Decarbonisation of electricity generation in an oil & gas producing country: "A sensitivity analysis over the power sector in Egypt"

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Overview

Egypt is the largest non-OPEC oil producer and the second largest gas producer in Africa. Decreases in oil production and depletion in related reservoirs over the last decade have been compensated by a remarkable growth of the natural gas sector for both internal consumption and export. Over the past ten years, Egypt has become an important gas producer and a strategic gas supplier for Europe. Moreover, natural gas represents around 80 percent of the Egyptian power sector mix. The country's electrification rate in 2009 was around 99.6 percent which is among the highest in the whole continent.
In this study, we analyse the current and future power generation situation of the country through a decision-tree analysis approach. Then we will perform a bottom-up cost analysis in order to determine the most cost-effective ways of power production by taking into account the integration and growth of the other alternative (non-fossil based) resources such as solar, wind and nuclear into the power generation mix of the country. Finally, the socio-economic impacts of these generation-mix modifications will be analysed (impacts on the net export, financial gain, socio-political benefits & etc.).

Methods

Most of the current literature concentrate only on one of the decarbonised technologies, either nuclear (e.g. Comsan 2010, Jewell 2010 & Selim 2009) or renewable (e.g. Hamouda 2012, Patlitzianas 2011). The existing academic literature does not provide criteria for the socio-economic motivation and capability of a specific North African country to introduce all non-fossil based power units, both nuclear and renewable options, in the national generation park. The main contribution of this chapter is to study the future integration possibility of all the non-fossil technologies. Moreover, this analysis is carried out in parallel with the possibility of conventional (fossil-based) units' development.
The methodology applied in this chapter is mainly based on a pure capital budgeting analysis of the Egyptian electricity sector's demand and supply structure. Cost calculation, break-even analysis and many other economic factors has been taken into account. Lastly, some social and political aspects of each technology such as sustainability, security and environmental issues have been considered.

Results

The result illustrates that in the short-term and under the discussed conditions the choice of combined cycle gas power plants can be beneficial for the Egyptian power sector. The renewable integration in the national power system could be also beneficial up to the point at which gas plants can provide a rational and economic back-up for their intermittency. A vast

and irrational expansion of these technologies could bring a huge uncertainty to the system. In the long-term, the promotion of nuclear and even advanced coal plants could become not only beneficial but also essential for the domestic electricity demand satisfaction.

Conclusion

Our cost and sensitivity analysis of the Egyptian's current & future energy resources and demands demonstrates the unfeasibility (from an economic point of view off course) of being dependent on national fossil fuel reserves so as to meet the electricity generation needs of the country.

Efficient utilisation of the energy resources concerning the electricity sector requires a considerable promotion of the alternative non-fossil techniques. Even though the renewable sources of power generation can be used efficiently at very decentralised and local scales, yet intermittent nature of these technologies does not permit to provide a large scale continues base-load power.

Therefore, a power generation strategy based on a gradual integration of nuclear and renewable is suggested. A power generation mix, based on an optimal choice of fossil, nuclear, hydraulic & other renewables, is considered to be the most appropriate way of electricity production in Egypt.

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