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A Comprehensive Sustainability Review in the Isolated Colombian Microgrids

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I. Introduction

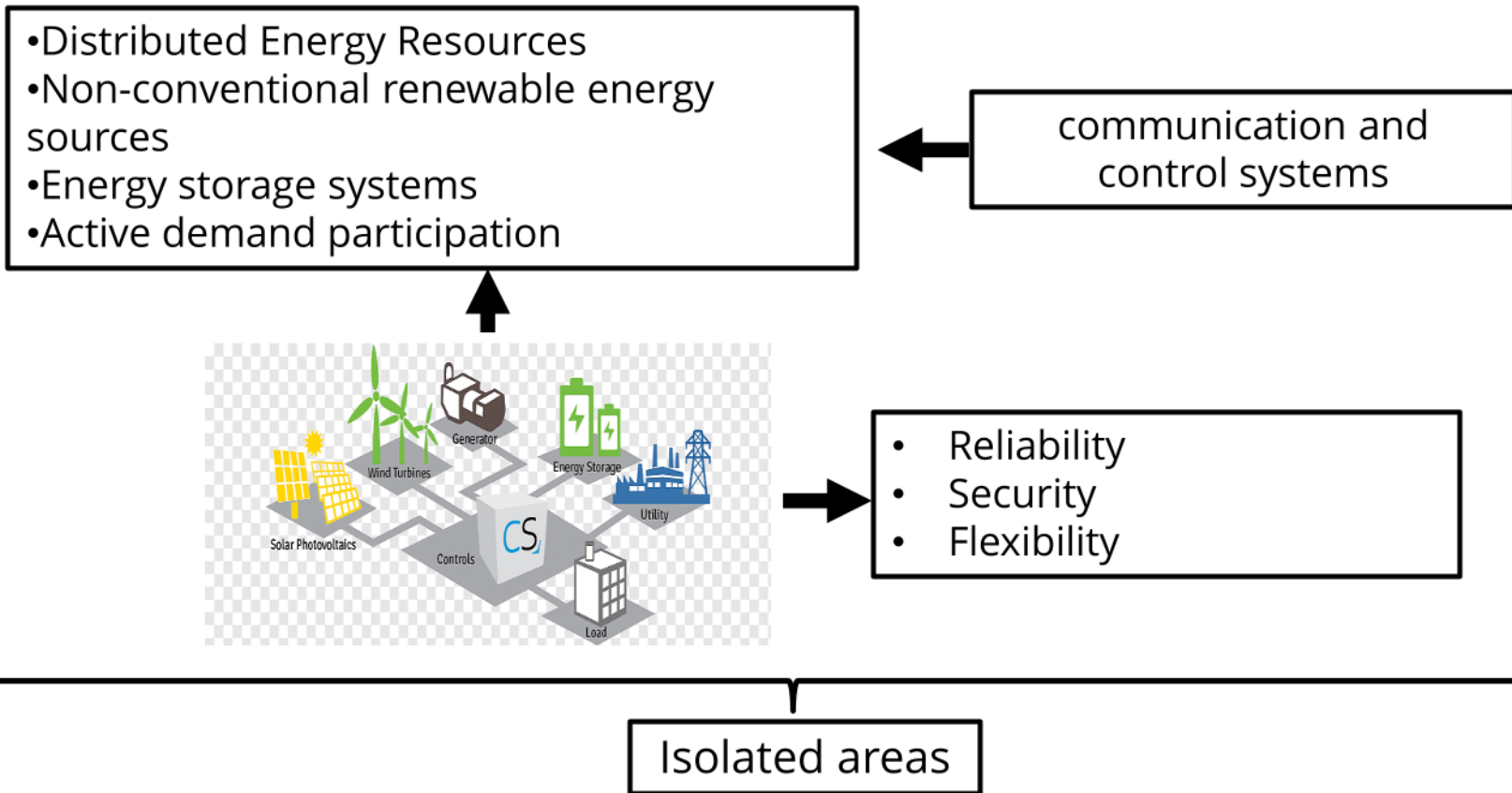


Figure 1. Microgrids. Source: Own elaboration

II. Energy challenges of the Colombian Non-Interconnected Zones



- 51% of the national territory
- 1,798 localities
- 14 localities have energy contributions from renewable energy sources
- 96% diesel generation
- 4% other sources of generation
- 1,448 communities of tropical forests
- 544 indigenous reservations

Figure 2. ZNI of Colombia. Source: IPSE.

Challenge	Time horizon		
	Short term	Medium term	Long term
Technical Sustainability	<ul style="list-style-type: none"> Blackouts during peak hours, due to the high concentration of residential, commercial, and service constructions without bioclimatic analysis. Ignorance of the need to make rational use of energy. 	<ul style="list-style-type: none"> Increase of electrical losses in distribution networks due to massive and uncoordinated growth in demand, due to the installation of appliances with reduced efficiency, energy costs related to the adaptation of habitat space and lack of measurement of electricity consumption by the end user. 	<ul style="list-style-type: none"> Need to expand conventional generation capacity from fossil fuels. Need for expansion and modernization of distribution networks.
Economic sustainability	<ul style="list-style-type: none"> High costs of generation, transportation of fuel, and low profitability of the companies providing the service. 	<ul style="list-style-type: none"> Increase in the value of electricity. Reduction of service quality. 	<ul style="list-style-type: none"> Reduction of service availability hours, due to the need to reduce operating costs. Need to increase government subsidies. Need to boost investment in projects to expand the provision of electric power service.
Social sustainability	<ul style="list-style-type: none"> Resistance to measurement and control projects. 	<ul style="list-style-type: none"> Aversion to supply failures that have an impact on decreased quality of life. 	<ul style="list-style-type: none"> Increase of the social gap and reduction of social equity due to a supply of electricity with reduced quality and high volatility.
Environmental sustainability	<ul style="list-style-type: none"> Ecosystem intervention with mass burning of fossil fuels. 	<ul style="list-style-type: none"> Changes in ambient temperature. Increase in the emission of greenhouse gases due to fossil fuel generation. 	<ul style="list-style-type: none"> Permanent modifications to protected ecosystems by fuel spills, hydrocarbon-based production, and by construction of new infrastructure. Need to promote the use of FN CER use.

TABLE I. Challenges related to technical, economic, social, and environmental sustainability in the short, medium, and long term on the operation and planning of electricity supply in the Colombian ZNI. Source: Own elaboration based on [7], [14], [15].

III. International Experiences

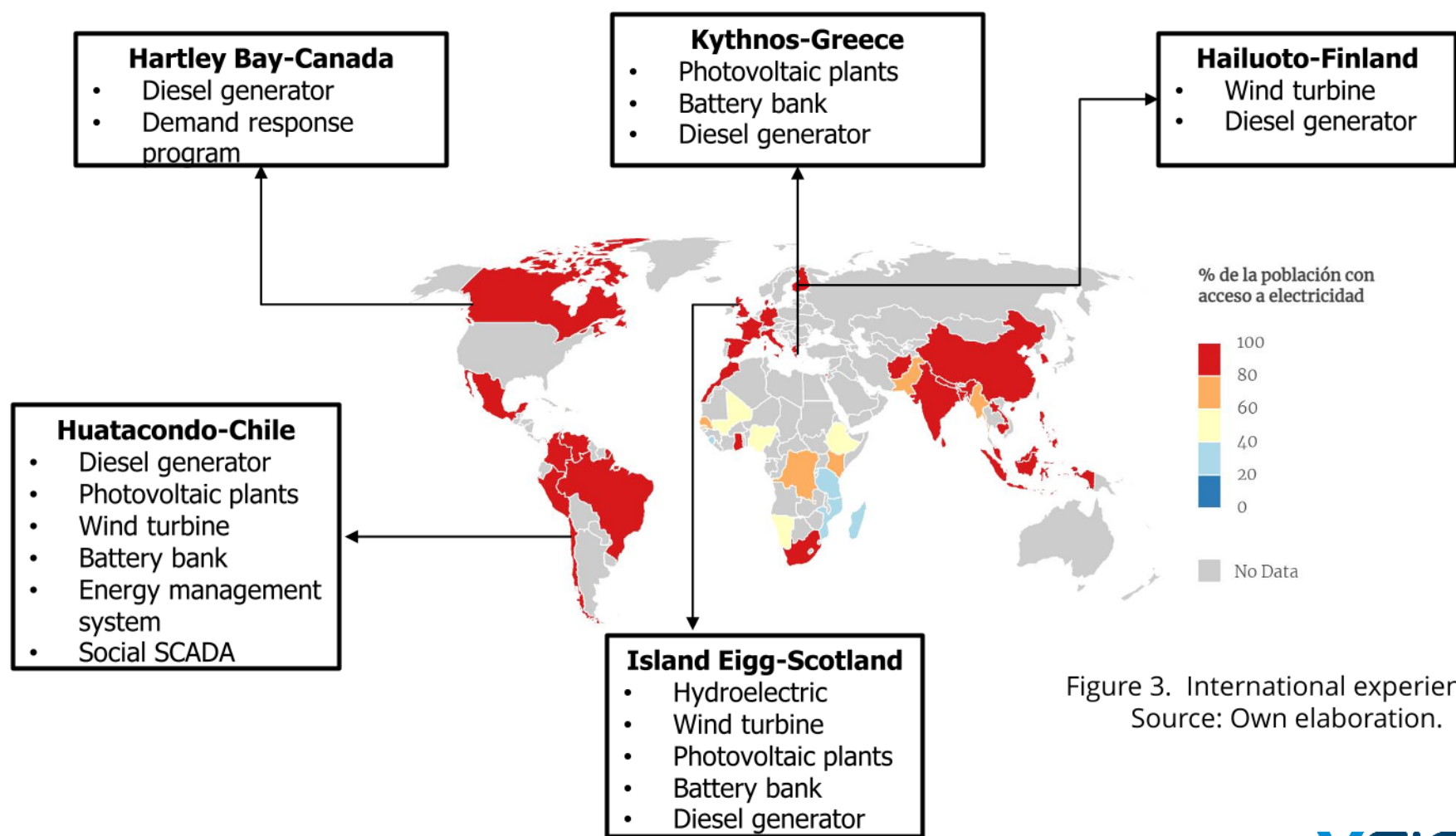


Figure 3. International experiences.
Source: Own elaboration.

IV. Microgrids in Colombia

Comunidad Indígena De Pangui - Chocó



Guacamayas-Caquetá



Palmor Ciénaga - Magdalena



Figure 4. General characteristics regarding the composition of the energy matrix in the ZNI. Source: Own elaboration based on [14] -[15].

Isla Fuerte-Bolívar




Isla Múcura - Bolívar





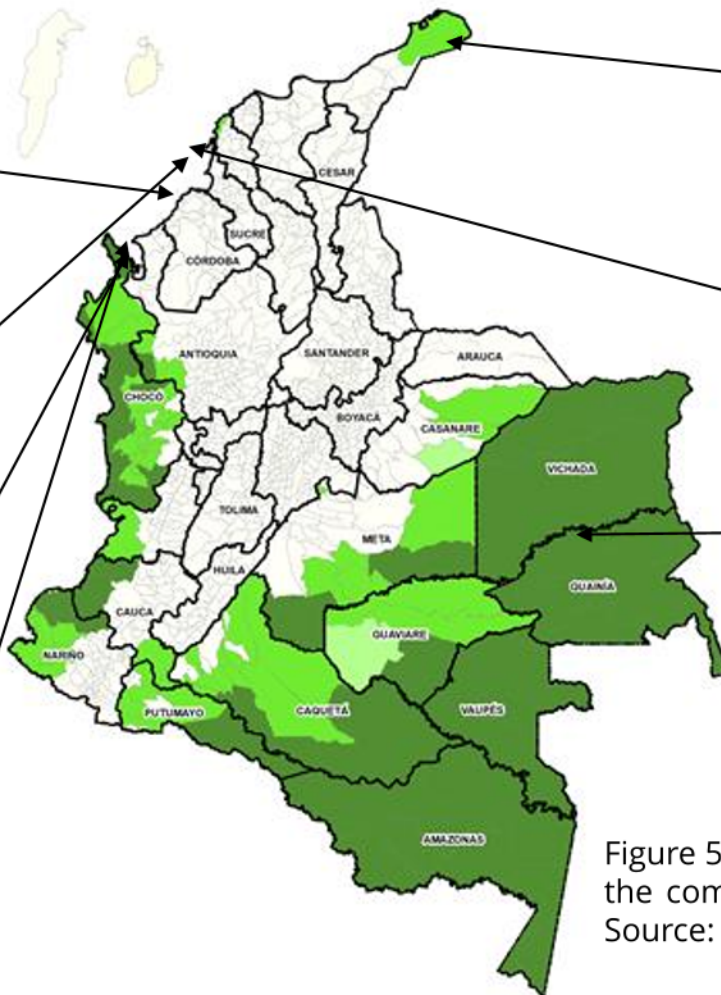
San Francisco - Choco





Titumate - Choco





Nazareth - La Guajira





Santa Cruz Del Islote - Bolívar





Barranco Minas - Guainía





Figure 5. General characteristics regarding the composition of the energy matrix in the ZNI. Source: Own elaboration based on [14] -[15].

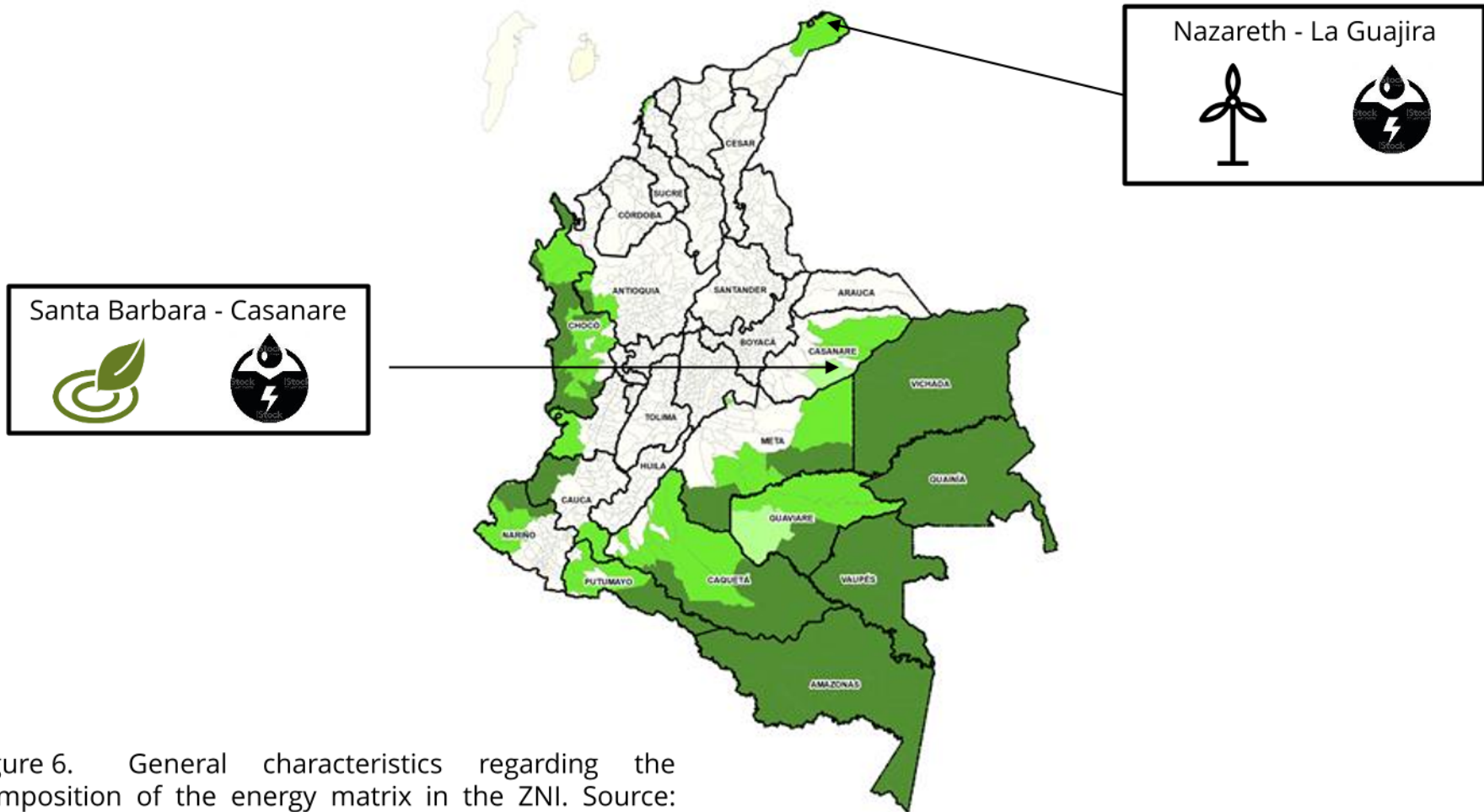


Figure 6. General characteristics regarding the composition of the energy matrix in the ZNI. Source: Own elaboration based on [14] -[15].

Locality name- Location	Daily average service provision [h]	Number of users
Locality name- Location	Daily average service provision [h]	Number of users
Isla Fuerte-Bolívar	4,51	406
Isla Múcura - Bolívar	14,56	43
Santa Cruz Del Islote - Bolívar	13,41	127
Guacamayas- Caquetá	18,8	205
Santa Barbara - Casanare	*	17
Comunidad Indígena De Pangui - Choco	21,35	88
Cúpica - Choco	16,33	344
Mutis - Choco	23,44	166
San Francisco - Choco		266
Titumate - Choco	1,32	105
Barranco Minas - Guainía	8	352
Nazareth - La Guajira	8,28	146
Palmor Ciénaga - Magdalena	23,13	436
Mitú - Vaupés	24	2293

Table II. General characteristics regarding the number of users, and the average daily hours of service provision of some of the projects that have energy contributions from renewable energy sources located in the ZNI. Source: Own elaboration based on [14] -[15].

V. Proposed Solution for the Energization of the Colombian Non-Interconnected Zones

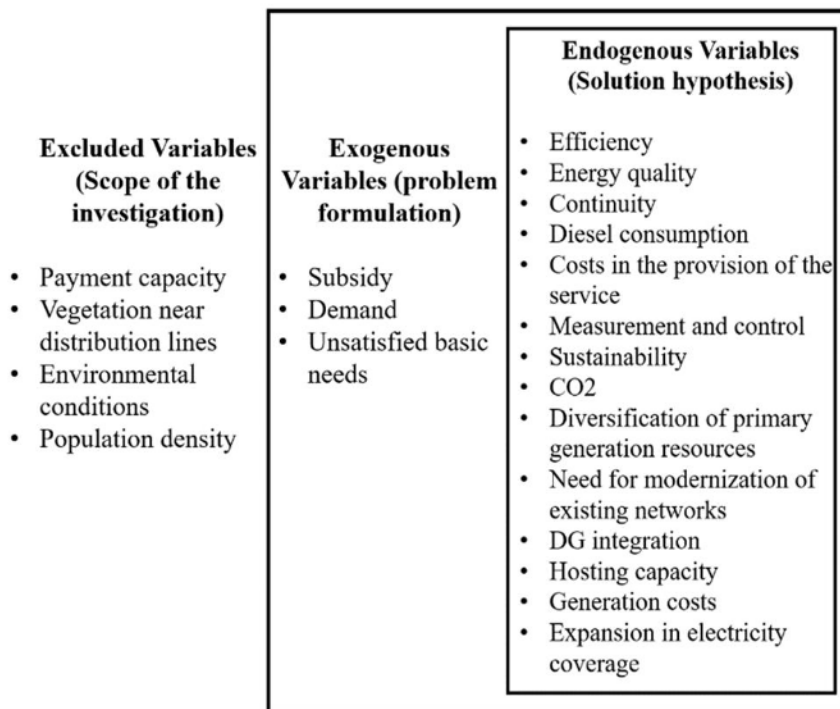


Figure 7. Defined variables of the proposed model. Source: Own elaboration.

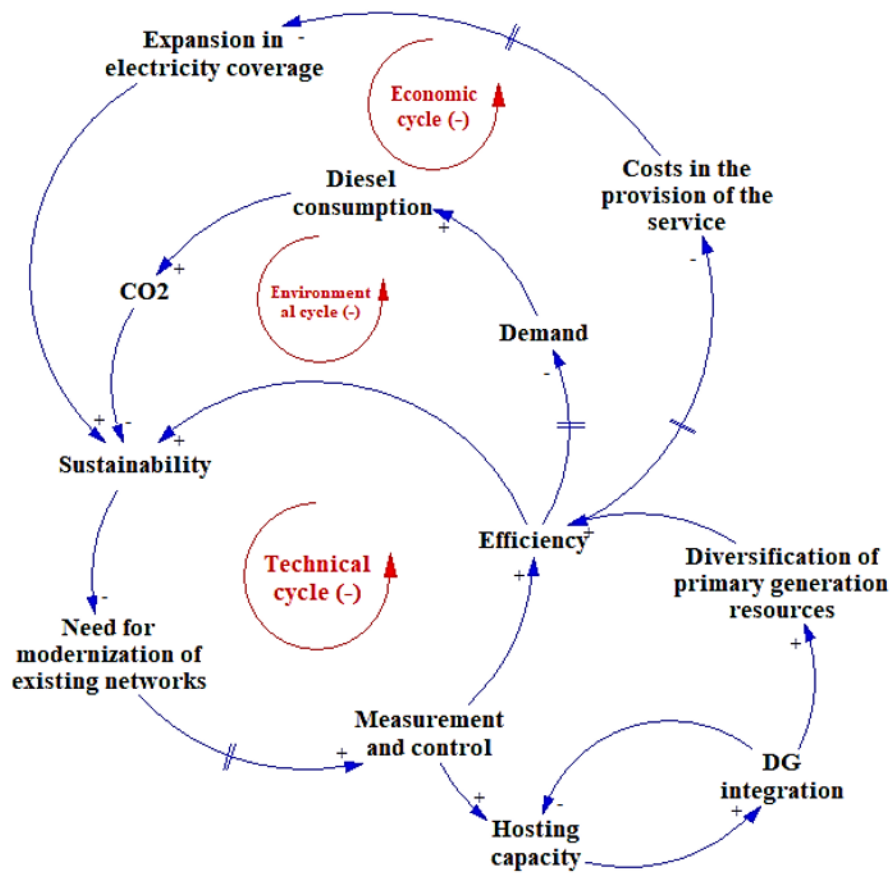


Figure 8. Proposed causal model. Source: Own elaboration

VI. Conclusions

- Is necessary to make investments in the modernization and control of the distribution network to guarantee the use of resources and to have the electricity supply throughout the day.
- The sustainability and continuity in the service provide improvements in people's living conditions and provides coverage for unsatisfied basic needs. In this sense, continuity promotes the implementation of productive projects, such as companies whose connection to the electricity grid boosts the household economy and encourages new ventures. Therefore, these projects increase the income of end-users and provide economic development to the regions.

Gracias



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