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A means to an industrialisation end? Demand Side Management in Nigeria

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ABSTRACT

Electricity is essential for economic development and industrialisation processes. Balancing demand and supply is a recurrent problem in the Nigerian electricity market. The aim of this work is to assess the technical and economic potential of Demand Side Management (DSM) in Nigeria given different future levels of industrialisation. The paper places industrialisation at the centrefold of the appraisal of DSM potential in Nigeria. It does so by designing industrialisation scenarios and consequently deriving different DSM penetration levels using a cost-optimisation model. Findings show that under the high industrialisation scenario by the year 2050 DSM could bring about 7 billion USD in cumulative savings thanks to deferred investment in new generation and full deployment of standby assets along with interruptible programmes for larger industrial users. The paper concludes by providing policy recommendations regarding financial mechanisms to increase DSM deployment in Nigeria. The focus on DSM serves to shift the policy debate on electricity in Nigeria from a static state versus market narrative on supply to an engagement with the agency and influence on industrial end-users.

1. Introduction

Electricity is an essential element of economic progress in the developing world. Energy use has accompanied economic development on account of a range of factors including industrialisation (Narayan and Smyth, 2009). This point supports an extant logic of the importance of modern energy sources for the manufacturing sector. Indeed, Ebohon (1996) and Templet (1999) have argued that energy is a necessary complement to labour and capital for production processes. The significance of access to electricity is also very relevant to contemporary debates on sustainable development. Menegaki and Tugcu (2016) suggest that limited access to modern energy sources is cited as a main obstacle to the achievement of sustainable development in Africa.

In Nigeria, the lack of electrification has been pointed out as a main factor undermining economic development and the expansion of industrialisation (Akinlo, 2009). Yet, the country features significant opportunities for further electrification and higher industrialisation. Much attention has been paid in research to the problems associated with generation and transmission systems in Nigeria. For instance, it has been pointed out that generation is low for the most populous country in Africa (Aliyu et al., 2013) and that the transmission network lacks the level of investment required to cover the size of the country (Adenikinju, 2005). The challenges of balancing electricity demand and supply in Nigeria are recognised as large cost drivers and have significantly negative environmental connotations.

The relationship between industrialisation and electrification is complex. One the one hand, industrialisation can facilitate further electrification. This was certainly the case in the independence period in Nigeria, as industrial development progressed from the 1950s to the mid-1960s leading to increased electricity generation of about 20% per annum to meet demand (Kilby, 1969: 104–105). More recently, expanding electrification in response to industrial development is especially evident with small-scale private electricity generation systems. However, these are renowned for high production costs burdens that impact negatively on competitiveness. On the other hand, electrification can underscore improved industrial development. For Nigeria, Yahaya et al. (2015) find that manufacturing output is reliant on stable and adequate access to electricity especially in the long-run. Against this background, the Nigerian state is attempting redress the challenge of access to electricity especially given its significance to industrialisation (Chete et al., 2014).

Much focus on addressing the problems presented by inadequate access to electricity in Nigeria are concerned with supply-side initiatives (Akinlo, 2009; Yahaya et al., 2015). Yet, a set of solutions from the demand side –also known as 'Demand Side Management' (DSM) – could prove more cost-effective than some new generation developments. DSM could address insufficient power supply against the background of intended expansion of industrial activities. Steep increases in demand may occur mainly due to large industrial end-use. Industrialisation is likely to trigger the dual effect of increasing the need

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for reliable supply whilst offering back flexibility in the form of DSM.

The aim of this paper is to assess the technical and economic potential of DSM in Nigeria given different future levels of industrialisation. In developing as well as developed countries, DSM has been operated mainly by utilities using industrial end-users as the main enablers. The history of the Nigerian electricity market shows that the steepest increases in electricity demand historically have been associated with changes in industrialisation processes. Contemporary reflections also highlight the reliance of industrial expansion on electricity access. For these reasons, the paper places industrialisation at the centrefold of the appraisal of DSM potential in Nigeria. It does so by designing industrialisation scenarios and consequently deriving different DSM penetration levels in the future using a cost-optimisation model.

After this introduction, the paper provides background information around the role of DSM for electricity systems in developing countries (Section 2); highlights the history of balancing demand and supply in the electricity market in Nigeria (Section 3); describes the methodology underpinning this work (Section 4); presents findings from a cost-optimisation model runs (Section 5); and concludes by discussing findings on the dynamics between industrialisation and demand-side measures and presenting potential policy options for incentivising DSM in Nigeria (Section 6).

2. Demand Side Management in developing countries

2.1. Demand Side Management: definition, objectives and measures

DSM can be defined as a wide ranging actions to reduce demand for electricity (or gas) and/or to shift demand from peak to off peak times (International Energy Agency, 2011). Traditionally, objectives associated with DSM were generally restricted to efficiency and conservation programmes. Hence, the measures were mainly focused on energy efficiency, including more efficient light bulbs (as explained in the case of Nigeria in Section 3.3).

With time DSM objectives encompassed programs emphasising price response as well as automated reductions in energy at peak times (Bradley et al., 2013). Corresponding measures include Demand Response (i.e. any reactive or preventative method to reduce, flatten or shift peak demand) and load management (i.e. advance or delay appliance operating cycles by a few seconds to increase the diversity factor of the set of loads). For utilities, both reducing and shifting electricity demand implies avoiding or delaying building additional generation capacity. In some situations, this would avoid or defer electricity price increases that would otherwise be imposed on customers to finance new investments in system capacity. Industrial plants are often targeted for DSM as they are able to reduce overall demand by adopting efficiency measures. Several industrial users can also shift consumption away from peak demand over relatively long time periods, depending on the processes used.

2.2. DSM implementation

DSM plays a vital role in integrated planning for energy systems in both developed and developing countries.

In principle, DSM was implemented as part of integrated planning in developing countries in the 1980s (Gellings, 1985). In both developed and –increasingly so- developing economies, environmental concerns of energy use and economic development became a major concern and the environmental dimension dominated the policy debate. This brought a major shift in the focus of DSM as well- the issue of local, regional and global environmental effects of energy use became an integral part of the picture. In the 1990s, liberalisation of energy markets and restructuring affected the entire world. Initially increased optimism over competitive pricing deflated DSM of its original value, but by the end of the century increased concerns about security of supply gave DSM new life. Climate change and other global and local environmental issues were also part of the picture. These changes brought new issues and challenges to the attention and by the end of the century, it became evident that unless the fundamental design, including DSM, is well thought through, liberalisation of energy market cannot achieve the expected results. In the first decade of the 2000s, the focus shifted to high oil prices, energy scarcity and the debate over state intervention as opposed to market-led energy supply. Concerns around security of supply, the return of the peak oil discussion in a carbon-constrained world caused much of this shift in the policy debate. Looking at the future of peak demand, a number of studies around the end of the first decade of the century set the scene for a future which is more and more challenging in terms of peak electricity demand which will have to deal with increased load from heat pumps and electric cars.

In practice, challenges around DSM implementation consist of lack of awareness about energy efficiency in consumers and insufficient auditing. For example, several industrial and commercial companies still have not carried out energy audits to collect reliable information on their current operations. While this may be due to a failure by management to appreciate the potential benefits of energy efficiency, some companies miss skilled personnel able to perform audits (United Nations Industrial Development Organisation (UNIDO), 2015).

DSM has been seen as an aid to deficient power supply in developing countries and specifically in India (Mukhopadhyay and Rajput, 2010) and China (Zhong et al., 2010). An example of DSM implementation extremely relevant to Nigeria consists of Brazil. Like Nigeria, this country has a generation fleet consisting primarily of hydro and thermal power. DSM has been deployed to defer new investments in distribution and transmission networks, and reduce the necessity of complementary thermal power operation during peak periods (Boshell and Veloza, 2008). In Mexico, a centralised, government-led initiative on DSM generated direct savings of 1.5 GW in electricity demand (ADEME, 2004).

3. History of balancing demand and supply in the Nigerian electricity market

3.1. The electricity market in Nigeria: a brief history

Balancing demand and supply is a recurrent problem in the Nigerian electricity market. Interruptions in electricity supply are frequent and pose continuous stress to the grid. Issue with balancing electricity demand and supply in Nigeria are not new and found different solutions over the years.

In the 1950s electricity demand in Nigeria was lower than supply. However, with industrial development, the demand for electricity gradually increased and later exceeded supply (Makwe et al., 2012). The rapid growth in electricity demand was countered initially by rising generation (20% increase per year on average between 1956 and 1965) alongside declining costs of generation from 1956 to the early 1960s (Kilby, 1969: 104–105). However, improvements in generation were not long-lived. Rather, instability and unplanned interruptions of supply from 1962 revealed the challenge to the capacity of provision. Electricity was an important input for industry and advancing structural transformation agenda that was emerging under the First development plan of 1962–1968. At this time, electricity was especially important for the development of the textiles and cement sectors (Adenikinju, 1998). However, the imbalance between supply and demand of electricity with particular reference to the manufacturing sector is a pattern that has remained to date.

Until its reform in 2005, when it was transformed into the Power Holding Company of Nigeria (PHCN), the Nigerian Electric Power Authority functioned as a government-controlled and vertically integrated monopoly responsible for power generation, transmission, and generation. PHCN was subsequently unbundled into 6 generators, 11 distributors and one transmission company. These companies are