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Smart and Just Grids for sub-Saharan Africa: Exploring options

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ABSTRACT

In 2009, an estimated 585 million people had no access to electricity services in sub-Saharan Africa. Unlike many other regions of the world, under current assumptions, that figure is expected to rise significantly to about 652 million by 2030-an unsustainable and unacceptable situation. Knowing of the intrinsic linkages between access to energy services and development, national governments and regional organisations have identified the urgent need for accelerated electrification rates. Some of the established and emerging concepts, systems and technologies grouped under the term 'Smart Grids' may offer an important contribution to achieving universal access to electricity.

We argue that these Smart Grid advances may enable sub-Saharan African countries to leapfrog elements of traditional power systems and accelerate and improve electrification efforts. We introduce the notion of Just Grids to reflect the need for power systems to contribute towards equitable and inclusive economic and social development without marginalising the poor. The paper reviews the literature, and identifies specific options that could be implemented in sub-Saharan Africa. After selecting criteria that focus on potential impact as well as requirements for their implementation, a qualitative first-pass assessment of the potential of these options is made. This paper provides support for policy development, and suggests areas for further, more detailed research.

Contents

1. Introduction . . . 337
2. Electricity in sub-Saharan Africa . . . 337
3. A Smart Grid approach . . . 337
4. Smart and Just Grids in the sub-Saharan African context . . . 338
   4.1. A new emphasis . . . 338
   4.2. Opportunities for leapfrogging . . . 340
5. Identifying specific options . . . 340
6. Selected assessment criteria . . . 343
7. Indicative assessment . . . 345
8. Suggested next steps . . . 345
9. Conclusion . . . 348
10. Annex-qualitative ranking . . . 349

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10.1. Consumers . . . 349
10.2. Operation and quality of supply . . . 349
10.3. Generation . . . 349
10.4. Environment . . . 349
10.5. Technical complexity . . . 349
10.6. Investments . . . 349
10.7. Human capacities . . . 349
10.8. Policy, regulation and standards . . . 349
10.9. Applicability of models for pre-assessments . . . 349
Disclaimer . . . 349
Acknowledgements . . . 350
References . . . 350

1. Introduction

According to the reference scenario in the World Energy Outlook [1], Africa's final electricity consumption is expected to double between 2007 and 2030 from 505 to 1012 TWh. Over the same time period, the United Nations (UN) Secretary-General's Advisory Group on Energy and Climate Change (AGECC) has proposed that the UN System and Member States commit to ensuring universal access to reliable, affordable and sustainable modern energy services by 2030 [2].

We propose that specific elements of current and emerging Smart Grid[1] concepts, systems and technologies might make an important contribution to achieving this goal by accelerating equitable and just access to electricity services in sub-Saharan Africa [3]. While this might include elements that are currently in the centre of attention in industrialised countries, some options might also emerge which explicitly address developing country needs.

In Section 2, a selective description of the electricity sector in sub-Saharan Africa is provided. Section 3 continues with a concise review of current Smart Grid concepts, projects and expected benefits. Section 4 places the Smart Grids concept in the context of sub-Saharan African, shifting the focus towards the facilitation of just access. It then illustrates potential opportunities for leapfrogging elements of traditional power systems.[2] Section 5 identifies selected Smart and Just Grid options with a potential role in the near- to medium-term. Section 6 introduces and provides background on criteria by which these options might be assessed. The selected criteria include: consumers; operation & quality of supply; generation; environment; technical complexity; finance; human capacities; policy, regulation & standards; and modelling. Based on these criteria, Section 7 provides an indicative assessment of the potential of these options. Section 8 suggests next steps to inform international cooperation, complementary to regional and national initiatives in sub-Saharan Africa. Finally, the paper concludes with Section 9. This study represents only an initial set of thoughts to support policy considerations and further research.

2. Electricity in sub-Saharan Africa

In 2009, around 585 million people in sub-Saharan Africa (about 70% of the population) had no access to electricity services [4]. This figure is expected to rise significantly to about 652 million people by 2030. 85% of those without access to electricity live in rural areas [5]. In addition to low energy access rates, the energy sector is characterised by several other significant challenges including: electricity costs as high as USD 0.50/kWh, insufficient generation capacity to meet rapidly rising demand, and poor reliability of supply [6]. The estimated economic value of power outages in Africa amounts to as much as 2% of GDP, and 6–16% in lost turnover for enterprises [7].

In 2008, sub-Saharan Africa generated 380 TWh of electricity, of which South Africa alone produced almost 70% [8].[3] For a sense of scale, with 68 GW, the entire generation capacity of sub-Saharan Africa is no more than that of Spain.[4] In addition, sub-Saharan Africa's average generation capacity was only about 100 MW per million inhabitants in 2009, ranging from less than 15 MW per million inhabitants in Guinea-Bissau and Togo, to 900 in South Africa, and up to 1080 in the Seychelles [11]. By comparison, the generation capacity is about 1680 MW per million inhabitants in the European Union, and 3340 MW per million inhabitants in the U.S.

The significant need for accelerated electrification rates has been identified by regional (economic) communities[5] and is largely underpinned by national electrification policies. More than 75% of sub-Saharan countries having defined targets for electricity access [12]. The importance of regional and national electrification initiatives is clearly understood at the policy level. The priority is to translate this understanding into provision of electricity services 'on the ground'.

3. A Smart Grid approach

The term 'Smart Grid' has come to encompass a range of innovative tools, technologies and practices envisioned to be supported by novel business models and regulatory frameworks. All of them ultimately should serve to help ensure a reliable, secure and economically efficient supply of electricity services. While there is consensus on this overall objective, the precise scope of the term Smart Grids is interpreted differently according

[1] It remains the case that modern power system planning and operational tools and systems currently employed in the OECD also have much to offer developing countries.

[2] We use the term *electricity infrastructure* or *power systems* to encompass the entirety of the system, from generation through transmission and distribution to customer services and associated operations.

[3] Refer to Niez [9] for more details on South Africa's electricity sector and policies.

[4] Without South Africa, this capacity goes down to 28 GW, 25% of which is currently not available for generation due to, amongst others, aging plants and lack of maintenance [10].

[5] Such as: The Forum of Energy Ministers of Africa's (FEMA) Position Paper on Energy and the MDGs [12]; The Southern African Development Community's (SADC) Protocol on Energy [13] and its Regional Indicative Strategic Development Plan (RISDP) [14]; The Economic Community Of West African States' (ECOWAS) Energy Protocol [15] and its White Paper for a Regional Policy [16]; The Common Market for Eastern and Southern Africa's (COMESA) Energy Programme [17]; The East African Community's (EAC) Regional Strategy on Scaling-up Access to Modern Energy Services [18] and its Power Master Plan Study [19]; The Treaty Establishing the Economic Community of Central African States [20]; The Economic and Monetary Community of Central Africa's (CEMAC) Energy Action plan with energy and electricity access goals [12]; the Africa-EU Energy Partnership [21,22].