Working Paper

Rwanda's Electricity Boom and the Danger of Too Much Power

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Executive Summary

- Electricity is a vital ingredient for modern societies, underpinning basic services, the economy and many recreational activities
- The electricity sector, and increasingly energy generation, is becoming a focus of international development (e.g. Sustainable Development Goal 7 and the African Union's Programme for Infrastructure Development, updated in the recent ambitious Agenda 63)
- In sub-Saharan Africa, the majority of governments have launched ambitious strategies to significantly increase their national installed power capacity.
- However, booms in electricity generation can be "too much of a good thing" as they can harm economic progress.
- This is especially true when governments decide to increase generation through private sector engagement because this often entails:
    - Building too many generation plants - but having to pay for the power they make available
    - Taking on too much public risk to entice private sector companies
    - Choosing technologies which do not meet the power grid's demands
- Ironically, for the continent with the worst electricity access in the world, overcapacity is a significant danger in Africa's electricity boom
- Rwanda is a striking example of this problem. It's capacity grew from 40MW in 2003 to over 200MW today, involving the completion of 43 plants in 16 years, with an additional 13 underway.
- The result will be an installed capacity of 570MW by 2026. In contrast (over-)optimistic forecasts suggest a maximum on-grid demand of 309MW by 2026. This is particularly problematic as it includes over 400MW of 'take-or-pay' contracts.
- This expansion will be costly. Rwanda already has one of Africa's highest customer tariffs and most expensive system costs. In 2017/18, the government had to pay the equivalent of 1.4% of national GDP to plug the fiscal gap, and the World Bank predicts that this may have already reached 4% in 2020/21, before all Power Purchase Agreements come online.

Policy Conclusions

For Donors:

- Support rigorous demand forecasting
- Exercise more caution about advocating and instigating private-solutions for the electricity sector. Include careful consideration of the risks and subsidies that African governments can bear.
- Increase support for scrutiny of electricity plans, especially by civil society

For Governments in Africa:

- Listen to internal critical voices within the civil service and government, as well as frank, external advice. These play a key role in improving and sense-checking policy.
- Ensure that civil servants are able to incorporate their knowledge and external expertise into policymaking and advice
- Exercise more caution about turning to private-sector solutions for the electricity sector. This includes appreciating the risks of take-or-pay power projects and careful consideration of how much subsidy to provide.

Introduction

Over the last decade, Rwanda has undergone a large increase in electricity generation. Official statistics suggest that the country will reach an installed capacity of 313MW by the end of this year, up by almost 750% from the level of the mid-2000s.[1] This surge entailed completing 43 projects since 2004, with 13 still under construction. Achieving this rate of increase, even from a low base, is remarkable for a land-locked, economically-poor nation still recovering from the horrors of the genocide. Equally impressive are the range of technologies Rwanda has chosen to develop. Hydropower remains dominant, but the government has diversified to almost all the available indigenous energy sources including rarer peat and globally-novel methane gas dissolved in Lake Kivu. In the latter two cases the government supported pilot plants to prove the concept, before contracting private companies to build larger plants. Given Rwanda's low starting base and rapid economic growth, a significant increase in installed megawatts was needed. However, Rwanda's dramatic increase in capacity, far from proving a boon for development, could derail progress.

This Rwandan case is instructive for developing countries in Africa and beyond. It demonstrates that amidst increasing global attention on universal energy access and boosting generation, awareness of the dangers of overcapacity and private sector participation in power plants is needed.

Cover Photo:
Nyabarongo Dam, Muhanga District, Southern Province, Rwanda © Dr Barnaby Joseph Dye

[1] Starting from 41.95MW to 313.57MW by the end of 2020 represents a 747% increase

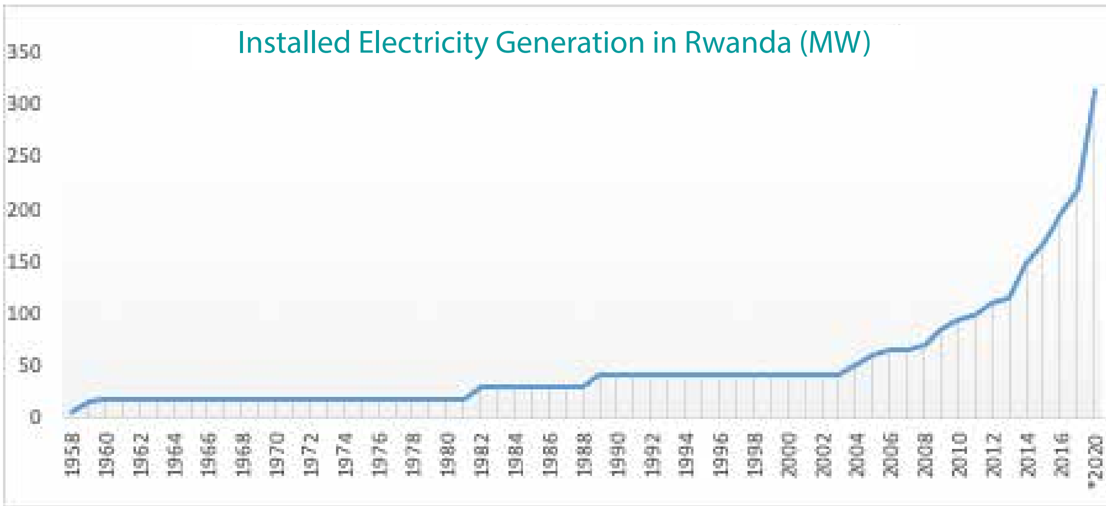


Figure 1: Rwanda's remarkable recent megawatt surge

2 Why Is Rwanda's Energy Boom a Problem?

2.1 Over-capacity

The principle oversight in Rwanda's energy boom are overestimates of the power-system's demand. As shown in Figure 2, the agreements signed by the government and the projects under construction will take the country to around 570MW by 2026. However, forecasts have long predicted electricity demand of roughly half of that figure. A recent analysis found that, for 2020, peak demand would be between 162MW and 187MW whilst for 2026 a high growth scenario (10% increase in demand per year) would still only reach 309MW, still more than 250MW short of installed capacity.[2] These estimates were already over-optimistic given Rwanda's historic growth - the on-going corona virus pandemic suggests that demand is likely to rise even less steeply.

This situation is worsened by the daily profile of electricity consumption in Rwanda. The country has a pronounced evening peak in electricity use given the overwhelming majority of electricity use is from residential customers and businesses such as hotels. This means that for the majority of the day, the demand on the grid is typically a third lower than the evening peak demand.

A significant gap will therefore exist between peak demand and electricity supply and an even larger gap will be present for most of the day.

2.2 Debt

Oversupply can cause two types of debt problem. The first relates to power plants financed through the government raising money on international markets or receiving subsidised development bank loans. Normally, the assumption is that these loans will

[2] Rwanda Energy Group (REG) 2019, 11

be paid off as more electricity generation supports more economic growth, which increases tax revenue. Non-performing electricity plants would not create this positive cycle, and therefore not directly provide government with the additional revenue to pay off such loans.

The second issue stems from finance agreements with the private sector. Here, the government does not take on debt directly but rather signs an agreement with a private firm who themselves raise money, construct and own the plant. Such contracts are risky as they include an obligation to pay for the electricity produced. To ensure the investor can make a return, the electricity utility buying the energy normally signs a Power Purchase Agreement (PPA) with a 'take-or-pay' clause. This ties the utility to paying the investor for typically 90% of the power they make available, regardless of whether it is used or not. In addition, to attract private companies to build plants, governments typically need to further reduce investors' risk. This can include, paying investors in an international currency and providing subsidies such as basic infrastructure (roads, grid connections etc.) and tax exemptions. In some countries, deals have even been known to guarantee investors' returns, although this has not occurred in Rwanda.

> Deals with the private sector to produce generation have tended to involve government's taking on significant risk of guaranteeing payment and providing subsidies.

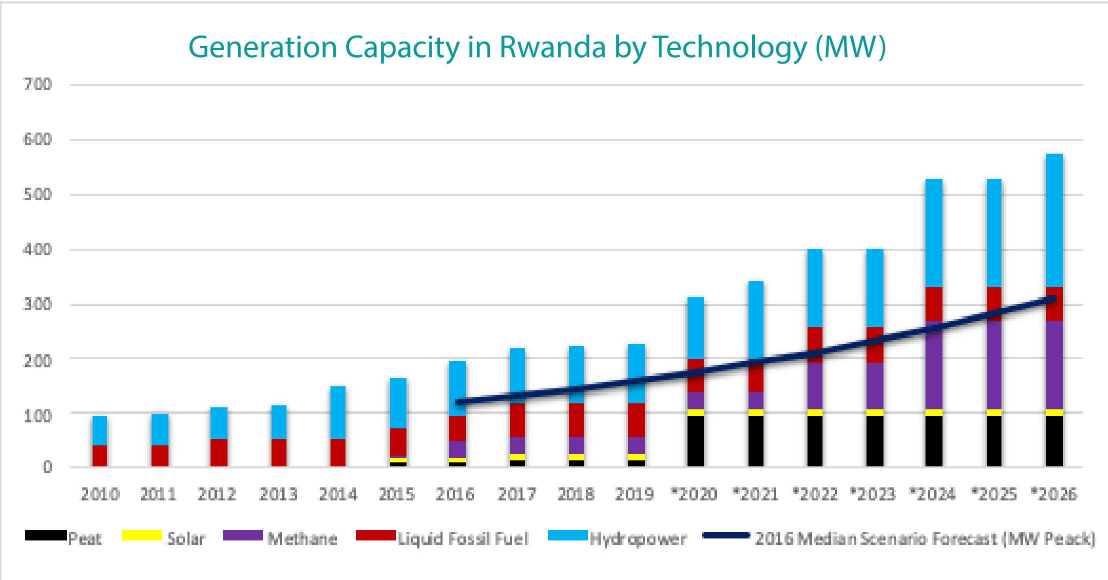
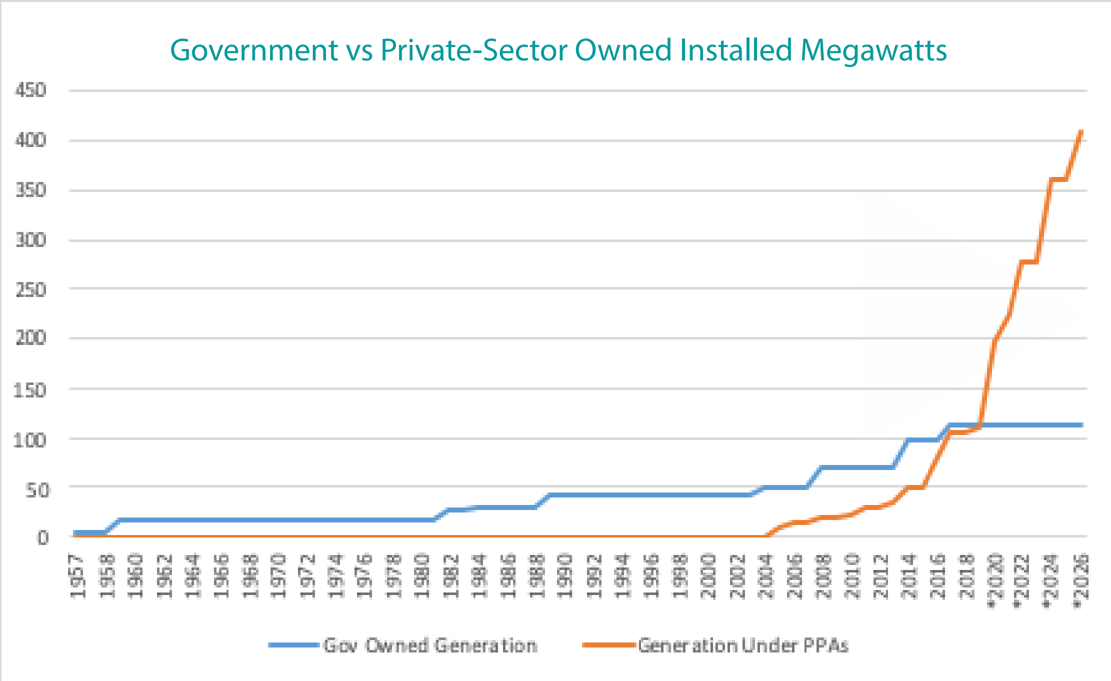


Figure 2: has not got a title note?????????????

2.3 Oversupply and Private Sector Power Purchase Agreements in Rwanda

Rwanda contracted the majority of its new plants through the Power Purchase Agreement (PPA) method. As Figure 3 shows, in 2019 both the government and private investors owned about 110MW of generation capacity each. However, once those .

projects currently under-implementation are commissioned, private sector PPAs will account for four times the generation capacity of government plants Given the forecast for limited future power demand, these PPA payment obligations are likely to push Rwanda's state energy utility into significant debt.[3]



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3, 154, 157

Figure 3: Depicting the increase in private-sector power plant ownership

2.4 De-risking measures

Additionally, the government provided a raft of de-risking measures to encourage private investors, pricing its PPA deals in US dollars, building roads and grid connections to each new power plant site and agreeing relatively generous tariffs.[4] Generous PPA deals in excess of US$20 cents per kWh (kilowatt hour)[5] have translated into continuing expensive electricity for customers; Rwanda ranks amongst the highest electricity tariffs at US$0.21 per kWh in 2018 compared to the sub-Saharan African median of US$0.15[6] in 2017 and has long been the highest in the region.[7] This is particularly problematic for Rwanda's comparative attractiveness to transnational companies, especially export industry, which tends to require rates of under US$7 cents per kWh to be able to sell to international markets and compete in global value chains. Additionally, it is a problem for selling Rwanda's power to regional neighbours on the emerging Eastern African Power Pool. In theory, Rwanda could sell its surplus power to neighbouring countries, but Figure 4 shows that doing so would be unprofitable.

Another cost pressure has come from the pricing of PPAs in US Dollars. To increase investor certainty, the Rwandan government priced its PPAs in US dollars rather than Rwandan Francs. This has proved costly with the continual appreciation of the dollar to the franc, further ramping-up 'real' prices of electricity and requiring government subsidy.[8]

[3] Dye 2020
[4] Chemouni and Dye 2020
[5] This is especially true for the micro-hydro projects
[6] World Bank 2017
[7] Rwanda is long ranked number 1 or 2 in comparative tariff surveys Economic Consulting Associates 2010; Chemouni and Dye 2020
[8] Chemouni and Dye 2020

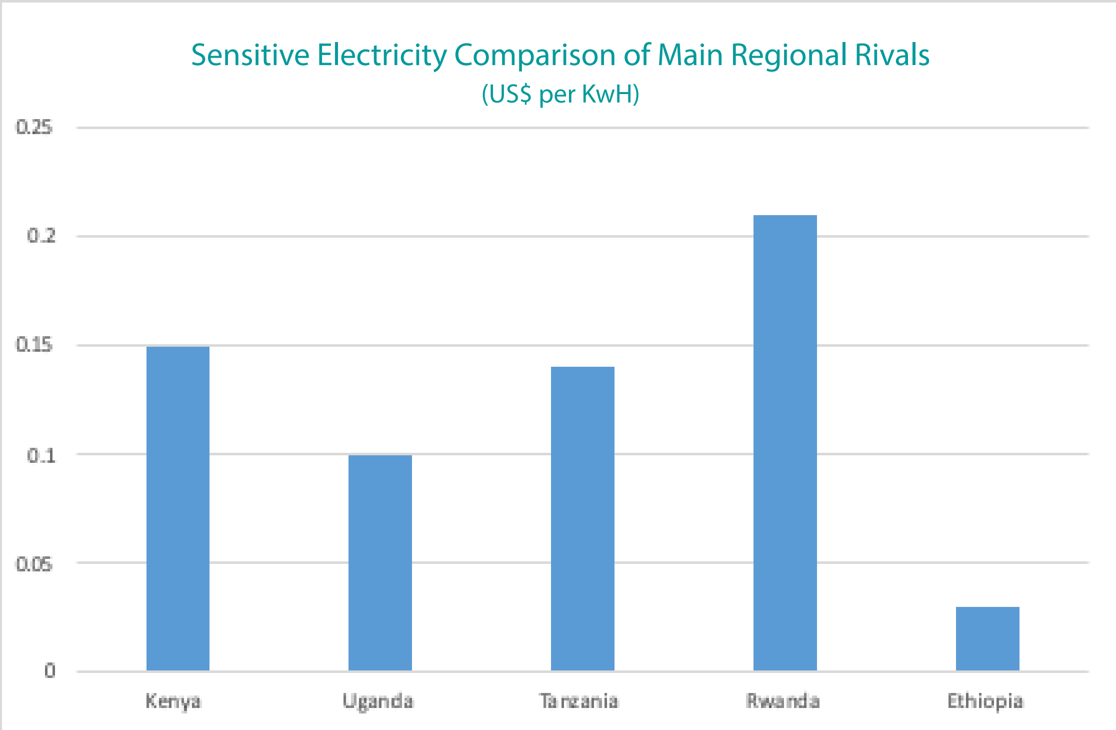

Figure 4: Complied by the author from official statistics and Muchira 2018

2.5 The cost of Rwanda's approach

Already, by 2016, Rwanda was in the African top 10 for the costs of servicing its electricity system and for the gap between the cost and revenue per unit of electricity.[9] The World Bank predicted this gap would grow from US$0.12 per kWh in 2017 to over US$0.30 by 2020. To date, the government has stepped in to finance the utility's debts, costing 1.4% of Rwanda's GDP in the year 2017/18. However, this has already risen, with the World Bank predicting that by 2020/2021, a business-as-usual scenario would see this subsidy equal 4% of GDP.

> Rwanda's use of PPAs, and their attempts to de-risk the sector for electricity investors, has worsened the sector's financial stability

The government has reacted to the risk of over-supply and high tariffs. In 2013, a 1000MW target was reduced to the more technocratic-sounding figure of 563MW, but this also not based on realistic demand forecasts.[10] Further steps were taken in 2016 when the government introduced measures to halt further power-plant deals, stop some incentives and delay projects. A final acknowledgement came in 2018 and 2019 with more rigorously produced revised demand forecasts. However, these measures have come too late to stop overcapacity without breaking existing contracts which would create significant financial penalties and potential reputation damage for future private-sector agreements.

[9] Kojima and Trimble 2016
[10] hRather the forecasts were significantly massaged to produce a 'political' figure. Dye 2020

2.6 Hydropower

One area that remains overlooked is Rwanda's reliance on hydropower. As figure 2 shows, hydropower was the country's sole technology for power generation for most of its history, and remains the major contributor today. This reliance has continued for three reasons: its abundance; its status as an established technology; and the fact that some plants, like Nyabarongo I Dam, are Rwanda's cheapest power source.

On the other hand, the government has overlooked the sectoral and socio-environmental risks of the technology. The most obvious of these is the displacement caused by large dams like Nyabarongo I, Rusumo Falls and the upcoming Nyabarongo II, given the high population density in Rwanda. Other issues are made worse by the concentration of hydropower plants in the Nyabarongo River Basin- a sub catchment of the Nile. For example, hydropower plants alter river flow according to electricity needs. This changes river hydrology from the conditions to which ecosystems and farming are adapted. Dams also trap fertile sediment that would otherwise support floodplain farming and habitats. This sediment trapping is particularly pronounced in Rwanda given its rivers' high sediment load. Sediment accumulation also reduces the storage capacity of hydropower reservoirs like Nyabarongo and damaged the first round of micro-hydro plants in the country. Relying heavily on hydropower reliance also creates vulnerability to drought. Historically, rainfall shortages have affected Rwanda significantly, causing seasonal, often severe, blackouts. Choosing to build so many hydropower plants therefore comes with risks and downsides which Rwanda did not factor into its planning process.

> Rwanda's hydropower dependence also carries risks to farming and the environment, and is vulnerable to the climate

3 The Politics Behind Rwanda's Electricity Boom

3.1 Rwanda's 'Political Settlement'

To explain why and how the boom in power plants occurred in Rwanda,[11] one has to understand the structure of political power in the country and the nature of the state. Since the genocide in 1994, the Rwandan Patriotic Front, led by President Paul Kagame, has governed Rwanda . The state officially looks like a democracy with the rule of law, parliaments and regular elections. But formal and informal power is strongly centralised on the President and on a small group of leading political-business-military families. This creates an authoritarian style of governance, but one marked by the cohesion of the ruling elite and the centralisation of policymaking whilst dissent against the ruling establishment is suppressed.[12]

Given their unrivalled grip on power in the country, this cohesive authoritarianism enables Rwanda's rulers to focus on the future. Without the need to fight expensive elections and worry about their short-term political survival, President Kagame and the senior RPF

[11] At first more informally, given Kagame was Vice-President
[12] See: Jones 2014; Behuria 2015; Behuria 2016; Reyntjens 2013; Goodfellow 2017

figures have the power to direct the country's private sector towards longer-term investment in strategic sectors. Their longer-term horizon also incentivises prosecuting corruption and cronyism within the civil service.

For the energy sector, this has meant that once key targets were decided by the political leadership, and the construction of the electricity generation made a priority, the Ministry of Infrastructure and Energy Utility company were under significant pressure to deliver. Their role was not primarily in policy formation; the Presidency decided this. Rather, government was there to implement. The degree of centralised power and the authoritarian nature of Rwanda also made it hard for any questioning of the high-level targets for power production. With the Presidency and party officials demanding results, ministers and civil servants had to focus on developing all available power sources.

> **Rwanda's highly concreted political power supports a leadership with longer-term ambitions but also a particularly hierarchical, implementation-focused policymaking practice.**

3.2 Modernising Vision of Development

The Rwandan political elite's ideas mattered in the pursuit of this energy boom. Academic studies suggest the influence of a development ideology that understands progress as technological modernisation (also called high modernism).[13] Rwanda's officials appeared to believe that the construction of energy generation would produce demand and that technology could by itself generate economic progress irrespective of other structural constraints. The limit to Rwanda's power plant building should therefore be its own ambition and ability to mobilise, not any predictions about what the system needed; *build it and they will come*.[14] Consequently, civil servants and politicians massaged demand forecasts to predict far higher electricity needs, thereby justifying the power plant construction boom.

> **The Rwandan elite's idea about what development is and how to achieve it favoured rapid electricity expansion irrespective of demand forecasts**

3.3 Capacity in the Bureaucracy

In order to implement this electricity boom, Rwanda needed a capable bureaucracy. Here Rwanda's wider political dynamic was again formative. The country's political elite, with their focus on long-term development and on disciplining corrupt practises, has helped create a focused, relatively effective government bureaucracy.[15] The Rwandan state has also instilled a strong work ethic. It famously uses a stringent performance target system known as *Imihigo*, to which individual's jobs and minister's positions are effectively attached.[16] This capacity and pressure to deliver targets was a key ingredient in driving the rapid action to process the 56 plants which are due to come online by 2026.

[13] Dye 2016; Huggins 2017; Ansoms 2009
[14] Dye 2020
[15] Chemouni 2016
[16] Klingebel et al. 2016

Rwanda's relatively meritocratic and capable bureaucracy were hierarchically-directed to focus on narrow implementation targets

3.4 The Role of Donors

The Western donor community supported the planning and delivery of this electricity drive. The German Development Cooperation Agency (GIZ), Belgian Technical Cooperation (BTC), Africa Governance Initiative and Overseas Development Institute supplied international experts for the Ministry of Infrastructure and Energy Utility.[17] They helped with planning and delivering individual projects and setting up private sector projects. Additionally, the World Bank supported the study of potential micro-hydro sites and general budgetary support came from many donors including the EU, DfID and USAID. Donors also provided project financing and capacity: Power Africa and the World Bank provided regulation, legislation and institutional support whilst private sector micro-hydro loans were given by GIZ, BTC, the World Bank, the United Nations Industrial Development Organisation (UNIDO) and the European Union. Additionally, for Nyabarongo I Dam, the Indian government provided concessional finance through its ExIm Bank.

This significant role for donors could have allowed them to question the planning process leading to the oversupply crisis. Indeed, consultants embedded in the Ministry of Infrastructure warned against the high target and persuaded the President and senior ministers to undertake a revision from 1000MW to 563MW. Additionally, Japanese experts supporting forecast planning predicted far lower demand, but their conclusions were overruled. Officials from the EU, DfID and the World Bank also warned the government against its rapid generation programme. However, all partners were resisted by the state until after 2016-when the PPA deals had already been signed.

This fits a well-noted pattern[18] whereby Rwanda maintains a high degree of independence from Western donors, despite their considerable financial support. This stems from the state's assertion of its sovereignty, its ability to play on Western donors' guilt over the 1994 genocide and its utilisation of implementation capabilities to win over Western donors who increasingly need to demonstrate concrete outcomes as part of their aid-effectiveness agenda. Moreover, Rwanda's ability to resist donors is reinforced by the aforementioned, pyramidal centralisation of power on the President and a select group of key, party political decision makers. Ministries are largely positioned as implementers to such higher policymaking. This structure reduces opportunities for donors to influence policymaking, particularly when their main engagement with electricity planning was through the Infrastructure Ministry and Utility.[19]

3.5 Mobilisation of the Private Sector

Alongside this governmental support, Rwanda mobilised domestic development financing. This involved the state-owned Rwandan Development Bank and Rwanda

[17] Whose name changed from Electrogaz to RECO (Rwanda Electricity Company) to EWSA (Electricity Water and Sanitation Authority) to REG (Rwanda Energy Group) and subsidiaries EDCL (Electricity Development Corporation Limited) and EUCL (Electricity Utility Corporation Limited)

[18] Hayman 2009; Marriage 2016

[19] Chemouni and Dye 2020; Dye 2020

Green Fund- Fonerwa. Additionally, more clandestine development funds were utilised. The RPF owns the investment fund Crystal Ventures, whilst the military has Horizon, both of which are routinely used to finance strategic development. The electricity boom was no exception, with Horizon, for example, backing the creation of Ngali Energy, which has become the largest micro-hydro developer.

The government also encouraged the country's politico-business elite to invest in this electricity boom. This saw RPF-connected businesses like the Rwanda Investment Group enter the sector, not least because such projects offer a legitimate source of rents (i.e. profits from public-sector activity). Arguably, such private contracts, with their limited oversight compared to the public sector, offer a means to reward the RPF-connected elite although there have been no notable corruption allegations in the sector to date.

In total 30 companies, the majority of which are Rwandan, are responsible for running, or have developed, 43 micro-hydro dams. Additionally, Israeli and US companies developed Kivu Methane gas and a Turkish firm Hakan is completing the larger peat plant.

> **Rwanda achieved the rapid electrification with strong enrolment of western donors, international finance and companies alongside Rwandan funds and the politically-connected private sector**

4 Conclusion

Rwanda has placed a high priority on the rapid construction of power plants. With pressure stemming from the top of government and pushed through the hierarchical decision-making process that characterises Rwanda, all forms of domestic electricity technologies were pursued. Established technologies, like hydropower, proceeded quickest, alongside pioneering lake-gas extraction, which required extensive mobilisation and organisation of international and national actors. But with the headlong focus on installed megawatt targets hard to contest, the risks of the government's *megawatt mission*, were overlooked. The result is a growing crisis of over-capacity and likely indebtedness.

Rwanda is not alone in facing these challenges in Africa. Other countries in Africa have fallen into similar oversupply traps. Ghana, for example, contracted double of what the country's electricity system needed between 2014-2016. Significant corruption is suspected in this case, particularly with a renegotiation of a PPA in 2017 that failed to improve terms for the state utilities. Additionally, Ethiopia has now built enough hydropower plants to satisfy between two and four times what peak demand is, with more dams on the way. The focus on installed megawatts has overlooked other crucial parts of the electricity system, such as the transmission grid to distribute that electricity. Moreover, over-reliance on hydropower causes dry-season power cuts. Rwanda is not the worst case of oversupply problems because it has a proven ability to learn and change direction.[20] Even if it reacted too late in this case, by 2019, a substantial policy shift had taken place. But Rwanda's experience has important lessons for other countries and for donors.

[20] Also see Behuria 2017; Behuria 2018

Lessons: What can be done to Avoid Power-Sector Debt Traps?

One might argue that Rwanda's power system issues are surprising, as the country has a cohesive and stable government with a long-term vision and a reasonably meritocratic and capable bureaucracy. However, these were not sufficient to chart an economically or socio-environmentally sustainable course for the sector. There are a number of takeaways here for policymakers and advisors working on electricity generation:

1. *Ideas about development matter*. The government's belief in technology's ability to create demand was a central driver of both progress and the ensuing problems.

2. *Involving the private sector involves significant risks*. In particular, there are dangers of signing contracts for too many megawatts, of pricing PPAs in international currency and of providing too many subsidies. For those countries with uncertain on-grid demand and delicate fiscal positions, the benefits of financing development through the government have been underestimated

3. Rwanda's bureaucracy needs to shift from an overly top-down, hierarchical service to appreciate:

    a. The need for the bureaucracy to incorporate its expertise and technical advice to inform policymaking. e.g. in the formulation of demand forecasts

    b. The crucial role of *critique and challenge to policymakers.* The civil service should be able to speak truth to power and sense check policy. Working alongside politicians, they should be able to question and improve the political goals and priorities set by the ruling party.

4. Donors should specifically consider:

    a. *Support for rigorous demand forecasting*

    b. *Support for the interrogation and questioning of electricity-sector plans* within government and, crucially by more independent civil society actors.

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