Methodology

The results of this paper serve as a guide to the performance of the electricity distribution for 26 countries in the Latin American and Caribbean Region. Sector performance is assessed according to the benchmarking of electricity distribution at regional, country, and utility levels. Broadly defined, benchmarking is the comparison of some measure of actual accomplishment against a reference or benchmark performance (Jamasb and Pollitt [2000]). In this study, the benchmarking model consists of a database containing annual information of 249 private and state-owned utilities using 26 variables indicating coverage, output, input, labor productivity, operating performance, quality and customer services, and prices. The time frame covers data as early as 1990 but the main focus is the period of 1995-2005. It is important to acknowledge that data availability and data sources vary from each respective country, often times depending on their ownership and means of regulation. While the benchmarking study uses a homogenous set of variables for collecting data and measuring performance, each country represents a special case and therefore efforts were made to assure consistency of the data across time and utility. The following sections define the indicators used, describe the process of data collection, and explain the efforts and challenges encountered in the completion of the database.

Performance Indicators:

In order to best describe the efficiency of the distribution sector of LAC, indicators were selected to determine utility-level performance. The utility-level indicators reflect relevant and feasible measurements in depicting the distribution segment of the electricity sector. The utility-level indicators were computed in order to measure factors such as technical efficiency, operating efficiency, cost efficiency, quality of service, etc. Technical efficiency is defined as the capacity of the utility to achieve maximum output from a given set of inputs. In order to compute the technical efficiency of a utility, output and input indicators reflecting operating and cost efficiency were aggregated.

The following table lists the output variables used in this benchmarking study. The data collected for the output variables are the prime indicators of a utility's efficiency. In the cases that data were not found according to the selected or designed variables, the second best option was selected. For example, when the Total number of connections was not available, the Total number of clients was used instead. Similarly, the Total electricity sold per year was also calculated and defined by several utilities as the Total electricity produced and thus used as a proxy once corrected for distributional losses.

OUTPUT VARIABLES		
1	Total Number of Connections (Residential and Non-residential) in the utility area.	number
2	Total number of residential connections in the utility area	number
3	Total electricity sold per year	MWh
4	Length of distribution network	km
5	Energy sold per connection per year	MWh

With respect to measuring the total cost efficiency, the following input indicators were calculated:

INPUT VARIABLES		
6	Total number of employees**	number
7	OPEX (operation expenditures) of the distribution services per connection.	in dollars
8	CAPEX (capital expenditures) of the distribution services per connection.	in dollars
9	TOTEX (total expenditures) of the distribution services per connection.	in dollars
10	OPEX of the distribution services per MWh sold.	in dollars
11	CAPEX of the distribution services per MWh sold.	in dollars
12	TOTEX of the distribution services per MWh sold.	in dollars

OPEX consists of operating and maintenance costs, customer service and accounts expenses, sales expenses, administrative, and general expenses. Usually, the biggest items of OPEX were labor, materials, and third party service contract expenses. While OPEX reflects the operations of the distribution segment, it includes purchases of electricity, taxes, transmission payments, and at times depreciation. CAPEX consists of the expenditures to acquire, expand, repair, or renovate fixed assets, implying the purchase of goods and services whose benefits extend beyond the year and add to the company's assets. CAPEX represents the annual gross capital outlays of a company.

However when calculating CAPEX and OPEX, there were several cases in which CAPEX and OPEX had overlapping or disaggregated amounts, making it difficult to calculate them or establish TOTEX. In addition, each country calculated and presented CAPEX and OPEX amounts differently according to their distinct accounting styles. When operating and capital expenditures were provided by the utility or regulator, that amount was registered. In the cases that OPEX and CAPEX were not provided, the amounts were aggregated according to the criteria mentioned above. Furthermore, collecting data for the average wholesale price, average transmission charges, and number of employees posed a challenge when the respective utility was vertically integrated, managing generation, transmission, and distribution. In such cases, the utility often times did not provide the internal price of transference but rather only accounted for the end user price.

With respect to labor productivity, two variables were used: residential connections per employee and energy sold per employee.

LABOR PRODUCTIVITY		
13	Number of Residential Connections per Employee	#

14	Energy Sold per Employee	MWh

When assessing labor productivity, it is worth noting that this value is affected by factors such as increased private participation and population growth in the case of residential connections per employee, and distributional losses when calculating energy sold per employee. With increased private participation and the unbundling of the sector, electricity utilities significantly reduced the number of employees. After the separation of electricity generation, transmission, and distribution, we gathered the total employment information for each of the segments in order to compute the average change before and after the reforms. For consistency purposes, we imputed the total percent reduction in each of the segments in order to have a proportionally similar drop in the number of employees.

The indicators used to measure operating performance consist of the energy losses (percent) in distribution, disaggregated, when possible, as technical and non-technical losses. While technical losses represent the energy lost in the network for physical reasons, non-technical losses represents the amount of energy stole from the system. While the selected variable set reflects the operating performance of electricity distribution, the study also accounts for external factors that may impact efficiency such as the environment and customer density per network.

OPERATING PERFORMANCE		
15	Energy losses in distribution per year (due to technical losses and illegal connections)	percentage
16	Energy losses in distribution per year due to technical losses	percentage
17	Energy losses in distribution per year due to non-technical losses (illegal connections)	percentage

In addition, the benchmarking study included the following variables to indicate quality and customer services.

QUALITY AND CUSTOMER SERVICES		
18	Average duration of interruptions per subscriber	hours / year
19	Average frequency of interruptions per subscriber	# interruptions / year
20	Number of residential subscribers per 100 households in the concession area (Residential coverage)	# / 100 households

When calculating the average duration and frequency of interruptions per subscriber, the majority of the information found expressed this information according to the standard international measures: SAIDI, System Average Interruption Duration Index (calculated by dividing the sum of all customer interruption durations, in minutes, by the total number of customers served) and SAIFI, System Average Interruption Frequency Index (calculated by dividing the total number of sustained customer interruptions by the total number of customers served). However, some countries such as Guatemala reported the quality of service in terms of TTIK (Total interruption time per kVA) and FMIK (Mean frequency of Interruption per kVA). In such cases, TTIK was used as a proxy after accounting for the difference in units.

When considering the variables for measuring quality and customer services, the recent trend reflects a greater emphasis on quality indicators as countries recognize the importance of measuring quality and customer service. Considering that most countries have only recently started to measure and report the quality of their services, the data collected for these variables is fragmented and, in some cases, inadequate. For example the average duration of interruptions was sometimes presented in hours, days, or minutes, depending on the country, year, and report. In light of this, the study accorded careful attention to measures of consistency and trends over time.

Finally, in order to determine the relationship between prices and cost, the study measured the allocative efficiency of each utility. The following indicators were used to measure allocative efficiency.

PRICES		
21	Average residential tariff	dollars / MWh
22	Average industrial tariff	dollars / MWh

The Process of Data Collection:

Data for each performance indicator was registered in a database with a detailed description of sources and collected variables, including comments clarifying the methodology used in the cases where variables were constructed or proxies used. For each identified indicator in the database, information was collected at country and utility level in order to have a product that could be compared across the region. In order to obtain such a cross-country product, data sources and categories were standardized and keen attention was given to the consistency of units. Necessary conversions were performed in electrical units or monetary currency in order to have an equivalent comparison. Furthermore, the data was collected with sensitivity to the variance in size of each respective country and utility, as well as other factors such as the time and process of privatization, geography, and subsidies.

The primary means of conducting research was field data collection and in house data collection. A standard template and set of variables was used by both field and in house consultants. Field consultants collected data to complement the information in some of the countries (see Annex XX � Source of the data). Due to limited information available on the web for these countries, local consultants were the most resourceful. For these selected countries and utilities a preliminary feasibility screening was conducted in order to determine which countries would be likely to provide information. While field workers had direct access to the respective utility and government, the process of data collection was often hindered by unexpected factors such as: political affairs, bureaucracy, un-systematized data, and confidentiality issues, among other elements.

The main sources for the in house data collection were the World Wide Web, information collected by staff bank for other projects, and the internal World Bank Databases (SIMA, IRIS, etc.). The main source of information on the internet was the utility's website. For some countries, the following proved to be useful sources: regulators, ministries, partnerships, central banks, online financial journals, papers, loan reports, financial reports, annual reports, monthly bulletins, statistics offices, and contacts with the companies and regulators. In addition, the following associations and organizations provided valuable statistics for the region: ARIAE (Asociacion Iberoamericana de Entidades Reguladores de Energia), ECLAC (Economic Commission for Latin America and the Caribbean), IEA (International Energy Agency), and CIER (Comision de Integracion Energetica Regional). However, since regulators and international organizations or and commissions cover the electricity distribution of the entire region, most of the information provided was aggregated at country level and not disaggregated by utility. One of the challenges of data collection was the inconsistency between the data provided by utilities or regulators in annual and financial reports. Considering this, appropriate calculations and approximations were made to construct missing data points. For example, through the method of interpolation, data was constructed for the earlier years of certain variables such as number of connections, number of employees, etc. However, it is essential to note that interpolation and other means of constructing data was the exception based on already concrete data and time trends. Specific methodologies were designed according to the variables at hand in order to ensure their comparability and consistency across time and utilities.

For the results presented at country and regional level, the values were averaged weighting the observations by the size of the utility (measured as the number of total connections). In order to avoid misleading tendencies due to the change in the composition of the sample, we computed the annual growth rate for each indicator and for each utility after which we aggregated these values for each year in order to calculate the weighted annual change. In order to define the average level, we computed the weighted average for 2002 and then imputed the annual change calculated before in order to build the time series. Finally, we filtered the annual growth rates out of the 3-standard deviation range from the mean in order to exclude outlier values.

Appendix:

Output Variables:

1. **Total Number of Connections (Residential and Non-residential) in the utility area.** This is the total number of connections (subscribers) in the utility area (i.e. Number of residential and non-residential connections)
2. **Total number of residential connections in the utility area.** This is the total number of residential connections (subscribers) in the utility area.
3. **Total electricity sold per year.** This is the total electricity supplied in MWh or the amount of electricity that was put on the network.

4. **Length of distribution network.**The length (km) of the network was reported by voltage. Only networks whose voltages are classified by the country's regulator as distribution were added in the distribution network length measure.
5. **Energy sold per connection.** This is the ratio between the Total energy sold per year and the Total number of connections.

Input Variables:

6. **Total number of employees.** This is the total number of employees related to electricity distribution activities. When the end of the year number was not available, then the Full Time Employment number (FTE) was used. Outsourced labor was added as an Extra variable at the end of the excel sheet.
7. **OPEX (operation expenditures) of the distribution services per connection (in dollars).** OPEX consists of operating and maintenance costs, customer service and accounts expenses, sales expenses, administrative and general expenses. Usually, the biggest items of OPEX were labor, materials and third party service contract expenses. OPEX reflects the operations of the distribution segment and therefore do not include depreciation. Nominal values were converted to nominal dollars. Finally, for each year observation, we divided by the number of total connections.
8. **CAPEX (capital expenditures) of the distribution service per connection (in dollars).** CAPEX consists of the expenditures to acquire, expand, repair, or renovate fixed assets, implying the purchase of goods and services whose benefits extend beyond the year and add to the company's assets. CAPEX represents the annual gross capital outlays of a company. Nominal values were converted to nominal dollars. Finally, for each year observation, we divided by the number of total connections.
9. **TOTEX (total expenditures) of the distribution service per connection (in dollars).** TOTEX is the sum of OPEX and CAPEX (TOTEX = OPEX + CAPEX). Nominal values were converted to nominal dollars. Finally, for each year observation, we divided by the number of total connections.
10. **OPEX of the distribution services per MWh sold (in dollars).** Same OPEX definition than above but divided by the total energy sold.
11. **CAPEX of the distribution service per MWh sold (in dollars).** Same CAPEX definition than above but divided by the total energy sold (in MWhs).
12. **TOTEX of the distribution service per MWh sold (in dollars).** Same TOTEX definition than above but divided by the total energy sold (in MWhs).

Labor productivity:

13. **Residential Connections per Employee:** This is the division of the number of residential connections by the number of employees.
14. **Energy Sold per Employee:** This is the division of the energy sold in MWh by the number of employees.

Operating Performance:

15. **Total Energy losses in distribution per year (due to technical losses and illegal connections)** Total Energy losses. Total distribution losses is the sum of technical and non-technical (commercial losses).

16. **Energy losses in distribution per year due to technical losses.** Energy losses due to technical reasons (i.e. Dissipation of power in electrical system components).

17. **Energy losses in distribution per year due to non-technical losses.** Energy losses due to non-technical or commercial losses (i.e. Theft of service (illegal connections) and losses due to failure in the billing system).

Quality and Customer Services:

18. **Average duration of interruptions per subscriber.** This is the number of hours-subscriber the system was without power in a year, divided by the total number of subscribers. The equivalent is SAIDI, System Average Interruption Duration Index calculated by dividing the sum of all customer interruption durations, in minutes, by the total number of customers served.

19. **Average frequency of interruptions per subscriber.** The average number of interruptions experienced by a consumer unit during one year. The equivalent is SAIFI, System Average Interruption Frequency Index calculated by dividing the total number of sustained customer interruptions by the total number of customers served.

20. **Number of residential subscribers per 100 households in the concession area (Residential coverage).** Ration of residential connections per 100 households (within the area of operation). In other words, the percentage of households connected in each concession area (residential service coverage = residential connection / number of households).

Prices:

21. **Average residential tariff.** The average price per MWh of electricity sold to residential consumers, including both fixed and variable components, in local nominal currency.

22. **Average industrial tariff.** The average price per MWh of electricity sold to industrial consumers, including both fixed and variable components, in local nominal currency.