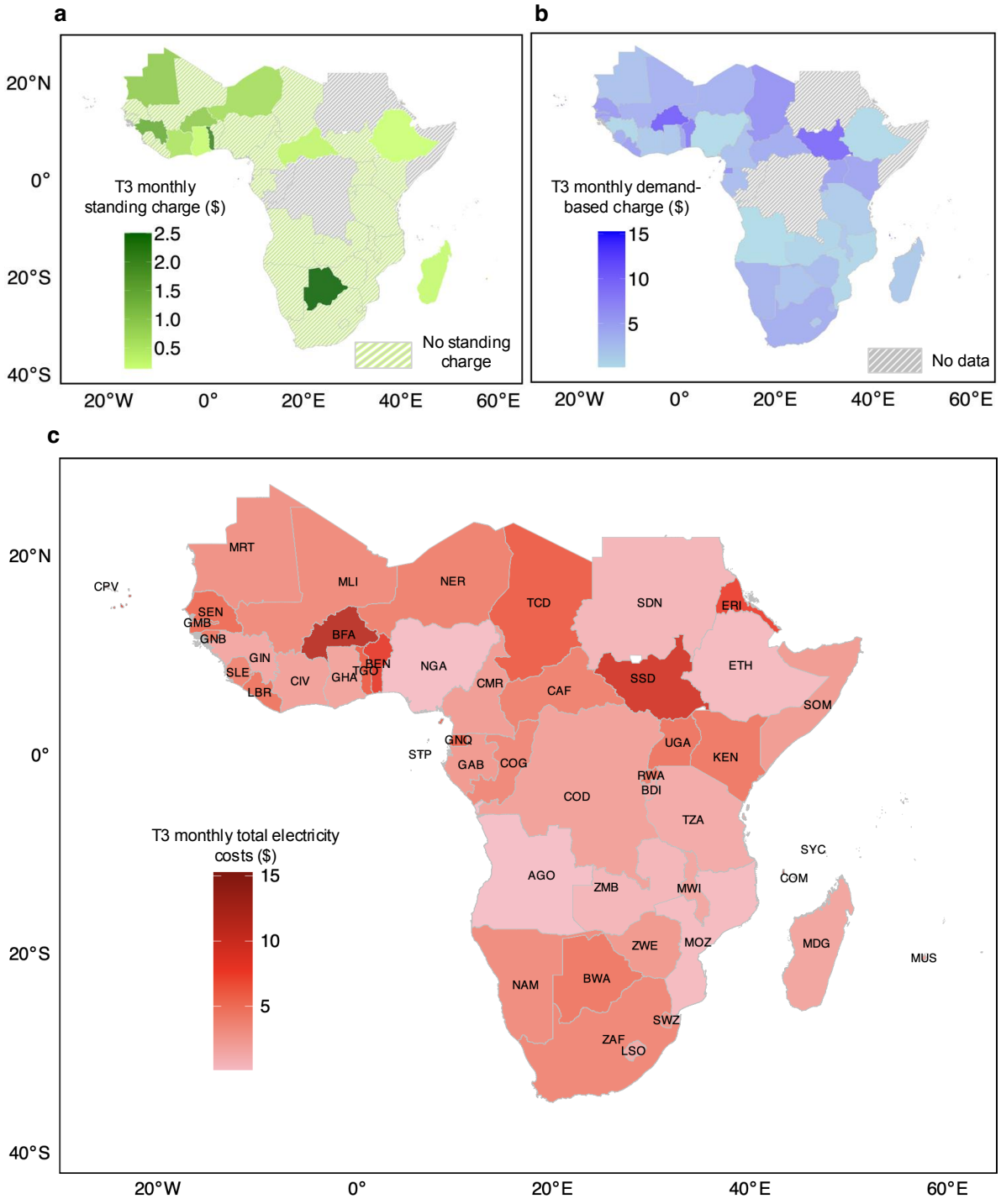

Fig. S1: T3 monthly household electricity costs by country in US dollars ($). a. T3 household standing charge (i.e., fixed monthly fee paid by household customers). **b**. T3 household demand-based charge (i.e., any charge which is proportional to kWh, kW, kilo-volt-amperes (kVA), or amperes, related taxes, irrespective of what the charge is called). **c**. Total T3 household electricity costs. These are calculated using the data in panels a and b. For the countries with no data in a and b, represented by grey parallel lines, total costs are calculated using average household electricity cost data. Countries are referenced with ISO alpha-3 codes. In Liberia (LBR), Mali (MLI) and South Africa (ZAF), no standing charge applies under the 30kWh per month household usage due to social tariffs. For Guinea (GIN), postpaid tariffs with standing charge are shown on the map. In Namibia (NAM), common tariffs without standing charges are included, but CENORED's postpaid household tariff, which is around $8/month, is not shown on the map, more details are provided in the Data Availability in Methods.

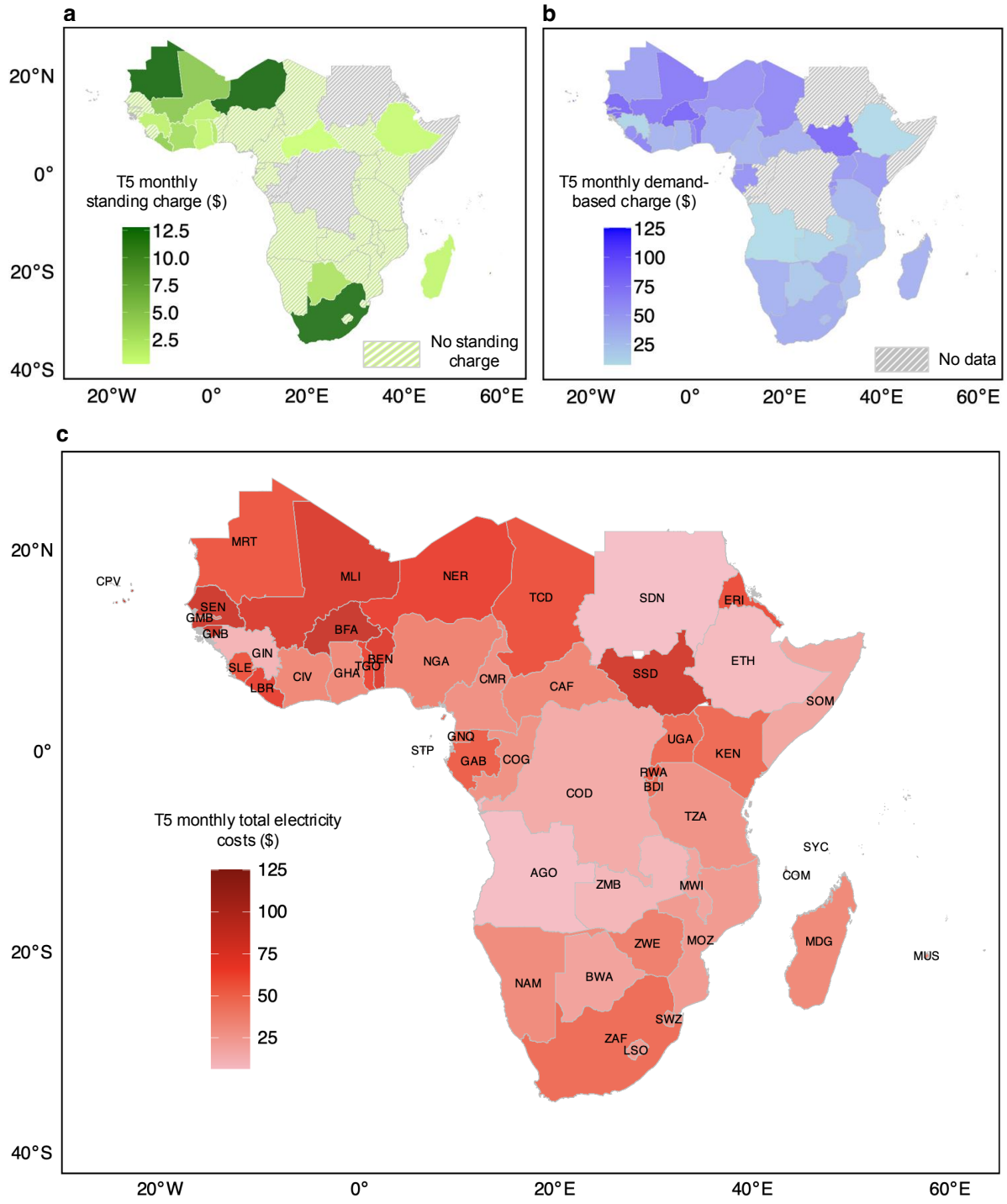

Fig. S2: **T5 monthly household electricity costs by country in US dollars ($). a**. T5 household standing charge (i.e., fixed monthly fee paid by residential customers). **b**. T5 household demand-based charge (i.e., any charge which is proportional to kWh, kW, kilo-volt-amperes (kVA), or amperes, related taxes, irrespective of what the charge is called). **c**. Total T5 household electricity costs. These are calculated using the data in panels a and b. For the countries with no data in a and b, represented by grey parallel lines, total costs are calculated using average household electricity cost data. Countries are referenced with ISO alpha-3 codes. The map shows the postpaid tariff with a standing charge in Guinea (GIN) and the prepaid tariff with a standing charge in Mali (MLI), respectively. In Namibia (NAM), common tariffs without standing charges are included, but CENORED's postpaid household tariff, which is around $8/month, is not shown on the map, more details are provided in the Data Availability in Methods.

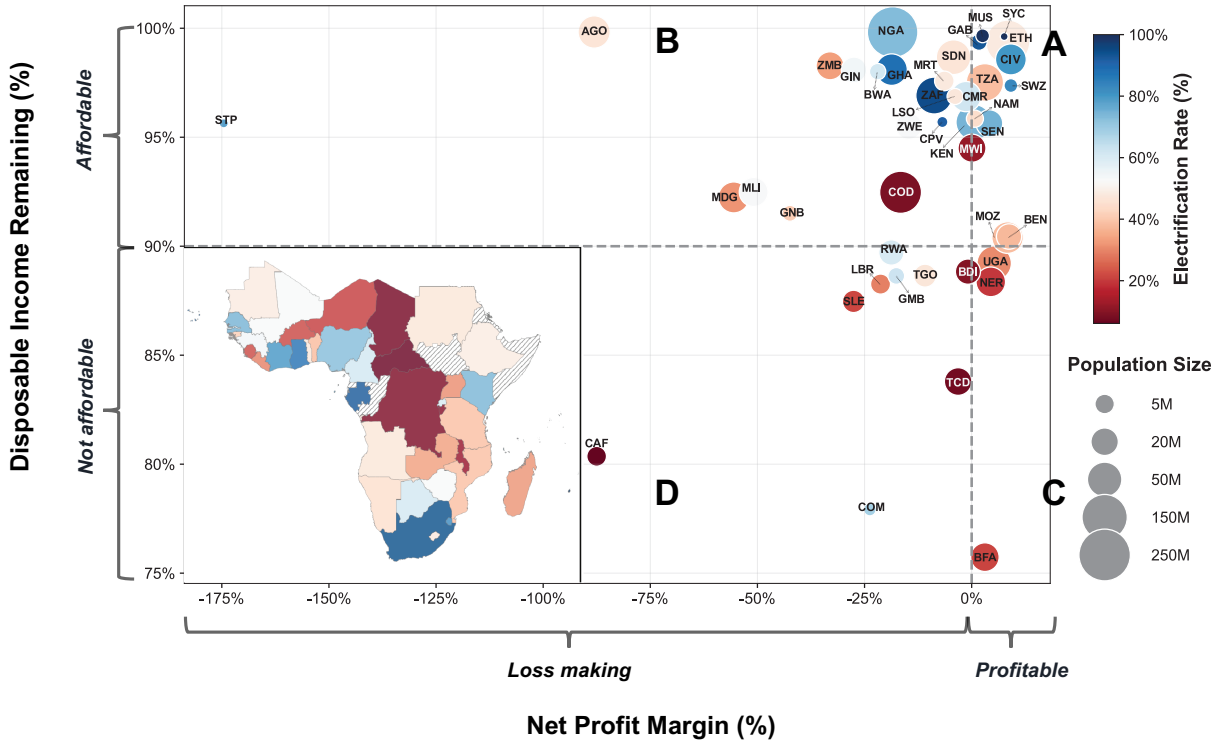

Fig. S3: **Comparison of Utility Health and Household Electricity Affordability in T3.** The x-axis represents the net profit margin of distribution power utilities or vertically integrated utilities, indicating utility health. The y-axis represents the theoretically disposable income percentage after T3 (30 kWh/month) electricity expenses, ranging from 75% to 100%. A value of 90% represents the afford- ability threshold defined in Methods, meaning households retain at least 90% of their income after electricity expenses. In this framework, the four quadrants help illustrate different electricity access challenges and opportunities: The top-right quadrant (A) of the separator range represents grid electrification opportunity; The top-left quadrant (B) indicates utility stress; The bottom-right quadrant (C) reflects affordability stress; and the bottom-left quadrant (D) signifies a grid electrification trap. Net profit margin data is unavailable for Equatorial Guinea, Eritrea, Republic of the Congo, Somalia, and South Sudan, denoted with parallel lines in the inset Africa map. Countries are labelled with ISO alpha-3 codes.

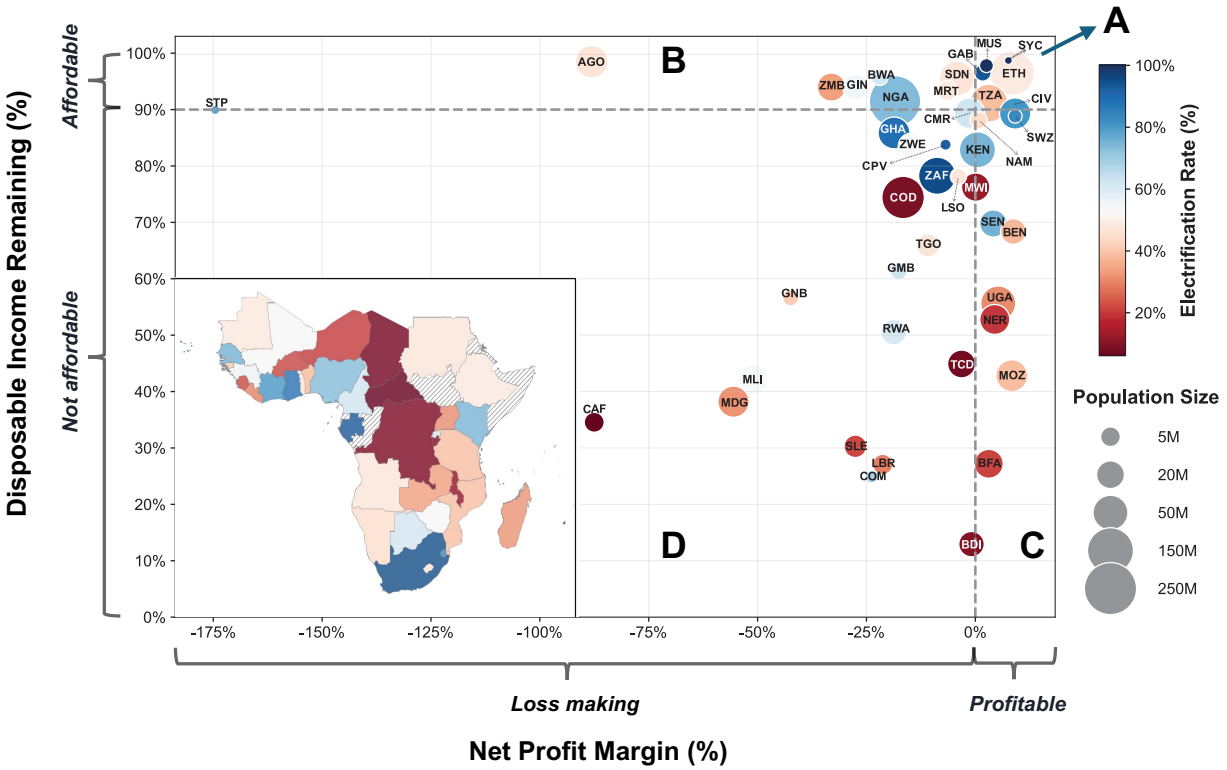

Fig. S4: Comparison of Utility Health and Household Electricity Affordability in T4 (included outliers). The x-axis represents the net profit margin of distribution power utilities or vertically integrated utilities, indicating utility health. The y-axis represents the theoretically disposable income percentage after T4 (102 kWh/month) electricity expenses, ranging from 0% to 100%. A value of 90% represents the afford- ability threshold defined in Methods, meaning households retain at least 90% of their income after electricity expenses. In this framework, the four quadrants help illustrate different electricity access challenges and opportunities: The top-right quadrant (A) of the separator range represents grid electrification opportunity; The top-left quadrant (B) indicates utility stress; The bottom-right quadrant (C) reflects affordability stress; and the bottom-left quadrant (D) signifies a grid electrification trap. Net profit margin data is unavailable for Equatorial Guinea, Eritrea, Republic of the Congo, Somalia, and South Sudan, denoted with parallel lines in the inset Africa map. Countries are labelled with ISO alpha-3 codes.

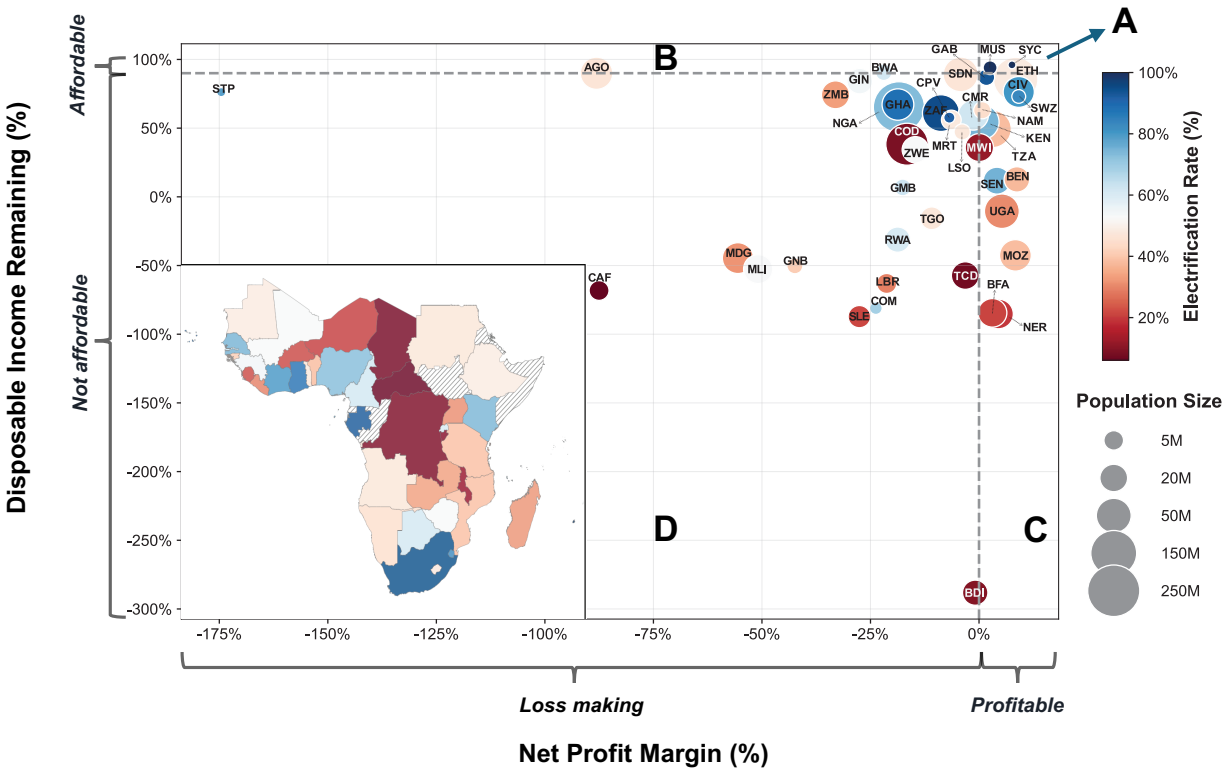

Fig. S5: **Comparison of Utility Health and Household Electricity Affordability in Tier 5.** The x-axis represents the net profit margin of distribution power utilities or vertically integrated utilities, indicating utility health. The y-axis represents the theoretically disposable income percentage after T5 (246 kWh/month) electricity expenses, ranging from -300% to 100%. A value of 90% represents the affordability threshold defined in Methods, meaning households retain at least 90% of their income after electricity expenses. In this framework, the four quadrants help illustrate different electricity access challenges and opportunities: The top-right quadrant (A) of the separator range represents grid electrification opportunity; The top-left quadrant (B) indicates utility stress; The bottom-right quadrant (C) reflects affordability stress; and the bottom-left quadrant (D) signifies a grid electrification trap. Net profit margin data is unavailable for Equatorial Guinea, Eritrea, Republic of the Congo, Somalia, and South Sudan, denoted with parallel lines in the inset Africa map. Countries are labelled with ISO alpha-3 codes.

Country	Tier 4 Electricity Affordable Population (%)	Tier 5 Electricity Affordable Population (%)
AGO	100	67
BDI	1	< 1
BEN	6	1
BFA	1	< 1
BWA	90	70
CAF	3	1
CPV	57	15
CMR	61	8
COD	23	4
COG	52	19
COM	3	1
CIV	40	7
ERI	1	< 1
ETH	98	39
GAB	97	48
GHA	48	14
GIN	89	27
GMB	6	1
GNB	2	1
GNQ	62	27
KEN	33	4
LBR	1	< 1
LSO	29	6
MDG	3	1
MLI	1	< 1
MOZ	9	1
MRT	84	2
MUS	100	86
MWI	19	2
NAM	65	28
NER	1	< 1
NGA	71	5
RWA	6	1
SDN	94	56
SEN	9	1
SLE	1	< 1
SOM	14	1
SSD	5	1
STP	63	21
SWZ	65	32
SYC	100	97
TCD	2	1
TGO	8	1
TZA	69	4
UGA	7	1
ZAF	48	31
ZMB	83	30
ZWE	46	7

Table S1: **Electricity Affordability for Tier 4 & 5 by Population Across Countries.** Affordability threshold: 10% of income spent on electricity. The population percentage represents the share of the country's population that can afford electricity within this threshold at each tier based on the income distribution modelling, affordability calculation and assessment methods. Countries are referenced with ISO alpha-3 codes.

Country	Tier 1 (%)	Tier 2 (%)	Tier 3 (%)	Tier 4 (%)	Tier 5 (%)
AGO	0.002054	0.034229	0.171145	1.516229	10.052614
BDI	0.133988	2.233131	11.165657	87.055816	388.147296
BEN	0.112580	1.229276	9.554171	31.616168	87.313670
BFA	4.848470	6.687084	24.265137	72.806171	184.446504
BWA	1.051949	1.230307	1.989276	4.266185	9.358037
CAF	1.505359	4.955724	19.638127	65.444436	168.204048
CMR	0.037621	0.627014	3.135068	10.659230	40.486201
COD	0.090309	1.505142	7.525710	25.587412	61.710818
COG	0.049287	0.821451	4.107257	13.964673	33.679505
COM	0.265000	4.416665	22.083326	75.083310	181.083276
CPV	0.051601	0.860012	4.300059	16.221632	42.352536
ERI	0.242611	4.043518	20.217589	68.739801	165.784226
ETH	0.210369	0.292117	0.639982	3.527983	14.445024
GAB	0.007619	0.126989	0.634945	3.488548	12.998147
GHA	0.200834	0.523800	1.898125	14.137900	32.815493
GIN	0.783276	0.997696	1.910121	5.983403	15.810443
GMB	0.136347	2.272449	11.362245	38.631632	93.170408
GNB	0.101869	1.697819	8.489097	43.395703	150.260503
GNQ	0.039804	0.663404	3.317018	11.277860	27.199544
KEN	0.051789	0.863143	4.315715	17.135444	45.550716
LBR	0.140849	2.347490	11.737449	72.915642	163.059252
LSO	0.037574	0.626237	3.131186	21.874735	52.756714
MDG	0.876923	1.593815	7.761285	61.795945	144.620808
MLI	0.090134	1.502236	7.511178	57.791007	152.630333
MOZ	0.115258	1.920970	9.604848	57.180284	142.612875
MRT	0.685709	1.015044	2.416466	6.620734	44.037049
MUS	0.109451	0.151790	0.346762	2.202298	6.026731
MWI	0.066029	1.100490	5.502448	23.748506	64.117686
NAM	0.816552	1.456001	4.150083	11.895184	36.969853
NER	1.552868	3.471326	11.634980	47.213588	185.282827
NGA	0.002179	0.036309	0.181546	8.530979	34.672145
RWA	0.073007	1.216779	10.287939	49.452743	131.154699
SDN	0.015936	0.265608	1.328038	4.515329	10.889910
SEN	0.057688	0.961459	5.865040	30.192927	88.239515
SLE	0.123290	2.054837	12.532250	69.706406	187.200953
SOM	0.085784	1.429731	7.148655	24.305427	58.618971
SSD	0.187091	3.118191	15.590953	53.075023	132.648087
SWZ	0.031543	0.525721	2.628607	11.171760	26.943656
SYC	0.004569	0.076157	0.380787	1.294675	3.950710
TCD	0.194496	3.241601	16.208003	55.107209	157.312968
TGO	3.623195	5.100193	11.350098	34.094769	115.633906
TZA	0.029815	0.496913	2.484564	8.861611	50.602285
UGA	0.061834	1.030561	10.783785	44.369066	110.483234
ZAF	0.037053	0.617552	3.087761	21.734309	39.061859
ZMB	0.020660	0.344339	1.721693	6.012882	25.734091
ZWE	0.053949	0.899157	4.495787	16.522057	65.713416

Table S2: **Average Affordability by Country and Energy Tier.** Affordability is calculated based on the share of electricity bills at each tier relative to household income based on the affordability calculation method. Countries are referenced with ISO alpha-3 codes.

Country	Monthly Demand by Households (kWh)	Energy Tier
AGO	127.79	Tier 4
BDI	16.02	Tier 2
BEN	5.76	Tier 1
BFA	9.53	Tier 2
BWA	255.29	Tier 5
CAF	12.99	Tier 2
CIV	57.41	Tier 3
CMR	36.20	Tier 3
COD	5.53	Tier 1
COG	50.35	Tier 3
COM	19.42	Tier 2
CPV	261.41	Tier 5
ERI	27.81	Tier 2
ETH	20.65	Tier 2
GAB	145.26	Tier 4
GHA	57.93	Tier 3
GIN	29.48	Tier 2
GMB	94.31	Tier 3
GNB	10.26	Tier 2
GNQ	259.98	Tier 5
KEN	19.22	Tier 2
LBR	17.05	Tier 2
LSO	83.54	Tier 3
MDG	8.22	Tier 2
MLI	101.16	Tier 3
MOZ	18.56	Tier 2
MRT	145.41	Tier 4
MUS	348.28	Tier 5
MWI	17.24	Tier 2
NAM	174.28	Tier 4
NER	18.96	Tier 2
NGA	24.20	Tier 2
RWA	3.91	Tier 1
SDN	83.77	Tier 3
SEN	132.26	Tier 4
SLE	35.09	Tier 3
SOM	14.39	Tier 2
SSD	5.99	Tier 1
STP	101.51	Tier 4
SWZ	389.77	Tier 5
SYC	1045.65	Tier 5
TCD	1.73	Tier 1
TGO	16.94	Tier 2
TZA	17.58	Tier 2
UGA	8.81	Tier 2
ZAF	313.64	Tier 5
ZMB	114.16	Tier 4
ZWE	37.59	Tier 3

Table S3: **Actual Monthly Electricity Demand per Household by Country and Identified Tier.** The result is derived using household electricity demand methods. Energy tiers are identified based on the MTF framework, as detailed in Table 1 of the main paper. Countries are referenced with ISO alpha-3 codes. In 18 countries, the estimated monthly electricity demand by households may be overestimated, as the reported data represent national averages that include demand from industrial, transportation, commercial, and public service sectors. These countries include: BDI, CAF, CPV, COM, GNQ, SWZ, GMB, GIN, GNB, LSO, LBR, MWI, MLI, MRT, SYC, SLE, SOM, and STP.

Household Appliance	Min Power (W)	Max Power (W)
Window air conditioner [?]	900	1440
Refrigerator [?]	300	800
Electric cookstove [?]	1000	3000
Vacuum cleaner [?]	600	2000
LED lighting [?]	10	10
Washing machine [?]	400	1400
Microwave [?]	600	1000
Oven [?]	2000	5000
Electric water heating [?]	2000	4000
TV [?]	50	200
Laptop [?]	30	70
Sum	7890	18920

Table S4: **Maximum Possible Peak Demand for Energy Tier 5 Household Appliances.** We assume all listed appliances in a Tier 5 household are used simultaneously and calculate the maximum possible peak demand before diversity.