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Transición energética en la 4ta revolución industrial

Universidad Tecnológica de Pereira

UNIVERSIDAD NACIONAL DE COLOMBIA

Methodology for Characterization and Planning of Electricity Demand in an Isolated Zone: Mitú Approach

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I. Introduction

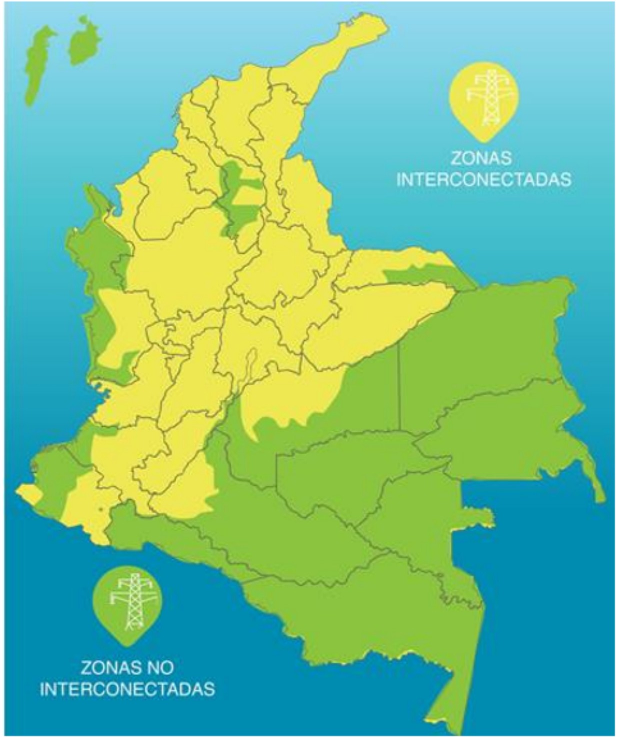

Fig. 1. Map and division of the Colombian electricity system.

- Communities with low population density.
- Remote or inaccessible location.
- Users are usually from strata 1, 2 and 3.
- Users have low payment capabilities.
- They depend mostly on fossil fuels as their primary source of generation.
- High costs of providing the electric power service.

I. Introduction

- It is one of the 5 departmental capitals of the ZNI.
- They depend mainly on a 4.6 MW diesel plant.
- They do not have electricity meters.
- Average monthly consumption for residential users is 314 kWh and 427 kWh for commercial users.
- High energy generation costs.

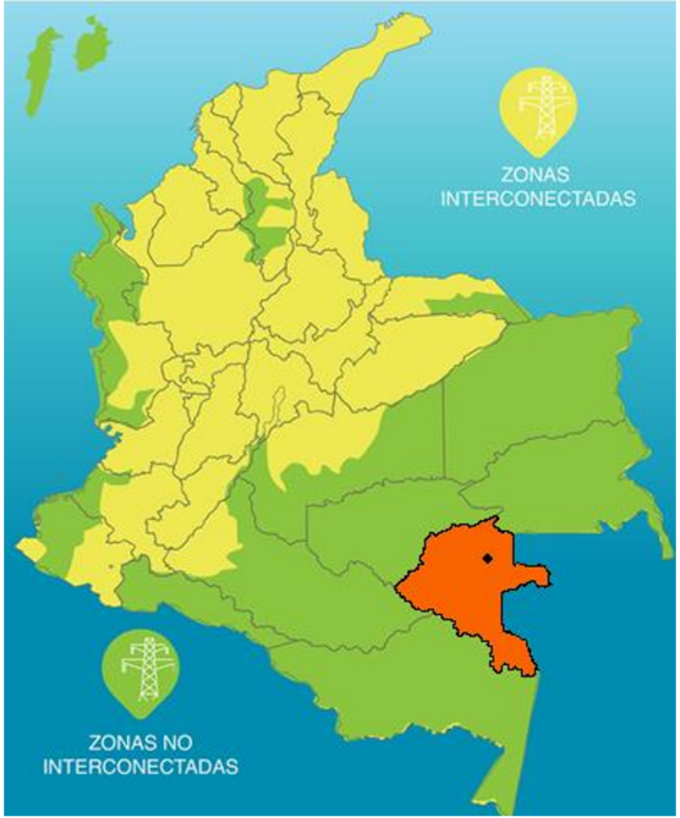

Fig. 2. Map and division of the Colombian electricity system. Department of the Vaupés highlighted

II. Theoretical aspects

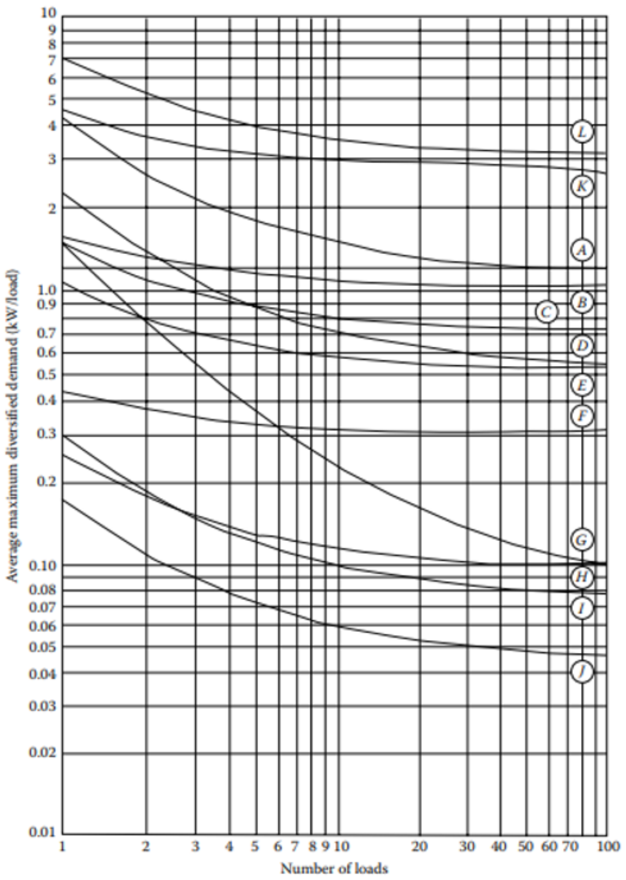

Fig. 3. Maximum diversified demand characteristics of various residential loads: A, clothes dryer; B, off-peak water heater, "off-peak" load; C, water heater, uncontrolled, interlocked elements; D, range; E, lighting and miscellaneous appliances; F, 0.5-hp room coolers; G, off-peak water heater, "on-peak" load, upper element uncontrolled; H, oil burner; I, home freezer; J, refrigerator; K, central air-conditioning, including heat-pump cooling, 5-hp heat pump (4-ton air conditioner); L, house heating, including heat-pump-heating-connected load of 15kW unit-type resistance heating or 5hp heat pump. Arvidson

III. Proposed methodology

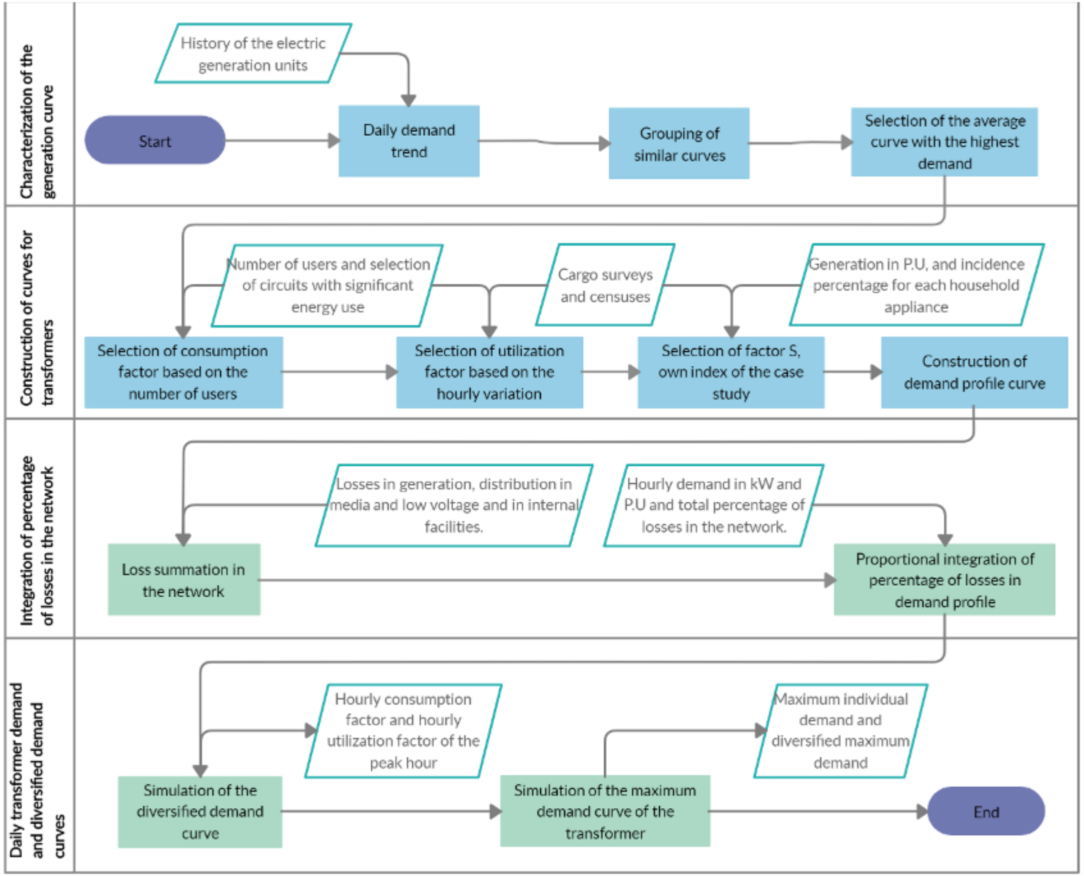

Fig. 4. Methodology for characterizing demand in non-interconnected electrical networks.

IV. Results

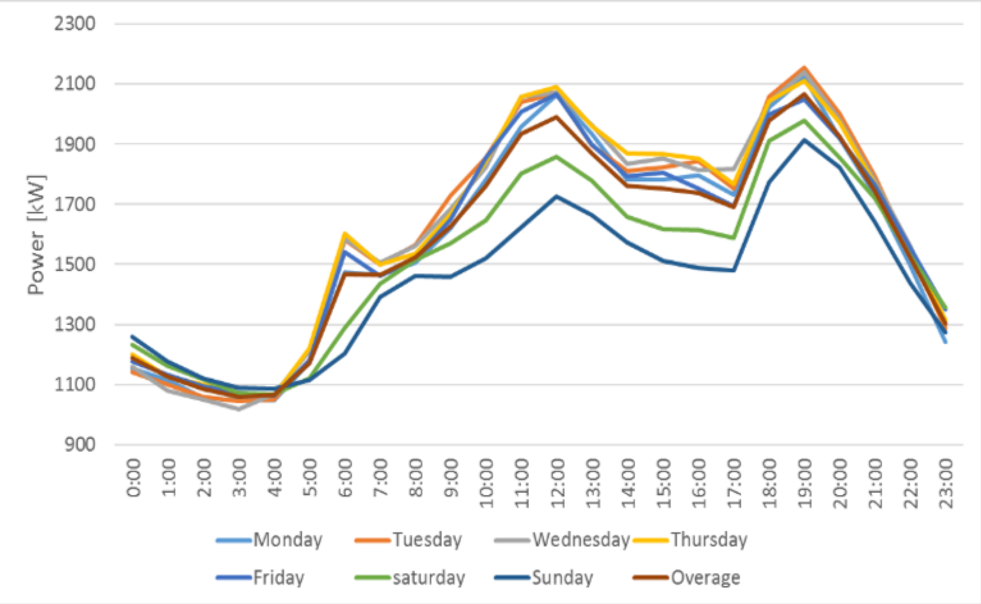

Fig. 5. Average hourly generation curve for the year 2017 for the municipality of Mitú. Information provided by the generator (Source: Gestión Energética Colombian utility).

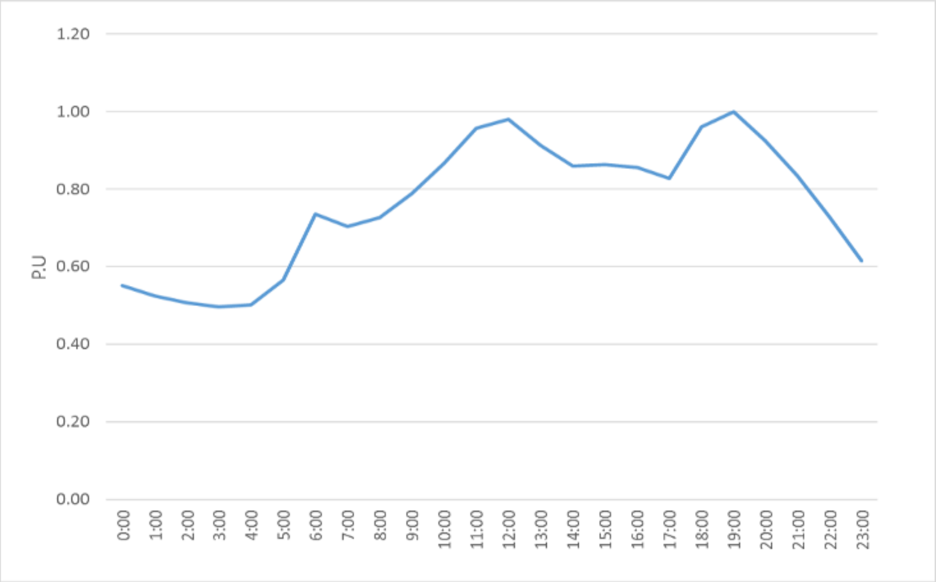

Fig. 6. Average hourly generation curve in P.U for weekdays of the year 2017.

IV. Results

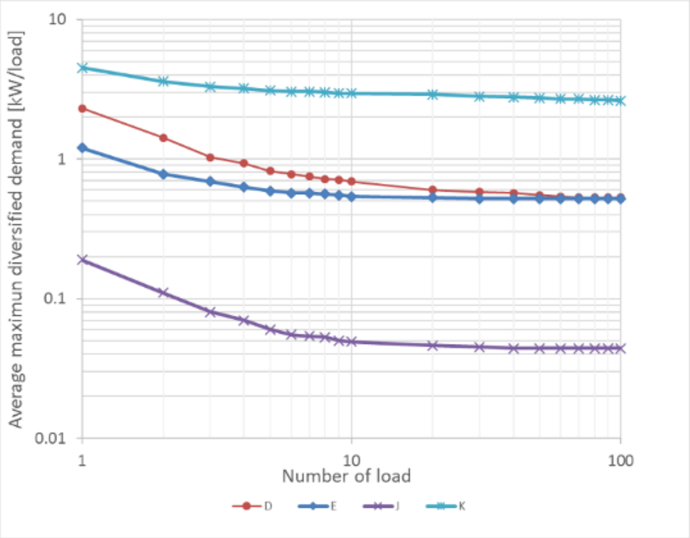

Fig. 7. Maximum mean demand curves, according to Arvidson, for electric stove (D), lighting fixtures and miscellaneous outlets (E), refrigerator (J) and air conditioning (K) circuits.

TABLE I
UTILIZATION FACTOR AS A FUNCTION OF THE HOUR VARIATION IN MITÚ

Hour	Electric stove	Air conditioning	Fridge	Lighting and miscellaneous out lets
00:00	0.02	0.4	0.93	0.32
01:00	0.01	0.39	0.89	0.12
02:00	0.01	0.36	0.8	0.1
03:00	0.01	0.35	0.76	0.09
04:00	0.02	0.4	0.79	0.08
05:00	0.05	0.65	0.72	0.1
06:00	0.55	0.7	0.75	0.19
07:00	0.47	0.6	0.75	0.41
08:00	0.28	0.61	0.79	0.35
09:00	0.22	0.62	0.79	0.31
10:00	0.22	0.72	0.79	0.31
11:00	0.85	0.9	0.85	0.3
12:00	1	1	0.85	0.28
13:00	0.9	0.94	0.87	0.26
14:00	0.5	0.85	0.9	0.29
15:00	0.4	0.84	0.9	0.3
16:00	0.5	0.85	0.9	0.32
17:00	0.7	0.85	0.9	0.7
18:00	0.8	0.95	0.9	0.92
19:00	0.95	0.99	0.95	1
20:00	0.9	0.87	0.95	0.95
21:00	0.75	0.71	0.95	0.85
22:00	0.04	0.68	0.88	0.72
23:00	0.02	0.55	0.88	0.5

IV. Results

Factor S, proper index based on the load census for the case study, Mitú

$$S = 1 + (G * P)/100 \quad (1)$$

Where the parameters to consider are:

G: Generation in P.U.
P: Incidence percentage for each appliance.

According to the surveys and load censuses carried out previously, it was found that the circuits with the highest energy consumption correspond to the stove, air conditioning, refrigeration and lighting circuits and miscellaneous outlets; therefore, the incidence percentage for the calculation of the S factor is 30%, 25%, 25% and 20% respectively.

IV. Results

To determine the total intra-hourly demand, the following multiplication of factors is applied:

$$N * FA_1 * FA_2 * S = Dth_i \quad (2)$$

Where:

N: Users.

FA_1: Arvidson consumption factor as a function of hourly consumption by number of users [kW * n users] (Figure 1).

FA_2: Peak hour hourly utilization factor.

IV. Results

Based on the losses that are proportional to the load, the hourly consideration of losses is made with the following formula:

$$Dh_p = Dh - Dh * (44\% * Dh_{P.U}) \quad (3)$$

Where:

Dh_p: Hourly demand with losses.

Dh: Hourly demand without losses.

$Dh_{P.U}$: Hourly demand in P.U. in generation

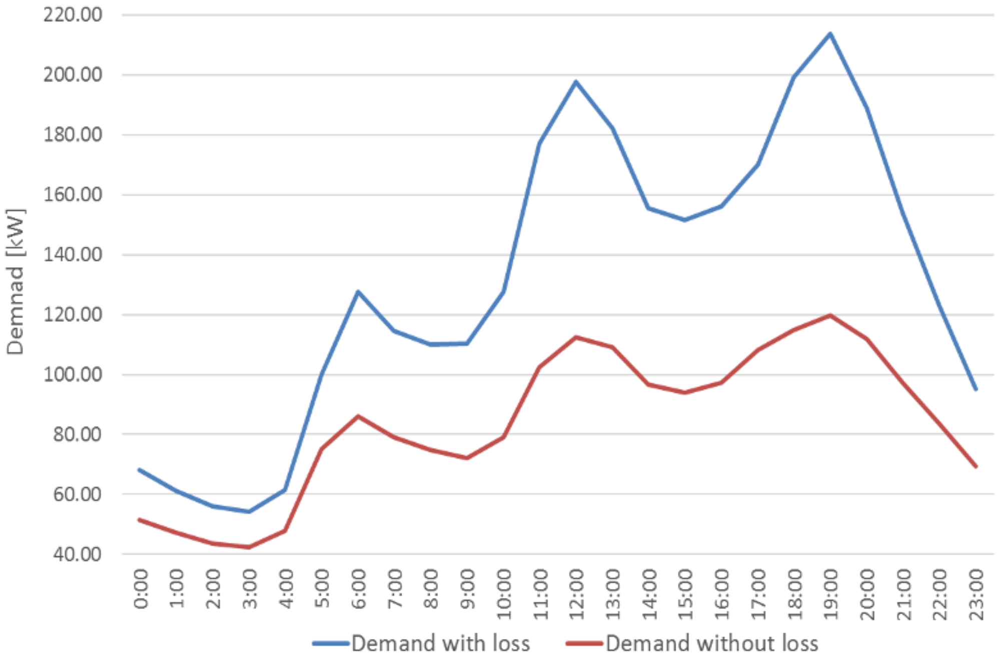

Fig. 8. Comparison of average hourly demand curves for weekdays of the year 2017 by integrating the percentage of losses.

IV. Results

Daily demand of transformer is calculated by dividing the maximum demand by a end-user by the diversified maximum demand [6].

$$Fdiv_n = \frac{Demanda\ máxima\ individual\ [kW/usuario]}{Demanda\ máxima\ diversificada\ [kW/usuario]} \quad (4)$$

On the other hand, the diversified demand is carried out according to the parameters recognized in the hour of greatest consumption, or peak hour of the day. [6], as follows:

$$\sum Fh_1 * Fh_2 = Fdh_n \quad (5)$$

Where:

Fh_1: Arvidson consumption factor as a function of hourly consumption by number of users [kW * n users] .

Fh_2: Peak hour hourly utilization factor.

Fdh_n: Diversification factor for n users.

IV. Results

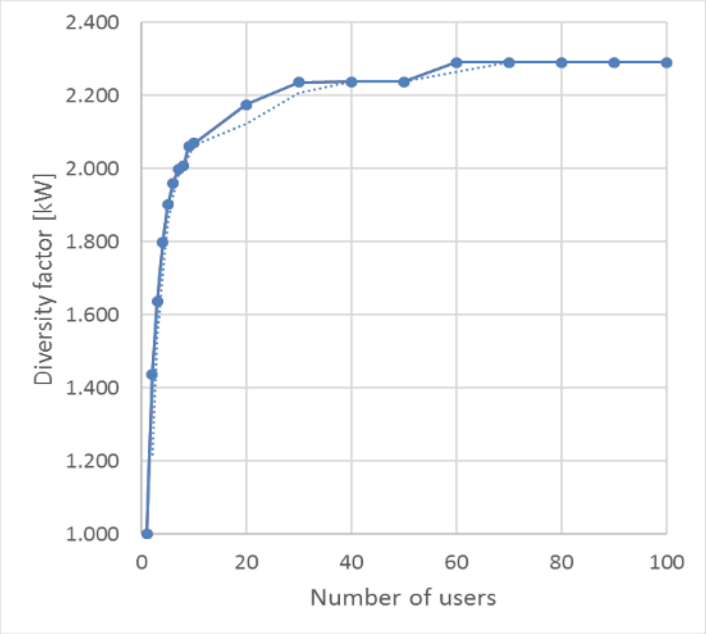

Fig. 9. Maximum demand curve of distribution transformer with 40 associated users. Source: own elaboration.

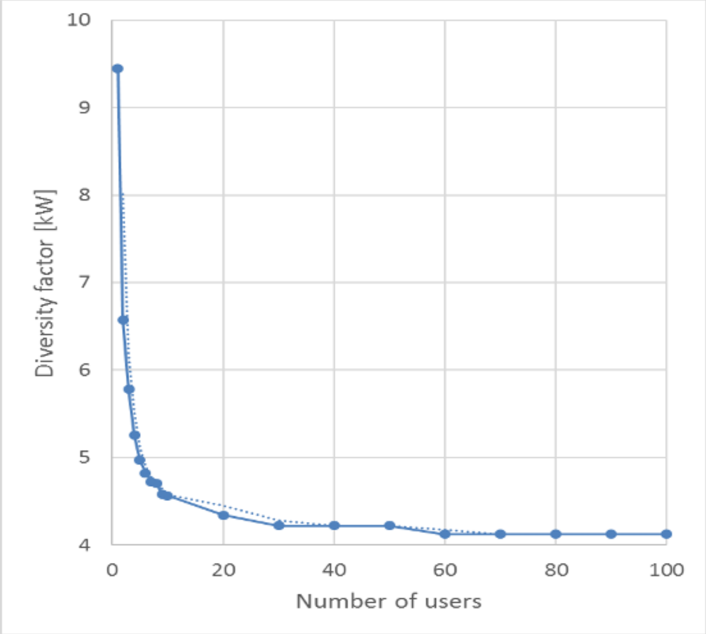

Fig. 10. Diversified demand curve for a distribution transformer with 40 associated users. Own elaboration.

V. Conclusions

- The Arvidson model was adapted and generalized to characterize the demand for isolated networks by inserting an additional adjustment factor under the criteria of surveys and load censuses carried out on the target population.

- For its part, the construction of the curves of diversified demand and maximum demand of the transformers was carried out, which will serve as planning tools for the due dimensioning of the electrical distribution system where there is no direct measurement in the users and macro measurement.

- The reduction of electrical losses and the optimal sizing of the equipment will be some of the benefits that lead to the continuity, efficiency and reliability of the electrical system, which also transcends the optimization of economic resources for sustainability.

VI. Questions

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