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Morocco's strategy for energy security and low-carbon growth

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ABSTRACT

In this paper, we reported the current status of the energy sector and its future challenges in Morocco. Recent strategies deployed by the government for sustainable development were reviewed and discussed. These strategies put the transition to renewable alternatives on the top of the national policy implications for energy security and low-carbon economy. We have also suggested a methodological tool to prioritize energy alternatives for power generation. It was found that wind energy is the most appropriate power generation alternative in Morocco at the current level.

1. Introduction

The world is currently facing a great challenge because the present energy use and supply is judged economically, socially and environmentally unsustainable.

According to the IEA (International Energy Agency) [1], the world's total net electricity consumption as well as electricity generation is increasing continuously. The world electricity generation was 14,781 billion kWh in 2003 and is projected to be 21,699 and 30,116 billion kWh in 2015 and 2030 respectively (an average increase rate of 2.7% annually). The GHG (greenhouse gas) emissions from electricity generation account approximately for 40% of total emissions since 80% of the electricity production is based on fossil fuels, particularly coal and oil [1,2].

The unsustainability of the energy sector will certainly have a significant influence on the economy's competitiveness, citizen's income and technological development.

Although the protection of energy sources is often found at the top of the international political agenda, actual standard energy sources are accompanied by threats of grave and irreversible damage to the environment, including world climate alterations [3,4].

The impacts of climate change are now too evident to be disputed. As stated by the Stern Review [5], it would be too costly to tackle the challenge of climate change if the world procrastinates in taking actions.

Recently, numerous international institutions and financial mechanisms have highlighted the necessity of diffusion and implementation of renewable energies and the restructuration of the energy sector for a of a low-carbon economy.

Accordingly, various regulatory instruments at global, national and regional levels have been proposed in order to mitigate GHG emissions [6,7]. The Kyoto Protocol linked to the UNFCCC (United Nations Framework Convention on Climate Change) [8,9], sets binding targets for 37 industrialized countries for reducing the GHG emissions and gave born to the CDM (Clean Development Mechanism). CDM gives the possibility for developed countries to receive credits from relatively low-cost emissions reductions. Actually, achieved reductions are translated into CERs (Certified Emission Reductions), and every credit amounts to 1 ton of CO_2 equivalent. Once verified and certified, these credits can then be used as one means of meeting the investor's "assigned amount" obligation.

Given the problems associated with identifying promising projects, quantifying the magnitude of the reductions, and monitoring the results, some means of reducing those barriers were clearly called for. As a result, the CIFs (Climate Investment Funds) were established in 2008 by the World Bank to serve as an intermediary for encouraging CDM reductions in greenhouse gases [10,11].

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The CTF (Clean Technology Fund) provides financing to larger emerging economies and to regional groups in order to promote renewable energy and energy efficient technologies in the power sector.

Since March 2013, 16 investment plans for $5.58 billion in direct funding (with a projected $40 billion in leveraged co-financing) were suggested in several developing countries.

This includes a regional investment plan covering Algeria, Egypt, Jordan, Morocco, and Tunisia (Middle East and North Africa: MENA).

Among others, Morocco has successfully registered renewable energy projects under the CDM [12]. Consequently, it seems interesting to introduce the Moroccan renewable energy potentials and address their priorities inadequacy with sustainable development pillars. The paper demonstrates as well the most recent policies and the national strategy currently underway to purse low-carbon opportunities in Morocco.

2. Energy and environment considerations in Morocco

Morocco, officially the Kingdom of Morocco, is a country in the Maghreb region located in North Africa, on the Atlantic and Mediterranean coasts. Its eastern border is with Algeria and a relatively narrow body of water separates it from Spain to the north. Morocco's population has more than tripled over the past 50 years, putting the country's natural resources under pressure.

Morocco's energy profile is dominated by imported fossil fuels. Presently, Morocco imports about 96% of its supplies of energy resources. Energy consumption has risen at an average annual rate of 5.7% from 2002 to 2011 [13]. This dependency on energy imports makes Morocco highly vulnerable to increases in international fuel prices, putting a heavy fiscal burden on the national budget. In 2012, petroleum represented nearly 60.7% of the overall national energy consumption (see Fig. 1). Fig. 2 and Fig. 3 present respectively the evolution of energy production and energy consumption (in thousand tons of oil equivalent) for the different types of energy resources between 2000 and 2012.

Morocco's electricity demand rose on average by about 5% per year in the past five years and is expected to increase by 7–8.5% per year in the next ten years (see Fig. 4). In 2013, electricity consumption was 32.02 TWh, 8.4% more than the previous year [14]. About 81% of the country's electricity production is based on fossil

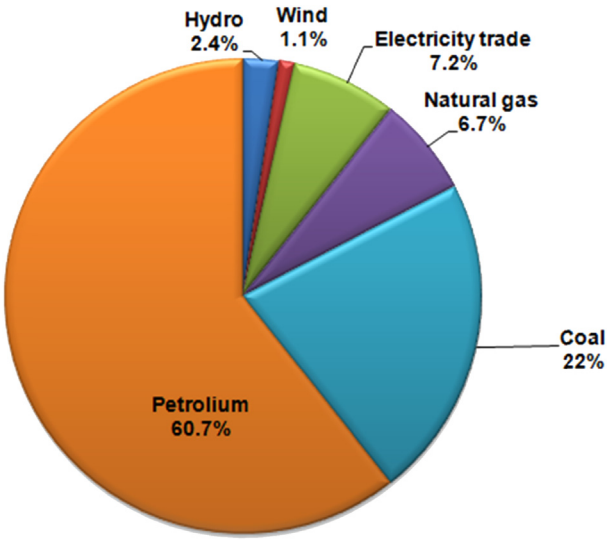

Fig. 1. Distribution of energy consumption, 2012.

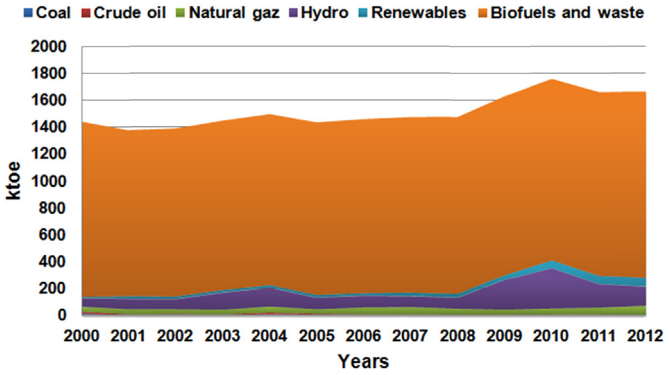

Fig. 2. Evolution of the Moroccan energy production (2000–2012).

fuels like: coal, oil and natural gas (see Fig. 5). Coal power plants, fueled by imported hard coal, form the backbone of the country's generation system. With 1.8 GW of installed capacity (Morocco's total capacity is 6.4 GW), they contribute about 45% of the country's forecasted electricity production of 26.5 TWh. About 12% of Morocco's electricity demand is currently supplied by open cycle and combined cycle gas power generation, and this share is expected to rise with additional combined cycle power plants coming online in the near future [15]. The remaining energy demand is satisfied by electricity imported mainly from Spain and Algeria. 15% of the national energy demand was originated from Spain in 2012. Spain and Morocco are connected through a 400 kV submarine AC cable that transfer up to 700 MW, which is both important for importing energy and also for potential exports in the future (See Fig. 6). Algeria and Morocco share three connections: a 400 kV circuit overhead line and two 220 kV overhead lines that transport up to 1400 MW, from Bourdim to Hassi Ameur, and Oujda to Ghazaouet and Tlemcen, respectively.

During the past 10 years, using the Global Rural Electrification Program (PERG) [16,17], the rural electrification rate has risen from 18% in 1995 to 98% at the end of 2011. This was a program of the National Power Office (ONE) of Morocco with governmental support. The financing of the project came from various sources. The Equipment Grant of 22.1 million € from ONE includes a 5 million € donation from the KfW German Bank, a 5 million € soft loan from the French Fund Development Agency (AFD), about 1.25 million € from the FFEM (French Fund for the World Environment), 3.5 million € from the Company's shareholders and another 3.2 million € via connection fees from customers.

By 2008, 3163 douars (villages) with 44,719 homes were equipped with individual solar PV kits not connected to the grid,

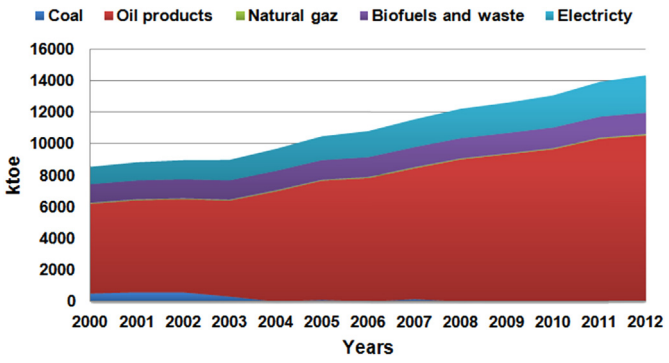

Fig. 3. Evolution of the Moroccan energy consumption (2000–2012).