X SICEL 2021

Transición energética en la 4ta revolución industrial

Universidad Tecnológica de Pereira

UNIVERSIDAD NACIONAL DE COLOMBIA

XSICEL 2021
Transición energética en la 4ta revolución industrial

Impact of the integration of energy-saving strategies on the demand profile of residential buildings in a tropical climate: a case study

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I. Introduction

Building impacts

Energy

Water

Others

Needs met

Impacts

Consumption of natural resources (30-50%)

Waste generation (45-65%)

25 %
Global water consumption

1/3 polluting gas emissions

40 % of global energy consumption

I. Introduction
Building's energy consumption

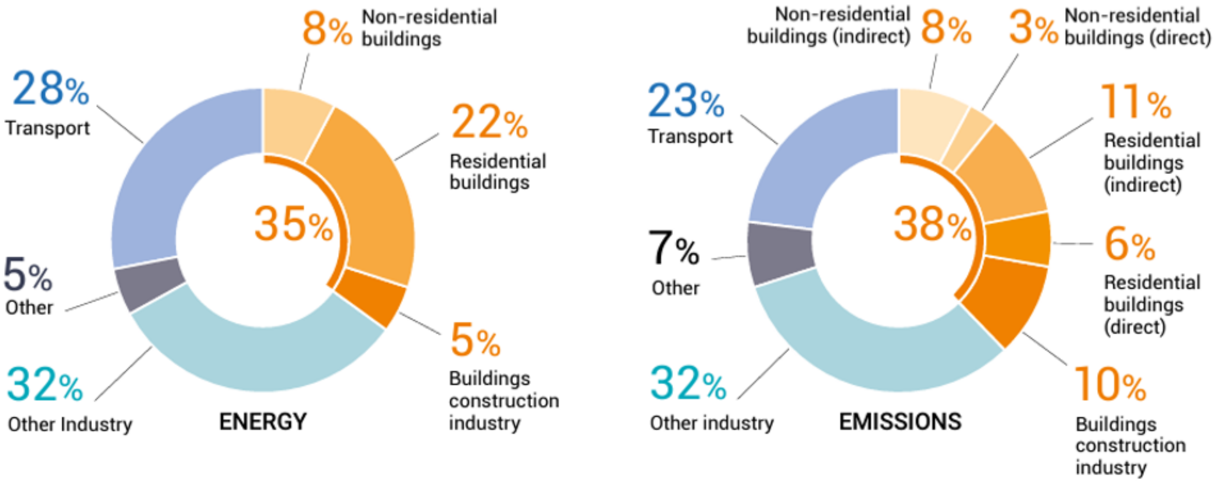


Figure 1. Global share of buildings and construction final energy and emissions 2019. Source: 2020 Global Status Report for Buildings and Construction.

The buildings and construction sector is a key player in the fight against the climate crisis. This sector represents 35% of final energy use and 38% of emissions.

I. Introduction
Building's energy consumption in Colombia

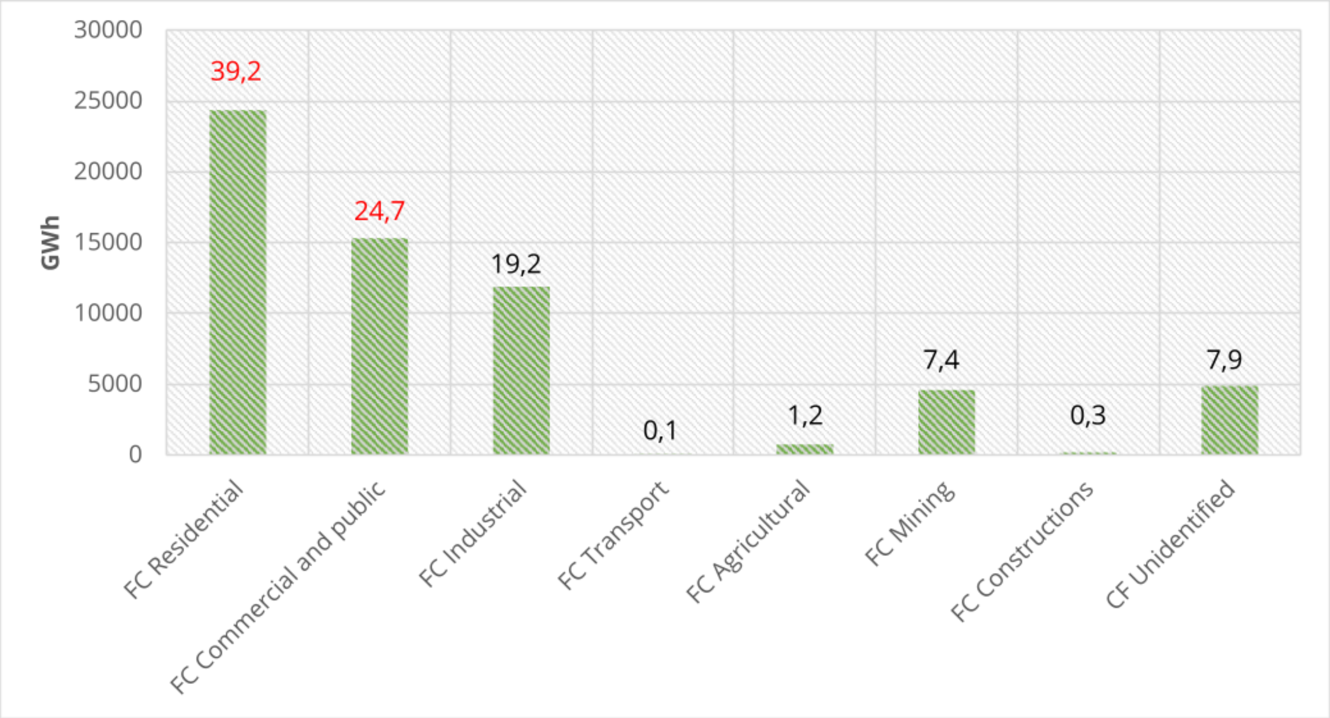


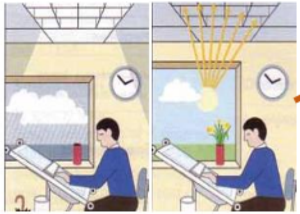
Figure 2. Distribution of the final electricity consumption of the SIN for 2020.
Source: Adapted from BECO – UPME 2021.

I. Introduction

Reduction of energy consumption in buildings

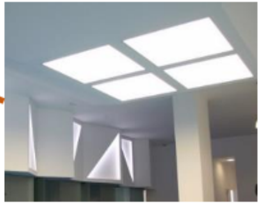
Passive measures

Hybrid measures



Renewable energy sources

Active measures



The massive integration of energy saving strategies in buildings is being promoted locally through energy standards and / or regulations.

I. Introduction

RES. 0549 of 2015

Ministerio de Vivienda, Ciudad y Territorio
República de Colombia

RESOLUCIÓN NÚMERO

0549 10 JUL 2015

"Por la cual se reglamenta el Capítulo 1 del Título 7 de la parte 2, del Libro 2 del Decreto 1077 de 2015, en cuanto a los parámetros y lineamientos de construcción sostenible y se adopta la Guía para el ahorro de agua y energía en edificaciones"

EL MINISTRO DE VIVIENDA, CIUDAD Y TERRITORIO

En ejercicio de sus facultades constitucionales y legales, y en especial las conferidas por el Decreto Ley 3571 de 2011 y el Decreto 1077 de 2015

CONSIDERANDO

Que en virtud de lo establecido en el numeral 2 del artículo 2° del Decreto Ley 3571 de 2011, el Ministerio de Vivienda, Ciudad y Territorio tiene como función, entre otras, la de *"formular las políticas sobre renovación urbana, mejoramiento integral de barrios, calidad de vivienda, urbanismo y construcción de vivienda sostenible, espacio público y equipamiento"*.

Que el Decreto 1285 de 2015 adicionó el Título 7 a la parte 2 del Libro 2 del Decreto 1077 de 2015, cuyo artículo 2.2.7.1.2 dispone que *"El Gobierno Nacional a través del Ministerio de Vivienda, Ciudad y Territorio, adoptará mediante resolución, los parámetros y lineamientos técnicos para la Construcción Sostenible.*

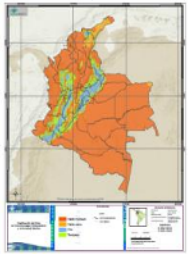
En lo relacionado con las medidas para el ahorro de agua y energía en edificaciones, los parámetros que se adopten deberán contener como mínimo los siguientes aspectos:

1. Porcentajes obligatorios de ahorro en agua y energía según clima y tipo de edificaciones.

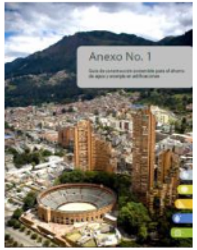
2. Sistema de aplicación gradual para el territorio de conformidad número de habitantes de los municipios.

Minimum energy saving requirements

Energía	Porcentaje mínimo de ahorro			
Con respecto a la línea base	Frío	Templado	Cálido seco	Cálido húmedo
Hoteles	20	35	25	45
Hospitales	35	25	35	30
Oficinas	30	30	40	30
Centros comerciales	25	40	35	30
Educativos	45	40	40	35
Vivienda no VIS	25	25	25	45
Vivienda VIS	20	15	20	20
Vivienda VIP	15	15	20	15



Climate zoning



Savings strategies recommendation

I. Introduction
RES. 0549 of 2015

CALIDO SECO	Hotel	Oficina	Centro comercial	Hospital	Educativo	Vivienda no VIS	Vivienda VIS/VIP
Relación ventana pared	x	x	x	x	x	x	x
Protección solar	x	x	x	x	x	x	
Ventilación natural	x	x	x	x	x	x	
Luz día y control de luz día	x	x		x	x		
Iluminación de energía eficiente	x	x	x	x	x		
Coeficiente de Desempeño (COP)	x	x	x	x			x
Recuperación de calor del aire de retorno				x			
Variadores de velocidad - torres de enfriamiento	x	x					
Sensores de monóxido de carbono para parqueaderos (CO)	x	x	x				
Variadores de velocidad - bombas	x	x	x				
Controles: sensores de ocupación	x	x			x		
Control de iluminación exterior		x			x		
Sub-medidores de electricidad		x	x				
Corrección de Factor de Potencia	x	x	x	x	x	x	x
Agua caliente solar	x			x		x	
Accesorios de conservación de agua	x	x	x	x	x	x	x
Tratamiento de aguas residuales y reciclaje de agua							
Recolección de aguas lluvia y reutilización							

What is the impact of integrating these measures?

MANDATORY SAVINGS PERCENTAGES

Prescriptive method

Performance Method

DOCUMENTATION

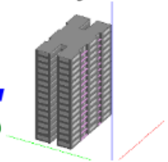
COMPLIANCE VERIFICATION

1 Baseline indicator

kWh/m²-año	Frío	Templado	Cálido seco	Cálido húmedo
Hoteles	96,1	151,3	132,5	217,8
Hospitales	249,6	108,3	344,1	344,1
Oficinas	81,2	132,3	318,2	221,3
Centros comerciales	403,8	187,8	187,8	231,5
Educativos	40,0	44,0	72,0	29,8
Vivienda no VIS	46,5	48,3	36,9	50,2
Vivienda VIS	44,6	44,0	34,6	49,3
Vivienda VIP	48,1	53,3	44,9	50,6

2 Indicator calculated by simulation

EnergyPlus



	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	130421.52	30.50	752.21
Net Site Energy	130421.52	30.50	752.21
Total Source Energy	413044.95	96.61	2382.24
Net Source Energy	413044.95	96.61	2382.24

I. Introduction

Findings from the literature review

Literature review on impacts of EEM integration on tropical climate buildings

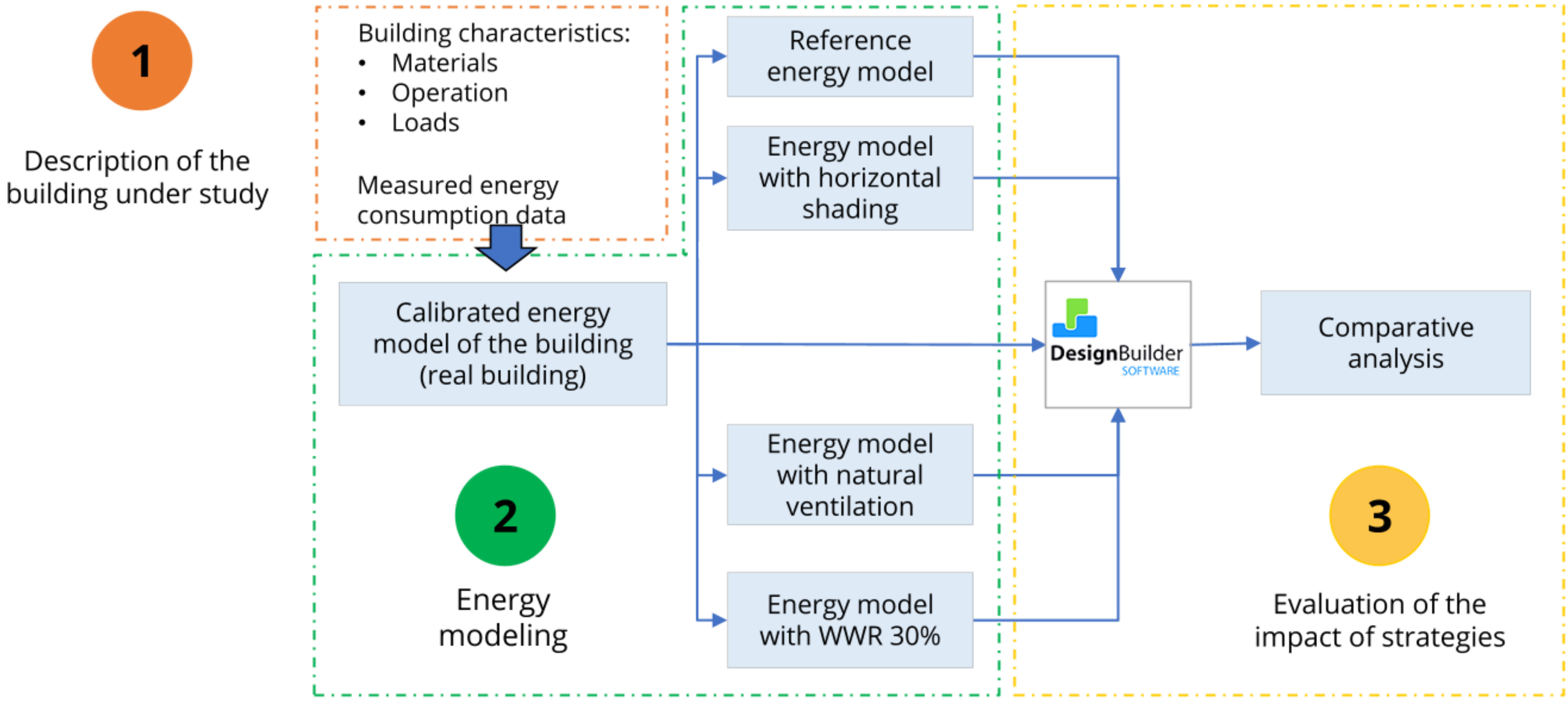
- **01** Impact on energy consumption of EEM integration
- **02** Impact on thermal comfort of EEM integration
- **03** Impact on reducing emissions
- **04** At the Colombian level, prospective studies of the impact of Res. 0549, and some sectorial ones.

The impact of integrating the recommended EEM in the network has not been studied in detail.

Lack of studies evaluating the impact of EEM on the demand curve

Study the impact of a group of energy-saving strategies on the demand curve of a residential building located in tropical climate.

II. Proposed methodology



II. Proposed methodology

Description of the building under study

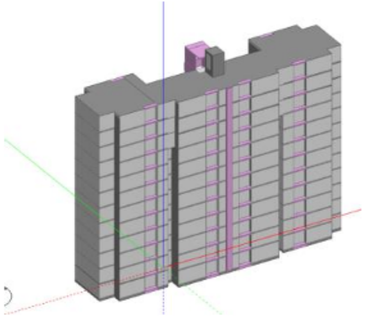
Characteristic	Value / Details
Construction system	Industrialized with a structure of plates and concrete walls.
Approximate WWR	19
Exterior walls configuration	Wall in concrete, putty, and paint inside, plastic stucco outside. Overall thickness: 13 cm
Exterior walls U value [$W/m^2 \cdot K$]	3.25
Roof configuration	Solid concrete plate, stucco, and lower face paint. Mortar, asphalt layer, and reflective paint on the upper face. Overall thickness: 16 cm
Cover U value [$W/m^2 \cdot K$]	2.76
Lighting power density - LPD [W/m^2]	2.22
Power Density of plug-in charges [W/m^2]	31.49
Average power consumption [kWh/m^2]	130
Air conditioning system	The main room of some of the apartment typologies (9000 BTU)
Elevators	1 x 7.5 HP
Apartment area [m^2]	4145.0
General services área [m^2]	456.6

II. Proposed methodology

Energy modeling

Architecture data

1 **Geometric modeling**



Data in categories: activity, enclosures, openings, HVAC, equipment.

2 **Model data definition**

Measured energy consumption data

3 **Model calibration**

Differences of less than 10% between measured and simulated data in 90% of the thermal zones

Error < 1%

II. Proposed methodology

Evaluation of the impact of strategies

Simulation scenarios

Real setting (1)

This scenario corresponds to the simulation of the energy model of the building under study as it is built.

Reference scenario (1)

A building with conventional characteristics, without any type of savings strategy

Strategy integration scenario (3)

Real building + horizontal shading (1)
Real building + Natural ventilation (1)
Real building + WWR 30% (1)

Analysis of energy consumption.
Results of the real scenario.
Comparison of the demand curve obtained for the proposed scenarios.

III. Results

Annual energy consumption

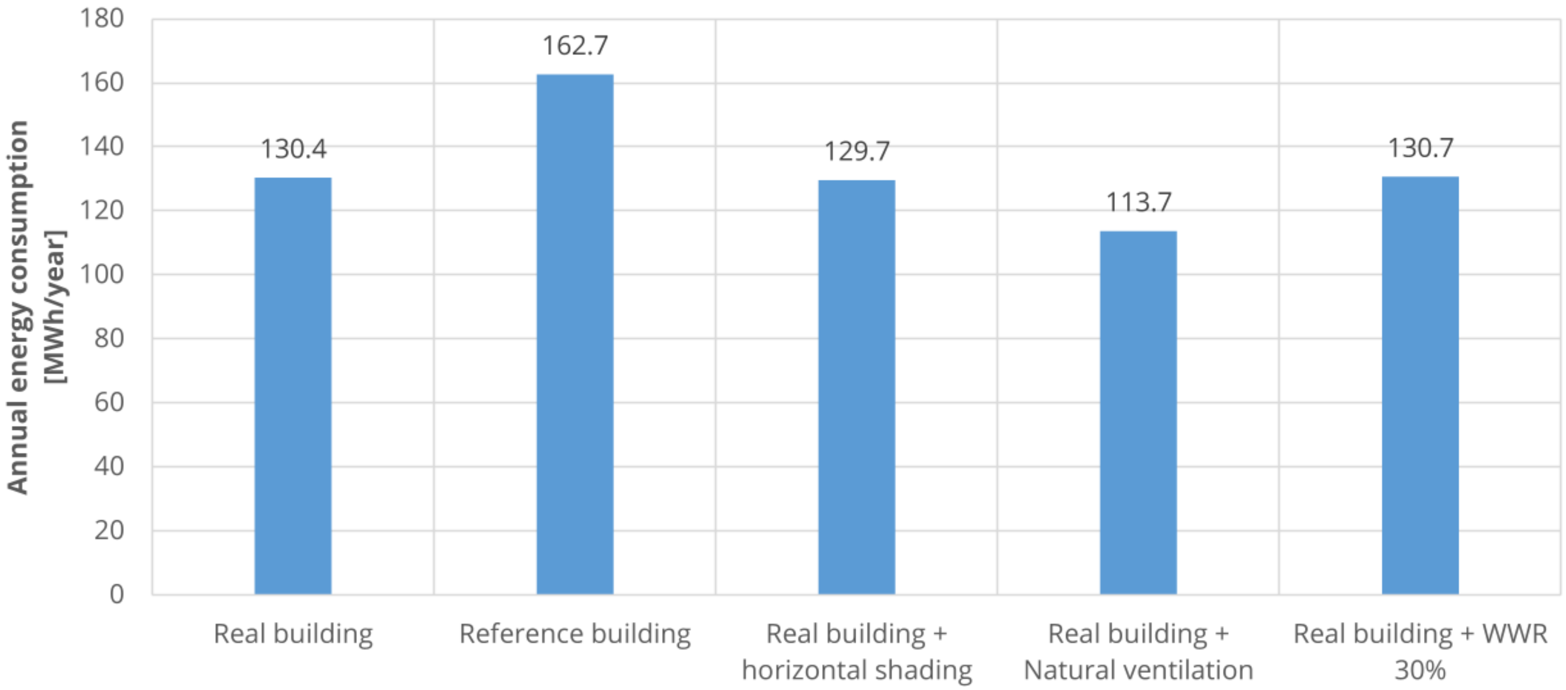


Fig. 3. Annual energy consumption of the different simulation scenarios. Source: Authors.

III. Results

Real Scenario

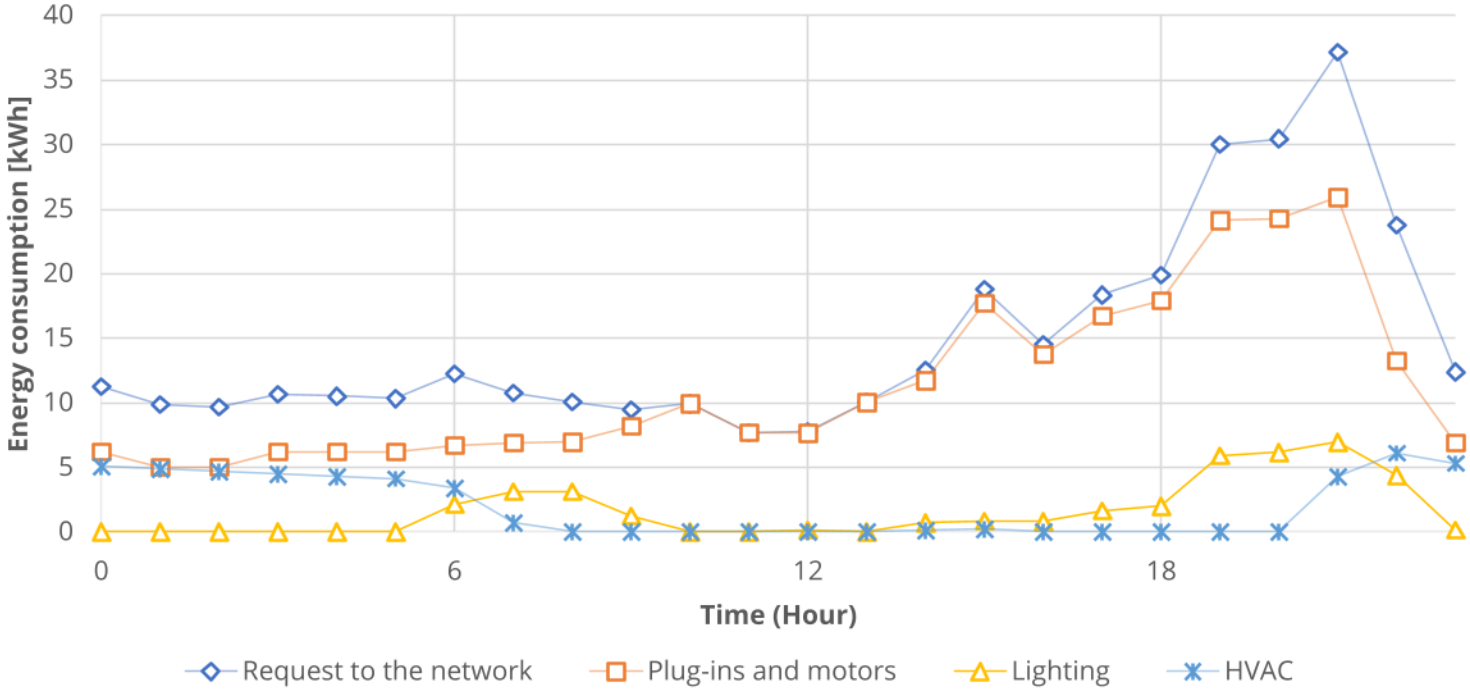


Fig. 4. The hourly curve of the energy demanded the real scenario. Source: Authors.

III. Results

Comparison of the demand curve for scenarios

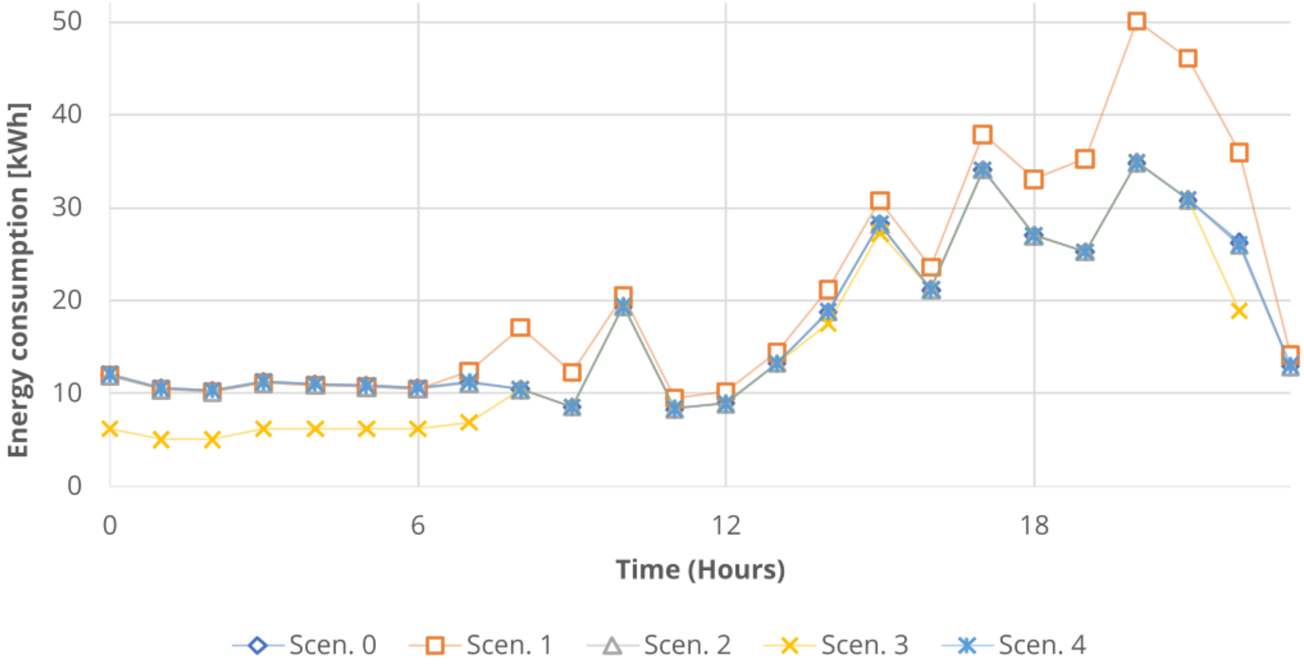


Fig. 5. Hourly energy consumption curves for the different simulation scenarios. Source: Authors.

III. Results

Comparison of the demand curve for scenarios

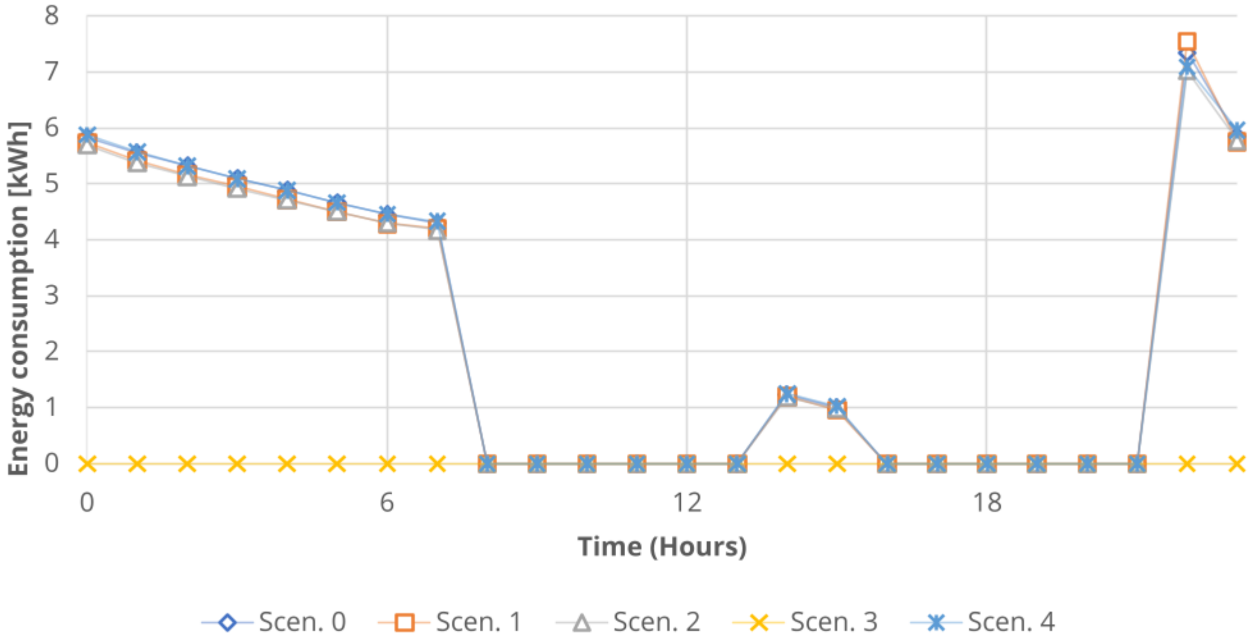


Fig. 6. Hourly curves of energy consumption for the use of air conditioning in the different simulation scenarios considered. Source: Authors.

III. Results

Comparison of the demand curve for scenarios

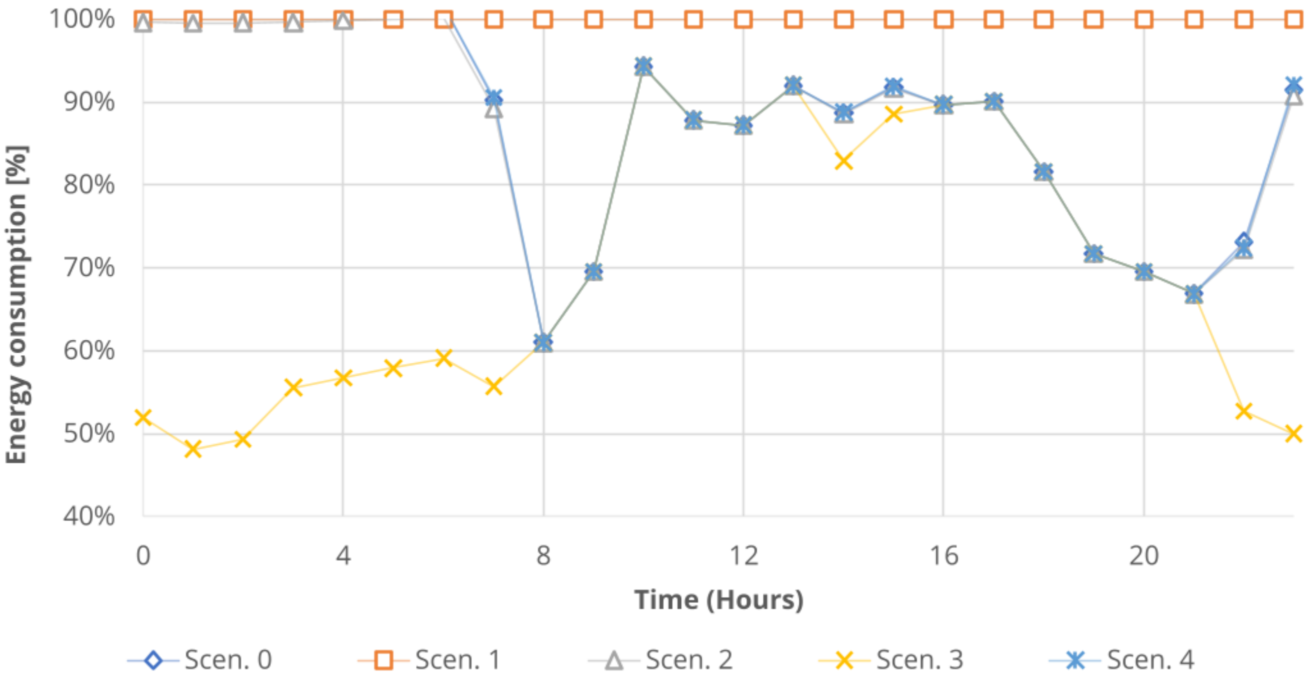


Fig. 7. Comparison of hourly consumption concerning the reference scenario. Source: Authors.

III. Results

Comparison of the demand curve for scenarios

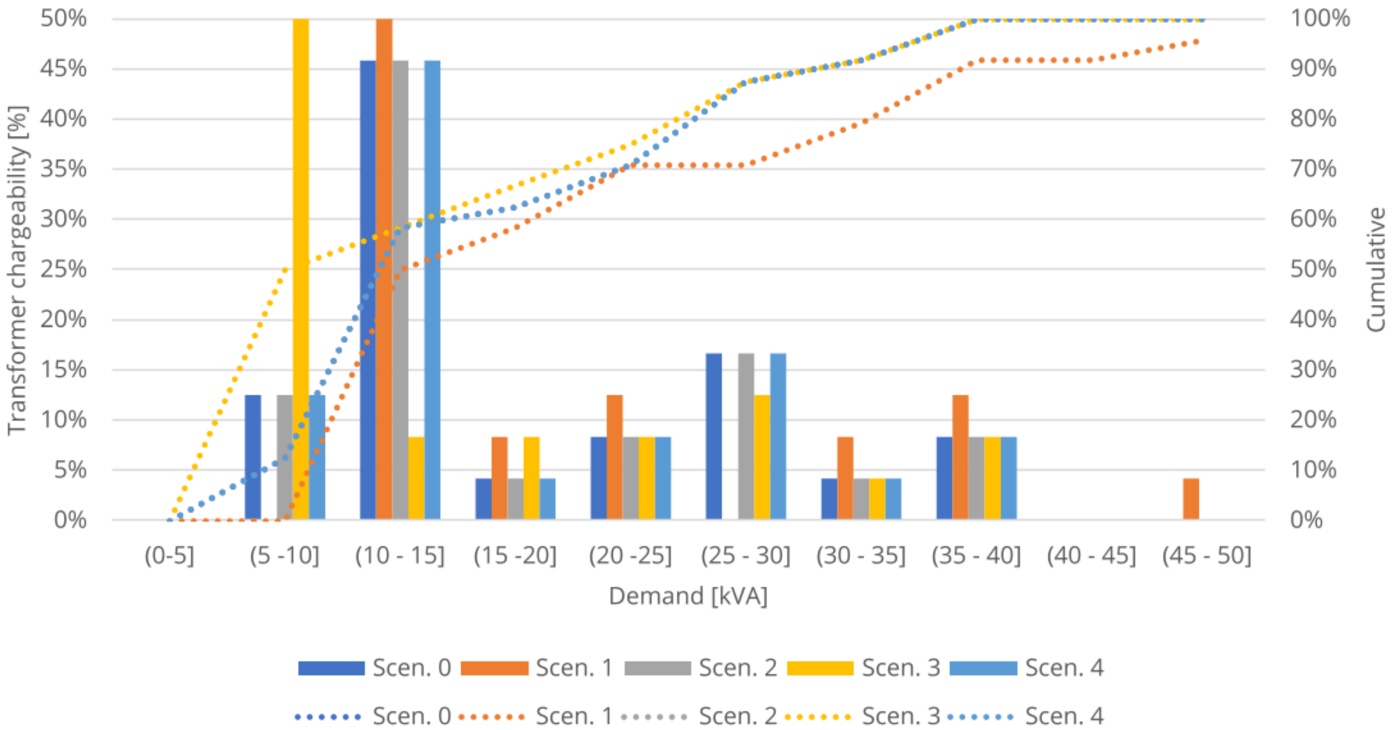


Fig. 8. Transformer chargeability analysis. Source: Authors.

III. Results

Comparison of energy use intensity indicators

Scen.	$kWh/m^2/year$	Baseline $kWh/m^2/year$		Savings Hot-Dry [%]	Savings Tempered [%]
		Hot-Dry	Tempered		
0	30.50	36.9	48.3	17%	37%
1	38.06			-3%	21%
2	30.33			18%	37%
3	26.60			28%	45%
4	30.52			17%	37%

IV. Conclusions

- The main determinants of energy consumption in the scenarios analyzed are plug-in equipment. These represent around 75% of total consumption.

- The presence of efficient elevators and LED lighting in the real configuration (Scenario 0) produces a saving percentage of 17%. concerning the baseline of Resolution 0549. However, under a temperate climate, the savings are close to 37%.

- Most of the scenarios that include strategies do not present significant changes in energy demand. Compliance with local regulations requires the integration of additional strategies. The opposite case occurs with the natural ventilation scenario. This is the only one that allows minimum savings to be achieved under hot-dry weather conditions.

IV. Conclusions

- The results allow appreciating that energy-saving strategies can influence the chargeability of the transformer. For this study, the integration of natural ventilation reduces the energy demand and makes that chargeability is near 25% most of the time.

IV. QUESTIONS