Acknowledgement

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# Table of Contents

Overview of African electricity markets ................................................................. 4
Challenges, barriers, and emerging opportunities for pumped storage development ...... 5
Current status of pumped storage & development potential .............................. 6
Recommendations .................................................................................................. 7

South Africa ......................................................................................................... 8
  Overview of the electricity market ......................................................... 8
  Overview of PSH ......................................................................................... 9
  Challenges, barriers and emerging opportunities for PSH ...................... 11
  Recommendations .................................................................................... 12

Morocco ............................................................................................................. 13
  Overview of the electricity market ......................................................... 13
  Overview of PSH ......................................................................................... 13
  Challenges, barriers and emerging opportunities for PSH ...................... 13
  Recommendations .................................................................................... 13

Kenya ................................................................................................................... 14
  Overview of the electricity market ......................................................... 14
  Overview of PSH ......................................................................................... 14
  Challenges, barriers, and emerging opportunities for PSH ...................... 14
  Recommendations .................................................................................... 14
Overview of African electricity markets

According to the International Energy Agency (IEA) the African electricity sector is characterised by its “large geography, limited interconnection and trade, improving electrification and prevailing system adequacy issues”\(^1\). It is estimated that the number of people in Africa without access to electricity increased from 579 million in 2019 to 592 million in 2020 because of the impact of the global pandemic and consequent economic decline\(^2\). In recent years the growth in population in Africa has outstripped the growth in electrification so that the percentage of households with electricity has declined\(^3\).

Pumped storage hydropower (PSH)'s crucial role is in ensuring continuity of supply and in providing systems services. There could be an argument that for many countries in Africa, they are less worried about continuity of supply as they have not yet reached full supply to all consumers and would rather pursue 100% electrification than uninterrupted supply. Given the shortage of finance for infrastructure, they may not be able to pursue both aims. Thus, PSH may not be highest on the priority list for public sector investment in many countries in Africa. The private sector is unlikely to invest in PSH given the lack of market mechanisms, such as time of day pricing or payment for system services, which would provide a secure revenue stream.

However, if in the pursuit of full electrification, countries rely on relatively cheap wind and solar generation, then issues such as continuity of supply and grid instability will only grow. Thus, countries may be building up a greater need for electricity storage in the future or building in a dependency on gas to balance the grid. The cost of intermittency should not be underestimated. The World Bank estimates that in Africa “for every percentage point increase in the frequency of electricity outages experienced by firms, output declines by 3.3\%” and goes on to suggest the tax revenue could be increased by 4\% if reliability issues were solved\(^4\).

Some countries with reservoir storage hydropower may be able to use this storage to balance variable renewable electricity (VRE) and thus may not yet need PSH. However, the contribution of VRE across sub-Saharan Africa is currently 13 GW and is expected to double by 2025\(^5\). This compares with installed hydropower, currently 38 GW and expected to grow to 44 GW by 2025. Of course, neither the VRE or the hydropower are evenly distributed which may give more opportunities to develop transmission systems with mutual benefit, and the hydropower may not have storage options of more than a few minutes if it is a run-or-river station.

Some countries such as Kenya are already considering the need for battery storage and are planning to go out to tender for such storage. Given the cost and environmental concerns over batteries, PSH may prove a better long-term option. As noted by Dehghani-Sanj et al in 2019 “the health and environmental impacts of compressed air and pumped hydro energy storage at the grid-scale are almost trivial compared to batteries.”\(^6\)

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\(^4\) Ibid

\(^5\) IEA Renewables 2020 – analysis and forecast to 2025

Africa’s current use of PSH is minimal. PSH capacity currently stands at 3.4 GW\(^7\) and is mainly concentrated in South Africa (1,332 MW Ingula, 100-MW Drakensberg, 180-MW Steenbras, 400 MW Palmeit), and in Morocco (465 MW STEP Afourer I and II). New plants are being considered in Egypt, Lesotho, and Morocco, which, if completed by 2030, would increase Africa’s pumped storage capacity by 4.5 GW. The 2.4 GW plant planned close to the Attaqa mountain near Suez, Egypt would, if completed, be the largest pump storage installation in Africa.

Challenges, barriers, and emerging opportunities for pumped storage development

One of the most fundamental barriers to the development of PSH (as with all large infrastructure in Africa) is access to finance. The structure of existing remuneration systems in most countries fails to recognise the added value of dispatchable power or system services. Energy market reform is needed (there was a reference for that on my list). This is already starting to happen in some countries. There may also be opportunities to develop regional cooperation in system services through greater interconnection.

PSH also raises environmental concerns. These can be addressed with careful safeguard procedures, but they add to the perception of projects which are long and complex to implement. Alternative storage such as batteries are not perceived to have such an environmental impact, as issues such as the mining of necessary minerals are not visible to the user, and concerns over recycling and disposal seem to be a long way in the future.

The long-term nature of the projects is also a challenge. Income is accrued over a long period of time and so return on investment is later compared to other renewable energy projects. This leaves that return vulnerable to changes in the country situation, ability to pay or regulation over a long period of time. Investors dislike uncertainty.

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\(^7\) IRENA (2020), Renewable capacity statistics 2020 International Renewable Energy Agency (IRENA), Abu Dhabi
Similarly, concerns over future levels of hydrology may also be a barrier (for open loop PSH), especially in countries where electricity is already largely from hydro. There is a need to create a supply system that relies on various technologies that are complementary (Markkanen and Plummer Braeckman 2021).

Users want a reliable supply so that they do not have to continue to invest in expensive back-up or endure outages. However, dependence on foreign funding means that countries build what they can get financed and what is quick, rather than what might be most sensible in the longer term.

There is an opportunity to build PSH either combined with new hydropower plants or retrofitted to existing reservoirs. This is an area which needs considerable forward planning as it may be that the pump storage is not needed immediately but that a new station should be designed with the future opportunity in mind. Retrofitting existing reservoirs may also be a possibility but will require market mechanisms to be in place to encourage investment in such projects.

Current status of pumped storage & development potential

According to the IEA Electricity Market report, Africa currently has 3.4 GW of pumped storage – the majority of which is in South Africa and 465 MW in Morocco. Three new plants are under development which, if completed, could increase PSH in Africa to 4.8 GW – these include the 2.4GW Ataga plant in Egypt, 1.2GW at Kobong in Lesotho, 300 MW El Menzel II and the 350 MW Abdelmoumem in Morocco. Zimbabwe has also been considering a pump storage plant, but there is no confirmed delivery date for this yet. Other countries have been considering storage options such as Senegal seeking storage solutions to combine with its 159 MW Parc Eolien Taiba N’Diaye wind plant (the largest wind farm in Africa).

For most countries the level of renewable energy penetration is still low (see Table 1), and the low levels of electrification imply a focus on adding baseload rather than flexibility. Thus, it is countries like Morocco and South Africa with high levels of electrification and growing share of VRE who are already investing in PSH. Similarly, Tunisia is also investigating a 400 MW PSH plant.

However, IRENA forecasts that non-hydro renewables will constitute 30% of African electricity generation by 2030. This may have a significant impact on the grid in some countries and early action to consider the need for long term energy storage is essential given the long lead times for PSH projects. Some countries will be able to use their hydropower reservoirs to provide ancillary services to the grid for some time to come, but for others the run-of-river nature of their existing hydropower allows only limited flexibility.

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9 IEA – 2020 Electricity market report December 2020 International Energy Agency
10 https://www.esi-africa.com/industry-sectors/generation/pumped-storage-hydro-proposed-for-zimbabwe/
Table 1 Ten African Countries with the higher VRE penetration – data from IEA Renewables Market Report 2020 Actual data 2018 and forecast for 2025; data on Electrification taken from World Bank Data for 2018\textsuperscript{12}

<table>
<thead>
<tr>
<th>Country</th>
<th>Onshore Wind 2018 TWh</th>
<th>Solar PV 2018 TWh</th>
<th>VRE Total 2018 TWh</th>
<th>2025 Forecast</th>
<th>Electrification Total Generation 2018 TWh</th>
<th>%VRE 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morocco</td>
<td>3.841</td>
<td>0.001</td>
<td>3.84</td>
<td>11.22</td>
<td>100%</td>
<td>35.53</td>
</tr>
<tr>
<td>Eritrea</td>
<td>0.002</td>
<td>0.043</td>
<td>0.05</td>
<td>0.13</td>
<td>49.6%</td>
<td>0.50</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>0.533</td>
<td>0.020</td>
<td>0.55</td>
<td>3.43</td>
<td>45.0%</td>
<td>13.58</td>
</tr>
<tr>
<td>Niger</td>
<td>0.000</td>
<td>0.024</td>
<td>0.02</td>
<td>0.19</td>
<td>17.6%</td>
<td>0.61</td>
</tr>
<tr>
<td>South Africa</td>
<td>6.467</td>
<td>3.212</td>
<td>9.68</td>
<td>17.08</td>
<td>91.2%</td>
<td>251.47</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.291</td>
<td>0.085</td>
<td>0.38</td>
<td>2.97</td>
<td>75.0%</td>
<td>11.77</td>
</tr>
<tr>
<td>Tunisia</td>
<td>0.453</td>
<td>0.174</td>
<td>0.63</td>
<td>1.93</td>
<td>99.8%</td>
<td>21.01</td>
</tr>
<tr>
<td>Benin</td>
<td>0.000</td>
<td>0.005</td>
<td>0.01</td>
<td>0.25</td>
<td>41.5%</td>
<td>0.20</td>
</tr>
<tr>
<td>Namibia</td>
<td>0.005</td>
<td>0.026</td>
<td>0.03</td>
<td>0.79</td>
<td>53.9%</td>
<td>1.20</td>
</tr>
<tr>
<td>Mauritius</td>
<td>0.015</td>
<td>0.049</td>
<td>0.06</td>
<td>0.28</td>
<td>97.5%</td>
<td>3.13</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.001</td>
<td>0.043</td>
<td>0.03</td>
<td>0.20</td>
<td>20.1%</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Recommendations

PSH is a long-term investment and requires long-term planning. Each country needs to consider the value (if any) of system services and storage over the next 10 to 15 years and then plan for market mechanisms in the long-term to address this – Multi-lateral Development Banks (MDBs) could assist with studies into this area for key countries. This may also involve more regional planning and consideration of the possibility of providing system services between countries or regions through interconnections.

Given the possibilities for hydropower investment in Africa over the next decade, it would be appropriate to consider whether there are pump storage opportunities which could be considered in advance for incorporation into these projects. This option may not need to be built immediately but if the hydropower plant is planned with a later addition of PSH in mind then the opportunity can be taken up when it is needed.

It would be useful to develop a strategy comparing different technologies such as hydrogen, batteries and PSH in technical and economic feasibility as well as sustainability – so that each country can then adjust this analysis for their own particular circumstances.

This paper will continue by focussing on South Africa and Morocco which already have significant PSH; and noting aspects relating to Kenya as indicative of similar situations in other countries which may need storage but have yet to invest in any PSH.

\textsuperscript{12} https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
South Africa

Overview of the electricity market

Due to the abundance of coal, and the scarcity of water, South Africa’s electricity network has historically been very reliant on coal. There are two medium-sized hydro power plants along the Orange river and some additional hydro power is imported from Cahora Basa in Mozambique. The coal fleet is supplemented with a nuclear power station in the Western Cape due to the industrial hub of Cape Town being quite far removed from the coal rich northern parts of the country where the bulk of energy generation is focused. Power outages in the start of the century forced Eskom to build and procure gas fired power.

In the past decade, the Government launched and implemented the highly successful Renewable Energy Independent Power Producers Program (REIPPPP) that allowed the procurement of private hydro, wind, solar photovoltaic (PV), and concentrated solar power (CSP). In recent years Eskom has struggled to maintain a good energy availability factor (EAF) due to poor maintenance of its generation fleet. The EAF has gradually declined from 85% in 2010, to levels sometime below 70% in 2018 and 2019. This has caused the department to launch a new form of tender called the Risk Mitigation Independent Power Producer Procurement Program (RMIPPP) that has an allocation of 2000 MW of technology agnostic bids to be submitted by the end of 2020, with anticipated commissioning of plants in the end of 2022. Over and above this the recent policy document, Integrated Resource Plan (IRP) 2019, highlights the decommissioning of 24 GW coal fired power plants and earmarked the replacement with 14.4 GW wind, 6 GW solar PV, 3 GW of gas and 2.5 GW of imported hydro. Of this allocation, approval has been granted for the procurement of 6.8 GW PV and wind in 2022 to 2024, 0.5GW storage in 2022, 3 GW of gas and diesel 2024 to 2027 and 1.5 GW of coal from 2023 to 2027. Error! Reference source not found. and Error! Reference source not found. shows the movement in generation mix in the country over the next decade.

The South African electricity market is in the process of becoming more liberalised. As recorded in the “Roadmap for Eskom”, a restructuring document launched by the department of public enterprises, the national utility will be undergoing a phased unbundling of generation, transmission, and distribution, with the transmission entity mandated to be a single buyer function from both Eskom and IPP generation. It is currently foreseen that the utility will be functionally split by 2021 and legally formalised by 2022. These latest developments were highly contested by worker’s unions in South Africa as the liberalisation of the market, as well as the renewable energy orientated policy, has caused much concern to the effect that it might have on job security within the mining sector. The fact that the energy sector falls under the same department as mining results in conflict of interests from a political perspective, this could be clearly seen by the long suspension of REIPPPP bid window 4.

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15 Roadmap for Eskom in a reformed electricity supply industry, (Unofficial DPE document), October 2019.
It is clear from recent policy decisions that the electricity market needs reform, growth, diversification (carbon divesting) and energy security. The need to replace coal with cheaper intermittent renewables while maintaining reliable power supply creates an environment where energy storage systems will become a necessity, this is especially the case due to most of these RE projects being built in remote areas where the resources are good. The following remains challenging for the development of energy storage systems (ESS):

- Although mentioned in the IRP 2019 and concurred by National Energy Regulator of South Africa (NERSA), there is no clear guidance of how the procurement of ESS will work.
- No clear guidance on pricing mechanisms and services required by the utility.
- The South African grid code have not yet been updated to adequately address the integration of private ESS, although a draft form for Battery Energy Storage is currently being reviewed.


- A decline in economic growth,
- The inability to meet energy demand,
- Limited ability to access capital markets,
- A deficit in skills and in-country know-how, and
- Political uncertainty, activism, and civil disobedience.

**Overview of PSH**

Currently South Africa boasts a total of 2,910 MW in pumped hydro storage with its oldest plant dating back to 1979. Three of these plants are owned by Eskom, the public electricity utility, and the other one by a metropolitan municipality and serve therefore as an augmentation of their own power system with main benefits lying in demand management.

The Steenbras Pumped Storage Scheme (180 MW) is built and owned by the Cape Town Municipality, and it was the first pumped storage built in Africa. Whenever demand exceeds the notified maximum demand...
contractually agreed with Eskom, Cape Town Municipality uses PSH to lower its peak demand, and avoid additional charges levied by Eskom. Steenbras can typically cycle on a daily basis and requires only 12 hours to fully recharge. The plant underwent major refurbishment between 1990 and 1996, and also extensive maintenance and repairs in 2019.

The first Eskom plant, Drakensberg PSS (1,000 MW), was first commissioned in 1981 and connects the Vaal and KZN water basins through a series of dams. It has the storage capacity to produce up to 27.6 GWh and is mostly used to shift load from off-peak to peak, based on weekly cycles. Up and till the 21st century it ranked as the 15th largest PSH by power capacity. Drakensburg was built jointly by Eskom and the Department of Water Affairs (DWA) due to this scheme serving another primary service of water transfer for the Thukela-Vaal Water Transfer Scheme.

Palmiet PSS (400 MW) is another Eskom plant jointly owned by DWA (25%) as it serves both to flatten electricity demand profile over weekly cycles and augments water supply to the Cape Town Metropolitan. The plant is also run in synchronous condenser mode to facilitate the management of reactive power on the network, system frequency and voltage control.17

The last and largest plant built by Eskom is the Ingula PSS (1,333 MW) and was fully commissioned in 2017. It also serves as a water transfer to the Vaal system and operationally services peak demand levels, with cycles ranging from day-to-day to longer week periods. With that said it has been recorded that more and more the Eskom PSS plants are being balanced on a daily basis to cope with Eskom supply problems.

Table 2 Summary of existing PSH in South Africa

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Nameplate Power</th>
<th>Energy Capacity</th>
<th>Storage Capacity</th>
<th>Maximum Head (Generating)</th>
<th>Turbine technology</th>
<th>Cycle Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingula PSS</td>
<td>4 x 333 MW</td>
<td>21.0 GWh</td>
<td>19 MCM</td>
<td>480 m</td>
<td>Reversible Pump Turbines</td>
<td>78.0%</td>
</tr>
<tr>
<td>Drakensberg PSS</td>
<td>4 x 250 MW</td>
<td>27.6 GWh</td>
<td>27 MCM</td>
<td>460 m</td>
<td>Reversible Pump Turbines</td>
<td>73.7%</td>
</tr>
<tr>
<td>Palmiet PSS</td>
<td>2 x 200 MW</td>
<td>10.0 GWh</td>
<td>15 MCM</td>
<td>286 m</td>
<td>Single Stage Reversible Francis</td>
<td>77.9%</td>
</tr>
<tr>
<td>Steenbras PSS</td>
<td>4 x 45 MW</td>
<td>1.7 GWh</td>
<td>2.6 MCM</td>
<td>300 m</td>
<td>Reversible Pump Turbines</td>
<td>N/A</td>
</tr>
</tbody>
</table>

17 Palmiet Pumped Storage Scheme – Official Eskom Generation Brochure
Ingula can run in multiple SCO directions making these favourable machines for quick network responses. Storage is partially recharged during the evenings and fully recharged over the weekends.\(^{18}\)

The units are run in SCO to supply inertia to the network and not for reactive power control. Voltage control is a localised phenomenon on the network and cannot be supported by remote PSH plants. However, inertia can be provided at any location as well the necessary frequency support services. The units are also fully automatically designed for black start purposes. Every 5 years a black start simulation is run using Ingula (1,332 MW), Majuba Coal Fired Power Station (4,110 MW) and a Richard’s Bay smelter as load. Eskom Generation Development was consulted on the matter of the grid services required by Eskom\(^{19}\).

Distributed sources and loads are currently used for the necessary voltage management, where meters are set up to measure kVARh and PPA’s are reflecting appropriate tariffs for this reactive power absorbed/produced. As loads are mostly the culprits in frequency changes, Eskom has contractual arrangements in place to disconnect/connect loads in these circumstances. The PSH are mostly run in SCO mode to provide inertia, and due to the increase of VRE that utilises induction machines and inverters more inertia will be required.

**Challenges, barriers and emerging opportunities for PSH**

The development of new PSH in South Africa is not foreseen in the near future, mostly due to financial constraints for Eskom and the Independent Power Producer (IPP)’s perspective that there is no clear policy framework. Although the 2 GW allocated in the IRP 2019 for storage could still be allocated to PSH. Of this 2 GW, 513 MW will be allocated under REIPPPP 5. According to NERSA\(^{20}\) this will be procured solely through the IPP office, will be technology agnostic and be required to supply the grid service as identified by Eskom in its Medium Term System Adequacy Outlook of 2019. Eskom has already identified and evaluated other schemes, with those most likely to be successful being the Tubatse (1,500 MW) and Mutale PSS\(^{21}\). Aside from these two projects there is still significant potential for further PSH in South Africa, particularly in the Great Escarpment, which separates the Central Plateau from Southern African coastline.

The Integrated Resource Plan 2019 allocates 513 MW of storage to be procured in 2022 and another 1,575 MW in 2029. In July 2020, Eskom placed a tender to procure 80 MW (320 MWh) of battery energy storage (BES). Another big step is the latest Risk Mitigation procurement which resulted in IPP’s bidding PV and wind projects that are either complimented by battery or gas for projects between 50 and 450 MW. This is one of the largest RE plus battery procurements internationally. For a program designed for 2,000 MW, over 6,000 MW was bid, showing the competitive nature of the market. The preferred bidders have been selected and are expected to reach financial closure in September 2021. Meanwhile a further tender for 80 MW of battery storage has also been issued. In line with this, NERSA has also drafted a new grid code specifically for BES.

The following challenges remain for development of PSH in South Africa:

- Remuneration mechanisms are poorly defined (Might consider how the Risk Mitigation IPP procurement payment mechanisms could evolve).
- Constraints on the availability of capital at the utility level.
- Perceptions of PSH in comparison to other storage technologies (i.e., taking longer to develop and being more complex).
- Viability of small-scale pumped storage – needs to still be proved in order to attract private investment. Utility scale projects (>100 MW) in a nascent market will be difficult to finance due to the large capital requirements for PSH.

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\(^{18}\) Interview with Eskom Peaking: Operations Director, 5 February 2021.

\(^{19}\) Interview with Eskom Generation Development: Technical Head of Electrical and Grid Services, 5 February 2021.


Emerging opportunities:

- Local authorities have only recently been allowed to run their own RE procurement; therefore, PSH can be developed directly with local authorities (i.e., Steenbras).
- De-bundling of Eskom and Independent Transmission and System Operator
- Significant new investment in RE in the short term
- Having both a very well-developed water infrastructure network (where existing dams can be used as PSH reservoirs) and an extensive transmission network, is well suited for further PSH development.
- Large mining industry – decommissioned mines can be retrofitted for PSH (e.g., in Kidston, Australia, use of former Kidston Gold Mine for 250MW PSH)

Recommendations

a) Given that 513MW of storage has been determined by the Department of Energy to be procured under REIPPPP bid window 5 (2021), greater clarity is needed on exactly what is required in terms of storage so that IPP's can start preparing projects

b) Eskom should develop a pricing framework with regards to what and how they would be willing to pay for grid services and implement a reverse auction mechanism (or similar) for procurement.

c) Eskom should run a longer-term system adequacy analysis (10-15 years)

d) Eskom should release a map with locations in which they require voltage stabilisation
Morocco

Overview of the electricity market

With a partially liberalised market, Morocco is in the midst of energy reforms based on three priorities outlined in the National Energy Strategy. The three priorities are to diversify the country's energy supply and increase uptake of renewable energy, to integrate regional electricity markets, and to improve energy efficiency. The link with PSH is how to encourage, explore, and manage Morocco’s endogenous PSH resources.

In Morocco, the presence of a time-of-day tariff for commercial and industrial customers is hugely conducive to the use of PSH. The utility also has an obligation to meet 24-hour supply and hence is incentivised to develop PSH. While the country benefits from considerable natural height (head) it is generally short of water which makes conventional hydropower less appropriate. The country currently generates 37% of its electricity from VRE which is expected to increase to 42% in the next 2-3 years and 52% by 2030. The majority of supply has traditionally been from thermal power, largely through imported coal. Morocco benefits from strong regulations and market mechanisms as there is strong capacity in the Office National de l'Electricité (ONE).

Overview of PSH

The 465 MW Afourer PSH was completed in 2004 and has mainly been used to shift electricity between the night-time and peak periods. At 350 MW, Abdelmoumen is still under construction and expected to be commissioned in 2021. Other sites (some 380 MW) are under investigation with the aim of supporting the target of 52% renewable energy on the grid by 2030. Planning is based on a closed system with resilience to high VRE stress. Morocco is looking to develop the ideal mix of storage technologies and including PSH in this mix.

Challenges, barriers and emerging opportunities for PSH

Morocco is ideally placed to support more PSH. It has natural head in its hills and mountains, even if it does not have a large amount of water flow. Morocco has already implemented a time-of-day tariff for commercial and industrial customers and its market and regulation are advanced and stable compared to most African countries. This combined with a strong national public sector energy provider is likely to make PSH important to Morocco for some time to come.

Recommendations

- Take a leadership role advising other countries in Africa on the steps required in long-term system planning and regulation.
- Continue the development of strong regulatory framework to support long-term strategy for generation storage.
Overview of the electricity market

In Kenya, the share of intermittent energy, e.g., wind and solar capacities is planned to evolve rapidly from 1.1% in 2017 to 22.7% in 2030. By 2019, the share of intermittent capacity had already reached 14%, with 335 MW of wind and 50 MW under operation over a total capacity of 2.81 GW. Under positive technical and economic conditions, the competitiveness of wind and solar is the main driver of this evolution.

In order to balance these non-firm sources of energy, a national programming plan, the Updated Least Cost Development Plan (ULCDP) 2017-2037, has recommended the introduction of two backup plants in the short term (2019 and 2020) amounting to approximately 5% (160 MW) of the total capacity for purposes of backup and provision of primary reserve and other ancillary services.

The ULCDP 2017-2037 provides the list of peaking and dispatchable power plants envisaged in Kenya. This list comprises only medium speed diesel plants and natural gas plants, namely combined cycled gas turbine (CCGT) and generic gas turbine. Assessing the levelized cost of energy (LCOE) of these plants using public data, it can be seen that PSH could replace planned fossil fuel power plants or displace the uses of existing fossil fuel power plants.

An update to the ULCDP for 2020 to 2040 specifically mentions the need for “Peaking capacity power plants and Battery storage” using “LNG gas turbines, pumped hydro storage and peaking hydro plants”. Several areas of Kenya where PSH could be implemented are suggested including sites in the northwest, west and southwest of the country. It also notes the need to “Carry out a comprehensive study on ancillary services requirements for the system, including battery storage, pumped storage and reactive power compensation, with the increasing levels of intermittent renewable energy sources”.

The challenge for Kenya is that there is no existing market for ancillary services and no regulatory framework defined for remuneration of storage plants. A study is currently being commissioned to consider the impact of provision of ancillary services on Kenya’s grid.

Overview of PSH

Kenya has an unbundled public sector electricity industry and, as yet, no PSH. Reservoir storage hydropower plants are remunerated for the electricity they generate (but not according to time of day or demand). Remuneration for the capacity exists below a certain load factor threshold.

Challenges, barriers, and emerging opportunities for PSH

Kenya has no regulatory framework for storage plants and thus a lack of revenue certainty. There are also major uncertainties on the development planning of storage projects. In the early stages of the projects, Development Finance Institutions (DFIs) could alleviate the high development risk by providing technical assistance to the government for the structuring of the legal and regulatory framework. Given the affordability challenges in Kenya, the DFIs could provide concessional loans with a long-term duration and low interest rate, thus reducing the cost of capital and consequent tariff.

Recommendations

- Kenya (in common with other countries) needs to evaluate the opportunity of developing storage projects, like PSH and BESS, against building new gas or diesel peaking power plants.
- If it wants to develop PSH, Kenya needs to define policies and regulations for storage projects, licensing and permitting needs for a pumped storage project, and design a market framework and revenue schemes for ancillary services that ensure long-term perspectives for developers and investors.

23 https://www.esi-africa.com/industry-sectors/generation/kengen-invites-consultants-to-provide-ancillary-services/