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Social Housing to nZEB - Portuguese Context

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Abstract

Abstract — In the 80's and 90's, the various Portuguese Governments set the goal of rehousing the majority of the low-income families without a proper house, through a program to build Social Housing. Municipalities assumed the role and developed the solutions to meet the needs. The necessities defined priorities, efforts were directed to quantity rather than quality: 120,000 apartments distributed by 24,500 buildings, in 25 years. Designed in-house or contracted out with a conventional approach and a limited budget, around 500 euros/m^2. The construction was outsourced and hasty, due to time constraints.
Although the construction were common, in technology and design solutions, some architectural prizes, National and International, were given to authorial projects. These became symbols of the progressive Portugal Architectural Heritage and of the success of the Portuguese Social Experience, recognized as architectural points of interest, for tourist and specialists.
As time goes by, maintenance falls short and requires critical conservation, tenants demand rehabilitation and renovation, mostly to situations related to the loss of comfort and quality, associated with water damages in the constructive solutions.
The research regarded the latest European Union policies, on GHG emissions and energy consumption reductions in new building design, to pursue the nZEB's, "nearly Zero Energy Building(s)" concept. By developing a low-cost building renovation founded on new constructive solutions to actualize the envelopes' response: decreasing maintenance's needs and expenses, increasing user comfort while aiming the reimbursement of the investment period. Based on the "Renovation or Rehabilitation — Decisive Gains (RoR-DG)," (Nuno D. Cortiços) benefits were accounted considering achieved savings minus investment: relying on the system's performance, as rated by the key indicators of "Facilities Maintenance Management Model" (Igal M. Sohet and Sarel Lavy). This approach was applied to measure the impact of the first Eco-Neighborhood, applied to a Lisbon social housing park (Bairro da Boavista, Monsanto). Although the Program's positive achievements, the results show a low impact on efficiency. For the future actions it is advisable an overall thermal reinforcement, follow-up measures, additional financial support, and the tenants' commitment.

Keywords: social housing, building performance; building maintenance; building renovation; facility management; properties managers

1. Introduction

The research aims to present the gains of the first renovation Program, Eco-Neighborhoods Environment+ - For an Integrated Model on Sustainable Innovation,'[1], a nZEB's, "nearly Zero Energy Building(s)" design concept, applied on a social housing park in Lisbon, Portugal, built between 1988 and 1996: "Bairro da Boavista".

The development of a building's low-cost renovation plan, founded on new constructive solutions, improves the envelopes' response, allows the decrease of maintenance's needs and expenses, and the increase of user's comfort while aiming the investment period reimbursement. Based on the "Renovation or Rehabilitation — Decisive Gains (RoR-DG)," (Nuno D. Cortiços) benefits were accounted considering achieved savings minus investment: relying on

[1] Free translation from the original, "Eco-Bairro Boavista Ambiente+ Um Modelo Integrado de Inovação Sustentável."

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the system's performance, as rated by the key indicators of "Facilities Maintenance Management Model" (Igal M. Sohet and Sarel Lavy) [1][2]. The Program defined guidelines to update the envelope systems to meet the contemporary requirements outlined for nZEB, equal to those required for new buildings in the European Union territory.

After the Paris Agreement, regions and territories went fast-forward to fulfill the committed objectives. The European Union (EU) defined two directives. One generic, "Energy Efficiency Directive (2012)" to help reach a 20% energy efficiency target by 2020, later revised to 40% for 2030 (2016) [3]. And, one specific for buildings, "Energy Performance of Buildings Directive (2016)" with the goal to cut CO_2 emissions by at least 40% by 2030 [4]. The latter puts the energy efficiency in first plan and supports the building's renovation, on a cost-efficient approach.

In the 28 EU countries, in 2016, the residential sector consumed 25,71% of all energy[2], were 6,27% in electricity

Table 1. Final Energy Consumption in Households by Fuel (%) [4][5]

Energy Consumption by Fuel	*Portugal*	*EU - 28 countries*
Electrical	42,3	24,4
Renewable	31,1	15,9
Petroleum Products	16,3	11,6
Gas	9,6	36,9
Solid Fuels	0,0	3,3
Derived Heat	0,0	7,8

consumed for space and water heating, plus other electrical appliances and devices by households. In Portugal, due to climate characteristics and households' social behavior, in that same year, energy consumption ascended to 16,27%[3], in which 6,99% of electricity, as defined above. [5][6] The Green House Emissions (GHG), represented 15% in the EU; and 7% in Portugal: explained by the renewable investment policies in the latter, as Table 1.

1.1. *Question*

In the 1980 and 1990, several Portuguese Governments set the goal of rehousing the majority of low-income families without a proper house, mostly residentes of slums, through the implementation of a program to build social housing. The municipalities assumed the implementation and development solutions to meet the needs. Directing the efforts to quantity in detriment of quality: 120,000 apartments spread over 24,500 buildings, in 25 years. Several projects, designed in-house or outsourced, with a common approach: 500 Euros/m^2, maximum value. Construction was outsourced and hasty, due to time constraints. This legacy is now outdated in energy efficiency, according to latest EU directives; and lacks on maintenance, just to sustain the initial building performance.

In Lisbon, a company, "Gestão do Arrendamento da Habitação Municipal de Lisboa, E.M., S.A" (GEBALIS), manages social housing: 22,949 apartments (plus 1,387 stores) in 5,849 buildings, with 1,211 elevators, distributed over 2,023 lots, in 66 public housing blocks, and 91,500 m^2 parking area.[4]

Based on the analysis of the available data, social housing, in Lisbon, occupies around 2.2 million of building square meters, that, if multiplied by 2.6 meters ceiling-high (plus 10%), results in 2.5 million[5] of façades' square meters. Regulations enforce that the surface of the windows corresponds to, at least, 10% of the interior floor area — the budget control is, as a rule, ensured by the minimum requirements defined in the legislation — resulting in 468,750 m^2 of transparent surfaces. Thus, the social housing tends to 81.25% of opaque façades and 18.75% non-opaque.

The expenditure on social housing, to build or to maintain the building stock, reaches 2.20% (76,194.06 MEUR) in the EU, but in Portugal barely surpasses 0,01% (5.34 MEUR), 2013 values [5].

[2] Households, in EU 28 countries, used 52,1% of natural gas and oils derivates as main energy source for space heating, 2016 (Eurostat).
[3] Households, in Portugal, used 27,7% of natural gas and oils derivates as main energy source for space heating, 2016 (Eurostat).
[4] Data shared on 2015 annual report, "Plano de Atividades e Orçamento de 2015 - Gebalis".
[5] Based on data presented on Statistics Portugal, "Caracterização da Habitação Social em Portugal", published July 9, 2010.

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The average rental income, as published in the GEBALIS' 2015 Annual Report, is € 78/dwelling/month, and the average requirement for building renovation amounts to € 500/dwelling [8]. In 2009, due to the underperformance conditions, the Government defined a 144 MEUR investment plan (around € 500/house), labeled “Integrated Program of Management and Requalification to the Municipal Housing,”[6] to renovate the stock, to start in 2011 until 2020. [9] However, due to recent Portuguese crisis, the plan was suspended and the building stock's condition is now far worse than 2008. As the country emerges from the crisis, it is urgent to resume to the European commitment made by Portugal: to reduce energy consumption in 20% by 2020 [10], although it has been revised to 30% [11]. The Commitment goals apply only to private housing, through the “Building Energy Certification System (SCE)"[7]; although the public buildings are under strict regulations, they only consider government buildings, not including the local administration properties, responsible for social housing’s.

The Portuguese government, through the Lisbon Regional Operational Program Authority (2014-2020), submitted a 50 MEUR plan to EU funds (ERDF - European Regional Development Fund), to renovate social housing stock: by growing in efficiency and lowering energy consumption and GHG emissions. Focusing on the thermal insulation of the envelope, the façades and shutter boxes; replacing windows with thermal-break frames, double glazed glass and new blinds; solar thermal collectors for water heating; and costs related with investment planning. [12] Nevertheless, Lisbon region (city include) is considered a developed area, therefore has to support 50% of the entire plan.

Although 50% of social housing stock is less than 20 years, the anomalies are significant and recurrent, especially in the envelope, with water infiltrations in roofs and façades, which also accumulate air-gaps problems, and extensive fractures [9]: with evident contribution to thermal exchanges. In older neighborhoods, the walls of the façades are double-layer finished masonry with cement plaster with 3 cm of insulation (expanded polystyrene boards), thermal insulation according to the current requirements. The absence of proper maintenance of the first envelope barrier, the paint film, impairs the thermal performance, raising the humidity levels.

Portuguese social housing does not use centralized heating or cooling systems; the tenants tend to suppress the needs with the use of individual boilers without condensation (for hot water). Natural gas, e.g. bottles of propane, is the main source of energy for heating water and cooking. Electricity is consumed in individual heaters, lighting and household appliances in general. [14]

1.2. *Background*

Housing promoted by governmental entities is commonly referred as 'public' or 'social,' aimed for a population characterized by low-incomes. The latter also includes minorities and seniors, in considerable numbers, and individuals living on social subsidies. The social housing urbanizations have high-density and a large number of housing units per building; all in small habitation areas with low accommodations availability.

Aging and the lack of maintenance promote a number of problems, especially with regard to indoor quality (from the user's perspective), deterioration of thermal conditions and promotion of moisture accumulation: resulting in the absence of proper thermal comfort and ventilation, adding cigarette smoking residues, pests, and the presence of fungi. The houses often show the presence of water damages, due to the ruptures on impermeables barriers, on roofs and, more often, in flat designs but, also, through the gasket seals in the windows frames; weakening the health of families. Programs on building systems renovation or retrofitting can solve the problems described and enable EU, such as nZEBs, to bem met. [15]

The EU is committed, to comply with the Paris Agreement, to decrease 80 to 95% of GHG derived from the building sector. The thermal renewal of today, of the entire housing stock, is not significative, is between 1-2%. [16]

EU directives imposed the requirement for renovation of the building, so municipalities, as property owners, designed and implemented Eco-neighborhoods programs to fulfill national commitments, in terms of energy-savings and reduction of GHG. The awareness of the residentes, for these problems, is also essential, especially the most vulnerable citizens. [17]

Quality data on building’s renovation is an accurate and fundamental tool for achieving the overall efficiency objectives, as it involves property owners, managers, and tenants; and, when applied to investments, can ensure a revenue of unquestionable value, to all parts. [18]

[6] A free translation from the original, “Programa Integrado de Gestão e Requalificação dos Bairros Municipais.”
[7] A free translation from the original, “Sistema Nacional de Certificação Energética e da Qualidade do Ar Interior nos Edifícios (SCE).”

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Volatile policies, short-term regulations', shared funding effort (as EU fund programs in Lisbon Region), permanent economic loss (tenant’s rent per reactive maintenance expenditure), long-term strategies lacking on implementation and complex technical development contribute to a poor systems' performance, even lower than initially achieved. [18]

The renovation of building stock can be efficient if an integrated methodology is used, as the Sustainability Rating Systems (BRS), establishing the reduction and reuse of resources, environmental protection measures, decreasing residues: applying a life-cycle cost control with focus on the overall quality and sustainability, resulting in GHG reduction. [19][20]

Local climate should, above all, guide the approach to implement energy savings policies. In a temperate climate, such as in the south of Europe, the buildings' renovation design must maximize the efficiency and speed the investment return. [21]

Recent literature focus on the importance of the relationship between property managers and tenants, pointing of energy efficiency active measures, mainly, managing consumptions; also, through the implementation of educational programs, assuming technical and social-economic strategies. [22][23] The approach must admit a longer time-frame to gather tangible results [24]; relating users’ comfort with energy savings, and for the household financial health [23].

Low-income, basic education or senior-age tenants tend to resist emerging technologies, unless earnings are direct and immediate, on their experience of comfort, and related costs. Moreover, energy efficiency strategies tend to fail if require daily interaction, due to the lack of immediate benefits. On the property management viewpoint, it is possible to ensure renovation outcomes, performance and constancy, but only in the long-term. To solve the problem, researchers and technical studies emphasize the tenants' behaviors and routines to design the renovation strategies, establishing measures, and tools to promote the objectives. [25]

The social housing is a non-profit solution (or a common answer) for dealing with the lack of housing for the less fortunate and more vulnerable citizens. The idea of addressing comfort and energy sustainability, on the public building stock, through today's technologies, depends on governments and external program's capacity; tenant's; economic stability; safety conscience; continuing service and support; and community and social services engagement. At the same time, the building stock renovation helps to promote community development and understand the proper way to engage it in the global problems. [26] [27]

Envelopes' renovation strategies have proven to solve uncontrolled losses and gains on social housing buildings, even without the direct contribution of household; only by accounting the external wall insulation is achievable, in theory, up to 11% in energy savings and cutting 8% of GHG, as presented by a survey on social housing in Nottinghamshire, UK. [28]

Considering the traditional external wall solutions, the thermal transmission coefficient, constructed during the 80 and 90's, in Portugal, is between 0,51 to 1,1 W/m^2.K maximum. The typical solution resorts to light-brick in double layer, finished with mortar on the exposed surfaces, the wall cavity with or without thermal isolation board. To reduce those values and pursuit the nZEB concept, 15 kW/m^2.year, the solutions cost tends to be above 10% when compared with the market current solution; therefore, the investment only justifies if guarantees the return before the lifespan term. But, if renovation's cost surpasses 50% current market value, is impossible to defend positive results. [29]

1.3. *Possible Approach*

The goal is to analyze the viability and the outcome of the first Eco-neighborhood, made in Lisbon, as an example for future projects. The Lisbon Municipality designed a Program to renovate the “Bairro da Boavista - Masonry Area,” in Monsanto, applied from 2012 to 2015, to retrofit selected buildings, through improvement on façades: on the walls, adding an external lime aggregate above a cork layer (30mm)[8]; and, on windows, replacing the simple aluminum frames of single glass by a PVC frame with double glazed window[9]. The Eco-neighborhood Program, submitted in 2009, approved and funded in 2011 by EU programs, divided: 65% by QREN[10] – Lisbon Operational Program and FEDER[11] - European Fund for Regional Development, and 35% by the Lisbon Municipality. The Program was organized into four phases and was under the Municipally Agency for Sustainability (Lisboa E-Nova) and the Engineering National Laboratory (LNEC)[12], technical support.

[8] Walls commercial solution, “Secil SecilVit CORK.”
[9] Windows commercial solution, "Caixiave PVC.”
[10] The “QREN - Quadro de Referência Estratégico Nacional” is a national strategy for the implementation of the Community policy on economic and social cohesion in Portugal in the period 2007-2013.
[11] “Fundo Europeu de Desenvolvimento Regional”
[12] “Laboratório Nacional de Engenharia Civil”

Although all literature produced on the Program guidelines, mainly to advertise measures, no data, results or conclusions were learned: on the Program or on tenant perspectives or other. The outcome remains uncertain. To account specific gains and to guide future programs it is imperative to understand the work produced. At the same time, it is aimed, through testing and improving, the development of the “Renovation or Rehabilitation — Decisive Gains" (RoR-DG)”: a method to understand the real impact of renovation operations. [31][32].

Table 2. “Bairro da Boavista”, Lisbon, under renovation Program.

Renovated Building Systems	Before (1988-96) [30]	After (2014)	Diferencial
Walls	1,1 W/m².ºC	0,60 W/m².ºC	0,50 W/m².ºC
Windows	4,8 W/m².ºC	2,7 W/m².ºC	2,10 W/m².ºC

1.4. Manuscript Structure

The paper begins by addressing the problem, the social housing renovation in the EU's perspective of existing building stock. The background exposes the approach of the principal published works, in the last three years (as below quoted), through conclusions analysis. By explaining the problem, on public and tenant’s perspective, is possible to establish the path adjust the RoR-DG to social housing specifications. In the end, by filling the method tables; results and findings get assessed, and the research presents the conclusions; by exposing the Program omissions and advising the future strategies.

2. Methodology

Social housing, in the city of Lisbon, provides residence to 75.000 citizens [30]; therefore, efforts to gain energy-efficiency must coordinate the actives and passive systems.

In the chosen sample/stock, the tenants control the indoor comfort temperature, therefore, is excluded from this approach, due to close relation to the solar exposure and other externalities (metabolism, occupation, acclimatization unities, induced ventilation, humidity presence, et cetera). Instead of analyzing the behavior data, its opted the National Legislation on buildings' thermal comfort (3rd generation), Decree-Law 118/2013 of August 20, 2013. That establishes 20ºC for the cold season and 25ºC for the hot season, setting the quantities in Celsius degrees needed to proper climatize a building in Monsanto, Lisbon. Data collected through photographs of the renovation work, on-site visual inspection and measurements, and designs, all confirmed by Portuguese construction codes (LNEC) [31].

2.1. Passive Building Systems - Investments

Two passive systems received renovation, façades wall and external windows. On façade walls, by applying the initial thermal transference values is possible to calculate the gains, when putting beside the renovation performance. The RoR-DG, on Table 3 and 4, exposes the impact of the Program in the years to come, on decennial periods (10, 20 and 30).

The method works by assessing the building systems to determine the main key-indicators. The “Building Performance Indicator” (BPI) defines the condition of the envelope systems, by multiplying the system’s weight on building's type [1][2][34], due to lack of maintenance, since the construction’s conclusion, it is classified as a “poor or dangerous performance condition”, translated by the visible cracks that promote leakages and the air gaps. The same happens in the original windows, with the waterproof barrier collapse and the lack of air tightness, due to misalignments derived from the manoeuvres. The “Decision Impact” (DI) is the expenditure, in percentage, to maintain the existing solution performance [34].

To understand the amount of energy saved, on intervened systems, the whole is reduced in one square meter: the two solutions have a “Wal-to-Windows Ratio” of 81,25% for opaque and 18,75% for transparency [35]. The ratio derives from the pavement areas, as requested for social housing, then façades areas and windows' occupancy.

The section “Investments per m^2” exposed the renovation costs, as shown. The “Condition Factor (percentage)” accounts the operational difficulties for workers and necessary technical skills, equipment, tools, materials, and security. “Renovation Solution Maintenance (Eur) (Cype)” means the renovation value expected for the next 10 years accordingly with Cype[13]. The “Subtotal” accounts all renovation costs on a square meter in the first 10 years (period).

Table 3 — RoR-DG — Investment Analyses

Year	Region	Period	Renovation or Rehabilitation — Decisive Gains - Investment Analyses				
2014	Lisbon	10	Envelope				Total
		Systems (BPI<0.80)	Walls	Roofs	Windows	Shaders	
		BPI [1][2]/System	0,33				0,33
		Decision Impact [34]	0,99848%				0,99848%
		Wall-to-Window Ratio [35]	81,25%		18,75%		100%
		Maintenance (previous year)	0,00 €				0,00 €
Investment per m^2							
		Preparation (Eur/m^2)	3,96 €		2,93 €		6,89 €
		Renovation (Eur/m^2)	47,76 €		492,05 €		539,81 €
		Condition Factor (%)	25,00%		10,00%		0,35 €
		Renovation Solution Maintenance (Eur) (Cype)	2,02 €		44,28 €		46,30 €
		Interest Rate					
		Interest Period (years)					
		Subtotal*WWR	54,17 €		110,39 €		784,35 €

Due to the Program financial nature, no interests were accounted.

The section “Savings per m^2” exposes the renovation gains, as presented. Those obtained through the reduction of thermal losses and savings with maintenance costs by multiplying the amount Celsius degrees needed to climatize the indoor spaces, in the city of Lisbon, with the “Local Energy Price (Eur/kWh),” when renovated systems values are confronted with the initials. The “Subtotal*WWR," on investments and savings, presents the values in decennials periods on a façade square meter; if multiplied by the total area, it would translate the absolute amounts.

2.2. Active Building Systems and Equipment

The appliance makers advertise the energy efficiency of active systems, by appealing to consumers to acquire “A++” labeled products, current or based on heat-pump technology. Medium income families, slowly recur to new technologies to cut electric consumption. But those, who live in social housing, by definition, do not have means to assume that role.

3. Results and Discussion

The results, at the end of Table 4, do not showcase significative reasons for all investments made versus savings, when the balance exposes the financial outcome. More, the improvements never, on any decennial period, reach a positive value. And even worse, when the focus is on the windows' systems; the investment is never recovered, due to

[13] © CYPE Ingenieros, S.A. - Software for Architecture, Engineering and Construction, 2017. Available: http://www.cype.com/en/cype/

the high prices of the framing and glass technology, with limited life expectancy, around the 30 years mark, and elevated maintenance expenditure. Even by accounting GHG emissions saved, as 45 to 50/t [36].[14]

The overall value almost breakeven before the 30 year mark, but the windows' systems, with a high degradation rate, invert the results cycle. The accountable outcomes do not consider all gains, as the immediate comfort and households' health on a long-term (and general). Although the energy savings did not pay back the investments, the Program points in the right direction in the pursuit of the nZEB concept.

The initial Program was more extensive and ambitious, by considering other measures as sun collectors, photovoltaic panels, and wind power towers, on a near communal sports field, but due to economics constraints, during development, none of those was installed. Something similar occurred to the passive solutions. The façade wall renovation went from the initial 40,000 m2 to 18,000 m2 [37], and the windows replacement, from initial 3,000 m2 to

Table 4 — RoR-DG — Savings Analyses

Local Energy Price (Eur/kWh)	0,17 €		Envelope		Solar Radiation (90º wide)	
$Q_{tr,i\&v} = 0{,}024.GD.H_{tr,i\&v}$	Heat		25,68 kWh/m2		South	
	Cooling		9,66 kWh/m2			
	Building Systems	Walls	Roofs	Windows	Shaders	Total
		Renovation over Rehabilitation - Impact Decision - Decennial Results - Savings per m²				
Thermal Coefficient, U (W/m2.K) [31]	Asc. / Desc.	1,10		6,20		
	Asc. / Desc.	0,60		3,00		
Energy, Q (kWh/m².year)	Asc. / Desc.	17,67		113,10		
CO_2/year	185,49 g/kWh	3 277,83 g/m2		20 978,12 g/m2		24 441,44 g/m2
Radioactive Residues/year	9,92 µg/kWh	175,3 µg/kWh		1 121,91 µg/m2		1 307,13 µg/m2
Energy per 10 year (Eur/m²)		30,04 €		192,26 €		222,30 €
Initial System Rehabilitation (Eur/m²)		6,96 €		0,00 €		6,96 €
Initial System Maintenance per 10 years (Eur/m²)		12,18 €		20,45 €		32,63 €
Disposable Initial System Value (Eur/m²)		0,00 €		0,98 €		0,98 €
	Subtotal*WWR	41,06 €		41,17 €		82,23 €
Savings - Investment = Total						0,00 €
	Total - 10 years	-13,11 €		-69,22 €		-82,33 €
	Total - 20 years	25,93 €		-72,34 €		-46,41 €
	Total - 30 years	64,97 €		-75,45 €		-10,48 €

(*) EDP - Portuguese Major Electric Company Data, 2015 - http://www.edpsu.pt/pt/origemdaenergia/Pages/OrigensdaEnergia.aspx

[14] Excluding GHG emissions of used materials and solutions, its logistics and build operations.

1,500 m2 (L. Ambrósio, personal communication, March 29, 2018).[15] Both measures covering numerous buildings, but none received a complete renovation; some had external wall renovations and others window replacement [38].

4. Conclusions

This manuscript presents the outcome of a renovation, through a method that deduces investments by savings, assessing the solutions lifespan. Realizing the improvements and results, when is intended to apply the nZEB goals for existing social housing, in Lisbon.

Culture behaviors' have a significant role in the reduced amount of energy spent in acclimatization in Portugal, when compared to the EU, due to energy prices (considering the average wage), traditional comfort expectations, and a temperate climate.

The recent Portuguese crisis imposed financial constraints, with impact on the management of the social agenda and delays on investments and studies, with potential for attract National and EU's funds, to improve social housing. The research also emphasizes the lack of a detailed plan, in alternative to the goals in merely described in the Program advertising.

Plans on energy efficiency [11] should consider financial loans to tenants, limited to active systems, and under low interest rates, to update high consumption appliance and equipment (boilers, stoves, fridges, incandescent lights, et cetera). Additional renewal's sources on-site, as sun and wind power devices, even depending on weather, must be installed to promote the increase of savings.

The Portuguese Energy Agency (ADENE) has the mission to aware and inform the society to the importance of energy efficiency and water savings, and their relation with the environment, contributing to the 'energy literacy' [12]. For tenants of social housing, the research suggests the installation of new reading meters on power, natural gas, and water supply with the monetary value display, in alternative to existing solutions (Kw, m^3 and m^3).

Although the data surveyed and results presented are derived from the official Program promotion, procurement processes, and supplier interviews, the researchers emphasize the lack of an official report, which compiles the final results of the first Eco-Neighborhood Program operation, in Portugal.

In the future, it is intended to apply RoR-DG to other European Eco-Neighborhood experiences to discuss the best strategies.

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