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Methodology note

Open Energy Tracking: Tracking Residential Electricity Consumption Tiers at the National Level

Binary access rates tell us who is connected to electricity, but not how much electricity people use once they are connected. A connection that powers a lightbulb and a phone charger counts the same as one that runs a refrigerator, a water pump, or an electric cooker. Yet household consumption, not connections alone, determines whether electricity supports health, education, and well-being.

The World Bank's Multi-Tier Framework (MTF) offers a way past binary access rates. It rates the electricity supply households receive on attributes such as capacity, reliability, and power quality, and separately defines tiers of annual household electricity consumption, from Tier 0 (below 4.5 kWh a year) to Tier 5 (3,000 kWh or more).[1] The consumption tiers capture what binary access rates miss: how much electricity people actually use.

Unfortunately, tracking consumption tiers at scale is not straightforward. Energy authorities do not report the share of households in each tier: many customers are not metered, utilities do not always keep comprehensive consumption records, and people without an official grid connection never appear in utility data at all. Household surveys help, but they cover few countries and years.

In August 2025 we showed how Open Energy Maps (OEMaps),[2] a machine learning platform that estimates electricity access and demand for individual buildings, can fill this gap, and presented a first snapshot of electricity consumption by MTF tier for African countries in 2020.[3]

Since then we have turned the snapshot into a tracker. Open Energy Tracking,[4] a public platform and dataset, now estimates the share of people in each MTF consumption tier for 84 low- and middle-income countries across Africa, Asia, and Latin America and the Caribbean, for every year from 2019 to 2025. Each estimate starts from building-level models of electricity access and demand, places each country's population and utility customers in those buildings, and matches the country's reported household electricity use. A final transformation, learned from utility billing records and household surveys, adjusts how consumption is spread across customers so that the method generalizes across all modeled countries. We check the method against household surveys and utility billing records.

[1] Bhatia, M.; Angelou, N. (2015). Beyond Connections: Energy Access Redefined. ESMAP Technical Report 008/15. Washington, DC: World Bank. https://hdl.handle.net/10986/24368. DOI: 10.1596/24368.

[2] Open Energy Maps website: https://www.openenergymaps.org.

[3] Lee, S.J.; Taneja, J. (2025). Methodology note: Tracking Multi-Tier Framework Attainment at the National Level with Open Energy Maps. Energy for Growth Hub, August 2025.

[4] Open Energy Tracking website: https://openenergytracking.org.

This note describes the methodology behind Open Energy Tracking, from building-level estimates to national tier shares, and how we check the results.

Measuring tiers per person

The MTF's consumption formulation defines tiers by annual household electricity consumption. Households vary widely in size, so the same household total can mean very different amounts of electricity per person. We therefore measure consumption per person and express the MTF thresholds per person by dividing each household threshold by five people (Table 1), the same convention as our August 2025 note. Tier 4 or above, at least 250 kWh per person per year, matches the household component of the Modern Energy Minimum.[5]

Tier	Household range (kWh/year)	Per-person range (kWh/year)
Tiers 0 & 1	below 73	below 14.6
Tier 2	73 to 365	14.6 to 73
Tier 3	365 to 1,250	73 to 250
Tier 4	1,250 to 3,000	250 to 600
Tier 5	3,000 or more	600 or more

TABLE 1: MTF household consumption ranges and the per-person ranges we report.

We report Tiers 0 and 1 together. The threshold between them, 0.9 kWh per person per year (enough for task lighting and phone charging), is too small to tell apart reliably with remote sensing data, so separating the two would carry high uncertainty.

Open Energy Maps: access and demand for every building

Open Energy Maps estimates two things for each building: how likely it is to have a grid or grid-quality connection, and how much electricity its residents would use if connected (Figure 2).

Remote sensing at scale. We join building footprints from Google, Microsoft, and other open sources with satellite-derived building heights and the year each building first appears, land cover, nighttime lights, and internet speed measurements.[6] Intuitively, all else equal, buildings are more likely to be connected and to use more electricity if they are larger and taller, sit in denser neighborhoods, appear under brighter nighttime lights, and lie in areas with heavy internet use and fast speeds. We now compile these features for nearly two billion buildings, through 2025 where data are available.

Ground truth from utility partners. We train our models where utility partners have shared georeferenced data with us, primarily in East African countries, with additional grid and mini-grid data from parts of West and Southern Africa. *Access* is learned from low-voltage distribution network records and meter locations: a building is labeled connected when a meter or a

[5] Energy for Growth Hub, The Modern Energy Minimum, https://energyforgrowth.org/project/the-modern-energy-minimum/.

[6] Building footprints: Google Open Buildings, Microsoft Global ML Building Footprints, and Overture Maps. Building heights and first-appearance years (2016–2023): Google Open Buildings 2.5D Temporal, with heights and volumes also from the DLR World Settlement Footprint 3D. Land cover: Esri and Impact Observatory 10 m annual land cover. Nighttime lights: VIIRS annual composites from the Earth Observation Group, Colorado School of Mines. Internet speeds: Speedtest® by Ookla® Global Fixed and Mobile Network Performance Maps, CC BY-NC-SA 4.0.

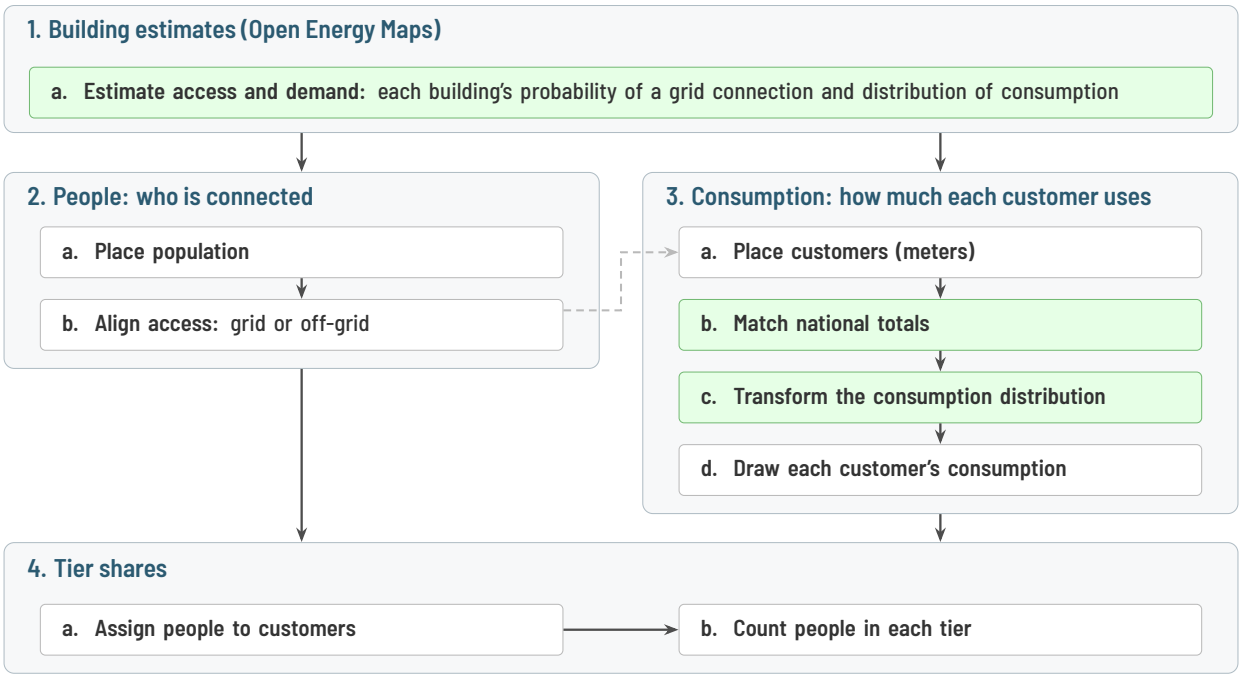


FIGURE 1: Our pipeline going from building-level estimates to national tier shares. Building estimates feed two tracks, people and consumption, which merge when people are assigned to customers and counted by tier. Key steps are shaded green; the dashed arrow shows customer counts rising where aligning access rates adds connections.

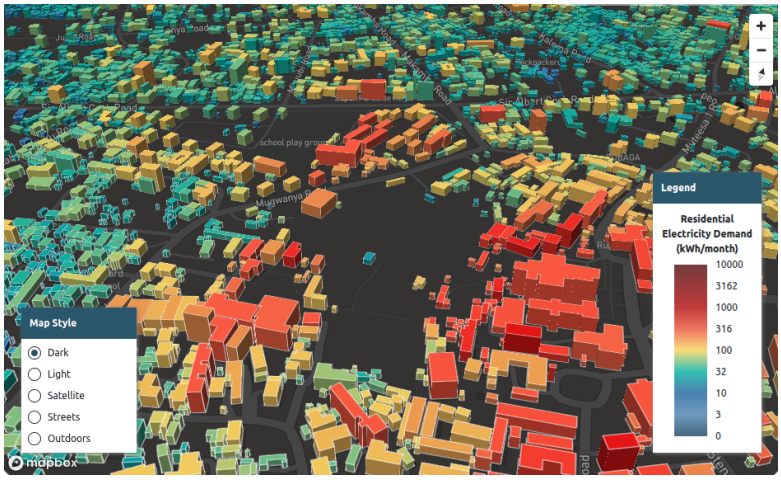


FIGURE 2: Estimated residential demand for individual buildings in Kampala, Uganda, at their estimated heights. Blue buildings use less electricity; orange and red, more.

low-voltage network endpoint lies within 40 m of it, and not connected otherwise. *Demand* is learned from monthly residential billing data for those meters.

A model built for demand. Consumption spans several orders of magnitude, and utility meter locations rarely match buildings exactly. Our demand model, LItLDF (Load Inference through Lightweight Data Fusion), predicts a full probability distribution of consumption for each build-

ing, and learns from meters that cannot be tied to one building with certainty.[7]

Tested against alternatives. Earlier versions of these models, tested on held-out utility data, reached 80.7% accuracy for access against 70.9% for the best published alternative. On held-out utility data from more than 8,000 settlements, they reduced demand estimation error by 15 to 46% relative to the best demand scenario in the World Bank's Global Electrification Platform.[8]

From buildings to people

Figure 1 groups the process into four stages, run for every country and year. Supplement S3 gives the details behind each one.

1. Building estimates. Open Energy Maps gives every building a probability of a grid connection and a distribution of consumption, as described above.

2. People: who is connected.

(a) *Place population.* We distribute WorldPop's gridded population across buildings in proportion to their expected number of dwellings[9] and match each country's total to World Bank figures.

(b) *Align access.* We split the World Bank access rate, which counts everyone with electricity, into grid and off-grid shares using household surveys and IRENA statistics[10] (Supplement S3), and adjust each building's modeled probability of a grid connection so that the share of people in connected buildings matches the grid share. Grid-connected users, including most users of grid-quality mini-grids, are modeled building by building. Users of solar home systems, solar lanterns, and other off-grid systems fall outside our demand model, which is trained on grid data, so we place them in tiers using MTF survey data on the capacity of their systems, or regional or cross-country medians where a country has no such survey.

3. Consumption: how much each customer uses.

(a) *Place customers.* Customer counts determine how a country's electricity is divided among meters. A model trained on a utility meter registry predicts the expected number of residential customers in each building from its features. Weighted by each building's probability of a grid connection, these predictions give both the national count and its spatial distribution. Where utilities or regulators publish residential customer counts, the modeled counts are rescaled to agree with them across the years they cover. Elsewhere, the modeled counts

[7] Lee, S.J. (2023). *Multimodal Data Fusion for Estimating Electricity Access and Demand*. Doctoral thesis, Massachusetts Institute of Technology. https://hdl.handle.net/1721.1/152664. IEA (2024). Africa's electricity access planners turn to geospatial mapping. IEA, Paris. https://www.iea.org/commentaries/africas-electricity-access-planners-turn-to-geospatial-mapping. License: CC BY 4.0.

[8] Access: Lee, S.J. (2023). *Multimodal Data Fusion for Estimating Electricity Access and Demand*. Doctoral thesis, Massachusetts Institute of Technology. Demand: Lee, S.J.; Taneja, J. (2025). Methodology note: Tracking Multi-Tier Framework Attainment at the National Level with Open Energy Maps. Energy for Growth Hub, August 2025, Supplemental Figure 1.

[9] Bondarenko, M.; Kerr, D.; Sorichetta, A.; Tatem, A.J. (2020). Census/projection-disaggregated gridded population datasets for 51 countries across sub-Saharan Africa in 2020 using building footprints. WorldPop, University of Southampton. DOI 10.5258/SOTON/WP00682. Bondarenko, M.; Kerr, D.; Sorichetta, A.; Tatem, A.J. (2020). Census/projection-disaggregated gridded population datasets for 189 countries in 2020 using Built-Settlement Growth Model (BSGM) outputs. WorldPop, University of Southampton. DOI 10.5258/SOTON/WP00684. Constrained version, https://www.worldpop.org.

[10] World Bank, World Development Indicators: Access to electricity (% of population), EG.ELC.ACCS.ZS, and Population, total, SP.POP.TOTL, https://data.worldbank.org. IRENA (2024, 2025). *Off-grid Renewable Energy Statistics*, 2024 and 2025 editions. International Renewable Energy Agency, Abu Dhabi. United Nations, Department of Economic and Social Affairs (2022). *Database on Household Size and Composition 2022*.

are used directly. Because counts follow connection probabilities, they rise where aligning access adds connections.

(b) *Match national totals.* Modeled consumption is scaled to each country's residential electricity consumption as reported in the IEA World Energy Balances or, where IEA data are unavailable, in the United Nations Energy Statistics Database or the utility's own published sales.[11] Where utility-reported residential sales indicate that this figure is inaccurate, the utility figure is used instead (Supplement S3).

(c) *Transform the consumption distribution.* Our models capture how consumption differs between buildings, and a transformation sets how widely it is spread across a country's customers. Learned from utility billing records by consumption band and six World Bank MTF surveys, it reshapes that spread while keeping the total. It is fitted to some countries' own billing records; elsewhere one pooled rule applies, and its effect depends on household electricity use per person[12] (Figure 3; equations in Supplement S2). We check the result separately against household surveys not used in fitting, rescaled to utility sales where possible so that surveys and estimates can be compared (see Validation).

(d) *Draw each customer's consumption* from its building's demand distribution; for most countries, part of the transformation applies after this draw (Supplement S2).

4. Tier shares.

(a) *Assign people to customers*, allowing for shared meters, second meters, and empty homes.

(b) *Count people in each tier*, for each country and each year.

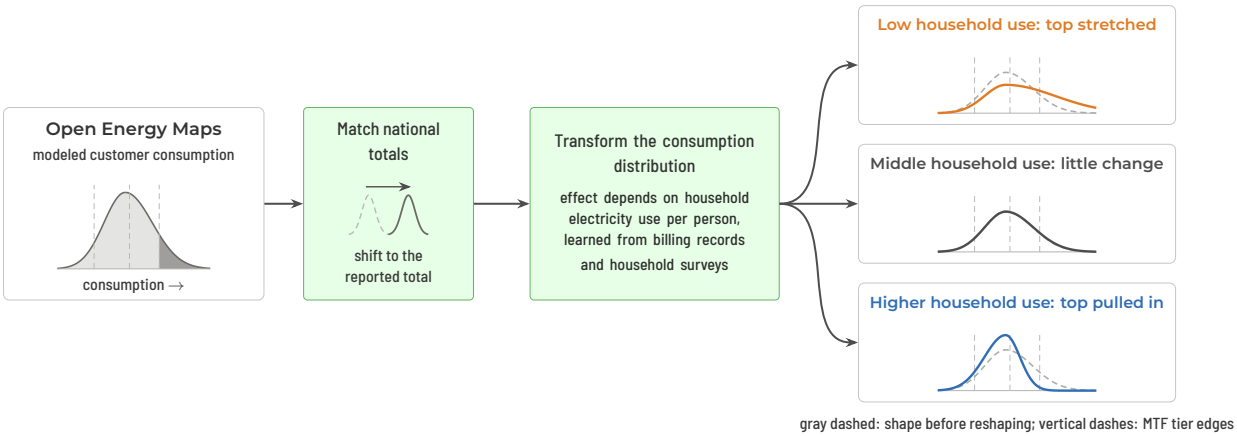


FIGURE 3: Matching national totals, then reshaping the spread (schematic). One rule, learned from billing records and surveys and parameterized by household electricity use per person, reshapes each country differently while keeping its total (see footnote 12). Gray dashed curves show the shape before reshaping. Countries with their own billing records are fitted to them directly (Supplement S2).

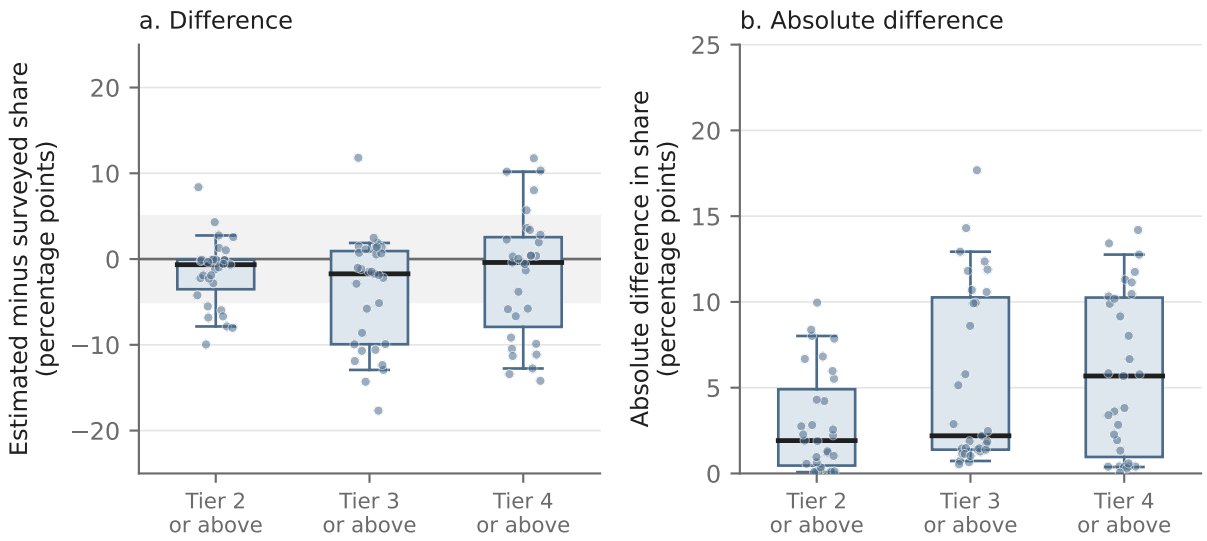


FIGURE 4: How our estimates compare with household surveys: the difference (a) and absolute difference (b) between our share of people at or above each tier and the survey's. Each dot is one of the 31 held-out surveys; boxes show the middle half of surveys and the median; whiskers extend to the 5th and 95th percentiles. The shaded band marks ±5 points.

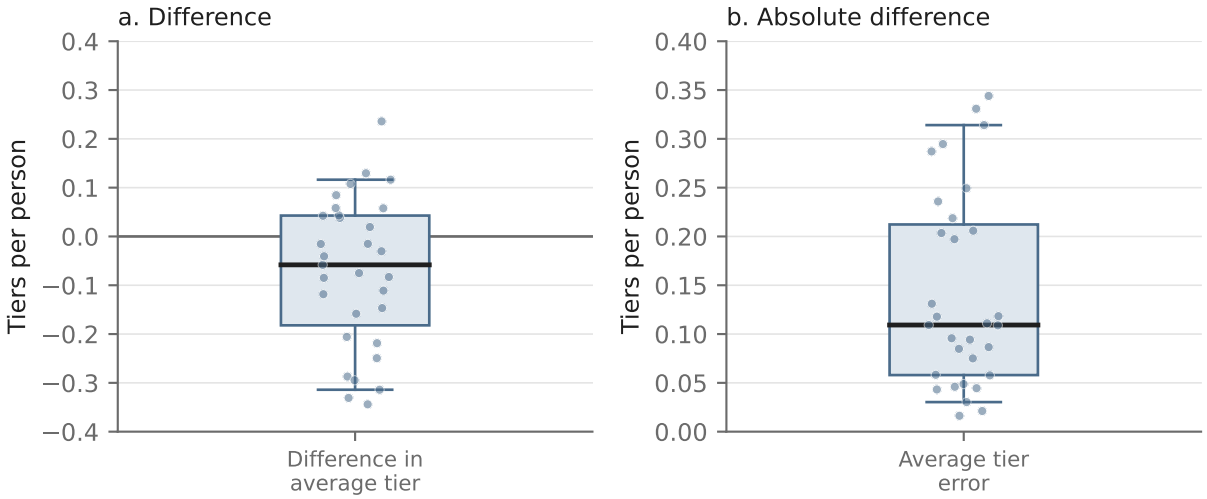


FIGURE 5: Difference in average tier (a) and average tier error (b), in tiers per person (Supplemental Table 2), for the 31 surveys not used to fit the transformation. In (a), positive values mean we place people higher on the tier ladder than the survey does, on average; in (b), the sign is dropped, so the value shows how far from the survey's placement a person lands on average.

Validation

Country-level tier statistics are not published regularly for most countries, so we check our estimates against every source we can find: 40 household surveys in 28 countries, including World Bank MTF surveys, and utility billing data for 21 countries, which also inform the transformation (Supplement S5). The tiers in published MTF reports rate the electricity supply households receive, such as capacity, hours, and reliability, rather than how much they use, so we do not compare against them. Instead, we compute our own per-person consumption tiers from each survey's household data: kilowatt-hours where the survey records them, and otherwise electricity bill spending, converted to kilowatt-hours with the country's residential tariff schedule. Utility billing tables are different: they count customer accounts by monthly consumption band, and their band edges rarely match the MTF tier thresholds. We therefore compare our modeled customers with each table at the table's own band edges.

Survey-based consumption figures carry errors of their own, unrelated to our model: sampling and reporting error, subsidies, billing periods, losses, misreported bills, and, where only spending is recorded, the conversion to kilowatt-hours. The national statistics to which our estimates are anchored are likewise imperfect. Many of these errors shift a survey's reported consumption up or down as a whole. Where the utility's billed residential sales for the survey year are available, every grid-connected household's consumption in the survey is multiplied by a single factor, chosen so that the national residential total implied by the survey equals those sales. This corrects the survey's overall level while preserving the relative distribution of consumption across households, so the comparison centers on how consumption is distributed. Some disagreement between a survey and our estimates is therefore expected even where the estimates are accurate.

Our primary validation set comprises 31 household surveys in 22 countries, each conducted within two years of the estimate year and held out from fitting the consumption distribution (Figure 4). The median absolute difference between our share of people at or above each threshold and the survey's is about 2 percentage points at Tiers 2 and 3 and about 6 at Tier 4. The mean difference (bias) is under 4 points in magnitude at every threshold, and the median tier error is 0.11 tiers per person (Figure 5). Every survey is within 20 points of our estimate at every threshold, and the larger differences come from a small number of countries.

These results come from a single method that combines national statistics with remote sensing to estimate each country's distribution of household electricity consumption, without fitting its consumption distribution to the surveys it is checked against. To our knowledge, it is the first approach to produce consumption-tier estimates across low- and middle-income countries that hold up against household surveys in this way.

What the tracker shows

Open Energy Tracking presents these estimates through an interactive map, a country list, and a page for each country. Each country page shows a stacked bar chart of the share of people in

[11] IEA (2026). *World Energy Balances*, July 2026 edition; residential final consumption of electricity. United Nations Statistics Division. *Energy Statistics Database*, electricity consumption by households, data through 2024, https://data.un.org. African Energy Commission (2024, 2025). *Africa Energy Balances*, 2024 and 2025 editions. African Union, https://au-afrec.org.

[12] Where average use is very low, a small group of wealthier households uses far more than everyone else, so consumption is more unequal than our models predict and the top of the distribution is stretched. Where use is higher, appliances such as refrigerators and televisions are widespread, use is more evenly shared, and the top is pulled in.

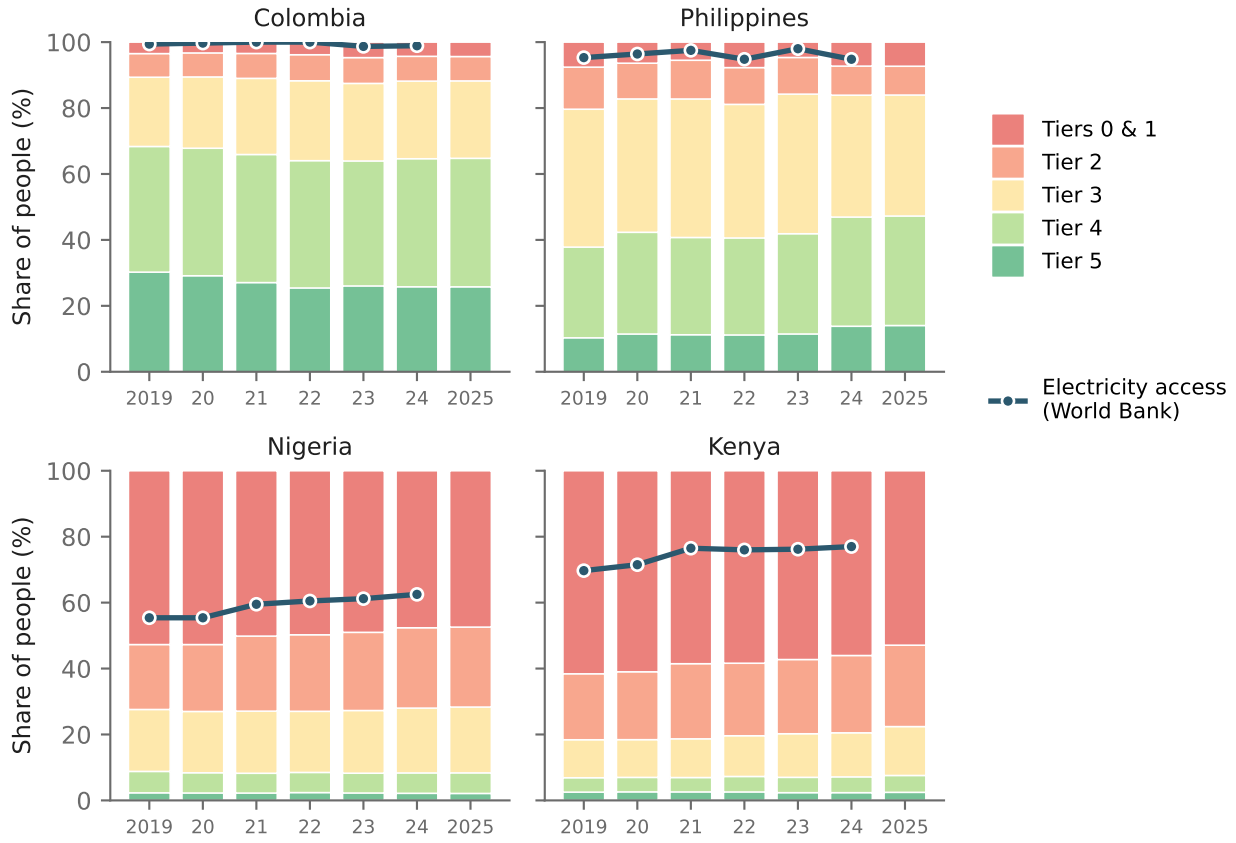


FIGURE 6: Share of people in each tier from 2019 to 2025 for four countries, as published on Open Energy Tracking. The line shows the World Bank electricity access rate, available through 2024. If our estimates and the World Bank access rates are accurate, the line may be read as dividing the combined Tiers 0 & 1 block: the portion below it approximates the share of people in Tier 1 and the portion above it the share in Tier 0.

each tier from 2019 to 2025, together with the World Bank's binary access rate (Figure 6; Supplement S4 shows the same chart for every country). Because people without any access fall in Tier 0, the gap between the access line and the top of the Tier 2 block can be read as an estimate of the share of people who are connected but use very little electricity. The page also identifies the national statistic to which the estimates are anchored, and it marks years in which that statistic is projected, as it is for 2025 in almost every country, or modeled where no usable statistic exists (Supplement S3). Countries whose estimates have a known weakness are flagged for use with caution, with the reason stated on the country page (see Known limitations). A comparison view sets countries' tier shares side by side, and the full dataset can be downloaded as a CSV file. The landing map shows which countries are covered (Supplemental Figure 1).

Known limitations

Seven countries are flagged for use with caution, under one of two rules:

- *Coverage:* our coverage checks fail, either because mapped buildings account for less of the population than a set threshold, or because modeled connections per person fall outside a set range around the demographic estimate.

- *National total:* the national total is less certain, for one of three reasons. No published statistic covers every year, so the total is modeled; the published statistic excludes part of the country; or it differs from the utility's own figures by more than 25%. Smaller differences are generally corrected with utility data (Supplement S3).

Some year-to-year noise also comes from the national statistics we anchor to. The World Bank revises its access series, and IEA and UN household electricity figures are sometimes estimated, rebased, or carried forward from an earlier year. We use these series as published, apart from the utility checks described in Supplement S3, so their revisions can shift tier shares from one year to the next. Where no statistic has yet been published, as for 2025 in most countries, the national total is projected; in backtests, these projections differed from the figures later published by a median of about 4% one year ahead.

Conclusion

Binary access rates tell us who is connected. Consumption tiers tell us how much electricity people use. To estimate these tiers at scale, Open Energy Tracking places people and utility customers in the buildings mapped by Open Energy Maps and aligns them with World Bank access rates and published customer counts. It then matches each country's reported residential electricity consumption and shapes its distribution using utility billing records and household surveys. Validated against household surveys held out from fitting the consumption distribution, the result is a consistent view of electricity consumption by MTF tier across 84 countries and seven years.

Future work

Expanded coverage and data quality. We plan to add the low- and middle-income countries not yet covered and to close the gaps behind the current caution flags, for example by compiling building data where coverage is short and finding utility data where national totals are modeled or uncertain.

Apartment buildings. Large multi-unit buildings remain hard to represent, because our demand models see one building where there may be dozens of households. We are developing an explicit treatment.

Additional validation data. Each new household survey, and each new partnership, lets us test and improve our estimates for more countries. We continue to incorporate new surveys as they are published, and we welcome partners who can share consumption records, household surveys, or off-grid consumption data from solar home systems and mini-grids.

Supplement

S1. Validation summary

Supplement S5 lists every survey and billing table we use. Two groups fit the transformation: the billing tables from all 21 countries and six MTF surveys (Burundi, Ethiopia, Nepal, Niger, São Tomé and Príncipe, and Zambia). All other surveys are held out from fitting and used for validation; the 31 surveys in 22 countries conducted within two years of the estimate year form the main check. Supplemental Tables 1 and 2 give the results.

	Tier 2 or above	Tier 3 or above	Tier 4 or above
Average difference (bias)	−1.6	−3.8	−1.8
Median difference	−0.7	−1.7	−0.4
Average absolute difference	2.9	5.4	5.8
Median absolute difference	1.9	2.2	5.7
90th percentile absolute difference	7.9	12.4	11.7
Largest absolute difference	10.0	17.7	14.2
Surveys within 5 points	74%	58%	48%
Surveys within 10 points	100%	74%	71%

SUPPLEMENTAL TABLE 1: Agreement with surveys at each threshold: our share of people at or above the tier minus the survey's, in percentage points, for the 31 held-out surveys, rescaled to utility sales where available.

	Tiers per person
Average shift in tier (bias)	−0.07
Average tier error	0.14
Median tier error	0.11
90th percentile tier error	0.29
Largest tier error	0.34

SUPPLEMENTAL TABLE 2: Average tier error: how far, in tiers, a person lands from the tier the survey places them in. A value of 0.14 means, for example, that 14% of people are one tier away from the survey's placement, or 7% two tiers away. The shift keeps the sign: negative means we place people lower than the survey does.

S2. Distribution transformation

How the forms were chosen. All forms are simple and parametric, with a handful of parameters, and were chosen in a validation framework that scores each candidate on data left out of its fit. For the pooled map after the draw, we compared more than 200 candidates (six families, each with or without one of several country characteristics) by leave-one-country-out cross-validation: each candidate was fitted with one billing-table country left out and scored on that country, repeating for every country. The own-billing form and the pooled slope were chosen among a few pre-registered alternatives in the same way. The pooled slope is fitted to 87 billing tables from 21 countries and the map's four coefficients to billing tables from 10 countries and six MTF surveys, so selection on held-out scores guards against overfitting; the chosen map also beat versions fitted to shuffled country characteristics on the combined score. The forms below are the ones the framework selected. Every step keeps each country's total.

Countries with their own billing records (sources in Supplement S5). Each customer's expected monthly consumption e_i is compared with the country's median m. The ratio e_i/m is raised to one power below the median (γ) and another above it (τ), so that the lower and upper halves of the distribution can be stretched or compressed independently:

$$e_i' = \begin{cases} k\, m\, (e_i/m)^{\gamma} & e_i < m, \\ k\, m\, (e_i/m)^{\tau} & e_i \geq m. \end{cases} \tag{1}$$

An exponent above 1 spreads that half of the distribution further from the median; an exponent below 1 draws it closer. The factor k rescales all customers so that the national total is unchanged, and γ and τ are fitted to each country's billing records.

All other countries. One pooled rule applies, in two steps. Before the draw, each customer's expected consumption is pulled partway toward the national mean, with a slope shared across countries. After each customer's consumption is drawn from its building's demand distribution, consumption in two ranges, the household Tier 2 range and the range above the household Tier 4 threshold, is stretched or compressed by a factor that depends on the country's household electricity use per person x_c:

$$s_c = A\, x_c^{\delta}, \tag{2}$$

with one pair of coefficients (A, δ) for each range. The rule thus has five parameters in all, shared by every country. Where use per person is low, the top of the distribution is stretched; where it is higher, it is pulled in (footnote 12). Every step keeps each country's total.

S3. Modeling assumptions

National residential electricity consumption totals come from the IEA World Energy Balances, or, where IEA data are missing, from United Nations statistics or the utility's own published sales. For 2025 (except Argentina and Brazil, which have provisional figures) and the few other years without a published total, a simple growth model projects it from the latest available year (Supplemental Table 5). Where a country's own utility reports show the IEA or UN figure to be inaccurate, we use the utility's figures instead (Supplemental Table 3). Countries with only short series use a modeled level throughout, informed by African Energy Commission statistics where available. Supplemental Table 4 lists the other modeling assumptions by step.

SUPPLEMENTAL TABLE 3: National totals taken from utility reports instead of IEA or UN statistics. Each rule applies where the utility's own sales show the international figure to be inaccurate; country pages cite the utility documents.

Rule	Trigger and action	Countries and years
Level	International statistic and utility sales differ by more than about 9%: move to the utility figure, or the closest bound it allows. Where the international figure is an estimate, low-voltage sales or generation serve as upper bounds.	Colombia 2019–2024; Côte d'Ivoire 2021; Gabon 2019–2024; Haiti 2020–2024; Jamaica 2022; Madagascar 2019; Malaysia 2023; Mauritania 2019–2024; Mozambique 2019, 2023; Senegal 2019–2024; Sri Lanka 2019; Sudan 2022; Timor-Leste 2022; Togo 2021–2024; Zambia 2019; Zimbabwe 2023
Growth	A year-on-year change differs from the utility's sales growth by more than about 5%: follow the utility's growth.	Angola 2019–2023; Benin 2019–2020; Burkina Faso 2019–2022, 2024; Burundi 2019; Egypt 2024; Indonesia 2020; Malawi 2019–2022, 2024; Tanzania 2024; Togo 2019–2020
Utility actuals	Published 2024 utility sales replace the projection.	Grenada and Saint Lucia 2024

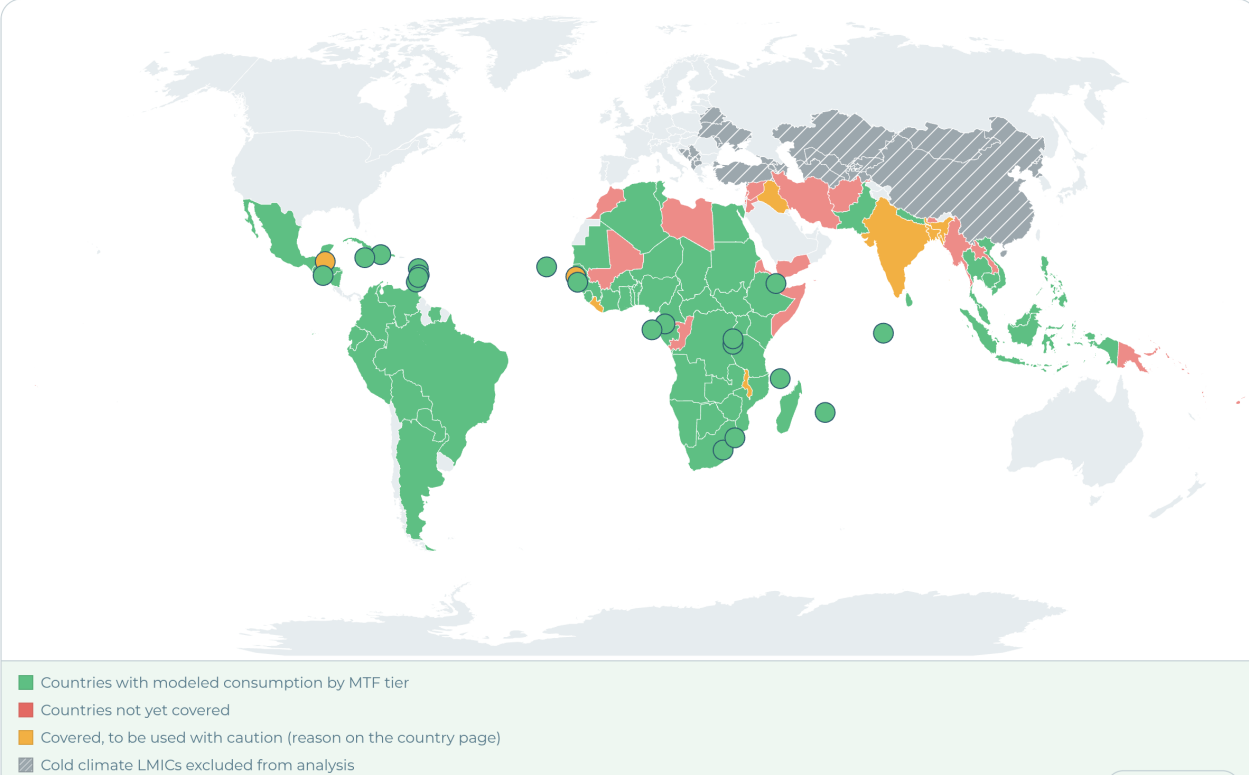
SUPPLEMENTAL TABLE 4: Modeling assumptions by step.

Step	Assumption	Source
Input data years	Latest available year for each input: buildings through 2023, other inputs through 2025; gaps take the closest year.	See main text
Population	WorldPop allocated to buildings by expected number of dwellings, scaled to World Bank totals.	WorldPop 2020; World Bank
Grid access	World Bank access rate minus the off-grid share, raised where customer counts imply more connections.	World Bank
Off-grid users	Share from household surveys, trended with IRENA statistics; tiers from MTF off-grid capacity data (country, regional, or cross-country median).	MTF, DHS, MICS, censuses; IRENA
People per customer	About 1.2 households per customer, capped at the 90th-percentile household size.	MTF surveys; UN household size data
Unoccupied accounts	Where accounts outnumber occupied households, the lowest-use accounts (at most 15%) are treated as unoccupied.	Census and utility counts
Countries not reported	Too little building coverage, too different from training data, missing inputs, or heating-dominated demand.	—

SUPPLEMENTAL TABLE 5: Setting national totals for 2025 and other years without a published statistic.

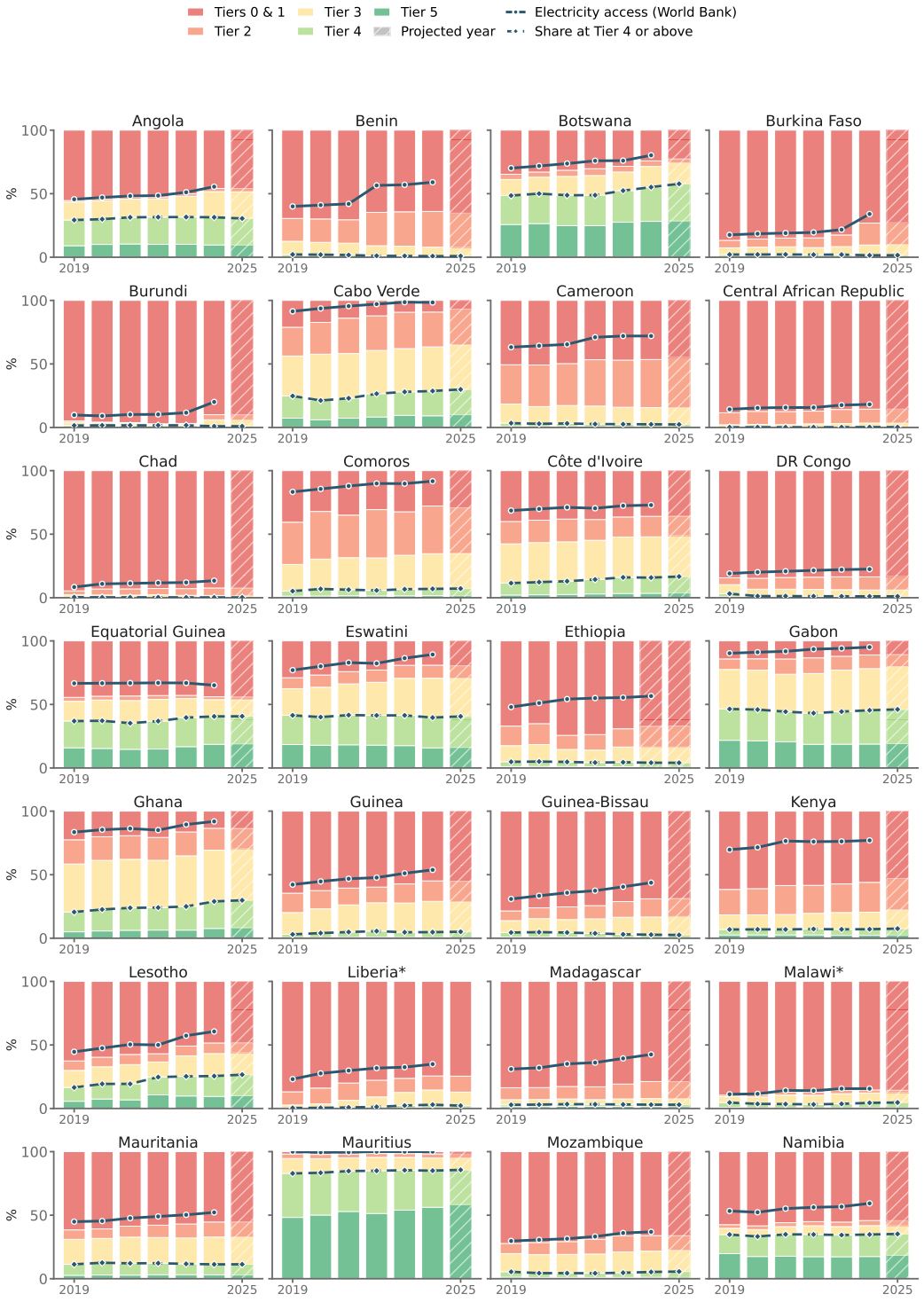
Situation	How the total is set
Default	The latest published total grows at the average of the country's own growth over the previous four years and the median latest-year growth in its World Bank region. Where a country has fewer than three years of history, the regional median is used alone.
Utility or regulator reports 2025 sales	The reported 2024–2025 growth in residential sales is applied instead: Egypt, Ghana, Kenya, Mexico, Nepal, Pakistan, the Philippines, Thailand, and Uganda.
IEA provisional figure available	Argentina and Brazil use the IEA's provisional 2025 figures.

S4. Tier shares by country

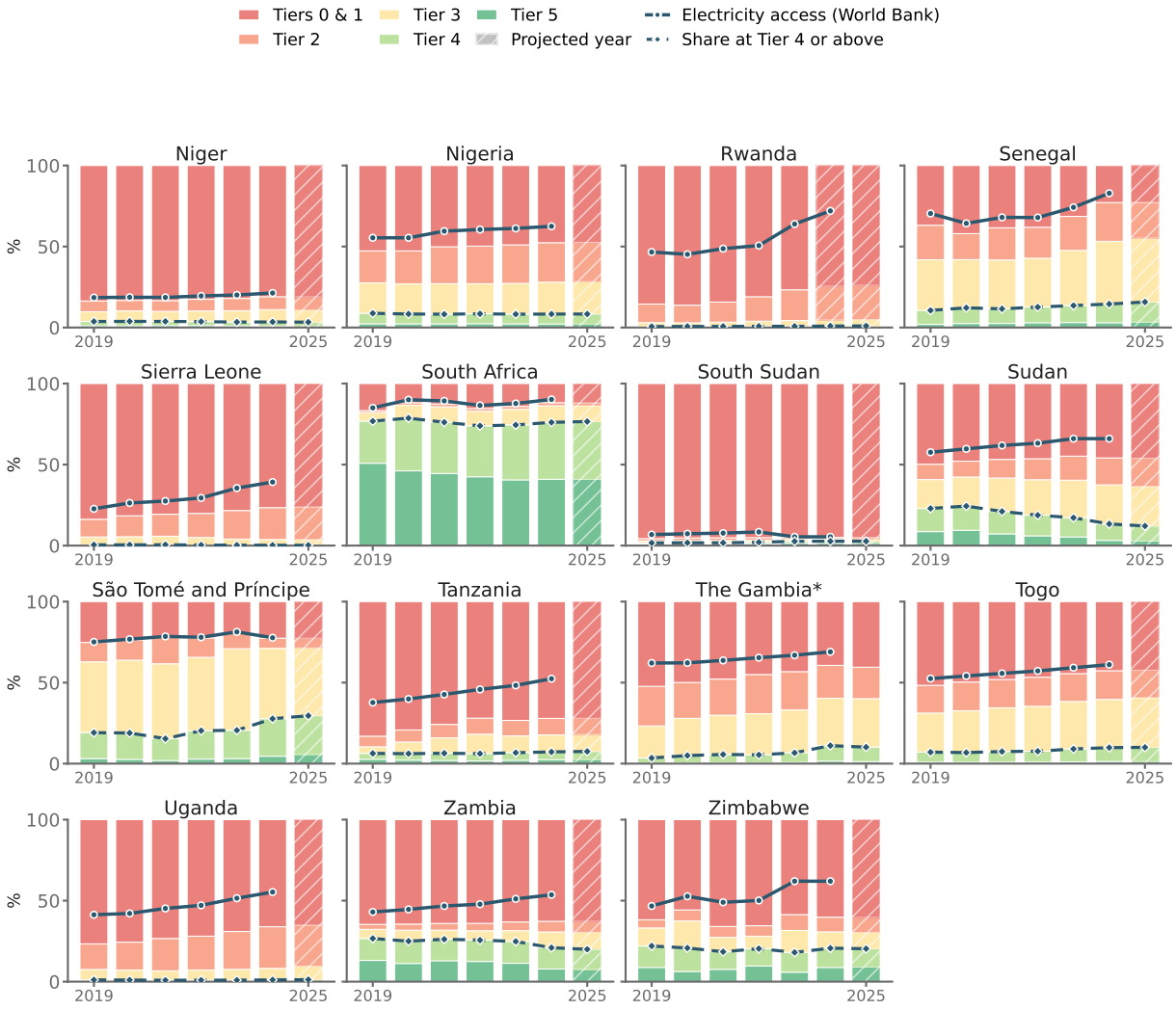


SUPPLEMENTAL FIGURE 1: Coverage on Open Energy Tracking. Green and amber: the 84 covered countries; amber ones are to be used with caution (each country page gives the reason). Red: not yet covered. Gray hatching: cold-climate countries excluded. Circles mark very small countries.

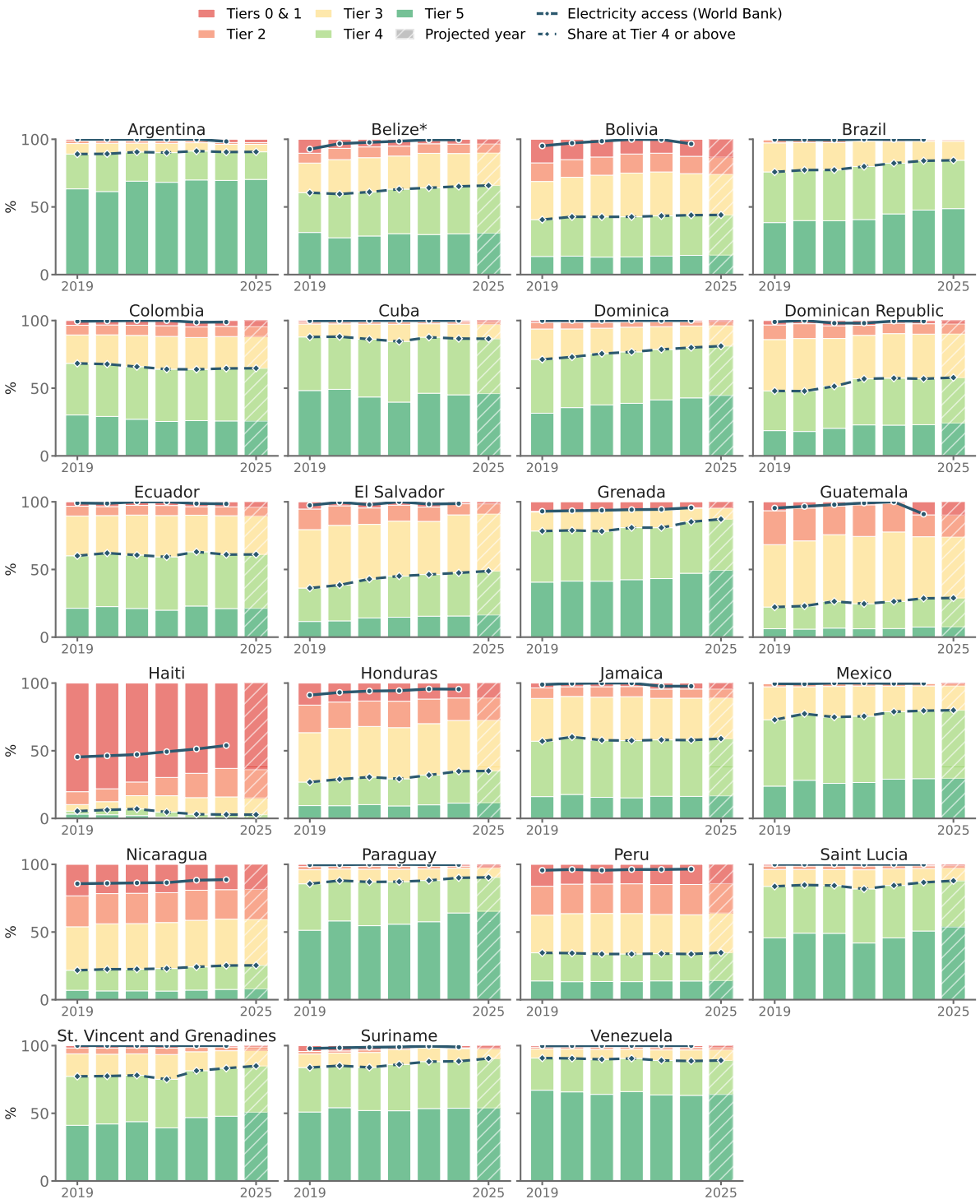
Supplemental Figures 2–6 show each country's tier shares by World Bank region, with the access rate and the share at Tier 4 or above (dashed). Hatched bars are projected years; asterisks mark countries flagged for caution.



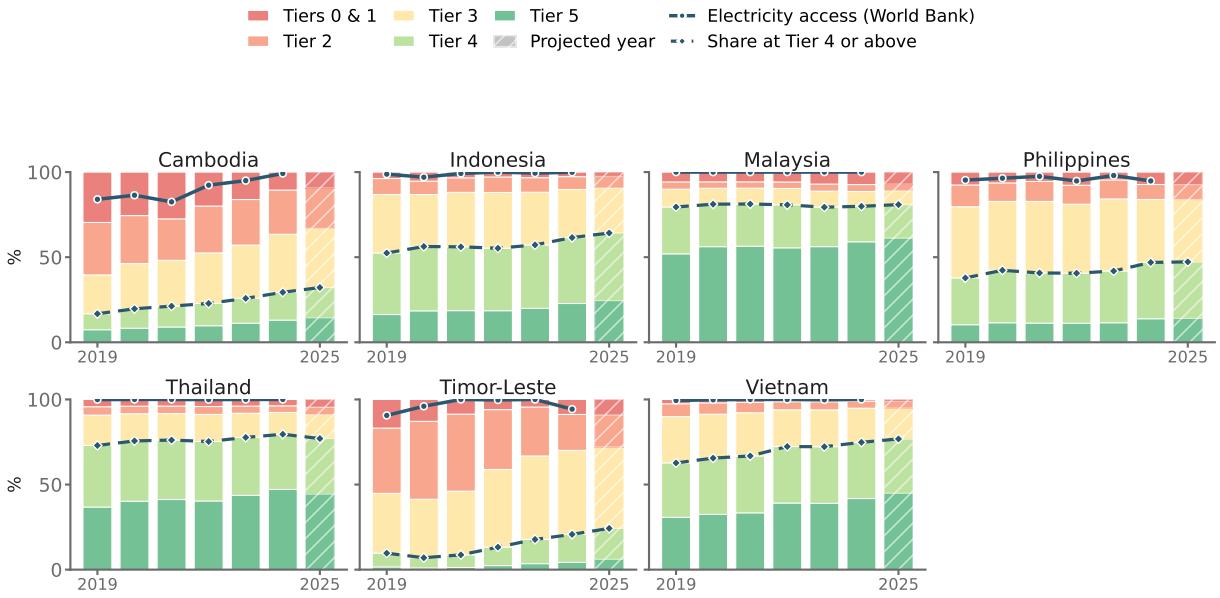
SUPPLEMENTAL FIGURE 2: Share of people in each tier by year, 2019–2025: Sub-Saharan Africa (Angola to Namibia).



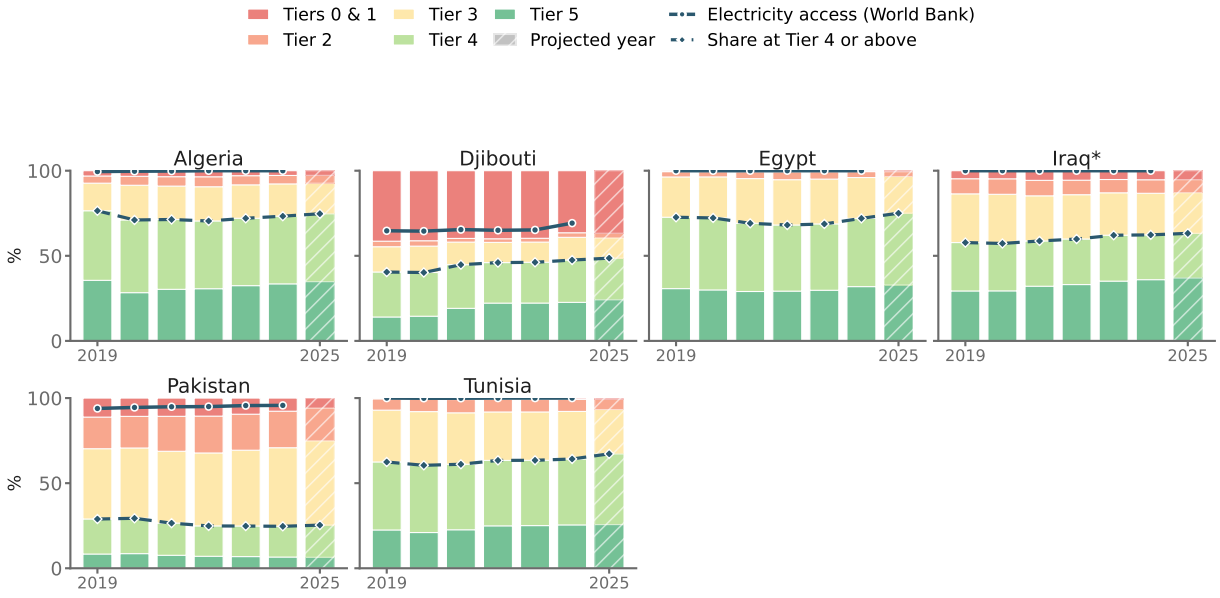
Supplemental Figure 2 (continued): Niger to Zimbabwe.



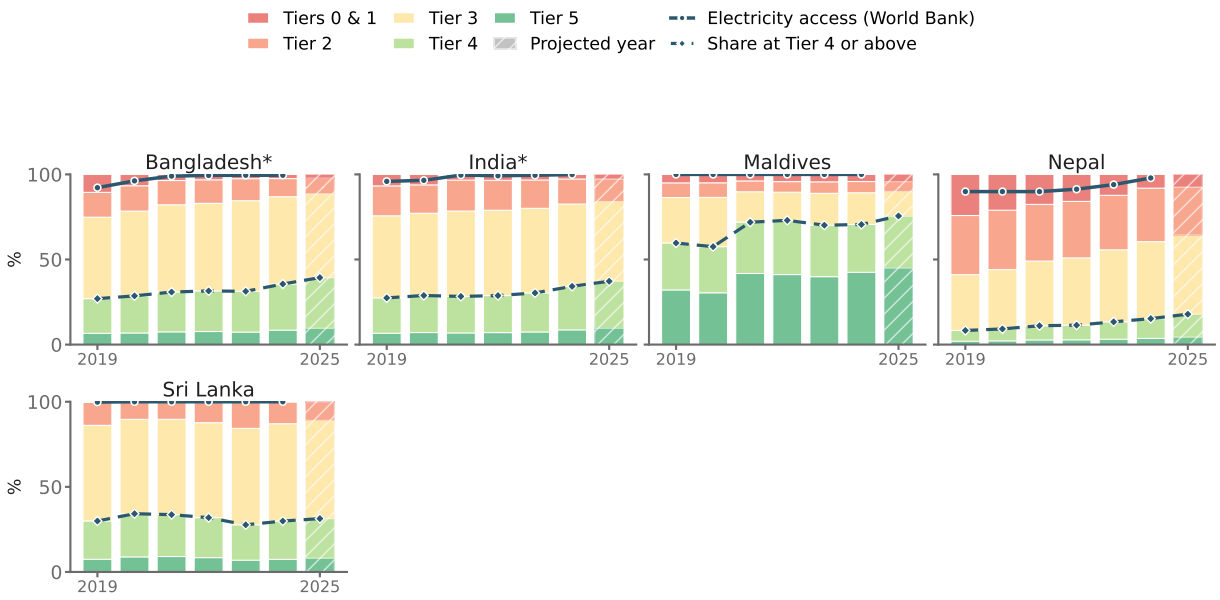
SUPPLEMENTAL FIGURE 3: Share of people in each tier by year, 2019–2025: Latin America and the Caribbean.



SUPPLEMENTAL FIGURE 4: Share of people in each tier by year, 2019–2025: East Asia and Pacific.



SUPPLEMENTAL FIGURE 5: Share of people in each tier by year, 2019–2025: Middle East, North Africa, Afghanistan, and Pakistan.



SUPPLEMENTAL FIGURE 6: Share of people in each tier by year, 2019–2025: South Asia.

S5. Validation data sources

The lists below give every utility billing table and household survey we use, with the data years and citation for each.

Utility billing data

Bolivia (2017–2021). Autoridad de Fiscalización de Electricidad y Tecnología Nuclear (AETN) (2021, 2025). Anuario Estadístico, chapter 8 (Tarifa Dignidad): Anuario Estadístico 2020 (2021), Cuadro VIII-4, data for 2020; Anuario Estadístico 2024 (2025), Cuadros VIII-1 and VIII-2, data for 2017-2019, 2021.

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Brazil (2017–2025). Empresa de Pesquisa Energética (EPE) (2026). Anuário Estatístico de Energia Elétrica 2026 (ano base 2025), workbook, Tabelas 3.24 and 3.53.

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Dominican Republic (2021, 2023–2025). Ministerio de Energía y Minas (MEM), República Dominicana (2022–2026). Informe de Gestión Comercial de las EDE, table "Indicadores por Rango de Consumo y Tarifa". Editions (data year: issue (publication year)): 2021: Diciembre 2021 (2022); 2023: Diciembre 2023 (2024); 2024: Diciembre 2024 (2025); 2025: Diciembre 2025 (versión definitiva) (2026).

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El Salvador (2017–2024). Superintendencia General de Electricidad y Telecomunicaciones (SIGET), El Salvador (2025). Boletín de Estadísticas Eléctricas 2024, Tablas 19-20.

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