Aloe Energy

RESEARCH PAPER · NOVEMBER 2026

# Can small hydro run a data center? Small hydropower and computing in Africa

Many small hydro plants in Africa have more power than the town around them can use, and computing needs cheap, clean power. We mapped 381 small hydro sites against fiber, cooling, the grid, dry seasons and the people nearby to see where the two could fit, and where they do not.

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Web version: aloeenergy.org/research/hydro-data-centers · Contact: brandon@aloeenergy.org

## Key findings

- **It fits computing that can pause.** A small run-of-river plant with spare power can sell it to batch work, model training or bitcoin mining that runs harder in the wet season and slows in the dry season. That is already happening at a run-of-river plant in Virunga National Park, DR Congo, and at a hydro pilot in Kenya.
- **It does not fit a data center that must always run, on its own.** In the African Hydropower Atlas, 72% of small plants run below 5% of capacity in the driest month of a dry year. Ethiopia's miners, on a mostly hydro grid, received about 23% of their contracted power in the 2026 drought. An uptime-rated site needs the grid, storage or a second source as well.
- **The size is small.** The median small hydro site on our map is about 6 MW. The realistic range is one container of about 1 MW up to edge sites of about 20 MW; large commercial data centers need tens to hundreds of megawatts near cities and cable landings.
- **The Albertine Rift lines up on the most factors at once.** Rwanda, Burundi, western Uganda and eastern DR Congo have 80 of the 381 sites, rain in the dry season, fiber within 25 km of 72% of sites, a cool climate and many people without power nearby. The Kenyan and Malagasy highlands follow on several factors.
- **Who benefits depends on the contract.** A computing customer can lower the tariff for everyone else; it can also take the income and leave the village dark. The paper ends with what a developer, funder or government should check.

## Why the pairing can make sense

**Small hydro needs a customer.** Many small hydro plants were built for a town or a mini-grid whose demand grew slower than planned. The plant runs below capacity and earns too little. A computing load can use the spare power, pay for it and make the plant bankable, while the community keeps first call on the power.

**Computing can follow the river.** Batch work, model training and bitcoin mining can run harder in the wet season and slow down in the dry season, which matches a run-of-river plant with no reservoir.

**Highland sites cool themselves.** Many good small hydro sites are in cool highlands, where outside air can do much of the cooling. In the Albertine Rift three in four small hydro sites have a mean annual temperature under 21 °C.

**It is an anchor load.** A steady, paying customer is the kind of load that makes a mini-grid worth building to grid standard, and the grid connection is then also its backup.

## What has actually happened

**Virunga, DR Congo.** Since September 2020 a bitcoin mine has used power from the park's Luviro run-of-river plant, which was built to supply a town grid that was never completed. The park director has said the income kept the park afloat (MIT Technology Review, January 2023). An investigation by The Continent and Follow the Money (October 2025) found that most proceeds go to the private operator, and that far fewer households were connected to the park's hydro than promised.

**Kenya.** Gridless, a Kenyan company, runs small mines at renewable mini-grids. CNBC (April 2024) visited a single container of about 0.5 MW at a geothermal and solar site, and reported a hydro pilot in Kenya whose power price fell from 35 to 25 US cents per kWh after the mine arrived.

**Ethiopia.** A large-hydro grid, not small hydro, but the clearest warning. Ethiopia stopped new mining contracts in 2025 (The Reporter Ethiopia, August 2025) and ended the miners' flat 3.14 US cent tariff from December 2025 (Capital Ethiopia, October 2025). In the 2026 El Niño drought, with reservoir inflows down about a fifth, Ethiopian Electric Power cut miners in steps from the promised 98% of contracted power to about 23% (Ethiopian Business Review, August 2026; Capital Ethiopia, September 2026).

We found no uptime-rated data center in Africa that runs mainly on small hydro. A planned project in Lesotho relies on 1,200 MW of large hydro plus solar and storage and is still at the memorandum stage (africa.com, July 2026).

## Why it often does not work

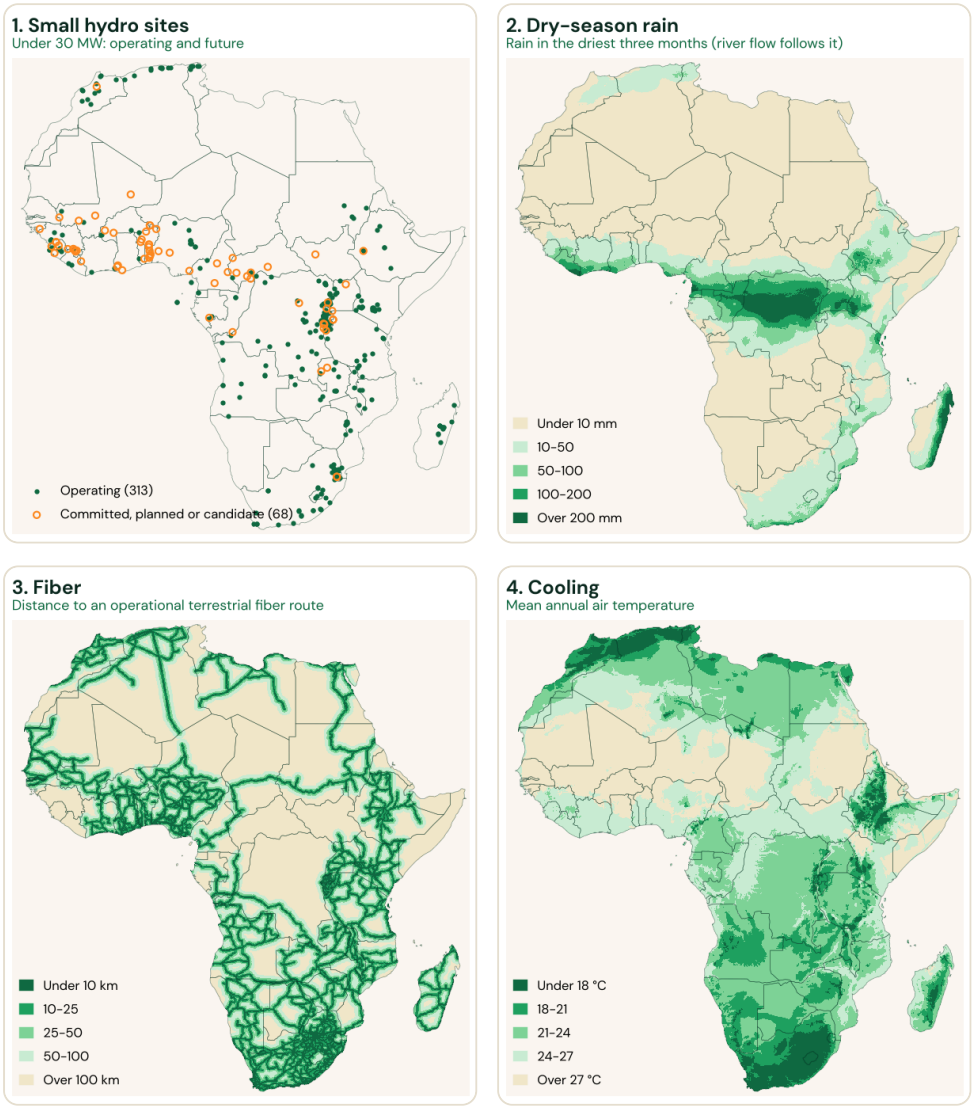
- **Dry seasons and droughts.** Run-of-river output depends largely on the rain, and floods and sediment in the rainy season can stop small plants too. Our analysis "When the river runs low" shows the same risk for whole grids.
- **Scale.** Commercial data center capacity in Africa's five largest markets is expected to grow from about 400 MW to 1.5 to 2.2 GW by 2030, almost all near the big cities (African Business, December 2025, citing McKinsey).
- **Fiber and backup.** Most workloads need fast links and a second route. Uptime-rated sites need a second power feed; even urban sites keep large diesel reserves (one 1.5 MW site holds about 90,000 liters, per African Business).

- **Remote sites and volatile customers.** Remote sites cost more to staff, secure and maintain. Bitcoin revenue swings with the price and the network, and Ethiopia shows that policy can turn quickly.
- **Rules and water.** Whether a private party can build hydro, supply itself, sell surplus to the community, keep data in the country and use the water is decided country by country. We could not map these.

## Where the conditions line up

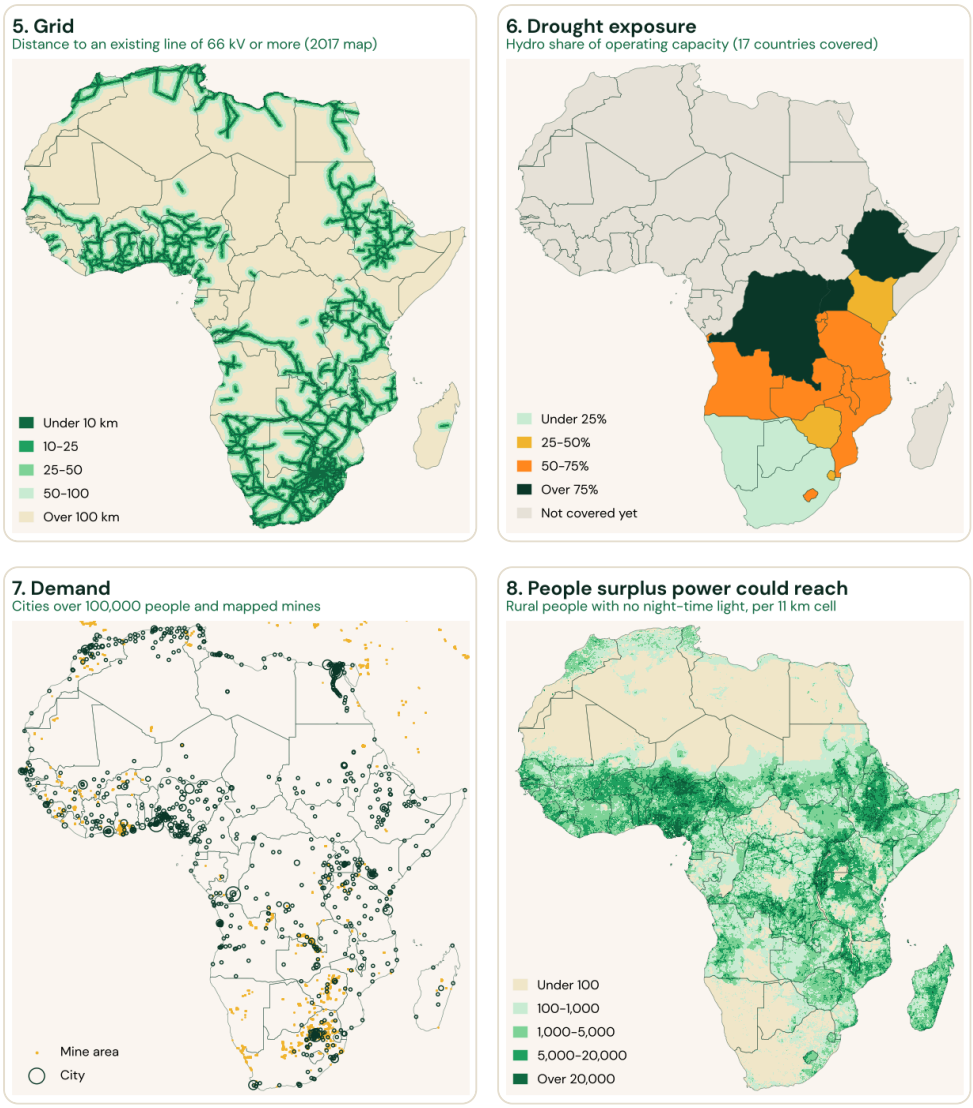
We mapped eight factors across Africa on a 0.1° grid (about 11 km) and at each small hydro site. Each map shows one factor; we do not add them into a score, because a site that is cool but dry, or wet but far from fiber, is a different proposition.

**Figure 1. Small hydro sites, dry-season rain, fiber and cooling**




Small hydro: African Hydropower Atlas v2.1 (IRENA, CC BY 4.0) and OpenStreetMap (ODbL). Rain and temperature: CHELSA v1.2 climatologies (CC0). Fiber: AfTerFibre operational terrestrial routes (NSRC, CC BY 4.0), November 2026.

**Figure 2. Grid, drought exposure, demand and people without power**




Grid: World Bank Africa electricity grid 2017 (CC BY 4.0), existing lines of 66 kV and above. Drought exposure: Aloe Energy hydro exposure (17 countries). Demand: GeoNames cities (CC BY 4.0) and Tang and Werner (2023) mine areas (CC BY 4.0). People: rural population with no night-time light in 2024 (Hengl and VIIRS, CC BY 4.0).

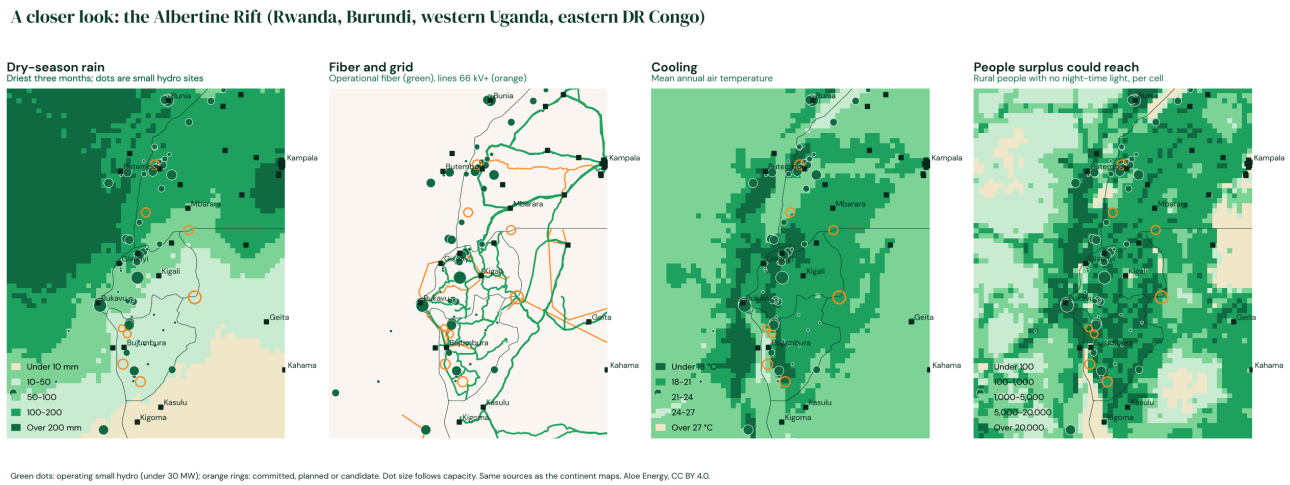
# The candidate regions side by side

| Region | Sites (operating / future) | Rain, driest 3 months | Within 25 km of fiber | Under 21 °C | To a 66 kV+ line | Unlit people within 25 km |
|---|---|---|---|---|---|---|
| Albertine Rift | 73 / 7 | 82 mm | 72% | 76% | 27 km | 387,000 |
| Kenyan highlands | 17 / 0 | 143 mm | 94% | 71% | 9 km | 124,000 |
| Ethiopia | 7 / 1 | 30 mm | 50% | 88% | 8 km | 299,000 |
| Madagascar | 13 / 0 | 42 mm | 85% | 85% | 32 km | 216,000 |
| Tanzania Southern Highlands | 7 / 0 | 7 mm | 57% | 71% | 15 km | 83,000 |
| Fouta Djallon (Guinea) | 5 / 0 | 6 mm | not in map* | 0% | 6 km | 134,000 |
| Lesotho | 3 / 0 | 33 mm | 0% | 100% | 27 km | 72,000 |
| Rest of Africa | 186 / 60 | 23 mm | 50% | 40% | 24 km | 82,000 |

Medians and shares over the small hydro sites in each region; distances are medians. * Guinea's national fiber backbone, opened in 2020, runs from Conakry through Mamou to Labé (OSIRIS, 2017; Huawei, 2022) but is missing from the open fiber map. Northern Malawi and Cameroon's western highlands have one mapped site each, too few to describe.

- **Albertine Rift:** the most small hydro, two rainy seasons that keep rivers running, fiber close by, cool air and the most people without power nearby. Weak points: a thin grid and insecurity in eastern DR Congo.
- **Kenyan highlands:** rain in the dry season, fiber and grid very close, cool. Fewer sites, and Kenya's grid is strong enough that a data center may simply buy grid power.
- **Madagascar's highlands:** cool and mostly near fiber, with a moderate dry season and few sites in the open data.
- **Ethiopia and Tanzania's Southern Highlands:** cool, but a long dry season.
- **Fouta Djallon:** rivers, but an almost rainless dry season and warmer air.
- **Lesotho:** very cool, few small sites; its data center plan rests on large hydro.

### Figure 3. A closer look at the Albertine Rift




Green dots: operating small hydro (under 30 MW); orange rings: committed, planned or candidate; dot size follows capacity. Same sources as Figures 1 and 2.

# The rules

Where a computing load handles personal data, data protection law decides where it may sit. About 44 African countries had a data protection law by early 2026 and 38 had a regulator at work (Digital Policy Alert, January 2026). Four of the countries below require some data to stay in the country, and DR Congo and Tanzania need an approval for every transfer abroad; both can create local demand for an in-country site. Computing that holds no personal data, such as bitcoin mining, mostly falls outside these laws but not outside crypto and energy rules.

| Country | Data protection law | Must data stay in the country? | Crypto mining | Internet shutdowns, 2025 |
|---|---|---|---|---|
| Rwanda | Law 058/2021 (NCSA) | Yes: personal data stored in Rwanda unless the regulator allows otherwise | Prohibited unless the Capital Market Authority approves (2026 law) | None recorded |
| Ethiopia | Proclamation 1321/2024 | Yes: data collected locally stored in Ethiopia | Licensed since 2022; no new power contracts since 2025 | Recorded |
| DR Congo | Digital Code 2023 | In effect: personal data may leave only with the data protection authority's approval (procedure not yet set) | Not found | Goma, during the conflict |
| Kenya | Data Protection Act 2019 | Partly: state strategic data, critical information infrastructure, and top secret and restricted government data (2025 cloud policy) | VASP Act 2025; mining not addressed | During protests |
| Uganda | Data Protection and Privacy Act 2019 | No general rule found | No crypto law | Facebook blocked since 2021 |
| Tanzania | Personal Data Protection Act 2022 | No general rule; a permit for every transfer | No regime; 3% tax on transfers | Eight, incl. election blackout |
| Burundi | Law 1/03 of 10 March 2026; agency still to be set up | No rule in the law text; transfers to listed countries or with approved safeguards | Not found | None recorded |
| Malawi | Data Protection Act 2024 (MACRA) | No rule found | Unregulated | None recorded |
| Madagascar | Law 2014-038 (CMIL being set up) | No rule found | Not found | None recorded |
| Cameroon | Law 2024/017, compliance due June 2026 | No rule found | Not found | Recorded |
| Guinea | Law L/2016/037; 2025 decree on ID data | No rule found | Not found | Recorded |
| Lesotho | Data Protection Act 2012 (commission not appointed) | No rule found | Not found | None recorded |
| Nigeria (reference) | Data Protection Act 2023 | Partly: payment data from January 2027 | Digital assets regulated as securities (2025) | Recorded |
| South Africa (reference) | POPIA 2013 | No general rule found | Licensed providers; crypto a financial product | None recorded |

"Not found" means no public source was found, not that no rule exists. Check the current law text before relying on any row; this is not legal advice. Sources: law-firm and research summaries of each law (DLA Piper, PwC Rwanda, Covington, Afriwise, Clyde & Co, TechHive, CIPIT, LEX Africa, CIO Mag, OSIRIS, Paradigm Initiative); Digital Policy Alert (2026); Access Now KeepItOn 2025 report (30 shutdowns in 15 African countries); New Times and Ecofin (Rwanda 2026 law); Webber Wentzel / ALN and Chambers (crypto).

## What it means

### Hydro developers

A computing load can buy power the town cannot use yet. Contract it as interruptible, with the community first in line, and plan for the dry season with a grid tie or solar and batteries.

### Data center operators

Small hydro alone suits workloads that can pause. For anything uptime-rated, treat the plant as the cheap part of a mix that also has the grid, storage or a second source, and check fiber capacity, not just distance.

### Funders

An anchor customer can make a small plant bankable. Ask for measured flow records, a dry-year plan and a written community share of power and revenue before counting the computing income.

### Governments

Clear rules for self-supply, selling surplus to nearby homes and water use would let these deals happen in the open. Ethiopia shows why tariffs and curtailment terms should be set before, not after, a drought.

**Before anyone builds: ten years of measured flow, the firm power in the driest month of a dry year and what covers the gap, a fiber route and a second path, the licensing route, environmental and downstream checks, and a contract that sets the community's share.**

## How we did it, and its limits

- **Small hydro.** Plants under 30 MW from the African Hydropower Atlas v2.1 (existing, committed, planned and candidate) plus operating OpenStreetMap plants not within 3 km of an atlas plant: 381 sites, 313 operating and 68 future. 37 OpenStreetMap plants have no size. Future plants are undercounted in East Africa: national lists in the UNIDO World Small Hydropower Development Report 2022 name 40 planned or ongoing small hydro projects in Burundi, Kenya, Madagascar, Malawi, Rwanda, Tanzania and Uganda, against 11 future plants on our map, but give no coordinates. Some operating plants are missing too: Rwanda's utility counts 37 grid-connected hydro plants and 11 off-grid micro plants, against 22 Rwandan sites on our map.
- **Dry seasons.** CHELSA rain in the driest three months for every place, and the atlas's dry-year monthly capacity factors where a plant has them. The atlas models flow for basins of 3,500 km² and up, so a small plant's profile reflects the larger river it sits on. Neither replaces measured flow.
- **Fiber, grid and cooling.** Fiber distance says nothing about capacity, price or a second path. The grid map is from 2017. Mean temperature is a rough guide to cooling; hours of free cooling would need hourly data.
- **Not mapped.** Environmental constraints (no open, reusable continent data); the rules are summarized in a table instead. Not used because their terms do not allow reuse: GRDC river discharge, PeeringDB exchange points, the TeleGeography cable map and the World Database on Protected Areas.
- No composite scores and no rankings. Sites are not named. Public data only; a screen, not a site study, and not investment advice.

## Sources

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Cite as: Simons, B. (2026). Can small hydro run a data center? Small hydropower and computing in Africa. Aloe Energy. Version 1.4. CC BY 4.0.