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CASE STUDY

The renewable energy plan in Morocco, a Divisia index approach

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ABSTRACT

The Moroccan National Energy Strategy (NES) launched in 2008 expects that 42% of the total energy mix to come from renewable sources by 2020; solar, wind and hydroelectric generation capacities are expected to be 2000 MW each. A 12% improvement in the total energy intensity is also targeted by 2020. We use a Divisia index approach to assess past contributions of different factors, including the supply mix, to the fuel requirements in the thermal power generation and to forecast such requirements for the year 2020. The wide range of the forecasts gives insights on the challenges of long-term planning with high renewable penetration rates.

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1. Introduction

Energy security, access to energy resources at competitive prices, environmental protection and regional integration are among the main segments of energy policies in different countries.

Energy policy in Morocco is no exception. Morocco is a net importer of petroleum products. The energy shortage stands at around 93–97.5% [1].

In its endeavors to reduce this energy shortage, the NES is planning for around 42% renewable energy generation in the energy mix. For comparison, the European Commission targets 27% participation of renewable energy sources in the EU energy mix by 2020 and California has opted for 33% of renewable energy in retail sales by 2020. The NES is also targeting around 12% total energy efficiency reduction by 2020 [2]. Total energy includes both primary energy to the power and the non-power sector.

We use a Divisia index approach to assess past contributions of different factors to the fuel consumption in the electricity sector. For different economy growth cases, we forecast such requirements for the year 2020, taking into account, the 42% renewable in the power mix and different energy intensity reductions plans. We find that there is a wide range of possibilities (forecasts of the thermal fuel requirements by 2020) which shows the challenges of long-term planning with high renewable penetration rates.

Decomposition techniques are widely used for the analysis of factors affecting changes in aggregate environmental and energy indicators. In terms of methodology, Liu et al. [6] proposed the general parametric Divisia method. Ang and Lee [7] and Ang [8,9] developed different methodologies based on the Divisia method. Multilevel decomposition was introduced in Ang [10]. Ang and Choi [11] proposed a logarithmic mean weight function that leads to the logarithmic mean Divisia index (LMDI) method. Multiplicative LMDI, proposed as the preferred index decomposition method, has been used extensively in energy and environmental analysis. Ang et al. [11–19]. Choi and Ang [20] have recently proposed a new decomposition approach that extends the methodology of index decomposition analysis in energy studies by quantifying the contribution of individual attributes to the percent change of factors such as the real energy intensity index. In terms of application, the Divisia index methodology has been widely used in energy intensity analysis and environmental emissions studies at a regional or country [21,22] level or on a sectorial basis [22,23].

We use the LDMI type I [19]. The method is perfect in decomposition, having no residual term. It is recommended for general use based on theoretical foundation, adaptability, ease of use, and ease of result.

We use both annual and chain time series decompositions. Time series decompositions are useful to detect patterns and structural breaks and chain computation is recommended compared to period wise decomposition [20].

The remaining of this article is as follows: Section 2 gives a description of the electricity

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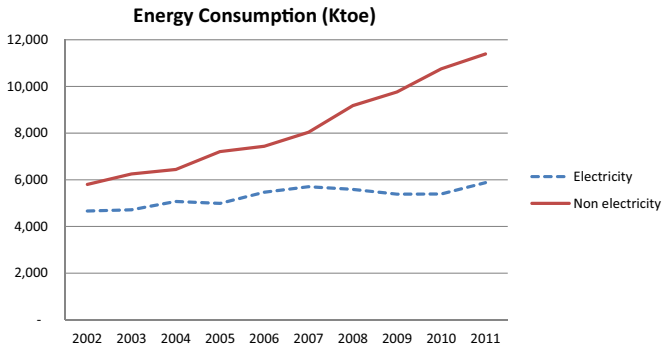

Fig. 1. Energy consumption in the power and non-power sectors.

sector in Morocco along with the new National Energy Strategy (NES). Section 3 is a description of the methodology to assess the evolvement of the fuel consumption in the electricity sector. Section 4 is a discussion of the results and an assessment of how the 42% renewable and reductions in electricity intensity are compatible with different economic growth scenarios, then Section 5 concludes.

2. The energy sector in Morocco

2.1. The primary energy sector

Fig. 1 shows the primary energy consumption in Morocco in the power and non-power sectors. The non-power sectors include mainly transportation in addition to industries feedstock and some residential usage.

The power sector consumption includes different fuels for power generation (coal, fuel oil, gas) along with wind production and power imports. Total energy imports to the total consumption range from 93% to 97.5% within the 2002–2011 period.

2.2. The electricity sector

The Office National de l'Electricité et de l'Eau (ONEE) is the traditional integrated state owned entity which operating in the Moroccan electricity. Since 1994, private players in the generation segment have entered the Moroccan Market.

As of 2012, the total installed capacity was 6910 MW. Fig. 2 shows the distribution of the installed capacity. A 464 MW Station Energy Transfer by Pumping (STEP) is used during off peak hours to generate peak capacity; another similar 350 MW plant is planned near Agadir. Morocco can also import electricity through regional interconnections. The Moroccan grid is connected to Algeria through a 1200 MW and to Spain through a 1400 MW line [1,2]. Morocco has been a net importer from Spain while the Algeria–Morocco exchange is almost balanced.

From 2002 to 2010, electricity demand growth averaged 7.1% [3] while GDP has been increasing at an average rate of 4.8% [3]. Factors contributing to such a growth include development projects (infrastructure, tourism, …) and the rural electrification program (PERG). PERG was launched in 1995. In 17 years, the percentage of rural electrification has grown from 18% to 98% in 2011. As of 2012, around 1.99 million rural houses have been supplied with electricity through the PERG. Around 97.4% of the rural households are supplied from the grid while the remaining use solar supply.

Fig. 3 shows the evolution of the annual electricity generation along with the ONEE, private and import contributions.

In its Business As Usual scenario, the Ministry of Energy and Mines is forecasting a generation requirement of around 50,000 GWh by 2020. This would require around 14.7 MW installed capacity including a 2000 MW from wind and 2000 MW from solar sources [5].

2.3. Renewable energy

Morocco has embarked in an ambitious renewable energy program for 2010–2020 period. The National Energy Strategy launched in 2008 aims at having 42% of the total power installed capacity from solar, wind and hydroelectric sources by 2020; solar, wind and hydroelectric generation capacities are expected to be 2000 MW each. A 12% total energy efficiency by the same horizon is also targeted. A series of measures have been taken to accompany this program including the establishment of renewable energy and efficiency agencies, legislations and the engagement of different domestic and international stakeholders.

The renewable energy program will create a structural change in the energy supply mix. Table 1 shows the actual energy mix in 2009

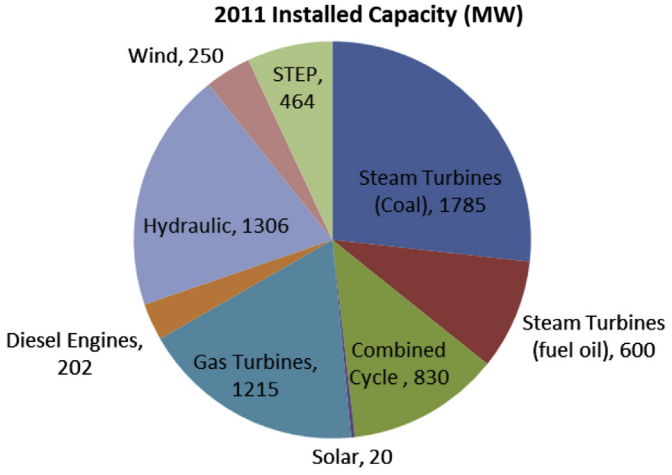

Fig. 2. 2012 Installed capacity by fuel source (MW).

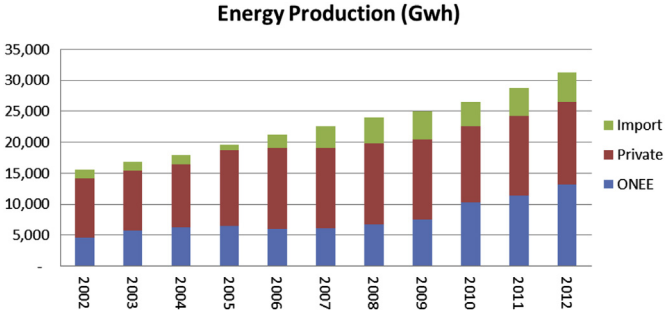

Fig. 3. Annual electricity generation (GWh).

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