

README — Reproducibility package (MASTER)

"Not Too Much, Not Too Little: A Goldilocks approach to sustainable, universal electricity access in sub-Saharan Africa"

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1. Overview

This is the entry point for the reproducibility package of the manuscript. The paper applies one integrated regulatory-financial framework to three countries, and the package is organized into **three country folders**, each self-contained with its own README:

- /Uganda — Table 1 and the figures in Section 4, reproduced by the authors' Uganda financial model (two Excel workbooks).
- /Zambia — Table 2 and the figures in Section 5, reproduced by the authors' Rural Electrification Master Plan (REMP) financial model (two Excel workbooks).
- /Madagascar — Table 3 and the figures in Section 6.3, transcribed from two public GIZ / Tosika Angovo factsheets (no model; the underlying district models are confidential).

Open the country README in each folder for the detailed instructions, the exact worksheet-and-cell (or page) locators, and the per-source data documentation. This master README gives the package-level map: the full list of exhibits, the consolidated data-availability statement, and how to run or verify each part.

2. Package contents and folder structure

- /Uganda/
 - An integrated...electrification.pdf — companion article (Energy Economics)
 - README_Uganda.docx
 - Uganda_Electrification_Model_2030.xlsx, Uganda_Electrification_Model_2040.xlsx
- /Zambia/
 - README_Zambia.docx
 - REMP - Financial Model_2030.xlsx, REMP - Financial Model_2040.xlsx
- /Madagascar/
 - giz2025-fr-...Fandriana.pdf, giz2025-fr-...Jiro_Taratra.pdf — GIZ / Tosika Angovo factsheets
 - README_Madagascar.docx
- LICENSE.txt — applies to the whole package (see Section 7)
- README.docx — this file

Exact filenames should match the folders character-for-character before submission.

3. List of Exhibits

Every exhibit in the manuscript, and where it is reproduced or sourced:

Exhibit	Folder	Status
Table 1 — Uganda: key comparative results	/Uganda	Reproduced from the Uganda financial model. See README_Uganda, List of Exhibits, for worksheet and cell.
Table 2 — Zambia: the five layers	/Zambia	Reproduced from the REMP financial model. See README_Zambia, List of Exhibits, for worksheet and cell.
Table 3 — Madagascar: two CERI districts	/Madagascar	Externally sourced. Transcribed from two public GIZ factsheets; not a model output. See README_Madagascar for the page-by-page source mapping.
Table 4 — design-choice calibration matrix	—	Qualitative synthesis. Authors' comparison across the three applications; not a model output.
Figure 1 — Finance-Co economic flows	—	Conceptual diagram.
Figure 2 — separation of the two gaps	—	Illustrative schematic. Stylized; consistent with the model flows but not a direct output.
In-text, Section 4 (Uganda)	/Uganda	Reproduced. Cell locators in README_Uganda.
In-text, Section 5 (Zambia)	/Zambia	Reproduced. Cell locators in README_Zambia.
In-text, Section 6.3 (Madagascar)	/Madagascar	Externally sourced. Page locators in README_Madagascar.

4. Data Availability

Consolidated statement. The two financial models (Uganda and Zambia) are built entirely from public, auditable, and referenceable data sources; no proprietary or confidential dataset is embedded. The Madagascar figures are taken from public GIZ factsheets. Provenance is documented per source in each country README:

- **Uganda** — public sources documented in the companion Energy Economics article (Section 4.2, data-sources table, and reference list); the model is that article's publicly available supplementary data.
- **Zambia** — public sources (REMP; Zambian statutes; ERB tariff order) documented inline in the model's 5_Assumptions worksheet and in Section 5 of the manuscript.
- **Madagascar** — two public GIZ / Tosika Angovo factsheets, included in the /Madagascar folder.

A small number of model parameters (financing terms and stakeholder-agreed returns) are embedded inputs rather than separately downloadable datasets; each is documented in the relevant country README. Per-folder data-availability categories and rights certifications are stated in each country README.

Uganda:

No external dataset is loaded at run time; all inputs are embedded in the workbooks. The categories below summarize their origin; the authoritative, parameter-by-parameter documentation (value, time frame, source) is the companion paper, **Table 2**.

- **Electrification plan, connection targets, and unit costs.** Uganda National Electrification Strategy (MEMD & World Bank, 2022). Encoded in the NES worksheet.

- **Source / URL:** <https://nrep.ug/document/national-electrification-strategy-for-uganda-national-electrification-strategy-study-report-nessr-vol1/>
- **Macroeconomic path (GDP growth, USD/US\$ inflation, FX).** IMF World Economic Outlook (Uganda).
 - **Source / URL:** <https://www.imf.org/en/Countries/UGA>
- **Tariff baseline and schedule.** ERA Q4-2024 approved tariffs by consumer category.
 - **Source / URL:** <https://www.era.go.ug/tariff-schedules/>
- **Utility historical and calibration data.** Umeme Ltd and UEDCL annual reports (2018–2024); 20% concession return from Twesigye (2023).
 - **Source / URL:** <https://www.umeme.co.ug> · <https://www.uedcl.co.ug>
- **Corporate tax rate.** PwC Uganda corporate tax summary (30%).
 - **Source / URL:** <https://taxsummaries.pwc.com/uganda/corporate/taxes-on-corporate-income>
- **Financing terms and agreed returns.** Grants pro-rata with CAPEX; concessional debt 2% / 6-yr grace; commercial debt 8%; off-grid 12% return; SHS regulated payment USD 12/hh-yr. Documented in the EU sector stocktaking (Pérez-Arriaga, Díaz-Pastor & de Abajo, 2022) and de Abajo (2023); see companion paper Table 2.

Zambia:

No external dataset is loaded at run time; all inputs are embedded in the workbooks and documented inline in 5_Assumptions.

- **Least-cost rollout: connection targets by mode and unit costs.** Rural Electrification Master Plan 2025–2030 (MoE & REA, 2026).
 - **Source / URL:** <https://www.moe.gov.zm/?p=5722>
- **Contractual and levy basis.** Public-Private Partnership Act No. 18 of 2023; Rural Electrification Act No. 5 of 2023; Statutory Instrument No. 52 of 2024 (Government of the Republic of Zambia).
 - **Source / URL:** <https://www.mofnp.gov.zm/?wpdmp=act-no-18-of-2023-the-public-private-partnership>
- **Tariffs and utility financials.** ZESCO Multi-Year Tariff Order (Energy Regulation Board, 2024–2027); cited inline in 5_Assumptions.
- **Macroeconomic and exchange-rate path.** Documented in the 6_Macro_FX worksheet.
- **Stakeholder-agreed parameters.** Cost of capital (ZESCO WACC $\approx$ 5.15%; private/off-grid $\approx$ 8.925%), grant shares (90% ZESCO / 20% PrivateCo / 50% off-grid), 3% rural electrification levy, 1.25 $\times$ coverage test. Documented in 5_Assumptions (sections D.2, G.1.4, G.5) and Section 5.2–5.3 of the manuscript.

Madagascar:

Source of Table 3 (included in the package):

- **GIZ (2025b) — Fandriana.** “Electrification Rurale Intégrée de Fandriana.” Deutsche Gesellschaft für Internationale Zusammenarbeit (Tosika Angovo). File giz2025-fr-...Fandriana.pdf.
 - **Public URL:** <https://www.giz.de/de/downloads/giz2025-fr-Electrification%20Rurale%20Intégrée%20de%20Fandriana.pdf>
- **GIZ (2025c) — Jiro Taratra.** “Electrification Rurale Intégrée de Jiro Taratra.” Deutsche Gesellschaft für Internationale Zusammenarbeit (Tosika Angovo). File giz2025-fr-...Jiro_Taratra.pdf.
 - **Public URL:** <https://www.giz.de/de/downloads/giz2025-fr-Electrification%20Rurale%20Intégrée%20de%20Jiro%20Taratra.pdf>

Context sources cited in Section 6 (not the source of Table 3, referenced only):

- GIZ (2025a), “La GIZ renforce l'accès à l'énergie durable à Madagascar” — <https://www.giz.de/sites/default/files/media/els-document/2026-01/giz-renforce-l-acces-l-energie-durable-madagascar.pdf>
- IMF (2025), Republic of Madagascar 2024 Article IV — <https://www.imf.org/-/media/files/publications/cr/2025/english/1mdgea2025001-print-pdf.pdf>
- Government of Madagascar (2017a/b), Laws No. 2017-021 (FNE) and No. 2017-020 (Electricity Code) — https://cnlegis.gov.mg/page_find_direct_mots/

5. Instructions for Replicators

- **Uganda and Zambia.** Open each Excel workbook in the country folder in Microsoft Excel 2016 or later (or Microsoft 365), with iterative calculation enabled (already set in the delivered files). Workbooks recalculate on open; reported values are also stored as cached results. Locate each value with the country README's List of Exhibits.
- **Madagascar.** There is no code to run. Open the two GIZ factsheets in any PDF reader and verify Table 3 against the page-by-page source mapping in README_Madagascar.

Each country README contains the complete, folder-specific instructions.

6. Requirements

- **Software:** Microsoft Excel 2016 or later (or Microsoft 365) for the Uganda and Zambia models, with iterative calculation enabled; any PDF reader for the Madagascar factsheets and the companion article. No add-ins, macros, or scripts.
- **Computation:** none beyond a standard laptop. No executable code; all computation is performed by native Excel formulas at workbook open / recalculation.
- **Runtime:** each workbook opens and recalculates in well under five hours — typically under one minute — so the World Bank's five-hour and one-day runtime provisions do not apply.
- **Storage:** the models total a few MB per country; the factsheets are small PDFs.