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Catalysing investment in sustainable energy infrastructure in Africa: Overcoming financial and non-financial constraints

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ABSTRACT

Energy infrastructure investment is crucial to development and poverty reduction across Africa. Given the scale of finance needed, governments are increasingly looking to attract private-sector investment. However, it is clear that building infrastructure does not automatically bring broad-based growth and social development. This paper focuses on how to drive investment in *sustainable* infrastructure – that is, infrastructure that meets local needs in a socially acceptable, environmentally friendly and equitable manner. We identify four tensions or challenges that arise in energy infrastructure development: balancing liberalization with regulation and control over resources; achieving attractive risk-return profiles while ensuring access and affordability of services; balancing the push for private-sector investment with effective public investments; and balancing local and national needs with the global sustainable development agenda. We use two case studies to examine these issues: natural gas infrastructure development in Tanzania, and electricity infrastructure development in Zambia. In both countries, infrastructure development has involved slow progress and constant struggle. Private-sector investment has been very difficult to attract, and there are clear tensions between the goal of attracting investors to the energy sector and other priorities, such as ensuring the broad and equitable distribution of benefits and keeping electricity affordable even for the poor. In both countries, there is a great need to build local capacity both to work in and to regulate the energy sector. Strong, effective, democratic governance institutions are also essential, combined with an engaged civil society.

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1. INTRODUCTION

Modern energy infrastructure is widely recognized as crucial to the development of Africa – particularly south of the Sahara, where access to electricity remains spotty and unreliable. Yet in many countries, infrastructure development has lagged far behind the growth in energy demand. This paper explores the financial and non-financial challenges in expanding and upgrading energy infrastructure in Africa, taking a historical perspective to show how the past continues to influence development. It identifies key tensions or balancing acts that policy-makers need to manage, and offers guiding principles that could help ensure that going forward, the expansion of energy infrastructure genuinely contributes to human development.

We apply this perspective to case studies of the development of natural gas infrastructure in Tanzania, and of grid-connected electricity infrastructure in Zambia. Both have considerable potential to boost economic growth, but also face constraints. For Tanzania, developing natural gas offers an opportunity to increase access to electricity while improving energy security by reducing dependence on fossil fuel imports and on a variable hydropower supply. Zambia, meanwhile, is facing an energy crisis: water shortages have led to a sharp reduction in hydropower production, and thus to a significant power shortage and load-shedding. We examine the history of energy infrastructure development in these two countries to understand the challenges they face in simultaneously addressing social and economic sustainability.

Section 2 provides an outline of infrastructure development needs and challenges in Africa, including the equity dimension, and presents four guiding principles for sustainable infrastructure development. Section 3 describes the methods used to explore the case studies, which are presented in Sections 4 and 5, respectively. Section 6 examines the two cases in relation to the guiding principles in Section 2. We conclude with key messages in Section 7.

2. INVESTING IN INFRASTRUCTURE IN AFRICA

Infrastructure is a vital component of a country's growth and development. Yet many African countries are starkly deficient in infrastructure. The power sector in sub-Saharan Africa generates the same amount of power as Spain's power sector, but serves a population nearly 20 times as large. Meanwhile, only one-third of rural Africans live within two kilometres of an all-season road, and less than 5% of Africa's cultivated area is irrigated (Foster and Briceño-Garmendia 2010).

Evidence suggests the marginal productivity of infrastructure is higher in countries with relatively low level of infrastructure, such as many in sub-Saharan Africa (Henckel and McKibbin 2010). Economic analyses suggest that per capita economic growth could rise by 2.2 percentage points annually if every African country only reached parity in infrastructure with Mauritius (Foster and Briceño-Garmendia 2010), a middle-income country that itself suffers from infrastructure bottlenecks (World Bank 2012b). Indeed, Foster and Briceño-Garmendia (2010) argue that for most African countries, "the negative impact of deficient infrastructure is at least as large as that associated with corruption, crime, financial market and red tape constraints" (p.2), all of which are widespread across the region.

For countries in sub-Saharan Africa to achieve the growth and sustainable development objectives to which they increasingly aspire, an estimated US$90 billion per year of investment in infrastructure is needed – two thirds for new infrastructure and one third for maintenance (AfDB et al. 2016). In the energy sector alone, building the infrastructure needed to meet growing demand and universal energy access goals will require estimated annual

investments of US$55 billion over the next 15 years, almost seven times the current level (Africa Progress Panel 2015).

2.1 Equitable infrastructure development

While there is an indisputable need for infrastructure investment in Africa, it must also be recognized that investments in infrastructure do not automatically bring broad-based growth and social development. In its FY2012–2015 strategy update, the World Bank's Infrastructure Strategy Committee (2012a, p.13) noted:

> Overall, the business [of the World Bank] has been biased towards infrastructure investments that promote growth, with expected "trickle-down effects". In reality, the results of any trickle down have been slow. In Bank projects, the poverty impact of sector-based interventions has proved complex to achieve and demonstrate.

The Infrastructure Committee established an Implementation Principle making a commitment to use lessons from experience to improve the delivery of infrastructure services to the poor (World Bank 2012a). This is a well-recognized need; Scott and Seth (2012), for instance, have argued that the poor are the last to benefit from infrastructure projects, with poverty reduction rarely being a specific project objective.

Indeed, as Alexander (2013, p.13) notes, large-scale infrastructure projects can actually harm the poor and hinder development, such as "destroy[ing] the social fabric of local cultures, key habitats for native biodiversity, and the natural resources upon which their existence depends". As a result, Alexander writes, the economic benefits "may accrue mainly to large firms or to more highly developed regions" (ibid.). Such risks arise especially with land-intensive projects, particularly when they conflict with customary land rights (Lindsay 2012). Fragile and conflict-affected states also pose special challenges (Jones and Howarth 2012).

Clearly, the social benefits of infrastructure development cannot be taken for granted. Projects often come with promises of modernity, economic growth and progress, but such broad statements fail to appreciate how infrastructure affect the ways in which people perceive and interact with the space where they live (Appel et al. 2015). This means that social benefits must be built into the design of infrastructure projects. Several steps are advisable, such as ensuring the investment is demand-driven, complying with strict environmental and social standards or safeguards,[1] adhering to participatory processes throughout the project cycle, and designing projects with the explicit goal of broad-based growth and poverty eradication (World Commission on Dams 2000; McIntyre et al. 2008; Bosshard 2012; Alexander 2013).

These concerns highlight the need, not only for increased investment in infrastructure in Africa, but for increased investment in *sustainable* infrastructure – that is, infrastructure that meets local needs in a socially acceptable, environmentally friendly and equitable manner. It is important not only that infrastructure projects are sustainable by these measures, but that the *process* by which projects are chosen, designed, developed and implemented is legitimate, transparent and equitable. The pursuit of that kind of sustainable infrastructure development also provides significant opportunities for maximizing social benefits and other positive impacts (e.g. technological spillovers, innovation, job creation, equitable access) and

[1] For example, the Envision sustainable infrastructure rating system provides a set of 60 quantitative sustainability criteria with which to assess environmental, social, and economic impacts of project design, construction and operation (see https://sustainableinfrastructure.org/).

minimizing negative impacts and social costs (e.g. greenhouse gas emissions, environmental pollution, waste, ecosystem stress) associated with infrastructure projects.

A first step in framing our analysis is to define what we mean by infrastructure. The term is typically used to describe large-scale, capital-intensive investments such as power generation and transmission, roads, ports, water treatment and distribution networks, and sewerage systems and treatment facilities. However, while such large-scale investments are crucial, in many African contexts, distributed meso- and micro-scale infrastructure may be a better – or at least complementary – strategy for growth and poverty eradication.

Meso- and micro-scale solutions are sometimes more effective and rapidly deployable, especially when there is limited finance. For example, in certain situations, solar home systems and solar lanterns may be preferable to grid expansion; improved latrines may be preferable to municipal sewerage; boreholes and standposts might be preferable to municipal piped water. Such options can provide services that are vastly superior to the status quo – for example, to dangerous kerosene lanterns (Johnson et al. 2016), or open defecation and unhygienic water (Ekane et al. 2014) – and can be deployed more quickly and generally far lower costs than conventional large-scale infrastructure options (Foster and Briceño-Garmendia 2010).

In some cases, investment in physical capital may overshadow much-needed investment in human capital. Many countries striving to achieve basic improvements in welfare require significant investments in human capital – for instance, through education, health, or nutrition initiatives – to realize both direct welfare benefits and their demonstrated contribution to growth (Barro 2001; Cohen and Soto 2007; Galor 2011; Hanushek 2013). Such investments in "soft" infrastructure can have the potential to generate more employment than investments in "hard" physical infrastructure (De Henau et al. 2016). Vaccinations, bed nets, improved cookstoves, and maternal and neonatal health care are examples of investments in human capital that might be worth prioritizing over investments in large-scale infrastructure, insofar as they are competing for scarce finance, institutional resources and political attention. Indeed, such investments in "soft" infrastructure are desperately needed. It is estimated, for example, that developing countries need to invest more than four times as much in education as they currently do (UNCTAD 2014).

In any event, aligning "soft" (human capital) and "hard" (physical capital) investments will make for a more coherent approach to development. The lack of sufficient soft investments can actually be a direct bottleneck to hard investments – for example, when a deficit in technical skill or the absence of an institutional framework pre-empts the effective implementation of a project. Foreign or multilateral investments may include significant numbers of expatriate staff who are not sensitive to the area's culture or its development needs (Fielding et al. 2015).

2.2 Barriers to sustainable infrastructure investment

Bhattacharya et al. (2015) assert that "[t]he infrastructure development model is broken" and "needs to be transformed fast if it is to enable the quantity and quality of growth that the world economy needs". While identifying numerous barriers and making several recommendations, the authors emphasize the importance of the private sector in mobilizing the additional financing needed to meet global infrastructure needs.

In principle, there is tremendous scope for the private sector to scale up its contribution to infrastructure finance. The private sector invested only US$146 billion in infrastructure in developing countries in 2013 (World Bank 2014), a small fraction of the $1 trillion per year

currently in infrastructure in those countries (UNCTAD 2014). That share is even smaller in poorer countries; of all private-sector investment in infrastructure, only 7% flowed to the 77 poorest (IDA, or International Development Association-eligible) countries (Kasper 2015). Private-sector investment also pales in comparison to the estimated US$90 billion/year in infrastructure investment needed across sub-Saharan Africa (AfDB et al. 2016). Table 1 shows the sources of infrastructure spending in sub-Saharan Africa in 2001–2006; notably, more than 60% of private investment was in information and communications technology.

Table 1: Annual infrastructure investment in sub-Saharan Africa, 2001–2006 (billion US$)

Infrastructure sector	Operation & maintenance	Capital expenditure					
	Public sector	Public sector	ODA	Non-OECD financiers	Private sector	Total	Total spending
ICT	2.0	1.3	0.0	0.0	5.7	7.0	9.0
Power	7.0	2.4	0.7	1.1	0.5	4.6	11.6
Transport	7.8	4.5	1.8	1.1	1.1	8.4	16.2
Water and sanitation	3.1	1.1	1.2	0.2	2.1	4.6	7.6
Irrigation	0.6	0.3	—	—	—	0.3	0.9
Total	20.4	9.4	3.6	2.5	9.4	25.9	45.3

Source: Foster and Briceño-Garmendia (2010).
Notes: ICT = information and communications technology; ODA = official development assistance; OECD = Organisation for Economic Co-operation and Development; WSS = water supply and sanitation. — = Not available.

Yet private-sector financial flows overall have grown substantially in the past decade. Almost US$700 billion in foreign direct investment (FDI) flowed to developing countries in 2014, about five times as large as official development assistance (ODA) flows of about US$130 billion – a complete reversal of the pattern a few decades ago (UNCTAD 2015). Domestic private investment (public and private) adds to this large amount. With private investment so high, a modest increase in the share devoted to infrastructure would yield a major contribution. Standard & Poor's (2014) estimates that if institutional investors increased their allocation to infrastructure across the world to an average of 4%, an additional US$200 billion per year could flow. Bhattacharya et al. (2015) estimate that more than US$1 trillion per year more could flow from institutional investors if aggressive measures were taken to increase that allocation to 8%.

In fact, given the preponderance of private-sector financial flows, it is private-sector investments that increasingly determine the overall shape and direction of a country's development. This is true especially during an era of austerity in which governments, particularly in advanced economies, are reducing their spending on infrastructure. In the United States, for example, government spending on infrastructure as a percentage of GDP has been reduced to a 20-year low of around 1.7% (Standard & Poor's 2014).

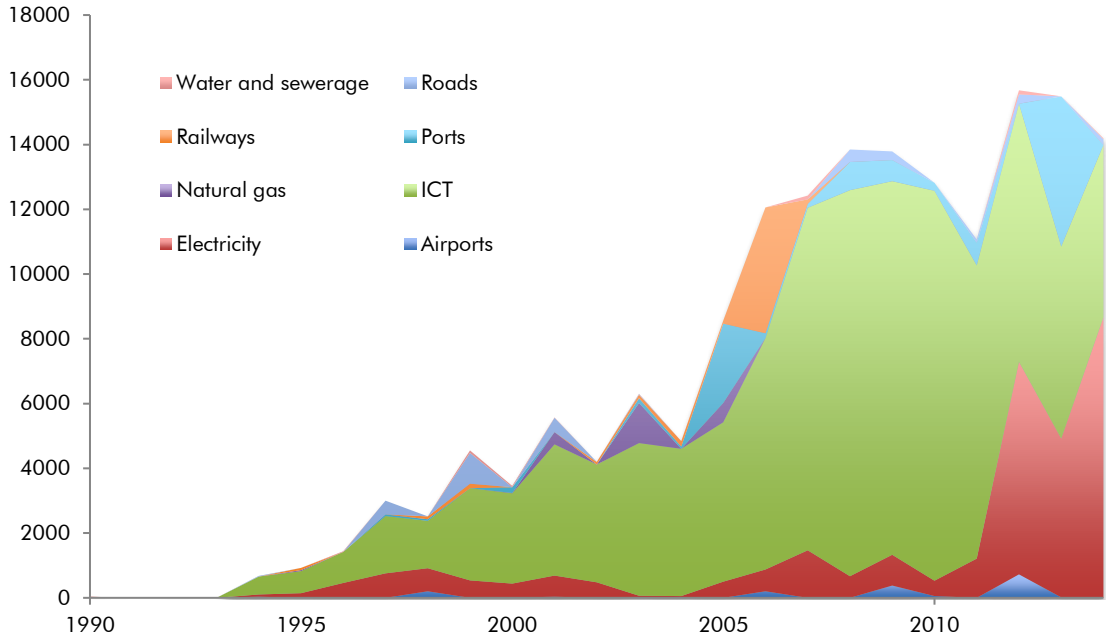
This makes it increasingly important – yet also increasingly challenging – for governments to guide finance flows toward sustainable infrastructure and other investments that are consistent with objectives of inclusive growth and environmental sustainability. There are several key reasons why it is difficult to direct private flows toward such ends. Investments in sustainable infrastructure are often "socially desirable but not privately profitable" (Henckel and McKibbin 2010), with private capital markets prioritizing near-term returns, externalizing

environmental costs, and neglecting the needs of populations that are too poor to amount to a financially attractive customer base.

Moreover, more sustainable approaches infrastructure can often require more upfront capital (Bhattacharya et al. 2015), while yielding a larger share of benefits that are public goods, rather than profits for investors. Ultimately, as highlighted by the UN Conference on Trade and Development (UNCTAD 2014), "the fundamental hurdle for increased private sector contributions to investment in SDG sectors [sectors related to the Sustainable Development Goals] is the inadequate risk-return profile of many such investments". Of course, this is why the public sector has historically dominated the infrastructure arena.

Certain recent developments in the financial markets exacerbate these problems. Investment in productive assets – to say nothing of sustainable infrastructure – is challenged by the ongoing financialization of capital markets, in which "financial returns increasingly arise from transactions that are disconnected from long-term value creation in the real economy" (UNEP Inquiry Team 2015), even while the financial sector enlarges relative to the rest of the economy (Epstein 2015).

Figure 1: Private investment in infrastructure in sub-Saharan Africa, 1990–2014 (million US$)



Source: World Bank Private Participation in Infrastructure (PPI) database (http://ppi.worldbank.org).

2.3 Guiding principles for negotiating sustainable infrastructure development

The extent of these challenges suggests that sustainable infrastructure finance cannot be based on current practice, but instead must tackle the contradictions and tensions that arise due to competing knowledge, experiences and beliefs about how development happens (Bhattacharya et al. 2015). Adapting UNCTAD's (2014) guiding principles for achieving private sector engagement in SDG sectors, we propose a set of guiding principles to steer infrastructure investments from "growth-led" to "people-led" development, with prosperity, social equity and environmental sustainability as core objectives. The sections that follow summarize the key tensions to be addressed; Figure 2 at the end summarizes the principles.

2.3.1 Balancing liberalization and the right to regulate

Until the late 1980s, investment in and operation of infrastructure was predominately a government activity. However, in the 1990s, liberalization – i.e. the introduction of market mechanisms, private-sector participation and competition – came to be seen as a panacea to increasingly inefficient, technically and financially insolvent, publicly run infrastructure services, in particular state-owned electricity utilities (Johnson 2011; Turkson 2000; Wamukonya 2003). Such a shift, particularly in the lending strategies of multilateral development banks, brought with it increasing tension over control of vital parts of countries' economic and social functioning.

Sub-Saharan African countries have generally struggled to attract private investment and effectively regulate private-sector involvement in the energy sector. As a result, they have resorted to various hybrid models (Gratwick and Eberhard 2008), aiming to find the appropriate balance for each country between liberalization and regulation, and guide private investment in the direction of national interest. By the turn of the century, it was clear that liberalization was only effective if accompanied by appropriate regulations and government oversight (Pollitt 2008; UNCTAD 2014). As Kessides (2005, p.85) notes, liberalization "poses significant risks if not accompanied by appropriate structural and regulatory safeguards". He goes on to caution that "strong institutions took a long time to develop even in advanced industrial economies. It is difficult to create such institutions overnight in societies that do not have the constitutional, political, and legal traditions required to support them" (Kessides 2005, p.88).

2.3.2 Balancing attractive risk-return rates with accessible and affordable services

A closely related issue is tension over the distribution of benefits from infrastructure services: who are the winners and losers? On the one hand, attracting private-sector investment requires ensuring opportunities for attractive returns on investment with manageable risk. But at the same time, infrastructure services must be accessible and affordable if they are to drive growth and development throughout a country. It has been estimated if infrastructure services such as electricity, water and sewerage were priced high enough to fully recover costs, the average citizen in sub-Saharan Africa spend 25–35% of their income on them (Estache 2010). The energy access debate highlights this most starkly. Rural areas are the most expensive places to electrify, since they tend to be sparsely populated and far from load centres and cannot take advantage of economies of scale. Yet they are also some of the poorest places, so full cost recovery would make the services unaffordable.

Addressing this tension means "placing clear obligations on investors and extracting firm commitments, while providing incentives to improve the risk-return profile of investment…[a]nd it implies making incentives or subsidies conditional on social inclusiveness" (UNCTAD 2014, p.12). The solution is not to stop change from happening, but to pursue gradual change, protecting the most vulnerable through safety nets and affordable progressive tariff schedules that do not involve economically unviable and publically unacceptable price increases (Kessides 2005). Public institutions will always have a role to play in liberalized, market-based systems to ensure adequate provision of basic services to all citizens at a reasonable cost. For example, the process of rural electrification in the United States and other developed countries relied on several interlinking measures by the public sector, including subsidies largely in the form of highly subsidized, long-term credit. Also important was the public-sector support and facilitation of institutional structures that were inherently deigned to prioritize rural access, such as rural electrical cooperatives (Carmody 1939; Pellegrini and Tasciotti 2013).

2.3.3 Balancing a push for private investment with a push for public investment

In the debate over how to regulate private sector involvement in infrastructure, it is possible to forget that public investment also remains important. Indeed, public and private investment can – and should – be viewed as complementary, with risks shared as appropriate (UNCTAD 2014). It is important that policy-makers seriously address what the public and the private sector will be responsible for in terms of financing of infrastructure (Estache 2010, pp.61–62). There are many synergies to be found – for instance, using public funds to lower the cost of raising private capital, or engaging private investors to support public-sector programmes (UNCTAD 2014).

Governments also need to complement private-sector energy and transport infrastructure; one counterexample was identified in an agro-energy investment in Sierra Leone where the government could have extended roads as little as 50 metres to facilitate community access, but did not do so (Fielding et al. 2015). More generally, it is not always easy to get the balance right: recent research has also demonstrated that when the public sector takes on excessive risk, the private sector often feels less incentive to undertake risk analysis and risk management (Laboul 2014). In such situations, policy-makers should not consider private investment as an alternative to public investment, neither in returns nor in risk.

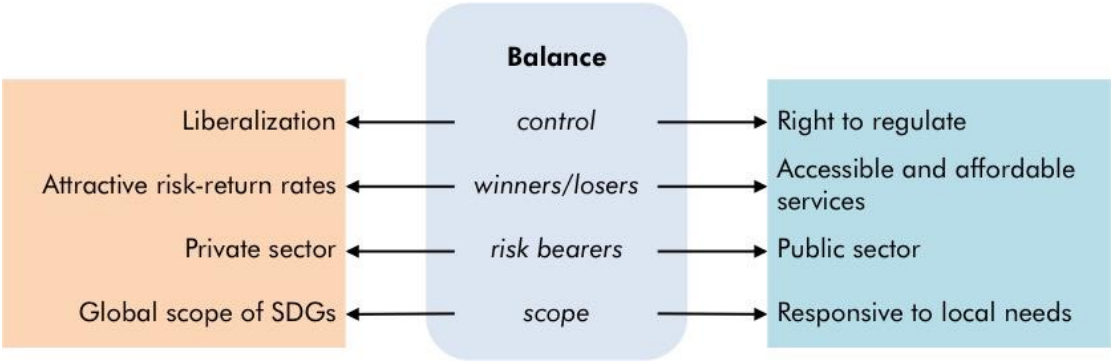
2.3.4 Balancing the global scope of SDGs with local needs

Sustainable Development Goal (SDG) 7 calls for access to affordable, reliable, sustainable and modern energy for all. But the financing needs to achieve this will differ by country. Financing mechanisms for poorer nations will need to address the particular constraints they face in attracting the required resources from private investors (UNCTAD 2014). In addition, financing needs for poorer nations should not be focused solely on important technical hardware, but should be geared towards building local capabilities (Byrne et al. 2011; Ockwell and Mallett 2012). Meanwhile, actions to achieve the different SDGs may influence one another, positively or negatively (Nilsson et al. 2016). Therefore, access to affordable, reliable, sustainable and modern energy for all should be pursued in a way that is appropriate to the local context and is in harmony with other goals.

To improve the odds that infrastructure investment serves the development needs of the local population, an important guiding principle is that projects be conceived, designed and implemented with all due attention to good practices to ensure democratic participation.

Especially in the case of the first three of these guiding principles, one can clearly discern the effort to resolve the tensions between distinct narratives of development. One narrative stresses overall economic growth, through liberalized markets, while the other prioritizes human development and benefits to the poorest people. While these goals need not be in conflict, there are certainly precedents showing that they can be. It is through the lens of reconciling these tensions that the case studies in Sections 4 and 5 can be most instructive.

Figure 2: Guiding principles for pursuing sustainable infrastructure development



Source: Authors' own, drawing on UNCTAD (2014).

3. STUDY DESIGN

We applied the guiding principles to two qualitative case studies: of Tanzania's natural gas sector, and of Zambia's power sector. Both offer clear examples of infrastructure development opportunities, but also of the balancing acts involved. The resulting insights should not be assumed to apply to all of Africa; instead, we have aimed to shed light on the historical factors that have shaped the current infrastructure development conditions. The research comprised a review of national and regional energy policy documents and other relevant publications, as well as interviews with key energy sector stakeholders in both countries.

3.1 Desk-based research

We reviewed official government documents, peer-reviewed studies and "grey" literature, including energy and economy-wide national policies, plans and strategies; reports on each country's energy sector; and other energy-related publications. These documents helped us understand the energy sector in Tanzania and Zambia, including current energy and future needs, past, present and planned energy infrastructure developments and prevailing policy, regulatory and institutional frameworks. We also reviewed regional policy documents, energy reports and publications on energy across the Southern African Development Community (SADC),[2] for regional context and to understand how efforts under the SADC fit with national energy strategies and plans.

3.2 Stakeholder interviews

We interviewed a total of 18 stakeholders in the energy sector in Tanzania and 12 in Zambia, including staff in government ministries, state-owned electricity utilities, rural electrification agencies, energy regulators, several development partners, the private sector and research institutions. All interviews were conducted in August 2015.

Our goal was to better understand which energy infrastructure investments have been most successful and why others have struggled, with a focus on the development of grid-connected electricity infrastructure in Zambia and natural gas infrastructure in Tanzania. In particular, we looked for insights on financial and non-financial barriers, aiming to identify financing

[2] For example, SADC energy policies and strategies, SADC regional infrastructure development plans, and SADC and Southern African Power Pool energy reports, among others.

mechanisms and additional institutional arrangements that could help catalyse energy infrastructure investments that genuinely support sustainable development.

4. CASE STUDY 1: NATURAL GAS INFRASTRUCTURE IN TANZANIA

Energy has become a difficult topic in Tanzania over the last few decades. The country continues to rely mainly on traditional biomass for its energy needs, with wood energy accounting for 90% of the country's overall energy supply and demand (Camco Clean Energy (Tanzania) Ltd. 2014). Electricity comes mainly from hydropower, with power cuts common during periods of low rainfall. However, thermal generation capacity is growing, in particular using domestically produced natural gas, which the country began producing in 2006. By 2014, Tanzania's total installed generation capacity was 1,380 MW (both grid and off-grid), including 717 MW of hydropower (52%), 585 MW from natural gas power plants[3] (42.4%), and 78 MW from liquid fossil fuel (distillate) plants (5.6%) (SAPP 2015).

As part of the government's Big Results Now! initiative, launched in 2012, Tanzania set out to more than double energy delivery by 2016;[4] increasing generation capacity to 2,780 MW; reforming the operations of the Tanzania Electric Supply Company Ltd. (TANESCO), the national power utility; phasing out high-cost emergency power plants, and meeting new demand through low-cost solutions. Looking further ahead, to 2025, the Tanzanian Ministry of Energy and Minerals *Electricity Supply Industry Reform Strategy and Roadmap* (2014) aims to increase power generation capacity eightfold over 10 years, to reach 10.8 GW by 2025, and to expand electricity access from the current 24% (7% in rural areas) to 50% in 2025, and 75% in 2033.

Achieving those goals would require adding an average of 765 MW in new capacity each year, so there is much emphasis on involving the private sector. The government's approach calls for the full unbundling of generation, transmission and distribution, with the private sector stepping in as independent power producers and distribution entities. The end goal is that the "generation segment will be lightly regulated for environmental compliance, market control and the protection of consumers", and "customers will be free to choose electricity supply from a large number of retailers", with tariffs set in accordance with the purchasing power of the buyer (Ministry of Energy and Minerals 2014).

Hence, the *Strategy and Roadmap* presents as its Strategic Objective #1 to "Improve environment for private sector investment". Still, attracting investment in the energy sector in a manner that is effective and consistent with national development goals continues to present challenges. For instance, although the plan focuses almost entirely on liberalization and privatization of the power sector, it does note in passing that the Rural Energy Agency "shall continue to play an instrumental role in promoting access to modern energy services" (Ministry of Energy and Minerals 2014), but with no further detail.

It is notable that the mechanisms and reforms that would be needed to ensure the institutional and policy support for expanding electricity access were not seen to be within the scope of the *Strategy and Roadmap*; they have only been addressed through focused and limited projects stimulated by donors (Tanzania Ministry of Energy and Minerals 2013). Similarly, despite the

[3] There are currently seven gas-fired power plants in Tanzania: Songas (2004), Ubungo I (2007), Mtwara (2008), Somanga (2010), Tegeta (2011), Ubungo II (2011) and Kinyerezi I (2015).
[4] See http://www.pdb.go.tz/energy.html.

known role of meso-scale investments in meeting electrification goals, especially in rural areas, the *Strategy and Roadmap* focused on major infrastructure. Meanwhile, a feed-in tariff that Tanzania introduced in 2008 to promote renewable energy generation has been limited to small power producers (100 kW to 10 MW) and has not had much effect in closing the supply-demand gap.

The development of Tanzania's natural gas resources, combined with construction of gas-fired power plants, diversifies the electricity generation mix, making it less vulnerable to drought and ending the need for expensive emergency power plants. Thus, it promises to advance multiple development agendas at once. More than 40% of the planned generation capacity expansion in the *Strategy and Roadmap* involves gas-fired power plants, in tandem with continued development of the country's oil and gas sector. However, attracting the required level of private-sector investment in the gas sector as a whole has proven difficult. As a result, the energy sector remains in crisis, with low water levels causing frequent disruptions in hydropower production, and a persistent gap between supply and growing demand (The Citizen 2015b; ESI Africa 2011).

In the sections that follow, we examine the factors that have hindered private-sector investment in natural gas infrastructure, as well as unresolved questions about how Tanzania will integrate natural gas into its broader development plans.

4.1 The chequered history of natural gas infrastructure in Tanzania

Natural gas fields were discovered off the coast of Songo Songo Island in 1978, and exploratory wells were drilled in 1978 and 1981–1982 (Williams 2009). However, it was not until the 1990s that efforts were made to exploit proven, commercially viable reserves. Part of the World Bank's *Power VI Project* in 1993 aimed to mobilize resources to exploit the Songo Songo and Mnazi Bay gas fields. The subsequent search for investors to develop, construct and operate (a) the gas field at Songo Songo, (b) a pipeline to Dar es Salaam, and (c) generating facilities at the existing Ubungo power plant culminated in proposals for the World Bank-led *Songo Songo Gas Development and Power Generation Project.* The project was large, expensive and complex, eventually costing US$296 million.[5] It also involved the creation of a new independent power producer (IPP), Songas (Johnson 2011; World Bank 2001b).

During the Songo Songo project negotiations, delays arose due to concerns over a second IPP deal into which the government had entered, in May 1995, with Independent Power Tanzania Limited (IPTL). This was a South-South collaboration between Mechmar of Malaysia (holding a 70% share) and VIP Engineering Limited of Tanzania (holding a 30% share). The 100 MW IPTL plant was to use slow-speed diesel generators initially, under the expectation that they would be converted to run on natural gas once the piped gas supply from Songo Songo was ready (Gratwick et al. 2006). Contractual issues, which arose in 1997, led to international arbitration and significant project delays until negotiations were concluded in 2001. IPTL, which came online in 2002, has still not been converted to gas; the gas-fired Songas plant was commissioned in 2004 (Gratwick et al. 2006; Globeleq 2004; Kapama 2016).

[5] The World Bank was the largest investor, providing a US$183 million concessional loan, with additional concessional debt financing of US$41 million coming from the European Investment Bank. Equity financing came from the UK government's Commonwealth Development Corporation and AES Sirroco (U.S.), the main private financier, contributing US$22 million and US$50 million, respectively. The government of Tanzania – through its electricity utility, petroleum development corporation and development finance company – contributed around US$8 million (World Bank 2001a; 2015b)

Given that this was the first attempt to develop natural gas for electricity production, and the contracting arrangements were fraught with difficulty, risk and incomplete information, it is perhaps not surprising that the process was lengthy and delays arose. Tanzania could have learned from this and other countries' experiences to build investor and public confidence and catalyse additional development. However, the problems with IPPs appear to have discouraged further private investment needed to build the natural gas sector.

4.1.1 Corruption scandals

Two major corruption scandals have rocked the power sector and undermined public and investor confidence. During a drought in 2006, the government sought to procure emergency generation to address energy shortfalls. A committee formed by the Ministry of Energy and Mines, which bypassed the official procurement channels, awarded the tender to a company called Richmond (Johnson 2011). The contract called for 100 MW of emergency generation, but by the end of 2006, Richmond had only provided 20 MW, leading to continued load-shedding. By the time the company had installed the full 100 MW, the power problems had been resolved. A special parliamentary investigation eventually uncovered that Richmond had no experience or expertise in the energy sector and should never have been awarded the tender; the Prime Minister and the Minister of Energy and Mines both resigned after being implicated in the scandal (Gratwick et al. 2006; BBC 2008).

In late 2014, IPTL became mired in a scandal as it became public that roughly US$183 million had been withdrawn from a government escrow account and paid to IPTL, which then gave the money to various government ministers. The Housing Minister was dismissed for receiving funds into her personal bank account, and a number of senior officials implicated in the parliamentary investigation opted to resign, including the attorney general and the chairmen of parliamentary committees for budget, legal affairs and governance, and energy and minerals. Development partners chose to withhold roughly US$490 million of general budget support in October 2014, while they awaited the audit report and subsequent government action (Kabendera and Anderson 2014; BBC 2014; The Citizen 2015a).

4.1.2 Negative attitudes towards power sector reform

The scandals are extreme cases, but public and investor confidence in the Tanzanian power sector is relatively low. From the mid-1990s to the mid-2000s, TANESCO was slated for privatization. Development partners withdrew their support for the utility, while a myriad of consultancy reports on how to privatize were prepared. As an interim measure, a South African firm was contracted to improve management in advance of full privatization. Although some progress was made on cost recovery, no investments were made to upgrade or build new infrastructure. In the mid-2000s, the management contract was terminated, and privatization plans were shelved. Ten years without investments had left the utility worse off than before, with the country increasingly reliant on costly emergency power plants as supply failed to diversify or keep up with demand. The public and Parliament were convinced that the notion of an efficient, reliable, competitive, privately run energy sector was unrealistic – the general consensus was that the government could run the sector better (ESI Africa 2013).

4.2 Opportunity and progress

Nevertheless, there is still strong interest in exploiting Tanzania's considerable gas resources. In 2003, Tanzania's reserves were estimated to be 43.1 trillion cubic feet (TCF) of total gas

initially in place, out of which 8 TCF is onshore, and the remaining 35.1 TFC is in the deep sea (Msaky 2013).[6] Assuming 100% gas-fired electricity generation and zero exports, these reserves would provide enough gas to meet domestic electricity demand for the next century.[7] Several production-sharing agreements have been developed for upstream infrastructure investments, but oil and gas exploration, including seismic surveys, drilling and well maintenance, is extremely expensive. Msaky (2013) estimates that the daily rates for on-shore and offshore drilling are more than US$200,000 and US$1.8 million, respectively. These costs are often prohibitive to governments in low-income economies such as Tanzania, so often the major investors are multinational companies. The ones that have been involved in exploration in Tanzania include British Gas, Statoil, the BG Group, and Pan African Energy.

Investments are also being made in power generation infrastructure. TANESCO's 105 MW Kinyerezi I power plant at Ubungo in Dar es Salaam was inaugurated at the end of 2015 and increased the share of gas-fired production from 594 to 699 MW out of roughly 1,600 MW (USAID 2015). The US$125 million plant was constructed by the Norwegian firm Jacobsen and financed by a loan from HSBC Bank, with guarantees from the Norwegian government (ESI Africa 2012).

Since then, construction has begun on the 240 MW Kinyerezi II power plant. Debt financing for the project came from the Development Bank of Southern Africa (DBSA), the Japan Bank for International Cooperation (JBIC) and SMBC Trust Bank, while equity financing is being provided in the form of a grant from the Japan International Cooperation Agency (JICA). The Government of Tanzania also has plans for two additional Kinyerezi plants: Kinyerezi III (300 MW for Phase 1 out of a planned total of 600 MW) will cost an estimated US$ 389.7 million and is planned to be funded through a public-private partnership model, whereby TANESCO and China Power Investment (CPI) will have 60% and 40% equity shares, respectively. Kinyerezi IV (450 MW) will also follow a public-private partnership model, in which TANESCO and Poly Group will have 60% and 40% equity shares, respectively.

The hybrid financing structures for the Kinyerezi I and II power plants – as well as the planned Kinyerezi III power plant – are typical of most ongoing downstream infrastructure projects in Tanzania, where government and private-sector project development and financing come together, often in the form of public-private partnerships.

Connecting the upstream and downstream, in October 2015, a 532 km pipeline from Mnazi Bay in Mtwara to Dar es Salaam was officially opened. The pipeline, which cost US$1.225 billion, funded by the Chinese Export-Import Bank, has the capacity to transport up to 210 million cubic feet of natural gas per day. The gas is being piped directly to TANESCO's Kinyerezi I plant (Xinhua 2015a; Kamagi 2015).

4.2.1 Development aims of use of natural gas

The latest investments are important for the continued development of Tanzania's energy infrastructure. But as the country builds momentum around and confidence in its natural gas sector, it will have to grapple with how to prioritize the use of this resource and align it with

[6] The gas initially in place describes the total volume of gas estimated to be contained in the sub-surface before any production has occurred. This includes gas that has already been discovered and produced and estimates of gas yet to be discovered through future explorations.

[7] Based upon a conversion of 1,000 cubic feet of gas generating 99 kWh, and Tanzania's annual electricity demand rising from 5,000 GWh to 13,000 GWh. (see https://www.eia.gov/tools/faqs/faq.cfm?id=667&t=3).

the country's long-term development objectives, including the high-profile goal of expanding electricity energy access to 75%.

The argument for general development of the gas sector hinges on the belief in its multiple benefits: that it will enhance energy security (by reducing dependence on increasingly vulnerable hydropower), lower electricity costs, bring in foreign revenues, create jobs, power domestic industries, contribute to eradicating energy poverty, and ultimately boost economic growth and help attain developmental goals (Alpha Nuhu 2015). Indeed, there is a huge opportunity to link and synchronize development of the natural gas sector with national development and industrialization plans. But while the government specifically highlights "equitable benefit sharing" as a pillar of its official Natural Gas Policy (Government of Tanzania 2013), what this means in practice is contested.

Not only is it Tanzania's intention to invest in electricity generation to meet domestic needs, but there are also plans to connect 30% of the population to natural gas infrastructure to meet thermal heating needs in the large cities of Tanga, Arusha and Mwanza. Household use of natural gas has a huge potential for replacing charcoal, thereby increasing access to modern energy services, which is currently low, and reducing greenhouse gas emissions from land use change. However, it has not received much attention and it may not be very attractive to private investors, especially compared with the competitive returns that can be gained from investing in the export market.

In the medium term, Tanzania envisions regional development and integration, starting with exports to other East African countries after 2025. As part of the East Africa Community (EAC) Power Master Plan, there is a proposal for the construction of a Natural Gas Pipeline project, to facilitate the delivery of gas to the Tanzanian port of Tanga and to Mombasa, Kenya. A key goal is to supply natural gas as an alternative fuel to a number of thermal power plants located in Mombasa, as well as to industries, commercial institutions and other consumers in Mombasa. The plan also aims to help diversify the region's energy sources in the region and reduce dependence on imported fossil fuels; strengthen the integration process as EAC Partner States share a regionally available energy resource and associated infrastructure; and enable further exploitation of the gas resources in Tanzania for regional development.

But how the benefits of Tanzania's natural gas resources will be distributed is a contentious issue, both in the context of competing domestic and regional uses, and with regard to exports beyond the EAC. Indeed, an "anchor" project in the gas sub-sector is a public-private partnership targeting exports of liquefied natural gas (LNG) to Asian countries where demand is high. With this project, one option would be to sell all the gas in liquefied form on the international market. The second option would be to use a portion of the resource for domestic gas-based industries, and export the rest.

Hence, a tension persists between how and where to use Tanzania's natural gas resources. Resolving these issues will require not only deciding how to allocate the actual gas across domestic, regional and international markets, but also how to distribute of the considerable revenues to be gained from the sale of gas. The World Bank has estimated that those revenues could grow to be a third of Tanzania's fiscal revenues, so the stakes are high (Morisset 2012).

Within Tanzania, meanwhile, different constituencies are demanding a fair share of the proceeds from gas production. In the region of Mtwara, for example, where gas reserves are situated, community members have protested the government's decision to pipe gas to Dar es Salaam for refining and sale without first determining how the benefits from the sale of the gas are going to be shared (Katunzi and Siebert 2015). In general, civil society in Tanzania

has been fairly vocal in raising concerns on how to proceed with development of the gas sector (see, e.g., Civil Society Coalition 2015).

If investments in the Tanzanian gas sector are to genuinely contribute to development, these concerns will need to be addressed. Given the sector's chequered history in Tanzania, and evidence of persistent problems (Makoye and Dawson 2014), wariness remains. As a cautionary example, Fletcher (2014) notes that although Tanzania is one of the world's top gold exporters, the people have scarcely benefited, and the government only collected 7% of the revenue from US$1.5 billion in gold exports in 2010. This highlights the importance of establishing transparency and empowering citizens to participate and hold the government to account (Morisset 2012; Fletcher 2014).

4.2.2 Policy and regulatory environment

The natural gas sector is regulated by the Petroleum Upstream Regulatory Authority (PURA) and Energy and Water Utilities Regulatory Authority (EWURA), both of which fall under the Ministry of Energy and Minerals. The agency's actions are guided by a number of laws and policies. The 2013 Natural Gas Policy makes an explicit link to existing overall national development policies, in particular the long-term plan, Vision 2025. Meanwhile, the Natural Gas Policy focuses on how natural gas is to benefit the population of Tanzania through institutional frameworks, regulatory frameworks and systems that ensure greater public participation. The 2015 Oil and Gas Revenue Management Act legislates how benefits are to be shared, and the government is in the process of developing a Natural Gas Utilization Master Plan.

In addition, a Model Production Sharing Agreement, 2008 (MPSA) between the government, the TPDC and the oil companies, as well as a Model Power Purchase Agreement (PPA), have been developed for seven sub-sectors, including natural gas. Yet there is no agreement between the government and the private sector on the investment framework for oil and gas, which will help to promote, attract and facilitate investment in the sector, and ensure that the exploitation of domestic gas resources contributes to national development. The original 2015 deadline to conclude this framework has been extended to 2019. In the meantime, five major development partners and philanthropic foundations are directly or indirectly supporting the reforms to strengthen the legislative framework for oil and gas.

4.2.3 Capacity development

Beyond the physical infrastructure and the governance architecture needed for natural gas development, Tanzania still needs to close a significant gap in skills and knowledge – both within the oil and gas sector, and within civil society, to be able to ensure accountability (Morisset 2012). Without capacity-building, employment opportunities and long-term competitiveness will be stifled, and the equitable distribution of benefits is unlikely.

In 2014, the government began drafting a local content policy for the oil and gas industry. This policy, which is close to being finalized, seeks to ensure that companies hire and train local staff and develop and procure local supplies and services (Government of Tanzania 2014; Mirondo 2016). In addition, there are several educational initiatives funded by the government, industry and donors. They support petroleum-related courses at higher education institutions, technical and vocational education, as well as the establishment of training institutions. For example, a vocational training centre in Mtwara offers natural gas related technical courses; the University of Dar es Salaam has a new master's programme on natural gas, and the UONGOZI Institute, established with support from Finland, provides leadership

training for the Tanzanian government. However, there are still major skills gaps at both professional and technical levels (NORAD 2013).

Another important consideration is how Tanzania's natural gas ambitions might fit with a low-carbon development pathway. While gas is often seen as a "bridging fuel" (Lin 2016) in the transition to low-carbon energy systems, there is concern that because energy infrastructure is so costly and long-lived, natural gas development will lock countries into carbon-intensive pathways (Unruh 2002). Given this concern, Tanzania may wish to examine the wisdom of focusing its efforts and investments on oil and gas, or whether it take its earnings from existing operations and invest them in clean energy infrastructure. Indeed, Tanzania has considerable solar and wind energy potential that could be tapped for grid-connected and decentralized electricity generation (Hermann et al. 2014). It is likely that a mix would be most appropriate: building local capacity in both oil and gas, and in renewables, with a long-term strategy that invests a substantial amount of gas revenue in development, aiming to create a diversified economy that can thrive even in a future without gas. That is the kind of approach that Dubai and Norway, for instance, have taken with their oil revenue.

5. CASE STUDY 2: ZAMBIA'S ELECTRICITY SECTOR

Erratic rainfall in southern Africa in 2015 led to increasing water shortages across the region (Njanji 2015; Reuters 2015). For Zambia, which relies heavily on hydropower for its electricity needs, the lack of water for electricity generation has resulted in a severe energy crisis. Power generation in Zambia had been fairly stable for years, but low water levels at the country's main hydropower stations – Kariba North Bank, Kafue Gorge and Victoria Falls – led to a power deficit of 1,000 MW and considerable load-shedding, which continued throughout 2016 (Lusaka Times 2016c; Mfula 2016).

While the energy crisis in Zambia is, on its face, a result of the biggest drought in decades, closer analysis reveals a more nuanced picture. The energy crisis is also the result of inadequate planning and power sector development: the electricity generation infrastructure needed to be diversified, but investment has been limited, for both financial and non-financial reasons. From that perspective, the crisis presents an opportunity to build political support for investment in energy infrastructure that is diverse and appropriate to local conditions, and that genuinely contributes to sustainable human development in Zambia.

5.1 The making of an energy crisis

Several factors came together to turn Zambia's drought into a severe energy crisis: lack of diversity in electricity supply; a widening gap between supply and demand; delayed implementation of planned energy infrastructure projects, and limited political will to address structural issues within the energy sector.

5.1.1. Lack of diversity in electricity supply

By 2014, installed hydropower generation capacity was 2,396 MW,[8] providing more than 95% of total generation capacity in Zambia (ERB 2015a); the remaining balance is accounted for by diesel, thermal, solar and heavy fuel oil.

[8] Hydropower: 2,255 MW; thermal: 80 MW; diesel: 11 MW; heavy fuel oil: 50 MW; solar: 0.06 MW (ERB 2015a).

The country's power sector revolves around the Zambia Electricity Supply Corporation Limited (ZESCO), a state-owned, vertically integrated electricity utility which owns about 92% of the total grid-connected installed capacity.[9] ZESCO operates on a single buyer model, where independent power producers (IPPs) sell their electricity to ZESCO for transmission and distribution within the national grid, although in some cases IPPs sell directly to large-scale industrial users, such as a mining company). In 2014, Zambia's three main IPPs – Lunsemfwa Hydropower Company, Copperbelt Energy Corporation, and Ndola Energy Company Ltd. – had an installed capacity of 56 MW, 80 MW and 50 MW, respectively (ERB 2015a). Decentralized electricity generation (off-grid and mini-grid) is currently minimal, but ZESCO owns most of what does exist.

Overall, the sector is governed by the Department of Energy within the Ministry of Energy and Water Development (MEWD). The Rural Electrification Authority, which reports to the MEWD, has the mandate for off- and on-grid rural electrification, although most of its work so far has focused on the latter. The government has also established specific institutions to attract private investments in the energy sector: the Office for the Promotion of Private Power Investors, a unit within the MEWD, was set up in 1999 to attract private investment in hydropower generation (including mini-hydro) and transmission development projects, and the Zambia Development Agency was set up in 2006 with a mandate to attract and facilitate private investment in all priority productive sectors, including energy.

5.1.2 Growing gap between supply and demand

Not only does Zambia's power sector lack diverse means of electricity generation, but generation capacity has failed to keep up with large growth in demand, putting further pressure on the system. Zambia's economy has experienced strong growth in recent years – especially in the tourism, mining, construction and agriculture sectors – with real GDP growth in 2005–2013 of more than 6% per year.[10] Over the past decade, this has resulted in an increase in electricity demand of 3% per year and a growth in peak-time electricity demand of between 150 MW and 200 MW per year (ERB 2014). In 2014, national electricity consumption was estimated at 10,720.5 GWh, with the mining and residential sectors accounting for 54.8% and 30.3% of total consumption, respectively, and other economic sectors collectively accounting for 14.9% (ERB 2015a).

As demand growth has outpaced supply growth, the power sector's situation has become precarious. Thus, when water shortages at the main hydropower stations made it impossible to operate at full capacity, the gap between supply and demand grew to 560 MW in August 2015. By February 2016 it had widened to 1,000 MW (Mfula 2016). Short-term management of this power deficit has been daily load shedding, which is carried out on a rotational basis throughout the day in different areas. According to ZESCO, it affects all customers (Lusaka Times 2015): households, businesses, industries, mines, and the agriculture and livestock sectors. However, in Lusaka, for instance, residential areas appear to be the most affected, being deprived of electricity services for at least eight hours a day and sometimes up to 14 hours. Load shedding also seems to vary between residential areas, as some neighbourhoods never experience load shedding or have it for shorter time spans (Lusaka Times 2016c).

[9] 2,214.05 MW in 2014

[10] According to the World Bank (2015c), in 2014, annual GDP growth was estimated at 5.6%, and GDP per capita at $1,802.

In addition to the gap between demand from existing connected consumers and current supply, there is also widespread suppressed demand from those currently without access to electricity. Of the 15 million people living in Zambia (World Bank 2015c), only 25% have access to electricity; in rural areas, it is only 5% (Ministry of Finance 2014). Given the current supply-demand gap, achieving the government's objective of increasing national electrification rate to 66% by 2030 – moving from 47% to 90% in the urban areas and from 5% to 51% in the rural areas – will be extremely challenging (European Union and the Government of the Republic of Zambia 2014).

5.1.3 Delayed implementation of planned projects

Through ZESCO, the government has drawn on support from development agencies, multilateral development banks and financial institutions[11] to invest in electricity generation, transmission and distribution infrastructure in both urban and rural areas. In 2012–2013, for instance, 260 MW of generation capacity was installed across several projects,[12] and in 2014, the 360 MW Kariba North Bank Extension power station was commissioned. Still, considerable further investments are needed to rehabilitate aging electricity infrastructure and add new capacity – but investment in a longer pipeline of potential projects has been limited.

ZESCO has built up a pipeline of potential generation and transmission projects, but many have never reached the feasibility study stage due to inability to secure adequate financing. Negotiation of financing, particularly for large-scale infrastructure, is a lengthy, resource-intensive process. There are multiple financing mechanisms, each with different processes and requirements. Feasibility studies, which are expensive, may need to be updated as the negotiations drag out over years, and procurement processes may need to be repeated or restarted if they do not yield the most appropriate contractor. Large-scale infrastructure investments are considerably affected by the global financing landscape (Johnson 2011). In addition, there are non-financial or structural – i.e. policy, regulatory and institutional – barriers to attracting public and private investment.

An example of how these issues act as a barrier to securing adequate financing is the 750 MW Kafue Gorge Lower hydropower project, widely considered to be vital and the least-cost option for expanding energy infrastructure in Zambia and the Southern Africa Development Community (SADC) region (Bhattarai et al. 2010; COMESA-EAC-SADC Tripartite Initiative 2013). Kafue Gorge Lower was first studied as a potential hydropower site in the late 1970s, during the development and construction of the Kafue Gorge Upper hydropower station (COMESA-EAC-SADC Tripartite Initiative 2013). The first detailed technical, environmental and economic feasibility studies were carried out in the mid-1990s, but significant shifts in the global financial landscape made investment unlikely. Bilateral and

[11] Power generation and transmission projects in Zambia have generally been funded, co-funded or supported (through concessional loans, grants, credits, guarantees) by development partners such as the World Bank, EXIM Bank of India, African Development Bank, European Investment Bank, French Development Agency, Development Bank of Southern Africa, KfW development bank (Germany), Industrial and Commercial Bank of China, and SIDA. Other partners include the China Development Bank (China- Africa Development Fund), the Japan International Cooperation Agency (JICA), the United Nations Development Programme (UNDP), the U.S. Agency for International Development (USAID), and the Norwegian Agency for International Cooperation (NORAD).

[12] Increased generation capacity was achieved by upgrading the Kafue Gorge Hydro Dam to 990 MW from 900 MW, the Kariba North Bank Dam to 720 MW from 600 MW and bringing the Victoria Falls power station to its full generating capacity of 108 MW, plus the construction of a 50 MW HFO (residual fuel oil) powered plant in Ndola (ERB 2014).

multilateral development partners, confident that the private sector could finance infrastructure more efficiently, increasingly withdrew their own support, but in the aftermath of the Asian financial crisis, private sector appetite for investment in Africa severely dwindled (Johnson 2011).

In the mid-2000s, as international support for infrastructure began to rise again, efforts to secure investors in Kafue Gorge Lower were renewed. In 2005, the government began discussions with Sinohydro, the Chinese state-owned hydropower engineering and construction company (HydroWorld 2006), and in 2007 the government, the International Finance Corporation (IFC), the African Development Bank and Development Bank of South Africa came together to fund a new US$6 million feasibility study, with the expectation that construction would begin three years later (HydroWorld 2008). However, the new study identified technical difficulties with the chosen site, resulting in delays as the project site was shifted (HydroWorld 2013). By 2010, negotiations between the government and the China Development Bank to support a $1.5 billion joint venture between ZESCO and Sinohydro to implement the project seemed to be moving ahead: construction was expected to begin in 2011 and commissioned in 2017 (HydroWorld 2010; World Bank 2015a).

By 2013, however, the financial arrangements were still not finalized and a transaction advisor was sought to help find additional funds on the international capital market (COMESA-EAC-SADC Tripartite Initiative 2013). In the meantime, the government sought to review and update the original environmental and social impact assessments (HydroWorld 2014). By 2015 a transaction advisor was in place, and full financing was secured, enabling construction to begin in November 2015 (Xinhua 2015b); the project is expected to be completed by 2019.

5.1.4 Tariffs, policies and institutional barriers

Policy, regulatory and institutional barriers remain a considerable impediment to attracting investment in electricity infrastructure in Zambia – in particular, the electricity tariff structure. Investors expect reasonable returns, but the average tariff for Zambian consumers is just 5.7 US cents/kWh, one of the lowest in the SADC region, where the average is 7.5 US cents/kWh (SAPP 2015). Zambia's low tariffs reflect a historical dependence on cheap, state-owned hydropower generation, but they are too low to cover the cost of maintaining and repairing infrastructure – much less the cost of further upgrades or expansions. Since its establishment in 1997, Zambia's independent energy regulator, the Energy Regulatory Board (ERB), has tried to gradually raise tariffs to make them reflect costs. A 2006 study by the ERB found that all customer categories were paying less than the cost of producing electricity; to reflect costs, tariffs would have to be raised by an average of 45%,[13] with additional steady increases to recover ZESCO's costs going forward. Over the years, the ERB has made four adjustments that add up to an increase of 100%, but cost-reflective tariffs are still to be attained (see further discussion below).

A second barrier to investment is the lengthy and complex bureaucratic procurement process to establish a private power project. Zambia has set up an Office for Promoting Private Power Investment (OPPPI), but it is still a challenge to obtain the appropriate licenses and negotiate

[13] 147% for residential customers, 46.3% for large industrial users and 28.5% for the mines (ERB, personal communication in 2015).

a power purchase agreement. This is not only an issue in Zambia – in many African countries, negotiations on power purchase agreements can take five to 10 years (Nedelcovych 2016).

5.2 Opportunities to catalyse investment in energy infrastructure

Political commitment is crucial to addressing the barriers to investment in Zambia's power sector. In interviews, stakeholders said the electricity crisis has created a huge opportunity, as it has motivated the government to prioritize renewable energy infrastructure development and diversification of the electricity mix. Added pressure is also coming from the Civil Society Poverty Observatory Group, an alliance of civil society organizations supported by Oxfam that has been advocating for action to address the electricity crisis (Chisanga 2016).

Indeed, at a special meeting on the electricity crisis in August 2015, the government adopted a series of measures to try to catalyse power sector investment and accelerate the completion of new projects. ZESCO was directed to ensure that generation projects under construction were finished on schedule, namely the 120 MW Itehzi-Tehzi hydropower station and the 150 MW Maamba coal-powered station, both of which were commissioned in mid-2016 (ESI Africa 2016; Lusaka Times 2016b). ZESCO was also told to expedite the implementation of many projects that were planned but were not yet being built. In addition, in an effort to diversify the power supply, the MEWD was directed to expedite investments in non-hydro renewable energy sources, such as solar.

5.2.1 Increasing consumer tariffs

As noted above, Zambia's very low electricity tariffs are a major barrier to investment in the power sector. Recognizing the urgency of the problem, at the August 2015 special meeting, the government issued a directive asking ZESCO to apply to ERB for a tariff increase and to migrate to cost-reflective tariffs immediately as a way to expedite power project development and accelerate investments (Mwale 2015). The move was aligned with a decision at the 34th meeting of SADC Energy Ministers in July 2015 that all SADC countries should have cost-reflective electricity tariffs by the end of 2019.[14] At the same time, the consumption range eligible for the R1 or "lifeline" tariff for low-income households was to be extended from 0–100 to 0–500 kWh per month, and the existing R1 tariff of ZMW 0.15/kWh (roughly US$ 0.02/kWh) would remain (Chongo 2015).

In December 2015, the ERB extended the lifeline tariff consumption range to 0–300 kWh per month and increased the average residential tariff from 6 to about 10.35 cents per kWh (ERB 2015b). Tariffs also rose for commercial and industrial customers and bulk supply users, such as mines. However, after a public outcry, in January 2016, President Edgar Lungu reversed the hike for residential, commercial and industrial customers (Lusaka Times 2016a; Cohen and Hill 2016), though more gradual increases may still be considered.

The rate hike reversal highlights a key challenge in raising electricity tariffs in Zambia: that the burden of increases falls mainly on residential consumers, as mining companies, the other major user group, typically have long-term contracts (typically 15–20 years) with fixed tariffs. The government has been trying for years to negotiate tariff increases with mining companies, but although the talks have been constructive, they have yet to result in cost-reflective tariffs.

[14] See press release: https://www.sadc.int/files/5714/3809/4355/34th_Meeting_of_SADC_Energy_Ministers.pdf.

The mandates from August 2015 did try to address non-residential tariffs and factors affecting power costs, through several measures:

- Reviewing bulk supply agreements between ZESCO and bulk consumers to allow for periodic adjustment of electricity tariffs, as with residential and other customers;
- Requiring all new industrial and mining customers to pay cost-reflective tariffs based on electricity from new generation plants;
- Providing government guarantees on behalf of ZESCO to underlay power purchase agreements with independent power producers until tariffs are cost-reflective;
- Requiring approval by the ERB for all power purchase agreements.

5.2.2 Adopting feed-in tariffs for renewable energy producers

USAID, through the Southern Africa Trade Hub, assisted the Department of Energy at MEWD to develop a renewable energy feed-in tariff policy, finalized in April 2015, aimed at attracting private investment in the renewable energy sector. The Trade Hub also supported the ERB by designing a pricing and regulatory framework based on the new policy, particularly for small-scale renewable energy projects.

Zambia has also worked with the KfW development bank's Global Energy Transfer Feed-in Tariff (GET FiT) programme, which was originally launched in Uganda. In Zambia, GET FiT aims to help overcome investment barriers for private developers of small-scale renewable energy projects (up to 20 MW each), with an overall goal of 200 MW of new capacity.[15] In addition, feasibility studies are being prepared for projects in Zambia under the Africa Renewable Energy Initiative,[16] which aims to add 10 GW of renewable power by 2020.

Furthermore, in 2015 President Lungu directed the Industrial Development Corporation of Zambia (IDC Zambia) to develop at least 600 MW of solar power in the shortest possible time to address the current power crisis (IFC 2015). As a result, the IFC, a member of the World Bank Group, signed a memorandum of understanding with IDC Zambia in July 2015 to explore development of two 50 MW solar PV independent power projects through the World Bank's Scaling Solar programme.

In mid-2016, the first bids were awarded to a partnership between First Solar from the U.S. and Neoen from France for 45 MW, and Enel Green Power for 28 MW (PV Magazine 2016). These would be Zambia's first utility-scale PV projects, providing competitively priced, clean power. IDC Zambia anticipates that the projects will create an opportunity for subsequent expansion and rapid scale-up of renewable energy generating capacity in Zambia (IFC 2015).

5.2.3 Exploring off-grid options

Until recently, most investments in renewable energy infrastructure have been directed to on-grid hydropower infrastructure (power plants, transmission lines), with little focus on household and meso-scale off-grid renewable energy projects. Smaller-scale renewable energy projects, mainly in rural areas, have generally not been seen as commercially viable by project developers due to the low tariffs and the complex process of implementation. Still, a number of off-grids projects are planned or have been implemented, mainly by Zambia's Rural Electrification Authority (REA), as part of the Rural Electrification Master Plan.[17]

[15] See http://www.getfit-reports.com/2015/risk-management/status-of-get-fit-roll-out/.
[16] See http://www.arei.org.
[17] See http://www.rea.org.zm/index.php/2013-08-24-13-50-58/remp.

In 2005, aiming to demonstrate, on a commercial scale, the technical and financial viability of renewable energy-based mini-grids for rural electrification in Zambia, the UN Industrial Development Organization (UNIDO) partnered with REA, ZESCO, the United Nations Environment Programme (UNEP), the Global Environmental Facility (GEF) and the Development Bank of Zambia to develop a 60 kW solar mini-grid in Mpanta, a 1 MW mini-hydro plant at Shiwang'andu and a 1 MW biomass gasifier in Kitwe.

In 2013, the Mpanta Solar Mini Grid Project in Samfya District, Luapula Province, was commissioned, Zambia's first commercial-scale solar project. The mini-grid supplies power to a cluster of fishing villages with about 2,700 residents on the shores of Lake Bangweulu. It is operated by a local cooperative – with considerable support from REA – and can provide about 173 kWh per day and benefit nearly 500 customers (ERB 2014). However, there continue to be significant challenges in maintaining financial and operational sustainability, with REA unable to fully withdraw from the project for fear that it would collapse (Grøn and Chisonga 2014).

Building on the lessons learned from this project, REA is also developing two community-operated solar mini-grids: the 300 kW Lunga Solar Mini Grid Project in Lunga District, Luapula Province, and the 200 kW Chunga Solar Mini Grid Project in Mumbwa District, Central Province. These are expected to come online in 2017, supplying power to district offices and households in Lunga and government wildlife offices and the local community at Chunga Camp in Kafue National Park. Meanwhile, Copperbelt Energy Corporation Plc (CEC) is developing a 20 MW solar plant in the Copperbelt Province, slated to go online in 2018.[18]

The UNIDO-supported Shiwang'andu hydropower mini-grid in Chinsali District in Muchinga Province was commissioned in December 2012, providing electricity to local households, schools and hospitals. Unlike the Mpanta mini-grid, the Shiwang'andu mini-grid has not suffered from significant financial and operational challenges, largely because it is operated and maintained by ZESCO, which has significant financial and institutional capacity to manage such a project (Grøn and Chisonga 2014). The Rural Electrification Master Plan identified about 29 potential mini-hydro sites, mainly in Northern and Luapula provinces (a total of 4 MW) and North-Western provinces (13 MW). A number of feasibility studies have been undertaken in selected mini-hydro potential sites, and the planned small hydro capacity (<30 MW) up to 2019 is about 45 MW (Singh et al. 2013). For example, REA has undertaken a feasibility study and detailed engineering design for a 3.5 MW off-grid hydropower generation plant at Chikata Falls in Kabompo, in North-Western Province.

REA has also started work on a 590 KW power generation plant at Kasanjiku Falls in Mwinilunga district, in North-Western Province, with feasibility study and power station design completed in 2013 (Ingram 2015). At the same time, several additional off-grid hydropower projects are being planned by private-sector developers, including Chavuma (15 MW), West Lunga (3 MW), and Chitokoloki Mission (0.15 MW). As of 2014, ZESCO also has hydropower mini-grids with a total capacity of about 24.75 MW. It should be noted that ZESCO has a number of diesel power mini-grids as well, to serve isolated rural areas, with a total capacity of 11.3 MW (ERB 2015a).

The UNIDO-supported biomass gasification plant in Kitwe in Copperbelt Province has yet to be built. ZESCO, the original developer, pulled out of the project in 2011 and was replaced by the CopperBelt Energy Company (Grøn and Chisonga 2014). In 2012, a feasibility study

[18] See https://cecinvestor.com/solar-development-2/.

showed that there was sufficient biomass – waste timber and sawdust from the saw mills in the Copperbelt Province – to fuel a 7 MW power plant.

Most recently, in early 2016, the Swedish International Development Cooperation Agency (Sida) launched the Beyond the Grid Fund for Zambia.[19] It aims to provide one million Zambians with access to clean electricity and accelerate private-sector growth in off-grid electricity generation and distribution. The €20 million fund will operate from 2016 through 2018, and is currently assessing the first round of proposals.

6. TENSIONS IN ENERGY-SECTOR DEVELOPMENT IN TANZANIA AND ZAMBIA

Infrastructure development in both Tanzania and Zambia has been marked by slow progress and constant struggle. Both countries, like so many in Africa, have found it difficult to attract private investment in a manner that contributes meaningfully to meeting development and poverty reduction goals. Inadequate institutional arrangements and lack of skilled staff have also undermined efforts. Often crises have been the greatest catalysts of positive change. In the sections that follow, we apply the guiding principles discussed in Section 2 to summarize the tensions that have arisen in the development of energy infrastructure in each country; the analysis is summarized in Table 3 at the end of this section.

6.1 Balancing liberalization and the right to regulate

Tension between calls for liberalization – to open up previously state-owned infrastructure monopolies to competitive private-sector participation – and the desire to maintain sovereign control over key economic and social assets/resources is a longstanding issue in sub-Saharan Africa. Overall, both the Tanzanian and Zambian governments increasingly see a need to engage the private sector in energy infrastructure development, to boost investment, improve efficiency, and overcome energy crises. But achieving this in practice is not easy, and both countries have faced difficulty in guiding private investment towards development objectives, such as energy access and poverty reduction.

In Tanzania, finding the appropriate balance between liberalization and institutions of effective regulation and accountability and control in the energy sector – and other sectors, such as water – has been particularly difficult. The country's chequered history with private-sector engagement in the power sector – and questions about ongoing efforts as well – have contributed to scepticism among the public and in Parliament about relinquishing control of such important economic and social assets. Zambia has also had mixed experiences with liberalization in infrastructure, particularly the energy sector. Attempts to attract private investment have faced serious delays, particularly due to the politicized tariff-setting process (as evidenced by the President's reversal of the 2015 hikes).

At the same time, the recent energy crises in both countries have opened up a policy window for more liberalization, as citizens are losing faith in the public sector's ability to deliver services. Importantly, Tanzania has an experienced regulator in place, and several production-sharing agreements have been developed for infrastructure investments upstream. Meanwhile, in downstream gas-fired power generation, public-private partnerships have been established between the electricity utility and two private companies. While in Zambia, there are ongoing attempts to diversify the generation mix – by incentivizing renewables – and broaden service

[19] See https://www.reeep.org/bgfz.

delivery models – for instance, through mini-grids. Thus, there is hope that an energy system less vulnerable to changing rain patterns can be established.

6.2 Balancing attractive risk-return rates and accessible and affordable services

Attracting private-sector investment requires offering opportunities for attractive returns on investment, with manageable risks. At the same time, the services provided by new energy infrastructure must be accessible and affordable if they are to drive growth and development. The public sector also cannot assume all the risks, or else it would discourage investors from undertaking due diligence and making a good-faith effort to address risks.

In Tanzania, the power sector has taken priority for the use of natural gas produced in the country, as that provided the best financial returns. However, in recent years, Mtwara region, where the gas reserves are situated, community members have protested the government's decision to pipe gas to Dar es Salaam for refining and sale without having a concrete plan on how the benefits from the sale of the gas will be shared locally. Some developers have already planned and implemented community projects in the water and power sectors. Ultimately, success is likely to depend on having processes in place for democratic engagement of civil society, and systems of transparency and accountability to maintain public confidence that benefits are being equitably shared.

The Zambia case clearly highlights the challenges of balancing attractive risk-return rates (or even being able to cover costs) and keeping services accessible and affordable. Electricity tariffs continue to be a major sticking point in Zambia. The August 2015 directive to raise tariffs to reflect costs, while keeping the lifeline tariff low and expanding its coverage, was an attempt to balance the need to attract investment with a desire to protect low-income households. In the end, the directive was reversed after protests from domestic consumers, highlighting the political nature of tariff-setting and the importance of public outreach and engagement before a major change. Meanwhile, Zambia's feed-in tariff for renewables is viewed as key lever to attain cost reflective tariffs and attract private investment in renewable energy, although it only focuses on small-scale renewable energy projects (<20 MW).

6.3 Balancing a push for private investment with a push for public investment

Sub-Saharan Africa needs very large amounts of investment in energy infrastructure, both to expand capacity and access to modern energy services, and to repair and upgrade existing infrastructure. In this context, the question is, how much of that investment can (or should) come from the private sector? Historically, infrastructure has been financed by the public sector – through bilateral and multilateral development assistance, and through development banks. As noted in Section 5.1, for several years, international development funders backed away from large-scale infrastructure projects, deeming them to be best suited to the private sector; in Zambia and Tanzania that contributed to decade-long delays to investment in major energy infrastructure projects. Now a more balanced view prevails, in which public investment is again seen as crucial, but it is also meant to leverage, catalyse and guide greater private investment in sustainable infrastructure and human development.

In general, Tanzania and Zambia both continue to rely on traditional bilateral and multilateral development partners (e.g. European development agencies, USAID, the World Bank) and traditional modes of financing (grants, concessional loans and government guarantees) for infrastructure project. Overall, it remains difficult to attract private investment, given the fairly low rates of return and high political risk.

There is also growing Chinese government and private investment in energy infrastructure in both countries, a new and different option. Like most internationally financed development projects, the majority of Chinese-built power projects in Africa are financed by sovereign loans guaranteed by recipient governments (IEA 2016). The key difference is that there are shorter timescales for project preparation and financial closure (Kapika and Eberhard 2013). Chinese government-backed investments also seem to lack the stringent environmental and social impact requirements that are typical of other public-sector funders. As China has become a major trade partner and source of foreign direct investment in Africa, with a particularly strong presence in mining (Romei 2015), many in the West have raised concerns about exploitation or neo-colonialism. However, as the Zambian-born economist Dambisa Moyo (2012) has noted, most Africans see China's presence as beneficial to their countries; where abuses do occur, Moyo argues, they are due to government corruption or ineptitude. The Chinese government and Chinese companies also appear to be making efforts to improve the environmental impact of their investments and operations (Shinn 2015).

The Tanzania case study highlights another aspect of the balancing act between private and public investment. Nearly 80% of the country's natural gas reserves are offshore, in deep-sea fields that are very costly to explore and exploit. Only the private sector has enough money to do this. Yet many, if not most, of current infrastructure projects are financed either solely through public funds, or through a blending arrangement with significant public-sector guarantees, equity and/or loans. The private sector may be reluctant to invest in such a high-risk market until projects are operational and cash flows are more certain – or else, backed by strong government guarantees. This is particularly the case now, given how low oil prices have been recently. The potential for profit is further diminished by the Tanzanian government's desire to use the gas for domestic consumption, where the returns are likely to be lower than if the gas were exported. If exporting the gas is the most viable path forward, the Tanzanian public would probably be more amenable if it was clear that the country would obtain a fair share of the revenues, and that those revenues would be being put toward broad-based and equitable development. Again, accountability, transparency and democratic engagement are critical, as well as trustworthy institutions of governance.

In Zambia, effort to attract private investment have had limited impact so far. Poor long-term planning, failed negotiations and weak implementation of tariff restructuring and business permit processing – despite setting up of the Office for Promoting Private Power Investment – has left Zambia with few privately funded energy infrastructure projects. However, the inclusion of Zambia in the U.S. government's Power Africa initiative, Sida's new fund to catalyse private investment in off-grid electrification, and the IFC's commitment to pilot grid-connected solar power all present exciting opportunities for Zambia to use public funds to attract private investment.

6.4 Balancing SDGs' global scope with local needs

In both Tanzania and Zambia, there is a need to build local capacity to work in and to regulate the energy sector, particularly in newer areas such as natural gas (in Tanzania) and renewables (in Zambia). The capacities needed include finance, project management, operation and maintenance, legal services and beyond.

In Tanzania, there is a need to sustain and grow ongoing capacity-building processes involving higher education and technical and vocational training. The initiative to establish a vocational training centre in Mtwara offering natural gas technical courses is a particularly welcome development. Tanzania is also grappling with the local social impacts of gas exploitation. It is important to ensure that training leads to employment opportunities for local people in gas

production areas, and that local benefits are realized from exploiting these local resources. For Tanzania, whose greenhouse gas emissions are still very low, exploiting natural gas resources for electricity production and export may be an appropriate course of action to meet development needs. However, Tanzania also needs to invest in renewable energy and build local capacities in that sector. Otherwise, like many other African countries before it, Tanzania could find itself locked into a carbon-intensive economy even as the world increasingly moves to decarbonize energy systems. Meanwhile, Zambia's plans for introducing smaller-scale renewables and mini-grids require much more attention to technical, business and community engagement skills to ensure privately-financed projects are appropriately designed.

Table 3 below provides a summary of our analysis.

Table 3: Tensions and opportunities around energy infrastructure development in Tanzania and Zambia

	Tanzania's natural gas sector	**Zambia's grid-based power sector**
Balancing liberalization and right to regulate	Struggling to learn from the negative experiences with reform and privatization Strong regulator and good regulations in some areas Transparency remains a critical challenge	Energy crisis highlights the limited generation capacity and ownership in the country Crisis opens up a policy window for more effective regulation and planning to attract private investment
Balancing risk, accessibility and affordability	Benefit-sharing Act clarifies balance in principle, still to be consistently implemented Efforts to ensure corporate social responsibility are under way Many development options, differ in attractiveness	Tariff-setting still dominated by politics. Ex ante engagement needed to increase public acceptance Feed-in tariff policy attractive to investors, especially when seeking to diversify generation
Balancing public and private investment	No investment framework and difficult to attract private investment Increased Chinese investment offering additional source finance for infrastructure Infrastructure still dominated by development partners and traditional financing mechanisms	Office for Promoting Private Power Investment established, but unattractive business environment continues to limit private investment Growing Chinese investment offers alternative finance for infrastructure Infrastructure remains dominated by development partners and traditional financing mechanisms Expansion of donor-supported programmes to catalyse private investment in on- and off-grid renewables
Balancing global and local needs	Capacity constraints remain a challenge, both among commercial and civil society actors Many development opportunities (gas exports, electricity exports local electricity consumption, local cooking fuel, employment, etc.) but priorities not always clear	Many initiatives to improve energy access in rural areas Capacity constraints remain a challenge

7. CONCLUSIONS

If the development benefits of infrastructure are to be realized, then engagement of the private sector will require much more than simply liberalization. As experience in Tanzania has shown, opening up to private-sector participation can lead to long-lasting negative public perceptions if effective institutions to govern relations between the private and public sector are not put in place.

For significant employment benefits to be realized, domestic capacity in the commercial sector needs to be actively cultivated; for example, in Tanzania's natural gas sector, training and capacity development programmes are required if the sector is to avoid being dominated by foreign experts. At the same time, capabilities must also be developed in other areas of the energy sector, to ensure competence in and development of a diverse range of energy resources. Meanwhile, for Zambia to take advantage of decentralized energy opportunities, it needs to invest in building local capabilities in this area.

In both countries, it is important to establish powerful institutions of democracy that can hold state authorities and decision-makers accountable to a clearly articulated vision of shared national development goals. For instance, parliamentary investigations into corruption in Tanzania's energy sector have done much to restore public confidence in development of the sector. In Tanzania and Zambia alike, conditions set by traditional development partners have helped ensure many infrastructure projects are governed by norms of good corporate citizenship. As the sources of investment diversify, governments must ensure that such norms are upheld even if a development partner is not setting them.

It is also critical to keep building an actively engaged civil society. The public in each country is far from complacent, with civil society groups engaged in debates on gas development in Tanzania and in the electricity crisis in Zambia. However, their concerns and priorities could be more effectively channelled if there is a range of engaged civil society actors (e.g. trade unions, research institutes, watchdog organizations, community development groups), along with the rules and norms (legal standing, freedom of information laws, whistle-blower protections, free press, etc.) that can empower them to participate and ensure accountability.

Even if the ultimate goals of energy infrastructure development are easily stated in universal terms – such as ending energy poverty, creating broad-based employment, and protecting the climate – it is critical to be cognizant of local social context and remain answerable to local priorities. Countries have distinct ways of balancing urban and rural needs: they have unique cultural perspectives and political approaches and different levels of commitment to different economic sectors and the livelihoods within them. These differences must be not be neglected.

We end with cautious optimism. Both Tanzania and Zambia now have two decades' worth of experience with infrastructure reform – particularly in the energy and natural gas sectors. This experience is valuable as they continue to negotiate future development pathways. In addition, there is a wealth of knowledge across Africa and beyond that can provide helpful lessons on pitfalls to avoid and processes worth emulating and adapting. Indeed, comparative analysis across varied experiences of sustainable infrastructure development across the continent would be a fruitful avenue for future research.

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