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A Global Map of Electricity and Gas Distribution Network Companies

EPRG Working Paper EPRG2519

Cambridge Working Paper in Economics CWPE2556

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Abstract

As we contemplate the role of distribution networks in advancing the energy transition, this paper seeks to present a global map of energy distribution system operators (DSOs). We do this to illustrate the variation in power and gas distribution sector utilities across the world. We analyse information on 194 electricity and 75 gas utilities in capital cities in 194 countries. The paper compares information on size, ownership, degree of integration, performance, information availability and innovation. We find a large degree of variation across the world with significant differences between continents and economic groupings. Overall, the paper highlights the significant challenges facing many distribution utilities in promoting the energy transition, given their very different – and often inauspicious - starting points.

Keywords: *Distribution System Operators, gas, electricity, energy transition.*

JEL Classification: *L94*

Funding: *PwC Amsterdam*

EPRG WORKING PAPER

A Global Map of Electricity and Gas Distribution Network Companies[1]

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27 June 2025

1. Introduction

Net zero targets of individual jurisdictions call for large investments and major infrastructure upgrades. While investments in renewable capacities have surged,

[1] With thanks to PwC B.V. for sponsoring this paper via Cambridge Enterprise. All errors are the responsibility of the authors

those in grid deployment and extension have not grown at the same rate. Of the total $3 trillion going to energy technology and infrastructure globally in 2024, only $400 billion have been invested in grids (IEA, 2024). In parallel, more than 3000 GW of renewable projects are waiting for grid connection (IEA, 2023). To meet national climate targets, annual grid investments would need to increase substantially by 2030 - to more than $600 billion - based on IEA estimates (IEA, 2023).

This paper is inspired by the crucial role that energy distribution network utilities are playing and are expected to play in the energy transition (Pollitt *et al.*, 2022). In electricity, distribution companies or distribution system operators (DSOs) are those responsible for the lower voltage network connecting the high voltage bulk transmission system to individual homes and businesses. In gas, distribution system operators are those responsible for the lower pressure network connecting the high pressure bulk transmission system to individual homes and businesses. Such companies may or not be integrated with transmission, upstream electricity generation or gas production or downstream energy retailing.

For this paper, DSOs are defined following the EU directive 2019/944, whereby 'distribution system operator means a natural or legal person who is responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area […] and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity'.[2] While such entities have different names and structures in other jurisdictions, for example Distribution Network Operators (DNOs) in the UK or integrated utilities in many other countries, we assimilate all such entities under the term DSO. The distinction between DSOs and DNOs is indeed relevant, as it involves potential separation of the system operation function from network operation. However, under our definition, a DSO is the entity that perform the network operation, even if the same entity performs other functions (including system operation or others) We use a similar approach and definition for gas DSOs.

In leading jurisdictions (such as the UK, California, Australia, etc.), we see DSOs engaging in innovation projects to facilitate the connection of distributed generation, electric vehicles and heat pumps.[3] We also see internal reorganisations where system operator functions are being separated from network asset availability

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019L0944#enc_1
[3] See Pollitt et al. (2022).

provision. For instance, UKPN in Great Britain has set up a separate distribution system operator (DSO) unit (UKPN, 2025).

There is also the question whether there are other options and what the future division of responsibilities is likely to be between the distribution system operator and transmission system operator (TSO). As electricity network companies begin significant network expansions for deep electrification, increasing build rates are required in conditions where supply chains may be tightening.

There also remain issues around the optimal organisation of the sector for the challenges of deep decarbonisation. These include the separation of gas and electricity, sub-optimal small scale and ineffective public ownership. In addition, in some jurisdictions – particularly across Europe - there are strict unbundling rules that reduce incentives for network investments with spillover benefits for generation or retail segments, effectively preventing battery investment by network companies. This raises questions about the extent to which the current operation, regulation or ownership structures of assets facilitate or hinder the energy transition.

Such challenges exist all over the world in an industry where the fundamental physics is the same and therefore much can be learned from the experience of others. In particular local hotspots have appeared in places where distribution networks struggle with large exports of distributed generation (e.g. from solar in Australia) or large new sources of demand for power (e.g. data centres in Virginia), for transport (e.g. EVs in Norway) or for heat pumps (e.g. in Germany) (EHPA, 2023; Aurora Energy Research, 2024; European Commission, 2024; BNEF, 2025). These experiences provide lessons for other companies contemplating or struggling to respond to rapid growth on the supply and demand side.

Looking beyond the OECD and the more advanced emerging markets, challenges tend to differ. There are countries where DSOs have to deal with lengthy and frequent interruptions or large losses both technical and commercial (e.g. in Guyana, Niger, Paraguay or Zimbabwe). In many countries, particularly in Sub-Saharan Africa, energy access rates (via electricity networks) are low, and many connection points are not metered. In these circumstances, utilities tend to be financially weak, with revenues below costs, which limits their ability to invest in improved performance. Their priorities tend to be restoring financial health, having cost-reflective tariffs, reducing operational costs, connecting new customers and finding ways to prevent the erosion of their revenue base as a result of the booming captive commercial and industrial (C&I) segment.

In this context, this paper seeks to present a map of global DSOs to illustrate the variation in the power and gas distribution sector across the world as we contemplate the role of DSOs in advancing the energy transition. Section 2 outlines the approach, methodology and challenges in undertaking the analysis. Sections 3 and 4 report the findings for electricity and gas DSOs respectively. Section 5 discusses conclusions and next steps.

2. Approach, methodology and challenges

The substance of our paper is to explore the organization, size, ownership, structure, performance, and perspectives on innovation of the electricity and gas distribution network companies around the world.

In addition, the paper will identify broad patterns by region, level of economic development and decarbonization status.

The indicators have been chosen because they are identified in the literature as being relevant for the electricity and gas distribution service in general, but especially in the context of net zero.

The scope is richer for electricity than gas, as indicators (especially performance indicators) are more widely reported for electricity grids.

The **size** of the distribution company, in terms of **number of customers**, **employees**, **energy distributed** and **length of network**, may determine its efficiency and capabilities to invest and manage major change processes required by the transition (Growitsch, Jamasb and Pollitt, 2009); Söderberg and Vesterberg, 2025).

The **ownership** (public, private or mixed), the extent of **vertical integration** (generation, transmission, distribution, retail) and the extent of **horizontal integration** (with gas, water or other utilities) are features of the organization of the distribution service that can have different (sometimes ambiguous) effects on the ability to face the challenges of net zero (Kwoka, 2005). The effect of public ownership can depend on state capacity, while vertical and horizontal integration can contribute to greater coordination and synergies (whole energy approaches) but also to inefficiencies and cross-subsidization. These features relate to the nature of the ’distribution firm’ and its capabilities (see Ajayi and Pollitt, 2024; Nillesen and Pollitt, 2021; Pollitt, 2025).

Related to ownership, **corporatization** captures the management approach to the distribution service, company structures being considered more independent and

efficient than public utility authorities. Non-corporatized energy provision is likely to be substantially less efficient and some forms of 'public' ownership are likely more efficient than others (see Haney and Pollitt, 2013). Whether the entity is **listed** or owned by a listed group is meant to capture the approach to revenue recovery and investment but also to information disclosure.

The **performance** of the distribution service is generally appraised via indicators of **continuity** (SAIDI, SAIFI) and **network losses**, which are more relevant for electricity than gas (Joint Research Centre, 2023). SAIDI represents the System Average Interruption Duration Index and is measured in minutes per customers per year. SAIFI represents the System Average Interruption Frequency Index, measured in number of interruptions per customer per year.

Finally, as a proxy for the **innovation** context of DSOs, we include a simple binary variable that captures whether a DSO has published a sustainability report since 2019 to date. Sustainability reports, while differing across jurisdictions and standards, will typically include a DSO's strategy to tackle the challenges of decarbonization (in addition to other social and governance issues), and this will inevitably require the firm to engage in innovation. A DSO publishing a sustainability report will have at least described its approach to innovative activities meant to navigate the transition.

Sample

For the analysis in this paper, we looked at 194 countries. For each country, we selected one DSO for electricity and one for gas which resulted in a sample of 194 electricity DSOs and 75 gas DSOs. We did this because of the difficulty of characterizing individual countries on the basis of identifying all of their distribution utilities, which exhibit a wide range of intra-country variation. In addition, some of these utilities are very small, with little identifiable internet presence.[4] The data mostly relate to the latest published data, which in most cases is for 2023 or 2024 but goes as far back as 2017 for some indicators and DSOs (for example, the number of customers of the electricity utility, SEDC Sudan). The criterion for selection was for the DSO to cover the capital city of the country.

Capital cities are relevant given their public and political importance, therefore we would expect better corporate governance of the DSO that covers the capital city. In addition, we would expect that regulation and innovation are at least as advanced for the DSO active in the capital city as any other DSO in the country. Moreover, the data transparency is likely to be highest for such DSOs. Finally, we would expect

[4] This was a significant issue in our earlier work (Kufeoglu, Pollitt and Anaya, 2018).

that if a gas network (that serves residential users) exists anywhere in the country, it exists in the capital city. At the same time, all capital cities have an electricity network of some size.

For each DSO we looked at the indicators introduced above, grouped into 5 clusters.

Table 1: Clusters of indicators and definitions

Cluster	***Indicators***	***Clarification***
Size	Number of customers Energy distributed per most recent available year Length of the distribution network (in km) Number of employees	The number of connection points. The energy distributed number will be approximated by energy sales if the former is not available. The number of employees of the entity reporting (which may be bundled).
Ownership	Public, mixed or private	Following Küfeoğlu et al. (2018), we consider a public DSO as the corporate entity with more than 50% ownership by the state or other public entities. Entities with an ownership stake by the state or other public entities between 5% and 50% will be labeled as mixed. The others will be labeled as private.
Vertical integration	Bundled or unbundled	There are numerous ways to look at unbundling, including ownership, legal, operational or accounting (Küfeoğlu et al. 2018) To simplify and enable comparability, we look at the corporate entity performing the power or gas distribution service and examine whether the same entity is responsible for other services as well. If they do not, they are considered unbundled and labeled ‘D’. If they do, they are seen as bundled and ‘G’ for generation, ‘T’ for transmission or ‘R’ for retail are added.
Horizontal integration	Integration with natural gas and/or water	Establishing whether the same entity is responsible for distribution of electricity

		and natural gas or water
Corporatization and public trading	Whether the entity performing the distribution service is incorporated as a company or as a state commission / authority / Whether the entity is listed or owned by a listed company	The information will be derived from the website of the organizational entity, where available.
Performance	Network losses Continuity indicators SAIDI and SAIFI	When reported at different network voltage levels, the low voltage will be included. When reported in hours, they are converted to minutes.
Innovation	Whether a company has published a sustainability report over the last 5 years [Y/N]	This will be established by performing a search using a common search engine of the DSO name and 'sustainability report' or accessing the company website

Issues of comparability

To ensure a good degree of comparability, we look at the corporate entity reports. We identify the number of consumption points, energy distributed, network length and employees. The performance indicators are also standard, for the most part.

However, there are significant issues of comparability.

For example, in some countries, there is a single company owning most of the assets in the sector (e.g. Eskom in South Africa), while in others, the entity owning networks in multiple countries presents the data in an integrated report (e.g. E.ON in Europe). Some entities have branches and report some data for each (energy distributed) but other data at the entity level (employees), making comparisons difficult.

Some countries have a dedicated DSO for the capital (e.g. Stromnetz in Berlin for electricity and Gradska Plinara in Zagreb for gas), owned by the municipality while others have a large multi-regional DSOs (e.g. Enedis in France for electricity and Distrigaz Sud in Romania for gas) or a single major distribution utility at the country level (e.g. ECG in Ghana in electricity and Azerigas in Azerbaijan for gas).

With regard to continuity metrics, there are multiple methodologies to calculate SAIDI and SAIFI, with different system boundaries, averages across regions, voltage levels, separated by urban and rural, planned and unplanned, excluding force majeure or not. In many developing countries, establishing SAIDI methodologies is still a work in progress.

There are issues with comparing the numbers of employees in the relevant DSO. In some cases, the number refers to the vertically integrated businesses (e.g. Tepco in Japan or Eneo in Cameroon) while in others it refers strictly to the distribution activity (e.g. Umeme in Uganda) and may or may not include contractors or temporary employees.

Network losses are sometimes split by voltage level or by sub-network (e.g. UKPN in the UK), making it difficult to derive one single number that is comparable to others.

In the case of distributed energy, some utilities present it as energy sold (e.g. Senelec in Senegal for electricity), while others (usually the unbundled ones) present distributed energy (e.g. PREdistribuce in the Czech Republic), including or excluding losses.

Finally, some countries have the biggest DSOs outside the capital (Italy) or have much larger cities that are not capitals (Brazil, Canada, Australia, Turkey, Nigeria, Tanzania, etc).

3. Findings electricity

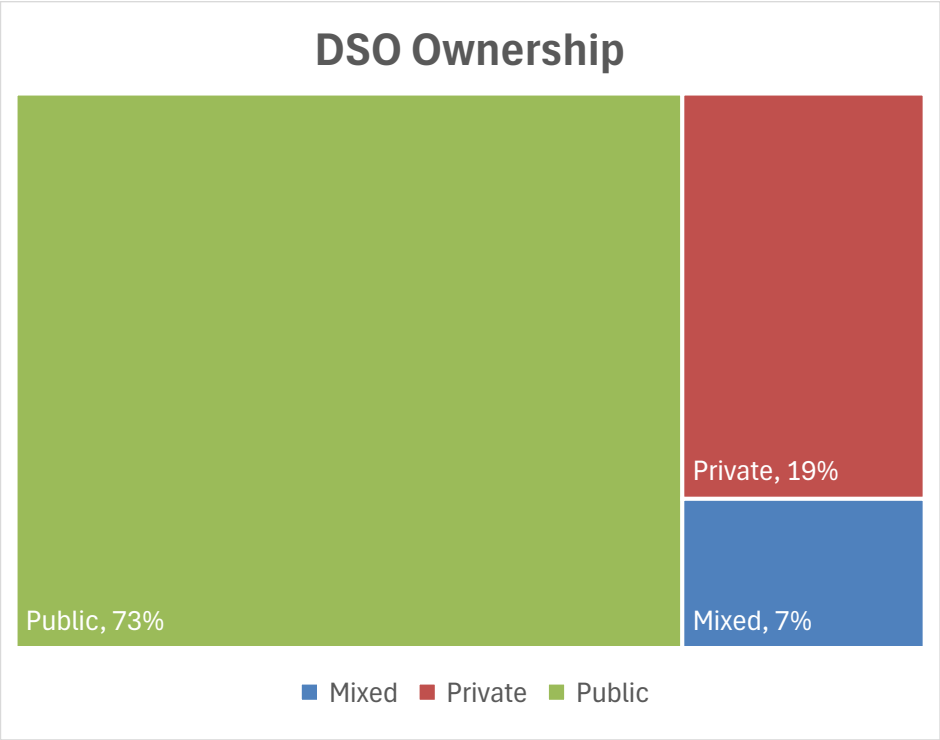
Ownership

Almost three quarters of the world's DSOs are state owned based on our definition, while 19% are private (Figures 1 and 2). South America and Europe have comparatively higher rates of private ownership. The largest DSO in the world, China State Grid Corporation, is state owned.

A few DSOs have been privatized in the past and came back into state ownership in recent years. Examples include Delpaz in Bolivia in 2012 and Disnorte-Dissur Nicaragua in 2020 (Havana Times, 2024; Bnamericas, no date). An interesting case is represented by the unbundled distribution company UMEME in Uganda, listed at the stock exchange and privatized with a group of development finance institutions (DFIs) as investors. The government chose not to extend the license starting in 2025, arguing that the improvements in connection, reduction of losses and interruptions were not significant enough to justify the costs (Twesigye, 2023). Another notable example is Cabo Verde, where the utility Electra has been repurchased by the government in 2006 and is planned to be privatized again in the following years

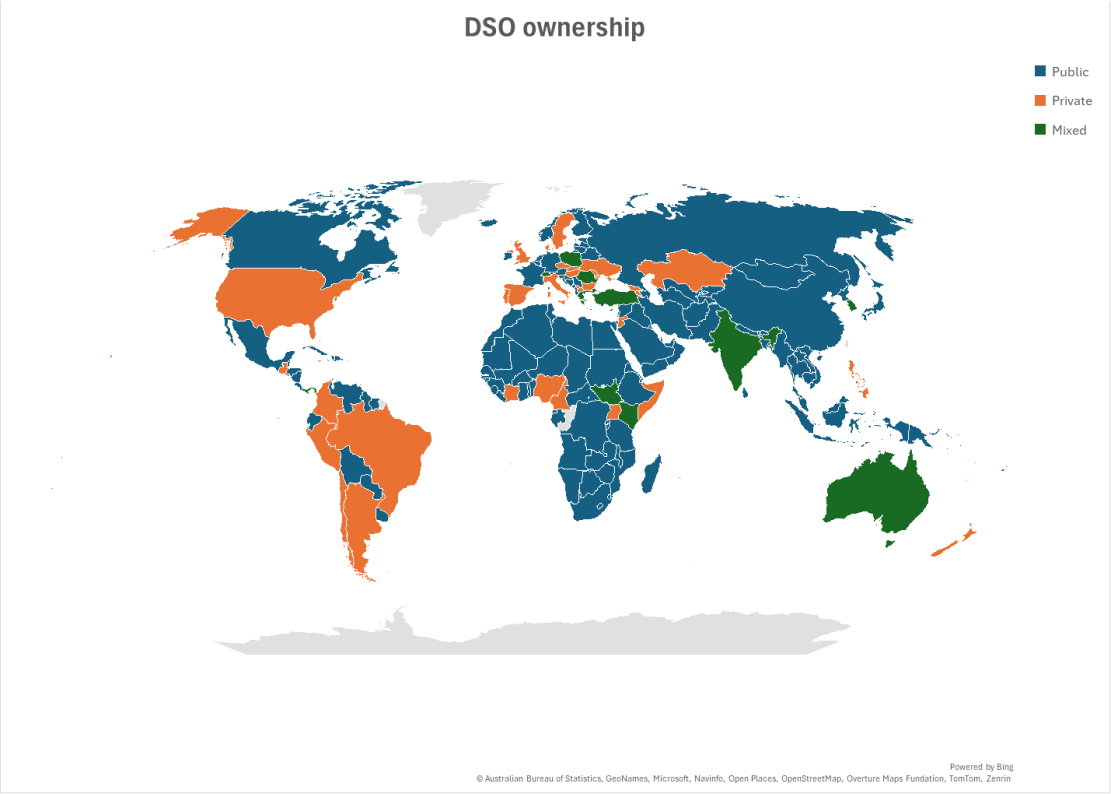
(World Bank, 2021). Finally, the integrated utility Eneo in Cameroon, currently owned by a private equity impact fund, is expected to go back to public ownership in 2025.

Figure 1: DSO ownership



Private ownership tends to be more prevalent in Central and Eastern Europe and Latin America, perhaps reflecting the 'waves' of privatization (Chang, Hevia and Loayza, 2009) seen as an efficiency requirement as part of EU accession or the IMF structural adjustment programs.

Figure 2: Electricity DSO ownership map



Research does not seem to find significant associations between public or private ownership of electric utilities and efficiency, but private ownership does tend to be associated with higher income economies (Alkhuzam, Arlet and Lopez Rocha, 2018). This is then reflected in breakdowns of sample ownership by continent (Figure 3) and by country economic grouping (Figure 4). The country groups we include are: ASEAN in Asia[5], Middle East and North Africa (MENA)[6], Central and Eastern Europe (CEE)[7], OECD[8], Sub-Saharan Africa (SSA)[9] and the European Union[10].

Figure 3: Electricity DSO ownership by continent

[5] https://asean.org
[6] https://www.worldbank.org/en/region/mena
[7] https://www.unescwa.org/sd-glossary/central-and-eastern-european-countries-ceecs
[8] https://www.oecd.org/en.html
[9] https://data.worldbank.org/country/sub-saharan-africa
[10] https://european-union.europa.eu/principles-countries-history_en

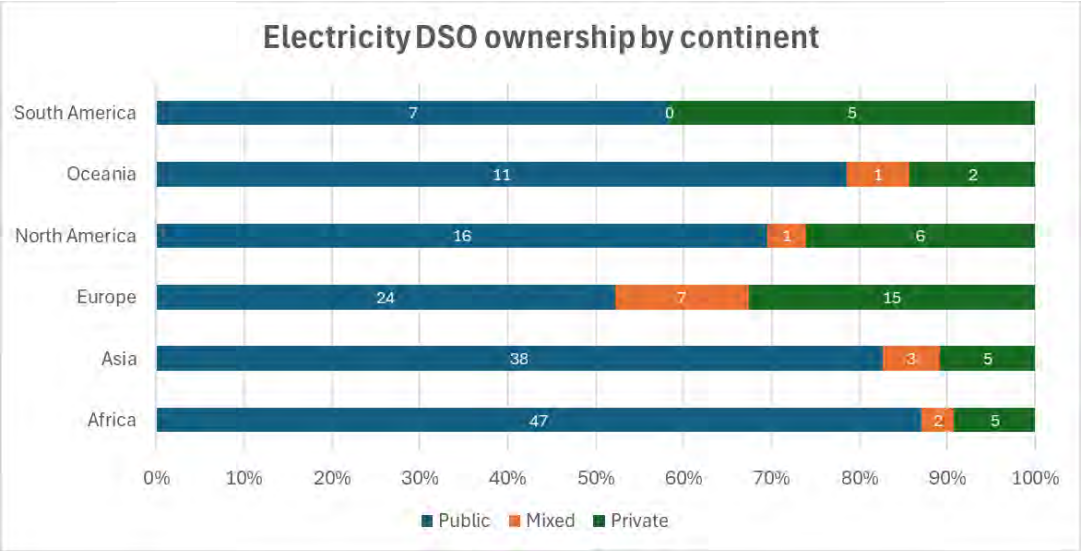
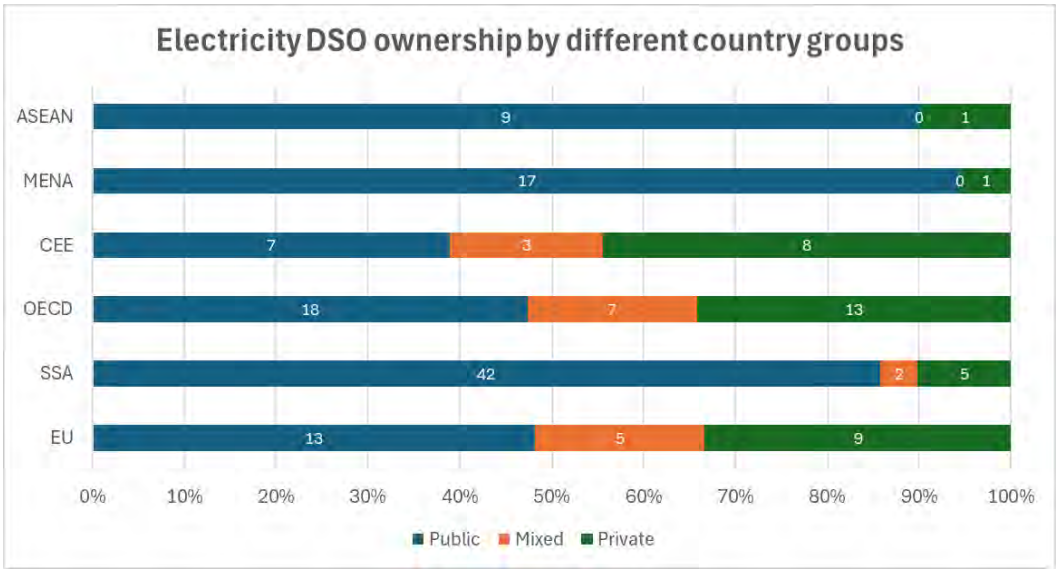


Figure 4: Electricity DSO ownership by different country groups



Corporatization and public trading

In almost all surveyed countries, the power distribution activity is performed under a corporate entity, with very few cases where there is still a state authority. For example, in Kuwait, the Ministry of Electricity, Water and Renewable Energy is responsible for the power distribution function. There are a number of entities with names that suggest other structures, such as State Commissions or Authorities, but they are in actuality incorporated as companies while keeping the names. Examples include Office National de l'Électricité et de l'Eau Potable in Morocco or the Trinidad & Tobago Electricity Commission.

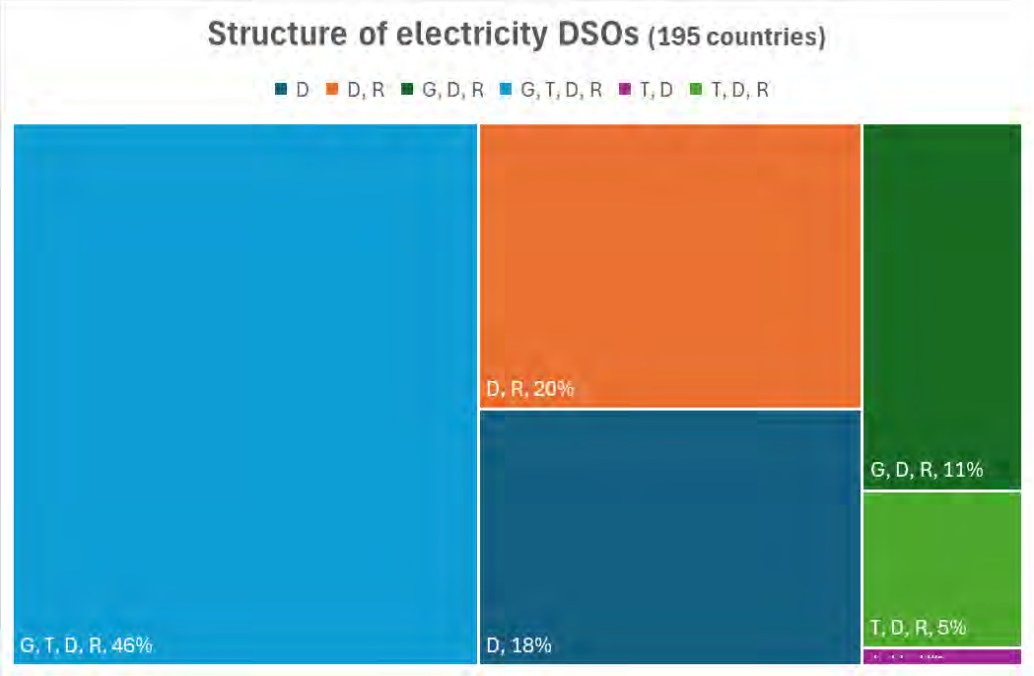
Slightly over 23% of the surveyed companies are listed or part of listed groups. Examples include KPLC in Kenya, listed on the Nairobi Stock Exchange, Meralco

listed on the Philippine Stock Exchange, but also DSOs that are subsidiaries of listed companies like PRE in the Czech Republic, owned by the listed group EnBw.

Integration

Many DSOs are part of vertically integrated entities with many countries having a single company managing the entire value chain. Almost half (46%) of the surveyed companies are part of groups that perform generation, transmission and retail in addition to distribution (Figures 5 and 6), while only 18% are in 'wires only' companies, with no retail or generation market presence (Figures 7 and 8).

Figure 5: Structure of electricity DSOs



Most 'wires-only' companies are in Europe. This suggests that specialist wires companies, strongly promoted in Europe as a result of vertical unbundling rules, remain globally rare.

In most countries, distribution and retail are performed under the same entity even when there is unbundling between generation and distribution activities.

Figure 6: Structure of electricity DSO map

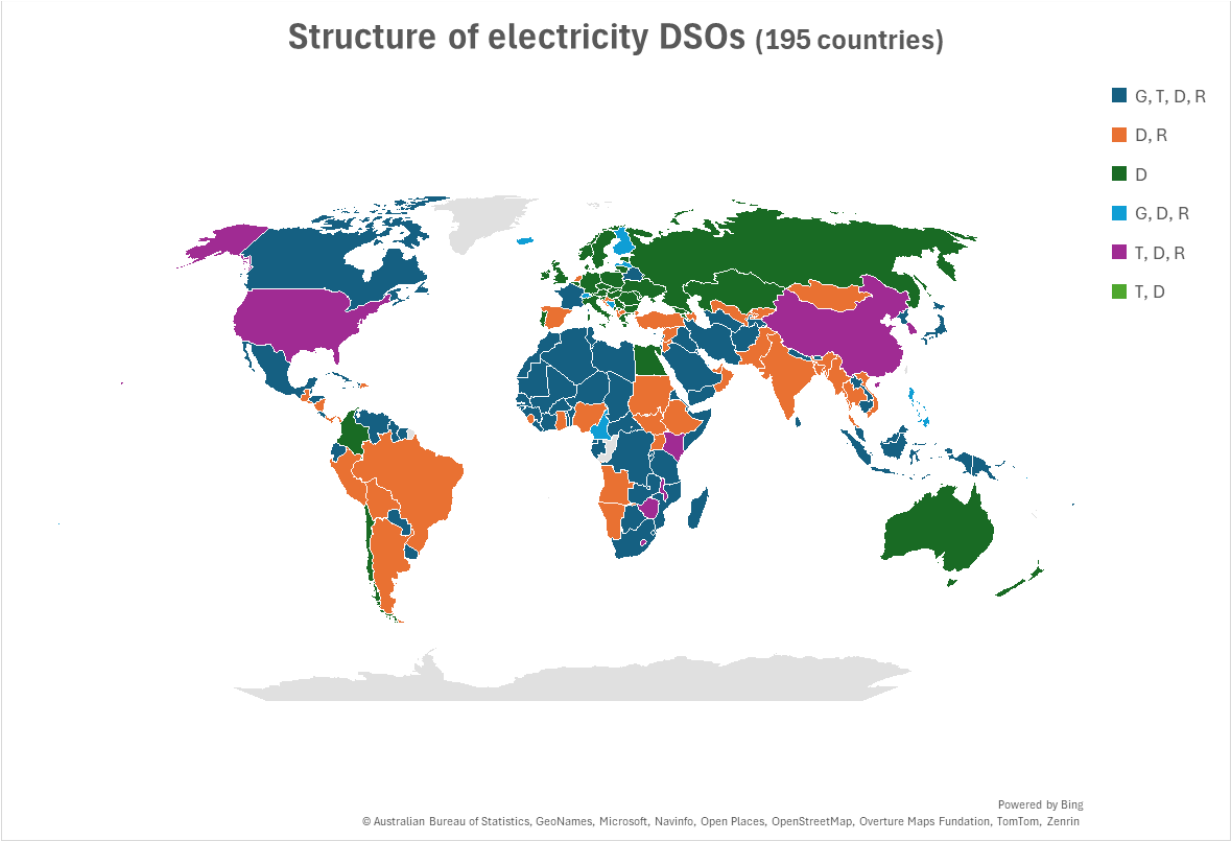


Figure 7: Structure of electricity DSOs wires only (WO) vs wires plus (W+)

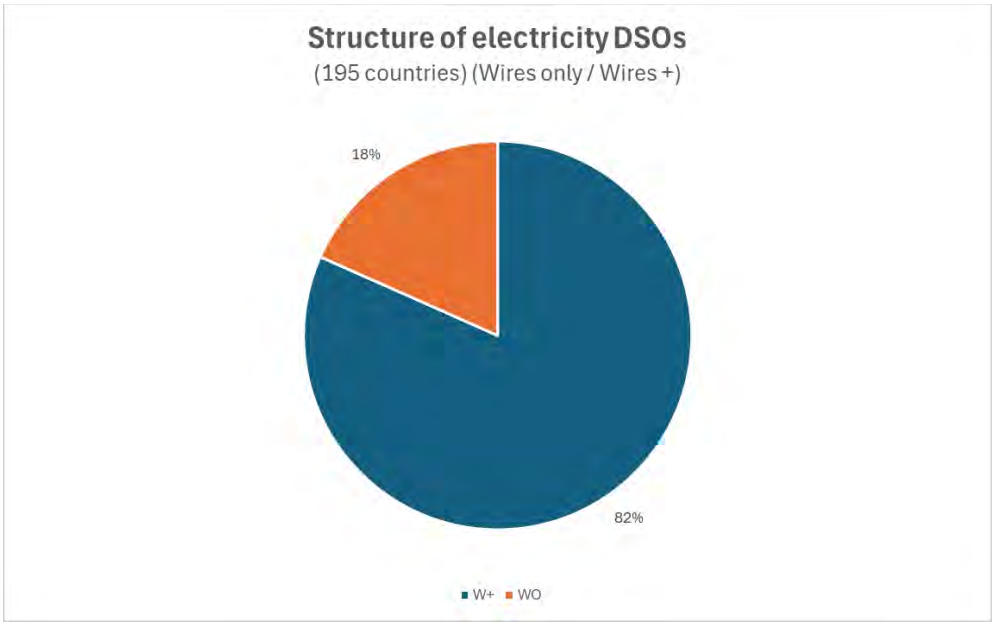
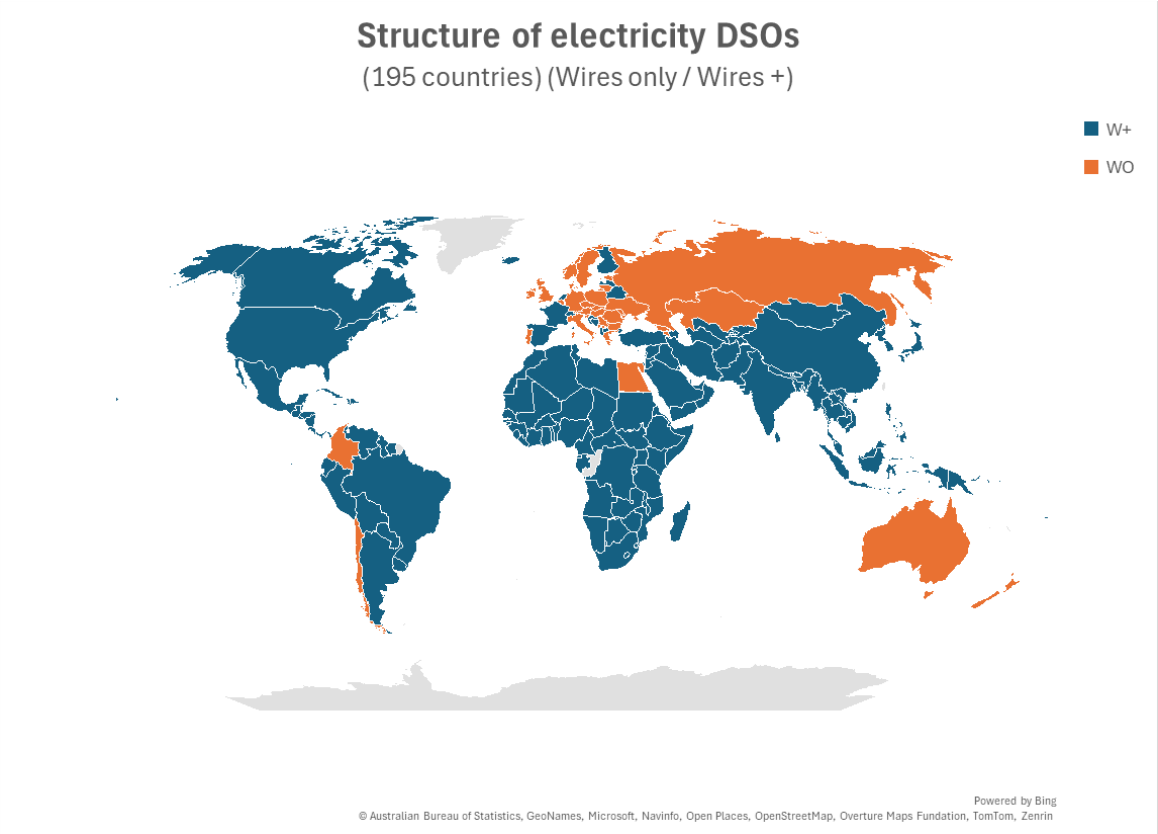


Figure 8: Structure of electricity DSOs wires only (WO) vs wires plus (W+) map



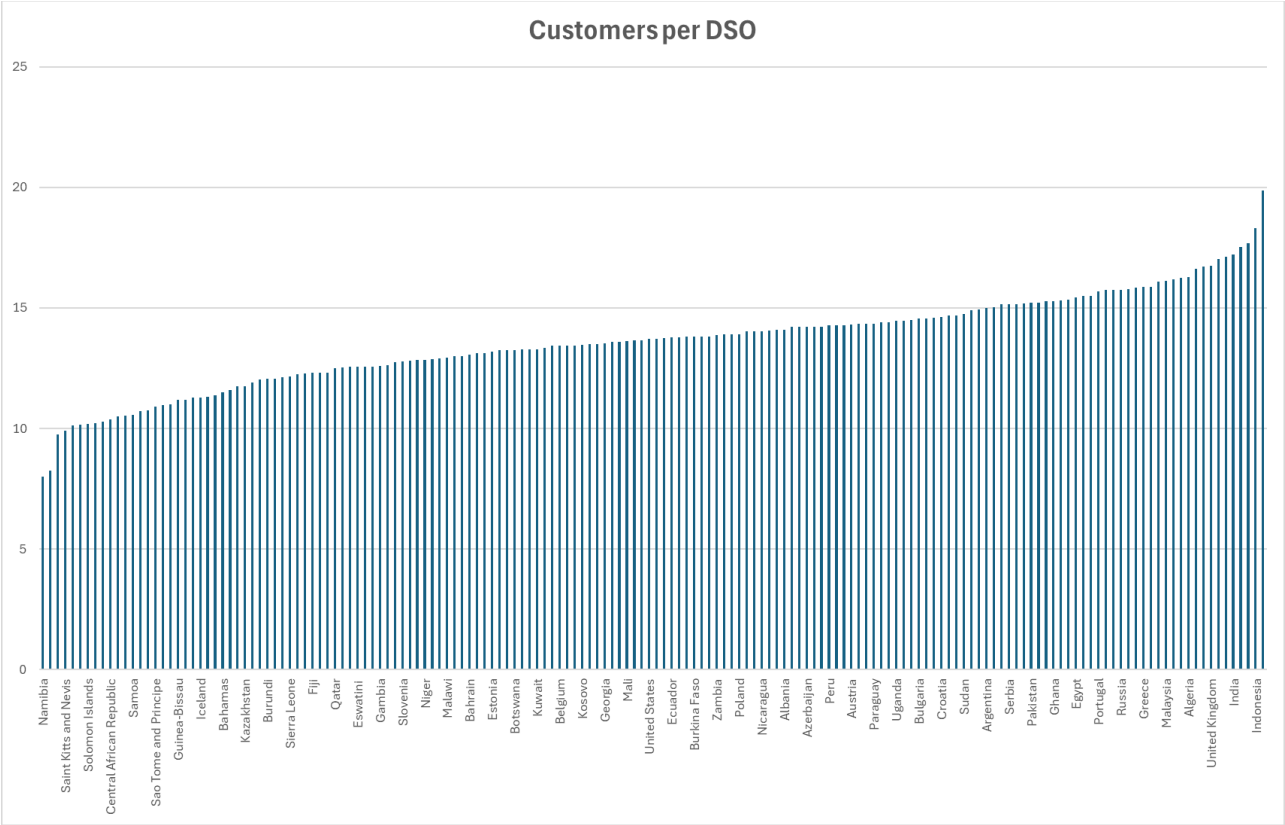
Outside Europe, there are unbundled DSOs in South America, Australia, New Zealand and a few other countries.

Groups like Enel, Iberdrola, E.ON and EnBw own significant shares of DSOs in Europe, but also in South America.

Size

DSO sizes range widely (Figure 9). In terms of numbers of customers, our global sample ranges from hundreds of millions (China) to tens of millions (Indonesia and Mexico) to a few thousands in island states like Vanuatu and Nauru. The average size is 3.7 million customers (excluding China) and 6.6 million including China, while the median is 906,000.

Figure 9: Electricity DSO customers (in logarithmic scale)



Note: selected countries; excluding China.

Performance

In terms of performance, network losses and SAIFI-SAIDI are commonly, but not universally reported. Where they are available, they are subject to inconsistent reporting (e.g. whether the reported numbers include force majeure or not or which area they relate to). We could only find SAIDI data for 91 DSOs (Figures 10 and 11) and SAIFI for 69 DSOs (Figures 12 and 13). In some regions, very few DSOs report continuity metrics and the ones that do have long interruptions. There are DSOs who report thousands of minutes of interruptions per customer per year (e.g. EDG in Guinea, Nigelec in Niger and ZETDC in Zimbabwe), but also DSOs with less than 5 minutes (e.g. Helen in Finland and Tepco in Japan).

Figure 10: Average of SAIDI by continent

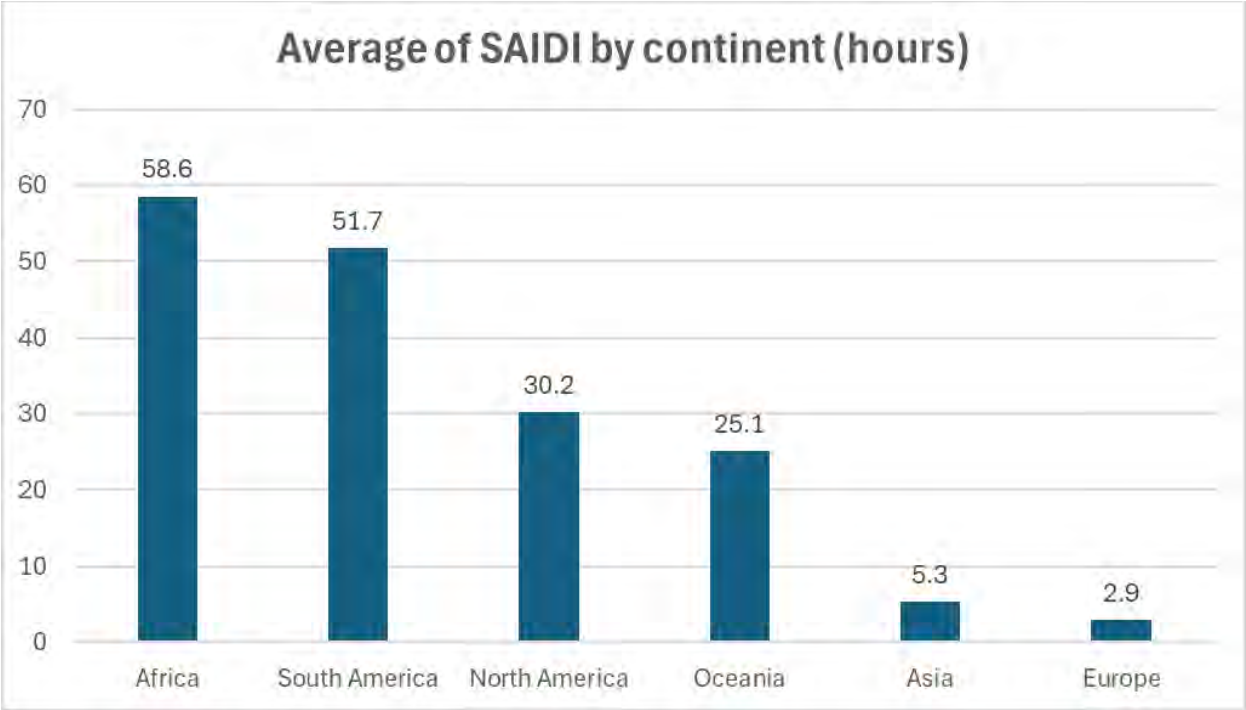


Figure 11: Average of SAIDI by different country groups

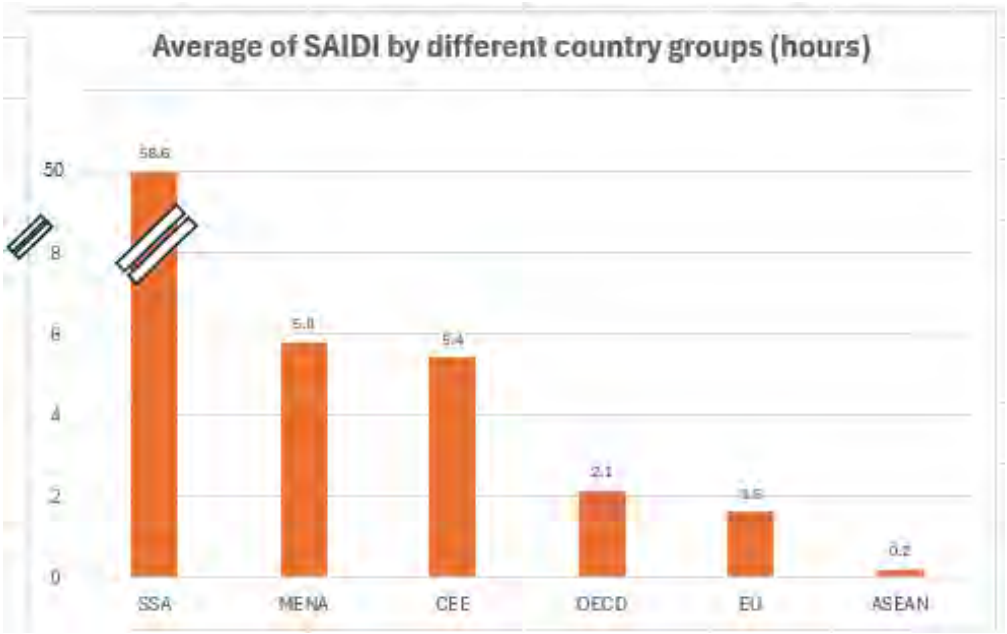


Figure 12: Average of SAIFI by continent

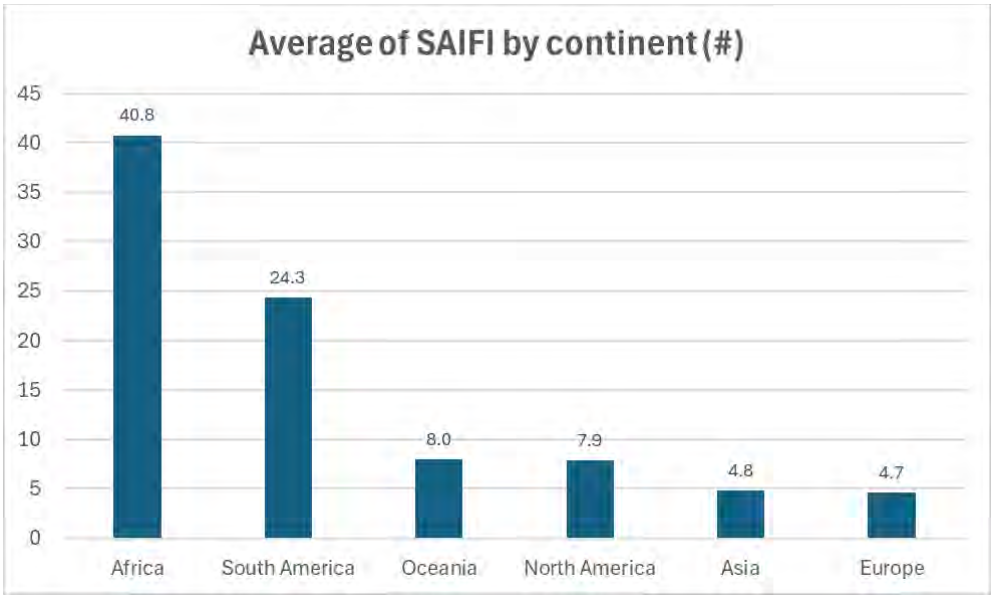
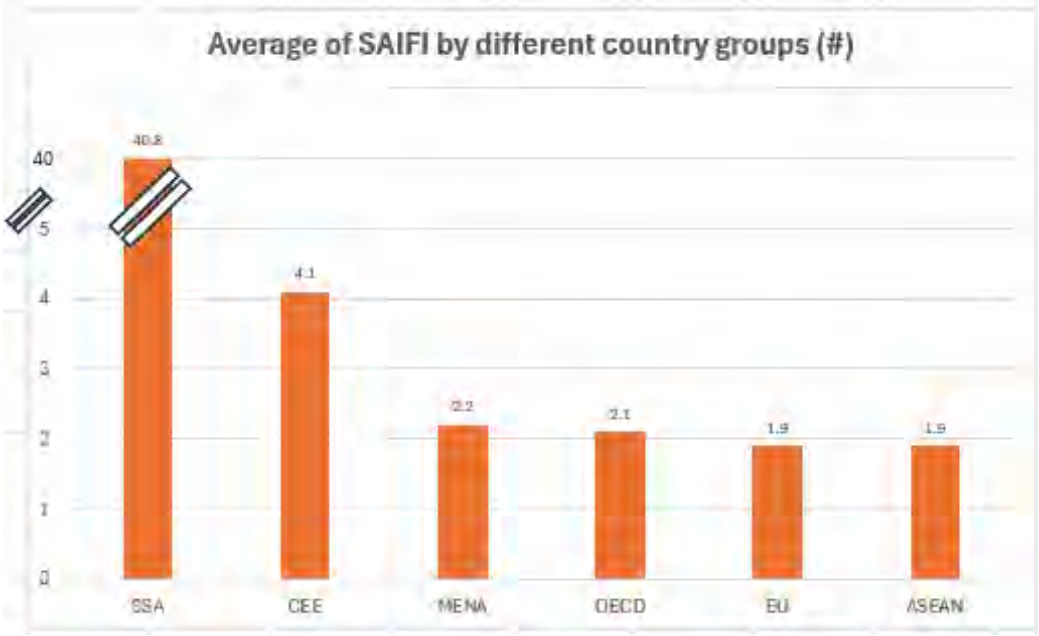
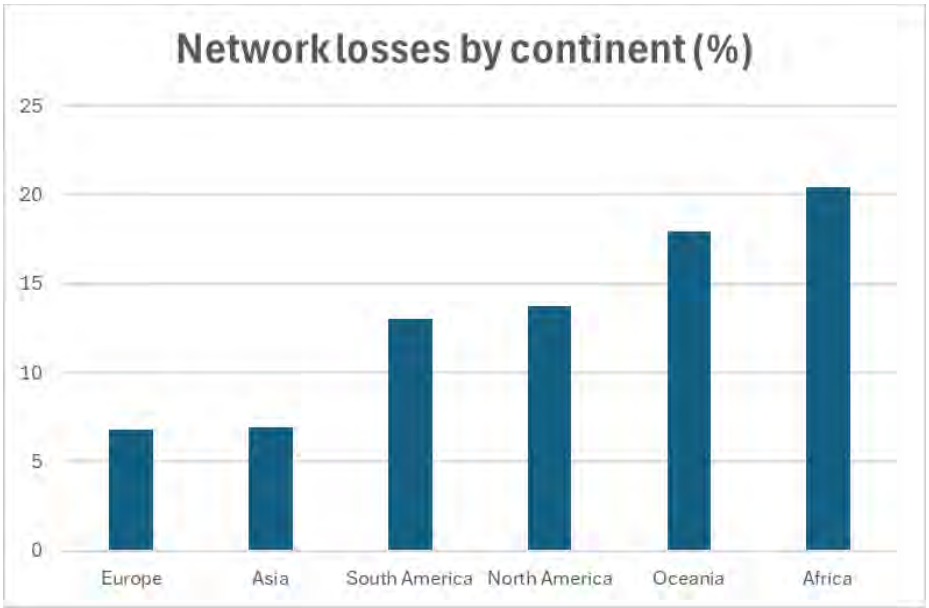


Figure 13: Average of SAIFI by different country groups



Similarly, there are DSOs with network losses as high as 35% (e.g. E2C in the Republic of Congo or ENEE Honduras) but also companies with losses below 4% (e.g. MEA in Thailand, Elektro Ljubljana in Slovenia and EvoEnergy in Australia). While data points are limited, utility performance is highest in Europe, Australia, New Zealand and North America, while Sub-Saharan Africa is facing numerous challenges in terms of interruptions and losses (see Figure 14).

Figure 14: Network losses by continent (%)



The average level of reported losses is 13.4%. Most DSOs (51 out 92 reporting) are below 10%. At the same time, more than 40% of DSOs have losses higher than 9.8% and almost 15% have losses higher than 25% (see Figure 15). The likelihood is that this overstates good performance as many of the non-reporting countries are likely to have poorer performance (Figure 16).

Figure 15: Histogram of network losses

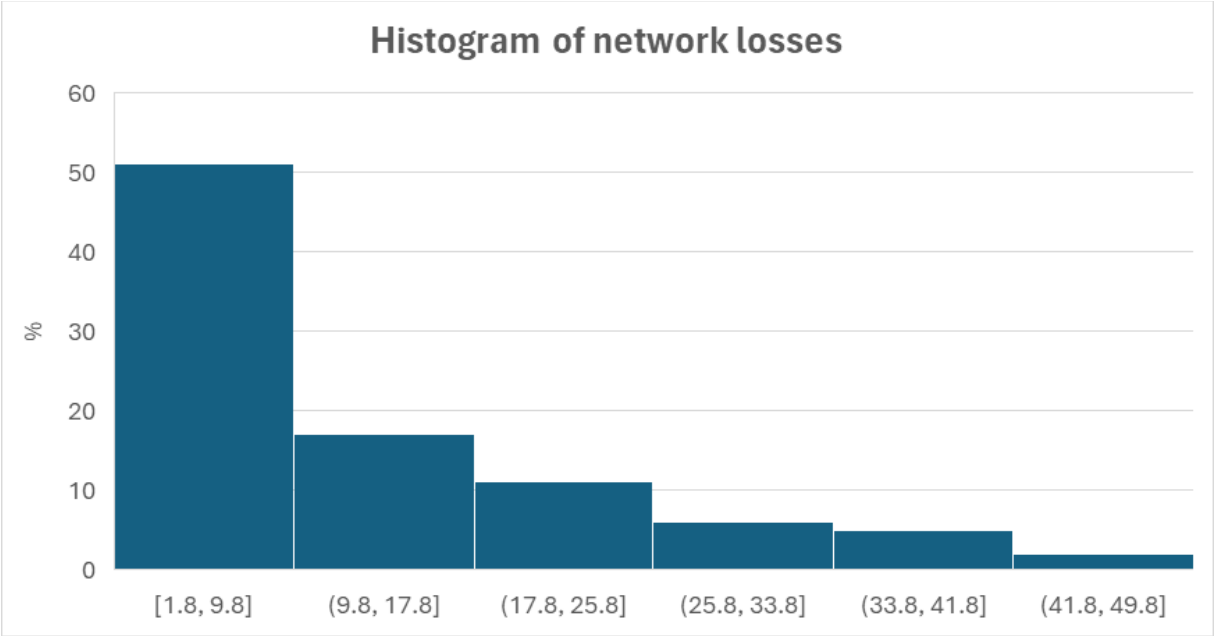
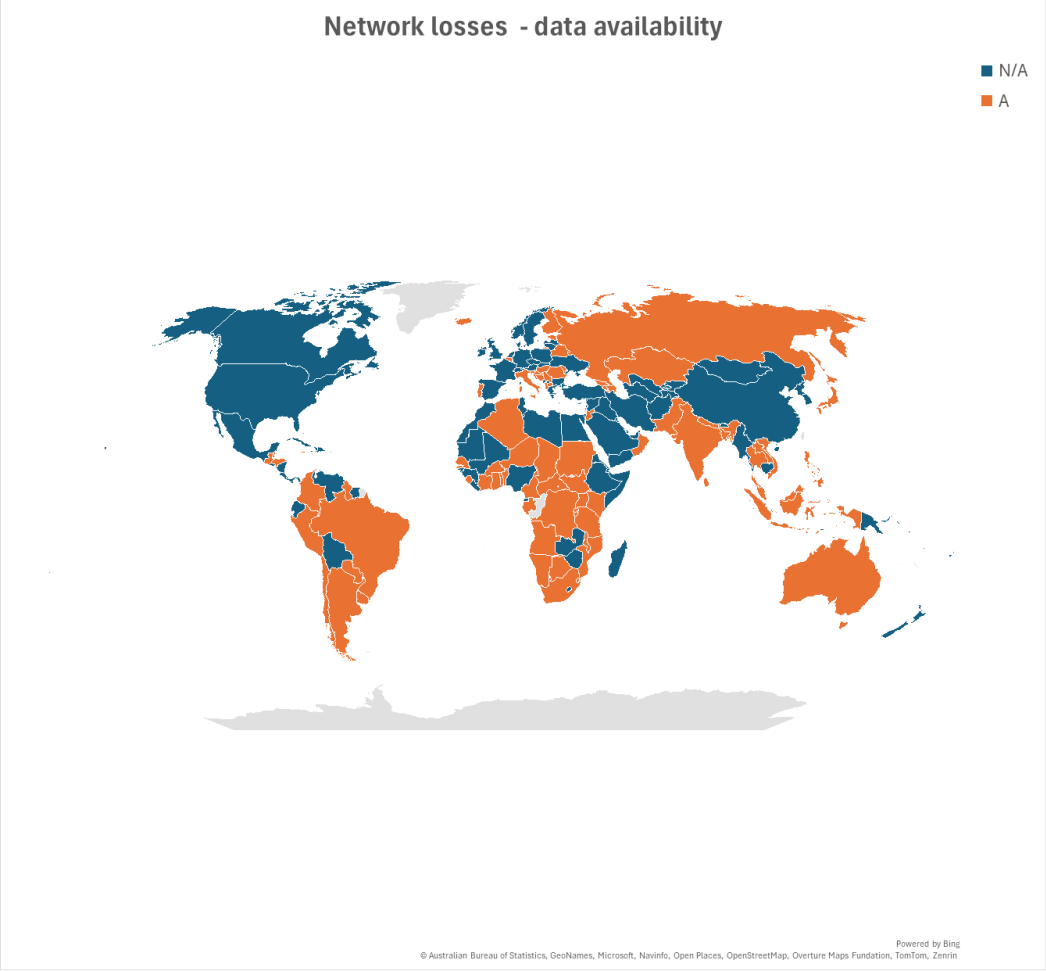


Figure 16: Network losses data availability



Innovation

Looking at sustainability reports (Figure 17), we found that the vast majority of DSOs (144 out of 194) did not publish a sustainability report since 2019. Some countries

report sustainability information in their integrated annual report, while others have dedicated sections on the website for corporate social responsibility or innovation.

A headline examination of the sustainability reports suggests that innovation activity can be clustered around themes, with the most common one being decarbonization and enabling renewable energy. However, there are also DSOs where customer management (including metering) or digitalization of the network represent the primary focus of their innovation.

Figure 17: Sustainability reporting for electricity companies

4. Findings natural gas

In 75 out of 194 surveyed countries there is a natural gas network in the capital. The minimum threshold for a country to be considered as having a natural gas network is that it serves households for heating and/or cooking, not just industry, gas-fired power plants or commercial clients (e.g. restaurants). There are grey areas as well for example in cities or regions with limited gas networks (like Stockholm) which has been largely converted to biogas serving a small number of clients. Many countries have plans of introducing pipeline gas in some regions after recent gas discoveries (e.g. Mozambique). Some countries do seem to have gas networks that may be operating on capital city territory but they mostly serve industry, power generation or desalination (e.g. Qatar, Saudi Arabia). Other countries have important gas networks but not in the capital (e.g. Brazil). Based on available public information, we decided to include those DSOs active in the capital serving residential consumers.

Ownership

Almost half of the sampled gas DSOs are in public ownership (Figures 18 and 19). Many gas DSOs are operated by private companies in the OECD, while outside the OECD the public ownership model is prevalent.

Figure 18: Gas DSO ownership

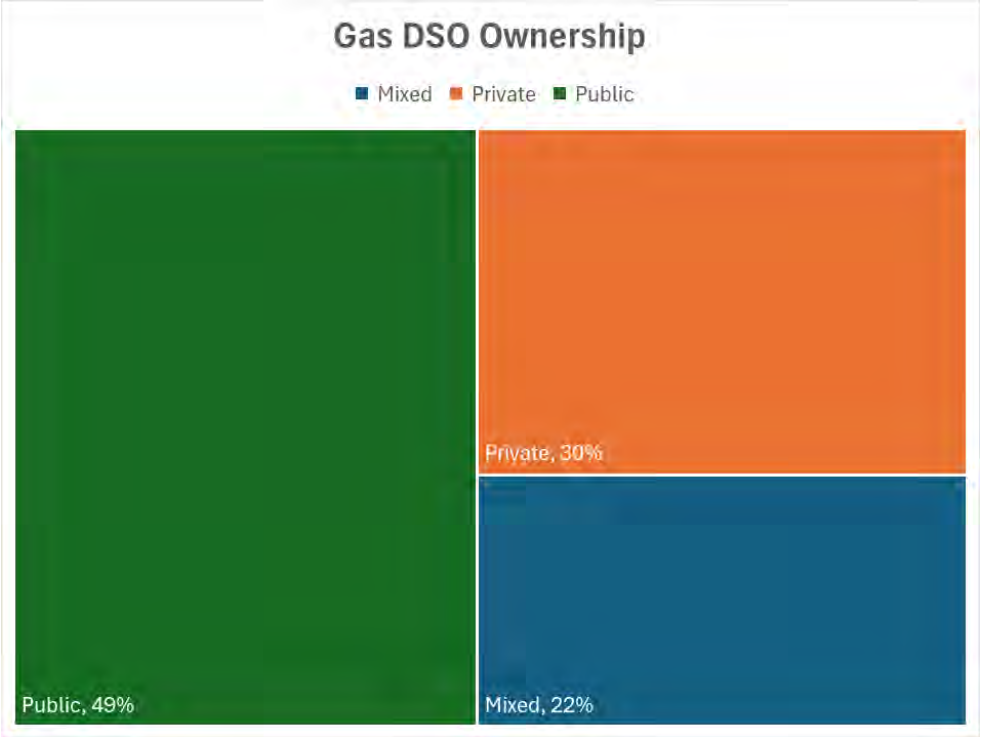
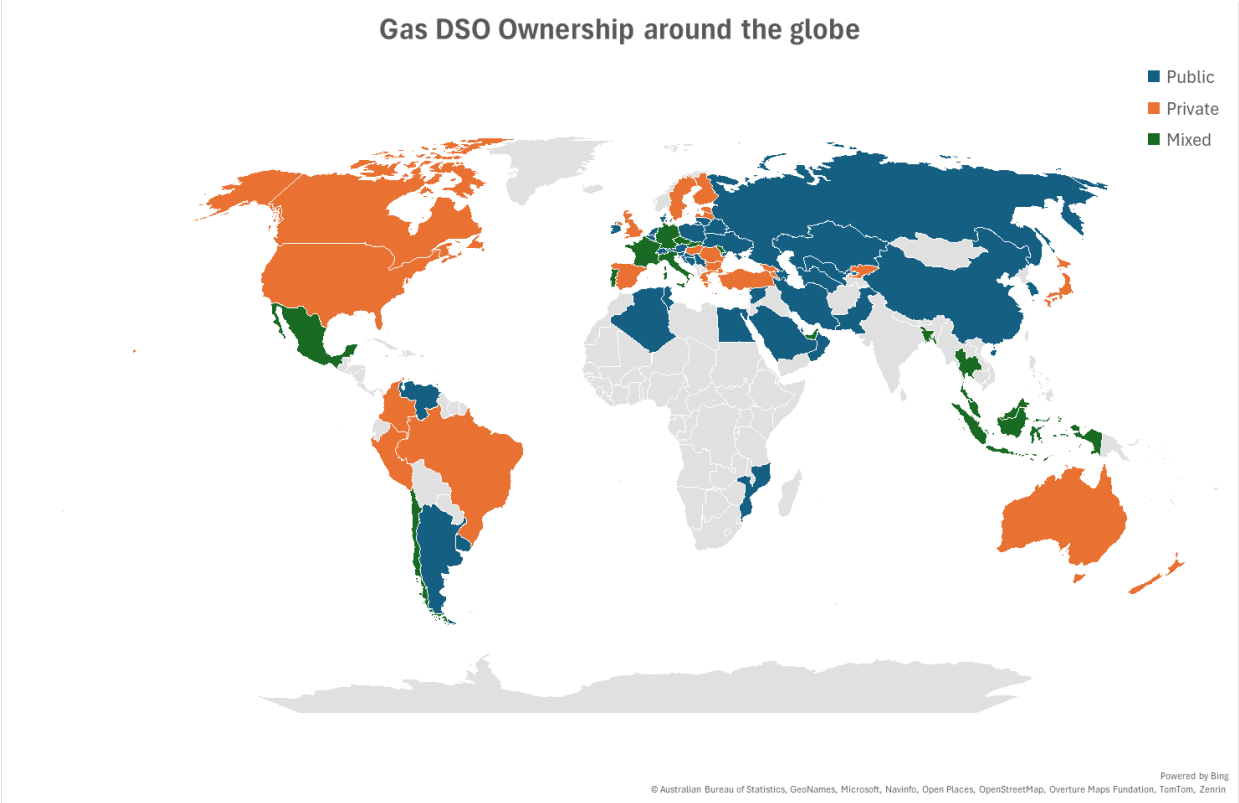


Figure 19: Gas DSO ownership map



Note: grey = no gas DSO in capital

Corporatization / public trading

The vast majority of gas DSOs are incorporated as companies but few are listed or part of listed groups.

Integration

The vast majority of gas DSOs (almost three quarters) are unbundled from upstream operations, but many are bundled with retail (Figures 20 and 21). One third of DSOs are fully unbundled. In our sample, only 15 DSOs are integrated with electricity DSOs.

Figure 20: Structure of gas DSOs

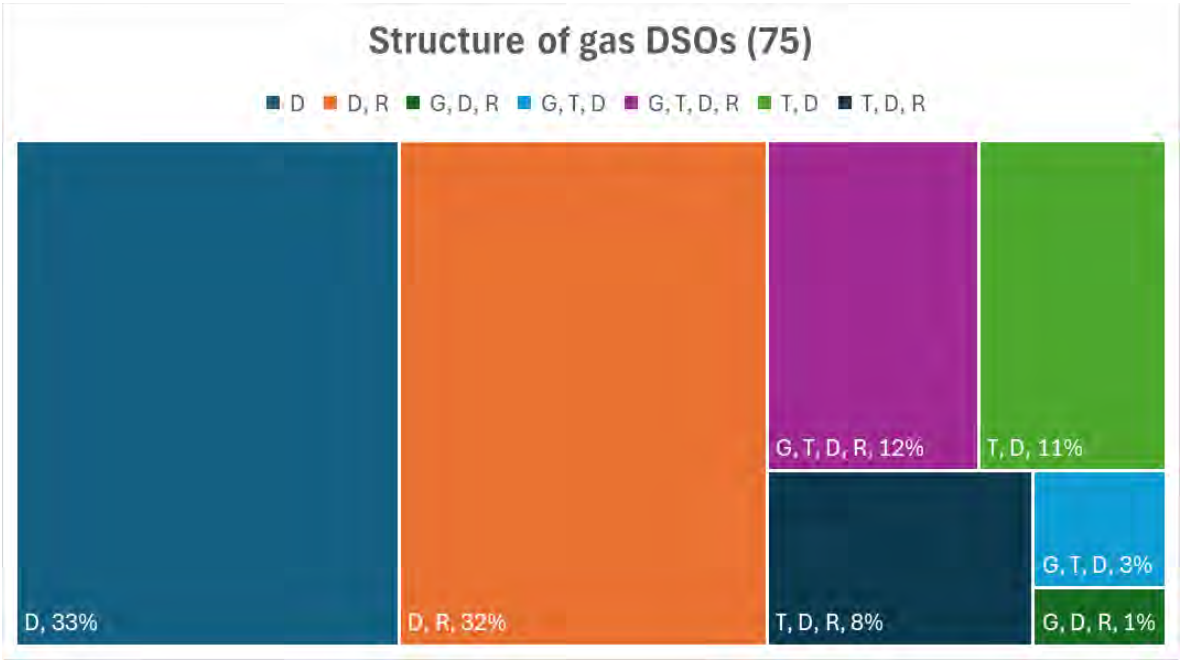
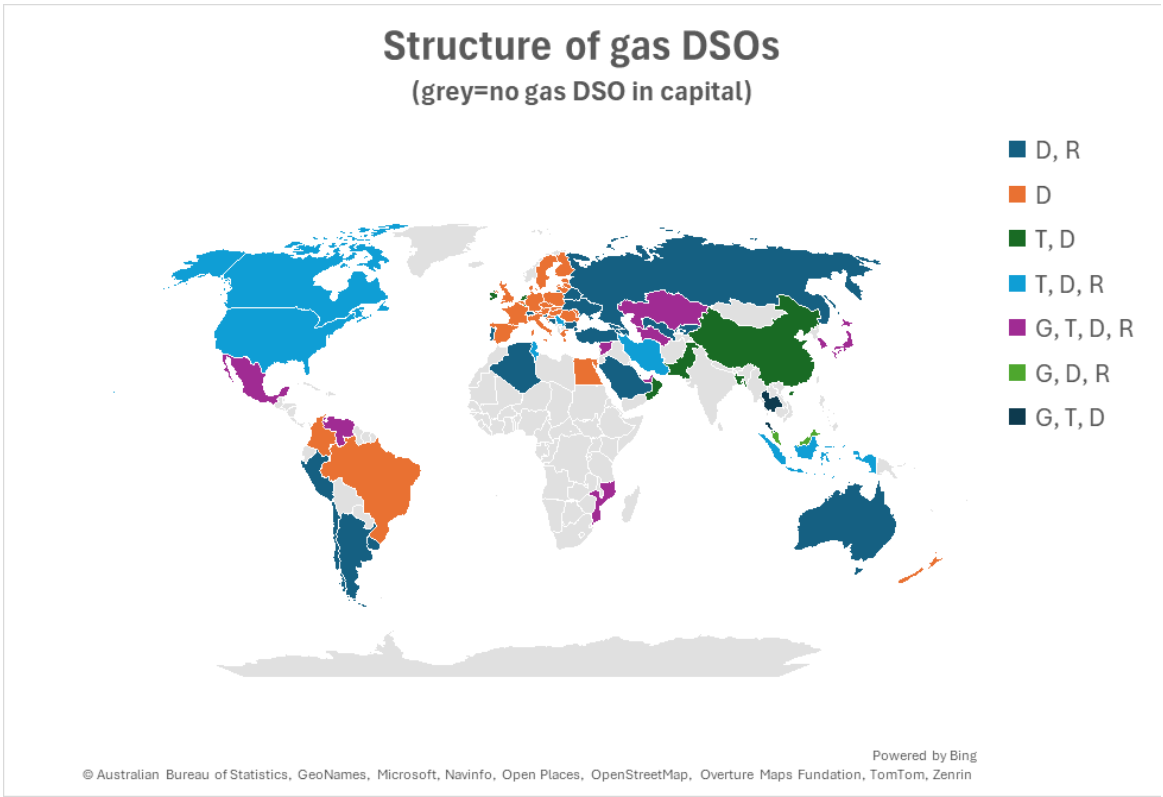


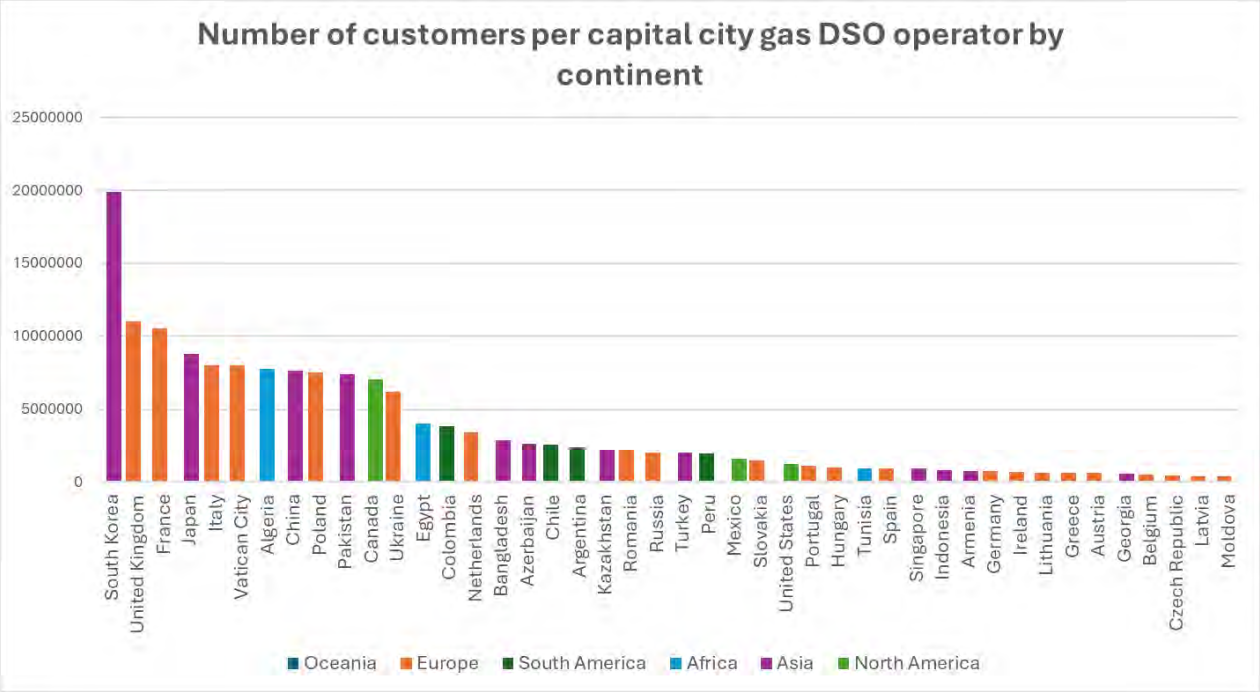
Figure 21: Structure of gas DSOs map



Size

Gas DSOs range from a few hundred customers in Malaysia to almost 20 million in South Korea (Figure 22) with a median of 915,000. The average gas DSO has 2.6 million connection points, which is lower than electricity (3.5 million without China, 6 million including China). The average network length is 34,500 km (of the 47 DSOs that report this number).

Figure 22: Number of customers gas DSOs



Innovation

On sustainability reporting (Figure 23), about half of surveyed DSOs (34 of 75) have published a sustainability report since 2019. The innovation themes they discuss the most are related to biomethane and hydrogen, but also customer management, metering and improved safety, reflecting the specifics of the gas business.

Gas versus electricity

The findings for electricity are richer than for gas, partly because the gas sample is smaller, but also because performance indicators are less widely reported publicly. Compared to electricity, gas DSOs are smaller on average, more likely to be private or mixed, and more likely to be ‘pipelines only’ (44%) compared to 18% of electricity DSOs who are ‘wires only’. This also reflects the fact that gas networks tend to be found in higher income countries where privatizations, market design reforms and unbundling have been more prevalent.

Figure 23: Sustainability reporting gas DSOs map

5. Conclusions

The power and gas distribution service varies widely around the globe in terms of ownership, integration, size and performance.

Most DSOs are in public ownership and vertically integrated. There is also a significant number of private DSOs, as well as cases of nationalization. Private ownership tends to be associated with higher income countries. Less than a quarter of the DSOs surveyed are unbundled from all other segments and most of those are in Europe.

Only a small minority of DSOs in developing countries have private sector participation.

Only around 40% of countries have a gas DSO active in capital and very few (15) DSOs are integrated between electricity and gas. In capitals where gas distribution utilities exist, they are significantly smaller than their electricity peers and relevant comparable data is scarcer, which may illustrate the insufficient attention given to the role of gas networks in the energy transition.

Developing countries face significant performance challenges with their electricity networks in the form of high losses and longer and more frequent service

interruptions. Often basic performance measures – losses, SAIDI and SAIFI – are not reported.

Not only is basic data difficult to get, but it also has significant comparability issues which makes it hard to evaluate the state of DSOs and the challenges they face. This also makes it difficult for DSOs to learn from each other. Poor data has implications for the likely quality of energy network regulation, such that poor reporting indicates weak regulation.

The degree of reporting varies considerably between countries and within regions. Even within the OECD, reporting standards vary – especially when DSOs are part of multinational groups and results are consolidated.

Europe constitutes an exception by most indicators. The impact of the European Union adopting the UK model of unbundling is seen even beyond its borders, with accession candidates adopting similar strategies. Also, in Europe, gas networks are more extensive and relatively bigger. Finally, by examining corporate reports including sustainability reports where available, we were able to determine that innovation has significantly different goals in different regions. In many countries innovation extends beyond decarbonization, including improved metering, reduced losses, and resilience to weather events. While most DSOs are facing the 4Ds (decarbonization, decentralization, digitalization, democratization), some aspects are much more salient in some regions than others (Soutar, 2021). Finally, we were able to infer that few countries truly have an active DSO in both electricity and gas (Duma *et al.*, 2024), one that goes beyond facing the challenges of net zero but actively enables it.

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