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The Preservation of the Solar Potential in Cities of Hispanic Trace. Analysis of the Current Situation, and Future Potential in Urban Areas of Argentina.

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Abstract

To achieve urban sustainability, the access to solar radiation must be a guaranteed right in the cities. There is an urgent need to review designs, patterns and constructive technologies to obtain energy efficient buildings providing thermal and lighting comfort for their occupants through the maximum utilization of available renewable resources of energy.
Although solar radiation is one of the most valuable resources of clean and renewable energy, the access to the same seldom constitutes a social right.
When analyzing the viability of a bioclimatic design in a new building or in the recycling of an existing one, it is fundamental to know what the solar available potential is, especially in urban consolidated areas where the characteristics of the structure significantly determine the access and availability of the resources. This problem is present in all Latin American cities, emerging from a Spanish colonial grid layout.

In order to reverse this tendency, it is necessary to ensure the future free utilization of solar power destined for central and water heating in urban surroundings regardless of their densities. However, the reality indicates that the legal existing frame in many countries of Latin America does not consider the renewable resources as appropriable.

This paper presents the evaluation of the impact of regulations in medium scale Argentine cities, in relation to the solar potential of buildings located in consolidated areas. If the present patterns continue, the application of rules orientated toward the utilization of solar resources, will be viable only with great difficulty.

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1. Introduction

As a result of the process of urbanization in many Latin American countries over half of its population lives in urban spaces. Therefore cities grow and require more and more energy and natural resources to deal with the people's demand for an improved quality of life. And this is the point where the situation becomes more complex since increased consumption is directly associated with increased generation of pollutants and waste production.

A critical step in this direction is to achieve buildings that provide thermal comfort and light with a minimal use of fossil fuels, while improving efficiency and maximizing the use of renewable energy resources available.

Radiation from the sun thus becomes an environmental asset, something that is already happening in the real estate market, where properties with very good solar lighting increase in value. But despite this, renewable resources are not considered, by ordinances on a national level, as appropriated goods, and considered less important before the law than other assets of easier evaluation.

It is not enough to establish norms specifying that all buildings should have sufficient light and air; legislation is required to guarantee free access to permanent sunlight in buildings located in areas that already have buildings of a specific and consolidated morphology. Thus protecting the quality of the interior spaces and, also, safeguarding the solar technology invested.

2. Solar access laws

Since ancient times, ensuring access to sunlight for all citizens has been an old and wise law. Thus the Roman Empire already had solar access laws. Vitruvius, in ten books on architecture proposes "... as the position of the sky with respect to a given area on earth naturally leads to different characteristics, due to the inclination of the circle of the zodiac and the sun's course, it is obvious that the designs of similar houses, should respect nature and diversity of climate" [1].

Later the Law of Indies (15th century) determined the optimal guidance to be applied to the foundation of new cities in the Spanish colonies.

By analyzing the current background, the right of access and best use of solar radiation can be constituted and structured according to the following criteria

2.1. The solar access within the Municipal Code

Solar Access Laws generally include provisions that allow local governments to create their own ordinances and land use regulations safeguarding solar access for all its inhabitants.

In the U.S., there are two lines of solar access: solar easements and solar rights. Solar easement describes the mechanism by which a property can maintain access to sunlight without any obstruction from the property of another. Solar rights, in turn, establish regulations to protect people who want to install solar systems and also protect access to sunlight for systems already installed. They are subject to private restrictions, and stipulations by local governments in their ordinances and building codes [2][3].

Not excluding the case mentioned, solar access is usually given in low density areas, where the availability of the solar resource on the walls of buildings is higher, and guidelines can be implemented to create "zones". Zoning to protect sunlight access is based on adjusting existing regulations, creating a regulatory overlay to existing urban codes. Limits are established that buildings must comply with to ensure free sunlight access to neighboring structures, and may have different limits, protect the roofs, walls or even entire batches, see Fig 1 and 2.

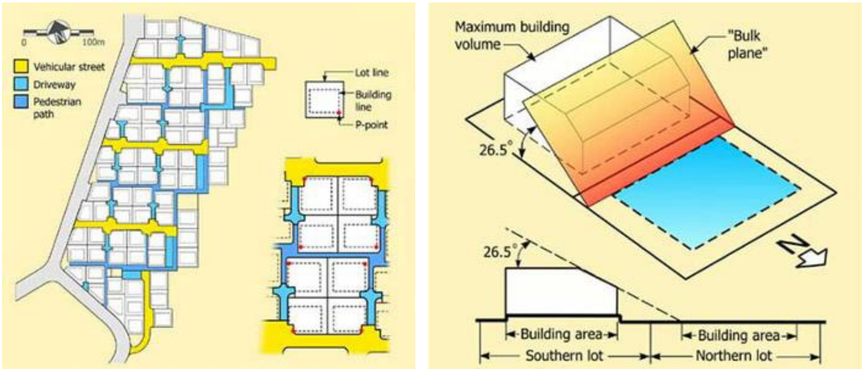


Fig. 1. The urbanizations of Neve-Zin and Sede-Boker in Israel (Etzion Yair, 1989) [2].

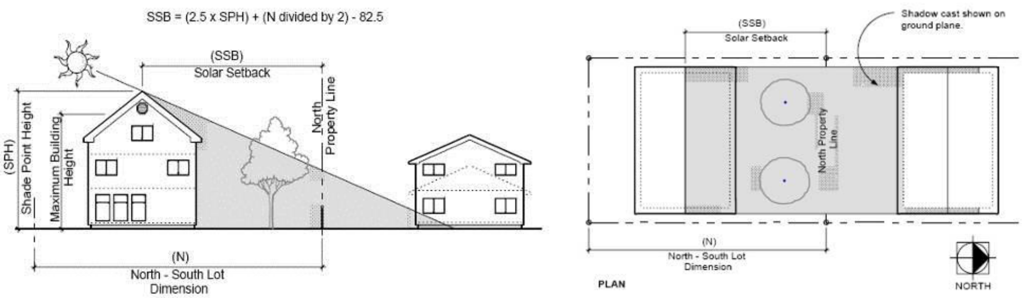


Fig. 2. Schemes from the Construction Code of the city of Eugene, Oregon [3].

They constitute a property right, but they are not grounds for expropriation to a third party. This right is inalienable, so that there can be no agreement that limits or restricts the use of solar energy in a property.

Currently 34 states have regulations regarding both cases, subtracting 16 that do not have any protection, even though some of them (Connecticut, Illinois, Pennsylvania, Texas, and Vermont) have enacted policies to promote the use of renewable energy.

2.2. The right to the sun within the Laws of Energy Efficiency

This is the case of the Spanish State, which as declared in the Technical Building Code since 2006, requires new buildings to be equipped with solar collectors to take advantage of sunlight for indoor heating, hot water and natural lighting. And obligations for solar radiation use are established without considering, in many cases, the preservation of the renewable resource from potential obstructions.

2.3. The right to the sun as a vested right

English law states that if a building has received natural light uninterruptedly for over twenty years, it can preserve that right, and the house owner is enabled to prevent any obstruction that would deprive him of it [4]. This right is protected by common law. It is a type of easement that gives the owner of a property with windows the right to maintain its level of illumination, and any aggrieved citizen may bring legal action if it is determined that the amount of light enjoyed uninterruptedly through an opening is limited or can be limited without any specific consent, see Fig. 3.

Fig. 3. Ancient Lights: The right to the sun as a vested right in the buildings of England [5].

2.4. Entailed agreement for solar rights between individuals

This is an agreement between two adjacent landowners, one as "beneficiary" and the other as "affected", which is integrated in the Public Property Register and transmitted to the deed title. These agreements are established when a landowner wants to ensure continuous and unrestricted access to sunlight during the useful life of the building.

Individual strategies impose direct restrictions on the sources of shade by simply prohibiting certain shade collecting elements to be set up on a determined covered surface. Individual strategies may have the force of law through express easements or restrictive agreements.

3. The solar resource availability in urban consolidated centers

Solar resource is conditioned in cities by the characteristics of urban areas, due to urbanization characteristics, building density and height of buildings, the gap between the built volumes, and the dimensions and proportions of outer space together with other obstructions created by the presence of the various components of the urban landscape.

These obstructions, in the case of low density structures are minimal, and this is where the particular design of the building is important. In the case of high density buildings a good design is not enough to ensure the availability of the resource; it depends rather on measures taken by government management agencies that should determine certain spaces within the urban fabric in grid volumetric limitations exactly what is to be built in an area.

In regions with available amount and intensity of solar energy throughout the year, using the same to heat and illuminate the interior spaces of buildings is an achievable goal that could provide significant savings toward energy consumption. It is therefore of great importance when planning for the future to consider that existing structures may be a limiting obstruction to the resource.

4. Analysis of the current regulations in mid-scale Argentine cities

In Argentina, the only mandatory rules that determine the solar resource availability in built spaces are the Codes of Urban Planning and Construction (CUPC) of each city. These regulate all variables related to building morphological characteristics, in many cases without contemplating inside living conditions or what energy aspects are produced by complying with them.

As an example of the latter, the Urban Planning Code of the City of Buenos Aires, in section 4.8.2 within the habitability standards based on the sunlight of tall buildings, makes it mandatory that new buildings ".. Should be located so as to ensure three hours sunlight during the winter solstice in at least fifty percent of first class premises in each dwelling unit ... "[6].

The problem in such cases is that the requirement set by the norms, does not guarantee the right to sunlight, since there is the future possibility that in buildings will be erected in the surrounding boundaries obstructing the passage of rays, thus denying the affected homeowner any right to lodge a complaint.

There are also national norms that establish minimum levels of thermal and illumination habitability for different living spaces in buildings. They depend on the Argentine Institute of Rationalization of Materials (IRAM) and the Association of Lighting of Argentina (AADL), and are not mandatory, but only recommended parameters.

The correlation between habitability and energy consumption is direct. As a result, the residential building sector represents over 30% of the total energy consumption. Of that percentage, 40% is used for central heating, and 35% for water heating, in both cases, natural gas being used for fuel.

Within this framework, approximately 50% of the entire population of Argentina (19.717.150 inhabitants) live in 7 of the 10 most populated urban centers, located in the central region, between 31 ° and 34 ° South Latitude . This area is known for its temperate climate, with annual average temperatures about 15 ° C, with temperature ranges above 14 ° C in the dry zone, needing significant energy requirements for heating in the cold season.

Previous studies of the area establish mean values of energy savings through the use of solar power, exceeding 40% in indoor heating and 80% in water heating for domestic use [7].

Solar energy is already being used in cities, in collector plates for water heating, which in most cases has no explicit legal protection, so that the enjoyment of the benefit can be interrupted or lost at any time.

To prevent this from happening, free access to solar energy must be ensured in an urban environment through the analysis of regulations governing the characteristics of its building structure; it being necessary to assess which are the factors causing obstructions on collector potential surfaces.

For buildings located within a grid, when analyzing the incidence of building morphological variables on the availability of the solar resource, there are two main situations regulated by the Urban Building Codes of Argentina.

The first is the one that deals with the withdrawals or setbacks between the built volumes (side, rear, and the dimension of the inner courtyards of the buildings for ventilation and lighting), which directly impact on sky obstruction experienced by vertical walls, main sensor elements through direct gain, see Figure 4.

The second situation is the one that regulates the height of the buildings, which added to the previous one, affects the roofs, where the photovoltaic or thermal collectors are placed. Withdrawal indicators are established between buildings, angles to limit the height of construction, but everything is analyzed only to the building itself, without evaluating the urban design that these policies can generate. And while the geographic characteristics of the analyzed cases are similar, the indicators established by each municipality are, paradoxically, dissimilar.

For comparative analysis, a similar situation is represented (a building in an area of 700 m2, located in a block of one hectare), considering the maximum possible density construction as established by the CUPC of the cities of Rosario, La Plata, Cordoba and Mendoza.

Fig. 4. Side and rear limits of buildings of Mendoza City.

In urban sections corresponding to higher construction densities, a height of up to 36 meters high will be reached, with 10 meter gaps between them (Table 1).

Table 1: Urban indicators established by the CUPC of the cities of Rosario, La Plata, Cordoba and Mendoza.

City	Population	Location	Heating degree days B18	Maximum height (m)	Retirement lateral (m)	Retirement posterior (m)	Minimum side yard light (m)
Rosario	1.360.286	32º 57' 60º 39'	1123	30	5	18	10
Córdoba	1.510.023	31º 25' 64º 11'	975	21	4.2	25	7
La Plata	894.253	34º 55' 57º 57'	1269	30	2	20	12.5
Mendoza	1.086.126	32º 53' 68º 49'	1395	36	5	10	7.2

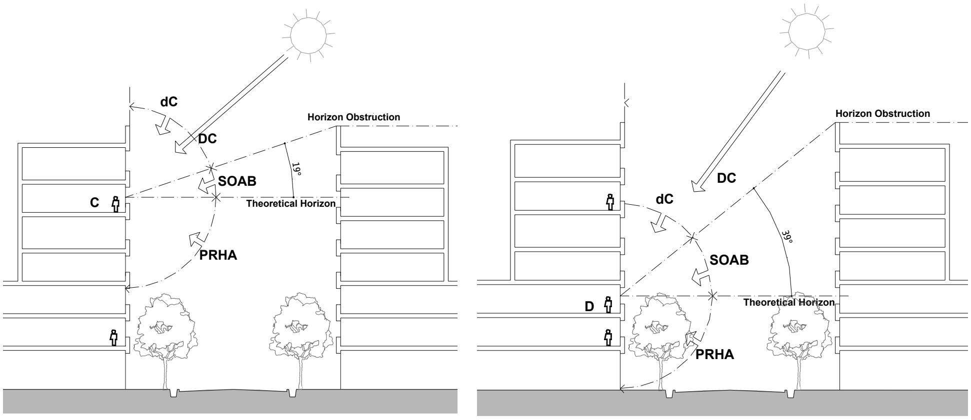
None of the codes regulate morphological homogeneity, trying in this way to avoid shade generated by the height difference between the volumes. Maximum heights are set, but not minimum and, even if stipulated, there are great differences resulting in shade between buildings, see Figure 5.

Fig. 5. Central area of the city of Rosario, Argentina

With the measures established for the gaps between buildings, direct solar radiation affects only the vertical top and does not reach the minimum values of light habitability inside of buildings established by the norms [8].

The application of these indicators gives as result constant obstructions that form a solar mask of uniform height. In Figure 6 there are two cases studied where, although the surrounding environment is the same, the percentage of solar radiation obstruction will be different, given the relative location of the evaluated point..

In the case of a continuous flat obstruction, such as the façade "runs" across the street, or front of building, the maximum sky obstruction would be in the direction perpendicular to the plane, and the strip that hides the sun paths obstructed by the surroundings continues the line of the corresponding angle.



DC: Direct component, dC: Diffuse component, SOAB: Obstructions areas caused by solid components of other buildings.
PRHA: Potentially reflecting horizontal area

Fig. 6. Variation of the incidence of the different components according to the capture's viewpoint

Figure 7 summarizes the continuous obstruction cases corresponding to Figure 6, where it shows the variation of the incidence of an obstacle, constant characteristics and dissimilar positioning situations.

Just to vary the location (9 meters) in the case cited makes the results of sky obstruction percentages vary from 21.11% in the first case to 43.33% in the second.

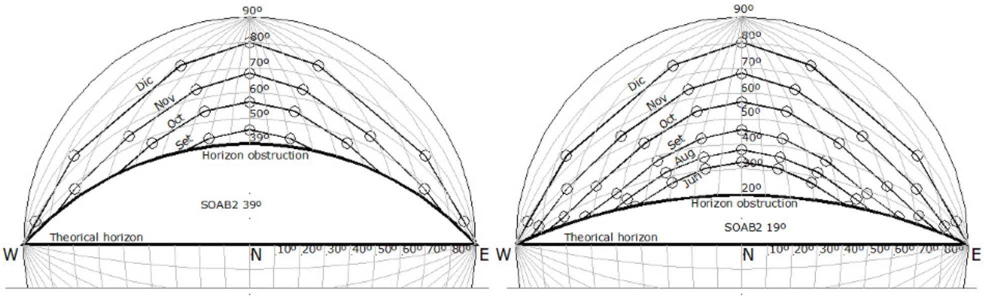


Fig. 7. Mask from the continuous planar obstruction shown in figure 12, for -32º 40’ latitude.

At the time of assessing the impact of these values, it was determined that in the second case, you cannot count on the solar resource throughout the period of higher heating requirements (June to August), and the first and last hours every day of the year, while in the first case, only a reduced uptake before 8.00 a.m. and after 4.00 p.m..

These values are reflected in the actual consumption of the apartment units analyzed. The lower levels of the towers have a mean yearly consumption greater than the higher levels, without considering their exposure (Fig. 8).

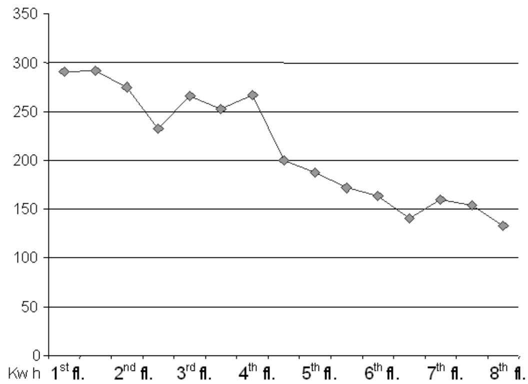


Fig. 8. Comparison of electricity consumption, per floor level of urban buildings of Mendoza City.

The effect of sky vault obstruction on the lower levels, with a mean yearly consumption greater than the higher levels, causes increased values of up to 100%, without the influence of exposure.

Both in the study case of the lateral limits incidence as in the analysis, only in the period between the end of spring and the summer months, do the lower levels of the building receive sufficient illumination.

In all cases analyzed, the availability of light in the lower levels of the buildings, within the limits set by the codes, is poor, and does not cover the minimum habitability requirements established for principal living spaces [9], in the middle of the year.

5. Conclusions

To be able to establish legislation, aimed at securing the growing use of solar energy for heating and natural lighting of interior spaces, and water heating in buildings located in urban centers whatever their densities, is a fundamental step in reversing the current trend of non-efficient energy growth of cities.

Basic guidelines appear from the analysis that should be incorporated into a model regulation that preserves the use of renewable energy in urban centers, as a complement to the Zoning and Land Use, Splits and Urban Construction Codes.

These aspects can be synthesized:

- To maximize the use of the solar resource providing the location, geometry, orientation and inclined planes with height, slope orientation and appropriate to the purpose of the building.
- To minimize interference from sunlight to a similar building in the surrounding land.
- To establish plot guidelines in subdivisions, street orientation and green areas, to guarantee unrestricted insolation conditions to buildings.
- Definition of urban morphology according to the climatic conditions of the geographic location.

All these considerations fall within the regulatory powers handled by the municipalities through their legislation, which should aim at preserving the best living conditions in built spaces and not respond to real estate market demands, as often happens.

The city management organisms should expand the requirements of the CUPCs with respect to building orientation, allowed minimum withdrawals, hours of sunlight needed for the main rooms, minimum and necessary protection measures for windows, and also establish necessary impediments so that the right to the sun, can become a vested right conditioning other buildings.

Assessing the theoretical studies and existing legal and legislative history in Argentina, it can be determined that the necessary tools do exist in order to implement a policy of preserving the right to the use of solar resources in urban environments. Coordination between the various government entities involved is critical, as each one has different legal tools, toward making the use of solar energy a practical reality.

In Argentina the existing legal framework and technical studies justify the enactment of the law to preserve free access to solar resource. However, to achieve this it is paramount to rely on the declared willingness of intervening government entities and on a reinterpretation of certain sadly outdated regulations from the beginning of the 20th century that do not serve the pursuit of a renewable resource in the present and for future generations.

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