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

Zero Energy Buildings: Colombian perspective

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Contents

I. Introduction

Climate change

Zero Energy Buildings (ZEB)

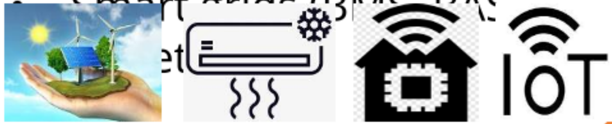
Reduce energy consumption

Passive Designs

- Ventilation.
- Thermal envelope.
- Solar gains.
- Energy efficient appliances.

Active Designs

- Renewable energy.
- HVAC systems (Heating, Ventilation and Air Conditioning).
- Smart grids (BMS, BAS, ...



II. Theoretical aspects: ZEB

Further development in ZEB:

Definitions and methodologies

Different conditions

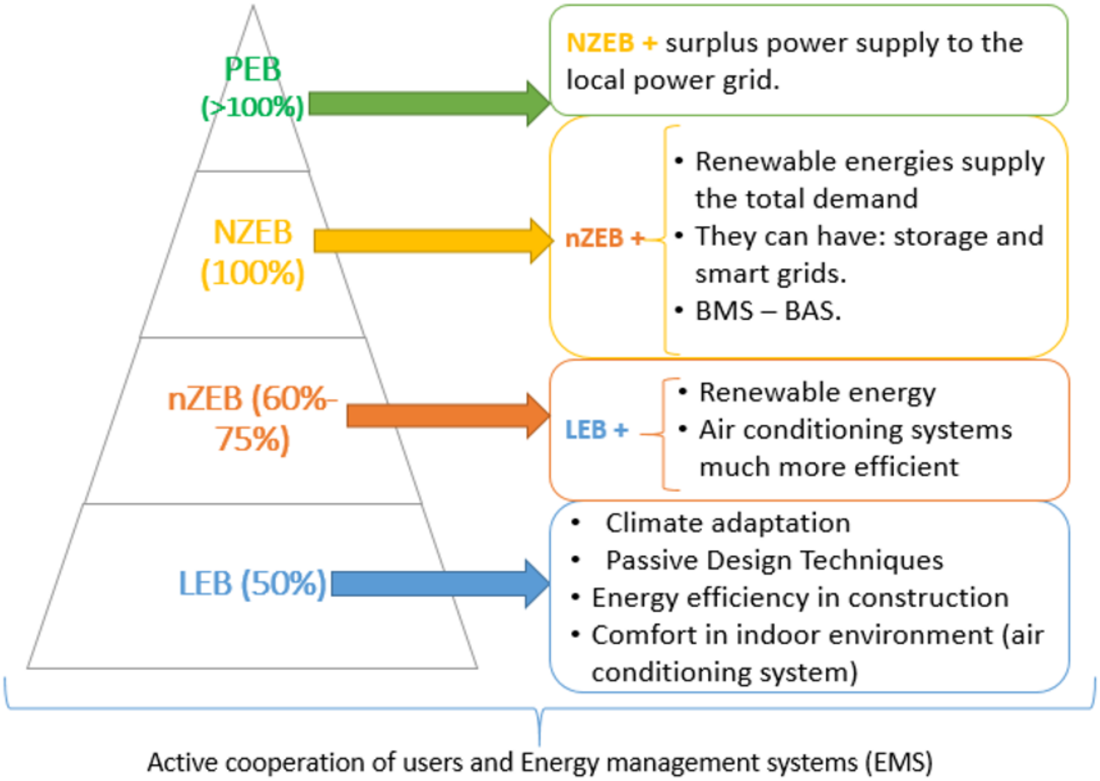


Fig. 1: ZEB classification according to Chinese energy reduction standards in 2016. Adapted from

III. Colombian perspective

- Law 1715 of 2014.
- CREG 030/2018 and CREG 038/2019.
- Resolution 549 of 2015 - Energy and Water Saving Guide

Design measure	Action area	Recommended measures
Passive	From the architecture of the building	• Window / Wall ratio • Solar protection • Natural ventilation
Active	illumination	• Daylight and daylight control • Efficient emergency lighting • Air economizers • Coefficient of performance (COP) • Exterior lighting control • Controls: occupancy

Table 1: Measures for educational institutions - Energy and Water Saving Guide.

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III. Colombian perspective

- Average base consumption:

$$= 40\,\frac{kWh}{m^2 * year}$$

- Energy-saving percentage: 45%

- LEB base consumption :

$$Base\ consumption\ - energy\ saving\ percentage\ = 40 - (40 * 45\%) = 22\,\frac{kWh}{m^2 * year}$$

IV. Case study: University campus ZEB

Characteristics:

- National University of Colombia headquarters Manizales Campus la Nubia (cold climate).
- 14 buildings with different uses of energy and different degrees of antiquity.
- 6 academic buildings (new and intermediate).

Building	Features	Load fp = 0,95
L	• Interior comfort - bioclimatic design. •Energy efficiency in architecture and electrical networks. opened in 2013.	161,5 кW
P	• Current architectural and electrical designs, but with deficits. Opened in 2003.	78,85 кW
Q	• Current architectural and electrical designs, but with deficits. Opened in 2003.	109,3 кW
S1	• Internal comfort - bioclimatic design. •Energy efficiency in architecture and electrical networks. Opening in 2019.	57 кW
S2	• Internal comfort - bioclimatic design. •Energy efficiency in architecture and electrical networks. Opening in 2019.	114 кW
W	• Internal comfort - bioclimatic design. •Energy efficiency in architecture and electrical networks, 10kVA photovoltaic solar systems, rainwater storage system for sanitation services. Inaugurated in [illegible]	95 кW

Table 2: Current status of the La Nubia campus academic buildings.

IV. Case study: University campus ZEB

A. LEB level Campus la Nubia:

- New buildings comply with the water and energy saving guide.
- Application of annual and hourly correction factors.
- Application of active and passive measures described in the guide for intermediate buildings.

Buildings	L	P	Q	S1	S2	W	
Area m^2	7226	3555	3700	2452	5000	5200	Total (kWh)
Load (kWh)	162	79	109	57	114	95	
Building base consumption kWh/(m^2*year)	49,6	49,2	65,5	51,6	50,6	40,5	306,9
Total per Building kWh/(m^2*year) with new LEB	27,3	49,2	65,5	28,4	27,8	22,3	220,4

Table 3: Base consumption by buildings of the La Nubia campus.

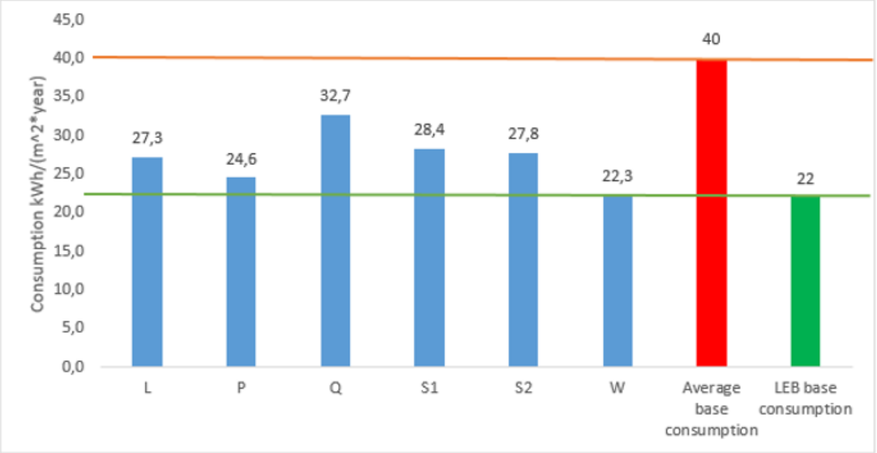

Fig. 2: Base consumption of each building compared to average base consumption and LEB base consumption. Source: Own elaboration.

IV. Case study: University campus ZEB

B. nZEB level Campus la Nubia:

- Reductions of 60% to 75% in energy consumption with renewable energies.

Building	L	P	Q	S1	S2	W	TOTAL
Area (m^2)	**7226**	**3555**	**3700**	**2452**	**5000**	**5200**	**27133**
Base consumption (kWh/ m2*year)	49,6	49,2	65,5	51,6	50,6	40,5	306,9
LEB consumption - 50% (kWh/ m2* year)	27,3	24,6	32,7	28,4	27,8	22,3	163,1
75% of base consumption (kWh/m2* year)	37,2	36,9	49,1	38,7	37,9	30,4	230,2
Consume to be a nZEB (kWh/ m2* year)	12,4	12,3	16,4	12,9	12,6	10,1	76,7
PV power (kWh/ m2* year)	14,9	12,3	16,4	15,5	15,2	12,2	86,3
PV generation (MWh/ year)	107,5	43,7	60,6	37,9	75,9	63,2	388,8
PV power (kWh). H.S: 4,5 day	65,4	26,6	36,9	23,1	46,2	38,5	236,7

Table 4: Consumption and power PV per building to be nZEB.

Buildings	Power PV (kWh)	Panel Quantity	m^2 Required on deck	m^2 Available in blocks
L	65,4	198	495,6	3300
P	26,6	81	201,7	1000
Q	36,9	112	279,4	1200
S1	23,1	70	174,9	0
S2	46,2	140	349,9	2000
W	28,5	86	215,8	1000
TOTAL	226,7	687	1717,3	8500

Table 5: PV capacity required to be nZEB.

IV. Case study: University campus ZEB

C. NZEB – PEB levels Campus la nubia:

- Reductions of 100% in energy consumption with the photovoltaic solar system, energy storage systems and smart grids.
- Building Management Systems (BMS) and Building Automation Systems (BAS).
- Laboratory in active demand management – GESDELEC.

Equipment:

(3) KING PIGEON GATEWAY S373

(1) KING PIGEON RTU S272

(1) Network analyzer

(2) Portable computing equipment.

(4) Humidity and temperature sensors

(1) 4G LoRa Gateway S281 King Pigeon

IV. Case study: University campus ZEB

C. NZEB – PEB

1) BMS development on buildings La Nubia Campus:

- Option I: Gateway S373

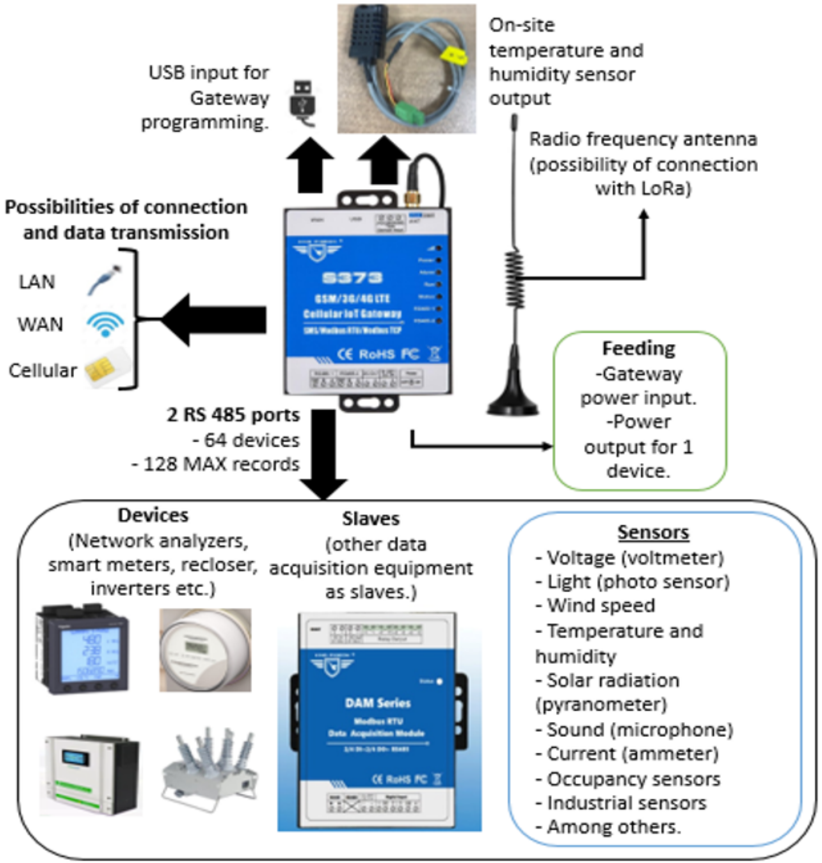

Fig. 3: Communication architectures for the BMS system using Gateway S373 proposed. Source: Own elaboration.

IV. Case study: University campus ZEB

C. NZEB – PEB

1) BMS development on buildings La Nubia Campus:

- Option I: Gateway S373

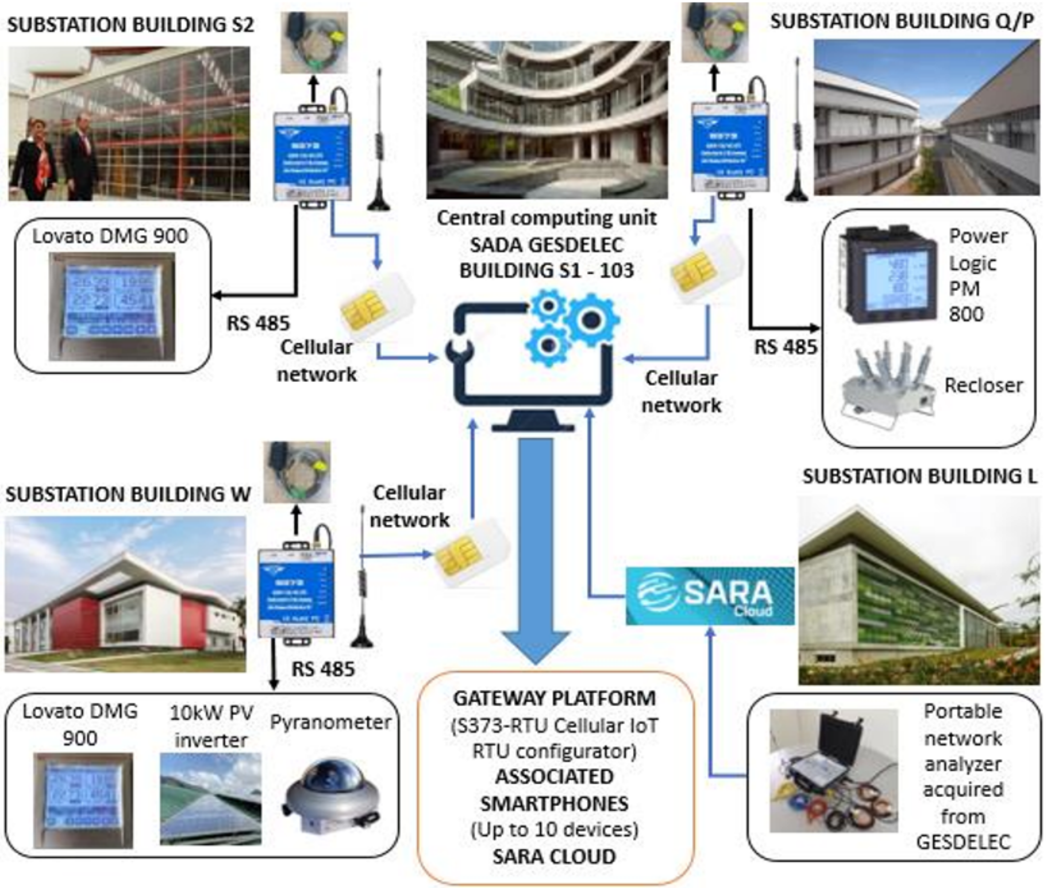

Fig. 4: BMS for some buildings on Campus la Nubia using Gateway S373 proposed. Source: Own elaboration.

IV. Case study: University campus ZEB

C. NZEB – PEB

1) BMS development on buildings La Nubia Campus:

- Option II: Gateway LoRa S281

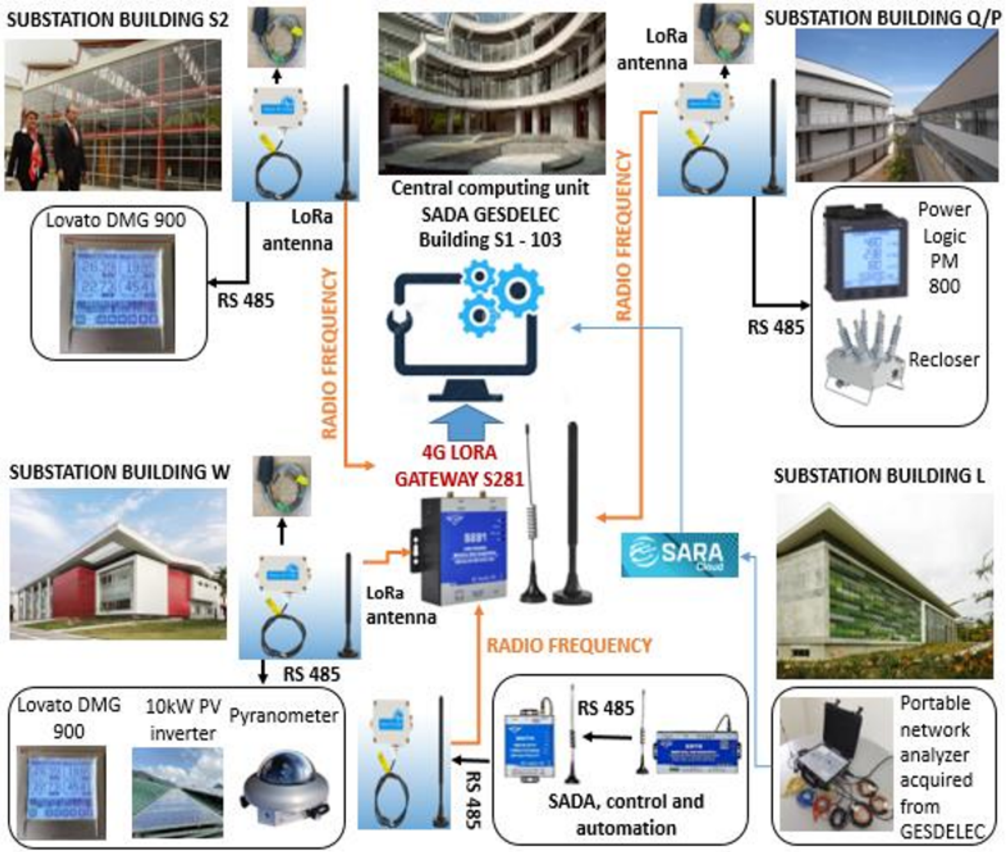

Fig. 5: BMS for some buildings using on Campus La Nubia S281 proposed. Source: Own elaboration.

IV. Case study: University campus ZEB

C. NZEB – PEB

2) BAS development (control and automation) on la Nubia :

Gateway S272

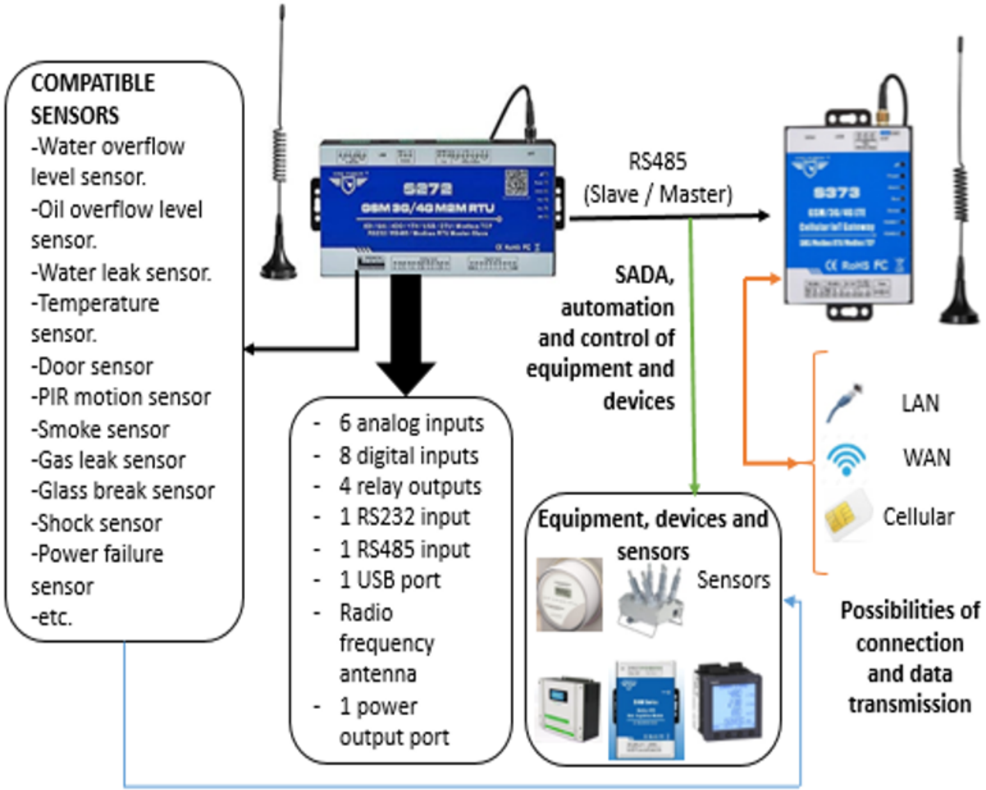

Fig. 6: BAS with automation and control on Campus La Nubia proposed. Source: Own elaboration.

V. Conclusions

- Competitive electricity markets through smart grids and distributed (renewable) energy resources.
- Integration of prosumers in distribution networks.
- There must be local adaptation for ZEBs (Latin America And Colombia).
- PEB as the last step of the ZEB (use of active and passive technologies at a maximum level).

VI. Questions