation in 2020	**129.2**	**83.9**	**32.2**	**12.2**	**1.0**
Generation over 35 years	**4,523**	**2,937**	**1,125**	**427**	**34**
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	1,236	737	350	139	11
OMEX over 35 years	231	138	65	26	2
Distribution and Transmission Losses over 35 years	77	27	36	12	2
Subsidies (2011 subsidy rate) over 35 years	635	429	147	58	0.4
Environmental Benefit (PPP$ Million in 2015 prices)					
Local over 35 years	1,818	1,460	249	106	2.7
Global over 35 years	64,719	38,590	18,801	7,253	574
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	0.44	0.28	0.108	0.04	0.003
Global (CO_2) over 35 years	2,085	1,354	519	197	16
2020 Upper Bound RET Target Scenario 3 (TW/h)					
Generation in 2020	**359**	**200**	**111**	**46**	**3**
Generation over 35 years	**12,572**	**6,997**	**3,890**	**1,594**	**90**
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	3,511	1,756	1,208	518	29
OMEX over 35 years	656	328	226	97	5
Distribution and Transmission Losses over 35 years	210	65	104	38	4
Subsidies (2011 subsidy rate) over 35 years	1,749	1,023	509	217	1
Environmental Benefit (PPP$ Million in 2015 prices)					
Local over 35 years	4,744	3,480	862	395	7.2
Global over 35 years	183,829	91,958	63,262	27,110	1,499
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	1.2	0.7	0.374	0.15	0.009
Global (CO_2) over 35 years	5,796	3,226	1,793	735	41
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Totals may not add up due to rounding. Figures were compiled and adjusted from various sources. Oman, Comoros and Somalia neither have detailed RET targets nor actual installed capacity. Subsidies 2011 rates are applied on electricity consumption that is generated under each scenario only, i.e., conventional energy and RET generated minus Distribution and Transmission losses. Distribution and Transmission losses are valued at conventional source production cost for scenario 1 and RET production cost for scenarios 2 and 3.
Source: same as Table 5.2; Annex II; and Author's calculation.

5.3 2020 Scenario Cost and Co-Benefit and Incremental Analysis

5.3.1 Cost-Benefit Analysis

82. When carrying out the cost benefit analysis of the 3 scenarios, all indicators for Arab Countries and Group Countries were found to be negative:

    1. The net present value is negative;
    2. Both economic (at 10% discount rate) and financial (at 5% discount rate) rate of return are negative; and
    3. The present value of the benefit over cost ratio is less than 1.

5.3.2 Incremental Analysis

83. The 2020 Pan Arab RET Target Scenario 2 was compared to 2020 BAU Scenario 1 to determine the cost increments and the co-benefits accruing to Arab Countries as the same trending is also noticed in all Group Countries (Table 5.4 and Figure 5.3):

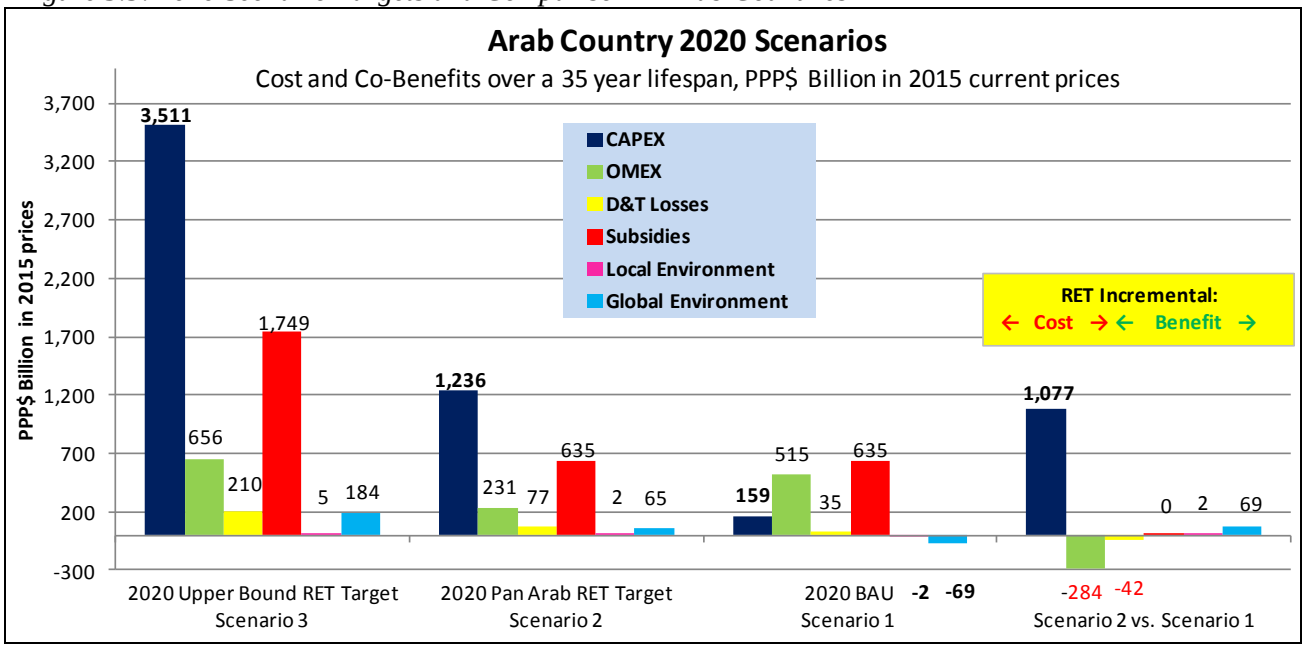
    1. On the positive side, RET's net OMEX are much lower (PPP$ 284 billion less over the period when compared to Scenario 1), and global environmental gains ($PPP 69 billion more over the period) are more substantive than local gains (PPP$ 1.8 billion more) in terms of less carbon and critical pollutants respectively released into the atmosphere.
    2. On the negative side, RET's net CAPEX are much higher (PPP$ 1.1 trillion more over 35 years), and distribution and transmission losses are higher under Scenario 2 as production costs are higher than Scenario 1 (PPP$ 42 billion). These distribution and transmission losses, which are eroding environmental gains.
    3. Yet, subsidies cancel themselves out when comparing both scenarios.

Table 5.4: 2020 Pan Arab RET Target Scenario 2 vs. 2020 BAU Scenario 1 in Arab Countries

Power Generation	**Arab Countries**	**GCC**	**Mashreq**	**Maghreb**	**LIC**
Scenario 2 over Scenario 1 (TW/h)					
Generation in 2020	**129.2**	**83.9**	**32.2**	**12.2**	**1.0**
Generation over a 35 year lifespan	**4,523**	**2,937**	**1,125**	**427**	**34**
Net Cost (PPP$ Billion in 2015 current prices)					
Net CAPEX over a 35 year lifespan	1,077	642	305	121	10
Net OMEX over a 35 year lifespan	-284	-169	-81	-32	-3
Net Distribution and Transmission Losses over a 35 year lifespan	-42	-15	-19	-6	-1
Net Subsidies (2011 subsidy rate) over a 35 year lifespan	0.0	0.0	0.0	0.0	0.0
Net Environmental Co-Benefits (PPP$ Billion in 2015 current prices)					
Net Local over a 35 year lifespan	1.8	1.5	0.3	0.1	0.003
Net Global over a 35 year lifespan	68.8	41.0	19.5	7.7	0.6
Net Emission Averted (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over a 35 year lifespan	0.44	0.28	0.108	0.04	0.003
Global (CO_2) over a 35 year lifespan	2,216	1,438	551	209	17
Exchange rate US$ to PPP$	2.39	1.90	2.35	2.46	2.41

Note: Table 5.3's Scenario 2 figures are subtracted from Scenario 1 figures except for global and local environment.
Source: Table 5.3.

Figure 5.3: 2020 Scenario Targets and Comparison in Arab Countries



Source: Table 5.4.

5.4 2020 Scenario Sensitivity Analysis

84. The sensitivity analysis of the 3 scenarios was carried out to derive the investment cost needed to bridge the CAPEX gap. In this particular case, only CAPEX were considered as costs and only environmental local and global gains were considered as benefits. Moreover, the flows are denominated in US dollar to

have a better sense of the real investments needed. Also, all flows are discounted at a 10% economic cost over the period. The RETs (see Table A2.4 in Annex II for RET category breakdown by country group) are based on the on the 2014 levelized electricity production cost (Figure 3.1) although cost are changing due to the rapid technological improvement and therefore should regularly be revisited.

85. The CAPEX gap is very important in all Arab Countries and could constitute a future burden on their public and even private finance. Therefore, in order to bridge the CAPEX gap, five alternatives are suggested (see the next Sections): (i) funding the CAPEX through countries' sovereign funds such as GCC countries and Algeria; (ii) funding the CAPEX through international development institutions including the Global Carbon Fund specifically for Mashreq, Maghreb and LIC; (iii) exploring the possibility of tapping private sector funds for all Arab Countries; (iv) gauging the reduction of the electricity subsidy needed to bridge CAPEX; and (v) utilizing a policy mix of the above listed 4 alternatives.

86. Only the subsidy reduction alternative was analyzed below based on the 3 scenario CAPEX needs (Table 5.5). Hence, the electricity subsidy based on 2011 rates was gauged downward to derive the breakeven point where CAPEX and co-benefits will even each other out by generating: a positive net present value just above 0; an economic rate of return of 10%; and a present value of benefit over cost of 1. The electricity subsidy rate reduction is assumed to start in 2016 prior to the 2020 Targets to show government commitment and to allow 4 years for feasibility and implementation of the 3 scenarios. A partial electricity subsidy reduction associated with the energy generation under each scenario was also attempted but proved inconclusive as the subsidy reduction could marginally defray the CAPEX needs.

87. The CAPEX needs as balanced by the suggested subsidy reduction in Arab Countries amount to (Table 5.5):

    1. Scenario 1 BAU based on conventional energy: US$ 21 billion with a reduction of the electricity subsidy by -2.8% to be able to bridge the gap;

2. Scenario 2 based on Pan Arab RET targets: US$ 165 billion with a reduction of the electricity subsidy by -14.2% to be able to bridge the gap; and

3. Scenario 3 based on the Upper Bound RET targets: US$ 458 billion with a reduction of the electricity subsidy by -39.5% to be able to bridge the gap.

Table 5.5: 2020 Scenario Analysis Matrix in Arab Countries, US$ billion

Option Matrix	Total Economic Flows over 35 years discounted at 10%						Cost/co-Benefit Analysis Using CAPEX & Benefit			Sensitivity Analysis based on 2011 Subsidy Rates
	Cost		Benefit		Subsidy	D&T Losses	NPV	RR	PV B/C	Subsidy Reduction Gauging as of 2016
	CAPEX	OMEX	Local	Global						
Scenario 1										
Arab Countries	21	69	-0.25	-9.2	1,097	4.4	**<0**	**<10%**	**<1**	**-2.8%**
GCC	14	45	-0.21	-5.9	688	1.8	**<0**	**<10%**	**<1**	**-2.9%**
Mashreq	5	17	-0.03	-2.3	287	1.9	**<0**	**<10%**	**<1**	**-3.8%**
Maghreb	2	6.5	-0.01	-0.9	121	0.6	**<0**	**<10%**	**<1**	**-2.4%**
LIC	0.2	0.5	-0.00	-0.1	1	0.1	**<0**	**<10%**	**<1**	**Not enough subsidies**
Scenario 2										
Arab Countries	165	31	0.25	8.6	1,097	9.7	**<0**	**<10%**	**<1**	**-14.2%**
GCC	107	20	0.21	5.6	688	3.9	**<0**	**<10%**	**<1**	**-15.2%**
Mashreq	41	8	0.03	2.1	287	4.2	**<0**	**<10%**	**<1**	**-12.4%**
Maghreb	16	3	0.01	0.8	121	1.3	**<0**	**<10%**	**<1**	**-10.5%**
LIC	1	0.2	0.00	0.1	1	0.2	**<0**	**<10%**	**<1**	**Not enough subsidies**
Scenario 3										
Arab Countries	458	86	0.70	24	1,097	26.2	**<0**	**<10%**	**<1**	**-39.5%**
GCC	245	48	0.50	13	688	9.4	**<0**	**<10%**	**<1**	**-35%**
Mashreq	142	27	0.10	7.4	287	12.2	**<0**	**<10%**	**<1**	**-46.8%**
Maghreb	58	11	0.04	3.0	121	4.2	**<0**	**<10%**	**<1**	**-45.5%**
LIC	3	1	0.00	0.2	1	0.4	**<0**	**<10%**	**<1**	**Not enough subsidies**

Note: This quasi economic analysis is just to derive the investment cost needed to reduce local and global emissions as shadow prices, including subsidies, wages, etc., are not adjusted and electricity benefits per se are not included in the analysis.2011 subsidy rates are assumed to be constant over the period and energy consumption breakdown among sectors are assumed to remain the same over the period. When considering the subsidy reduction or the real tariff increase on electricity consumption (price elasticity of electricity) in Arab Countries, more subsidy reduction would eventually be needed to account for the reduction of electricity consumption associated with the subsidy reduction.
Source: Tables 5.1-5.5; Annex II; and Authors.

6. Development of Policies to Move Towards Green Energy Within the Next 10 Years

The diagnosis and analysis in the previous sections helped reach the following conclusions:

f) The path toward moving to a green energy requires first a reduction of the environmental damages caused **by local and global pollutants**. These damages are extremely high and in the order of PPP$ 73.2 Billion in 2010 affecting both the health and the economy of the Arab countries. Unless they are addressed simultaneously, installation of RETs as a mean of reducing GHGs in order to show political commitment to the international community, will not ease the path towards green energy.

g) Loss of opportunities due high subsidies are even higher (PPP$ 423 billion almost 6 fold the cost of environmental degradation. This means a significant loss of revenues that would have generated additional income to provide additional investments for a change in process and clean technologies to reduce both the local and global pollutants.

h) The targets in the Pan Arab Renewable Energy strategy in 2030 are over ambitious and their financial and economic impacts have not been properly assessed.. The investments required by Arab Countries are of the order of US$ 165 billion and far beyond their affordability with the exception of the GCC countries and Algeria which have very large sovereign funds. Both financial and economic returns on these investments are negative which would discourage private sector penetration and financing from the commercial banks.

i) The major culprit is the large subsidies which should be reduced by 14.2% over the RET investment period to be able to bridge the capital investment gap in order to comply with the 2020 Pan Arab Strategy Targets. A policy mix measures could help gradually reduce these subsidies while benefitting from soft loans (very low interest rate of the order of 0.1-0.4 % with a 40 years maturity and grace period of 10 years) from international financing institutions or from the Green climate Funds.

j) Cautions should be considered for not enabling the Arab Countries with the exception of the GCC to commit over and above the already ambitious targets in the Pan Arab Strategy. In such instances, these investments required, to meet for example an average of 19% target, will be even higher and of the order of US$ 458 billion and will require a higher reduction of subsidies to the tune of -40% over the RET investment period.

k) The resources allocation to the energy sector do not reflect the reality of the socio-economic condition of the Arab countries especially the Mahsreq, the Maghreb and Least income countries. There is no approved integrated energy resources master plan at the country level which should take into account the demand and supply management based on economic principles, the future long term needs of the sector taking into consideration population growth, climate change impacts as well as the necessary environmental and social damages at the local and global levels.

l) Grant financing and concessionary loans already available worldwide by international financing institutions and from the forthcoming GCF, could be partly allocated to the Arab Region on quota or percentage basis and /or meeting economic and technical criteria. Even if these occur, they will not be enough to ensure the RET market penetration and they should be considered as a complement to encourage internal reforms such as reduction of the energy subsidies which is politically painful.

Based on the above general conclusions, the following recommendations are proposed for moving towards a green energy using the proposed the following four axes of intervention:

A. Focusing first on "the low hanging fruits" by:

a) Financing high-profile demonstrations projects or pilot projects of green technologies specifically relevant to every country using existing climate funds. This would show that countries in the Arab region are committed towards moving towards green energy and are a favorable location for installation of new manufacturing plants for key technologies and would attract more national and international investors.

b) Investing in energy efficiency through reducing transmission and distribution losses and especially improving energy efficiency from the end users including the adoption of no/low cost measures

B. Improving the planning and programming, investment efficiency in conventional and non conventional energy using the programmatic approach and the maximization of environmental and social benefits in the energy sector by:

a) Preparing an integrated energy business plan at the national and sub-regional levels that would identify the best solutions for establishing green energy based on benefit/cost analysis and on a complete set of management actions, including coordination needs among all the stakeholders along these priorities in ways that are protective of the environment, affordable, and responsive to feedback from the public.

b) *Underpinning the programmatic approach versus the project based approach* with sound economic, environmental and social understanding and improve analytical tools for planning and cost accounting at the national and regional levels.

c) Consider a different approach based on ensuring that a well phased and priority RET investments program is in place so that economic and financial returns are reasonable and sustainable. Such an approach would:

i. Focus on 'soft' interventions of policy and planning, monitoring and enforcement. The private sector can deliver a high level of services and more effectively if there is a strong management capacity within the public sector to administer, monitor and enforce contracts;

ii. Involve the stakeholders in the design and choice of the available technologies commensurate with the affordability of these investments by the beneficiaries;

iii. Decouple financing investment in capital costs from operation and maintenance costs. Investment in capital costs may have better revenue. Profits generated from the latter are of long term and might require in some cases co-financing from the State budget in the form of subsidies. Such subsidies could be justified on the grounds that the investments in capital costs which are for protecting public goods. Cost for operation and maintenance are not considered public goods and should be borne by the energy users.

d) Establish a benefit tracking system whereby key performance indicators on investment opportunities and environmental benefits due to green energy can be measured and reported to the public by an independent third party.

C. Creating favorable financial conditions for the banking and private sectors to finance green investments by:

a) Realigning the existing regulatory framework so that to provide incentives for the adoption and production of green technology; to revise business and environment practices; and to facilitate the disclosure and dissemination of environmental and business information to attract markets. The retrofitting of existing energy sector policies and strategies must be: (1) realistically achievable in the country context; (2) affordable; (3) able to create jobs; and (4) able to generate direct and indirect revenues

b) Establishing an incentive system which should be based on performance, such as achieving specific targets and on time-bound compensation for the incremental costs incurred for adopting and scaling up the penetration of green energy. One example would be to implement a system for issuing environmental permits that incorporates an estimate of GHG emissions and alternatives for green technologies based the environmental impact assessment/environment audit studies.

c) Priority should lie on a few “champion” countries that are ready to move concurrently on catalyzing policy reform and leveraging private and public capital. The main criteria for the selection of these

countries are: (1) where the results would be easiest to achieve; (2) where there are financially feasible projects already available for attracting private capital; and (3) where there can be partnerships and cost-sharing mechanisms between private and public capital, with the possible support of international financing institutions and donors.

d) Developing financing mechanism of RE projects based on win-win approach taking into account the circumstances of all stakeholders

e) Another option would be to establish a transparent system of subsidies/financial support for capital costs for green technologies, as well as for capital depreciations and amortization on a life-cycle basis. One proposal would be to match one dollar of reduction of subsidies by one dollar of incentive provided by the existing and forthcoming Climate Funds for market penetration of RET by the private sector.

D. Partnering with Climate and International Financing Institutions and Donors by

a) Supporting national Governments and sub-national entities through grants and technical assistance for the "software interventions" related to policy and planning, monitoring and enforcement, cost recovery and administration oversight.

b) Developing with Governments and sub-national entities new financial engineering for leveraging new revenues with soft loans.

c) Financing programmatic capital costs investments on the basis on the difference between the total cost of the program and the cost fraction paid by the national government and sub-national entities.

d) Developing a "Arab Regional Climate fund" with national and international banks based on the principles of "show results and get funds"

e) Conducting periodic evaluation on the progress made for policy and planning reforms based on mutually approved implementation plans with national governments and sub-national entities.

7. Global Climate Finance

88. This section reviews the potential green investment financing mechanisms in Arab Countries and explores ESCWA roles and responsibilities as facilitator for accessing the Green Climate Fund by member countries and provider of related advisory services.

7.1 Financing Arrangements

89. Financing arrangement is an important part for the implementation of green energy and its access represent an important barrier to investments. Governments have limited budget with competing investment priorities especially that investments in energy conservation and efficiency and renewable energy require upfront financing of investments. Also an exclusive emphasis on technical/financial solutions gives limited results unless price and other incentives are conducive. There are specific issues that need to be addressed whenever financing arrangement are required: namely financing needs; risks, returns, and available financing instruments; sources of funding; and institutional mechanisms for accessing those instruments and sources.[26]

    1. *Identification of financing needs*. There are two activities categories that would require financing: (i) project preparation activities for investments which consist of project development, and project design needed to efficiently and effectively package good projects; and (ii) investment implementation. A common failure is the imbalance of these two categories of needs: there is either insufficient project pipeline to meet the needs of the financiers, or the inability to arrange for financing on well developed projects which leads either to insufficient project pipeline

[26] World Bank. 2008. Seizing a Hidden Resource Energy Efficiency. Washington, D.C.

development to meet the needs of financiers, or to inability to arrange and deliver financing for a series of well-developed projects.

2. *Risks, returns, and financing instruments.* Investments in green energy is costly, risky and complex to manage. Hence the projects risks and its economic and financial returns should be determined during project design and before selecting the financing instruments. In the Middle East and North Africa region different financing instruments were used: Government subsidies to producers and consumers, investment grants, and concessionary loans (low interest and long maturity). In GCC, the major financing instruments were government grants or low concessionary loans all from the Treasury.

3. *Sources of funding.* In most cases, public financing for investing in green energy is needed either from the Government and/or from Bilateral and International Development Institutions. The national banks and the private sectors have started to investment in green technology: In Lebanon in order to stimulate private sector participation and open new markets, the Banque du Liban (BDL --Central Bank of Lebanon) has established three dedicated funds to enable commercial banks to on lend sub-loans to private enterprises on concessionary terms for: (i) energy projects (energy savings and renewable energy projects) with an envelope of € 12.2 million; (ii) energy efficiency and renewable projects in small and medium enterprises in co-financing with the European Investment Bank and the European Commission for a total investment of € 50 million; and (iii) an Environmental Compliance Fund for pollution abatement projects co-financed with the World Bank at a level of US$ 15 million. Participating banks will be allowed to either be exempted by using a portion of their mandatory reserves to offset the interest rate spread or use soft loans through BDL's financial mechanism: Incentive Circular no. 365-2014 allows commercial banks to recoup their spread charged on the polluting enterprises by obtaining parallel funding in Lebanese pounds to be invested in Treasury Bills to bring the overall loan interest to near zero. In Morocco, the Banque Centrale Populaire and the Attijariwafa Bank, as well as equity funding from Nareva

Holdings SA I have raised US$ 563 million[27] for developing a 300 MW wind farm in Trafaya which is being developed by the Moroccan company Nareva Holdings SA and International Power.

4. *Institutional mechanisms.* The selection of an effective institutional mechanism to be the funding recipient and implement the project will depend on the fund source, the type of investment, and the financing instrument used and would vary from one country to another. In all cases, investment and funding systems must fit local institutional environments in order to be effective. There are however a number of regional organization that could serve as a technical and knowledge support to the countries and stimulate the adoption of renewable energy technologies. The organizations summarized below, are considered essential for enhancing the human resources capacity, providing knowledge, stimulating green energy reforms, and arranging to finance projects based RETs. These are:

   - **The Regional Center for Renewable Energy and Energy Efficiency (RCREEE**) is non-profit regional organization established in Cairo. Its mandate is provide to the 16 Arab countries capacity development, and learning, policies and regulations, research and statistics and technical assistance. This organization is co-financed by GIZ, DANIDA and NREA.[28] RCREEE would like to achieve five strategic results: (i) facts and figures; (ii) Institutions effectiveness with a regional cooperation; (iii) Strengthening human capacity through regional training, strengthening policies through regional dialogue and coordination and assistance in Finance through international and regional funds through interregional exchange.

   - **The International Renewable Energy Agency (IRENA),** a 160-member country intergovernmental organization headquartered in Abu Dhabi whose mandate is "to

[27] The International Renewable Energy Agency: MENA Renewable Status Report, 2013.
[28] The Regional Center for Renewable Energy and Energy Efficiency (RCREEE), Annual Report, 2013.

establish new synergies, facilitates dialogue and information and best practice sharing."[29] IRENA is a knowledge platform for stimulating operation among stakeholders at the international, regional and national levels for enabling policies, strengthening capacity and encouraging investment flows, technology and cooperation. IRENA considers partnership and cooperation and stakeholders a cornerstone of its work. IRENA provides renewable energy data and analysis, costing and performance of renewable energy technologies as well as insights on financing mechanism. The Abu Dhabi Fund for Development (ADFD)[30] made commitments of up to US$ 350 million, over seven funding cycles, to a new IRENA-guided program. These funds are of soft loans types and will be used to only finance renewable energy projects recommended by IRENA in developing countries. In the first and second funding cycles, 11 projects were approved for funding with a total amount of US$ 98 million. None of these projects belonged to Arab Countries.

- The Mediterranean Renewable Energy Center (MEDREC), based in Tunisia, was launched by the Ministry of Environment and Territory and involves the governmental institutions of Algeria, Morocco, Tunisia, Libya and Egypt. Its mandate is to develop regional competencies in renewable energy technologies, research and project activities related to financing sources, and capacity building for development of regional competencies in renewable, development of renewable energy markets and stimulate private sector initiative.[31]
- The UN Economic and Social Commission of West Asia (ESCWA)[32] headquartered in Beirut Lebanon, is carrying out studies, holding meetings, organizing workshop and

[29] IRENA Website: <www.irena.org>.
[30] ADFD Website: <www.afdf.ae>.
[31] MEDREC Website: <www.medrec.com>.
[32] ESCWA Website: <www.escwa.un.org>.

providing training on climate change vulnerability as well climate change negotiations technical assistance in advancing green economy polices and tools.

7.2 International Climate Finance

90. Governments in Arab Countries are faced with a tradeoff between sustaining economic growth, creating jobs and alleviating poverty on the one hand, and reducing green house gases (GHGs) emissions on the other. Multilateral and bilateral financing institutions can manage such tradeoff[33] and provide incentives for moving towards low carbon development.

91. There are a number of multilateral funds in the amount of US$ 8.7 billion, that have grown up since the establishment of the Global Environment Facility in 1992 and for which Arab Countries have modestly benefitted from in the amount of 1.018 billion (11.7 %). In order to stimulate investments to mitigate climate change effects and until a new climate change agreement is reached, the World Bank has established in 2008 with multilateral financing institutions the Climate Investment Fund (CIF) outside the UNFCCC. Subsequently to a series of Conference of the parties, several funds were established under the UNFCCC, namely the GEF Trust Fund for Climate change, the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SPCCF), and the Adaptation Fund (AF). The CIF is fully administered by the World Bank whereas the GEF assumes on interim basis the administration of the LDCF, the SPCCF and the AF. All these fund are fully operational.

92. The newest Fund that was created by UNFCCC is **the Green Climate Fund** (GCF) which is not yet operational. Envisioned under the Copenhagen Accord of 2009, established in Cancun in 2010 and adopted in 2011 in Durban, the GCF has now appointed its Board, recruited its core staff and issued its internal policies an guidelines.[34] In November 2014, a pledge of US$ 10.2 billion was made (see below).

[33] Nakhooda, S. and M. Norma. 2014. Climate Finance: is it making a difference? Website <www.odi.org>.
[34] GCF Website: <www.gcf.org>.

It is anticipated that all the other funds under or outside the UNFCCC purview would ”sun set” once the GCF will become fully operational, though it is unclear when and how these funds will be closed given that these funds provide also concessionary loans for up to 40 years maturity.

93. The following management characteristics distinguishes the funds outside the UNFCCC purview from those that are within:

    1. Funds administered and managed by the World Bank such as the CIF and its two windows: the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF) are usually blended with loans from the World Bank in specific projects agreed between the World Bank and its clients. These projects follow standard World Bank policies and regulations pertaining to procurement management, financial management, environment and social safeguards and gender mainstreaming.
    2. Funds that are under the purview of the UNFCCC follows a different management and operational structure. The GEF manage the Funds with the World Bank as a Trustee. The LDCF and SPCCF have a common Governing Board, their own policies, rules and regulations and most importantly any Fund recipient which could be the National Designated Authority (NDA) or the National Implementing Entity (NIE) to implement or execute projects on behalf of these funds should be accredited.

94. The purpose of the accreditation process is to ensure that the recipient of the funds comply with the fiduciary standards and the environment and social safeguard standards. The accreditation process is required along the three major categories: (i) audit, financial management and control framework; and investigation; (ii) project activity process and oversight; and (iii) minimum environment and social safeguard standards and gender mainstreaming. The accreditation process is extremely rigorous, time consuming as each applicant is supposed to answer several questions under each of the three categories and provide evidence to support its answers. The applications is reviewed by an independent panel of experts who should provide the accreditation prior to the signing of an agreement between the Fund

administrator and the applicant. Unfortunately the accreditation of these funds are all different; the GEF environment and social safeguard standards were developed on the basis of the World Bank environment and social safeguard policies,[35] whereas the GCF developed its environment and social safeguard standards on the basis of the International Finance Corporation (IFC) environment and social safeguard policies[36] which are different from those of the World Bank. The LDCF/SCCF have a tailored made environment and social safeguard standards which are less rigorous but also different from those of the GEF and the SCF. The lack of harmonization between the different climate change fund poses a real challenges to the applicants who would like to benefit from these funds and increase their transaction costs.

7.2.1 Key Features of the Multilateral Climate Funds

Funds that are operational outside the UNFCCC purview

95. **The Climate Investment Fund** (CIF) was established by the World Bank in collaboration with multilateral development banks[37] (MDBs) in 2008 with a funding window of US$ 8.1 billion. The CIF mechanism was to bridge the financing and technical assistance gaps between 2008 and the next climate change agreement.[38] The CIF consists of two trust funds:

    1. *The Clean Technology Funds (CTF)*[39] with an envelope of US$ 5.3 billion is aimed at promoting demonstration, deployment and transfer of low carbon technologies in middle income countries. The CTF is focusing on large infrastructure in smaller number of countries. Its aim is to reduce the technology costs, stimulate private sector participation and promote replication in other countries. Among the ECWA member countries, two countries have benefitted from the CTF:

[35] World Bank Website: <www.worldbank.org/environment/safeguard policies>.
[36] IFC Website: <www.ifc.org>.
[37] The MDB are the African Development Bank, the African Development Fund, the Asian Development Bank, the European Bank for Reconstruction and Development, and the Inter American Development Bank.
[38] Wikipedia Website: <www.wikipedia.org>.
[39] Climate Investment Fund Website: <www.climatinvestmentfunds.com>.

- ❖ Egypt received a US$ 300 million grant and concessionary loans from CTF to establish a 250 MW Build Own Operate Wind Project in the Gulf of Suez with an envelope of US$ 140 million and a transport modal shift for developing new bus and rail infrastructure with an envelope of US$ 160 million
- ❖ Morocco received US$ 388 million of grants and concessionary of which US$ 125 million was to help establish a wind farm and US$ 25 million to introduce a solar PV in the south eastern region, and US$ 238 million a contribution for the establishment of the Noor–Ouarzazate Concentrate Solar Power Complex.[40]

2. *The Strategic Climate Fund (SCF)*[41] with an envelope of US$ 796 million aimed at developing new approaches in specific sector or climate change challenge. One of the three climate change challenges is Scaling up Renewable Energy in Low Income Countries Program (SREP) " in order to create economic opportunities and increase energy access in the production and use of renewable energy. Among the Arab Countries, the SCF provided an upper funding of US$ 40 million for scaling up renewable energy in Yemen.

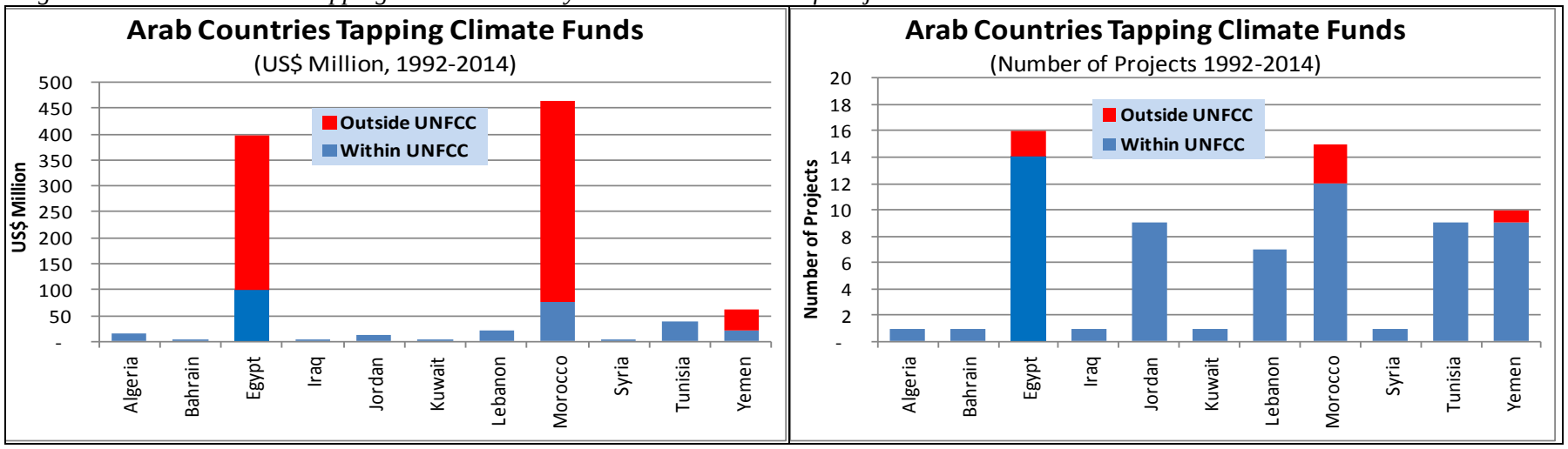
[40] World Bank, Morocco Project Appraisal Document, Report No: PAD1007.
[41] CIF Website: <www.climateinvestmentfunds.com>.

Table 7.1: Arab Countries Tapping Climate Funds by Volume and Number of Projects, 1992-2014

Arab Countries	Total GEF and WB Administered Grants and Concessionary Loans		GEF Administered TFs within the UNFCCC								WB administered TFs outside the UNFCCC			
			GEF Trust Fund (1992 to date)		Special Climate Change Fund (SCCF) (2001 to date)		Least Developed Climate Fund (LDCF) (2002 to date)		Adaptation Fund 2009		Clean Technology Fund (CTF)		Strategic Climate Fund (SCF)	
	# of Projects	US$ million	# of Projects	US$ million	# of Projects	US$ million	# of Projects	US$ million	# of Projects	US$ million	# of Projects	US$ million	# of Projects	US$ million
Algeria	1	15.30	1	15.30										
Bahrain	1	0.33	1	0.33										
Egypt	16	398.40	11	79.69	2	11.81			1	6.90	2	300.00		
Iraq	1	2.20	1	2.20										
Jordan	9	13.20	8	11.20	1	2.00								
Kuwait	1	0.85	1	0.85										
Lebanon	7	20.56	5	5.56	1	7.14			1	7.86				
Morocco	15	463.50	9	58.5	3	17.00					3	388.00		
Syria	1	4.07	1	4.07										
Tunisia	9	37.80	8	32.30	1	5.50								
Yemen	10	62.34	6	7.14			3	15.20					1	40.00
Total	**71**	**1,018.55**	**52**	**217.14**	**8**	**43.45**	**3**	**15.20**	**2**	**14.76**	**5**	**688.00**	**1**	**40.00**

Source: Websites of GEF <www.thegef.org>, UNFCCC <www.unfccc.int>, and World Bank <wwww.worldbank.org>.

Figure 7.1: Arab Countries Tapping Climate Funds by Volume and Number of Projects



Source: Websites of GEF <www.thegef.org>, UNFCCC <www.unfccc.int>, and World Bank <wwww.worldbank.org>.

Funds that are operational within the UNFCCC purview

96. ***The Global Environment Facility*** *(GEF)*, which was established since 1992 by the World Bank, UNDP and UNEP with its secretariat hosted at the World Bank, consists of:

1. *The GEF Trust Fund (GTF)*[42] is the largest and longest public climate change fund. The GEF supports mitigation activities in the climate change focal area. Funding is replenished every four years based on 39 donor developed and developing countries. The GEF trust fund has received a total US$ 15.2 billion for its six focal areas during the five replenishments and is now at its six replenishments for which it has raised more than $1 billion in 2014 for its 6th replenishment which will run through 2018. A total of US$ 910 million was allocated to support national mitigation policies and strategies, renewable energy, and energy efficiency. With the exception of GCC countries, all Arab Countries have received financial support for 52 projects totaling US$ 217 million (Table 7.1 and Figure 7.1) or 23.8% of the GEF climate change allocation, where Egypt and Morocco are the largest beneficiaries of the GTF with US$ 79.7 million and US$ 58.5 million respectively.
2. *The Least Developed Countries Fund (LDCF)* to support adaptation activities in all developing countries which are party to the UNFCCC and facilitate technology transfer with an envelope of US$ 930 million focusing on the 49 least developed countries as well as supporting the preparation of the National Adaptation Plan of Action (NAPA). Yemen is the only country that benefitted of three projects for an amount of US$ 15.2 million.
3. *The Special Climate Change Fund (SCCF)* finance climate change mitigation and adaptation activities that are complementary to the GEF climate change focal area and by bilateral and multilateral funding. The SCCF in the amount of US$ 349 million has four windows: as adaptation, transfer of technologies, energy, transport forestry and waste management, and economic diversification for fossil fuel. The SCCF supports the preparation of the NAPA.

[42] GEF Website: <www.thegef.org>.

Five Arab Countries (Egypt, Morocco Tunisian Lebanon and Jordan) have taken advantage of the SCCF for a total of US$ 43.4 million.

4. *The Adaptation Fund (AF)*,[43] which is the instrument of the Kyoto Protocol, was established in 2009 to support the implementation for concrete adaptation projects in developing countries that are vulnerable to the adverse effects of climate change. During the last three years, the AF has allocated US$ 291 million in 44 countries. Two Arab Countries (Egypt and Lebanon) have taken advantage of the AF in the sector of Agriculture and Food Security in the total amount of US$ 14.8 million.

7.2.2 Funding Sources and Levels for Arab Countries

97. Table 6.1 and Figure 6.1 show multilateral finance contribution received from the above trust funds to the Arab Countries. The total amount allocated by these funds are of the order of US$ 1.018 billion with Morocco and Egypt receiving the largest share. The largest contributor is the World Bank CIF which limited its funding to only two countries: Morocco and Egypt. This is expected as the nature of the CIF is to finance large infrastructure through concessionary loans with very low interest and long maturity. The GEF trust fund comes second in terms of funding level and is provided to Arab Countries in the form of grants for projects that are stand alone GEF projects or co-financed by World Bank loans. Egypt, Morocco, and Tunisia have benefitted of 65% of the GEF trust fund allocated to Arab Countries. The GCC countries with high per capita incomes, have benefited the least from climate funds.

7.2.3 The Forthcoming Green Climate Fund

98. The main goal of the CGF is to become the main global financial mechanism for climate change financing. Its objective is to promote low carbon emission and climate change resilience by providing deeply concessionary loans to eligible countries of the UNFCCC. The GCG is governed by a board composed of 24 members and its interim secretariat is housed in Sodongo in South

[43] Adaptation Fund Website: <www.adaptation-fund.org>.

Korea. The CGF expects to raise a US$ 100 billion over by 2020 although this is not the official figure of the size of the fund.

99. The agreement reached by the COP in Cancun in 2010 clearly specify that the funds provided to the developing countries should be: "new" and "additional" of existing development assistance. This term" new" requires that the pledges from the developed counties should be on the top of those provided in previous years. The "additional" terms remains vague and has not be clearly defined.

100. The allocation of the GCF portfolio is projected to be 50% for mitigation and 50% for adaptation of which its 50% will be allocated to the Small Island Developing States (SIDS) and the Less Developed Countries (LDC) and the African States.

101. GCF has established six investment criteria,[44] namely: (i) impact potential; (ii) paradigm shift potential; (iii) sustainable development potential; (iv) responsive to recipients needs; (v) promotion of country ownership; and (vi) efficiency and effectiveness.

102. The strategic impact areas[45] for funding adaptation projects are: (i) livelihoods of people, communities and regions; (ii) health and well-being of people, food and water security; (iii) infrastructure and built environment; and (iv) ecosystems and related services.

103. The strategic impacts areas for funding mitigation projects[46] are: (i) low-emission energy and electricity; (ii) low-emission modes of transport; (iii) buildings, cities, industries and appliances energy intensity; and (iv) land use and forests.

104. All implementing entities/intermediaries will need to meet fiduciary, environmental and social standards tailored to the types of programs they will manage. Details are available online.[47]

105. The GCF did not finance any project yet but it is established a very important readiness program to provide technical assistance to countries and support the accreditation process and help

[44] The Green Climate Fund: Information Pack, November 2014.
[45] Ibid.
[46] Ibid.
[47] GCF Website: <www.gcf.org>.

develop the project pipeline. The readiness program has already a funding of US$ 15 million from the planned allocation of US$ 30 million. Also, 50% of any allocation will be devoted to the SIDS, LDCs, and African States. The readiness program will:

- Support countries to engage with funds.
- Respond to country needs and priorities, working in collaboration with the National Designated Authority/Focal Points.
- Build on existing structures and efforts, and work in partnership with others.
- Identify and support interventions that will add value at country level.
- Develop responsive readiness interventions that help countries make effective use of the GCF.
- Support the accreditation process.

106. As of November 2014, Jordan was the only country among Arab Countries that benefitted from the readiness support program. There is therefore a need to promote this program within Arab Countries and assist them in developing a pipeline of projects based on the above six investment criteria and the strategic impact areas for mitigation and adaptation:

- Financing potential green investments in the Arab Region and ESCWA roles and responsibilities as facilitator for accessing the GCF by member countries and provider of related advisory services:
- Initiate a new program on readiness of the Arab Region for the GCF at the regional level in order to provide member countries with the needed support to formulate their requests to GCF and to meet the accreditation standards of the Fund.
- Develop initial pipelines of program and project proposals aligned with the objectives and investment criteria of the Fund and provide support to member countries for their submission to the GCF.
- Play a key role for creating synergies between member countries with relevant international.

- and national investors in order to introduce new partnerships for adaptation and mitigation to climate change.

- Development of an outreach and communication strategy so that ESCWA member countries are fully aware of green technologies and innovative financing schemes, for which ESCWA will be providing networking knowledge sharing through the Green Help Desks.

- Proposal of next steps after the preparation of the Report, its discussion and approval by ESCWA member countries as following:

  - Detailed plan of execution;
  - Details on implementation schedule;
  - Details on funding and projected cash flow;
  - Identification of executing, implementing, monitoring and evaluating agencies; and
  - Negotiations with ESCWA countries to confirm their interest.

8. The Role of ESCWA

107. Based on the four axes of interventions in the last section, this section focuses on ESCWA's niche in green energy. It is intended to contribute to a strategy for its future development but focusing namely on support for the fund-raising aspects.

8.1 ESCWA Opportunity

108. The approach adopted by various regional programs dealing with the green energy is that it focuses on technical and engineering solutions, rather than starting with economic and policy solutions that would create an enabling environment for adopting the appropriate green energy technologies. This is not the kind of holistic approach which is really needed to bring the green energy environment on a truly sustainable basis.

109. While considerable progress has been made among many of the Arab countries in the shape of setting up the institutional and policy framework for potential green energy program, much progress still needs to be made on actually developing the material capability of making the institutions function and putting the policies into practice.

110. While energy legislation were or being developed in many countries, the capability to enforce it remains inadequate in many cases. Moreover, national energy and environment legislations are inconsistent among themselves; the basic knowledge upon which effective energy policy can be conducted is fragmented and not readily accessible; standards required for green energies are inconsistent; and so is the capacity of public institutions to receive and approve or disapprove studies and projects. Not to mention also the lack of empowerment of the public.

111. While legislation and policy papers commit national governments to energy sustainability, the financial resources to implement these commitments are in many cases lacking at the national level especially among the Machreq, Maghreb and Least Developed Countries, and are scarce and dispersed at the development and financing institution level.

112. The issue of insufficient resources could be eased if a regional approach to energy sustainability could not only be agreed on paper, but also developed into an action plan with

prioritized areas of activity, in a logical sequence which progressively builds up capacity and becomes increasingly independent of development partner support.

113. The problem remains of how to raise the necessary resources in order to bridge the gaps; develop the full institutional capability and address those priorities which the development and financing institutions have not picked up.

114. This is where ESCWA has a unique potential as it can provide the required holistic approach. It appears to be the only entity on the Arab horizon which can service Arab countries in developing what is required: policy tools, advisory services, project proposals to implement a real policy of green energy sustainability, bridging the gaps left by the scattered interventions of development partners and international financing institutions.

115. There are several reasons why ESCWA could undertake this holistic approach:

1. It has the convening power in bringing together decision makers and experts from all Arab countries and from the regional financial institutions such as the Arab Fund for Economic and Social Development, the Saudi Fund for Development, etc;
2. As presently based in Lebanon, ESCWA has the respect and professional credibility in Arab countries and works very closely and in partnership with the League of Arab States, and the regional offices of UNDP, UNEP, and ILO in joint studies, reports and regional forum. ESCWA is capable to provide them with the political and technical umbrella in influencing decisions in sensitive sectors such as energy security and climate change;
3. ESCWA has the necessary in house capacity and skills among its qualified staff in the field of sustainable development, water, energy, trade, economics and social development that are essential for assisting Arab countries in engaging into the path of sustainable development and in particular with the future introduction of the SDGs. These types of skills and knowledge are not available in any other Arab institutions.

116. However, ESCWA is not a funding agency and it did not implement green energy development projects and programs. This however should not be considered as a major barrier for:

(a) conducting with a sufficiently critical approach the identification of the real resources to be dedicated to green energy in Arab countries; and (b) working with Arab countries so as to move from dependence on external assistance to national resources mobilization through market-based instruments and leveraging global benefits from existing climate change funds as well as the newly established Green Climate Fund.

117. Climate change adaptation and mitigation are two sides of the same coin. Work should be at two levels namely:

1. Upstream - to develop with and for the decision makers, strategies, risk and vulnerability assessments at the sub-regional and national levels, financial scenarios and actions plans to adapt and mitigate climate change impacts in the energy Downstream – to engage the private sector as a financier or intermediary in programmatic carbon finance and to improve at the national level, managerial and technical competence for designing and implementing adaptation projects at the community level.

2. Both levels are now required to embark into the path of climate change adaptation and mitigation. At the upstream level, to catalyze policy and institutional reforms and develop monitoring targets and indicators and at the downstream level, where countries are focusing their investments and where the operational impacts can be measured. Working at the extreme levels of the development agenda will also pave the way for reducing transaction costs resulting for developing tools and guidelines for policy actions and strengthening technical and managerial capacity for project development and for private sector participation.

8.2 ESCWA Objectives for the Green Energy

118. The overall objective of ESCWA's green energy is to strengthen the momentum for policy reform and institution building for moving towards a low carbon economy in the energy sector by assisting counties in the Arab Region to better use their energy assets and resources. This would ultimately contribute to the countries' economic growth and/or poverty reduction.

119. In order to achieve such objective, ESCWA should consider establishing a one-stop-office, as the first platform for knowledge generation, information dissemination, capacity building, technical support and advisory services in green energy.

120. In order to achieve the overall objective, the one-stop-office will focus on a capacity building program consisting of:

1. Upstream analytical work to develop outcome-oriented strategies and programs in the energy sectors of priority to be established by country based on both sound economic criteria, and the MDGss;
2. Strengthening the institutional and legal framework, as well as stakeholders' participatory capabilities, for successful implementation of policy initiatives developed for a low carbon economy;
3. Providing the technical and economic tools to ensure that strategies and policies in the energy sector would be considered by decision makers for a sustainable use of their energy assets and resources; and
4. Assisting countries in project preparation aimed at stimulating the role of the private sector in designing, financing and implementing priority projects based on Arab country priorities and/or in their MDGs s.

8.2.1 Opportunities for Cooperation with Regional Institutions and Partners

121. Following are the opportunities that ESCWA could play a major role in achieving the above objective.

1. One of the outcome of ESCWA one-stop-office should be to act as a catalyst and facilitator for generating business development and investments in collaboration with Regional Financing Institutions and Partners such as the Islamic Bank for Development and the Arab Funds such as the Arab Fund for Economic and Social development, the Saudi Fund for Development, and the Kuwait Fund for Arab Economic Development, and the Abu Dhabi Fund for Development.

2. International development partners and regional financing institutions consider now that the key to greater prosperity lies in increasing economic ties within south-south and north-south collaboration. In this regards, they have adopted a two pronged strategy in the Middle East and North Africa Region: (a) Support regional programs aimed at regional integration; and (b) financing bilateral projects that can have also a regional dimension.
3. There are two major forms that could lead to regional integration namely: (a) regional cooperation whereby countries cooperate in regional projects and facilitate exchange of information and best practices; and (b) regional harmonization in which countries try to minimize inconsistencies in their policies and regulations so that their cooperation is made more effective and common rules and regulations can be used across countries in the region.
4. ESCWA should stimulate investments and contribute to regional cooperation and harmonization of green energy. In this regards, ESCWA opportunities would be to take the lead and work in partnership with IRENA, which is the international arm of renewable energy in the Arab region, and RCREEE, which is the regional NGO in energy efficiency and renewable energy, UNDP and UNEP regional offices, to identify specific national activities but of regional nature and as explained in Section 5).

8.2.2 Opportunities for Cooperation with the Private Sector

122. Leveraging private sector funding on an adequate scale rest on the effective capacity to address the issue of both externalization by the private sector, and the environmental and social costs of unsustainable energy development. This is the crucial issue: externalization of these costs far outstrips investment in repairing the damage, and nullifies the foundation of any environmental policy based on the polluter pays principle.

123. The windows of opportunity that ESCWA should take advantage of, being developed for the introduction and dissemination of energy friendly technologies and practices. Part of this is the result of targeted policies, such as those to support renewable energies. Another, perhaps more determining part is the result of market dynamics due to world competition for scarce resources-oil, water. While the theory of environmental economics, which shows how green technologies are

also more economically attractive and how it makes every good sense to be adopted, the stark reality is that the market in many member countries in the Arab Region is able to push things exactly in the opposite direction- witness the corrosive subsidies on conventional energy. This is because the migration to green technologies and practice requires important behavioral changes. And as long as there will be billions going into subsidies against millions in rather pious demonstration and pilot projects, there will be little hope for change. Typically, the producers of greener technologies are pioneering, small to medium enterprises and they are pitched against these unsustainable policies.

124. Private capital could flow to green energy programs, provided sufficient progress is achieved in the following "software" elements, namely:

- A supportive institutional, legal and financial framework based on financial incentive.
- A bottom up approach of meeting customer requirements and satisfaction and minimize costs through adoption of commercial principles.
- A well defined and understood contractual relations between government and the private sector.
- A fair competition and transparency and continuous accountability from both parties.
- An incorporation of environmental considerations into feasibility studies and financial evaluation of environment and social risks as well establishment of a reliable system to accurately assess relevant environmental issues.
- A responsible banking sector to provide green energy friendly loans and minimize liability exposure.
- A guarantee for payment of services by the client in accordance with contractual performance.

125. ESCWA can provide authoritative, documented and credible information to the private sector, in support of greener technologies. It can catalyze the resources of green entrepreneurs, pool them and reinforce them. ESCWA's role is to produce the basic data necessary for the developers of business plans for green technologies.

ESCWA should assist selected countries in studying private participation and assessing the possible contribution of the private sector to the achievement of potential investments in green energy technologies by promoting and supporting direct private sector participation in carbon procurement and in building confidence in private sector intermediation, particularly in the programmatic carbon emissions trading. This is achieved through dissemination of business practices and could include:

a. Adaptation of new methodologies for carbon emissions reductions in the energy so that investment programs s could take advantage of carbon emission revenues

b. Development of guidelines and tools for: (i) the promotion of performance-based contracts; (ii) fair sharing of risks between contracting parties, and (iii) economies of scale; (iii) involvement of financial sector to create a more attractive business environment in the solid waste sector/energy sector; and (iv) take advantage of carbon market benefits and opportunities.

c. Development /adaptation of new financial engineering arrangements to blend carbon emission revenues with investments in the energy sector.

d. Preparation of a tool kit for the design and implementation of the programmatic approach to carbon emissions reduction and revenues.

8.2.3 Carbon Finance Business (CFB) Outreach Opportunities

126. Carbon Finance is now recognized as a mechanism for supporting actual transfer of know-how related to Greenhouse Gas (GHG) mitigation and adaptation technologies as well as enabling the transfer of financial resources from developed to developing countries. The establishment of the GCF in 2010 marks a real breakthrough and opportunity for this mechanism. However countries of the Arab Region, as shown in section 8, have benefited but slightly so far from existing climate change funds. The major stumbling blocks are the lack of: (i) technical and managerial experience in developing projects for GHG mitigation and adaptation; (ii) information on business models and procedures; (iii) capabilities to bring to the market projects with significant emission reduction potential and, (iv) national policy and institutional frameworks.

127. Access to the Green Climate Fund's resources can be through" sub-national, national, regional and international, public and private entities that should be accredited by the Board of GCF[48] for financial management project management environment and social safeguards and gender mainstreaming. Accredited entities may submit funding proposals directly to GCF. Entities that are not accredited may submit funding proposals to and work with accredited entities. Operating within the scope of their accreditation type, GCF's resources can only be channeled through its accredited entities to developing countries. As stated above, the GCF has allocated US$ 15 million for its readiness program to assist in development of a project pipeline and assistance for accreditation.[49]

128. ESCWA should make a decision after consulting with its legal office as to whether its existing mandate enable ESCWA to be a regional or international entity that can be a recipient of GCF. In such instance, ESCWA should submit its request online through the accreditation process.[50] In case ESCWA cannot be considered as a legal entity, it can still act as an intermediary to regional institutions and organizations namely the Islamic Development Bank and Arab Funds such as the Arab Fund for Economic and Social development, the Saudi Fund for Development, and the Kuwait Fund for Arab Economic Development, and the Abu Dhabi Fund For Development. In such case, ESCWA should take the lead by contacting these entities and encourage them to be accredited and receive financial support from the GCF readiness program. ESCWA will therefore provide advisory services for these entities and assist them in the preparation of project pipeline, assist in the accreditation system and assist in the development and implementation of clean energy projects.

129. Irrespective as to whether ESCWA can be accredited and act as an intermediary for its Regional Partners and in view of the importance of the GCF mechanism for linking global to local

[48] Green Climate Fund website: <www.gcfund.org/operations/accreditation/accredited-entities.html>.
[49] GCF Readiness Information Pack, 2014: <www.gcfund.org>.
[50] Green Climate Fund website: <www.gcfund.org/operations/accreditation/applications.html>.

benefits, ESCWA should play a major role in strengthening the GCF mechanism and its implementation through:

- Capacity building in the form of workshops and training at the regional / local stakeholders for preparing, submitting and implementing GCF projects. Already UNEP, IRENA and the RCREEE have provided under their capacity development (CD) technical assistance for a significant amount of support to countries geared essentially towards the satisfaction of administrative requirements set forth by the Climate Change Convention. ESCWA will complement these activities by assisting selected Arab countries and regional entities to identify and develop a pipeline of bankable GCF projects;
- Develop with the regional institutions and the Islamic Development Bank, the necessary Nationally Appropriate Mitigation Actions (NAMA)[51] which refers to any action that reduces emissions in developing countries and is prepared under the umbrella of a national governmental initiative. They can be policies directed at transformational change within an economic sector, or actions across sectors for a broader national focus.[52] Jordan and Tunisia prepared NAMAS for the municipal waste sector. Tunisia also prepared NAMAs for energy efficiency ;
- Strengthening the links between the LAS, the IRENA and the RCREEE on climate change related programs through conducting joint studies and providing regional and sub-regional workshops for the benefit of linking global to the local environment.

8.2.4 Opportunities for ESCWA to implement stand alone regional activities for removal of basic gaps in green energy technologies

[51] Wikipedia website: <http://en.wikipedia.org/wiki/Nationally_Appropriate_Mitigation_Action>.

[52] NAMAs are supported and enabled by technology, financing, and capacity-building and are aimed at achieving a reduction in emissions relative to 'business as usual' emissions in 2020.

NAMAs are defined in two contexts: 1) At the *National Level* as a formal submission by Parties declaring intent to mitigate GHG in a manner commensurate with their capacity and in line with their national development goals; 2) At the *Individual Action* Level as detailed actions or groups of actions designed to help a country meet their mitigation objectives within the context of national development goal

Once the major framework for ESCWA work program is agreed among its partners, ESCWA should take the lead in launching two major activities that are considered fundamental to bridge a major regional gap and to establish its credibility in the region by using to the extent possible its own budget. These two activities are:

- Designing and establishing of tool kit for green investments energy technologies at the national and regional level.
- Developing and implementing a strategy and a technical proposal for public communication and awareness in green energy technologies.

8.3 Establishment of a Tool Kit in ESCWA

130. No ministry or agency has a tool kit on investment requirements in green energy that can be accessible to decision makers, operational staff and the public. Many agencies such as IRENA and RCREEE have developed country reports, data and information generated for the technical staff, scientific and research community but without including economic and financial data on the environment and social externalities; the remediation tools for decreasing global and local damages; as well as economic models for reducing subsidies in the energy sector, without which decision makers are unable to make the right decisions at the strategic and investment levels.

131. The objective of this activity is to design and establish a tool kit that is simple and accessible to users without a previous technical knowledge of the system. The major outcome of this activity would be the develop information on investment opportunities in green energy for each of the ESCWA member counties highlighting the externalities, the damage costs, the market size the technical, financial barriers, business models and procedures; potential capabilities to bring to the market projects with significant emission reduction potential as well as the incentive system for attracting private sector investments.

8.4 Public Communication and Awareness on Green Energy

132. There is until now, no established regional strategy for communication targeting the public and stakeholders for involving them into the decision making process and in the design of implementation of green energy technologies. Formal and informal stakeholders are considered key for the penetration and adaptation of the green energy technologies.

133. ESCWA should be the platform to enable a leverage for knowledge and technology- based public information in investment in green energy technologies and to establish effective communications tools between the users and the providers. Working with the users and facilitating their communication with national and local authorities result in improved understanding and adoption of green energy technologies accompanied by a credible and realistic incentive system. Feedback systems from the users and stakeholders results in improving also the relationship between them and their governments..

134. The purpose of this activity is the design, and implementation of appropriate communication and information tools to ensure the understanding and to assess the impact of implementing green technologies by stakeholders and users. This activity would require: (a) the development of strategic actions at the regional level as well in specific countries through the identification of existing best technologies and practices, information and communication tools on public disclosure, and development and provision of training economic and financial tools; and (b) design and implementation of communication and disclosure tools trough development of communication materials in Arabic, assistance to the media in providing simple and understandable materials on green energy technologies and transfer the experience of other developing countries.

8.5 Design Considerations for the Green Energy Framework

135. Five determinants will determine the effectiveness of this framework namely: (a) strong country commitment to regional cooperation; (b)realistic scope matched to national and regional capacities; (c) clear delineation and coordination of the roles of national and regional institutions;

(d) accountable governance arrangements; and (e) planning for sustainability of outcomes and activities at both the national and regional level.

136. 21. This framework should be a flexible mechanism that can adapt easily to the requirements and mandates of countries in the Arab region, potential donors and to the demands of the individual countries and the privates sector. It implies a new way of thinking and working in the countries so as to move from:

a. considering environment as a liability that would drain budgetary resources to considering it an asset to generate financing through policy and institutional reforms;
b. a focus on inputs and outputs (projects, programs) to targets and outcomes (impacts of projects and legal changes) derived nationally;
c. a top-down approach and centralized decision making into a system of information sharing and improved governance;
d. a dependence on external assistance to national resources mobilization through market-based instruments and leveraging global benefits (GEF, GCF); and
e. A reliance on the Ministries of Energies for their guidance to catalyze the process of measuring performance and accommodating learning into focusing on the other sector ministries, the financial and private sectors.

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Annex I: Local and Global Environmental Damage Quantification and Valuation

National Level

137. At the national level, ambient air emissions are due to mainly anthropogenic (e.g., criteria pollutants such PMx, SOx, NOx, CO, O_3 and VOCs as well as CO_2 released in conjunction with human activities) and to a lesser extent natural (e.g., sand storms as dust includes PMx) causes. It is important to note that 80% of ambient coarse and fine particulate matters (PMx), which contributes significantly to ill-health in terms of cardio-pulmonary diseases including certain forms of cancer, is derived from fuel combustion in general. The remaining 20% stem from a number of factors ranging from geological material, e.g., dust associated with construction activities and sand storms, to marine salty water droplets. The majority of the population of Arab Countries is exposed to a mean 32 $\mu g/m^3$ concentration of $PM_{2.5}$ annually with large variations accross Arab Country groups (25 to 58 $\mu g/m^3$) against a recommended WHO threshold of a mean 10 $\mu g/m^3$ of $PM_{2.5}$ annually (see Table A1.1).

138. The mean annual exposure to particulate matter concentration is by far the highest in GCC countries (58 $\mu g/m^3$) due to their energy intensive and not necessarily efficient processes. These results are at odds with the *Environmental Kuznets Curve* whose hypothesis postulates an inverted-U-shaped relationship between different pollutants and per capita income, i.e., environmental pressure increases up to a certain level as income goes up which is not the case in the higher income and large oil/gas exporting countries subgroups where both environmental pressures and income are still trending upward.

139. The damage cost valuation considers a significant portion of damages attributable to these criteria pollutants and more specifically these high level of particulate matter concentration. Widely used to calculate the Burden of Disease, the Disability-Adjusted Year Life (DALY) metric, which is equivalent to *one year lost of healthy life*, is aggregated for Arab Countries in

2010 as generated by the Institute for Health Metric and Evaluation[53] that took the relay from WHO for the calculation of the burden of disease (WHO, 2010).

140. The international dollar (PPP$) is used for the calculation instead of the United States dollar because it allows to compare international living standards between countries as it defines the correct exchange rates for comparing prices and incomes in different currencies so that goods and services should cost the same everywhere after converting to a common currency.

141. The 2010 GDP per capita denominated in international purchasing power parity dollar (PPP$) is applied to each DALY lost. This method, which is called human capital approach, calculates forgone future discounted earnings lost due to premature death, is a lower bound valuation method applied for premature death. Although considered controversial, the PPP$/DALY lost was used in the IPCC 5[54] and is adopted for the calculations. A method to derive the upper bound is the value of statistical life, which calculates the willingness to pay to reduce the premature mortality risk, is used in this particular case for comparative purposes and is increasingly considered in valuations. However, the cost of illness method (hospitalization, physicians, drugs, coping, pain and suffering, etc.), which should be added to the premature mortality valuation, is not considered in this particular case. Therefore, the lower bound ambient air damage cost results are very conservative and are caused by both anthropogenic (criteria pollutants and greenhouse gases) and to a lesser extent natural (mainly PMx) emissions. The upper bound valuation is only cited for comparative purposes.

Global Level

142. At the global level, the carbon dioxide emissions used are emissions from the burning of fossil fuels and manufacture of cement and include carbon dioxide produced during consumption of solid, liquid and gas fuels, and gas flaring in 2010 as calculated by the United States Carbon

[53] IHME Website: <www.healthdata.org/>.
[54] IPCC Website: <www.ipcc.ch>.

Dioxide Information Analysis Center[55] (CDIAC) and reported in the 2015 WDI.[56] The figures are closer to the EU EDGAR[57] model results than the International Energy Agency (IAE) results in 2010:[58] 1.601, 1.577 and 1.431 billion tons of CO_2 in 2010 respectively (Table A1.1). Also, the IAE breakdown by fuel and by sector do not add up and the discrepancy is shown in Table A1.1. Still, the IEA are considered for total CO_2 emissions as well as for the fuel and sector breakdown to provide an order of magnitude.

Table A1.1: References for Emissions by Fossil Fuel and Sector in Arab Countries, 2010

Emissions	World	USA	China	Arab Countries
0. $PM_{2.5}$ Annual Mean ($\mu g/m^3$)	**31**	**13**	**73**	**32**
1.a CO_2 emissions (source: US CDIAC) (kilo Tons)	**33,615,389**	**5,433,057**	**8,286,892**	**1,601,122**
1.b CO_2 emissions (source: EU EDGAR) (kilo Tons)				**1,576,894**
1.c CO_2 emissions (source: IEA) (kilo Tons)				**1,430,700**
By Fuel (source: IEA)				**1,458,208**
Liquid fuel consumption				822,966
Gaseous fuel consumption				615,301
Solid fuel (coal, etc.) consumption				19,941
Discrepancy with IEA 1.c Total				*-27,508*
By Sector (source: IEA)				**1,515,710**
Electricity and heat production				722,570
Transport				352,150
Manufacturing indust. & const.				350,780
Resid. blg. and com. & public serv.				65,800
Other sectors not listed above				24,410
Discrepancy with IEA 1.c Total				*-85,010*
2. CO_2 equiv. GHG comp. (source: WDI) (kilo Tons)				**354,622**

Note: $PM_{2.5}$ Mean Annual Exposure stem from both anthropogenic and natural causes. Discrepancy is the difference between IEA total CO_2 emissions and available aggregate fuel and sector data. Other GHG compounds include methane, NOx and other GHG emissions associated with fuel combustions and are accounted for in CO_2 equivalent. CO_2 eq. CO_2 emission data on Palestine, Comoros, Djibouti, Mauritania and Somalia is not available under EDGAR and IEA. GHG compound data on Palestine and Sudan is not available under WDI.
Source: CDIAC total and IEA breakdown as listed in the WDI (2015); IEA total as listed on the IAE Website <www.iea.org>; EDGAR total as listed on the EU EDGAR Website: <http://edgar.jrc.ec.europa.eu/>; and CO_2 equiv. GHG compounds as aggregated from various sources listed in WDI (2015).

143. Biomass burning, methane, nitrous oxide, sulfur hexafluoride (SF6) and other greenhouse gas (GHG) generating GHG emissions account for 354.6 million tons in 2010 (WDI, 2015) to which must be added carbon emissions from maritime and aviation bunkers. The bulk of these GHG

[55] CDIAC Website: <http://cdiac.ornl.gov/>.
[56] World Bank Website: <www.worldbank.org>.
[57] EU EDGAR Website: <http://edgar.jrc.ec.europa.eu/>.
[58] IEA Website: <www.iea.org>.

emissions are listed separately (Table A1.1) and mostly associated with the oil and gas industries and their derivatives, especially in large oil/gas exporting countries. However, it is not clear whether these GHG emissions are already included in the IEA figures and therefore are not accounted for in the damage cost figures. It is important to underline that totals need further adjustments especially since it is unclear how much of these other GHG is considered in the breakdown by fuel and by sector.

144. Carbon emissions from fossil fuel combustion and process are illustrated by fuel and by sector in Table A1.1. Liquid fuel remains the major fuel used across income and energy subgroups especially in middle/low income and small oil exporter/net oil importer countries. By sector, electricity is by far the largest emitter of CO_2 followed by transport and manufacturing and industries in absolute terms and across income and energy subgroups.

145. Regarding the valuation, a subset of climate change risks and impacts are often measures using aggregate economic indicators such as GDP.[59] Nevertheless, GDP does not capture all the social cost of releasing one extra ton of carbon dioxide as future impacts are very difficult to value (limitations, evidence and confidence, discount rate, scenario used that has different impact by region and country, etc.) while it is not only each Arab country that will bear the cost of these emissions but the world at large. Yet, estimates of the aggregate economic impact of emitting one extra ton of carbon dioxide lie between few dollars to few hundred dollars where the social cost of CO_2 is the present and future (2000-2099) damage from a ton of current emissions in terms of: decreased agricultural yields, harm to human health and lower worker productivity, floods, droughts, sea-level rise, declining food production, species extinction, migration, productivity, ecosystem disruptions, etc. For instance, specific estimations are available for the social cost of CO_2 emissions ranging from few US cents up to US$ 220[60] (e.g., Stern, 2007; IWGSC, 2010; Nordhaus, 2011; IPPC 5, 2014; Moore and Diaz, 2015). The European Commission (EC 2008 and DECC 2009) has reported US$ 6 per ton as a lower bound value of CO_2 and the French study

[59] IPCC Website: <www.ipcc.ch>.
[60] Moore, Frances C. and Delavane B. Diaz. 2015. "Temperature impacts on economic growth warrant stringent mitigation policy." Nature Climate Change. 5, 127–131.

(Centre d'analyse stratégique, 2009) as an upper bound value of CO_2 with US$ 11 per ton in 2009. The United States Interagency Working Group on Social Cost of Carbon (IWGSC --2010) has estimated damages from global warming of US$ 25 per ton of CO_2 emission. The US Environmental Protection Agency considers that an additional ton of carbon dioxide emitted in 2015 would cause US$ 37 worth of economic damages.[61]

146. For the global damage cost, a range of US$ 11-15 per ton of CO_2 in 2010 prices was considered as lower bound based on Nordhaus, 2011, which estimated the social cost of carbon for the current time (2015) including uncertainty, equity weighting, and risk aversion at US$ 13.4 equivalent to PPP$ 18 per ton CO_2 (US$ 48.4 per ton of carbon) in 2010 international prices when using the worldwide exchange rate between the US$ and the PPP$ (1.35) in 2010. The upper bound valuation is only cited for comparative purposes and is based on 2010 IWGSC's US$ 25 equivalent to PPP$ 33.6 per ton of CO_2 emission.

[61] US EPA Website: <www.epa.gov>.

Annex II Power Generation and Load Emission Projection

IEA New Policy Scenario

147. In its 2012-2014 World Energy Outlooks, IEA used the GHG and Air Pollution Interaction and Synergy (GAINS) model to simulate 4 investment and emission scenarios at the global and regional levels over the 2010-2035 periods with: (i) the business as usual (BAU) Scenario 1 where the emission trends will remain unchanged based on pre-2012 policies; (ii) the new policies (NP) Scenario 2 with 2012 policy commitments on a voluntary basis after Cancun Climate Change Conference in 2010; (iii) the High Energy Efficiency Scenario 3 promoting energy efficiency in all countries; and (iv) the 450 (ppm) Scenario 4 where radical policy action consisting of limiting the global temperature increase to 2° Celsius is adopted.[62]

Arab Country Target Assumptions

148. Preliminary assumptions were needed to carry out the cost/benefit analysis that will determine the marginal reduction of NOx, SOx, $PM_{2.5}$ in conjunction with CO_2 reduction. Table A2.1 illustrates NOx, SOx, $PM_{2.5}$ and CO_2 emission loads from various power generation types in gram per KW/h and the marginal cost of each compound is derived from the EU DG Environment (2005)[63] and Nordhaus (2011) values (see Annex I). Table A2.2 provides levelized cost per KW/h for each type of plant. All scenarios will be compared to the combine cycle gas (CCG) turbine. For the cost, the marginal cost of RET, i.e., the incremental cost of each RET as compared to the cost of the CCG. For the benefit, the marginal benefit of RET, the local and global benefits accruing from considering each RET as compared to the CCG emissions. Implementation is over 3 years and investment time life is over 35 years discounted at 10%.

[62] IEA. 2012 and 2013. World Energy Outlook. Paris: <www.iea.org>.
[63] EU DG Environment. 2005. Damages per tonne emission of $PM_{2.5}$, NH_3, SO_2, NOx and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas. Prepared by AEA Technology plc. Brussels.

Table A2.1: Emission Load Factors and Marginal Cost from Various Power Generation

Plant	CCG	PV	Geoth.	CSP	Hydro	Wind	Marginal Cost US$/g			
Compound	g per KW/h						CCG	Machreq	Maghreb	LIC
CO	0.02797						0.00032	0.00011	0.00012	0.00004
$PM_{2.5}$	0.00083						0.04801	0.01730	0.01850	0.00607
PM_{10}	0.00083						0.00503	0.00171	0.00183	0.00059
NO_X	0.06295						0.00812	0.00293	0.00313	0.00103
SOx	0.00200						0.01034	0.00373	0.00398	0.00131
VOC	0.00170						0.00175	0.00063	0.00068	0.00022
CO_2	490	45	38	27	24	11	0.00002	0.00002	0.00002	0.00002

Note: CCG = combined cycle gas turbine.
Source: UNCCC 5th Report Website: <www.unccc.ch>; Cai et al. (2012);and EU EMEP-EEA Air Pollution Guidebook (2014).

Table A2.3: Levelized Cost of Power Generation Types, 2015 prices

Plant	CCG	PV	Geothermal	CSP	Hydro	Wind
	US$ per KW/h					
CAPEX	0.016	0.125	0.037	0.212	0.078	0.070
OMEX Fixed	0.002	0.012	0.013	0.046	0.004	0.014
OMEX Variable	0.053	-	-	-	0.007	-
Transmission	0.001	0.004	0.002	0.007	0.002	0.003
Total	0.072	0.141	0.052	0.264	0.092	0.087
Low	*0.066*	*0.110*	*0.050*	*0.191*	*0.067*	*0.078*
High	*0.082*	*0.218*	*0.055*	*0.422*	*0.150*	*0.098*
Subsidy	0.07	0.07	0.07	0.07	0.07	0.07
% of Subsidy	96%	49%	134%	26%	76%	80%
Incremental cost as compared to CCG	0.00	0.07	(0.02)	0.19	0.02	0.02

Note: Totals may not add up due to rounding.
Source: IMF (2014), WDI (2015); EIA Website: <www.EIA.gov>; and Author's calculations.

149. Marginal cost of emissions are derived from EU EDGAR[64] that are available for Europe. The 2005 figures were adjusted by a benefit transfer function[65] and rebased to 2015 in US$.

150. The transfer of the unit to adjust for differences in income value is as follows:

$$MCEp = MCEs \times (Yp / Ys)^{ß}$$

Where:

MCEp = Marginal Cost of Emission in policy country
MCEs = Marginal Cost of Emission in study country
Yp = income in the country policy denominated in purchasing power parity dollar (PPP$)
Ys = income in the country of study denominated in purchasing power parity dollar (PPP$)
ß = income elasticity for different environmental goods and services, which are considered normal goods,[66] are typically greater than 0 (perfectly inelastic which would have meant that the MCEp = MCEs only adjusted by income where ß = 0) and smaller than 1 (inelastic), and often range between 0.9 and 0.4.

[64] EU EDGAR Website: <http://edgar.jrc.ec.europa.eu/>.
[65] Navrud, Ståle. 2009. *Value Transfer Techniques and Expected Uncertainties*. New Energy Externalities Developments for Sustainability (NEEDS). Project no: 502687. Deliverable n° 2.1 - RS 3a. SWECO. Stockholm.
[66] Pearce, David, 2003. *Conceptual Framework for Analysing the Distributive Impacts of Environmental Policies*. Prepared for the OECD Environment Directorate Workshop on the Distribution of Benefits and Costs of Environmental Policies. Paris.

151. In this particular case, the lower and upper income elasticity is assumed to be conservatively set at 0.8 (more inelastic) for LIC, which means that the percentage responsiveness of quantity demanded (in this case the resource) is significantly and slightly lower to the percentage change in income respectively; 0.7 for Machreq and Maghreb; and 0.4 for GCC. The adjusted EU figures are illustrated in Table A2.3.

Table A2.3: Marginal Cost of Emission, US$/Ton, 2015 Prices

Compound	EU 2015	GCC	Machreq	Maghreb	LIC
	US$/ton	US$/ton	US$/ton	US$/ton	US$/ton
CO	292	325	111	118	38
$PM_{2.5}$	39,994	48,007	17,303	18,501	6,067
PM_{10}	4,516	5,032	1,715	1,834	590
NO_X	6,768	8,124	2,928	3,131	1,027
SOx	8,614	10,340	3,727	3,985	1,307
VOC	1,461	1,754	632	676	222
CO_2	15	15	15	15	15

Source: EU EDGAR Website: <http://edgar.jrc.ec.europa.eu/>; WDI (2015); and Authors' calculations.

152. A cost benefit analysis was used to prioritize investments. Usually, 3 indicators are considered for a Cost Benefit Analysis:

- The Net Present Value (NPV) which is the difference between the discounted total benefits and cost;
- The Rate of Return (RR), which is the discount rate that zeroes out the NPV or, the interest rate that makes the net present value of all cash flows equal to zero; and
- The Benefit-Cost Ratio, which is the ratio of the present value (PV) of benefits over the PV of costs over the lifetime of the project.

Arab Country Installed Capacity and Power Generation Targets

153. Arab Country estimated renewable energy technology (RET) targets for 2015-2030 have been compiled from various sources but remain preliminary and incomplete as Bahrain (unofficial target of 5% by 2030), Oman, Iraq, Comoros and Somalia did not release future, official or

detailed RET targets although unofficial, existing or in-the-pipeline RET capacity was considered. Still, the 2013 Pan-Arab comprehensive strategy calls for an increase of renewable technologies from 11 GW in 2010 to about 75 GW of installed capacity in the Arab countries by 2030 (Table A2.4).

Table A2.4: Estimated Renewable Energy Installed Capacity Targets in Arab Countries, 2015-30

RET Cumulative Targets by Category	Arab Countries		By Group			
			GCC	Mashreq	Maghreb	LIC
	MW	%	MW	MW	MW	MW
2015 Target	**21,682**	**100%**	**4,053**	**9,835**	**5,671**	**2,123**
CSP	3,228	15%	2,500	210	518	0
PV	1,347	6%	294	546	466	41
Wind	5,992	28%	1,093	1,932	2,583	385
Biomass and Waste	266	1%	167	4	40	55
Hydro	10,850	50%	0	7,144	2,064	1,642
Geothermal	0	0%	0	0	0	0
2020 Target	**59,277**	**100%**	**26,118**	**20,027**	**10,589**	**2,543**
CSP	20,915	35%	15,790	1,500	3,625	0
PV	6,177	10%	3,619	1,187	1,330	41
Wind	20,572	35%	6,543	9,974	3,300	755
Biomass and Waste	444	1%	167	182	40	55
Hydro	11,120	19%	0	7,184	2,294	1,642
Geothermal	50	0%	0	0	0	50
2025 Target	**81,524**	**100%**	**41,468**	**23,597**	**13,269**	**3,190**
CSP	25,365	31%	18,140	3,250	3,875	100
PV	16,578	20%	12,319	2,387	1,830	42
Wind	25,582	31%	9,043	10,474	4,970	1,095
Biomass and Waste	2,630	3%	1,967	302	300	61
Hydro	11,120	14%	0	7,184	2,294	1,642
Geothermal	250	0%	0	0	0	250
2030 Target	**119,685**	**100%**	**65,895**	**24,887**	**24,528**	**4,375**
CSP	40,315	34%	26,840	3,250	10,075	150
PV	31,639	26%	22,756	3,037	5,159	687
Wind	31,262	26%	12,133	10,974	6,700	1,455
Biomass and Waste	4,037	3%	3,167	442	300	128
Hydro	11,183	9%	0	7,184	2,294	1,705
Geothermal	1,250	1%	1,000	0	0	250

Note: Totals may not add up due to rounding. Figures were compiled and adjusted from various sources and are cumulative over 2015-30. Bahrain, Oman, UAE, Iraq, Comoros and Somalia do not have detailed targets per se but their actual installed capacity as well as the one in the pipeline is considered. Target years that fall before or after the 4 landmarks are included in the closest landmark year, e.g., Sudan's target is set for 2031 and is included in 2030.

Source: RCREEE 2012 Country Fact Sheets <www.rcreee.org>; Lins, C., L. Riahi and R. Zissler. 2013. Arab Environment Sustainable Energy, Chap. 3: Renewable Energy; AfDB. 2013. Djibouti Geothermal Exploration Project in the Lake Asal Appraisal Report. Abidjan; LAS-IRENA-RCREEE. 2014. Pan-Arab Renewable Energy Strategy. Abu Dhabi; ESCWA. 2015. Regional Coordination Mechanism, Issue Brief for the Arab Sustainable Development Report: Energy in the Arab Region. Beirut; IRENA Website <http://resourceirena.irena.org/gateway/index>; and Clean Technica Website: <http://cleantechnica.com>.

Scenario Analysis

154. The three scenarios considered for the cost and co-benefit assessment and analysis, i.e., 3%, 11% and 29% RET in 2020 are illustrated in Tables A25-7.

Table A2.5: 2020 BAU Scenario 1 Cost and Co-Benefit in Arab Countries

Power Generation	**Arab Countries**	**GCC**	**Mashreq**	**Maghreb**	**LIC**
2020 Conventional Power Generation (TW/h)					
Generation in 2020	**129.2**	**83.9**	**32.2**	**12.2**	**1.0**
Generation over 35 years	**4,523**	**2,937**	**1,125**	**427**	**34**
Cost (US$ Billion in 2015 prices)					
CAPEX in 2020	2.20	1.43	0.55	0.21	0.02
OMEX in 2020	7	5	2	1	0.1
Distribution and Transmission Losses in 2020	0.46	0.19	0.20	0.06	0.009
Subsidies (2011 subsidy rate) in 2020	9.0	6.5	1.8	0.7	0.004
Cost (PPP$ Billion in 2015 prices)					
CAPEX in 2020	4.55	2.71	1.29	0.51	0.04
OMEX in 2020	15	9	4	2	0.1
Distribution and Transmission Losses in 2020	1.00	0.36	0.47	0.16	0.02
Subsidies (2011 subsidy rate) in 2020	18.1	12.3	4.2	1.7	0.01
Cost (US$ Billion in 2015 prices)					
CAPEX over 35 years	77	50	19	7	1
OMEX over 35 years	249	162	62	23	2
Distribution and Transmission Losses over 35 years	16.1	6.6	7.0	2.2	0.3
Subsidies (2011 subsidy rate) over 35 years	312	226	63	24	0.15
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	159	95	45	18	1
OMEX over 35 years	515	307	146	58	5
Distribution and Transmission Losses over 35 years	35.1	12.5	16.4	5.5	0.8
Subsidies (2011 subsidy rate) over 35 years	635	429	147	58	0.4
Environmental Benefit (US$ Million in 2015 prices)					
Local in 2020	-26.2	-22.0	-3.0	-1.2	-0.032
Global in 2020	-949	-617	-236	-90	-7
Local over 35 years	-919	-768	-106	-43	-1.1
Global over 35 years	-33,243	-21,583	-8,272	-3,135	-253
Environmental Benefit (PPP$ Million in 2015 prices)					
Local in 2020	-52	-42	-7	-3	-1.1
Global in 2020	-1,965	-1,172	-556	-220	-17
Local over 35 years	-1,818	-1,460	-249	-106	-2.7
Global over 35 years	-68,790	-41,018	-19,452	-7,709	-610
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) in 2020	0.012	0.008	0.003	0.001	0.0001
Global (CO_2) in 2020	63	41	16	6	0.5
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	0.44	0.28	0.108	0.04	0.003
Global (CO_2) over 35 years	2,216	1,438	551	209	17

Note: Totals may not add up due to rounding. Figures were compiled and adjusted from various sources. Oman, Comoros and Somalia neither have detailed targets not actual installed capacity. Target years that fall before or after the 3 landmarks are included in the closest landmark year, e.g., Sudan 2031 target is included in 2030. Subsidies are applied on electricity consumption that is generated under each scenario only, i.e., RET or conventional energy generated minus Distribution and Transmission losses. Distribution and Transmission losses are valued at RET production cost.

Source: RCREEE 2012 Country Fact Sheets <www.rcreee.org>; Lins, C., L. Riahi and R. Zissler. 2013. Arab Environment Sustainable Energy, Chap. 3: Renewable Energy; AfDB. 2013. Djibouti Geothermal Exploration Project in the Lake Asal Appraisal Report. Abidjan; LAS-IRENA-RCREEE. 2014. Pan-Arab Renewable Energy Strategy. Abu Dhabi; ESCWA. 2015. Regional Coordination Mechanism, Issue Brief for the Arab Sustainable Development Report: Energy in the Arab Region. Beirut; IRENA Website <http://resourceirena.irena.org/gateway/index>; Clean Technica Website: <http://cleantechnica.com>; and Author's calculation.

Table A2.6: 2020 Pan Arab RET Target Scenario 2 Cost and Co-Benefit in Arab Countries

Power Generation	**Arab Countries**	**GCC**	**Mashreq**	**Maghreb**	**LIC**
New 2020 RET (TW/h)					
Generation in 2020	**129.2**	**83.9**	**32.2**	**12.2**	**1.0**
Generation over 35 years	**4,523**	**2,937**	**1,125**	**427**	**34**

Power Generation	Arab Countries	GCC	Mashreq	Maghreb	LIC
Cost (US$ Billion in 2015 prices)					
CAPEX in 2020	17.1	11.1	4.2	1.6	0.1
OMEX in 2020	3.2	2.1	0.8	0.3	0.02
Distribution and Transmission Losses in 2020	1.00	0.41	0.43	0.14	0.02
Subsidies (2011 subsidy rate) in 2020	8.9	6.5	1.8	0.7	0.04
Cost (PPP$ Billion in 2015 prices)					
CAPEX in 2020	35	21	10	4	0
OMEX in 2020	7	4	2	1	0
Distribution and Transmission Losses in 2020	2.19	0.78	1.02	0.34	0.05
Subsidies (2011 subsidy rate) in 2020	18	12	4	2	0.01
Cost (US$ Billion in 2015 prices)					
CAPEX over 35 years	597	388	149	56	5
OMEX over 35 years	112	73	28	11	0.9
Distribution and Transmission Losses over 35 years	35.04	14.29	15.16	4.88	0.70
Subsidies (2011 subsidy rate) over 35 years	321	226	62	24	0.2
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	1,236	737	350	139	11
OMEX over 35 years	231	138	65	26	2
Distribution and Transmission Losses over 35 years	76.51	27.16	35.65	12.00	1.70
Subsidies (2011 subsidy rate) over 35 years	635	429	147	58	0.4
Environmental Benefit (US$ Million in 2015 prices)					
Local in 2020	26.2	22.0	3.0	1.2	0.032
Global in 2020	894	580	222	84	7
Local over 35 years	919	768	106	43	1.1
Global over 35 years	31,276	20,306	7,782	2,950	238
Environmental Benefit (PPP$ Million in 2015 prices)					
Local in 2020	52	42	7	3	0.1
Global in 2020	1,849	1,103	523	207	16
Local over 35 years	1,818	1,460	249	106	2.7
Global over 35 years	64,719	38,590	18,801	7,253	574
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) in 2020	0.012	0.008	0.003	0.001	0.0001
Global (CO_2) in 2020	60	39	15	6	0.5
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	0.44	0.28	0.108	0.04	0.003
Global (CO_2) over 35 years	2,085	1,354	519	197	16

Note: See Table A2.5.
Source: See Table A2.5.

Table A2.7: 2020 Upper Bound RET Target Scenario 3 Cost and Co-Benefit in Arab Countries

Power Generation	Arab Countries	GCC	Mashreq	Maghreb	LIC
New 2020 RET to cover total incremental demand (TW/h)					
Generation in 2020	**359**	**200**	**111**	**46**	**3**
Generation over 35 years	**12,572**	**6,997**	**3,890**	**1,594**	**90**
Cost (US$ Billion in 2015 prices)					
CAPEX in 2020	47	26	15	6	0.3
OMEX in 2020	9	5	3	1	0.1
Distribution and Transmission Losses in 2020	2.7	1.0	1.3	0.4	0.04
Subsidies (2011 subsidy rate) in 2020	24.1	15.4	6.2	2.5	0.01
Cost (PPP$ Billion in 2015 prices)					
CAPEX in 2020	100	50	35	15	1
OMEX in 2020	19	9	6	3	0.2
Distribution and Transmission Losses in 2020	6.0	1.8	3.0	1.1	0.1
Subsidies (2011 subsidy rate) in 2020	50	29	15	6	0.03
Cost (US$ Billion in 2015 prices)					
CAPEX over 35 years	1,660	924	514	211	12
OMEX over 35 years	310	173	96	39	2
Distribution and Transmission Losses over 35 years	95.1	34.1	44.1	15.4	1.5
Subsidies (2011 subsidy rate) over 35 years	843	538	217	88	0.4
Cost (PPP$ Billion in 2015 prices)					
CAPEX over 35 years	3,511	1,756	1,208	518	29

Power Generation	Arab Countries	GCC	Mashreq	Maghreb	LIC
OMEX over 35 years	656	328	226	97	5
Distribution and Transmission Losses over 35 years	210.1	64.7	103.8	37.8	3.7
Subsidies (2011 subsidy rate) over 35 years	1,749	1,023	509	217	1
Environmental Benefit (US$ Million in 2015 prices)					
Local in 2020	67	52	10	5	0.1
Global in 2020	2,484	1,382	769	315	18
Local over 35 years	2,361	99	25	11	0.2
Global over 35 years	86,934	48,387	26,902	775	621
Environmental Benefit (PPP$ Million in 2015 prices)					
Local in 2020	136	99	25	11	0.2
Global in 2020	5,252	2,627	1,807	775	43
Local over 35 years	4,744	3,480	862	395	7.2
Global over 35 years	183,829	91,958	63,262	27,110	1,499
Emission reduction (Million tons)					
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) in 2020	0.03	0.02	0.01	0.004	0.0002
Global (CO_2) in 2020	166	92	51	21	1.2
Local (CO, VOC, NOx, SOx, PM_{10}, $PM_{2.5}$) over 35 years	1.2	0.7	0.374	0.15	0.009
Global (CO_2) over 35 years	5,796	3,226	1,793	735	41

Note: See Table A2.5.
Source: See Table A2.5.