



MRC | CONSULTANTS
AND TRANSACTION
ADVISERS
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Electricity Tariff Setting Methodology and Tariff Structure in Ghana

Task 2 – Comparative Analysis of DisCos Performance

Prepared for

World Bank Group



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Submitted by

MRC Consultants and Transaction Advisers

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Paseo de la Castellana 123, ESC DCH, 5B, 28046, Madrid, Spain

<https://mrc-consultants.com/>

jcolomer@mrc-consultants.com



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1. Introduction to the Comparative Analysis

The Public Utilities Regulatory Commission (PURC) has announced the process for the 2021 Major Tariff Review. The 2021 multi-year tariff review process is part of PURC's mandate of examining and approving rates that will be charged for electricity tariffs in Ghana.

The following note is an initial comparative analysis of some KPIs related to the technical and operational performance of Ghanaian DisCos, with the purpose of providing PURC quantitative elements to discuss and assess Discos' tariff petitions along the review process¹.

For such analysis we have considered the information included in 2022 tariff petitions of ECG and NEDCO, and cross-checked them with information in MRC data base, that includes unbundled electricity distribution companies in Latin America, MENA and SSA.

Along the note, comparisons are based on certain specific performance KPIs suitable to be measured with the available information, related to the technical and operational performance of the utilities:

Table 1 – Selected Ratios DISCOs Performance Comparison

Technical KPIs	Formula	Description
Energy losses (%)	$\frac{\text{Total losses}}{\text{Total electricity circulated}}$	The ratio of the total losses during the year over the total electricity transmitted or distributed.
SAIFI	$\frac{\text{Sum of customers interruptions}}{\text{Total number of customers}}$	It is the average number of times per year that the supply to a customer is interrupted (applicable to Discos).
SAIDI (hours)	$\frac{\text{Sum of interruption duration}}{\text{Total number of customers}}$	It is the average of time per year that the supply to a customer is interrupted (applicable to Discos).
Operational KPIs	Formula	Description
Customers per employee	$\frac{\text{Total number of customers}}{\text{Total number of employees}}$	It gives the number of customers per employees
Network length per employee	$\frac{\text{Total Km of lines}}{\text{Total number of employee}}$	It gives the Km per employee, to relate staff numbers with the need to manage a network of a certain size

The analysis developed in the following sections is just an initial and short time referential comparison, that does not allow to obtain any conclusion per-se on the respective tariff petitions, but to provide an initial picture of the operational performance of ECG and NEDCO, that must be the starting point for a detailed explanation and assessment of the business plan and projections included in those petitions, in line with the Tariff Guidelines issued by PURC.

¹ In general terms, capital expenditures are not suitable to be assessed through comparisons, but with a precise analysis of DisCos expansion plans. On the other side, financial KPIs could be assessed, but in any case they are usually ex-post diagnostic indicators more than ex-ante conditions for the approval of tariff petitions.

2. Distribution Companies Technical Performance

▪ QUALITY OF SERVICE

SAIDI and SAIFI are among the indicators selected to measure overall quality of service (reliability), and they are reported by the two distribution companies in Ghana annually.

Table 2 shows the evolution of these indicators during the last 4 years.

Table 2 – SAIDI and SAIFI evolution during the last 4 years

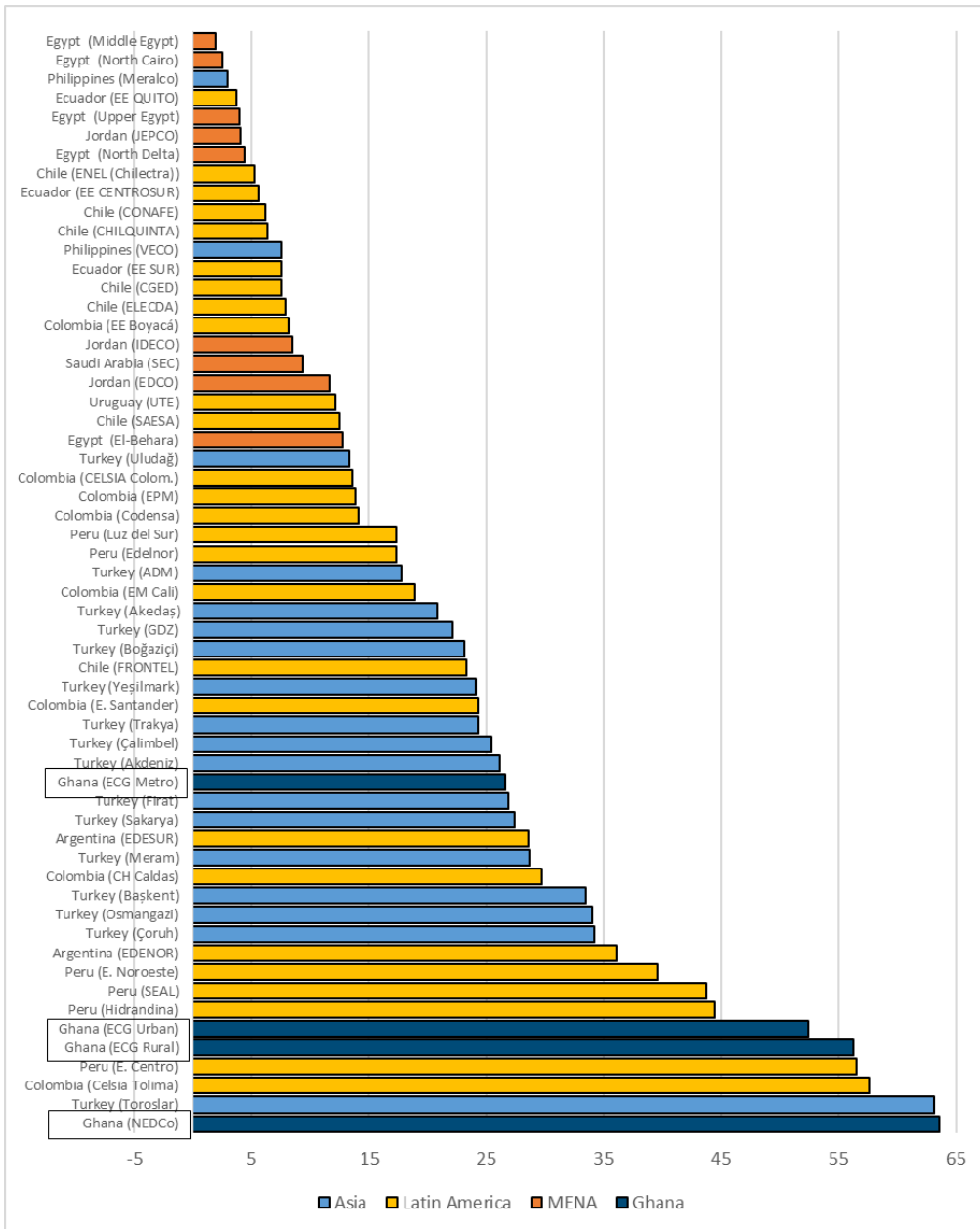
Category		SAIDI				SAIFI			
		2018	2019	2020	2021	2018	2019	2020	2021
ECG	Metro	55.93	36.9	21.95	26.63	36.28	24.99	15.36	17.8
	Urban	90.53	61.99	42.92	52.43	72.99	47.06	26.45	27.69
	Rural	100.62	79.29	51.81	56.29	100.62	79.29	51.81	56.29
NEDCo	Total	115.4	60.1	59.4	63.6	77.9	48.8	69.1	40.9

Source: ECG: AGGREGATE REVENUE REQUIREMENT AND TARIFF – March 2022' / NEDCo: TARIFF PROPOSAL FOR 2022 – April 2022

There is a slightly increase from 2020 to 2021 to all category's indicators, but in general it can be seen a downward trend in ECG (Metro, Urban and Rural) and NEDCO's key performance indicators SAIDI and SAIFI.

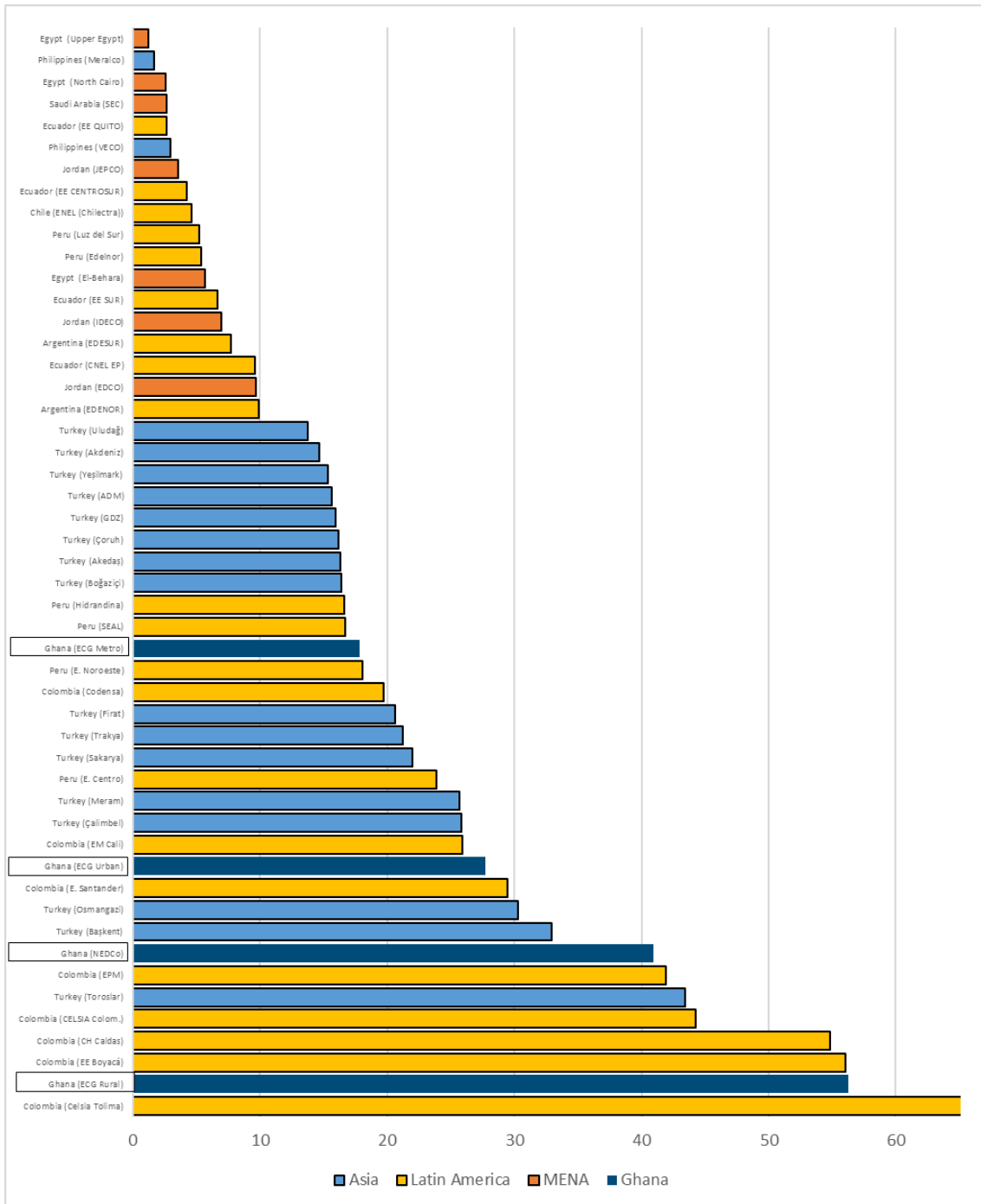
Figure 1 and Figure 2 below show the reliability indexes for the companies included in the sample.

Figure 1 – SAIDI Comparison [hours/customer/year]



Source: Own elaboration based on MRC data base

Figure 2 – SAIFI Comparison [# interruptions/customer/year]



Source: Own elaboration based on different public sources

Ghanian companies are positioned in the lower performance range. The best performance from Ghana is ECG Metro, that performed in the middle of the Asiatic bloc of companies used in this comparison.

In Europe, the average time a customer is disconnected for maintenance purposes is extremely low. Networks are redundant and live maintenance is generally performed. Reducing interruptions due to maintenance activities or load shedding should be an objective for companies in Ghana.

■ NETWORK LOSSES

The following table summarizes total losses ratios for both DisCos in 2021:

Table 3 - Distribution Losses 2021

Category	2021		
	Total Losses	Technical Losses	Non-technical losses
ECG	29.84%	10.55%	19.29%
NEDCo	27.29%	9.20%	18.09%

Source: ECG: AGGREGATE REVENUE REQUIREMENT AND TARIFF – March 2022 / NEDCo: TARIFF PROPOSAL FOR 2022 – April 2022

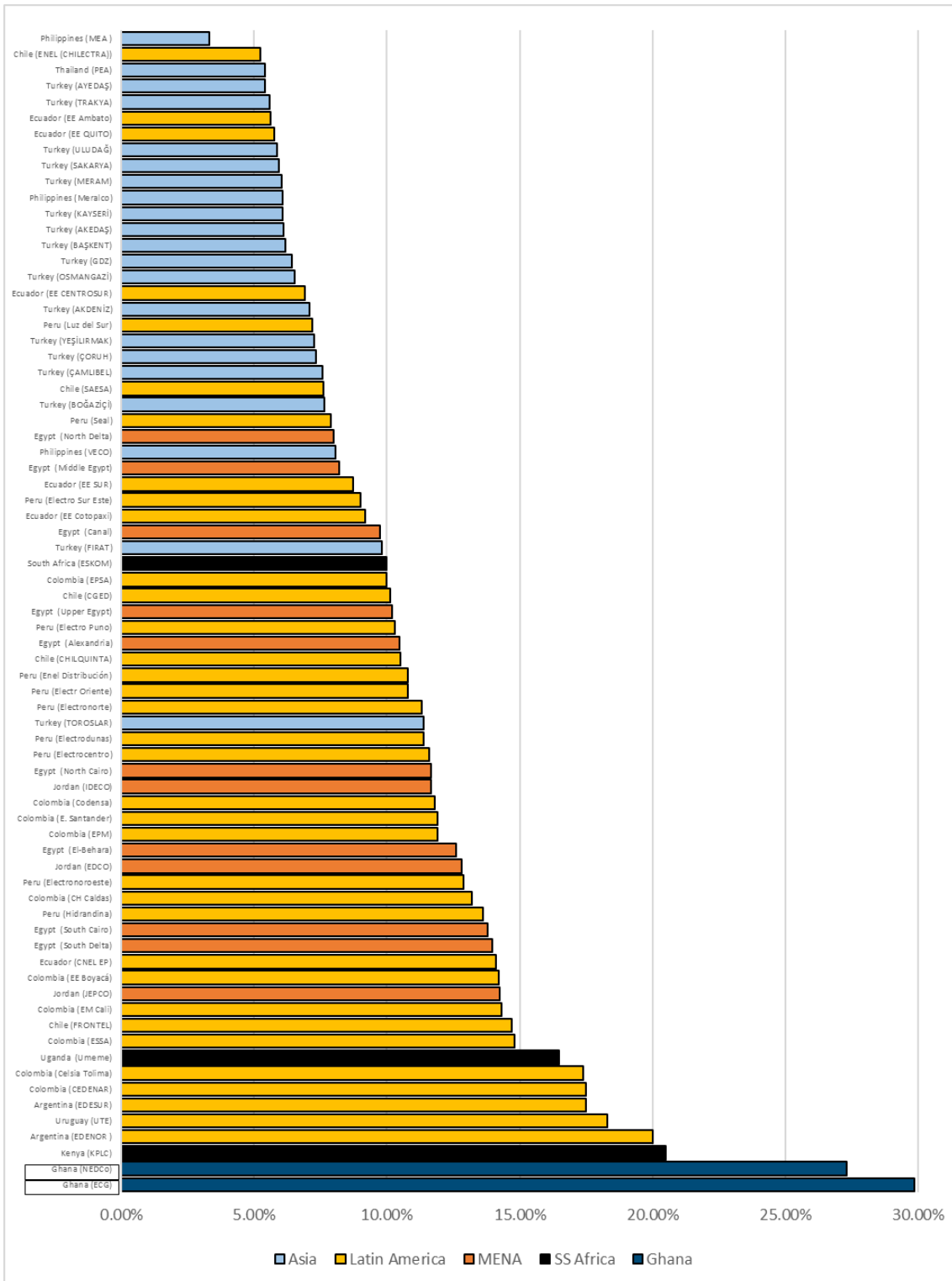
Figure 3 below shows network losses ratio for the companies included in the sample.

In this case, the situation is totally different than in the case of quality of service:

- Although, in general, companies in European countries present lower losses than in the rest of the sample, there are some Latin American companies which also present very low levels.
- Turkish companies have also relatively low level of losses, reflecting the efforts made by these companies, supported by the regulator, in controlling technical losses and eliminating the commercial ones².
- The distribution companies in Ghana are right in the bottom of the comparison, performing worse than the other African companies of the selected group: ESKOM (South Africa), EMEME (Uganda) and KPLC (Kenya).

² Three distribution companies, operating in the Kurdish zone, have been excluded from the sample. These companies present level of losses above 50% which corresponds to a global problem which exceeds the framework of this comparison.

Figure 3 – Distribution Losses [% of distributed energy]



Source: Own elaboration based on different public sources

Losses performance of ECG and NEDCO requires high attention, especially if compared with the achievements obtained in relation with the quality of service.

3. Operational Performance

Operational performance of power utilities is related to the way utilities organize their internal activities in the most efficient way, trying to reach highest levels of productive efficiency. We are analysing in the next section total labour productivity indexes. In simple terms, the amount of output per labour unit as a result of the production process.

There is no single variable to measure the total output of a distribution company. In most of the cases three are considered:

- The total amount of energy distributed (MWh). DisCos sale energy, therefore, the higher the energy distributed, the higher the administrative and managerial requirements.
- The total number of customers. The number of customers determines the efforts in metering, billing, and collection.
- The distribution network length. Operational and maintenance activities are directly related with the size of the distribution network (neither with the clients or the amount of energy sold), considering total MV plus LV lines.

▪ LABOUR PRODUCTIVITY

To compare the degree of labour productivity, we have considered three different ratios:

- Network length per employee
- Customers per employee
- Energy distributed per employee

Initially, the comparative analysis in the next sections consider the three of them. However, as international experience demonstrates, the total amount of energy distributed is somehow affected by factors beyond the control of the DisCo, as for example climate or socio-economic conditions. Therefore, number of customers and network length are usually more robust size indicators for productivity ratios computation.

Table 4 – ECG and NEDCo Data

2021	Energy distributed (GWh)	Customers (#)	Network Length (kms)	Employees
ECG	9,978	4,290,148	18,446.0 ³	6,383
NEDCo	1,060	1,136,050	41,623.3	3,000 ⁴

Source: ECG data base and NEDCo 'TARIFF PROPOSAL FOR 2022 – April 2022' table 12

Figure 4 and Figure 5 below show the values of the KPI associated with the labour force, for the companies included in the sample.

³ <https://energycom.gov.gh/files/2020%20Electricity%20Supply%20Plan.pdf>

⁴ https://www.dnb.com/business-directory/company-profiles.northern_electricity_distribution_company_limited.9655d1d1aaba2f35f1bb74bf21d2f784.html

Figure 4 - Customers per Employee

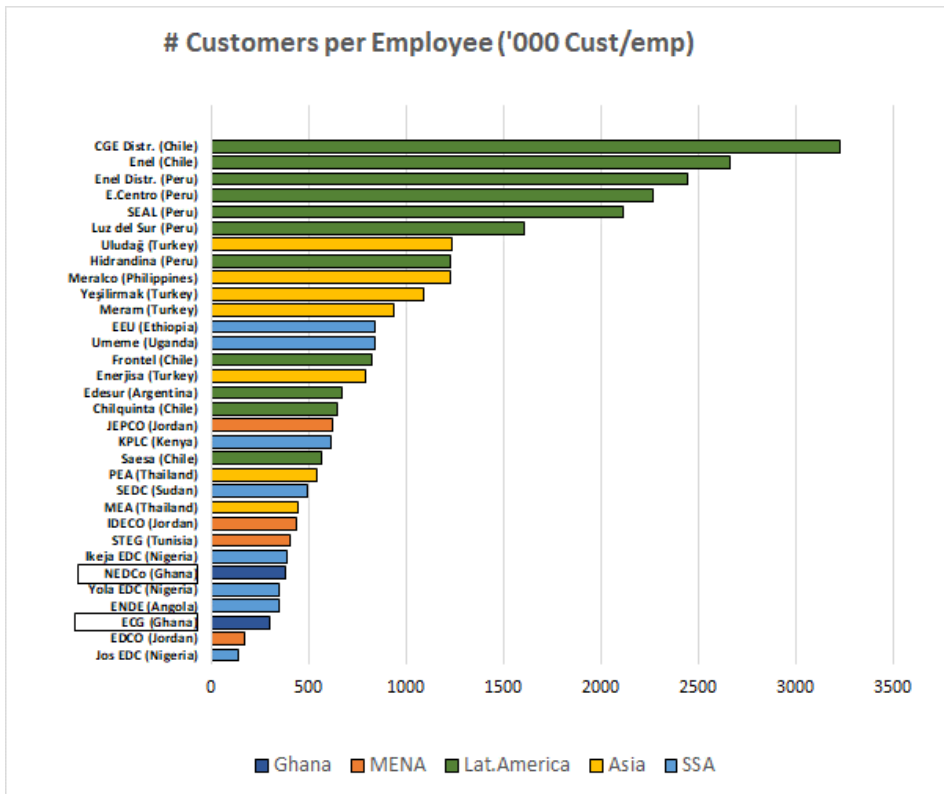


Figure 5 - Network Length per Employee

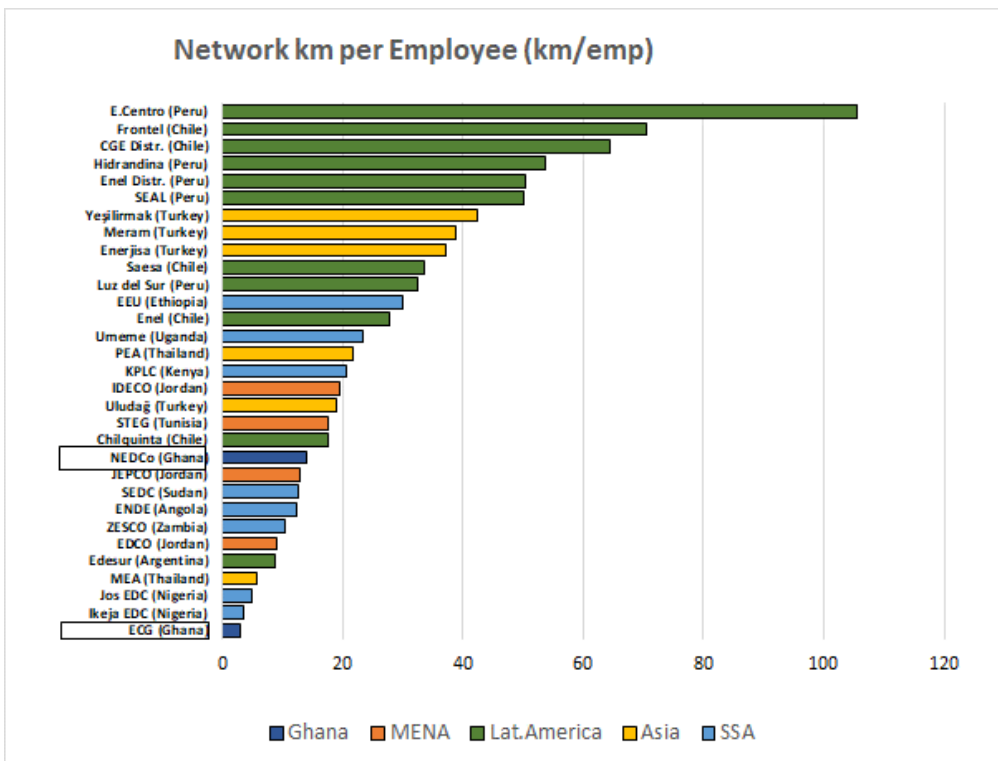
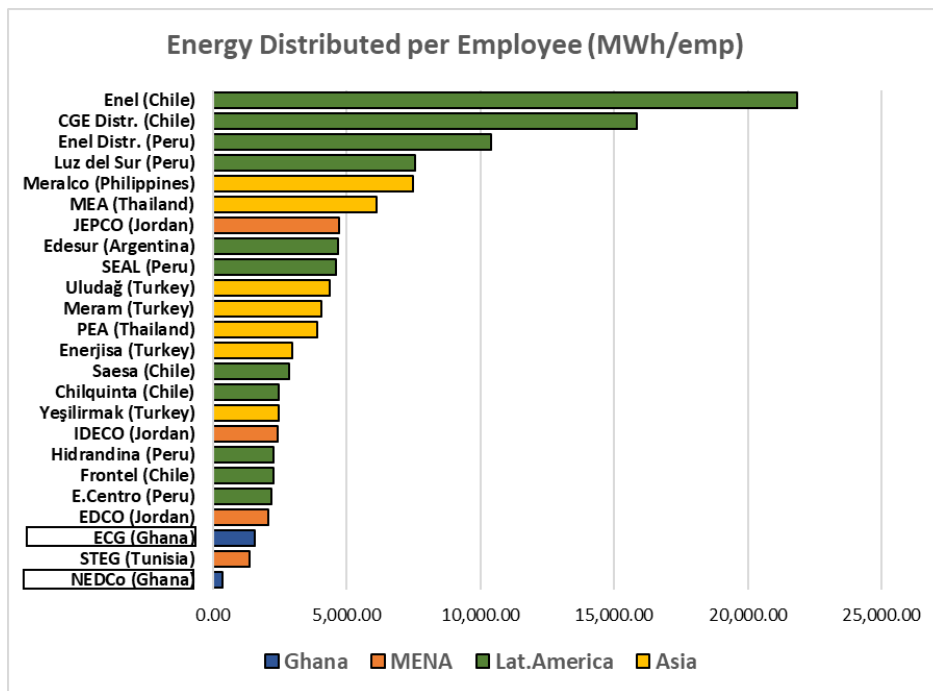


Figure 6 - Energy Distributed per Employee



(*) As previously said, be aware that ratios based on energy distributed may be affected and by factors beyond the control of the DisCo, deriving in somehow misleading results

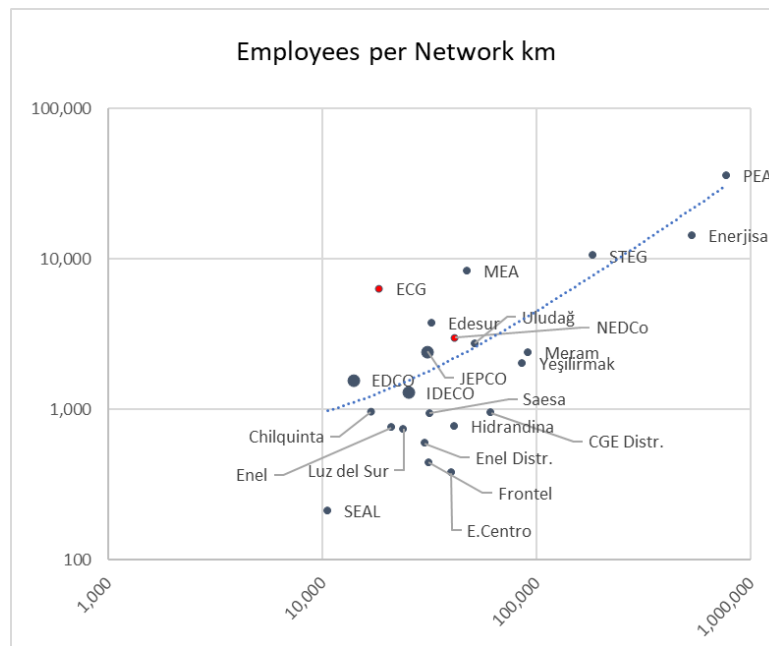
Regardless the indicator used to measure the “size” of the Disco, it seems that companies in Ghana are in the bottom range of labour productivity when compared with the selected peers. Taking the indicator of employees/km of network, which is probably the most relevant for maintenance and operation, it can be seen that the most efficient one, NEDCo, has around 14 km per employee, while Meram, Enerjisa or Yeşilirmak in Turkey have slightly less than the triple. In other words, they require one third of the staff per km of network. ECG has even lower indicators.

It should be considered that those companies which appear “up” in the ranking (i.e., Enel Perú, Enel Chile or Yeşilirmak in Turkey) use to operate and maintain the distribution network with relative reduced staff, highly qualified and trained, relying in specialized outsourced services to carry out much of the ground activities (i.e., maintenance). Through this method they increase the overall efficiency of the company.

One way to show these differences is plotting the number of employees as a function of the network size. Figure 7 shows this relation. It can be seen that both Ghanian DisCos are above the regression function, indicating that, in average, similar companies use to operate with less staff⁵.

⁵ Note that the graph uses logarithmic axes, so even differences which may be seem as “small” may significantly differ.

Figure 7 – Employees vs. Network km



It should be considered that those companies which appear “up” in the ranking (i.e., Enel Perú, Enel Chile or Yeşilirmak in Turkey) use to operate and maintain the distribution network with relative reduced staff, highly qualified and trained, relying in specialized outsourced services to carry out much of the ground activities (i.e., maintenance). Through this method they increase the overall efficiency of the company.

■ OPEX PERFORMANCE

Using only headcount as an indicator of efficiency may be misleading. As indicated, operational and maintenance activities can be developed either using own personnel or subcontracting them, and neither option is, necessarily, superior to the other. For such reason, a similar analysis was carried out, but considering Total OPEX as the monitoring variable.

Table 5 – ECG and NEDCo OPEX

2022		GHS 'million
ECG	OPEX	980.85
	Human Resources	976.29
	Total	1,957.14
NEDCO	Fixed O&M Component	438.36

Source: ECG: AGGREGATE REVENUE REQUIREMENT AND TARIFF – March 2022 / NEDCo: TARIFF PROPOSAL FOR 2022 – April 2022

A major problem of comparing total OPEX among companies in different countries is how to deal with the different local currencies. One possibility is to refer all costs to current USD, using the official (or predominant) exchange rate. However, this approach may benefit/harm companies which operates in countries in which this exchange rate is under governmental control and/or there are significant barriers to the international trade.

An alternative, although not perfect, is to convert these costs using the Power Purchase Parity (PPP) calculated by the World Bank⁶. This conversion rate tries to reflect the purchase power of the local currency, reflecting better the local economic conditions. As a large portion of the OPEX of a distribution company are spent locally, we consider that such rate is more appropriate to make comparisons.

Figure 8 below shows the values of the KPI associated with OPEX, for the companies included in the sample:

Figure 8 – OPEX PPP/Network km

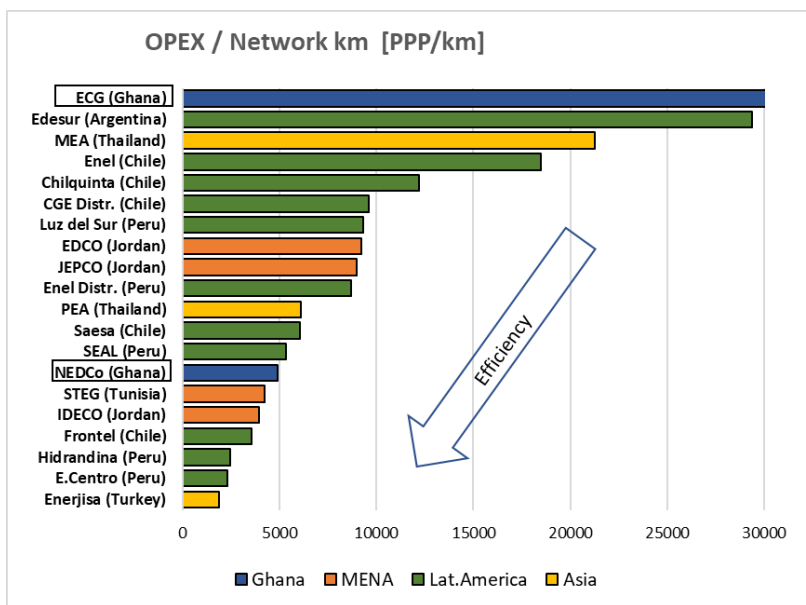
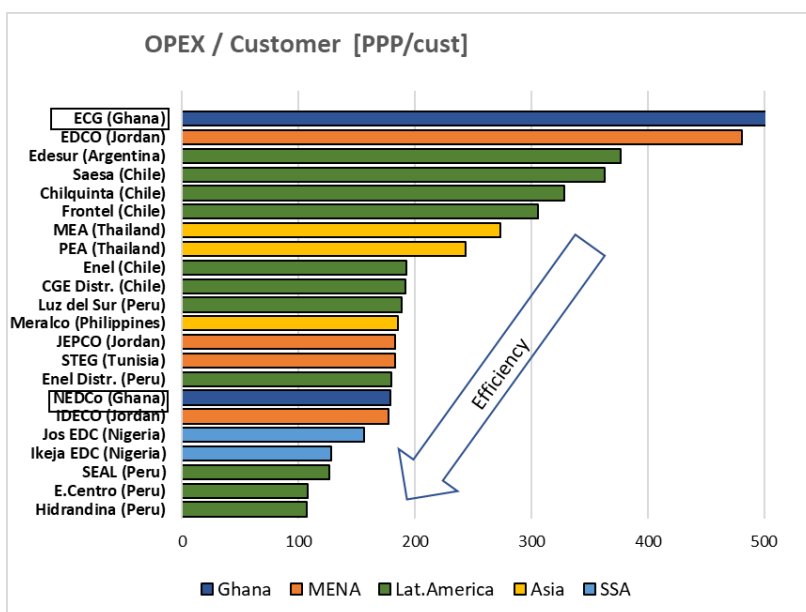


Figure 9 – OPEX PPP/Customer



⁶ WB PPP Conversion Factor (<https://data.worldbank.org/indicator/PA.NUS.PPP>)

Irrespective of the indicator considered, ECG appears to be in the top range of the sample with highest unit costs, and NEDCO position in the lower half range when considering OPEX per network length or customer.

However, it must be said that the previous comparisons are not conclusive and may be misleading if partially considered. In general terms, international experience shows that consumption/customer density (per network length) are the most relevant structural variables affecting operational efficiency, instead of the absolute scale of the utility (measured as sales, lines length, or customers). In other words, economics of density are the main determinant of operational efficiency, instead of economics of scale.

A usual metric for electric density is the length of distribution network per customer⁷. Higher values of this parameter imply that customers are more dispersed and, consequently, the network requires more kilometres per customer (more “extended”).

⁷ Different typologies of distribution networks are based on higher or lower deployment of MV lines against LV. To use a uniform metric for the different sample countries, we have considered the sum of MV and LV kms.

Annexes

Annex 1 - Quality of Service Indicators

Region	Country	Company	Year	Unscheduled		Scheduled		Total	
				SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI
				[h/year]	[1/year]	[h/year]	[1/year]	[h/year]	[1/year]
Jordan		JEPKO	2019/20	3.94	3.49	0.14	0.05	4.08	3.54
		IDECO		2.97	4.86	5.49	2.08	8.47	6.94
		EDCO		7.55	8.41	4.15	1.28	11.69	9.69
MENA	Egypt	North Cairo	2016	2.52	2.59	N/A	N/A	2.52	2.59
		North Delta		4.44	N/A	N/A	N/A	4.44	N/A
		El-Behara		12.76	5.67	N/A	N/A	12.76	5.67
		Middle Egypt		1.94	N/A	N/A	N/A	1.94	N/A
		Upper Egypt		4.01	1.22	N/A	N/A	4.01	1.22
	Saudi Arabia	SEC	2020	6.97	2.10	2.37	0.51	9.34	2.61
Region	Country	Company	Year	Unscheduled		Scheduled		Total	
				SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI
				[h/year]	[1/year]	[h/year]	[1/year]	[h/year]	[1/year]
Latin America	Argentina	EDENOR	2015	N/A	N/A	N/A	N/A	36.10	9.90
		EDESUR		N/A	N/A	N/A	N/A	28.60	7.70
		CGED		N/A	N/A	N/A	N/A	7.60	N/A
	Chile	FRONTEL	2015	N/A	N/A	N/A	N/A	23.35	N/A
		SAESA		N/A	N/A	N/A	N/A	12.46	N/A
		CHILQUINTA		N/A	N/A	N/A	N/A	6.35	N/A
		CONAFE		N/A	N/A	N/A	N/A	6.18	N/A
		ELECDA		N/A	N/A	N/A	N/A	7.91	N/A
	ENEL (Chilectra)	2020	N/A	N/A	N/A	N/A	5.23	4.62	

Region	Country	Company	Year	Unscheduled		Scheduled		Total	
				SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI
				[h/year]	[1/year]	[h/year]	[1/year]	[h/year]	[1/year]
Latin America	Ecuador	CNEL EP	2015	N/A	N/A	N/A	N/A	10.98	9.59
		EE QUITO		N/A	N/A	N/A	N/A	3.74	2.68
		EE CENTROSUR		N/A	N/A	N/A	N/A	5.64	4.21
		EE SUR		N/A	N/A	N/A	N/A	7.60	6.63
	Peru	Edelnor	2016	N/A	N/A	N/A	N/A	17.34	5.34
		Hidrandina		N/A	N/A	N/A	N/A	44.52	16.58
		Luz del Sur		N/A	N/A	N/A	N/A	17.32	5.24
		E. Centro		N/A	N/A	N/A	N/A	56.54	23.88
		E. Noroeste		N/A	N/A	N/A	N/A	39.54	18.08
	SEAL	N/A	N/A	N/A	N/A	43.74	16.67		
	Uruguay	UTE	2014	N/A	N/A	N/A	N/A	12.17	6.20
	Colombia	EE Boyacá	2019	N/A	N/A	N/A	N/A	8.19	56.06
		CELSIA Colom.		N/A	N/A	N/A	N/A	13.55	44.28
EPM		N/A		N/A	N/A	N/A	13.85	41.91	
Codensa		N/A		N/A	N/A	N/A	14.12	19.71	
EM Cali		N/A		N/A	N/A	N/A	18.94	25.89	
E. Santander		N/A		N/A	N/A	N/A	24.30	29.42	
CH Caldas		N/A		N/A	N/A	N/A	29.77	54.80	
Celsia Tolima	N/A	N/A	N/A	N/A	57.59	114.84			

Region	Country	Company	Year	Unscheduled		Scheduled		Total	
				SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI
				[h/year]	[1/year]	[h/year]	[1/year]	[h/year]	[1/year]
Asia	Turkey	Toroslar	2019/20	47.16	38.10	16.04	5.35	63.20	43.45
		Çoruh		24.78	14.10	9.47	2.10	34.25	16.20
		Çalimbél		17.33	22.80	8.15	3.00	25.48	25.80
		Başkent		24.81	30.80	8.70	2.10	33.51	32.90
		Osmangazi		24.90	27.45	9.13	2.85	34.03	30.30
		Meram		16.97	22.90	11.72	2.80	28.69	25.70
		Sakarya		20.83	20.35	6.61	1.60	27.44	21.95
		Akdeniz		17.26	13.50	8.89	1.15	26.15	14.65
		Firat		20.58	17.30	6.28	3.35	26.86	20.65
		Yeşilmark		17.28	13.50	6.84	1.80	24.12	15.30
		Trakya		13.80	19.65	10.53	1.55	24.33	21.20
		GDZ		13.15	14.60	9.01	1.35	22.16	15.95
		Akedaş		16.26	14.70	4.52	1.65	20.78	16.35
		ADM		12.41	12.30	5.41	3.35	17.81	15.65
		Boğaziçi		19.06	12.00	4.05	4.40	23.12	16.40
	Uludağ	7.81	11.50	5.51	2.25	13.32	13.75		
	Philippines	Meralco	2019/20	1.95	1.32	0.97	0.32	2.92	1.64
		VECO		3.70	2.14	3.90	0.84	7.60	2.98

Annex 2 - Distribution Losses

Region	Country	Company	Year of Data	Distr. Losses
MENA	Jordan	JEPCO	2020	14.26%
		IDECO	2020	11.68%
		EDCO	2020	12.80%
	Egypt	North Cairo	2016	11.68%
		South Cairo	2016	13.80%
		Alexandria	2016	10.48%
		North Delta	2016	7.99%
		South Delta	2016	13.98%
		Canal	2016	9.73%
		El-Behara	2016	12.60%
		Middle Egypt	2016	8.20%
		Upper Egypt	2016	10.18%
		Latin America	Argentina	EDESUR
EDENOR	2019			20.00%
Chile	CGED		2019	10.12%
	FRONTEL		2019	14.70%
	CHILQUINTA		2019	10.50%
	SAESA		2019	7.60%
	ENEL (CHILECTRA)		2020	5.24%
Ecuador	CNEL EP		2018	14.12%
	EE QUITO		2018	5.76%
	EE CENTROSUR		2018	6.93%
	EE Ambato		2018	5.62%
	EE Cotopaxi		2018	9.18%
	EE SUR		2018	8.72%
Peru	Electrodunas		2020	11.40%
	Electro Oriente		2020	10.80%
	Electro Puno		2020	10.30%
	Electro Sur Este		2020	9.00%
	Electrocentro		2020	11.60%
	Electronoroeste		2020	12.90%
	Electronorte		2020	11.30%
	Enel Distribución		2020	10.80%
	Hidrandina		2020	13.60%
	Luz del Sur		2020	7.20%
	Seal		2020	7.90%
Uruguay	UTE		2018	18.30%
Colombia	EE Boyacá		2018	14.20%
	EPM		2018	11.90%
	Codensa	2018	11.80%	
	EM Cali	2018	14.30%	

		E. Santander	2018	11.90%
		CH Caldas	2018	13.20%
		Celsia Tolima	2018	17.40%
		CEDENAR	2018	17.50%
		EPSA	2018	10.00%
		ESSA	2018	14.80%
Asia	Turkey	AYEDAŞ	2020	5.40%
		SAKARYA	2020	5.93%
		MERAM	2020	6.05%
		GDZ	2020	6.43%
		KAYSERİ	2020	6.08%
		AKEDAŞ	2020	6.10%
		BAŞKENT	2020	6.18%
		TRAKYA	2020	5.58%
		ÇORUH	2020	7.33%
		OSMANGAZİ	2020	6.54%
		FIRAT	2020	9.81%
		YEŞİLIRMAK	2020	7.28%
		ULUDAĞ	2020	5.86%
		TOROSLAR	2020	11.37%
		BOĞAZİÇİ	2020	7.64%
	Turkey	AKDENİZ	2020	7.08%
		ÇAMLIBEL	2020	7.57%
	Philippines	Meralco	2020	6.08%
		VECO	2020	8.05%
		MEA	2017	3.32%
Thailand	PEA	2017	5.40%	
SSA	South Africa	ESKOM	2018	10.00%
	Kenya	KPLC	2018	20.50%
	Uganda	Umeme	2018	16.47%

Annex 3 - Basic Information of Sample Companies

Country	Company	Year	Electricity Distributed	Customers	Network Length	Staff
			[GWh]	[#]	[km]	#
Jordan	JEPCO	2020	11,509.00	1,518,655	30,974.00	2,435
	IDECO	2020	3,122.20	565,764	25,264.20	1,298
	EDCO	2020	3,256.00	269,101	14,008.00	1,573
Chile	Enel	2020	16,481.00	2,008,018	20,980.00	755
	Chilquinta	2020	2,382.50	624,013	16,818.00	965
	Frontel	2019	1,001.00	366,000	31,376.00	445
	Saesa	2019	2,668.00	528,000	31,665.00	941
	CGE Distr.	2019	15,054.00	3,066,920	61,317.00	951
Argentina	Edesur	2019	17,548.00	2,529,953	32,500.00	3,760
Turkey	Enerjisa	2020	42,356.80	11,313,962	532,779.20	14,356
	Uludağ	2020	11,948.20	3,380,111	51,551.00	2,739
	Meram	2020	9,594.60	2,227,181	91,831.00	2,371
	Yeşilirmak	2020	4,962.30	2,206,997	86,018.00	2,028
Peru	Enel Distr.	2020	6,204.00	1,459,252	30,097.00	597
	H. Andina	2020	1,740.40	946,786	41,456.00	771
	Luz del Sur	2020	5,594.60	1,184,681	24,032.00	739
	E. Centro	2020	833.3	857,317	40,017.00	379
	SEAL	2020	976.9	448,355	10,611.10	212
Thailand	MEA	2017	50,701.00	3,703,312	47,700.00	8,290
	PEA	2017	139,548.00	19,360,779	771,744.00	35,661
Philippines	Meralco	2020	43,572.00	7,132,000	N/A	5815
Tunisia	STEG	2020	14,194.00	4,233,733	183,189.00	10,500
Nigeria	Ikeja EDC	2022	3,972.30	1,640,198	N/A	N/A
	Jos EDC	2022	954.9	695,209	N/A	N/A

Annex 4 - Productivity KPIs

Country	Company	Elec. distr. per employee	Customers per employee	Network km per employee	OPEX/net.km
		[MWh/emp]	[cust/emp]	[km/emp]	[PPP/km]
Jordan	JEPCO	4.73	623.7	12.72	8978.15
	IDECO	2.41	435.9	19.46	3975.30
	EDCO	2.07	171.1	8.91	9233.50
Chile	Enel	21.83	2659.6	27.79	18477.69
	Chilquinta	2.47	646.6	17.43	12186.76
	Frontel	2.25	822.5	70.51	3562.23
	Saesa	2.84	561.1	33.65	6054.80
	CGE Distr.	15.83	3224.9	64.48	9589.13
Argentina	Edesur	4.67	672.9	8.64	29357.11
Turkey	Enerjisa	2.95	788.1	37.11	1913.96
	Uludağ	4.36	1234.1	18.82	N/A
	Meram	4.05	939.3	38.73	N/A
	Yeşilirmak	2.45	1088.3	42.42	N/A
Peru	Enel Distr.	10.39	2444.3	50.41	8705.27
	H. Andina	2.26	1228.0	53.77	2445.82
	Luz del Sur	7.57	1603.1	32.52	9304.12
	E. Centro	2.20	2262.1	105.59	2303.12
	SEAL	4.61	2114.9	50.05	5353.21
Thailand	MEA	6.12	446.7	5.75	21241.34
	PEA	3.91	542.9	21.64	6105.02
Philippines	Meralco	7.49	1226.5	N/A	N/A
Tunisia	STEG	1.35	403.2	17.45	4221.53
Nigeria	Ikeja EDC	N/A	N/A	N/A	N/A
	Jos EDC	N/A	N/A	N/A	N/A