Energy Research & Social Science 21 (2016) 101–113

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Thinking big? Ghana, small reactors, and nuclear power

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ARTICLE INFO

Article history:
Received 6 December 2015
Received in revised form 1 July 2016
Accepted 5 July 2016

Keywords:
Ghana
Energy
Nuclear power
Small modular reactors

ABSTRACT

Ghana has been seen as a potential market for small nuclear reactors and Ghanaian nuclear officials have, on occasion, expressed an interest in such reactors. However, Ghana seems to be heading towards procuring a reactor from Russia with a capacity of 1000–1200 MW. A power plant with such a large power generation capacity is not appropriate to Ghana's limited electricity grid or its financial circumstances. This paper examines the likely reasons for this focus and argues that despite greater government interest in setting up nuclear reactors, Ghana's nuclear establishment may not have the political clout to force through the purchase of a reactor, and has therefore attempted to position itself as a complete, one-stop solution to Ghana's electricity crisis, by calling for the construction of just one or two large nuclear power plants. The paper draws on the role of discursive elements in energy policy making, discusses the policy implications of this reactor choice, and offers evidence for the proposition that decision about nuclear power are not made on the basis of merely techno-economic considerations but are driven by a range of social and political factors.

1. Introduction

In August 2015, the Ghana Atomic Energy Commission (GAEC) signed a Memorandum of Agreement with the State Atomic Energy Corporation of the Federation of Russia (Rosatom) for the construction of a Nuclear Power Plant in Ghana [1]. According to Ghana's Minister for the Environment, Science, Technology and Innovation, the agreement provides for the purchase of Russian design power units of 1000–1200 megawatt (MW) capacity as well as the training of staff and establishment of necessary nuclear infrastructure [1].[1]

Ghana's plans to set up a nuclear power plant are part of a trend involving multiple countries in Africa that are considering nuclear power. In July 2015, for example, representatives of ten African countries formed the African Network for Enhancing Nuclear Power Programme Development (ANENP) [2]. A common justification offered for these nuclear plans is the fact that a very large number of people in the region do not have access to electricity. The International Energy Agency (IEA) in 2012 estimated that Sub-Saharan Africa has "more than 620 million people, nearly half of the global total" that do not have access to electricity [3]. In the last decade, energy access has grown increasingly as a focus of social and economic policy for national governments across the sub-continent and for developmental partners like the African Development Bank, World Bank, and African Union. During the same period, scholars have analyzed requirements for an energy transition in Africa [4]. This is the context in which plans for nuclear power are being made.

Given this milieu, Ghana's nuclear power plans are not surprising. And yet, GAEC's preference for a reactor with 1000 MW or more of generation capacity, assuming it is implemented, does raise a puzzle. As of 2015, Ghana's total installed electricity generation capacity is only 2831 MW [5]. Installing even one 1000 MW reactor within such a small grid would create instabilities in the operation of the national electrical system. Surely, energy planners must be aware of this mismatch. Indeed, as late as 2008, Ghanaian officials stressed "suitability to the Ghanaian and West African grid size" as an important criterion in choosing a reactor [6]. Why, then, is Ghana considering the purchase of such a large reactor?

The puzzle is even greater in light of the extensive promotion and marketing of small nuclear reactors (with power levels of 300 MW or smaller) that the nuclear industry has engaged in over the last decade. Given their smaller power output, such reactors would be a better fit to Ghana's grid. Further, as described below, Ghana has been viewed for decades as a likely customer for such reactors, both because of its long-expressed interest in acquiring nuclear power plants and because of its technical and financial constraints. Thus, Ghana offers a good case study to test the idea that

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[1] All use of MW refers only to MWe (megawatt electric) in this paper.

http://dx.doi.org/10.1016/j.erss.2016.07.001
2214-6296/

small developing countries that are interested in nuclear power will acquire small reactors.

As we argue below, Ghana's preference for large reactors has much to do with the narrative put out by the Ghana Atomic Energy Commission about the potential for nuclear energy to solve the country's energy shortages by constructing just one or two plants. Although the decision does not make sense from the view point of electric grid management, Ghana's choice of a Russian reactor offers further evidence for the proposition that decisions about nuclear power are not made on the basis of merely techno-economic considerations but are driven by a range of social and political factors [7–12].

This paper starts with a short literature review followed by sections that lay out the electricity profile of Ghana and recount the history of Ghana's efforts to set up a nuclear program. This is followed by examining the factors that lead to the expectation that Ghana would purchase a reactor with relatively low levels of power, roughly in the few hundred megawatt range. Next, we describe the constraints on Ghana's nuclear reactor choices, followed by a discussion of the strategies adopted by GAEC and Russia, which is likely to be invited to supply the first nuclear plant, to overcome these constraints. Before concluding, we offer our main argument about why GAEC prefers a large reactor to a small one.

2. Discursive elements

Over the last couple of decades, there has been increasing attention paid to the role of discursive elements such as narratives, fantasies, imaginaries and stories in energy and environmental policy making. Scholars have applied such methods to settings as varied as Russia's extraction and exporting of hydrocarbons [13]; energy efficiency in buildings [14]; the Desertec project for concentrating solar power in the Sahara Desert [15]; electricity rate setting in the state of Illinois [16]; the diffusion of photovoltaic technology in Ontario, Canada [17]; energy transitions in general [18,19]; and the idea of an economy based on hydrogen energy [20–22]. These are just a few examples, but they serve to reinforce the importance of examining how discursive elements can shape energy policies and energy politics.

Coming specifically to nuclear energy, Sheila Jasanoff and Sang-Hyun Kim have explored the role of "national sociotechnical imaginaries" which they define as "collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects" in shaping the trajectories of nuclear power in the United States and South Korea [23,24]. John Proops has sought to explain the growth of nuclear power despite its uneconomic nature by tracing it to the close match between the discourse of the modernizing and interventionist state and the discourse of nuclear power, as offering control and modernity [25]. Geels and Verhees have addressed the role of cultural legitimacy in shaping Dutch nuclear energy policy [26]. Jonas Anshelm has documented the turn to magical and mythical metaphors utilized in establishing the Swedish nuclear program [27].

Discussions of nuclear power by its proponents have largely focused on the future in preference to the present or the past [28–30]. This focus allows nuclear advocates to paint a glorious prospect of a country with no shortages of electricity, ignoring all the problems associated with setting up nuclear reactors. But there are other features that mark discussions about nuclear energy, and, because of the intimate relationship between the two, nuclear weapons. Analyzing nuclear history in the United States, William Kinsella has identified four key themes that characterize nuclear discourse: secrecy, mystery, potency, and entelechy. Of these, Kinsella points out, entelechy – a philosophical concept that refers to that which realizes or makes actual what is otherwise merely potential – is a key rhetorical resource that can motivate "action toward certain outcomes rather than others" [31].

This literature suggests many insights, three of which are important for our purposes. First, and most obvious, a variety of actors – governments, bureaucracies and individuals (for example, scientists and technologists) – do use discursive elements to further their goals. Although these are not always successful, the fact that they do work in some cases results in other actors attempting similar narratives. Thus, it should not be surprising that Ghanaian nuclear technologists would resort to such a strategy. Second, the discursive elements that are deployed and the expectations that underlie them are biased by the concerns of the time and demonstrate "functional thinking" in targeting the fulfillment of some perceived social need [32]. As we shall see, in Ghana's case the major concern that the nuclear establishment has targeted is the shortfall in energy.

Third, especially when it comes to technologies, the discursive elements employed often portray technologies as capable of creating a desirable society. As Frank Laird suggested through his examination of the advocacy of solar and wind energy technologies in the United States, these advocates believed that "creating new technological systems would eventually bring about the society they wanted" [33]. Advocates of these technologies routinely exaggerate potential benefits and downplay risks [32,34]. In the context of nuclear power, Paul Josephson has explained how the technological utopianism of Russia's political and scientific leaders has led them to endorse an ambitious program of nuclear reactor construction without adequate controls or public involvement and one that comes with the "potential for significant human and environmental cost should there be a mishap" [35]. Likewise, Ghana's nuclear establishment, as we document below, has underestimated the economic costs of, and the financial risk associated with, nuclear power.

3. Ghana's power profile

Across Sub-Saharan Africa, Ghana has produced one of the greatest success stories in energy access expansion. Aggressive efforts in the last two decades have resulted in 72% of the population being connected to electricity; in comparison, the regional average of national electrification rates stands at 32% [3].

Yet over the last two decades, power supply to consumers in Ghana has become more unreliable. Since the year 2000, the country has experienced at least three major power crises: first in 2002, followed by another in 2006–2007, and the crisis that began in 2013 and has continued till the time of this writing [36]. In early 2015 the Volta River Authority, Ghana's parastatal generation company, announced it was shutting down the third of six turbines at the 1020 MW Akosombo hydroelectric plant due to low water levels. Efforts to address the shortage through the use of floating emergency plants may not entirely resolve the power problems in Ghana because natural gas supplies have not been reliable or affordable. Domestic gas production has been challenged by technical and financial deficiencies [37]. The systemic nature of the crisis in the electricity system is paralleled in the area of oil-based energy, which has been described by scholar Franklin Obeng-Odoom in this journal [38].

Along with these supply challenges, government projections made in 2013 suggest an additional 4000 MW will be required over the next 20 years to sustain economic growth. The government has responded, inter alia, by announcing that it would increase installed capacity to 5000 MW by the end of 2016, setting a goal of 10% renewables in the generation mix by 2020 [39], and expanding capacity at existing gas plants. The government has also plans to use a combination of energy efficient technologies (LED lights,