1. Key development issues and rationale for Bank involvement

Yemen is amongst the poorest countries in the Middle East and North Africa region with a per capita income of less than US$870 in 2007. About 73 percent of the Yemeni people live in rural areas, where the poverty rate exceeds 40 percent. Their lives are characterized by lack of access to basic infrastructure facilities like energy, education, health, water supply and sanitation. Amongst all consumer categories, households consume about 80 percent of all energy needs which, for the rural population, is primarily restricted to lighting and cooking. While electricity/kerosene is used for lighting, Liquefied Petroleum Gas (LPG)/fuelwood are used for cooking purposes. Only 15 percent of rural areas are covered by the national grid, with total national coverage standing at 42 percent in 2005.¹

Yemen’s total population registered an annual increase of 3.7 percent since the past decade reaching over 22 million in 2007. As a result, the demand for energy services has also accelerated. Electricity demand, as indicated by the Public Electricity Corporation’s (PEC) electricity sales, reached 3,294 GWh in 2005 – representing an increase of 9.6 percent annually since 2000.² PEC estimates indicate that this rapid growth rate will continue in the medium term. This estimate is substantiated both by the Government of Yemen’s (GOY) efforts to diversify the economy from its heavy dependence on declining oil production, and its ambitious program of rural electrification which will double the number of electricity customers by 2015. This program, which is elaborated in the government’s Power Sector Development Strategy Note of 2006-2010, and in its Socio-Economic Development Plan for Poverty Reduction (SDPPR) of 2006-2010, also highlights the importance of selecting the most suitable alternative power sources including new and renewable energy resources, such as solar and wind energy in order to provide the necessary increases in supply to satisfy the growth in electricity demand.

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¹ Socio-Economic Development Plan for Poverty Reduction, Government of Yemen, 2006-2010
² Public Electricity Corporation, 2006
Furthermore, the Country Assistance Strategy (CAS) for Yemen, FY2006-09, which builds upon the SDPPR, identifies improvement in power infrastructure as a fundamental contributor to support: (i) diversifying growth through better delivery of public services; (ii) improving human development through more efficient service delivery; and (iii) improved safety nets. In addition, the CAS emphasizes encouraging private provision of electricity services with full cost recovery for providers.

Electricity in Yemen is, at present, mainly generated from oil-based (light and residual fuel oil) power plants. The planned commissioning of natural gas-based power plants in Marib starting from 2009 will address the current power shortage and at the same time will increases the share of natural gas in the generation fuel mix to 80 percent. Natural gas share will surpass the 90 percent mark with the Ma’abar natural gas-based power plant expected to come on stream in 2013 with some oil-based power plants that may be retired during the same period. The share will stabilize at 98 percent by 2018 with the commissioning of the natural gas-based power plant in Aden. The current Power Generation Expansion Plan transforms the power generation mix from completely dependent on oil to high dependence on natural gas. A total of 2,858 MW gas turbine plants is planned to be commissioned between 2007 and 2025. However, risks associated with total dependence on single fuel for power generation are high for Yemen and, while available gas resources can help meet short term needs, high dependence, whether on liquid fossil fuels or natural gas, increases the risks of supply availability and technical disruptions. It is important therefore, to increase the diversity of fuel supply as part of a strategic approach to mitigate fuel supply risks. Domestic use of natural gas also precludes opportunities to increase gas exports. Renewable energy development in Yemen could potentially address key electricity sector issues as well as generate other benefits to the economy (in particular reduced fuel price risk) and to the environment. Also, it is a way of managing price volatility of fossil fuels.

Consistent with the goals of the Power Sector Development Strategy, the GOY’s renewable energy strategy study prepared under the recently concluded GEF funded Rural Electrification and Renewable Energy Development Project (REREDP) proposes to promote the development of renewable energy under the following objectives: **on the demand side** - optimize the utilization of domestic energy resources; and **on the supply side** - (i) increase the share of renewable energies in electricity generation (both on-grid and off-grid), and (ii) promote sustainable electricity sector development. The primary benefits of the proposed strategy include: (a) alleviating electricity supply shortage and reducing dependence on fossil fuels in power generation; (b) diversifying fuel source (e.g. to wind energy) to improve security of fuel supply and optimize benefits from natural gas resources; and (c) reducing emissions of airborne pollutants and global warming gases.

One of the key energy sector issues facing the government is the high level of subsidies. Since the sharp rise in crude oil prices, subsidies for domestic petroleum consumption are estimated to amount to US$3.5 billion in 2008, or about 11 percent of GDP (of which about one third is channeled through the electricity sector). The subsidies in the electricity sector include both, explicit subsidies to cover the difference between cost of generation and selling price, as well as implicit subsidies in the form of investment cost subsidies and fuel cost subsidies.
Analytical work currently being undertaken by the Bank to support a subsidy reform program has won strong support from the Government. As price distortions are corrected to better reflect real costs, it is expected that wind energy and other potential sources of renewable energy (e.g. solar PV, biomass, etc) would be evaluated on a level platform with gas based generation as well as other generation options, thereby creating an enabling environment for scale up of the wind program.

In the short-term, wind is likely to be competitive as compared to HFO based generation. Due to the rapid annual electricity demand growth of about 9.6 percent, HFO based generation is expected to be in place even after the Marib-1 plant is commissioned. Since the proposed Project is a demonstration project, one of its outcomes would be accurate valuation of wind based energy generation and input to the PEC grid-system. This step would be important before Yemen launches large scale wind energy development program.

The long-term economics of wind energy development program are important and would need to consider at least three aspects: (a) projections related to the costs of natural gas as this is being currently projected to be the main source of electricity generation; (b) benefits related to diversification of the portfolio of generation assets; and (c) evolution of the carbon market. Such analyses could be incorporated as part of the TA package in the proposed Project.

One of the studies carried out under the REREDP addressed the technical, financial and institutional parameters of developing Yemen’s wind resources and identified over 15,000 MW of wind power potential that could be developed in the country. Though, availability of wind energy is intermittent, the REREDP also analyzed details at two sites which could serve as demonstration projects and concluded that a wind farm at Al-Mokha, on the Red Sea coast, west of Taiz, would be both financially and economically justified.

2. Proposed objective(s)

The objective of the proposed Project is two fold: (i) to demonstrate the operational feasibility of wind power by implementing the first wind power development project in Yemen; and (ii) to add 60 MW of clean energy to the national grid.

3. Preliminary description

The wind energy potential was estimated based on the wind map developed in the wind assessment feasibility study. A class II wind energy converter and the power curve of a class II turbine with a hub height of 50 meters and rotor diameter of 52 meters were used in the analysis. The theoretical potential represents the electric potential at the height of 50 meters above the ground level. Mountainous areas with more than 30 percent slope have been excluded in the calculation. The coastal areas from Hodeidah, down to Lahj and towards Abyan (i.e. in the southwestern part of the country) have high potential for wind power generation. The theoretical wind power potential of Yemen is estimated at more than 15,000 MW.

The proposed Project (60 MW) is expected to demonstrate the sustained financial and economic viability of the wind farms. Successful operation of the pilot scheme is expected to generate
interest in the future development of wind energy along the Red Sea coast which can supply up to 1000 (5x200) MW.

The proposed Project would consist of the following components:

**Component 1 - Al-Mokha Wind Farm (US$120 million):** The proposed Project will support the implementation of a wind farm at Al Mokha of approximately 60 MW generation capacity which would be connected to the PEC grid. Preparation of the requisite feasibility studies as well as a model power purchase agreement were initiated under the REREDP and being scaled up through grant financing made available by the AFD. The proposed Project would be wholly owned by a Special Purpose Company (SPC), to be created as a subsidiary of PEC. Other donors have expressed interest in contributing towards financing the proposed Project; the expected IDA share of the cost is about US$20 million.

**Component 2 - Capacity Building and Market Development (US$5 million):** The proposed Project would include a technical assistance component to help build local capacity in the development and implementation of wind projects. In addition, the component could help in preparing a scale-up plan for the development of wind resources in Yemen through a public-private partnership (PPP) approach.

The proposed Project is expected to help in emission reduction and should also qualify for additional financing from carbon funds. Accordingly, the team has initiated processing of a Carbon financing operation. If successful, the carbon finance funds would be used to reduce the GOY contributions to the project, and also lessen the tariffs required for cost recovery.

**4. Safeguard policies that might apply**

*Environmental Assessment (OP/BP 4.01).* An Environmental Assessment (EA) of the project and of the various works that have to be undertaken will be carried out as part of the project preparation studies. The EA will be consistent with the World Bank Operational Policies 4.01 on Environmental Assessment. The EA will include the Environment Management Plan (EMP) for any adverse impact of the construction activities as well as of the operation of the project may have on the environment. The EMP will consist of mitigation measures, a monitoring program, and an institutional development/strengthening program for implementation of the EMP.

*Involuntary Resettlement (OP/BP 4.12).* A Resettlement Policy Framework (RPF) will be carried out as part of the project preparation studies. The RPF will be consistent with the World Bank Operational Policies 4.12 on Involuntary Resettlement. The RPF will include a Resettlement Action Plan for any adverse impact.
5. Tentative financing

Source: ($m.)
Borrower 10.0
International Development Association 20.0
Other donors 65.0
Financing gap 30.0
Total 125.0

6. Contact point

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