

ABSTRACT

Title of Thesis: ENERGIZING SUSTAINABLE LIFESTYLES

 Florencia Sahaniuk, Master of Architecture
 2017

Thesis Directed By: Clinical Associate Professor, Michael Ambrose,
 Architecture

The decrease in energy costs to the population of Buenos Aires has increased the consumption of energy and the lack of investment in the infrastructure of the electric grid has caused for the province of Buenos Aires to experience constant blackouts in the built environment. The major blackouts have been seen within the Autonomous City of Buenos Aires, where the urban fabric is extremely dense and where the residential areas are consuming large amounts of power during the summer months, December to March, while the energy infrastructure keeps deteriorating and cannot handle the demand of energy. This thesis aims to aid the barrio of Caballito by searching for an architectural solution in the residential realm to alleviate the impact of the blackouts. Caballito, has experienced the most issues with power and while it is away from the tourist areas, it remains very well connected through public transportation and is surrounded by essential amenities that allow for a sustainable lifestyle to be implemented.

Energizing Sustainable Lifestyles

by

Florencia Sahaniuk

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Master of Architecture
2017

Advisory Committee:

Michael Ambrose, Clinical Associate Professor, chair

Brian Kelly, Professor

Steven Hurtt, Professor

© Copyright by
Florencia Sahaniuk
2017

Preface

This thesis began focused entirely on the major blackouts happening in the Autonomous City of Buenos Aires and hoping to figure out a way to find a design solution to operate off the grid. The extensive energy modeling with the use of Green Building Studio and Sefaira, did not prove to be sufficient evidence to justify some design decisions but the research concerning the existing typology and culture of the city has brought to the surface an issue dealing with the social realm of sustainability. These findings pushed this thesis to analyze and respond to the vernacular in a way that would create a new infill typology, benefiting the public and private zones of the building whilst connecting back to the city.

Acknowledgements

I would like to thank

Michael Ambrose

Brian Kelly

Steve Hurtt

For their continuous mentorship, guidance and help through the whole thesis process and all my years at the University of Maryland.

My family

For all their support and love through the ups and downs of the architecture life.

Friends

For being there constantly at our best and worst, through the all nighters and the celebrations.

Table of Contents

Preface.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Figures.....	vi
Chapter 1: Introduction.....	1
Infrastructure Issues.....	1
Background.....	1
Energy Infrastructure Issues.....	1
Energy and Architecture Problems.....	3
Chapter 2: Site Search.....	6
Buenos Aires, Argentina.....	6
Autonomous City of Buenos Aires.....	9
Dense Urban Fabric.....	10
Connectivity Through Transportation.....	11
Energy.....	12
Caballito.....	15
Green Spaces.....	17
Transportation.....	24
Bus Transportation.....	25
Subway Transportation.....	26
Bicycle Paths.....	29
Transportation Overview.....	30
Land Use.....	31
Amenities.....	32
Educational Institutes.....	35
An Immediate Site.....	36
Existing Typology.....	38
Chapter 3: Precedents.....	43
Precedent Selection Criteria.....	43
Background.....	43
Reimagining the Balcony Condition.....	48
Hanging Gardens Tower.....	48
The Oliv.....	52
Energy Efficient Strategies.....	54
The Sol Lux Alpha Apartments.....	55
Edificio Construcciones 14.....	57
Plaza Real.....	59
Chapter 4: Program.....	61
Existing Typology.....	61
Towers.....	61
Mid Height Apartment Buildings.....	62
Ground Floor.....	64
Interior Street.....	64

Commercial Store	65
Lobby	65
Lounge	65
Apartments	66
Mudroom/Entry.....	68
Kitchen.....	69
Dining Room.....	70
Living Room.....	70
Balcony	71
Bedroom.....	71
Amenities	72
Lobby	72
Fitness Center.....	73
Chapter 5: Design.....	74
Culture and Weather	74
Light wells	75
In context.....	75
Proposed Light wells.....	76
Connection to the Lung of the Block.....	78
Existing v. Proposed	79
In context.....	79
Daylight Analysis.....	81
Unit Comparison.....	81
Proposed Building.....	83
Ground Floor.....	83
Amenities Floor.....	87
Typical Residences Floor.....	88
Passive Strategies.....	89
Passive Cooling.....	89
Passive Ventilation.....	90
Passive Solar Strategies	91
Active Strategy.....	92
Conclusion	92
Bibliography	94

List of Figures

Figure 1: Comparison of Energy Demands in Argentina from 2012-2015 (CAMMESA).....	7
Figure 2: Argentina in Context (Author, Underlay: Google Earth).....	8
Figure 3: Buenos Aires Province Location (Author).....	8
Figure 4: Autonomous City of Buenos Aires in Context (Author).....	9
Figure 5: Barrios of the Autonomous City of Buenos Aires (Author).....	9
Figure 6: Dense urban fabric through small blocks and network of streets (Author). 10	
Figure 7: Urban Fabric (Google Earth).....	10
Figure 8: Multi Modal Connectivity to Tourist Zone via Public Transportation (Author).....	12
Figure 9: Energy providers to the city (Author)	12
Figure 10: Energy providers to the city (Author)	13
Figure 11: Average number of blackouts per neighborhood in 2013 (Author, Info: Aca No Hay Luz)	14
Figure 12: Caballito within the context of the city (Author)	15
Figure 13: Caballito blocks organization (Author)	16
Figure 14: Green spaces in Caballito (Author)	17
Figure 15: Major Green Space in Palermo (Google Maps)	17
Figure 16: Small green space as a part of educational building (Google Earth)	18
Figure 17: Pocket park with short surrounding fence at intersection (Google Earth) 18	
Figure 18: Large public green space with integrated pedestrian paths (Google Earth)	19
Figure 19: Air Conditioning Units on Facade (Author).....	20
Figure 20: People Enjoying Public Spaces, Parque Rivadavia (Author).....	21
Figure 21: Estación Saludable (Health Station) in Parque Rivadavia (Author)	22
Figure 22: Workout Groups in Parque Rivadavia (Author).....	23
Figure 23: Parks Enclosed by Fence Closed at Night (Author).....	23
Figure 24: Traffic patterns (Google Maps).....	24
Figure 25: Bus stops and Paths (Author)	25
Figure 26: Buses Stopping for Pedestrians (Author)	26
Figure 27: Subway Stops and Paths (Author).....	27
Figure 28: Subway Entrance in Caballito (Author)	28
Figure 29: Bike Paths and Future Implementation (Author)	29
Figure 30: Protected Bike Lanes (Author).....	29
Figure 31: Transportation overview (Author).....	30
Figure 32: Land use map demonstrates high density residential as primary zone (Author).....	31
Figure 33: Location of Police Stations, Hospitals, and Supermarkets (Author).....	32
Figure 34: Carrefour Express Market (Author)	33
Figure 35: Local Produce Market (Author)	34
Figure 36: Higher education and public k-12 school (Author).....	35
Figure 37: Potential site selection (Author)	36
Figure 38: Possible Site Location Elevation (Author; Underlay Google Maps)	37

Figure 39: Block organization around 1928 (Author)	39
Figure 40: Introduction of a Lung of Block, 1945 (Author)	40
Figure 41: Introduction of Tower Typology (Author)	41
Figure 42: Caballito Mix of Blocks (Google Maps)	42
Figure 43: Heavy Concrete Facades (Google Maps)	44
Figure 44: Aerial View of Block, Light Wells and mini Patios within Lung of Block (Author).....	45
Figure 45: Balconies are often Personalized (Author).....	46
Figure 46: Apartments Shut Out Sun and Light from Inside Spaces (Author).....	47
Figure 47: Hanging Gardens Tower (Archdaily)	48
Figure 48: Vegetated Balcony Diagram (Author).....	49
Figure 49: Narrow Street Edge Conditions, Residential or Mixed Use (Author).....	50
Figure 50: Wide Street Edge Condition, Residential or Mixed Use (Author)	51
Figure 51: The Oliv Facade (Architecture.sg.wordpress.com)	52
Figure 52: Different Facade Approaches (author)	53
Figure 53: Different Balcony Conditions (Author).....	54
Figure 54: Sol Lux Alpha (solluxalpha.com).....	55
Figure 55: Edificios Construcción 14 in Mendoza, Argentina (Diariovox)	57
Figure 56: Plaza Real Apartments (Ultima Hora).....	59
Figure 57: Palermo Uno Tower's Vast Lot (Author)	61
Figure 58: Mid-Height Apartment Buildings (Author).....	62
Figure 59: Newly Implemented Trashbins with Time to Take Out Trash (Author)...	63
Figure 60: Ground Floor Design Options (Author)	64
Figure 61: Different Ground Floor Conditions (Google Maps).....	64
Figure 62: Possible Floor Layouts and Typical Plan (Author)	66
Figure 63: Mid-rise Apartment Building with Multiple Units per Floor (Google Maps)	67
Figure 64: Single Bedroom Apartment Program Components (Author)	68
Figure 65: Adjacency Diagram of 2BR Program (Author).....	70
Figure 66: Typical Floor Layouts with One Light Well (Author)	72
Figure 67: Weather description (Author).....	74
Figure 68: Light-wells in Context (Author)	75
Figure 69: View up existing light well (Author).....	76
Figure 70: Existing versus Proposed Site (Author)	77
Figure 71: Existing versus Proposed Connections to Lung of Block (Author)	78
Figure 72: Existing v Proposed North Side of Block (author).....	79
Figure 73: Existing v Proposed North Elevation (Author)	79
Figure 74: StreetSide Ground Floor Conditions (Author)	80
Figure 75: Diagrammatical Proposed Elevation (Author)	80
Figure 76: Existing v Proposed Daylight Analysis (Author)	81
Figure 77: Existing v Proposed Typical Unit (Author).....	82
Figure 78: Front View from El Maestro Street (Author).....	83
Figure 79: Interior Street Floor (Author)	84
Figure 80: Interior Street View (Author)	85
Figure 81: Back Patio View (Author).....	86
Figure 82: Amenities Floor (Author).....	87

Figure 83: View of Lightwell from Amenities Level (Author)	87
Figure 84: Typical Residences Floor (Author)	88
Figure 85: Passive Cooling Strategies through the Balcony and Flush Facade (Author)	89
Figure 86: Green Roof Detail (Author).....	89
Figure 87: Green Roof Rendering (Author).....	90
Figure 88: Passive Ventilation Strategies through Unit & Building (Author).....	90
Figure 89: Passive Solar Strategies through Solar Panels (Author).....	91
Figure 90: Passive Solar Strategy through Solar Water Tubes (Author).....	91
Figure 91: Radiant Flooring as Active Strategy (Author).....	92

Chapter 1: Introduction

Infrastructure Issues

Background

A major issue that cities around the world are facing is the constant population growth. The vast increment of people has currently exceeded 7.3 billion and is projected to be around 9.3 billion by 2050¹. This rapid growth poses many implications in relation to the built environment and its infrastructure. The Urban Land Institute has recently brought to the surface how the United States has undergone decades of underfunding as well as limited investment, which have had an adverse reaction in the systems that allow the country to keep on functioning. These systems include transportation, energy, water, logistics, and communication.

The constant improvement of these systems is critical to sustain positive economic growth and to serve a quickly expanding population. Infrastructure of a country is the vital and essential foundation in running of a country as well as keeping a global competitiveness against other countries and ensure future prosperity.

Energy Infrastructure Issues

Buenos Aires, Argentina has been facing many problems due to the skewed investment in infrastructure by the city government from the 1990s. While the Kirchners, Nestor and his Wife Cristina, were in the presidency, the business climate

¹ “U.S. and World Population Clock.” United States Census Bureau, last modified January 20, 2017, accessed September 28, 2016, <http://www.census.gov/popclock/>.

was unfavorable, which has produced large setbacks in the energy sector of the country in the last several year. There has been a major drop in the production of energy although the energy demands continue to increase at a fast pace. The decrease of energy related investments had created a restriction in the economic growth and the inability to attract external investments². The energy sector was one of the weakest and managed poorly in the past decade, in fact the infrastructure was found to be extremely deteriorated and creating major deficits in energy production. Alongside this there were major irregularities in external commerce, subsidies that were not only arbitrary but bulky as well and lastly a major notorious crisis in the provision of energy.

Tariffs of the electricity had been frozen for over a decade and with the addition of major inflation. Between the years of 2001 and 2012 the residential electricity tariffs significantly decreased 80% and the artificially low prices led to an exponential increase in consumption, creating a fall in the production of energy. During 2003 to 2015 the consumption of electrical energy grew by 58%, natural gas by 41% and gas 153%. In 2003 to 2014 a major stock was lost which was equivalent to two years of production of oil and more than nine years of gas production³. This completely deteriorated the services and major cuts in the provision of gas and major blackouts of electricity occurred in the metropolitan region of Buenos Aires, from 8.3 hours per home in 2003 to 32.5 hours per home, in average, in 2015⁴.

² “Energía y Minería,” Casa Rosada Presidencia de La Nación, last modified December 2015, accessed November 5, 2016, <http://www.caserosada.gob.ar/elestadodeleestado/energia.html#energia>.

³ Casa Rosada Presidencia de La Nación, “Energía y Minería.”

⁴ Casa Rosada Presidencia de La Nación, “Energía y Minería.”

Through these significant troubles Argentina lost its self-sufficiency in energy, the production fell while the consumption increased, in turn reducing the exports and increasing the imports, leading to a major deficit of 5 million dollars in 2015 from a surplus of 4.9 million dollars in 2003. Allowing the energy related politics to be part of the many causes that caused a halt to exchanging the local money, pesos, to dollars in order to stop the erosion of international reserves in the Banco Central⁵.

The gap in production costs and the artificially low prices of energy were covered by the nation's subsidies that over the years would transform to be the main cause for the fiscal deficit. Between 2007 and 2015 the accumulated subsidies poured into the nation's energy system was over 600,000 millions of pesos⁶. The subsidies were not equally distributed and a large part benefited the middle class of the metropolitan region. According to the foundation for electric development the electric rate paid by users of Edesur and Edenor was seven times lower than the users of the interior part of Argentina, therefore the residential consumption of energy skyrocketed while the deteriorated energy infrastructure was trying to continue providing energy to the city resulting in major blackouts.

Energy and Architecture Problems

As explained above, the massive energy subsidies set in place by the former presidency in Argentina, made the energy prices for the people very cheap. Low

⁵ Casa Rosada Presidencia de La Nación, "Energía y Minería."

⁶ Casa Rosada Presidencia de La Nación, "Energía y Minería."

energy bills led people to consume more and more energy without a care. This started to be seen more drastically during the summer months, where the air conditioning usage was at its highest. As the presidency changed in 2016, Mauricio Macri, the current president, got rid of the energy subsidies and the price of the energy was raised by a 200 to 300%. The costs of energy were kept artificially low through the last decade due to the previous Kirchner presidency when there was a major economic crisis around 2002 and it came to cost about 10% of what it cost in its neighboring countries like Chile or Uruguay⁷.

The increase in energy consumption due to the low costs has caused the old energy infrastructure to collapse and not be able to handle the vast amounts of energy demanded by the people. Everyone is dependent of this energy and many businesses lost money since they were not able to function and residential homes became places that were unbearable to be in. The existing typology of buildings, as explained in the site chapter have minimal contact to the outside environment, through balconies and some only through small windows. The existing architecture is very old from the 1900s and the newly implemented apartment buildings need to have a redesign towards a more sustainable lifestyle. The usage of air conditioning units has become a huge energy problem and there must be more incorporation of natural passive ways to cool, ventilate and light an environment in a dense urban fabric. By searching for

⁷ Veronica Smink, “El “tarifazo eléctrico que causa polémica en Argentina,” *BBC Mundo*, January 27, 2016, accessed October 10, 2016, http://www.bbc.com/mundo/noticias/2016/01/160127_argentina_tarifazo_electrico_vs.

architectural solutions, newer buildings will have a more responsible usage of resources.

The culture of Buenos Aires is very friendly and has come together when there are issues they are against and don't agree with, if people are made more aware of a sustainable way of life it will improve their living. The new government has implemented many sustainable changes for everyday life, for example no more plastic bags given out at stores and only reusable bags you bring yourself, constant reminders and commercials explaining the urgency of keeping the air conditioning at 24 degrees Celsius and what the implications were when consuming too much energy, major blackouts. The city is plastered with billboards of reminders on how to be sustainable. Through architecture, people will be made more accountable and there must be a way to incentivize people to consume less and invest more in sustainable and energy efficient buildings, technology and appliances.

Buenos Aires is a city, where although it is very large, there's a major community that one sees while walking around. It may be the block or facing blocks that could be turned into a sustainable community where it becomes a place where people are held accountable and participate in ways to make their block or street more sustainable.

Chapter 2: Site Search

Buenos Aires, Argentina

When searching for the best site in Argentina, many factors were taken into consideration but the driving one was energy, the demand and consumption. Since the country has been experiencing blackouts in the past 4 years, examining the CAMMESA (the Wholesale Electric Market Management Company) annual reports of energy was the main source when choosing which province to focus on. After reviewing the reports from 2012 to 2015, it clearly stated that the Greater Buenos Aires region (which includes the Autonomous City of Buenos Aires and 24 districts that are included in the make up the province of Buenos Aires) always had the greatest demand in comparison to the other provinces. The Greater Buenos Aires region's demand stated to be 40% while the other provinces had a demand percentage ranging from 3% to 13%⁸, as seen in figure 1. Thus, this thesis shall focus more in depth in the Autonomous City of Buenos Aires.

⁸ “Informes Anuales 2012-15,” CAMMESA, accessed September 2016.

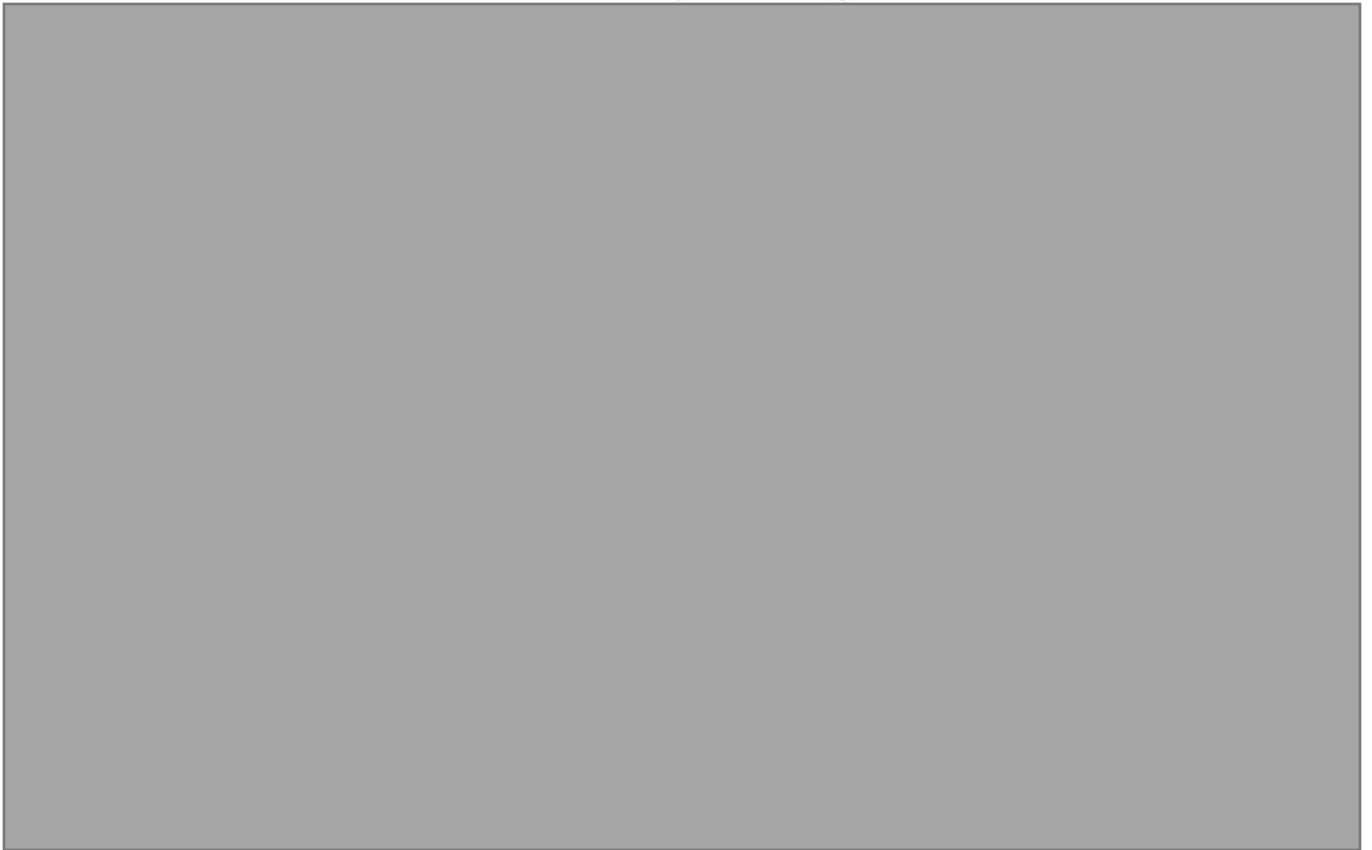


Figure 1: Comparison of Energy Demands in Argentina from 2012-2015 (CAMMESA)

Argentina is a country located in the South American Continent, as seen in Figure 2, and shares a border with Chile, Bolivia, Paraguay, Brazil, and Uruguay. The South of the Atlantic Ocean flanks the right side of the country, providing connections to export and import activities.



Figure 2: Argentina in Context (Author, Underlay: Google Earth)

The country is composed of 23 provinces and the province of Buenos Aires has the Autonomous City of Buenos Aires, a major metropolitan city.



Figure 3: Buenos Aires Province Location (Author)

Although the Autonomous City of Buenos Aires is a small part of the province, it contains the largest part of the population. The city is a major metropolitan region that one could relate back to New York, Boston or Chicago.

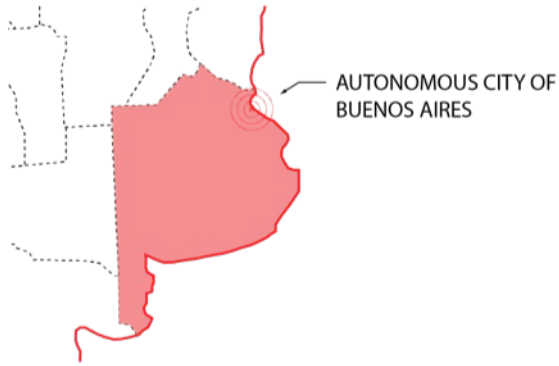


Figure 4: Autonomous City of Buenos Aires in Context (Author)

Autonomous City of Buenos Aires



Figure 5: Barrios of the Autonomous City of Buenos Aires (Author)

Considering the city, which is comprised of 40 barrios (neighborhoods), mapping out different factors that make up the city is of great importance to figure out where the site would lie.

Dense Urban Fabric



Figure 6: Dense urban fabric through small blocks and network of streets (Author)

The city is composed of small blocks that create a very dense urban fabric (Figure 6). This provides a more fluid and direct connection from barrio to barrio. The small blocks create a fine street grid pattern that becomes easy to navigate. Intersections are smaller and even closer together, aiding the walkability due to the intersections being smaller and closer together. One can start to see where the more commercial areas lie by the implementation of wider streets. Where the commercial zones lie, you can notice the street grid become more rigid street grid, (Figure 7).



Figure 7: Urban Fabric (Google Earth)

There is very little variation in block size and when there is, it is almost always a type of public space, whether a green space or a plaza. The smaller blocks allow for more intersections and as a result slower traffic and safer pedestrian paths. Not only are the blocks small but also the buildings within. A group of blocks is composed of a conglomeration of buildings that are not uniform in shape or size or even façade. Whether residential or mixed use, the street front is always narrow but they strategically maximize their lot by building all the way into the center of the block and sometimes they leave a courtyard in the middle of the block.

Connectivity Through Transportation

The extensive network of public transportation in Buenos Aires is due to the high population density. Through the exploration of all modes of transportation one can see how important the network of bus lines is since it provides a connection to the Greater Buenos Aires region outside the Autonomous City of Buenos Aires. This allows for people outside of the city to be able to come in for work, events or commercial reasons. There are almost 200⁹ bus lines that run all day long with no set times, but their constant frequency is guaranteed.

⁹ “Colectivos,” Buenos Aires Ciudad, accessed November 2016, <https://turismo.buenosaires.gob.ar/es/article/colectivos>.

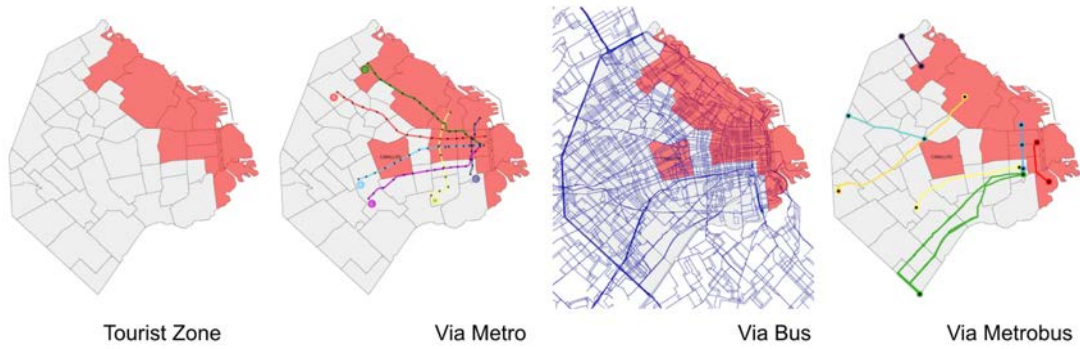


Figure 8: Multi Modal Connectivity to Tourist Zone via Public Transportation (Author)

Public transportation is a major characteristic in this urban environment that provides connectivity between the barrios (Figure 8). Through the mapping of the transportation one can see where the central hub of the city is. The easternmost side is where most of the bus lines and metro lines converge. This clearly depicts that the convergence area is a popular destination and it happens to be the most touristic and commercial region. The touristic region is composed of Palermo, Recoleta, Retiro, Puerto Madero, San Telmo, and La Boca.

Energy

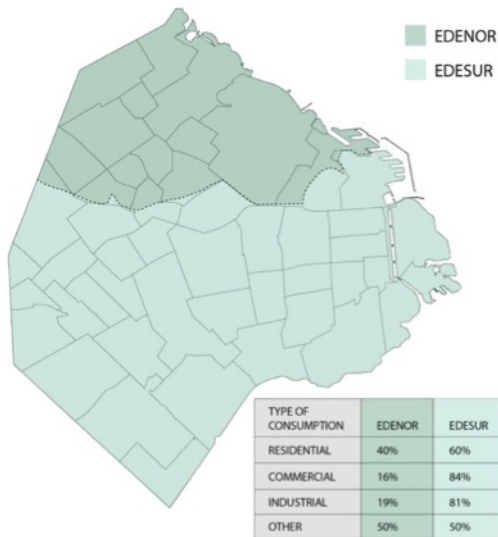


Figure 9: Energy providers to the city (Author)

Buenos Aires's energy system is comprised of three different companies, ones that generate the energy, ones that transport the energy and ones that distribute the energy. There are two energy distributor companies, Edenor and Edesur, which supply energy to the Autonomous City of Buenos Aires. The major issue this thesis seeks to address is the lack of energy in the city's built environment. The energy demand in the country has stayed constant as seen in Figure 9, but as the years go by the infrastructure keeps getting older with no outlook for improvement in the near future due to the lack of investment.



Figure 10: Energy providers to the city (Author)

The blackouts occur during the summer months, December to March. The CAMMESA annual reports clearly depict that during those months the demand for energy is the highest of each year, 2012 to 2015, more specifically in the residential buildings. Due to the constant blackouts, the media coverage was the main outlet to identify which barrios were without power, not only this but also the social media

realm, like twitter, was a major resource. A group formed a site called “Aca No Hay Lúz”, which means, “There is no light here”, where people could report this information and it is the only source of data concerning the blackouts that one can find and access.

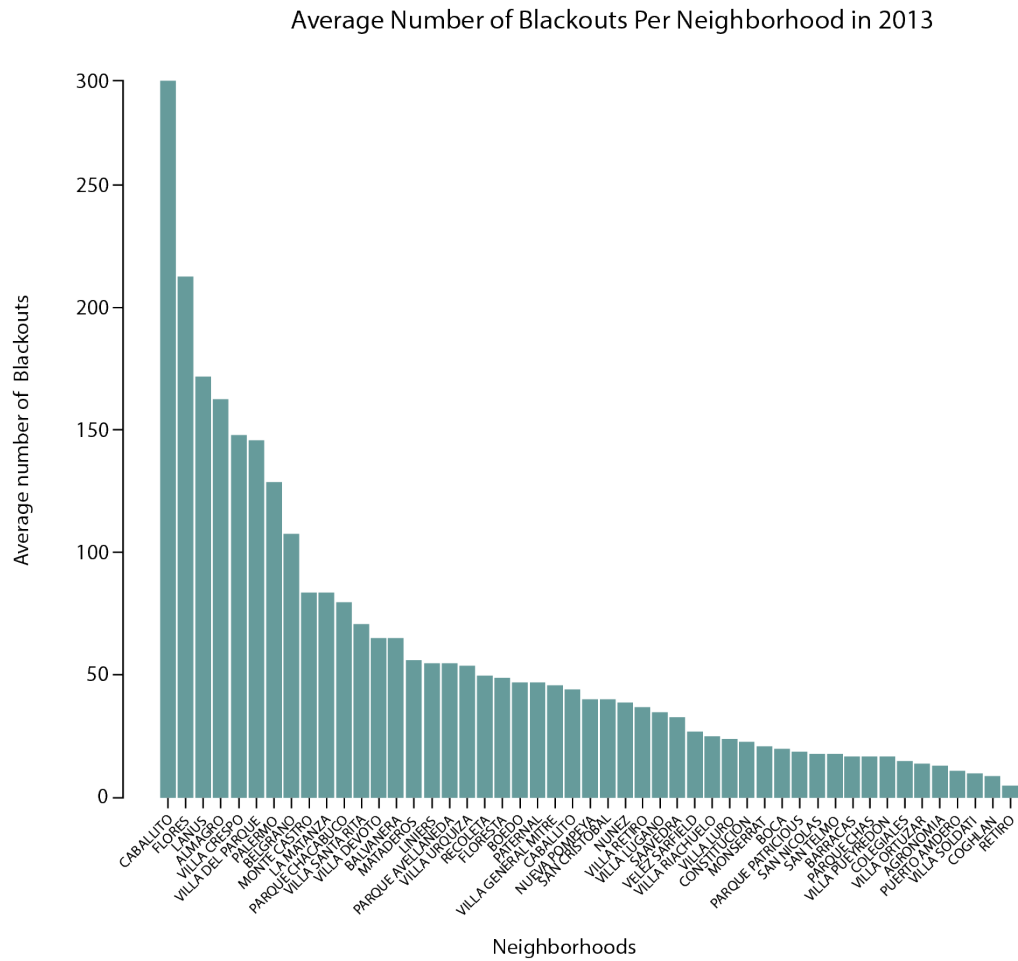


Figure 11: Average number of blackouts per neighborhood in 2013 (Author, Info: Aca No Hay Lúz)

As shown by Figure 11, all the barrios in the city were affected by the blackouts, a few more than others and through this information, Caballito has been the most affected in a dramatic manner in comparison to the other barrios. Due to the great impact of blackouts in Caballito, this thesis will focus in analyzing this

neighborhood in order to find a site and alleviate the pressure the residential areas are facing.

Caballito



Figure 12: Caballito within the context of the city (Author)

Caballito, or “Little Horse”, owes its name to a grocery store from 1804, which displayed a little horse as a weather vane that would indicate the direction of the wind¹⁰. This neighborhood began its development at the arrival of the railroad through the middle of it. While currently it is a mainly residential zone, it used to be a luxury neighborhood for vacationing during the weekend, along the current Rivadavia Avenue¹¹. In fact, Parque Rivadavia is where a well-known country house used to be and now lays a rather large park.

¹⁰ “Caballito,” Buenos Aires Ciudad, accessed September 2016, <http://www.buenosaires.gob.ar/laciudad/barrios/caballito>

¹¹ Buenos Aires Ciudad, “Caballito.”

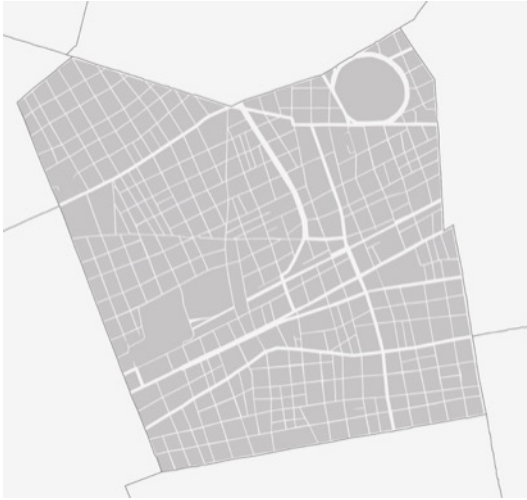


Figure 13: Caballito blocks organization (Author)

As seen in Figure 13, there is a grid organization, not as rigid as seen previously but the majority of the blocks have a constant size, sometimes are halved by a street, that depicts a residential zone, while the large blocks depict large public spaces such as a park, and the medium size blocks or the ones that irregularly shaped and are not following the grid may have an institutional building or a building of importance.

In order to find an optimal site in Caballito, there must be an analysis of what the neighborhood has to offer the community. A neighborhood that offers proximity to green spaces, different types of transportation, more specifically public transportation, to educational institutions, religious institutions and a plethora of commercial resources provides for a more sustainable community. The inclusion of these amenities that a neighborhood can offer allows for a more connected and well-rounded outlet that the residents can enjoy. The search for this site involves keeping in mind that a sustainable residential building or community must be in close proximity to the city's and neighborhood's amenities.

Green Spaces



Figure 14: Green spaces in Caballito (Author)

Caballito is one of the few neighborhoods in the Autonomous City of Buenos Aires that contains numerous green spaces as seen in Figure 14. Other neighborhoods, especially in the more touristic area contain larger green spaces but are usually concentrated in one area, (Figure 15), in the neighborhood of Palermo, where the forest of Palermo is, the Japanese gardens and the botanic gardens are.



Figure 15: Major Green Space in Palermo (Google Maps)

Caballito offers many different types of green spaces that are spread out through the neighborhood. The green spaces vary in size, shape and even organization and program. Although there are many they seem to lack connectivity between each other.

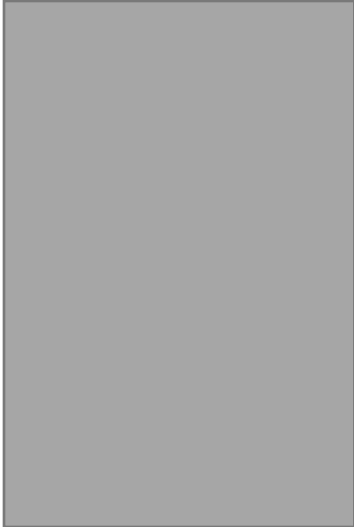


Figure 16: Small green space as a part of educational building (Google Earth)

As seen in Figure 16, some green spaces are considered completely private by being within an educational institution. These spaces are usually well defined by a fence or wall and allows for leisure space for students to enjoy in an urban setting while being able to be supervised and safe.

The next type of green space is set within the existing block and is normally surrounded by a short fence, delineating the public realm of the sidewalk and the more semi-public aspect of the green space.



Figure 17: Pocket park with short surrounding fence at intersection (Google Earth)

As seen in Figure 17, the addition of this type of irregularly shaped green space allows for a break in the built environment, providing the residents with a change in the monotonous dense fabric. The people of the city love to get away from the built environment to enjoy nature, which will be seen in the utilization of the large green spaces.

The larger green spaces, such as Parque Rivadavia, provides the city with a huge amenity that the residents enjoy in various ways. As seen in Figure 18, Parque Rivadavia is more of a planned green space, with many trees, pedestrian paths, open spaces, monuments and even public amenities.



Figure 18: Large public green space with integrated pedestrian paths (Google Earth)

As one visits these green spaces, especially the public ones, there is a sense of community that radiates from these zones. The residents of the neighborhood love to be outdoors, at all times of the day one can see many people enjoying the green spaces. As seen in Figure 19, the residential buildings do not have a central air conditioning unit, and if they can afford they install a small air conditioning unit for a room.



Figure 19: Air Conditioning Units on Facade (Author)

This can become very frustrating to enjoy especially during the summer months, when the heat becomes unbearable. But overall, staying indoors is not what the residents are used to. The people are very social, they love to walk, talk with friends and neighbors, exercise, become connected to nature, enjoy the history of the city by admiring the monument in the public spaces.



Figure 20: People Enjoying Public Spaces, Parque Rivadavia (Author)

The people love to enjoy the outdoor public spaces since they are large and provide a sense of freedom from the dense city fabric (Figure 20), and being cramped in their apartment during the day or weekends is not particularly pleasing. As one sees in the images of the building that are around this area, the lots of the buildings are not that large, therefore the apartments are not particularly spacious and the amenity that the green public spaces provide is a major one.



Figure 21: Estación Saludable (Health Station) in Parque Rivadavia (Author)

The city wants to bring the people to these spaces and they attract them by providing them with free health services. The Estación Saludable, (Figure 21), provides people with medical services that can be done quickly such as measuring their blood pressure or glucose, and this can in turn bring awareness to their health and measure that they can take in order to lead a healthy life.



Figure 22: Workout Groups in Parque Rivadavia (Author)

These spaces also bring a lot of exercise groups, jogging ground and even boot camp style groups (Figure 22). The hectic life of a city dweller may not allow for time or money to be spent in a gym and indoors, therefore the utilization of a public space is well cherished.



Figure 23: Parks Enclosed by Fence Closed at Night (Author)

Lastly, these larger parks are normal opened during the day but closed at night through a fence (Figure 23) that provides a safety measure and protection of vandalism. The protection of these spaces bring awareness to the people that this type of space in an urban setting is a privilege and shall be taken care of to keep on enjoying in the future.

Transportation



Figure 24: Traffic patterns (Google Maps)

After examining the traffic patterns (Figure 24), one can see the dense street grid layout and notice how every street directs traffic only in one direction. This poses a question as to why? Does it alleviate traffic? Does it aid the bus routes? Does it lighten the pressure on pedestrian or bikers? In fact, all of this is true. The one way streets make the flow of traffic more predictable and flows more rapidly. Although the driving is rather reckless and there isn't much organization via car lanes or stop

signs, the predictability of the direction of traffic aids in the safety of the pedestrian and biker.

The public transportation in Buenos Aires is very reliable and cheap. This mode of transportation is used by a large number of people within the Autonomous City boundaries but also by the people coming in from the province of Buenos Aires. Recently there has been an initiative for public transportation to be paid with a SUBE card, which provides a safety measure since paying for the bus, metrobus or subway is now all dealt with a card instead of cash.

Bus Transportation



Figure 25: Bus stops and Paths (Author)

The city is filled with over a thousand bus routes and over a million bus stops (Figure 25). The connectivity that this provides to the people is enormous, especially with the reliability of the schedule and frequency of the buses. Many of the bus lines

use the same stops, providing an organization within many lines of buses. The buses will usually drive on the right side of the road due to the frequent number of stops they make, as seen in Figure 26. Some of the buses provide air conditioning, adding an extra layer of comfortability while using public transportation, especially during the hot summer months, where walking in the hot humidity is unbearable.



Figure 26: Buses Stopping for Pedestrians (Author)

Subway Transportation

Caballito is intersected by subway line A, and in close proximity lies subway line B and E (Figure 27). The subway usage increases yearly, and has seen to increase by 12% in 2015 and is considered the most efficient, quicker and least contaminant mode of public transportation that the people have at their disposal¹².

¹² “Aumentó un 12% la cantidad de usuario que usan el subte a diario” *La Nación*, May 7, 2015, accessed November 2016, <http://www.lanacion.com.ar/1790855-aumento-un-12-la-cantidad-de-usuarios-que-usan-el-subte-a-diario>.



Figure 27: Subway Stops and Paths (Author)

The subway entrances are clearly represented in the street and point out with line letter and color (Figure 28). There is also a lit-up sign that gives information about the other lines and denotes which lines you can transfer to. This allows for people to be up to date on the state of the subway and possibly choose an alternate mode of transportation in case of delays.



Figure 28: Subway Entrance in Caballito (Author)

Not only does the city offer public transportation but also many bike paths. In 2009, protected bike paths started being constructed and have built around 159 km¹³ and future plans for many more. The movement for more bicycle usage has been designed to integrate and connect different points of the city that contain educational institutions, hospitals, touristic zones and other modes of transportation. By implementing ciclovías or bike paths around the city, Figure 31 shows the connection between the two prominent parks vertically through the neighborhood and has three lanes cutting horizontally through it. This allows for many connection through the

¹³ “Pedaleá la Ciudad,” Buenos Aires, accessed November 2016, <http://www.buenosaires.gob.ar/ecobici/pedalea-la-ciudad>.

neighborhood. The city has many plans to keep constructing this bike paths (Figure 29).

Bicycle Paths

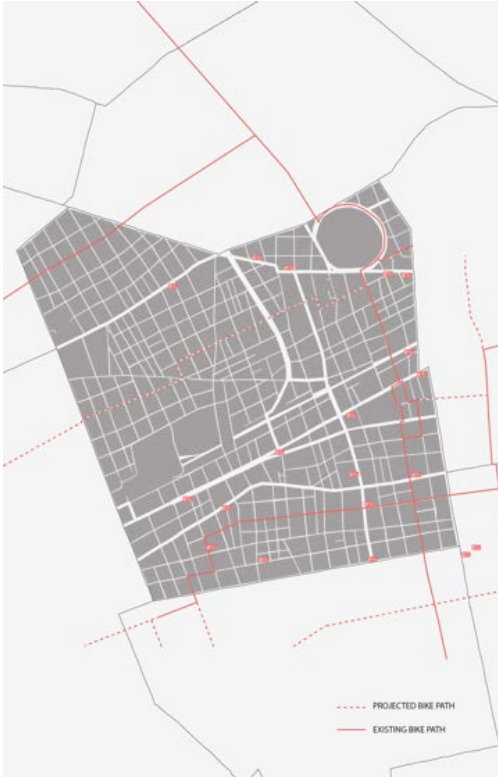


Figure 29: Bike Paths and Future Implementation (Author)

The bike paths that are incorporated into the streets are strategically separated from the vehicular traffic to provide a safe zone where two bikes can safely navigate



Figure 30: Protected Bike Lanes (Author)

the city (Figure 30). The separation of the vehicular traffic keeps the organization and flow of traffic to keep moving without problem. The lanes are usually on the left side of the street and is a two directional lane. There are signs painted on the street to delineate the direction of the lane as well as posts that highlight the separation of lanes from the cars for better signifiers at night time.

Transportation Overview

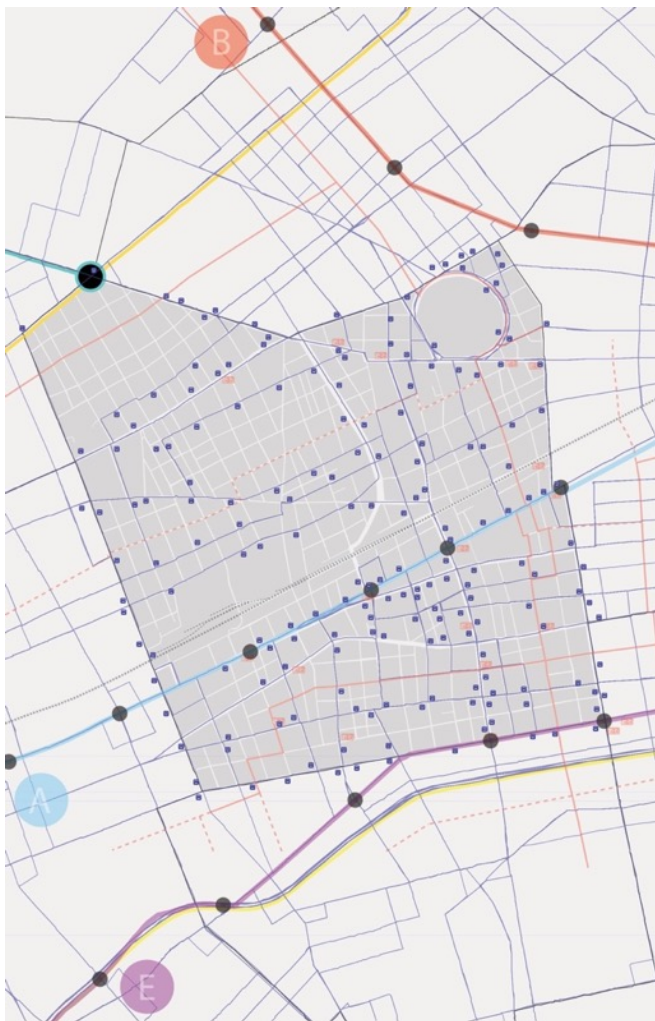


Figure 31: Transportation overview (Author)

As one can see in Figure 31, the interconnection of the metro lines, buses and metrobuses, streets, railroad and bike paths allows for immediate connections from one side to the other through the neighborhood of Caballito and into the surrounding neighborhoods as well. Bicycle paths have become an imperative to implement more in order to lessen the vehicular traffic and be more sustainable. The Metro lines are a great resource to connect back to the more touristic areas of the city of Buenos Aires and a faster one for that matter.

Land Use

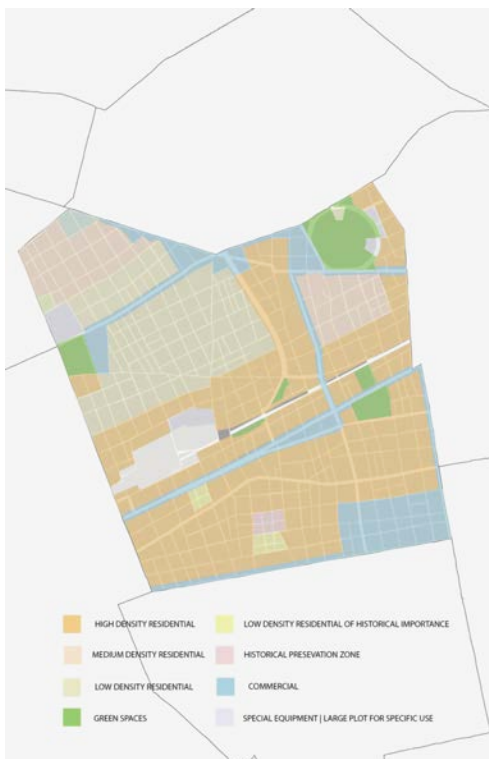


Figure 32: Land use map demonstrates high density residential as primary zone (Author)

The land use in Caballito is separated into residential, commercial, green spaces, historical preservation zone, and special equipment (Figure 32). The residential component is divided by sub categories depending on the density of the residences and then further into high-rise or low-rise. The majority of Caballito is

considered high density residential and along the main avenues the commercial corridor is very apparent. The dense fabric permits for building up and taking advantage of the building lot. The major modes of public transportation are flanked by the high density residential, the orange zone, which speaks to the building typology and how that area may be more populated than the light yellow and light orange zones of medium to low density residential areas. This is a key diagram to consider when picking a site and knowing what the typologies are surrounding the site and what the codes for building are.

Amenities



Figure 33: Location of Police Stations, Hospitals, and Supermarkets (Author)

Although Caballito is heavy with residential zones, it is mostly mixed use. Other factors to keep in mind when searching for a site should relate to the way of life of people and what amenities are necessities (Figure 33). These amenities are essential in an urban setting to lead a sustainable lifestyle. One should not have to drive over 30 minutes to an educational institute, a market, a park, a restaurant, a bar, a retail store, a healthcare facility, or an entertainment area.

The usual typology for the residential apartments includes 3, 7, 10 or even more floors with a small commercial store on the ground floor or a garage that leads to underground parking. This provides the neighborhood with many amenities. The community in the city seek for more convenient ways to shop and will usually rather attend a small privately owned store or “almacen” than a large supermarket, which even the large supermarkets have set up express markets (Figure 34).



Figure 34: Carrefour Express Market (Author)

These commercial stores include produce markets (Figure 35), butcher shops, seafood shops, flower shops, dry cleaners, hair salons and barbershops, locksmiths, hardware stores, kiosks of candy, chips, and drinks, liquor stores, banks, currency exchange stores and more.



Figure 35: Local Produce Market (Author)

The variety of stores available allows for the people to have all their necessities within walking distance rather than far away at a mega store where one would require a vehicle for all their purchases compiled. Many of these stores open early and close late at night to their busy life convenience.

Educational Institutes

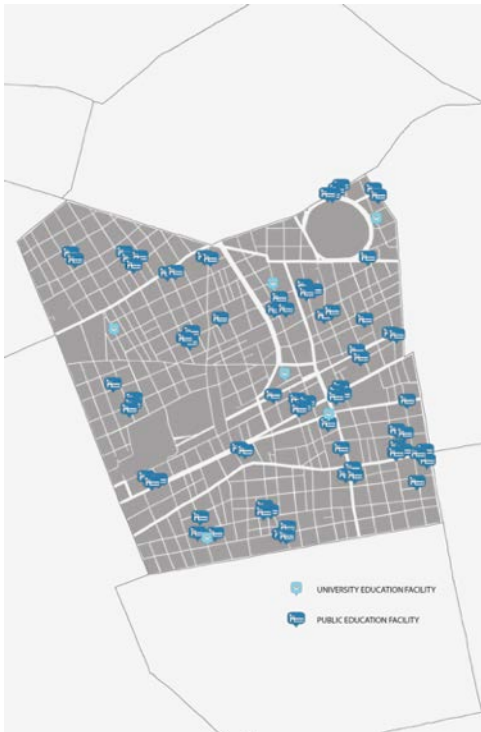


Figure 36: Higher education and public k-12 school (Author)

Caballito's urban fabric is densely populated by a large number of public schools as well as various higher education institutions (Figure 36). When searching for a site for a mixed used residential apartment, one begins to think that not only do users need commercial stores but also educational institutions. Users of all ages may be in need and the intended program for it, being residential, the users may be of all ages and may require the availability to an educational institution at a close proximity. The conglomeration of schools enhances the neighborhood's fabric through the inclusion of different building types and diverse program factors, creating the neighborhood more dynamic in demographics.

An Immediate Site



Figure 37: Potential site selection (Author)

As many of the layers are placed on one another, one can start to see many possible blocks that are nearby amenities as well as public transportation. When zooming in into a block one has to start to consider the orientation of the block. The highlighted block has the advantage of being behind a block that is split in two allowing for sun to penetrate through to the middle of the selected block (Figure 37). One can see the potential of the site to house a residential or mixed use building through the sustainable methods of living. This also creates a threshold to bring

awareness of sustainability in the less touristic areas while keeping the authenticity and history of the neighborhood and what it has to offer. The walking radii clearly demonstrate the walkability of the site and how it can connect directly to almost all the parts of the neighborhood, as seen in Figure 38. This site is not only at a close proximity to the commercial areas but also the green spaces the neighborhood has to offer. Locating the site in a high-density area will allow for immediate access to the public transportation as well as the nearby amenities.



Figure 38: Possible Site Location Elevation (Author; Underlay Google Maps)

Figure 38 represents the possible site on Rosario Street., the site to the left of it could also be used while preserving an aspect of the commercial store. The sun that shines on the site and front façade is due to El Maestro Street providing a tunnel of light, which could be very useful as solar energy. The site is surrounded by 7 floor residential and mixed use buildings as well as flanked by a local market. As you walk

along Rosario Street there are various markets, hair salons and other commercial stores, cafes, restaurants and bars showing a liveliness to the proximate neighborhood.

Existing Typology

Buenos Aires over the years has transformed the relationship between the city and typology of the residential buildings. Thus, the organization of the block has changed as well. The lots within the block have a direct impact on the block organization and determines the typology of the building. Corner lots will clearly have greater exposure to light and ventilation of the main spaces and have become the most desired. On the other hand, lots further into the block are built with a shared party wall and will only allow fewer spaces to receive light and ventilation. This has led to the creation of light wells to allow for main spaces within apartments in the middle of the lot to attain some light.

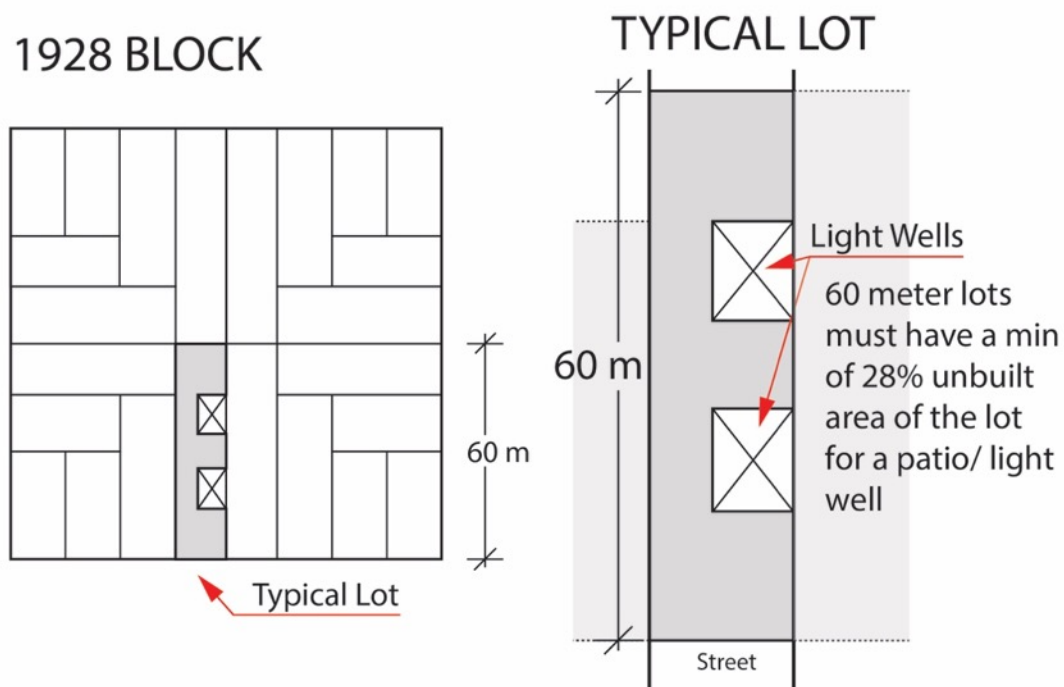


Figure 39: Block organization around 1928 (Author)

The lot dimensions did not determine the urban form or block organization alone, regulations and building codes had a major influence as well. In 1928, the municipal regulations defined the public space, heights and façade characteristics, while allowing the architect the freedom within their lot. The main regulation was the requirement to utilize non-built areas within the block as patios. Of the lot measured 60 meters then 28% of it was required to be open space, each project was given its own freedom to meet that requirement as they saw fit¹⁴ (Figure 39) while being able to build to the middle of the block.

¹⁴ http://www.javeriana.edu.co/viviendayurbanismo/pdfs/CVU_V4_N8-01.pdf

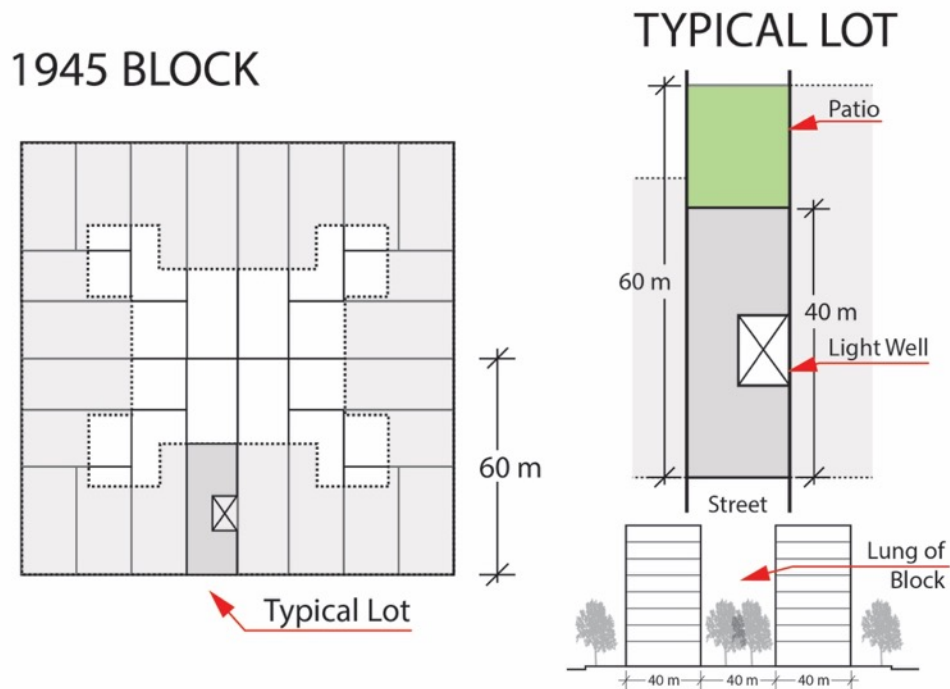


Figure 40: Introduction of a Lung of Block, 1945 (Author)

In 1945, the building code established the concept of “pulmón de manzana” or lung of the block, which enhances the light and ventilation requirements. This mainly affected lots of 60 meters that would reach the middle of the block since now the open space for the lung of the block should be 33% of the lot, meaning that only 40 meters of the lot could be built on¹⁵ (Figure 40). This code made it even more necessary for light wells to be built that would act as tubes of light and air especially as the height of the buildings increased to about 10 floors, and the density of the blocks increased.

¹⁵ http://www.javeriana.edu.co/viviendayurbanismo/pdfs/CVU_V4_N8-01.pdf

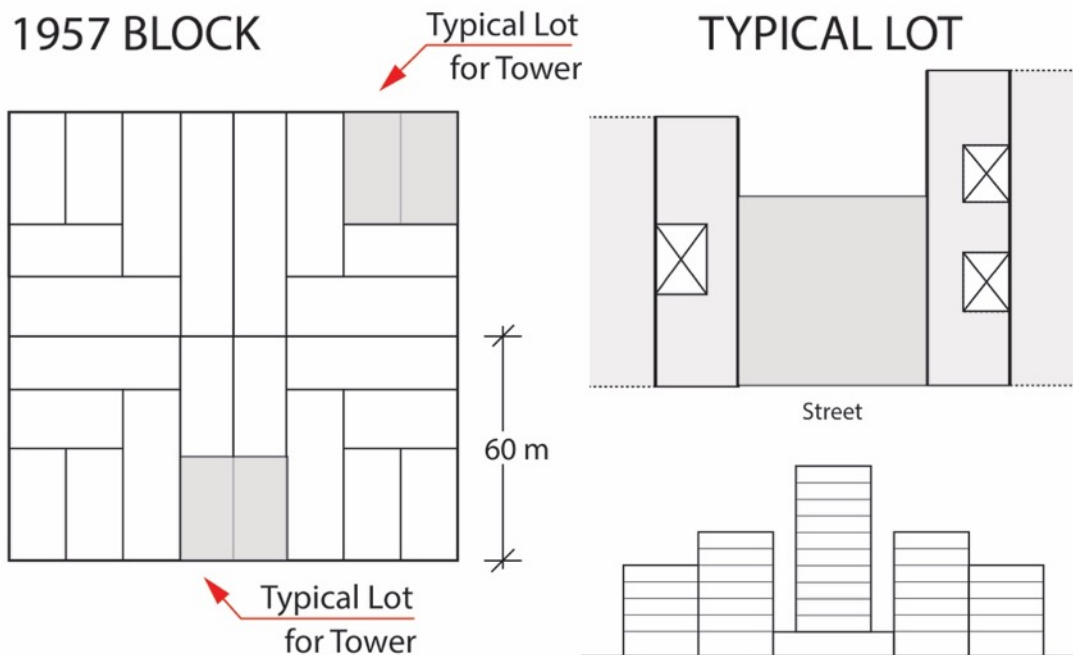


Figure 41: Introduction of Tower Typology (Author)

Lastly, around 1957 there came another modification to the building code where introduced towers, buildings that exceeded the 10 floors in height. These towers required even larger lots to ventilate and provide light to many of the interior spaces¹⁶. The corner lots were ideal for these towers but once they started being built in the middle of the block they required larger ground floor areas and were built on pedestals to provide privacy to lower level apartments and allow for the surrounding buildings to not be overshadowed by such a tall building (Figure 41).

¹⁶ http://www.javeriana.edu.co/viviendayurbanismo/pdfs/CVU_V4_N8-01.pdf



Figure 42: Caballito Mix of Blocks (Google Maps)

As one analyzes an aerial view of the neighborhood of Caballito (Figure 42), there is a clear depiction of the transformation of the block typologies that were explained above. Understanding the organization of the block and typology of the buildings is important to understand the ventilation and lighting of the interior spaces as well as the program that is within these buildings.

Chapter 3: Precedents

Precedent Selection Criteria

Background

“Solar radiation is the primary source of renewable energy. Besides offering a direct source of energy, it drives the Earth’s climate creating opportunities to draw energy from wind, waves, tidal (together with the moon) and a host of biological sources...Since the sun drives every aspect of the climate it is logical to describe the techniques adopted in buildings to take advantage of this fact as ‘solar design’.”¹⁷

Passive solar design utilizes solar gain to its advantage and the access to solar radiation is determined through the sun’s position in relation to the building’s principal facades, the site orientation and slope, the existing obstructions on and around the site as well as overshadowing¹⁸. The residential zones in Caballito, Buenos Aires are comprised of older apartment buildings that have been built a before and after the 1920s. This informs how old construction methods that were used which led to the lack of efficiency of the building performance

¹⁷ Peter F. Smith, *Architecture in a Climate of Change* (Oxford: Architectural Press, 2005), 45

¹⁸ Smith, *Architecture in a Climate of Change*, 45.

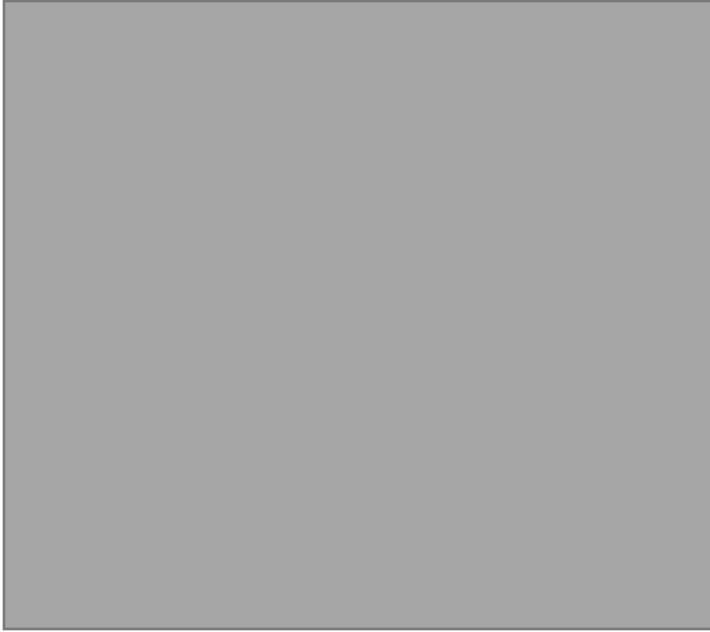


Figure 43: Heavy Concrete Facades (Google Maps)

The city has forever been a built out of cmu blocks, concrete and brick¹⁹ have provided high thermal mass and insulation, by keeping the inside cool in summer days and warm at nights while during winter the absorption of heat helps to keep in the solar heat. On the other hand, the residential apartment's heavy building methods have on the created a lack of transparency to the outdoors, there is a lack of views from the inside out (Figure 43), from the party wall.

The usage of party walls has also played a major role in the development of a block. The tight knit buildings share these walls keeping them from being open facades. Most of these buildings have light wells as explained in the site chapter which allows for air and light to travel to the lower levels (Figure 44), especially since the heights of buildings are at a similar point, blocking light from many interior spaces. These light wells allow for the building to have more apartments while

¹⁹ Güiraldes, Pablo, Interview Meeting, January 4, 2017.

providing some light. Many residents of these buildings have expressed the lack of connection to the outdoors. Some of these only have two windows that come from the light well and even that gets dark quick for the lower levels.



Figure 44: Aerial View of Block, Light Wells and mini Patios within Lung of Block (Author)

Another major implication is the balcony design. These balconies extrude about 4 m and are not very pleasing. The balcony is a privilege amenity and many apartments within a building don't have them. The balcony most of the times is on the front façade facing the street but some buildings may have ones facing the interior of the block. This is the only connection to the natural environment within a very urban city. The balcony is an extension of the living areas and should make one feel comfortable and at home but also not completely excluded from their surrounding environment (Figure 44).



Figure 45: Balconies are often Personalized (Author)

Examining the typology of building and the facades that are in the Caballito area, they usually have a metal railing that goes up half way and the residents will usually personalize them, most of the time for protection and add either metal extensions of the railing all the way to the balcony above or simply a net as a protection from birds (Figure 45). The balcony is also the main area that houses the air conditioning unit that will usually drip water down to the sidewalk below and falling on people. This begins to spark a few aspects that ought to be reimagined on

how they are designed, the balcony can become a more pleasant living area that utilizes the daylight and helps to bring it indoors in a passive manner.



Figure 46: Apartments Shut Out Sun and Light from Inside Spaces (Author)

Nowadays, in the summer time, the residents will lower blackout plastic or wooden shades (Figure 46) to reduce solar heat gain that is produced from the blaring sun. The sun, as a natural resource could become utilized in a more advantageous way rather than shutting it out completely. This type of shading makes the interior spaces very dark and lack natural light and ventilation, making the usage of electricity higher for lighting.

Reimagining the Balcony Condition

Hanging Gardens Tower

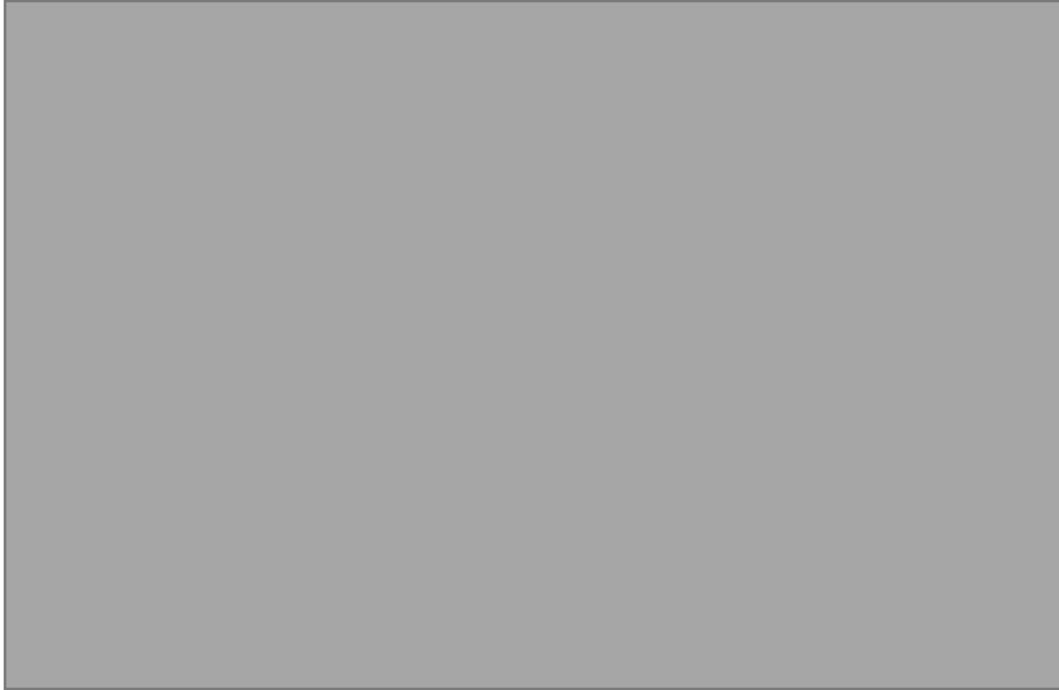


Figure 47: Hanging Gardens Tower (Archdaily)

Copenhagen's Studio LOKAL recently won a competition for a design of residential towers that promotes the use of the balconies to bring vegetation to the residences. The tower is located on a former vegetable market and therefore attempts to maintain the environmental aspect that the site was previously known for.

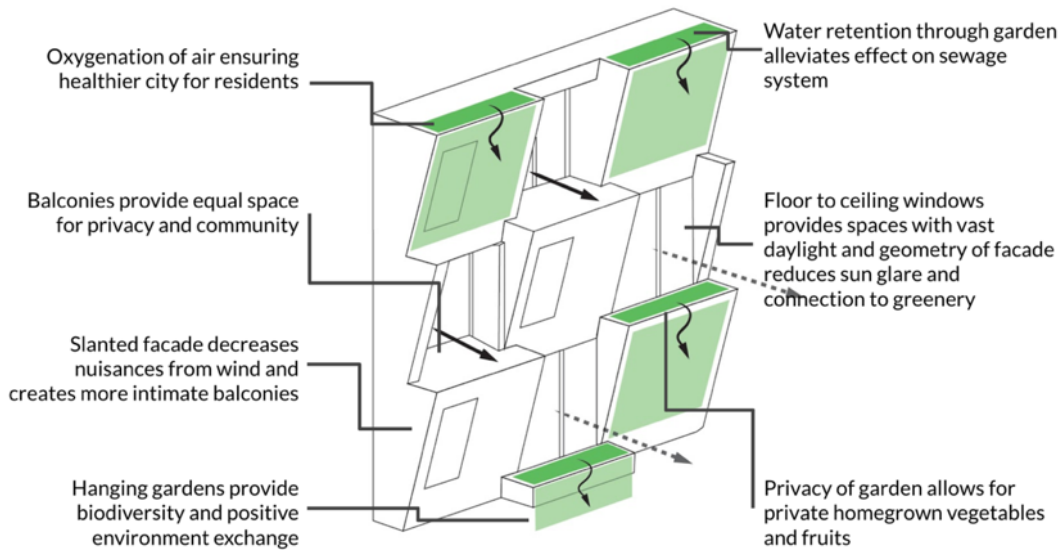


Figure 48: Vegetated Balcony Diagram (Author)

The residents are encouraged to grow and maintain a vegetated space that could even be used to grow their own produce, as shown in Figure 48. The gardens also handle rainwater and attempt to retain it rather than completely allowing it to run down the façade. The addition of green becomes a visually pleasing view to the outdoors, whether there is an actual balcony or simply large windows that allow for ample views out and sun and daylight in. The addition of green truly emphasizes the production of oxygen, creating a better air quality and comfortability.

The residential spaces are enhanced through the balconies but the Hanging Garden Tower also takes into consideration the many edge conditions that could happen at ground level on the street edge, both the narrow and the wide edge condition explore the possibility of having residential at the ground level or mixed use and have an addition of commercial to the ground level program.

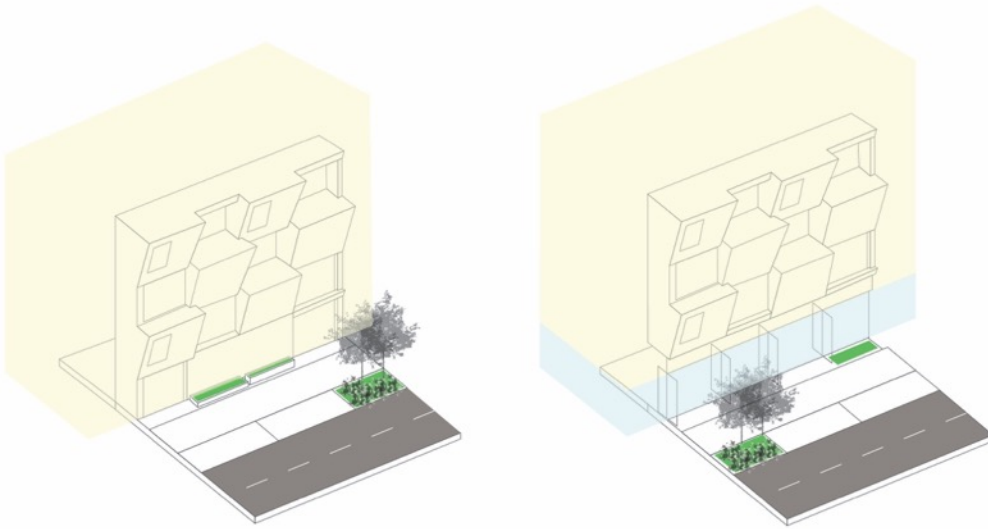


Figure 49: Narrow Street Edge Conditions, Residential or Mixed Use (Author)

The narrow street edge condition, as seen in Figure 49, allows for a series of narrow layers that include the pedestrian and vehicular zones. The vegetated zones help to buffer the transition from the interior of the residence or the commercial zone into the public realm outside. The addition of parallel parking with vegetated slots aids in a safeguard from cars to be able to cross or even walk parallel to the traffic.

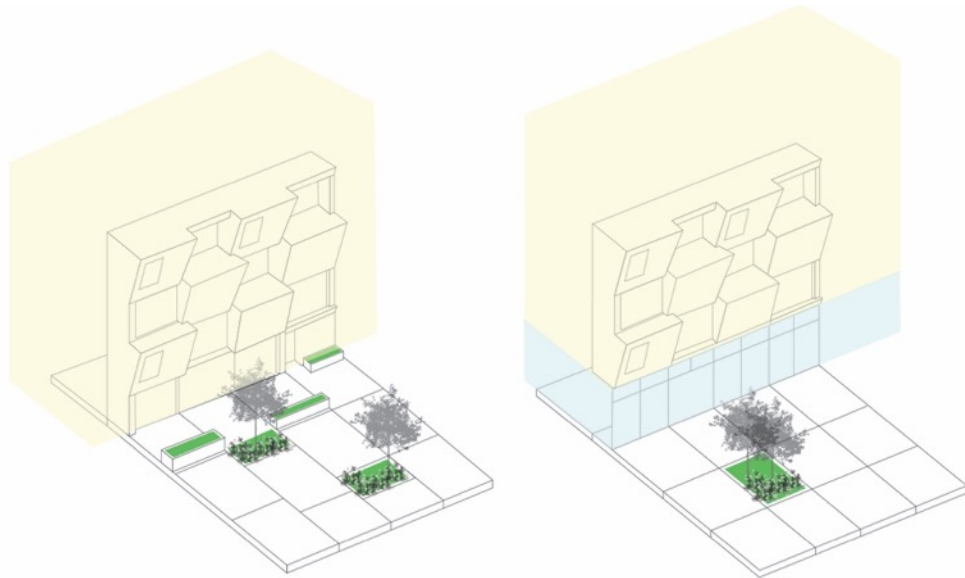


Figure 50: Wide Street Edge Condition, Residential or Mixed Use (Author)

The wide street edge condition, as seen in Figure 50 is more focused on the pedestrian experience rather than including the vehicular realm. The creation of a wider street resembles a small plaza with vegetated planters that help break up the hardscape that a city is abundant of. This condition works well with both residential only and mixed use, lower retail ground floor, it could either be considered a semi-private residential plaza or a public retail area that the commercial stores can use for outdoor cafe seating or popup markets.

The Oliv



Figure 51: The Oliv Facade (Architecture.sg.wordpress.com)

The Oliv is a residential apartment building located in Singapore, that houses 23 units. The northern and southern façade have massive vegetated balconies enrich the street views. The deep cantilevers that the balconies create act as horizontal sunshades and have automatic watering systems that are monitored to shut off when it rains. The east and west facades have operable perforated aluminum shades that the residents are able to control, as see in Figure 52.

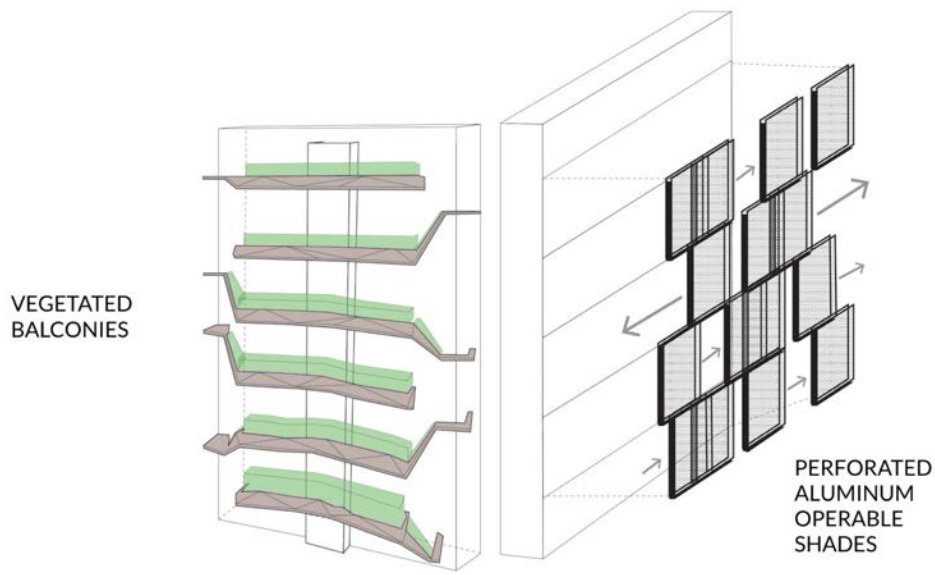


Figure 52: Different Facade Approaches (author)

The vegetated balconies have three different conditions, as seen in Figure 53 which enhance the outdoor experience that is lacking when in an urban setting. The apartment units not only have a horizontal vegetated surfaces to have outdoor views, but also a semi-vertical surface that can be used for vegetation as seen in condition 1. The deep cantilevered balconies allows for ample room to enjoy outdoors with seating areas and lastly, the vegetation can provide a barrier that is more natural and doesn't obstruct views back to the city as seen in condition 3. All of these conditions aid views back to the city but also help to bring vegetation back into the urban setting and into the residential units.

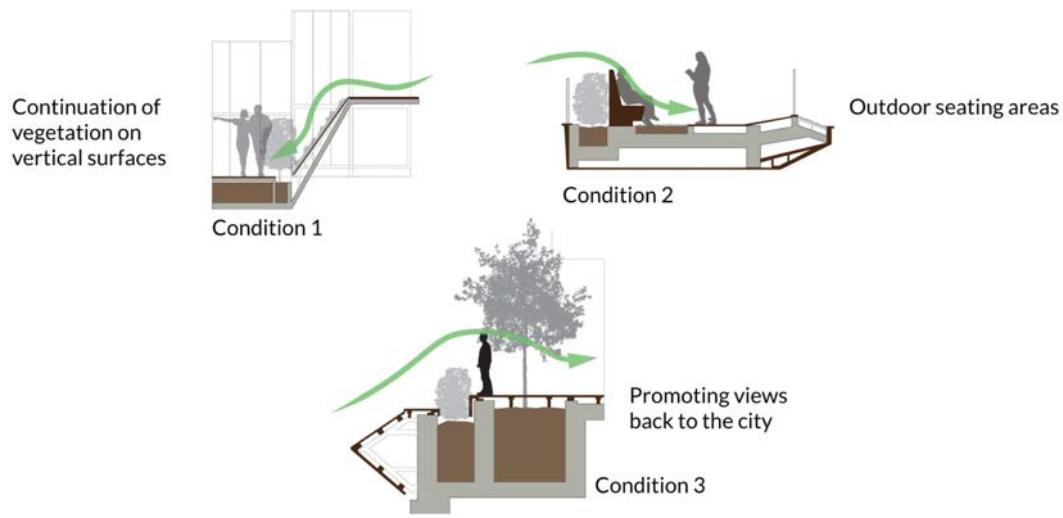


Figure 53: Different Balcony Conditions (Author)

Energy Efficient Strategies

Buenos Aires is a huge metropolitan city that keeps growing which has concerns for unplanned growth and pollution therefore many initiatives have been put in place in 2009. Not only has Buenos Aires set in place the Climate Change Action Plan which sets a global goal for 2030 to reduce GHG emissions by 30%²⁰. They have addressed the increased urban heat island effect, capture rain-water and reduction of flooding risks by constructing more green terraces and roofs, recovering green spaces, planting more trees and plants, installing storm water capture systems and increasing disease prevention measures. Not only the climate change plans but also an energy savings act, The Energy Savings Efficiency Act of 2009²¹. The governments of the city will be given 20 years to reduce energy use in public spaces, the lighting, traffic lights and governmental facilities. An energy efficient plan has

²⁰ Buenos Aires Ciudad, “Climate Action & Energy Efficiency.”

²¹ Buenos Aires Ciudad, “Climate Action & Energy Efficiency.”

been created for public buildings with the installation of photovoltaic solar panels, solar thermal collectors for water heating and solar-eolic street lights.

For the homes, Banco Ciudad (City Bank) offers credits at subsidized rates for SMEs working on environmental improvement projects²². Also, offering incentives for purchasing energy efficient kitchenware and appliances. The installation of solar collectors and utilizing the solar energy for water heating has become a large movement in households and community soup kitchens in low-income neighborhoods to include

The Sol Lux Alpha Apartments



Figure 54: Sol Lux Alpha (solluxalpha.com)

Private full floor apartments situated in San Francisco. These sun powered residences minimize San Francisco's carbon footprint and they produce vast amounts

²² "Climate Action & Energy Efficiency," Buenos Aires Ciudad, accessed November 2016, <https://turismo.buenosaires.gob.ar/en/article/climate-action-energy-efficiency>.

of energy that can in turn be sold back to the grid and then is returned to residents' pockets²³. The generation and storage of energy will allow for the building to function as its own microgrid²⁴ and will therefore be detached from the main city-wide grid and will be one of the first Passive House Certified Net Zero energy condos (Figure 54). The building has a large roof deck and garden that is covered with semi-translucent BIPV which allows for sun to seep through while still capturing the sun's energy. The raised trellis that is composed of 96 Bi-Facial BIPC solar modules will produce up 30% more power (up to 46Kw) due to its bi-facial effect²⁵, meaning that the modules utilize the reflected and ambient light energy from the deck and surrounding city. The energy is then stored in Sony Lithium Iron Phosphate battery banks that provide 104.5Kwh of energy in the nanogrid of the building²⁶.

The interior of the building uses an energy recovery ventilation (ERV) which allows for continuous filtered fresh air and improves the climate control and air quality and uses less heating and cooling energy use. Also, the heat pump water heater located behind the refrigerator will use the heat from the refrigerator to heat the water and cold air produced by the water heater used for refrigeration²⁷.

²³ Sol Lux Alpha, "Technology," accessed December 2016, <http://www.solluxalpha.com/technology/>.

²⁴ Andrea Fleischman, "San Francisco's first Passive House apartment complex produces so much energy it powers its own Microgrid," *Inhabitat*, December 2, 2015, accessed December 2016, <http://inhabitat.com/san-franciscos-first-passive-house-apartment-complex-produces-so-much-energy-it-powers-its-own-microgrid/>.

²⁵ Sol Lux Alpha, "Technology."

²⁶ Sol Lux Alpha, "Technology."

²⁷ Andrea Fleischman, "San Francisco's first Passive House apartment complex produces so much energy it powers its own Microgrid."

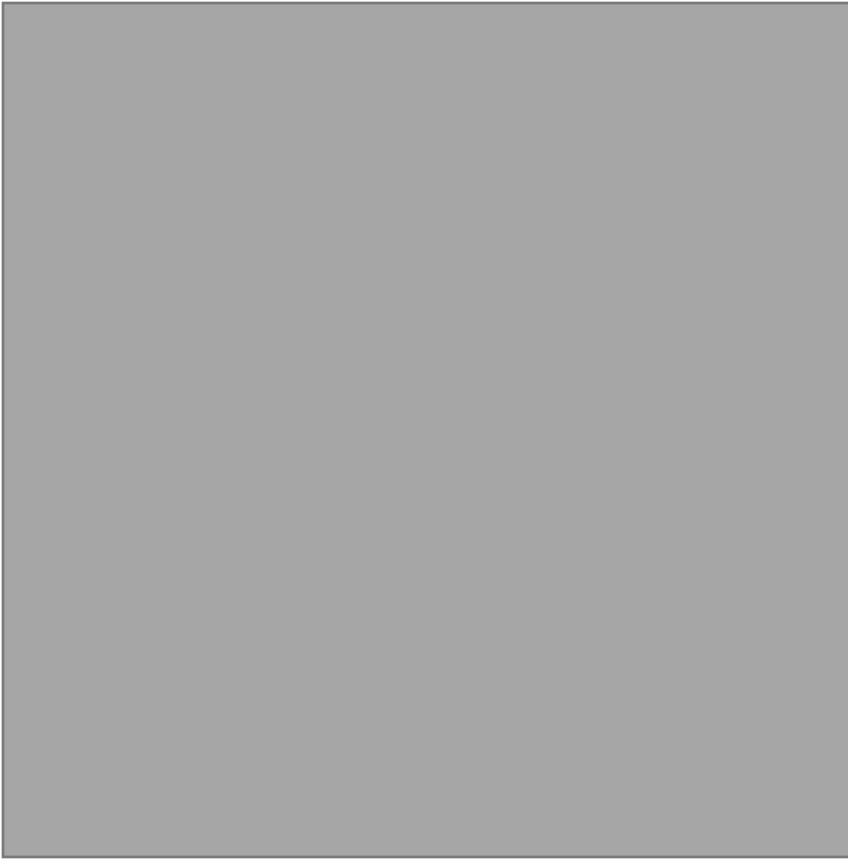


Figure 55: Edificios Construcción 14 in Mendoza, Argentina (Diariovox)

The province of Mendoza in Argentina has built their first sustainable apartments. The building has 8 floors, a commercial ground floor with two stores and 33 parking spots in two of the lower levels. The building houses 32 apartments of 1 to 2 bedrooms distributed among the 8 floors²⁸. The building is a generator of solar energy which is used for the electricity for the common areas and solar thermal technology utilized to heat water. Each floor has its own panels of solar thermal technology to heat their water which is then stored in a conventional gas water heater

²⁸ Diario Vox, “Construyen el primer edificio que genera energía solar en Mendoza,” April 20, 2016, accessed December 2016, <http://diariovox.com.ar/construyen-el-primer-edificio-que-genera-energia-solar-en-mendoza/#>.

of each apartment, although it doesn't eliminate the gas consumption it highly reduces it.

There's a misconception that sustainable apartments are more expensive but the people from Mendoza have begun to see that there's a cost differential not higher than 3%²⁹ in this building and now they have a plan B when it comes to their energy and have two sources of energy which will alleviate their blackout worries. The residents save 70% in energy consumption and have more security³⁰. The inclusion of photovoltaic solar energy, solar thermal energy, energy efficient appliances and LED lights, renewable energy reducing pollution and still being connected to the energy grid provides them with a safeguard. They obtained their panels and equipment from Enge SA³¹ and the majority of these components are found within the country and there is always more demand to keep producing better alternatives.

²⁹ Diario Vox, "Construyen el primer edificio que genera energía solar en Mendoza."

³⁰ Tiempo del Este Redacción, "Mendoza tiene el primer edificio solar del país", October 7, 2016, accessed December 2016, <http://tiempodeleste.com/mendoza-tiene-el-primer-edificio-solar-del-pais/>.

³¹ Diario Vox, "Construyen el primer edificio que genera energía solar en Mendoza."

Plaza Real

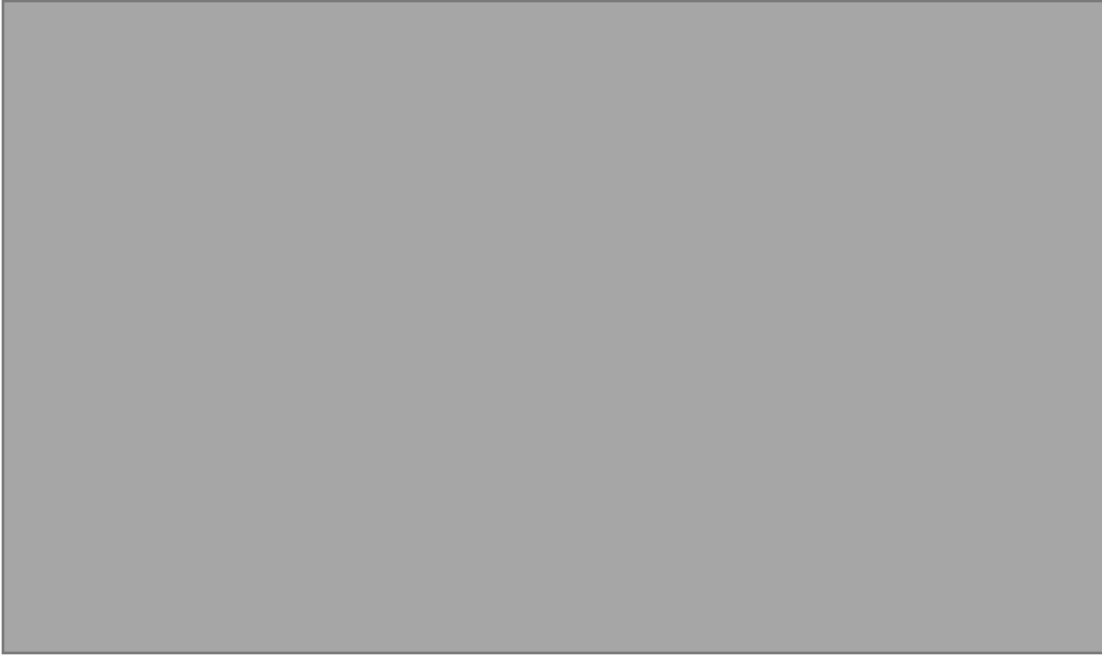


Figure 56: Plaza Real Apartments (Ultima Hora)

Paraguay built their first luxury energy efficient apartment building, Plaza Real. The building houses 10 apartments and uses solar energy. The front façade of the building is composed of a bay full of over 100 photovoltaic panels that are capable of generating 8kW of energy per hour and around 32 kW per day³². This energy is utilized to power the lights of the building, the common areas and the elevators. The addition of LED technology reduces around 80% consumption and the air conditioners utilize a green gas or biomethane that is highly sustainable and renewable³³.

³² Jhojhamni Fiorini, “El primer edificio con energía solar del Paraguay,” *Ultima Hora*, September 14, 2015, accessed December 2016. <http://www.ultimahora.com/el-primer-edificio-energia-solar-del-paraguay-n930137.html>.

³³ Jhojhamni Fiorini, “El primer edificio con energía solar del Paraguay.”

The building consumes 100kW a day, 32 of those kilowatts are generated through the photovoltaic panels. This aids in lowering the energy consumption of each resident. The incorporation of the solar panels also allows for passive cooling through the panels since there are small opening that allow for air to circulate past the panels as well as maintain an accumulated heat during the night time.

The building not only uses the solar energy for electricity but also to heat the water and store it in solar water heaters that contain 200 liters providing each apartment with hot water, saving a grand amount of energy. These water heaters are able to keep the water hot all day.

Chapter 4: Program

Programmatic Elements

Existing Typology

Analyzing the existing programmatic typologies is a major driver to develop possibilities of the program for this thesis. Buenos Aires has many different building typologies that mix in a block. As seen in the previous chapter there are three different block organizations developed over time. Caballito has properties that are residential towers, 7-10 floor apartment buildings, and 3 floor apartment buildings and the PH, “horizontal property” typology, which is essentially a 1 floor housing “complex”, simply contains three houses within a lot, one in the front, a middle property and a back property with a courtyard, all connected through a corridor, usually very old construction.

Towers



Figure 57: Palermo Uno Tower's Vast Lot (Author)

The tall residential towers will usually occupy a major lot (Figure 57) there are security cabins on both sides and pedestrian entrances as well, while the garage opening is located on the right side. These towers will usually have over 14 floors all the way to about 30 floors. In the last 10 years, there has been newer constructions that have included many amenities. These amenities include fitness center, a pool, a sauna, solarium, within the building and on the ground level open space and patio as opposed to older buildings that didn't have many, if any, common areas or amenities. Both will still have one or two main entrances onto the lot that will include open ground floor space and the tower placed on tall columns in the middle of the lot. The towers usually have 2 or more elevators for accessibility, in addition to stairs.

Mid Height Apartment Buildings



Figure 58: Mid-Height Apartment Buildings (Author)

The 7 to 10 floor apartment buildings usually have either a commercial component or a garage entrance for the cars to be parked underground (Figure 58). On the other hand, they may not have a commercial store or garage and have two to three apartments on the ground floor, this would depend on the lot size. Next to this will be the main entrance to the residential side and lobby of the building, which will most likely have a doorman that oversees the mail, deliveries and the trash to the newly implemented trash and recycling bins on the street (Figure 59).



Figure 59: Newly Implemented Trashbins with Time to Take Out Trash (Author)

The building will have both stairs and an elevator for accessibility to a lower level garage as well as to the roof level. The typical floor will have three apartments. The connection of the light-wells across the site will divide the building into three separate towers connected via bridges. The major light-wells will bring more sun light and air flows into the units.

Ground Floor

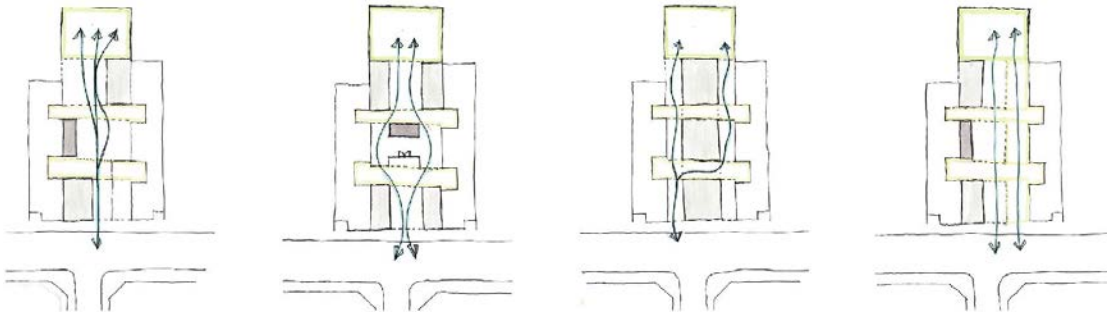


Figure 60: Ground Floor Design Options (Author)

Interior Street

The ground floor will provide a full commercial experience. The creation of an interior street will create a pause, a moment to breathe as one walks past the monotonous street facades. The narrow lot sizes have created limited possibilities that only allowed for the residential entry and an apartment unit, garage or commercial component. The interior street will house restaurants, cafes, small retail business that will bring more people into this area. The interior street will extend all the way into the lung of the block in order to liven up this middle section. Figure 61, shows different possible variations of the interior street and the location of its commercial components, yet all leading into the middle of the block.



Figure 61: Different Ground Floor Conditions (Google Maps)

Commercial Store

The alternative to a garage is the integration of a commercial store. As seen previously in the site chapter, many residential buildings have grocery markets, butcher shops, hair salons, kiosks, and many other. This has truly made the fabric of the city very walkable and although dense, these stores provide life to otherwise dead facades. The culture of the people involves a lot of walking around as well as shopping and eating out. There are ice cream shops on every other block and they are always full, especially in summer. There's a social behavior that entices people to always be out and about rather than inside their home. These commercial stores provide an activity for them. The interior commercial street will provide a huge social outlet for the residents to enjoy throughout the year.

Lobby

Lounge

As you approach the entrance a doorman will greet you and a lobby with a small lounge area will follow. This will ensure that deliveries or unknown guests to not be in direct access to the apartment units. You will enter to see a lounge area that will be furnished with small couches for visitors to the building. The open floor space will allow for large groups to gather before proceeding to the street, elevator or stairs. Off to a more semi-private space the mailroom will be inset into the wall.

Apartments

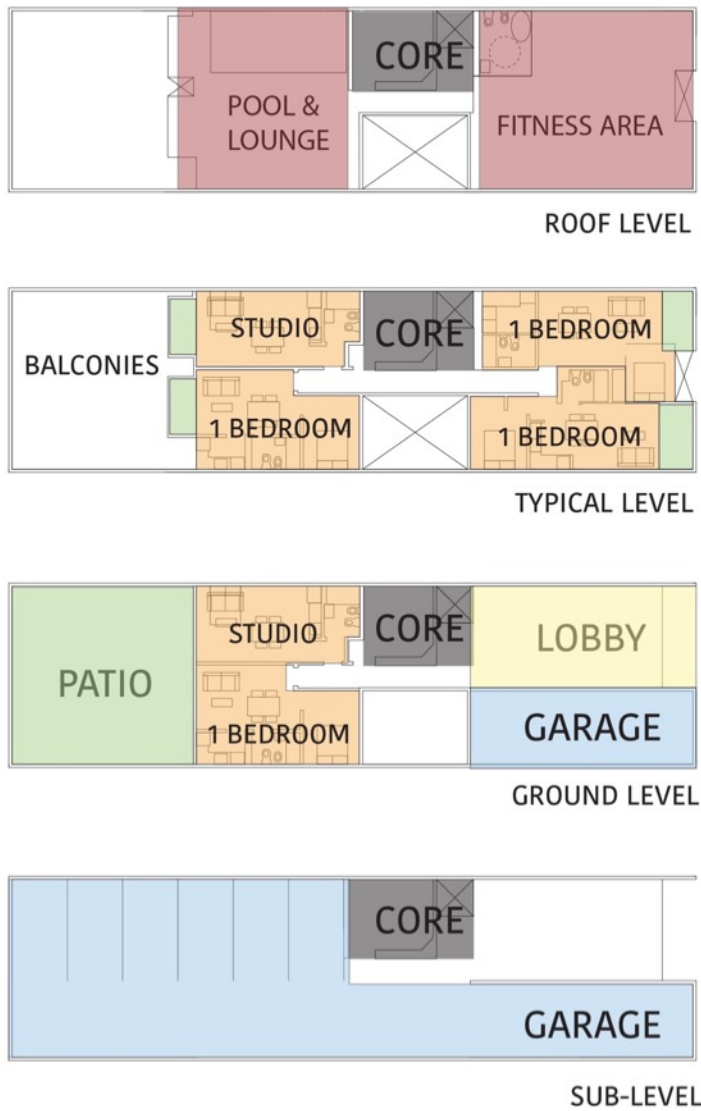


Figure 62: Possible Floor Layouts and Typical Plan (Author)

According to the surrounding context, the buildings in Caballito normally are designed to have four apartment units per floor if it has one light well and up to six apartment units if it has two light wells (Figure 64). Since these buildings are sharing

a party wall there aren't many options to bring in light to apartments that don't touch the front or back façade, therefore the light wells allow for one or two windows for the middle apartment units (Figure 65).

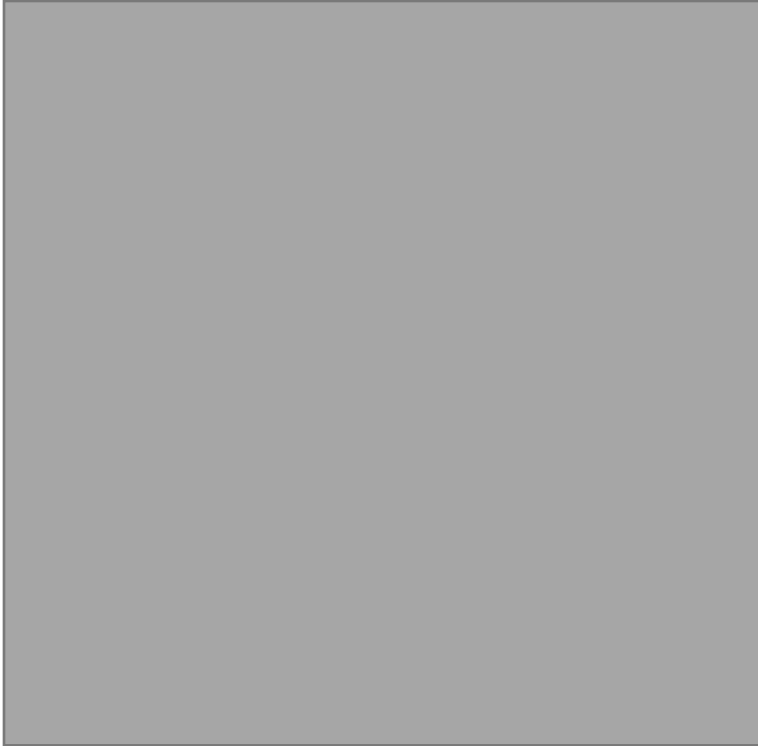


Figure 63: Mid-rise Apartment Building with Multiple Units per Floor (Google Maps)

The program specifics per unit would include a living area, kitchen, dining area, entryway, balcony, storage, and bedroom with a water closet, as seen in Figure 47. When arriving at each floor via the elevator, there shall be a component of a micro lobby or threshold space to allow a transition from the inside of the elevator to the inside of the apartment and add a measure of security. This space before entering the residence will provide space for larger delivered packages that cannot be left in the lobby's mailbox and privacy while delivering packages directly to a residence.

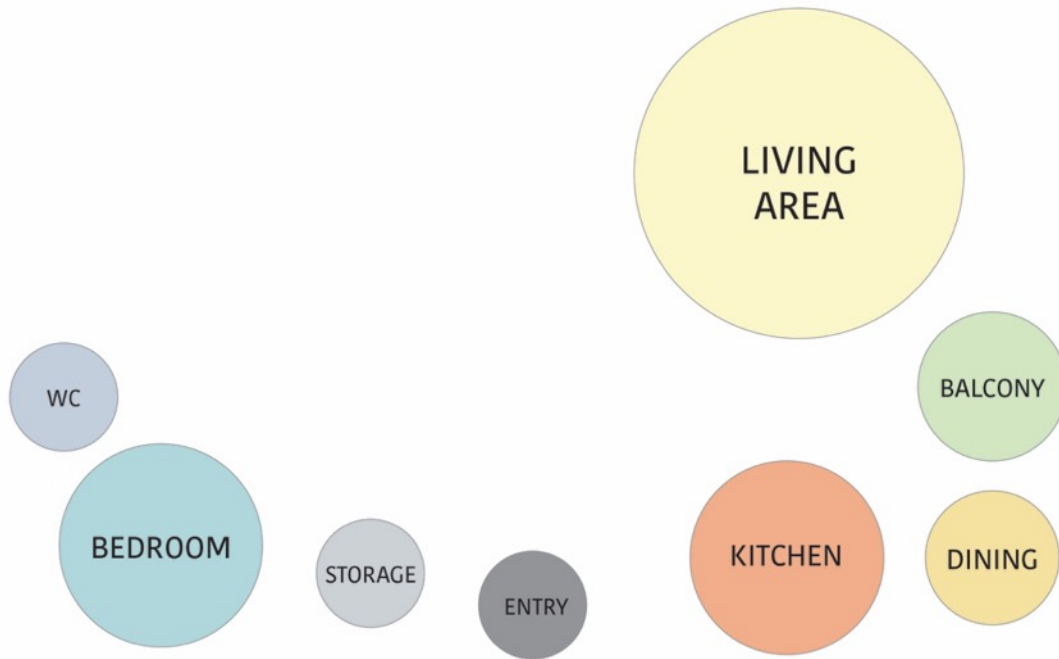


Figure 64: Single Bedroom Apartment Program Components (Author)

Mudroom/Entry

Once you step in through the door to the apartment. There shall be a threshold space where tile flooring is in place for protection from exterior and outdoor dirt being brought into the residence. Inclement weather outer clothing and shoes will have a place in the front closet where they shall be taken off and stored.

A direct connection from this space to the kitchen is essential to bring in and store groceries as smoothly as possible and so there is no intrusion with the living areas.

A half bathroom should also be connected directly to this space in case children's coming in from outdoors have quick access to the facilities and wash room. Children will also need to transition from the mudroom to their bedroom without interrupting the living spaces.

Kitchen

An open kitchen allows for direct views into the living areas but also a direct connection to the dining area. Storage will be provided through wall-mounted cabinets as well as a shallow pantry for food storage. Under the counter tops cabinets will be utilized for storage of cooking supplies and drawers for utensils and kitchenware.

The kitchen will have a bar countertop that will have the sink at standing height and on the side of the dining area, a higher bar that will allow for bar seating for informal eating and drinking.

There should be a sequenced connection from the refrigerator to counter space, moving towards the sink, then cooking preparation countertop and then the cooking area, stovetop and oven. One then should transition to the serving countertop before leaving to serve in the dining room or living area. The kitchen will have a direct natural daylight from the living areas in order to reduce the use of artificial lighting.

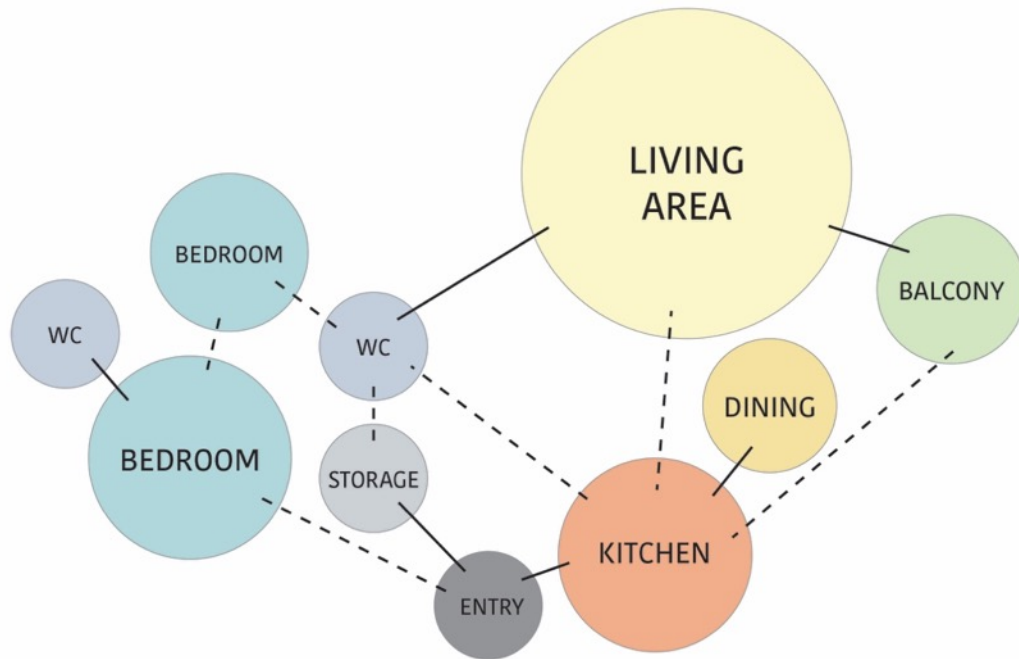


Figure 65: Adjacency Diagram of 2BR Program (Author)

Dining Room

A dining room will be connected directly to the kitchen and living areas to allow a direction flow of air and light. The dining is a space of huge importance due to the food culture that is set within Argentina. Family dining is very important and providing the apartments with a large space for this brings importance to their culture.

Living Room

The living room should be emphasizing interactions of families and inviting friends to feel comfortable. The space should allow group activities and for entertaining of visitors, enjoy watching television, listen to music and enjoy individual relaxation. These activities will be accompanied with the sight of a balcony that will bring in vast amounts of natural light and connect you back to the city.

Minimum furniture components are a couch, two chairs or more for larger apartments, a television set, and a coffee table.

Balcony

The balcony provides a direct external extension of the residence. It will be directly connected to the living area to bring natural daylight indoors. Sitting furniture allows for pleasant relaxation outdoors when the weather is nice. The balcony provides an urban outdoor space where the residents are able have a vertical garden and grow vegetation. This will also implement passive cooling while the sun is out, especially during summer months.

Since the blocks in the city grid have a courtyard in the middle, this will enable to have daylight coming in from both sides of the apartment, into the living areas as well as the bedrooms. This will help to bring in light to studios that share a floor.

Bedroom

The bedrooms are private spaces and will be located through a corridor past the living areas. The number of bedrooms will depend on the size of the apartment. Depending on the size of the lot there will be one or two light wells and as there begins to be space for two bedroom apartments, there will be a master bedroom that will have a built-in full bathroom as well as a regular sized closet. Most units will include a smaller bedroom that would utilize the bathroom in the public realm of the apartment that will be a full bathroom, with a bathtub or possibly just a shower.

For a single light well building, each floor would have a mix of unit sizes, a studio will be around 315 square feet, a 1 bedroom, 450 square feet, a 2 bedroom 575 square feet and a 3 bedroom about 700 square feet. As mentioned previously balconies are a privilege and varying per floor which units access them is important to have diversity of spaces rather than a monotonous building. Allowing for larger units to access balconies may be of greater value since there are more people, while a studio can simply access one or two windows along the light well (Figure 68).

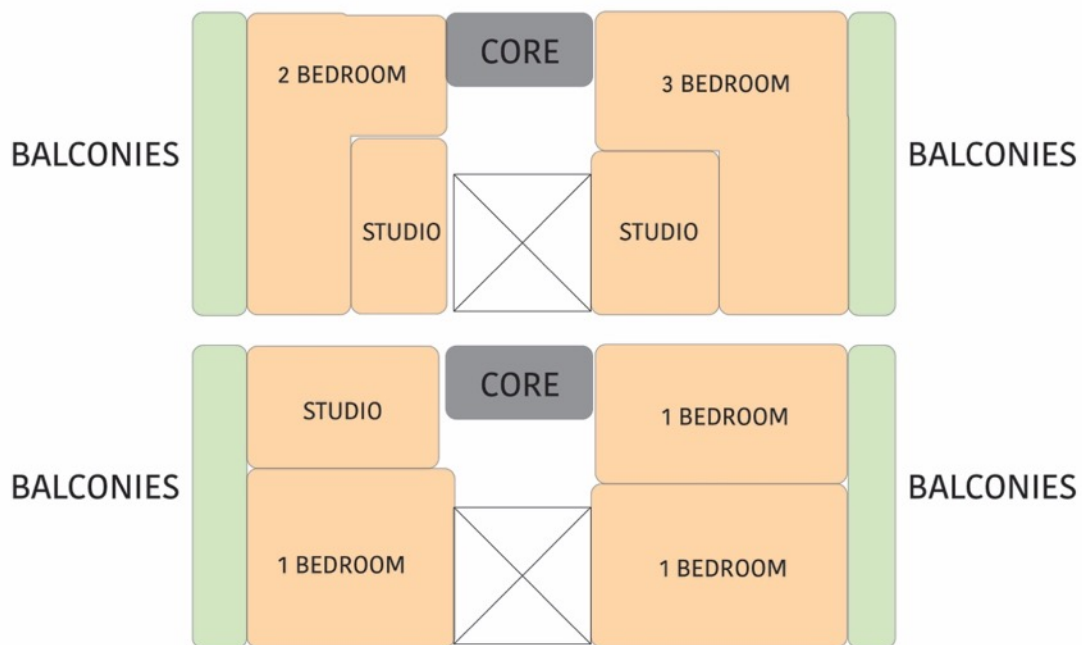


Figure 66: Typical Floor Layouts with One Light Well (Author)

Amenities

Lobby

The apartment building will include a full level that will house amenities for the residents and visitors as well. From the ground floor the lobby will be a level up

to provide a sense of privacy and security before people head up to the residences and the fitness center.

Fitness Center

The units of the building will be complemented with a grand space on the first floor above the interior commercial street, which will house the fitness center. This will be a large space that will have views out to the city on the north side and views to the interior lung of the block on the south side. The connection and transparency of these large spaces will provide a lot of natural light and ventilation.

Creating more communal space for amenities will provide more of a community presence. The fitness center will provide the essential machines to stay in shape and promote a healthy lifestyle. Lastly, the green roof will enable a community garden quality that will possibly become an urban agriculture type of space. The inclusion of a green roof will be able to mitigate the heat gain especially during the summer months.

Chapter 5: Design

Culture and Weather

Buenos Aires' culture is very focused on the notion of gathering and being social. Whether it is through food, arts and crafts shops/festivals or the greenery that the city has to offer through parks and plazas as written about previously in the document. Friends and family will tend to gather for hours to snack on or “picar algo” and talk about anything and everything. Since the weather is very temperate (Figure 67) with the winter being the coldest, although never below freezing temperatures, it is always a thing to gather at a café, to sit outdoors and to enjoy the city and food.

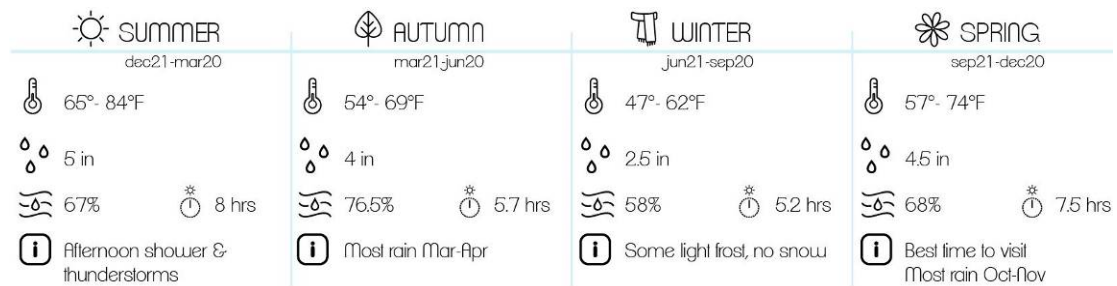


Figure 67: Weather description (Author)

The weather varies a bit for the winter months of June to September but other than that the average temperatures are around mid 60s, rising to mid 80s on average but can easily reach up to mid 90s during summer. This leads to very hot interior in the existing typology due to the lack of ventilation through the units, especially through studios that only have one or two small windows facing the light wells. This leads to high consumption of AC units that are based per room. Since HVAC is not a common thing in this area, AC units are prevalent and sometimes are required in every room depending on the placement of the unit in relation to the sun and the outdoors.

Light wells

In context

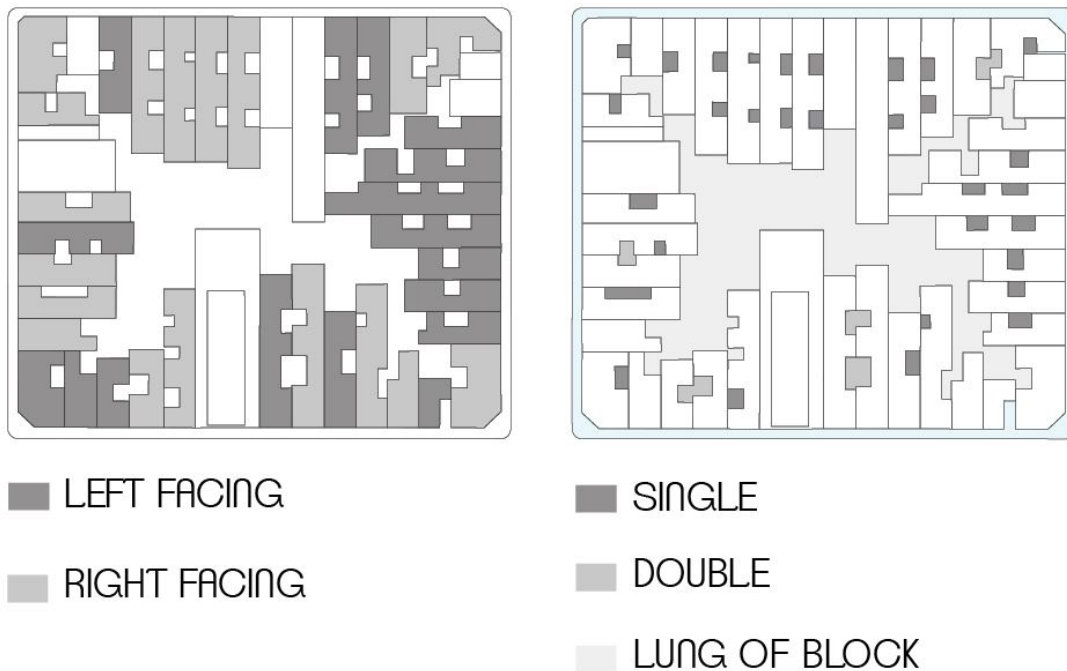


Figure 68: Light-wells in Context (Author)

The block of the site is an example of the lung of the block evolution type that has informed the block development. Figure 67 shows how the buildings within the block are composed of light wells, sometimes one or two, yet they very rarely work with one another to create wider light-wells for more air and light to come down. There always seems to be a series of buildings facing to the right or left and twice or so are they facing inwards on both sides. The light wells are usually 10 to 20 ft wide and 10 ft deep into the building.

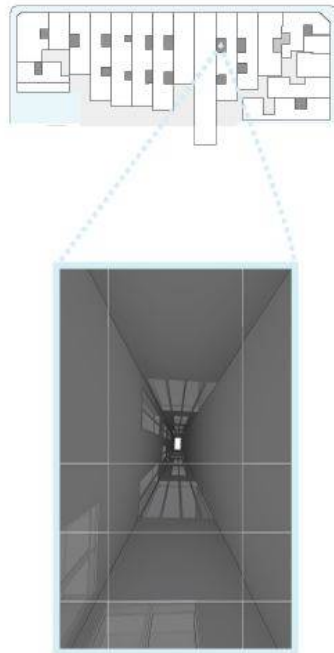


Figure 69: View up existing light well (Author)

The existing small light well conditions do not provide much natural daylight to come down into the lower levels of the buildings, as seen in Figure 69. These buildings usually have 7 to 9 floors and another buildings with the same number of floors next to it. Therefore there is not much room for variation in light well condition.

Proposed Light wells

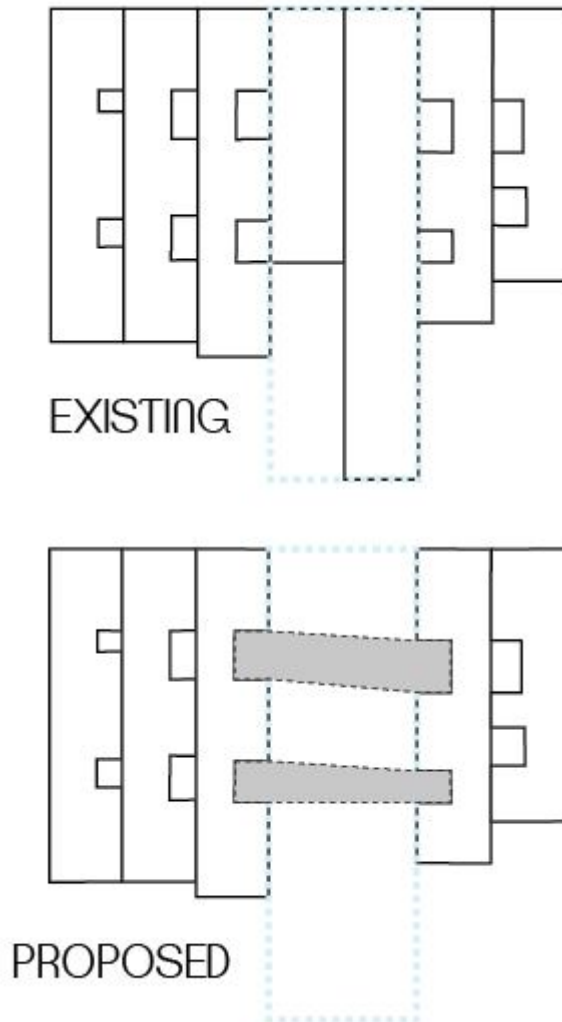


Figure 70: Existing versus Proposed Site (Author)

The existing building typology of having small light wells that never seem to work with one another has had a missed opportunity in the urban fabric. This thesis proposes to work with the neighboring buildings and light wells in order to create larger light wells through the site of this thesis (Figure 70). By doing so, the light wells expand from one existing build across the site and to the next existing building, this is over 60ft and will enhance the air and light conditions not only for the proposed building but for the existing buildings next to it as well.

Connection to the Lung of the Block

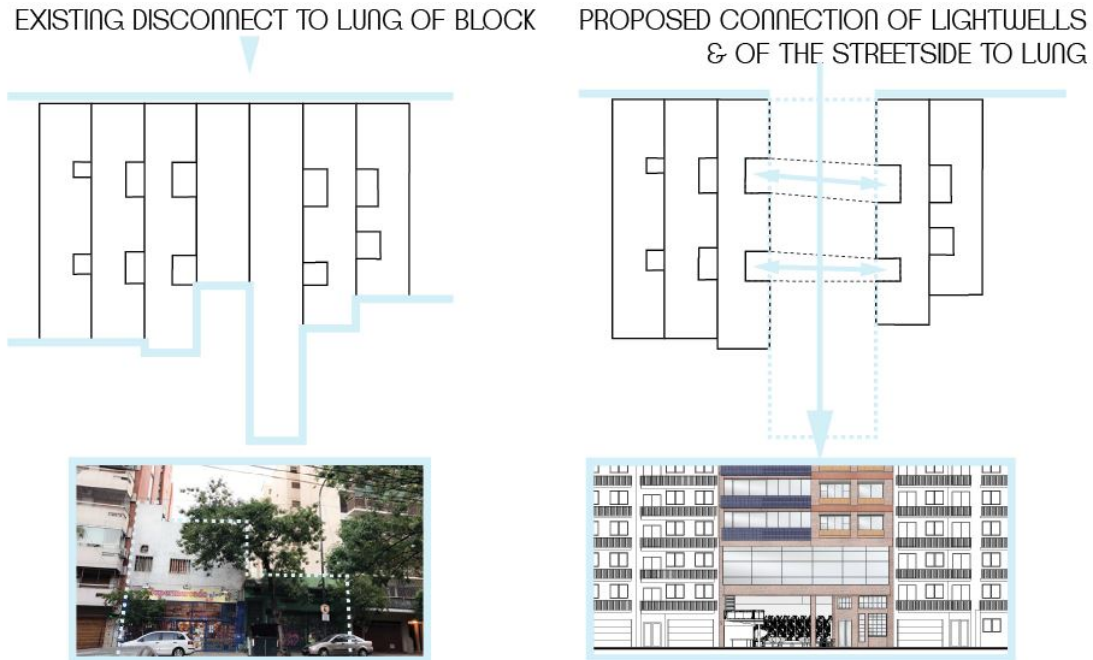


Figure 71: Existing versus Proposed Connections to Lung of Block (Author)

As previously mentioned the evolution of the block typology has developed a lung of the block, which was to improve the air and light into the middle of the block, since before this building code, the buildings were allowed to be built all the way into the middle, with no breathing room. The proposed design will implement an interior street that will have a more porous and transparent connection to the lung of the block. This will start to activate the lung of the block which currently is subdivided on the ground floor by the building that share it (Figure 71).

The proposed design will incorporate retail that will drive you into the interior street and lead you into the middle of the block. This idea can spark an idea and be a driver and motivator to the surrounding buildings to pursue a similar idea to liven up the middle of the blocks, rather than for the middle to become a storage, left behind space.

Existing v. Proposed

In context

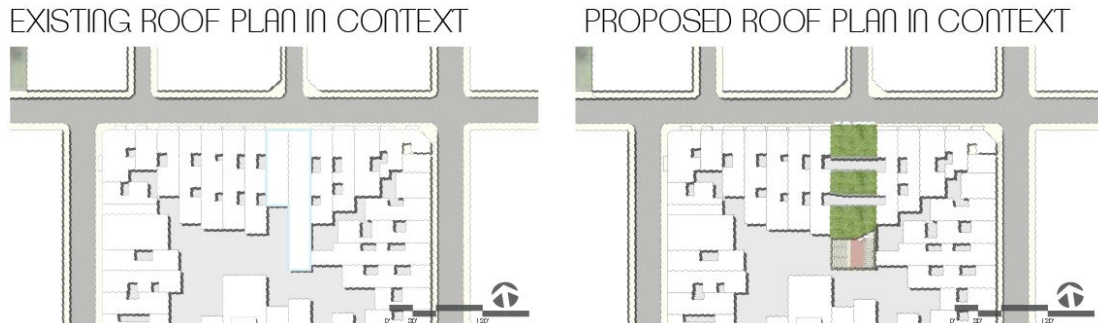


Figure 72: Existing v Proposed North Side of Block (author)

The existing and proposed north side of the block begin to change tremendously with the idea of connecting two existing light wells. It is very clear how much of an air and light improvement there will be and the presence of the green roofs also liven up the block image. The interior street on the ground floor can be seen bleed into the middle of the block and already starts to bring more life into the current dead space.

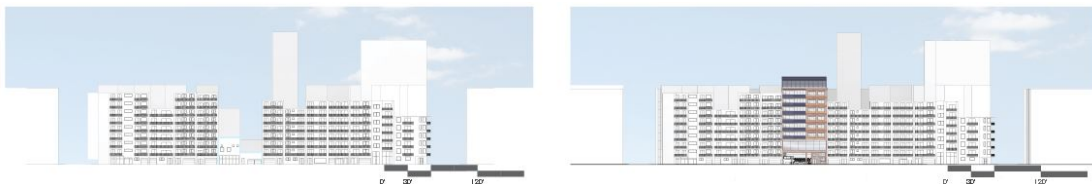


Figure 73: Existing v Proposed North Elevation (Author)

Not only is it seen in plan, but it is even more apparent how the existing elevation is very monotonous especially along the street side where the public travels by. It is always a combination of an entryway for residents and a garage, or an entryway with a small retail, or an entryway with a ground floor apartment, or some combination of these.

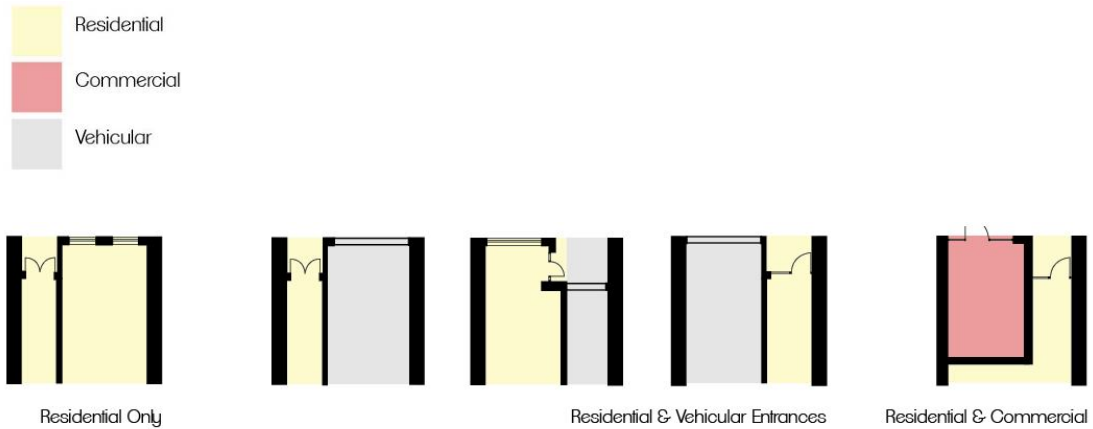


Figure 74: StreetSide Ground Floor Conditions (Author)

These conditions (Figure 74) are what make the StreetSide so monotonous for the public, therefore creating a more wide, retail based interior street that doesn't necessarily have storefronts right on the street allows for a more diverse experience. The openness of the interior street will drive people in rather than keep walking by, since it is such a different space (Figure 75).

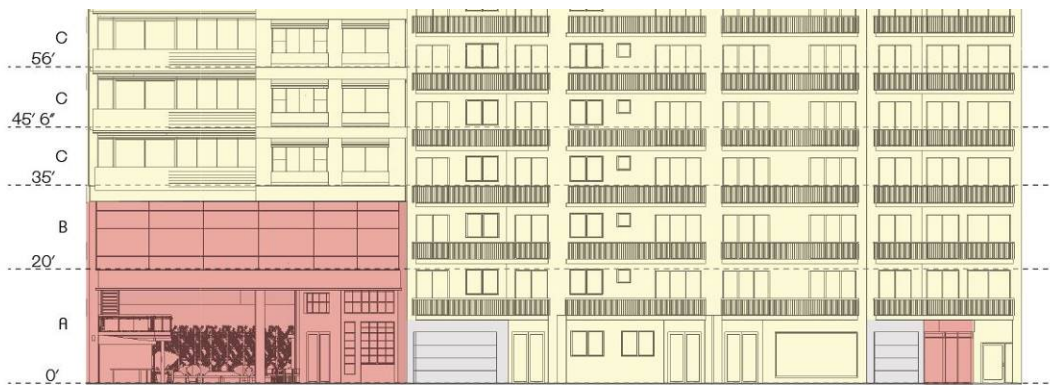


Figure 75: Diagrammatical Proposed Elevation (Author)

Not only will the openness help but also the high ceiling in this interior street will create a more monumental space and be seen as a different space than a residential entry or garage, which are all now the same height in almost all instances.

Daylight Analysis

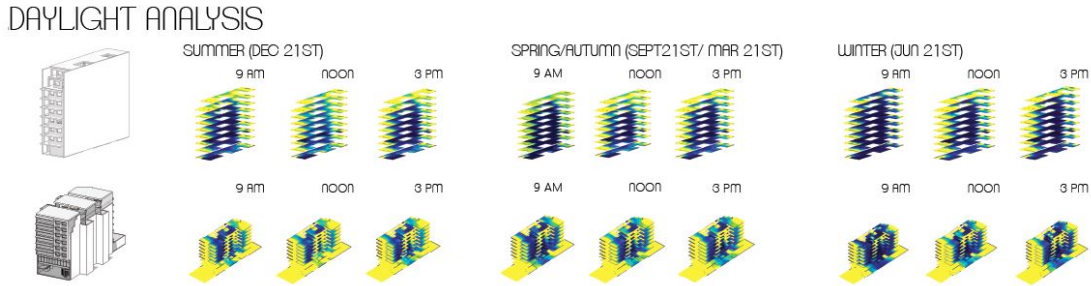


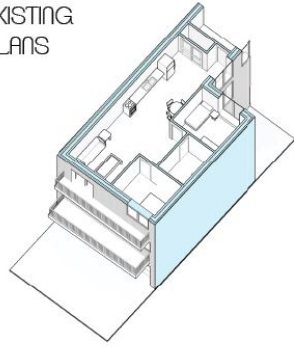
Figure 76: Existing v Proposed Daylight Analysis (Author)

As spoken about previously, this thesis began very focused on the energy aspect of the blackout issues in Buenos Aires. Figure 76, shows a bit about the daylight analysis which was done to investigate the proposal of extending the light well from one building to the next, through the thesis site.

It can clearly be seen how dark the spaces are in the existing topology of building especially when the light wells have no outlet and are being built right upon them. The proposed infill typology is easily still poses darkness issues, according to this early daylight study but it is a huge improvement on the existing. This study helps to realize where the issues are and how to improve upon them with the massing of the proposed building.

Unit Comparison

TYP EXISTING
UNIT PLANS



TYP PROPOSED
UNIT PLANS

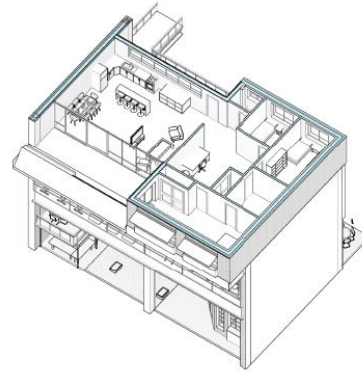


Figure 77: Existing v Proposed Typical Unit (Author)

The comparison between an existing and proposed typical unit is tremendous. The existing unit has no porosity to the outdoors and is very closed off. The existing typology has a 3ft deep balcony which is very small to even occupy in comparison to the proposed 10ft – 12ft deep balconies that are made into spaces that can be enjoyed by the residents, to hosts guests, have family dinners have the afternoon tea or “merienda” with “mate” which is the local hot “tea” drink that everyone is constantly drinking no matter how hot it is outside.

The living area is more than half of the unit in order to emphasize the communal spaces where the family comes together. This culture is very much based on togetherness and family and friends that the living spaces are the ones more utilized than the sleeping quarters, the master bedroom with two smaller bedrooms for the kids or guests.

Proposed Building

Ground Floor



Figure 78: Front View from El Maestro Street (Author)

The ground floor acts as an interior street that leads into the middle of the block. It is axially connected to El Maestro Street which allows major sun exposure to the north façade on the proposed building as well as directionality through the interior street.

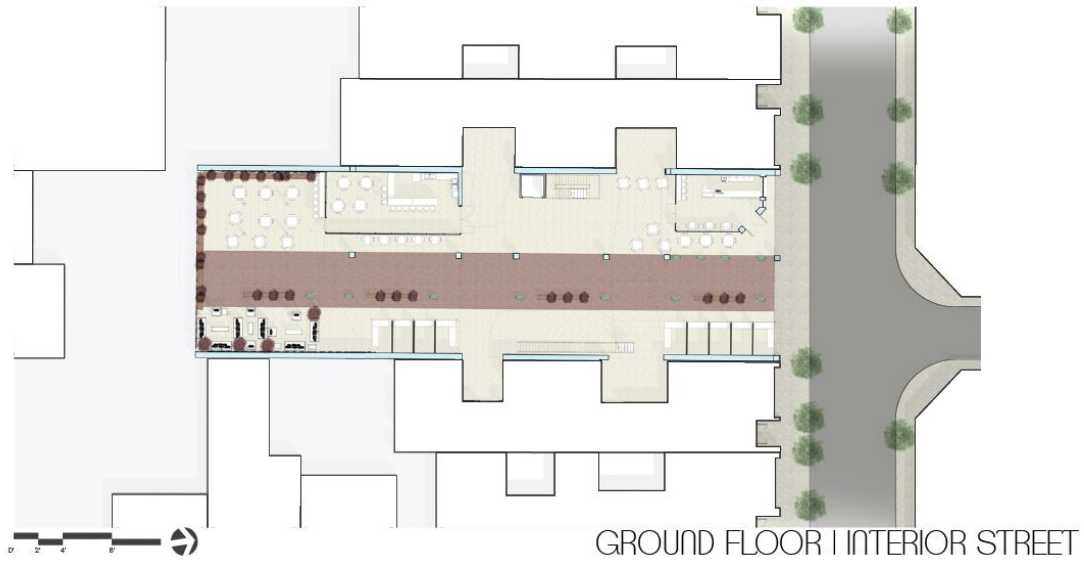


Figure 79: Interior Street Floor (Author)

Its asymmetrical nature allows for different retail to bring diversity and attract attention. The left side has short small pop up market stalls which will be used for local arts and crafts as well as produce from local farmers. The right side of the interior street will have more established cafes or restaurants that will provide outdoor seating for people to come enjoy as long as they please.



Figure 80: Interior Street View (Author)

The differentiation in pavement provides a directionality to the street aiding to move people through to the back where there is a more comfortable back patio. The openness of the interior street allows transparency between the public and the private realm. The different program within the interior street allows for friends and family to come in to a café, restaurant or simply browse the pop up markets. Being able to view up the light wells gives a connection to the outdoors and vegetation that is imbedded with the levels above and creates natural ventilation through the interior street as well as the light wells.



Figure 81: Back Patio View (Author)

The back patio will become a place to enjoy during the day and night as a space to come together with friends and family for food, music and to enjoy the day. This space will provide an openness to the middle of the block as a secondary experience of what the city has to offer. There is a lot of history within the blocks which will be an advantage to see and be a part of. This can lead to the development of a more social and interactive interior of the block.

Amenities Floor

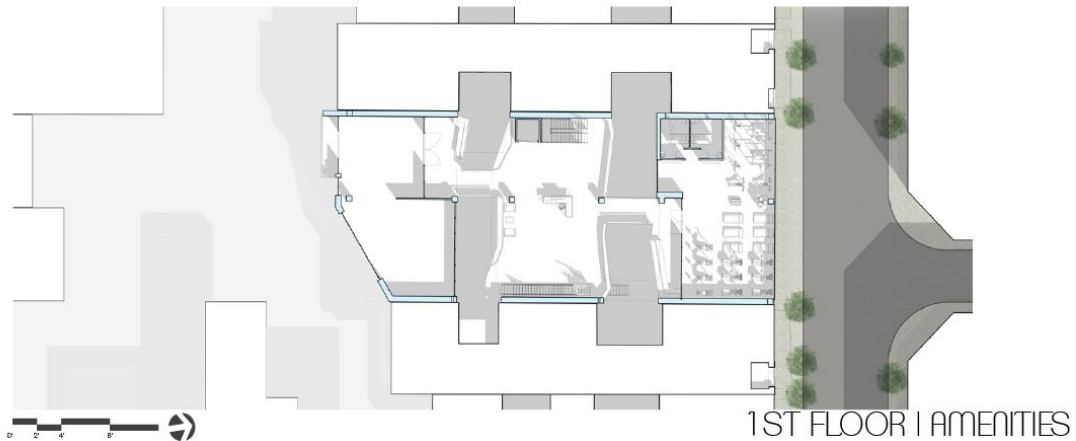


Figure 82: Amenities Floor (Author)

The amenities floor will allow for a fitness center and flex space to reside in the first and last tower, flanking the lobby space in the middle tower. The amenities space not only allows for communal space but also as a buffer between the public and private realm. This level will provide great views to the light wells, both up and down.



Figure 83: View of Lightwell from Amenities Level (Author)

This view will be a selling point about how much light comes through the light wells and how open this building will be to the residents and public. This level of

transparency brings the community closer rather than compartmentalizing the places where people reside and get together. The light wells will bring much greenery into these spaces and improve the air quality that the existing light wells probably lack.

Typical Residences Floor



Figure 84: Typical Residences Floor (Author)

The residential floors will house three units per floor, which will allow for large family oriented units. The living areas are always pushed to one side creating an open zone from the front to the back of the unit, in order to allow for passive ventilation from the low windows in the living room towards the high windows in the entrance.

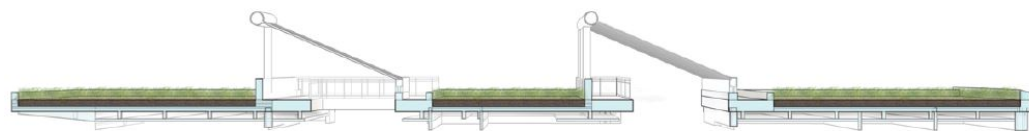
Passive Strategies

Passive Cooling



Figure 85: Passive Cooling Strategies through the Balcony and Flush Facade (Author)

By installing planters in the balconies and in the windows of the flush facades they are able to diffuse the heat that the sun will bring into the units. The operable shading devices create an adjustable component for the residents during year around. By mapping out the summer, spring/fall and winter sun one can see how deep the sun can go into a unit if the solar shading is propped up.



GREEN ROOFS LOWERING INCOMING HEAT INTO BUILDING

Figure 86: Green Roof Detail (Author)

The addition of green roofs to every tower will lower the incoming solar heat which will keep the tower cooler and reduce the heat gain. The green roofs will liven up the urban fabric and the community of residents. The green roof could become a

communal space for planting and a learning space for the solar water tubes and green roof care.



Figure 87: Green Roof Rendering (Author)

As seen in the Green roof rendering the vast green space and solar water tubes become the main attraction for the roof. The residents are able to come up to visit and utilize this space as a getaway from the city environment.

Passive Ventilation

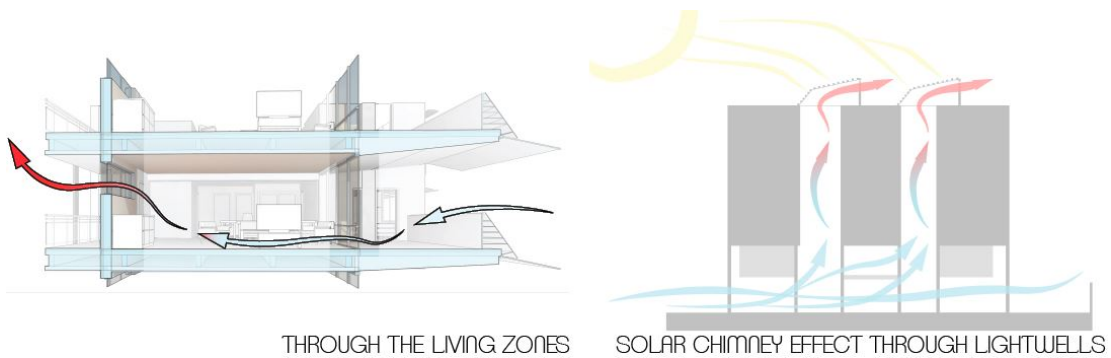


Figure 88: Passive Ventilation Strategies through Unit & Building (Author)

Passive ventilation through the units was a major driver through the light wells and by placing low windows in the living areas and high windows in the kitchen the air flow brought in from the interior street up the light well is able to pass through. By raising the building on stilts by 20 ft, the low cold air from the streets is

able to come in to the light wells and push up the warm air up and out of the roof since the light wells are uncovered.

Passive Solar Strategies

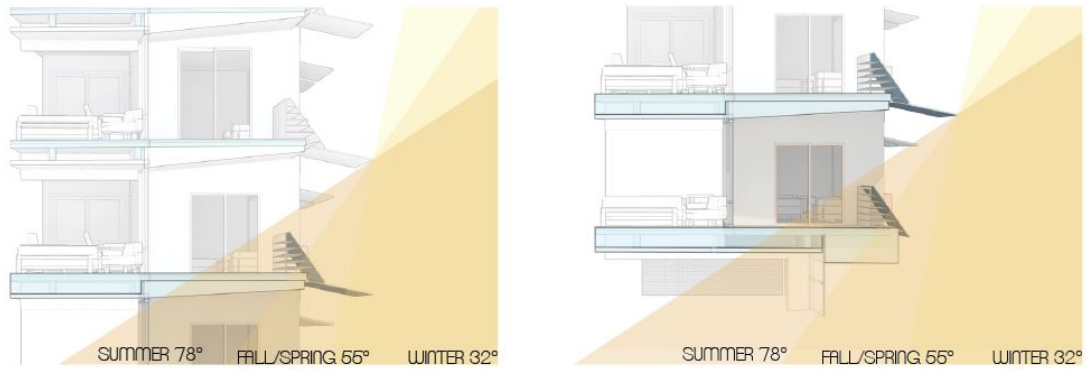


Figure 89: Passive Solar Strategies through Solar Panels (Author)

The solar shading devices are composed of solar panels which will store the solar energy from the north façade. These are operable to be able to move them for maximum solar energy gain.

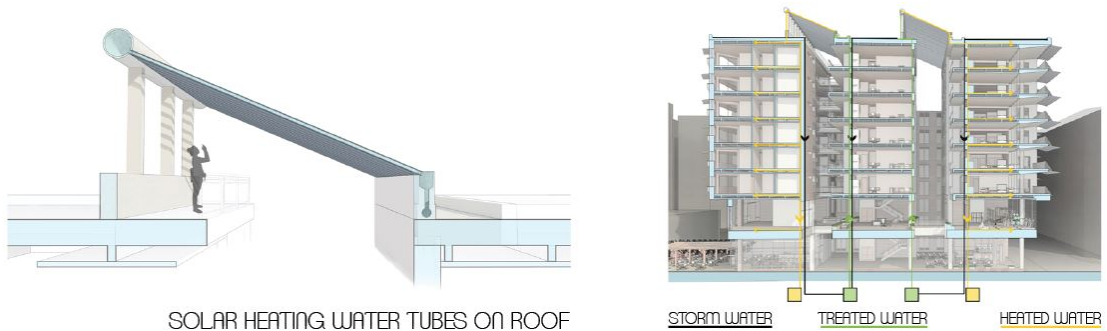
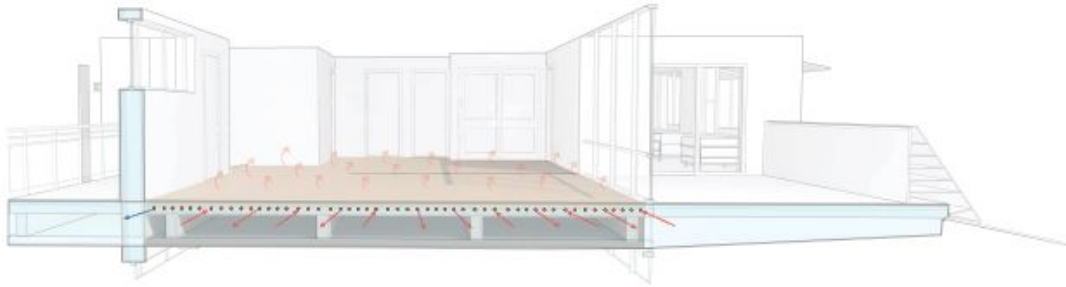


Figure 90: Passive Solar Strategy through Solar Water Tubes (Author)

Solar water tubes will be installed on top of the light wells to diffuse direct sunlight but also to heat water and provide hot water without the use of mainly mechanical systems. There will be storage of hot water tanks underground and the green roof water filtration will be stored in cisterns as well. Lastly, storm water

drainage will lead to get treated and circle back up to the solar water tubes to be heated and utilized again.

Active Strategy



RADIANT HEATING AND COOLING WITHIN CONCRETE SLAB

Figure 91: Radiant Flooring as Active Strategy (Author)

An active strategy as radiant flooring will also utilize the passive strategies product of hot water to be able to heat up the floors during winter and cool them during summer by being connected to the pipes that are connected to the solar water tubes and storage tanks. This will lower the usage for a water heater and heating within units.

Conclusion

By analyzing the existing typology of the buildings and blocks, this thesis was able to find an architectural solution to the energy problem through a socially conscious sustainable way. The culture of the people in Buenos Aires is a huge driver as to how the people live. By incorporating their values into the architectural design, one is enhancing their way of life. The passive strategies added to the connection of the existing light wells brought in another layer of sustainable ways to power the

building without the major use of mechanical systems. The existing light well vernacular is a huge disconnect between the outdoors and the building interior. By creating spacious units, the light wells will be more useful rather than a single window utilized by a studio unit. The notion of family living together is a major culture driver and by creating large units, the families stay within the cities rather than moving to the suburbs. Lastly, the creation of the interior street brings in the people to the commercial indoor/outdoor area and leads them deep into the middle of the block which is currently underutilized. The lung of the block, now is a missed opportunity and by developing a new infill typology it activates not only the public realm but the private residential realm as well with the expansion of the light well.s

Bibliography

Andrea Fleischman, “San Francisco’s first Passive House apartment complex produces so much energy it powers its own Microgrid,” *Inhabitat*, December 2, 2015, accessed December 2016, <http://inhabitat.com/san-franciscos-first-passive-house-apartment-complex-produces-so-much-energy-it-powers-its-own-microgrid/>.

“Aumentó un 12% la cantidad de usuario que usan el subte a diario” *La Nación*, May 7, 2015, accessed November 2016, <http://www.lanacion.com.ar/1790855-aumento-un-12-la-cantidad-de-usuarios-que-usan-el-subte-a-diario>.

“Caballito,” Buenos Aires Ciudad, accessed September 2016, <http://www.buenosaires.gob.ar/laciudad/barrios/caballito>

“Climate Action & Energy Efficiency,” Buenos Aires Ciudad, accessed November 2016, <https://turismo.buenosaires.gob.ar/en/article/climate-action-energy-efficiency>.

“Colectivos,” Buenos Aires Ciudad, accessed November 2016, <https://turismo.buenosaires.gob.ar/es/article/colectivos>.

Diario Vox, “Construyen el primer edificio que genera energía solar en Mendoza,” April 20, 2016, accessed December 2016, <http://diariovox.com.ar/construyen-el-primer-edificio-que-genera-energia-solar-en-mendoza/#>.

Tiempo del Este Redacción, “Mendoza tiene el primer edificio solar del país”,
October 7, 2016, accessed December 2016, <http://tiempodeleste.com/mendoza-tiene-el-primer-edificio-solar-del-pais/>.

“Energía y Minería,” Casa Rosada Presidencia de La Nación, last modified December 2015, accessed November 5, 2016.

Güiraldes, Pablo, Interview Meeting, January 4, 2017.

“Informes Anuales 2012-15,” CAMMESA, accessed September 2016
Jhojhanni Fiorini, “El primer edificio con energía solar del Paraguay,” *Ultima Hora*,
September 14, 2015, accessed December 2016. <http://www.ultimahora.com/el-primer-edificio-energia-solar-del-paraguay-n930137.html>.

“Pedaleá la Ciudad,” Buenos Aires, accessed November 2016,
<http://www.buenosaires.gob.ar/ecobici/pedalea-la-ciudad>.

Peter F. Smith, *Architecture in a Climate of Change* (Oxford: Architectural Press, 2005), 45

Sol Lux Alpha, “Technology,” accessed December 2016,
<http://www.solluxalpha.com/technology/>.

“U.S. and World Population Clock.” United States Census Bureau, last modified January 20, 2017, accessed September 28, 2016, <http://www.census.gov/popclock/>.

Veronica Smink, “El “tarifazo eléctrico que causa polémica en Argentina,” *BBC Mundo*, January 27, 2016, accessed October 10, 2016, http://www.bbc.com/mundo/noticias/2016/01/160127_argentina_tarifazo_electrico_vs.

