



Empowered lives.
Resilient nations.

Policy Note

Prospects of Solar Energy in Yemen

January 2014

United Nations Development Programme

ENVIRONMENT AND ENERGY



Prospects of Solar Energy in Yemen

Walid Ali

Climate Change Policy Advisor

Poverty and Sustainable Development Unit
UNDP Yemen

Fuad Alkadasi

Team Leader, Poverty and Sustainable
Development Unit, UNDP Yemen

Kishan Khoday

Environment and Energy Practice Leader
Regional Bueuer for Arab States
UNDP Regional Office, Egypt

Table of Contents

		Page
Section I	Introduction	4
Section II	Situation Analysis	4
Section III	Alternative non-conventional energy in Yemen	6
Section IV	Solar Energy Prospects in Yemen	8
Section V	Solar Energy Policy Framework	14
Section V	Conclusion	14

Section I: Introduction

1.1 Purpose

- 1- The purpose of this Policy Note is to explore the prospects of solar energy potential in Yemen, and advocate sustainable and cost-effective solar energy-related policy interventions.

1.2 Background

- 2- This Policy Note document builds on findings, lessons and recommendations from various relevant experiences and reports at the national, regional and global levels. The Concept Note brings various elements of sound economic analysis, and put available information into a relevant context to advocate sustainable and cost-effective solar energy-related policy interventions.
- 3- Furthermore, the Policy Note provides a comprehensive review of available reports and studies. It establishes trends from available information in light of new emerging issues, relations and changing realities on the ground from national, regional and global contexts in relation to renewable energy in general and solar energy in particular.

Section II: Situation Analysis

2.1 Setting a broader national context

- 4- Yemen is a Least Developed Country (LDC): First, Gross Domestic Product (GDP) per capita is less than US\$1,086 per annum; Second, Human development is a weak asset in which illiteracy, malnutrition, child mortality rate are high; Third, with the increasing population rate (around 24 million in 2004), high unemployment rate, the economic vulnerability of the country is escalating. Yemen's major challenges for economic growth includes for instance poorly diversified economy which is characterized by largely relying on declining stocks of oil. The incidence of poverty is high particularly in rural areas where about 75 percent of the total population lives. The multidimensional poverty in Yemen is characterized by the indicated lack of access to basic social services such as education, health, and energy. As such, energy poverty for instance is a facet of a multidimensional poverty.
- 5- In this regards, Yemen has the lowest access rate to electricity (i.e. 40 percent of the population) compared to the regional rate of around 85 percent. Inequalities in terms access to electricity exists among rural and urban households. Although rural accounts for about 75 percent of population, only around 23 percent have access to electricity compared with about 85 percent of urban population. Despite the low access rate of electricity, only about one-half of those populations are connected to public grid, and the other one-half gain access through other private sources including diesel generators which usually operate for few hours for lightening, and less-intensive electric appliances. Alternative lighting devices are being used by non-grid electrified rural households including kerosene Lamps (about 67 percent) and Lequified Petroleum Gas (LPG) Lamps (about 5 percent) which have serious environmental impacts. On the other hand, renewable energy share is estimated about 0.009 percent of the total energy mix.
- 6- The majority of Yemen's supply of electric energy is depending on fossil fuels (see Table 1.1) including Mazot, Diesel, and recently LPG. Reliance on the indicated fossil fuel for electric generation is not

sustainable in the long-run. The associated externality is high in terms of non-priced costs of negative environmental and climatic impacts. For instance, electric power production is based overwhelmingly on the use of residual oil and diesel oil and accounted for about 28 percent (about 4,943 Gigagram CO₂-equivalent) of the total anthropogenic Green House Gases (GHG) emissions such as CO₂ in Yemen.

- 7- In general, energy supply in Yemen is limited, and weak generation capacity, high electricity losses from the grid (about 30 percent of production capacity), and increasing demand are among the top sector challenges. The total generation capacity of the Yemeni electricity system is about 1.223 GW after accounting for the recently installed capacity of about 341 MW powered by Natural Gas Turbines (NGT), Phase I. The supply gap against demand is estimated about 500 MW in 2013. The latest Power Development Plan (2009-2020) forecasts a total capacity demand of 3,102 MW at an annual growth rate of 10 percent over the next decade. New capacity of 3,538 MW by 2020 will need to be added to the grid to replace the retiring units and to accommodate the growing demand with sufficient capacity. It is worth mentioning that power demand of industrial development will require additional power supply beyond the aforementioned projections.
- 8- Although the percentage of on-grid connected population is very low, electric power supply from the public network experiences is intermittent, and experiences regular rolling blackouts because of recurring technical failures due to outdated infrastructure which has exceeded its lifespan, in addition to shortage of fuel, particularly diesel, as well as non-technical failures due to frequent tribal attacks. The cost of electric power intermittent is enormous especially on household welfare, delivery of quality basic services as well as Small, and Medium Businesses (SMEs) including Small-scale Industries (SSIs) upon which the economic growth largely hinges.
- 9- Energy-related constraints have seriously been affecting the performance, and sustainability of SMEs, and SSIs in Yemen. For instance, with the lack of access to electricity, and fuel during the 2011 political instability, a quite number of SMEs both shut down business, and large numbers of their employees, and workers were laid off. In addition, many other SMEs downscaled or suspended their operations in 2011. On the other hand, lack of access to electricity in rural areas has further been limiting the livelihood potentials of the poor. Without access to adequate energy service, the poor particularly in rural areas have limited choices for income generation, improved education, and health services, etcetra.

Section III: Alternative non-conventional energy

3.1 Potentials of Renewable Energy in Yemen

- 10- Yemen has vast untapped potential of renewable energy sources. Several studies including the Clean Development Mechanism (CDM) potential in Yemen have indicated the renewable energy potential particularly related to solar, wind, geothermal, and biomass are encouraging. The four naturally renewable sources exist in abundance in Yemen and can be harnessed and utilized to meet the country mounting demand for energy towards low-emission economic growth. A recent study by the Ministry of Electricity has outlined the various aspects of potentiality for five types of renewable energy in Yemen. Table (1) illustrates the five sources of renewable energy, and the various aspects of their potentials including theoretical and physical.

11- For ease of elaboration, definition of terms is provided. The theoretical potential indicates the physical, meteorological or biochemical energy available in a certain region and at a certain time or period. The gross technical potential implies the achievable potential using known technologies taking into account technical factors and land-use. However, the practical technical potential takes into account electricity grid accessibility.

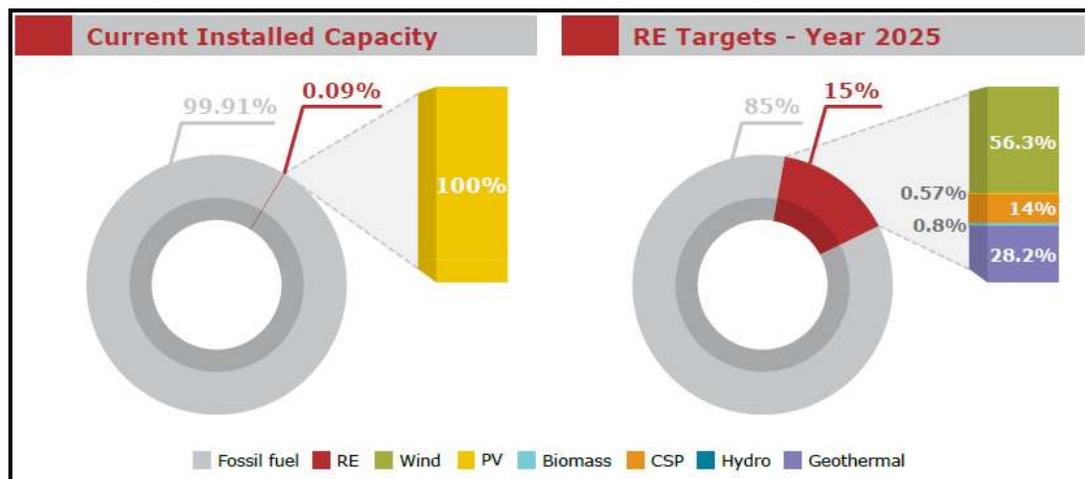
Table (1): Renewable Energy Potentials in Yemen in MW

Resource	Theoretical Potential (MW)	Technical Potential	
		Gross (MW) Practicable (MW)	Gross (MW) Practicable (MW)
Wind	308,722	123,429	34,286
Geothermal	304,000	29,000	2,900
Solar electric	2,446,000	1,426,000	18,600
Biomass-landfills	10	8	6
Hydropower- Major Wadies	12 – 31	11 – 30	-
Solar thermal-Solar Water Heater	3,014	278	278

Source: Joint Socio-economic assessment

12- It is worth noting that among the five sources of renewable energy in Yemen, solar has the largest gross technical potential but ranks second after wind in terms of gross practicable potentiality. The average solar radiation is about 18 - 26 MJ/m²/day over 3,000 hours per year clean blue sky and the theoretical potential for solar electric using concentrated solar power (CSP) reaches about 2.5 million MW. Wind energy on the other hand reaches a potential of 308,000 MW and Geothermal potential of about 304,000 MW. However, the current energy mix in Yemen is dominated by fossil fuel (about 99.91 percent) while renewable energy share is estimated about 0.09 percent. Nevertheless, the National Strategy for Renewable Energy and Energy Efficiency has set targets including a 15 percent increase of renewable energy contribution to the power sector by 2025 (see Figure 1 below).

Figure (1): Share of Renewable Energy in Energy Mix in Yemen



Source: Regional Center for Renewable Energy and Energy Efficiency

As far as this concept is concerned, the potential and prospects of solar energy in Yemen will be highlighted in the next subsections.

3.2 Solar Energy Potential in Yemen

- 13- Yemen is arid and semi-arid country with interior high mountains, upland desert, and long semi-desert coastal plain across the Red Sea and Arabian Sea. The country is characterized by hot and clear weather. Temperatures are generally very high, particularly in the coastal and desert areas. Geographically, Yemen is located in the Sunbelt area of the world. It is endowed with solar energy radiation ranges between 6.8–5.2 kWh/m² per day and annual average of daily sunshine ranges between 7.3 and 9.1 hours/day. Even in winter, the daily average of sunshine hours is estimated of about more than 8 hours per day.
- 14- On such ground, Yemen has immense naturally endowed potential (i.e. above minimum solar radiation rate as well as longer daily sunshine hours even in winter) to generate solar energy by harnessing the physically abundant radiant light and heat it receives from the sun using a range of available solar technologies on a sustainable manner. In other words, on-grid and off-grid solar energy have the potential to significantly contribute in filling the energy gap in Yemen especially in remote rural areas. Solar power is supplied through a technological process through which sunlight is converted into electricity either directly using photovoltaic (PV) systems, or indirectly using concentrated solar power (CSP) modules.
- 15- There are two main applications of solar power supply systems. First, decentralized solar power supply system (on-grid) which typically is produced in large farms, and then fed into an electric grid. Second, a decentralized solar power supply system (off-grid) that is produced for small-scaled and /or individual purposes (i.e. off-grid industrial applications, rural electrification). On the other hand, it worth mentioning that solar power is as sustainable GHG-free energy and has high environmental payback. For instance, the average potential avoided CO₂ emissions as well as other pollutants including SO₂ through deployment of solar systems is estimated about 270g -1050g of CO₂/kWh. Clean Development Mechanism (CDM) which has been institutionalized in Yemen can provide incentives for promoting clean energy initiatives in Yemen. CDM is a mechanism under the Kyoto Protocol qualifies solar energy projects in developing countries and LDCs including Yemen for Certified Emission Reductions (CERs) due to implementation of GHG reducing projects which can be sold in the Carbon market, and hence reduces the total capital investment. Nowadays, the average price of Metric Ton of CO₂ –equivalent is estimated about 10 US\$.
- 16- Although solar power has high potential in Yemen, its current share from national energy mix is quite limited. On-grid and off-grid could potentially contribute to significantly fill this gap especially in relation to providing of electricity to remote and rural areas. However, due to a number of barriers including lack of supportive policy frameworks, highly subsidized diesel, as well as the relatively higher upfront capital cost of solar technologies compared to fossil fuels, its large-scale deployment is constrained. The next subsection will explore in more details the prospects of solar energy in Yemen including economics of deployment solar energy applications.

Section IV: Solar Energy Prospects in Yemen

4.1 Solar Energy Market Outlook: Two Scenarios

- 1- Yet, solar energy market is still limited particularly in rural areas. At present, an increasing number of small entrepreneurs are entering this business as suppliers. The majority of solar initiatives across the country are either donor driven or small-scaled with limited potentiality for expansion. The demand of solar energy for use by businesses in Yemen has not been growing enough. On the other hand, the demand of solar energy in rural areas is hindered by the low purchasing power of rural inhabitants due to the high prevalence of poverty, and a lack of an appropriate policy instruments (i.e. Rural Solar Fund, and/or Solar Loan Schemes, etc) to compensate for the high upfront cost of solar installments. It is worth noting that, initial solar technologies available in the market were imported from Europe. But with the availability of low-cost solar technologies imported from China, the upfront capital investment of solar installments has dropped in the country, and hence positively influenced demand.
- 2- The following are the key policy challenges related to expansion of solar energy market in Yemen:
 - First, a policy to promote solar energy in Yemen is lacking;
 - Second, lacking dedicated institution for implementing the solar energy policy; The MOIT initiative intends to address this gap.
 - Third, yet, a national solar energy map/solar atlas, and solar energy quality standards and codes are non-existent;
 - Fourth, a financial mechanism such as a solar fund for financing, and/or subsidizing solar energy projects is absent;
 - Fifth, lacking of supportive legal framework related to engagement of private sector (i.e. local and/or international business entrepreneurs, and investors) in electric power generation so that electricity surplus is fed into the public grid, a mechanism for compensation (i.e. Feed-in Tariff, no net-metering) is non-existent.
- 17- At present, and in the short-term, solar energy market in Yemen will remain largely constrained by a lack of the conducive environment for promoting of aggressive private engagement in solar energy sector, while at the same time influence demand particularly in rural areas. Due to the involved uncertainty especially in the medium-, and long-term economic outlook of the country, the market prospects solar energy is difficult to project. However, it is most likely that the prospects of large-scale on-grid, and/or small-scale off-grid will largely be reliant on introducing of conducive solar energy related policy reform which includes perusing of appropriate policy instruments to influence both of supply and demand sides. Put this way, the prospects of solar energy market in Yemen can be projected by taking the following two possible scenarios into perspectives.
 1. First, Business as Usual (BaU) Scenario, in which no major change in Government policy related to energy sector and no conducive framework for promoting renewable energy including solar power, are institutionalized. Under this pessimistic scenario, the demand for solar energy will likely remain limited. In addition, deployment of large-scale solar energy projects by local and/or international investor, donors will continue at the current slow paces, and supply will accordingly experience a sluggish growth. Hence, the prospects of solar energy sector will likely be stagnant.
 2. Second, Sustainable Development (SD) Scenario, in which introduction of major changes into the current energy policy including institutionalizing of appropriate policy instruments to influence

solar energy's demand and supply. Under this optimistic scenario, Government spending related to enabling of appropriate institutional and legal framework, and appropriate policy instruments will likely to leverage market prospects as probably driven by incentivized solar energy demand-supply dynamics. Under such market dynamics, the economics of large scales will likely intervene to drag solar energy prices of supply in the local market downward. As such, the expansion of solar energy service will contribute in realizing greater human development dividends. In other words, the projected expansion of solar energy service under this scenario in Yemen will not only address the energy gap significantly, but also payback numerous human development co-benefits including for instance: more job opportunities, more efficient and productive small businesses, and industries (SMEs and SSIs), larger business profitability and revenues, less environmental pollution, as well as faster and sustainable economic growth, and reduce poverty, etcetera.

- 18- Despite that the two aforementioned scenarios are proposed by this Policy Note, it is useful to point out that the country has been experiencing changes since 2011, and the ongoing National Dialogue can be further indicative to draw upon in relation to whether Scenario One or Two will likely to evolve in the future. To put into a relevant context, the positive signs from the National Dialogue might be relevant in supporting greater chances pertaining to the likelihoods of the SECOND SCENARIO.
- 19- In other words, the initial and directive messages from the National Dialogue such as the call by its Sustainable Development committee for maximizing renewable energy's share in the energy sector's investment mix, give positive bearing in terms of projecting the future and consequently supports the greater likelihoods of the optimistic/second scenario rather than the pessimistic/first scenario. However, to further minimize uncertainty related to the aforementioned projection, hedging is employed using conditionality: in that the aforementioned projection will largely hinge upon peaceful completion of the transition, and that the related policies are immediately turned into actual actions. The next sub-section will underscore the advantages and disadvantages of solar energy.

4.2 Solar Energy: Advantages and challenges

- 20- In general, solar energy has numerous economic, social, and environmental advantages. As mentioned in a number of places throughout this Policy Note, solar energy is sustainable in the sense that its technology entirely relies on renewable sun's light, and heat radiation rather than using fossil fuels which is limited, non-renewable, and declining over time while at the same time polluting to the environment. As such, solar energy has zero-GHG emissions, and negligible environmental and social externalities. In addition, it has lower running Operation and maintenance (O&M) costs over longer lifetime (i.e. approximately 10-20 years), and hence ensures greater energy security.
- 21- More importantly, Yemen is naturally endowed with huge solar potential which can be harnessed in order to contribute in filling the existing electricity gap particularly in rural areas. The flexibility of solar technologies related to their installations whether on-grid and/or independent/decentralized units (off-grid) provide a real energy security advantage in terms of their superior suitability for promoting sustainably decentralized and cost-effective energy services across urban and rural areas in general, and remote rural settlements in particular. For instance, instead of using diesel generators especially during electricity intermittent, solar energy technology provides feasible and decentralized business solutions for

small industries and workshops, commercial buildings, and business shops as well as homes (solar home systems) in Yemen.

- 22- Additionally, solar energy can also provide opportunities for local labor, and creates job opportunities as well as promote greater efficiency and productivity of business and small industries (SMEs and SSIs). Nevertheless, the present high upfront capital cost of solar technologies, and low conversion efficiency (i.e. the reported sun light, and heat conversion efficiency into electricity by current PV technology is approximately 20 percent, but significantly improves at higher rate of solar radiation) are the major limitations on way forward. It is worth noting that CDM incentives can also reduces upfront cost of solar investments.
- 23- On the other hand, it's worth pointing out that the opportunity cost which includes for instance the cost of not perusing solar energy as business model will likely run very high (i.e. avoided energy cost saving, and workplace comfort). Furthermore, the opportunity cost will involve the loss of benefits from the potential contribution of increased SMEs performance as well as loss of its potential economic spillover such as potential generation of new employments in addition to creations of new green jobs into the economy.
- 24- Solar installments particularly for securing business's electric power needs require enough space and this might turn technically infeasible especially when space is a constraint. However, the conversion efficiency of light and heat into electricity by PV technologies is on increase. In addition, Government's diesel pricing policy has unfavorable implications on solar energy expansion- the latter is neither subsidized nor incetivized. The subsidized diesel for electric power generation which is estimated at US\$ 4.7 billion in 2008 (i.e. equivalent to 50 percent of the average annual national budget, and 17 percent of GDP) has made solar energy less cost-competitive compared to disel-based power generation. The next sub-section will highlight in more details the economics of solar energy, and solar technologies for enhanced solar energy-related policy-making in Yemen.

4.3 Feasible Solar Applications in Yemen

- 25- As indicated earlier, solar technology converts sunlight into electricity through Solar PV, and into heat for heating, drying, and cooking through Solar Thermal. The flexibility of solar technologies related to their installations whether on-grid and/or off-grid provide a real advantage in terms of their superior suitability for promoting sustainably cost-effective energy services across urban and rural areas in general, and remote rural settlements in particular. For instance, instead of using diesel generators especially during electricity intermittent, applications of solar energy in Yemen has the potential to provide feasible, and sustainable decentralized business solutions (i.e power backup) for SMEs including SSIs.
- 26- In addition, rural off-grid electrification Solar Home Systems, coastal and Wadi solar water pumping, small agricultural industries (e.g. drying of coffeee beans, apricot, dates, fig and turkish fig, etcetra), solar water desalinization, solar water heating, solar lanterns and road solar lightening are among the various feasible applications of solar energy which has high potential in Yemen

4.4 Economics of solar energy

- 27- The present cost of producing solar electricity is higher than power produced from conventional sources such as diesel. The cost of electricity from solar sources ranges between \$0.10- \$0.15 per kWh compared to

about \$0.6 from diesel fuels. However, the cost of energy produced from the conventional fuels such as diesel is lower owing to the fact that externalities are not internalized into electricity bill either by neither on-grid public corporation and private providers nor off-grid generators. In addition, diesel for electricity generation is highly subsidized in Yemen so that electricity costs are usually greater than its prices in Yemen. On the other hand, the upfront investment cost of conventional energy production technologies is lower than solar ones.

- 28- However, solar energy technologies are ever-evolving and the initial investment cost of PV panel for instance is rapidly dropping specially by growing large scale demand and deployment of solar infrastructure. Competition among rivals over global solar industry market share has also significantly advanced the technology through Research and Innovation (R&I) which is contributing toward reducing the technology cost per unit. Nowadays, China for instance is the first largest manufacturer of solar PV panels. The increasing global demand for solar technologies is also largely influenced by green climate policies, energy security as well as low-emission growth strategies (i.e. fossil fuels are environmentally polluting, heavily GHG emitting, and non-sustainable owing to declining limited proven reserves and high volatile prices).
- 29- To put into a context, the globally growing demands for solar energy technologies and solar energy technology advancement have been driving the market prices of solar energy infrastructure downwards. Projection related to technology market prospects indicates that solar energy technologies will likely be the most cost-competitive technology in the medium and long-term futures. However, the present higher upfront cost (about 80 percent of the total capital investment cost- total investment cost includes cost of manufacturing, transportation, installment, as well as operation and maintenance (O&M)) of solar energy infrastructure than conventional energy-producing technologies is among the key barriers for rapid deployment of the technology.
- 30- The lower capital upfront cost of the conventional energy-producing technologies (climatic and environmental non-friendly) compared to their sustainable alternatives (climatic and environmental friendly) has made the earlier be PERCEIVED of being more cost-competitive that the later. Nevertheless, it is worth noting that the upfront capital cost of an investment is always not decisive in sound economic analysis. For instance, the economic, social, and environmental benefits which will likely to accrue in the medium and long-term are usually overlooked especially in many low-income countries including Yemen (this applies as well on the majority of low-income household in Yemen) so that ill-informed decisions related to policy and/or household allocations of limited resource.
- 31- As such, solar energy technologies are PERCIEVED being less cost-competitive owing to their present higher upfront capital cost compared to conventional technologies, and hence limited resources are allocated at non-efficient manner. Instead, by accounting on the other key economic parameters including Return of Investment (ROI) for private business solar investments, lower O&M, positive environmental, and social impacts, the long-term benefits of solar energy technologies compared to conventional ones will exceed their total investment costs over the course of technology's lifetime span.
- 32- Proper cost-benefit analysis is an instrumental tool to support making sound economic analysis related to comparison of capital investments, and options for allocation of scarce and limited resources. Put this way, although the present upfront capital cost of solar energy technologies are relatively high, they have

minimal O&M cost, zero-fuel consumption, least environmental and social externalities, as well as zero-fuel cost, hence zero-climatic footprint, and most likely carbon payback (For instance, CDM incentives reduces the upfront cost of solar investments). Notably, a zero-fuel cost in its own drastically reduces the total costs over the lifespan of a solar energy technology options. Simple feasibility calculations can indicate that solar PV systems for instance may be cost-effective on a life-cycle cost basis.

33- To better illustrate how cost-efficient are the solar systems compared to the conventional energy systems, a simple calculation is suggested which includes accounting for key economic parameters including upfront capital costs as well as Operation and Maintenance (O&M) cost over their respective life-span periods. By aggregating upfront capital cost, and cost of diesel over the technology estimated life-span period, it can easily be noted that the total investment costs of solar energy are smaller while on the other hand the cost-per unit of electricity produced by conventional energy system is greater than solar alternatives. By deducting diesel costs and considering it as saving, the total upfront cost of the solar energy can be recovered in few years, and the other period electricity will be received at diminishing cost but mainly O&M which is negligible compared to business as usual in which conventional energy supply dominate the energy-mix.

34- For instance, a preliminary feasibility assessment was conducted by the UNDP Yemen Country Office in its efforts to demonstrate a in-house model for securing its energy needs from renewable sources has concluded the following in terms of cost-efficiency: The proposed solar energy system will help UNDP Yemen reduces its energy bill on an incremental basis during the first 10 years of the installing the new system, and up to 100 percent over the subsequent 10 years assuming 20 years of the proposed system average life-span.

Section V: Solar Energy Policy Framework

35- This section will highlight a policy framework to influence on-grid and off-grid solar energy prospects in Yemen- the section draws upon the aforementioned insightful policy implications as well as related national and regional policy reports, and experiences:

1- Develop Solar Policy And Legislative Framework:

Developing of appropriate national solar energy planning capacities which includes conducive policy and legislative frameworks are essential instruments to facilitate expansion of solar energy in Yemen. The solar policy will remove barriers that are preventing expansion of solar energy as well as extensive engagements of private sector. The policy will identify appropriate cost –effective instruments (i.e. economic, financial, fiscal policy instruments) to incentive of expansion of solar energy and extensive engagement of private sector in Yemen. It worth noting that signing of the official accession to the World Trade Organization (WTO) by the Government of Yemen is an opportunity to build on in that it implies Government’s commitment to reduce or remove tariff of imported goods and services including solar technologies.

On the other hand, appropriate legal frameworks as well and solar quality standards need be defined too. The solar energy framework will encourage business entrepreneurs to engage in electric power

generation of solar energy including feeding of electricity surplus to the grid (i.e. Feed-in Tariff for large-scale private entrepreneurial investments, and net-metering for small-scale initiatives). Land tenure related to feasible large-scale solar energy projects need to be legalized, and appropriate social, and environmental impacts assessments need to be perused, if any. More importantly, Solar Energy Plan needs to be developed so in order to determine solar energy needs, suitable places including solar Atlas for large-scale on-grid solar projects in addition to the underlying energy generation technological capacity, capital investment implications, and source of financing.

2- Set-up a financial mechanism to facilitate access to solar finance

Due to high upfront capital costs of solar energy investments, developing of appropriate financing mechanisms to support expansion of on-grid, and/or off-grid solar energy especially for rural electrification is critical (i.e. establishment of Rural Solar Fund using climate finance incentives to subsidize or provide loans for installment of rural Solar Home Systems as well Community Solar Systems, etc) will be instrumental. Establishing of a Solar Fund is an appropriate mechanism as a dedicated entity to implement national solar policy and plans while at the same time promotes access to solar finance. The fund will provide support for greater access to financing by private sector especially the first movers whose investments might imply high implementation risks.

The fund will also foster strategic public-private partnership (PPP), and provides incentives, and establish purchase agreements with private local, and/or international entrepreneurs (i.e. Foreign Direct Investments (FDI) including south-south development financing and/or south-south infrastructure banks) for long-term partnership in solar investments particularly in rural areas- purchase agreements needs to substantiate a grantee of payment under delivery of service. The fund will foster and enhance partnership with non-Governmental solar energy organization (NGOs) as well as research institutions and universities (i.e. for R&D services) so as to participate in promoting expansion of solar services, enhancing level of awareness.

Altogether, developing of appropriate national solar capacities which includes the aforementioned policy instruments will continuously contribute towards improving solar energy prospects while at the same time support solar energy expansion, and creates new green job potentials in Yemen.

Section V: Conclusion

Yemen has untapped solar potential to fill the exiting energy gap. Yet, solar energy market prospects are still limited particularly in rural areas due to a number of impeding conditions such as lack of conducive policy framework to remove barriers related to solar energy expansion which includes high upfront capital investments. Nevertheless, developing of appropriate national solar capacities which includes cost-effective policy instruments, and a dedicated financial mechanism will continuously contribute towards improving solar energy prospects in Yemen while at the same time support solar energy expansion, and creates new green job potentials.

Acknowledgment

The authors would like to express thanks and appreciation to UNDP Yemen CO senior management for their advice and support. Also many thanks go to Poverty and Sustainable Development team at the Country Office. We would also like to extend our appreciation to Boots on the Ground, Environmental and Energy Team at HQ.

List of References and Sources

1. Yemen's Second National Communication (SNC 2013)
2. Governance and Climate Change in Yemen: A Policy paper (UNDP Yemen 2012)
3. Joint Social and Economic Assessment for the Republic of Yemen (2012)
1. Fourth National Plan for Development and Poverty Reduction (DPPR 2007-2011)
2. A Framework to Strengthen National Climate Finance Readiness in Yemen (UNDP Yemen 2013)
1. Readiness for Climate Finance: A framework for understanding what it means to be ready to use climate finance (UNDP 2012)
2. Catalyzing Climate Finance: A Guidebook on Policy and Financing Options to Support Green, Low-Emission and Climate-Resilient Development (UNDP 2011)
3. Human Development in a Changing Climate: A Framework for Climate Finance (UNDP 2010)
4. Climate Change Governance: Background Paper to the 2010 World Development Report
5. Climate Economics: The State of the Art (2011)
6. Readiness for Climate Finance: A framework for understanding what it means to be ready to use climate finance (UNDP 2012)
7. National Climate Funds: A Guidebook for Decision-Makers (UNDP 2012)
8. Catalyzing Climate Finance: A Guidebook on Policy and Financing Options to Support Green, Low-Emission and Climate-Resilient Development (UNDP 2011)
9. Human Development in a Changing Climate: A Framework for Climate Finance (UNDP 2010)
10. Adapting to climate change-UNDP-GEF Initiatives Financed by the Least Developed Countries Fund , Special Climate Change Fund and Strategic Priority on Adaptation (UNDP 2011)
11. International Guidebook of Environmental Finance Tools: A sectoral Approach (UNDP 2012)
12. Climate Change Governance: Background Paper to the 2010 World Development Report
13. Climate Economics: The State of the Art (2011)
14. Effective Resourcing to Address Climate Change
15. Study of the effects on employment of public aid to renewable energy sources (March 2009)
16. Financing Mechanisms of Solar Home Systems for Rural Electrification in Developing Countries
17. Solar Home Systems for Rural Electrification in Developing Countries.
18. Household Energy Supply and Use in Yemen: Volume II
19. Industrial Policy in Developing Countries (2011)
20. Joint Social and Economic Assessment for the Republic of Yemen.
21. Potential of Solar Pumping in Palestine.
22. Prospects of the Renewable Energy Sector in Egypt (2010).
23. Renewable Energy in Industrial Applications (An assessment of the 2050 potential).
24. Small and Micro Enterprises Development in Yemen and Future Prospects (2011).
25. Creating Village Enterprises to Replace Kerosene Lamps with Solar Lighting System (2012).
26. Solar Photovoltaics in Africa (May 2004)
27. Solar-Photovoltaics in The Deregulated Electricity Industry Of Developing Countries.
28. Strategy on Scaling Up Access to Modern Energy Services.
29. Solar Means Business: Top Commercial Solar Customers in the U.S. (2012)
30. UNIDO and the Least Developed Countries
31. PROPOSAL: A Renewable Energy Promotion Policy for Achieving a Low-carbon Society (February 2009).

32. Provision of Technical Support/Services for an Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for Renewable Energy and Energy Efficiency (Country Report Yemen 2010)
33. Energy Data and Indicators 2013 for RCREEE Member States (2013)
34. Guidance for NAMA Design Building on Country Experiences
35. Latest Electricity Price Schemes in RCREEE Member States (2013)
36. Energy Efficiency Country Profile (Yemen 2012)
37. Potential and Prospects for Renewable Energy Electricity Generation in the ESCWA Region (2001)
38. Solar and wind opportunities for water desalination in the Arab regions (2009)
39. An Assessment of Solar Energy Conversion Technologies and Research Opportunities (GCEP Energy Assessment Analysis, 2006)
40. Small-scale Concentrated Solar Power A review of current activity and potential to accelerate deployment (March 2013)
41. PV and Solar Market Intelligence Report (2013)
42. Renewable energy country attractiveness indices (November 2012)
43. Renewable Energy Technologies: Cost Analysis Series (Concentrating Solar Power, June 2012)
44. Solar energy for heat and electricity: the potential for mitigating climate change (June 2009)
45. Yemen: Energy Efficiency Institutional Framework & 3 Year Dsm/Ee Action Plan (March 2009)