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A nuclear-powered North Africa: Just a desert mirage or is there something on the horizon?

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ABSTRACT

All of the North African countries have plans to develop nuclear power. If successful, nuclear energy could supply up to 9–15% of all electricity consumption in the region by 2030. How realistic are these plans and under what conditions can they be implemented? This paper seeks to answer this question by analyzing the motivations and capacities for deploying nuclear energy in the five North African countries by examining both regional and national factors. These factors are compared to similar characteristics of the countries with existing nuclear power programs using a series of quantitative indicators. While all five countries have strong motivations to develop nuclear power, which result from the high growth rates in demand for electricity and energy security concerns, their financial and institutional capacities to deploy nuclear energy vary and are generally lower than in those countries which already operate nuclear power plants. Most likely, North Africa will need to rely on external assistance to implement its nuclear energy plans. The article identifies three scenarios of nuclear power development from the interplay between internal and external factors, particularly the success of renewable energy projects and the ability to attract international investment in nuclear power.

1. Introduction

All five North African countries intend to deploy nuclear power (Table 1). These intentions range from more concrete plans as in the case of Egypt, which has signed a contract for design and construction management of its first nuclear power plant (NPP) (Worley Parsons, 2009), to more general declarations as in case of Libya. If the most concrete of these plans is realized, nuclear power may provide up to between 6% and 8% of the region's electricity consumption by 2020 and up to between 9% and 15% by 2030.[1] But are these plans realistic and if so under what conditions?

One approach to addressing this question is to consider the nuclear power plans of North African countries in the global context. According to global projections (IEA, 2009c; IAEA, 2009a), the global use of nuclear power is likely to increase in response to the rising energy demand and decrease in availability and attractiveness of fossil fuels. Nuclear power is currently operational in 30 countries (further called Established Nuclear Power Countries) and over 50 additional countries (further called Newcomer Countries) have recently contacted the IAEA for help in starting a nuclear power program (Rogner, 2009). This global "nuclear renaissance" – as some analysts and media refer to the increased interest in nuclear power (Grimes and Nuttall, 2010; Adamantiades and Kessides, 2009; Nuttall, 2004; Sauga, 2008; Wolfe, 2007) – should in principle provide a supportive environment for nuclear power in North Africa.

On the other hand, the potential of the "nuclear renaissance" has been questioned (Parenti, 2008; Schneider, 2008). The global expansion of nuclear power has not been progressing in line with expectations and has been uneven across the world (Deutch et al., 2009) and the *World Energy Outlook* observes that "few governments…have taken concrete steps to promote the construction of new reactors, other than in those countries that have had active nuclear power construction programmes in place for a long time" (IEA, 2009, p. 100). Since the introduction of nuclear power in China in 1985 no new country has managed to join the nuclear energy club. Even the expansion of nuclear energy in Established Nuclear Power Countries, with existing expertise and

Abbreviations: CSP, Concentrated Solar Power; ENP, European Neighbourhood Policy; EU, European Union; FAO, Food and Agriculture Organization; FDI, Foreign Direct Investment; GDP, Gross Domestic Product; GEI, Government Effectiveness Index; GHG, Greenhouse Gas; HVDC, High Voltage Direct Current; HWR, Heavy Water Reactor; IAEA, International Atomic Energy Agency; IEA, International Energy Agency; LWR, Light Water Reactor; MENA, Middle East and North Africa; NEA, Nuclear Energy Association; NPP, Nuclear Power Plant; NPT, Nuclear Weapons Non-proliferation Treaty; PPP, Purchasing Power Parity; RO, Reverse Osmosis; RPT, Reserve to Production Ratio; WNA, World Nuclear Association; WWN, World Nuclear News

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[1] These estimates assume compound linear growth in electricity consumption; the lower estimate projects the region's average (2002–2007) annual growth rate in electricity consumption of 7.5% while the higher estimate projects a lower annual growth rate of 5%. Both estimates assume 81% capacity factor for the NPPs, which is the world average (IAEA, 2010).

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Table 1
Nuclear power plans in N. African countries.

Country	Plans and recent activity	Cumulative max capacity	
		2020 (GWe)	2030 (GWe)
Algeria	First NPP planned by 2020' 1 Additional NPP every 5 years after first plant. Law under study.	1	3
Egypt	First NPP is planned to be operational by 2019; four are planned by 2025; a total of 10 are planned across the country. Currently engaged in a contract for design, construction management and start-up of a 1.2 GW NPP.	1.2	4
Libya	In 2007 the ambassador to the IAEA reported that Libya would not build NPPs for 10–15 years. Established Nuclear Energy Board in 2008 to promote peaceful use of nuclear power and preparing nuclear bill.		
Morocco	Plans for a 700–1000 MW NPP to go online in Sidi Boulbra between 2016 and 2017; two NPPs planned between 2020 and 2030.	1	2
Tunisia	First NPP planned by 2020 (900 MW).	0.9	
Regional total		**4.1**	**13.1**

Note: Table is compiled from: Reuters (2009a), Samira (2010), RIA Novosti (2010), Worley Parsons (2009), Acton and Bowne (2008), IISS (2008), Tripoli Post (2010), WNN (2010a, 2010b), Benmehdi (2005), and Reuters (2009b).

infrastructure, has difficulties in reviving their nuclear programs. Out of the 60 new nuclear reactors being constructed as of September 2010, 38 were located in just six Asian countries, 11 in Russia and the remaining 11 in 8 countries in Europe and the Americas (IAEA, 2010). If countries with nuclear reactors under construction for more than 20 years are excluded, the number of countries with recent reactor experience drops to 9: Brazil, China, Finland, France, India, Japan, South Korea, Pakistan, and Russia.

Thus, it seems that the discussion of the "nuclear renaissance" – which primarily takes place at the global level – does not provide sufficiently discriminating insight into the future of nuclear power in individual countries. Though decisions on nuclear power are made and implemented at the national level, there is a surprising lack of studies on national readiness to deploy nuclear energy.

One attempt to fill this gap is Jewell's (in press) comparative analysis of motivations and capacities to deploy nuclear power in 52 Newcomer Countries, which range from high-income European to low-income Sub-Saharan African countries. Among other things, the study shows that the majority of the Newcomer Countries have much smaller economies as well as less stable and efficient institutions than the Established Nuclear Power Countries and thus may face significant barriers in developing technical and institutional infrastructure necessary to support their nuclear power plans. Establishing a nuclear power program requires: ensuring a sufficiently large and reliable electric power grid, developing human resources and a regulatory and legal framework for nuclear power, establishing a safety culture, approving and adhering to relevant international conventions, and developing the physical supportive infrastructure to help manage a nuclear power plant including acquiring (or enriching) nuclear fuel and dealing with nuclear waste (IAEA, 2007a).

The current paper further develops this approach of comparative analysis of national motivations and capacities for deploying nuclear power to evaluate in what form and under which conditions nuclear power could realistically be introduced in North African countries. More specifically, we identify the present motivations and barriers to introducing nuclear power in the region and assess how these factors may change under different scenarios. The utility of this analysis may extend beyond the energy future of North Africa. As argued above, there seems to be substantial evidence that it is national (and possibly regional) rather than global factors that play the most crucial role in determining the expansion of nuclear power.

The next section explains the method of analysis used in the article, particularly the indicators of national motivations and capacities for nuclear power. Section 3 examines national capacities and drivers for nuclear power development in each of the five countries and identifies factors that either hinder or support nuclear power development. In Section 4, these national factors are examined in the regional context and a series of potential external and internal developments are described, which could affect nuclear power development; these potential developments are presented as a series of scenarios in order to analyze under which conditions nuclear power might develop. Finally, Section 5 provides concluding reflections on the future of nuclear energy in the region.

2. Methodology

The current academic literature does not provide criteria for establishing whether a particular country is motivated for and capable of introducing nuclear power. This gap is partially filled by institutional publications such as the IAEA's "Milestones in the development of a national infrastructure for nuclear power" (IAEA, 2007b) and "Evaluation of the status of national nuclear infrastructure development" (IAEA, 2008a). Both documents, intended for socio-economically and politically stable countries, provide guidelines and milestones on technical and institutional infrastructure necessary for operating nuclear power including: technical compatibility, financial capacity, human resources, physical infrastructure for transport of materials and supplies, the legal and regulatory framework, and facilities for processing radioactive waste (IAEA, 2007b). However, they do not address questions about whether the introduction of nuclear power is desirable for a particular country and whether establishing the required infrastructure is feasible under a set of national conditions. The requirements (except for technical capacity) are primarily formal and qualitative so that they can be verified by reviewing national documents and government activities.

Another widely used approach is evaluating the market potential for nuclear power in different countries. It seeks to answer the question of whether nuclear power is economically feasible and competitive as compared to other energy options. Most of the market potential studies are parts of proprietary reports geared towards investors (see for example, Market Research, 2010; Report Linker, 2009). Market potential studies analyze the desirability of nuclear power from the rational economic actor perspective and thus do not consider non-economic motivations for nuclear power such as energy security. Neither do they address the capacities of countries to mobilize resources necessary for deploying nuclear power.