Images Courtesy of LarVerdeLar

THE FIRST LEED v4 PROJECT IN BRAZIL

Espaço LarVerdeLar is a unique commercial office project that serves as an example of functional sustainable design in the face of geographical and context constraints. Using the LEED v4 framework, the project team designed a truly remarkable building that meets the needs of users today and in the future.

The project hopes to inspire similar projects in small and medium sized cities, and is transparent about the projects successes and lessons learned so other project teams may follow suit. The choice of LEED-certification met the company's mission and values while proving to be economically, environmentally, and socially viable. Espaço LarVerdeLar proves that green building is feasible for small-scale buildings and small enterprises.

PROJECT STATS

Location: Governador Valadares, MG

Gross Area of Building: 189 m^2

Type: Commercial - headquarter space

Square Foot Cost: 216 R$*/$ft^2$

Cost of Construction: 440,000 R$*

*R$ Brazilian Real

Total Project Cost: 550,000 R$* (~$140,000 USD)

Contract Date: May 2014

Construction Started: October 2015

Construction Completed: January 2017

Registered LEED: September 2014

Certified LEED v4 BD+C Gold: March 2017

PROJECT TEAM

Reynaldo Santo Tosetto, Project Owner - Controle Prestação de Serviços

Micheli Goncalves, LEED Consultant, Integrative Process Management – LarVerdeLar

Vitor Tosetto, LEED Consultant – NewFields

Vanessa Scaff, Architect & 3D Modeling – Vanessa Scaff Arquitetura + Interiores

Diego Spreng, Landscape Architect – Diego Spreng Arquitetura e Paisagismo

Bruna Tosetto, Architect – LarVerdeLar

Marco Antonio Carvalho, Architectural & Hydraulic Desgn - Toca Arquitetura

Renata Carvalho, Lighting Design - Toca Arquitetura

Rafael Sant'Anna, Renewable Energy Design – Servicos Eletricos

Celeste Oliveira & Rhuan Oliveira, Electrical Design – Celeste Engenharia

Alexandra Lara, Commissioning Agent – A&F Partners Consulting

Arthur Cursino, Energy Modeling – Mitsidi Projetos

Fernando Carvalho, Construction Consultant

PROJECT CONTEXT

Brazil is the 5th largest global market for LEED[1]

- **461 LEED-certified projects[1]**
- **14.83 million LEED-certified gross sq. meters[1]**
- **248 LEED credential holders[2]**
- **30% increase in LEED projects between 2015-2016[3]**

"The many projects pursuing LEED certification are helping Brazil grow its green economy. We are proud of our contribution to Brazil's green building surge and the corresponding ripple effect across the entire region" –Mahesh Ramanujam, President & CEO, USGBC & GBCI[3]

GREEN BUILDING IN BRAZIL

Sustainable Architecture and green building has reached far beyond the United States, and everyday new building projects push the limits of sustainability in the built environment. LEED is the most widely used green building rating and certification system in the world, and is the most common green building standard in Brazil. The majority of the nation's LEED registered and certified projects are located in the large urban cities of São Paulo or Rio de Janeiro.[4] There are fewer green buildings, if any at all, in the small and medium sized cities in Brazil, especially in low income regions and inner cities.

THE PROJECT

The project was born out of a need for a new headquarters for Controle Prestação de Serviços, a service provider in the state of Minas Gerais. Controle is in their 20th year of operation. With the new headquarters, the owner wanted to give back and leave a legacy in the community. "The owner wanted to have a legacy, to give back to the community they have operated in for years. The city is not a rich area, it's a moderate region with very few initiatives for sustainability measures," said Espaço LarVerdeLar's LEED Consultant, Vitor Tosetto. When Tosetto pitched LEED to Controle's project owner, "they saw LEED as an opportunity to give back." Tosetto and his team were able to convince the owner based on the reduced operations costs, as well as the marketing and value to the brand. Tosetto and the entire project team are proud of the project: "I think we were able to leave a legacy."

The new headquarters is located in the city of Governador Valadares, a medium-sized city with approximately 275,000 inhabitants located in Minas Gerais northeast of the state's largest city Belo Horizonte. The region faces its own challenges: The city is known for high temperatures throughout the year, and only gets water from one source, the Rio Doce. In 2015, an iron mining dam failed upstream of Governador Valadares, sending 50 million tons of toxic waste water into the river.[5] The cities and ecosystems downstream from the spill were left to recover from contamination of their only drinking water source. The topography is susceptible to flooding, though depending on the year, long periods of drought can undermine the population's water supply. On top of these challenges, Controle had limitations on the building itself: the building site is in a residential area, so it was crucial that the headquarters would be able to become a residential house in the future. Therefore, the building size and form must be compatible with the surrounding buildings.

Working within these conditions, the project team developed Espaço LarVerdeLar, which translates to "Green Home." The project proves that green building is feasible and successful for all communities, in any corner of the world.

SOURCES:

1: USGBC Releases Annual Top 10 Countries and Regions for LEED – January 2018: http://newsroom.usgbc.org/us-green-building-council-releases-annual-top-10-countries-and-regions-for-leed/

2: LEED Professionals at a glance – April 2018;: https://www.usgbc.org/articles/leed-professionals-glance-april-2018

3: 2016 LEED Report Shows Green Building Growth for Brazilian Economy – August 2016: http://newsroom.usgbc.org/2016-leed-report-shows-green-building-growth-for-brazilian-economy/

4: LEED in Motion – Brazil: https://readymag.com/usgbc/brazil2016/

5: UN Newsroom: https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=16803&LangID=E

INTEGRATIVE PROCESS

LEED, or Leadership in Energy and Environmental Design is the world's most widely used green building program with projects in more than 167 countries and territories. LEED is a global, regional and local solution that provides a framework for buildings, communities and cities to create healthy, highly efficient and cost-saving spaces while working to improve quality of life. LEED v4 emphasizes the integrated process as a key to finding synergies among building systems early in the process. The Integrative Process ensures that project design plans do not result in negative impacts along the system, as oftentimes a change in one area might lead to a negative change in another area. Implementing the Integrative Process supports high-performance, cost-effective project outcomes through the analysis of key systems interrelationships before decisions are made on building form and throughout the design process.

When asked about the greatest benefit of the Integrative Process, the project's LEED Consultant Vitor Tosetto said, "one of the main benefits of the process getting all of our professionals to understand the goals of the project within the LEED framework. The city and the region is not well versed in green buildings, and many projects have no sustainability initiatives." Green building practices and the LEED framework were uncharted territory for much of the project team. "The process helped everyone understand the goals, during the process and the project phase. As a result, we actually had no major problems during the project phase," said Tosetto.

"Thermal comfort was the biggest challenge on this project ," Tosetto recalled, " In Brazil our air conditioning devices are simple but do not achieve minimums for ASHRAE thermal standards. We were going to have to use a better air conditioner that was very expensive to meet ASHRAE." Instead of spending more on air conditioning, "the alternative was no air conditioning and to use natural ventilation," said Tosetto, "Ultimately, we achieved this goal. And, after one year of operation we can say that it is possible to build and operate without an air conditioner in this climate. Before the project, people, myself included, did not believe it was possible to construct such a building without air conditioning. Now we know it is possible, and we are doing this (building without air conditioning) in other projects today."

May 5, 2014: First project meeting with team (listed on page 1) to introduce LEED v4. Many of the designers were from the region, but had no experience with green building or LEED. The team divided research tasks including a hydrology study, sun path study, thermal comfort strategies, nearby public & alternative transportation, and availability of materials and equipment in the region.

May 12, 2014: Second project meeting. Project members discussed research findings and information for decision making and performance goal setting. This meeting defined the criteria and goals for the project. From this meeting the Owner's Project Requirements (OPR) document was created, which served as the starting point for project design.

November 12, 2014: Basic project design complete. CxA analysis to ensure project developed according to OPR.

December 2014: First energy model to evaluate annual energy consumption, thermal comfort of each room, and natural light. With these results, the project team made corrections to make the building more efficient and comfortable. Some of the most important corrections: substitution of cellular concrete blocks from 12.5 to 15 cm thickness; adding 7 cm layer of polyethylene between the slab and green roof; and removal of several windows to minimize internal heat.

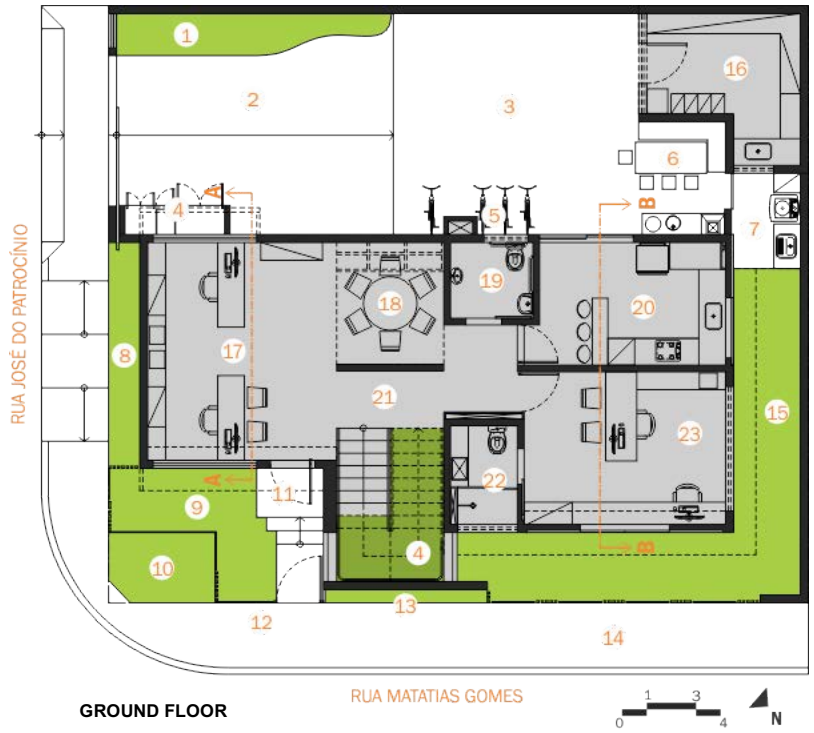
July 2015: Basis of Design (BOD) to justify the criteria, calculations, and materials used.

October 2015: Construction begins.

December 2016: Second CxA evaluation and energy model to generate definitive result of the project's performance.

January 2017: Construction complete.

March 2017: LEED Gold certification (v4).



GROUND FLOOR

L E G E N D

1. Garage garden/ 2. Outside ramp/ 3. Garage/ 4. Stairs/ 5. Indoor bike rack/ 6. Barbeque area/ 7. Laundry room/ 8. Outdoor garden/ 9. Entrance garden/ 10. Outdoor bike rack/ 11. Entrance hall/ 12. Façade/ 13. Outdoor vertical garden. 14. Sidewalk/ 15. Garden/ 16. Chemical product storage room/ 17. Office/ 18. Meeting room/ 19. Bathroom/ 20. Kitchen/ 21. Hallway/ 22. Bathroom/ 23. Executive office

N O R T H E A S T F A Ç A D E - R U E M . G O M E S Renderings Courtesy of LarVerdeLar

ARCHITECTURAL DESIGN - CONCEPT

PROJECT GOALS

Based on the Integrative Process, the project developed the following goals:

- Natural ventilation and thermal comfort, without mechanical ventilation or climate control methods;
- Easy conversion of the building into a single family residential unit given the building's location in a residential area;
- Minimize heat island effect;
- Promote water filtration, reducing runoff;
- Promote occupant health, safety and comfort;
- Maximize use of natural light;
- Promote accessibility to handicapped.

CONCEPT

The project team designed an efficient building utilizing simple but effective systems and focused on affordable materials available in and inspired by the region.

The building's modern design draws on Brazilian architecture techniques that are adapted to and inspired by the local climate. Firm, straight lines are the first point of inspiration, defining the form of the building. Brise soleil, Cobogós, and lighting trays reinforce the rectilinear, or straight line features of the building and contribute to the thermal comfort and environmental quality of the building. Brise soleil, acting as a solar shade, is incorporated on the exterior of the building. Common in hot climates, brise soleil reduce the heat gain of a building by deflecting sunlight with either horizontal or vertical strips of material. Cobogós are uniquely Brazilian, first appearing in the Northeastern city of Recife as early as 1920. Cobogós are perforated blocks, usually made of concrete, that increase ventilation and allow sunlight into a space. As the generous tropical sunlight changes throughout the day, so too does the light let into a space from the openings of the cobogós.

Brise soleil and cobogós design elements are inspired by the Brazilian style, representing the culture of the region in the physical form. The terrace garden and outdoor plants contrast the hard surfaces and lines, providing biophilic elements to the exterior. Ceramic bricks were used as a partial external covering, softening the external façade.

ARCHITECTURAL DESIGN - BIOCLIMATIC DESIGN

CHALLENGE

Through the Integrative Process, the team determined that it was too expensive to install an air conditioning system to meet thermal comfort standards. Therefore, the project team developed strategies to promote natural ventilation and thermal comfort without a mechanical air conditioning unit.

SOLUTIONS

The project relied on bioclimatic architecture, a sustainable design approach that maintains thermal comfort based on the local climate and connections to nature that optimize resource consumption. The strategy works with nature, rather than fighting it, to reduce the environmental impact of a building. The project implemented the following strategies to meet project goals:

- Cross ventilation in heavily used/occupied spaces
- Ventilation by the chimney effect in the center of the building
- Cellular concrete blocks 15 cm thick, with thermal conductivity of 0.16 W/m*K
- Efficient concrete used for revetment, 60 X 30 cm autoclaved cellular blocks
- Green roof with urban garden
- Vertical and horizontal external brise soleil

The performance strategies were verified by energy models, finding that in over 88% of occupation period of the building in one year, users will be inside the thermal comfort target range. The comfort range was defined by the American rule ASHRAE 55-2010, which determines maximum temperature (close to 25C or 77F) and minimum temperature (close to 17C or 62.6F). To compensate the period of time outside the thermal comfort zone, ceiling fans were installed.

BRISE SOLEIL - SHADING

After analyzing the solar chart of the building site, the team found that the openings on the southwest and northeast facades had a high incidence of insolation, or exposure to the sun's rays. Therefore, it was necessary to shade the facades when the sunlight is the strongest during the day. The brise soleil helped achieve a glare reduction and excessive gain of thermal load.

The brises are set both horizontally and vertically. The horizontal brises are fixed, placed between solar trays that also add to the façade of the building. Windows for the office room, the meeting room, and the rest area are fitted with horizontal brises. For the open office space, the brises were installed vertically. The vertical brises are mobile and can be adjusted throughout the day as the sun moves. The brises are made of 4 layers of adjustable shutters attached to the window frame.

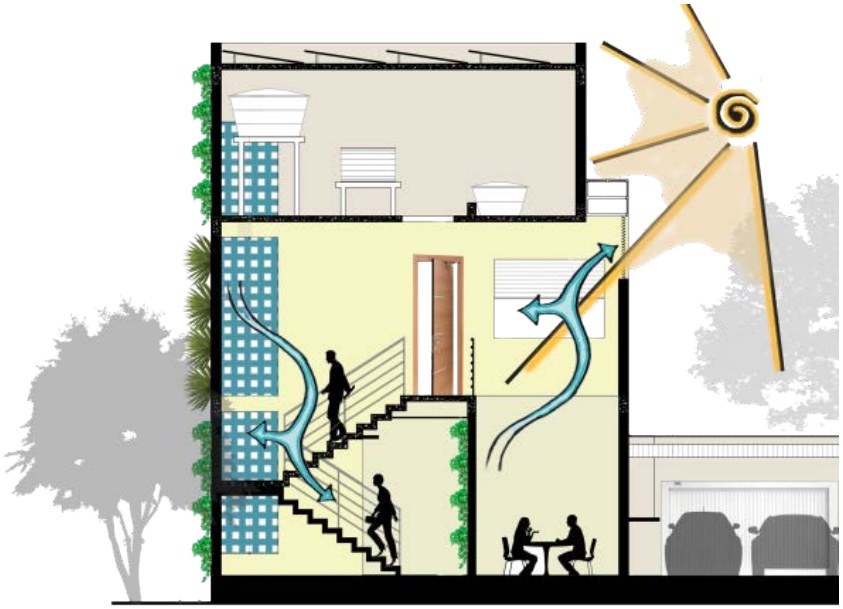
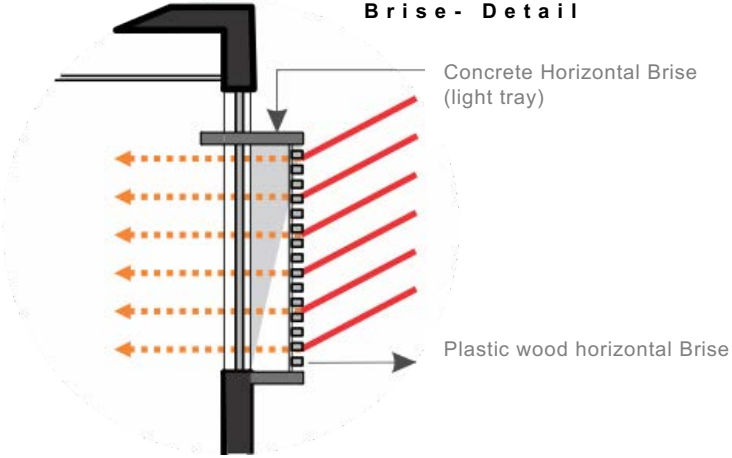


Image Courtesy of LarVerdeLar

Ventilation - Chimney Effect

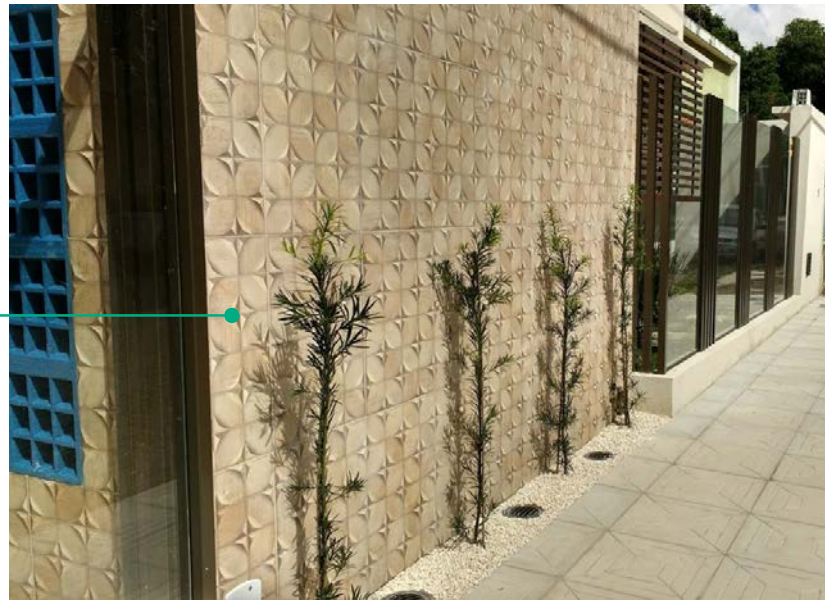


Brise- Detail

Image Courtesy of LarVerdeLar

ARCHITECTURAL DESIGN - PHOTOS

The ceramic tiles & greenery soften the hard surfaces and strong lines of the building. The textured ceramic tiles add detail and contrast to the flat, smooth facades. The native plants add to the building's aesthetic. Green facades do more than add to the visual appeal of a building - these structures are thought to improve air quality, provide additional thermal insulation, reduce stress and reconnect the built environment with nature.



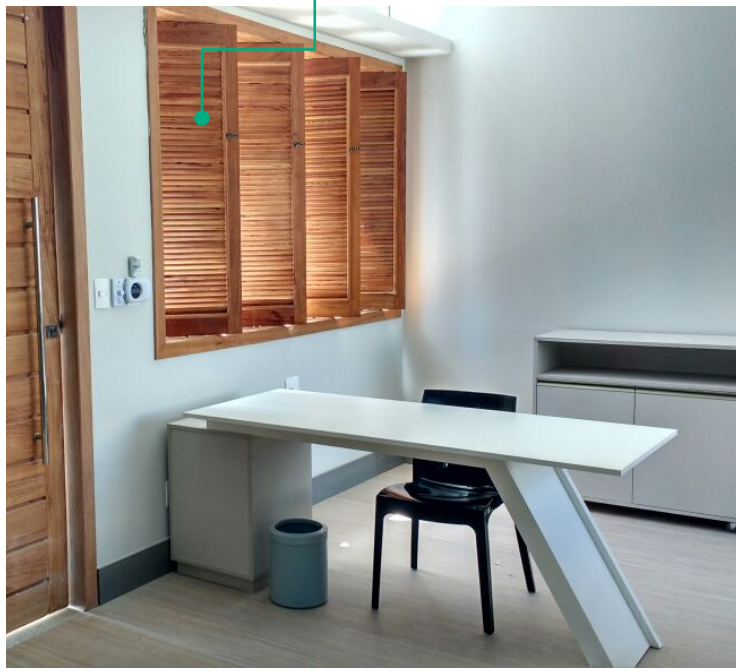
Strong lines and modern design define the form of the LarVerdeLar building.

Images Courtesy of LarVerdeLar

ARCHITECTURAL DESIGN - PHOTOS

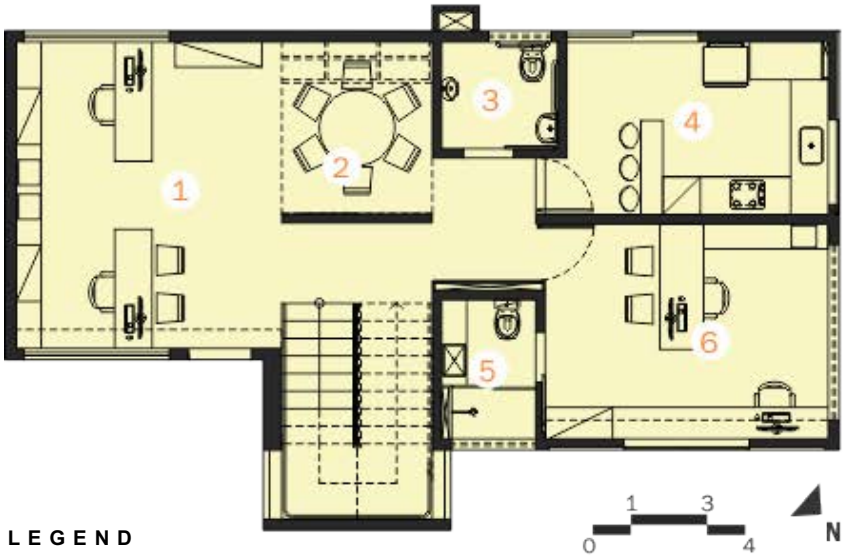
Cobogós are used in the building stairwell. Originating in Brazil, cobogós are bricks with cut out spaces that promote ventilation, provide natural light and add to the design aesthetic of the space.

Brise Soleil create shade, reduce glare, and contribute to thermal control of the building. Horizontal brises (above) are fixed, while the vertical brises (below) are adjustable and can be moved as needed throughout the day.



Images Courtesy of LarVerdeLar

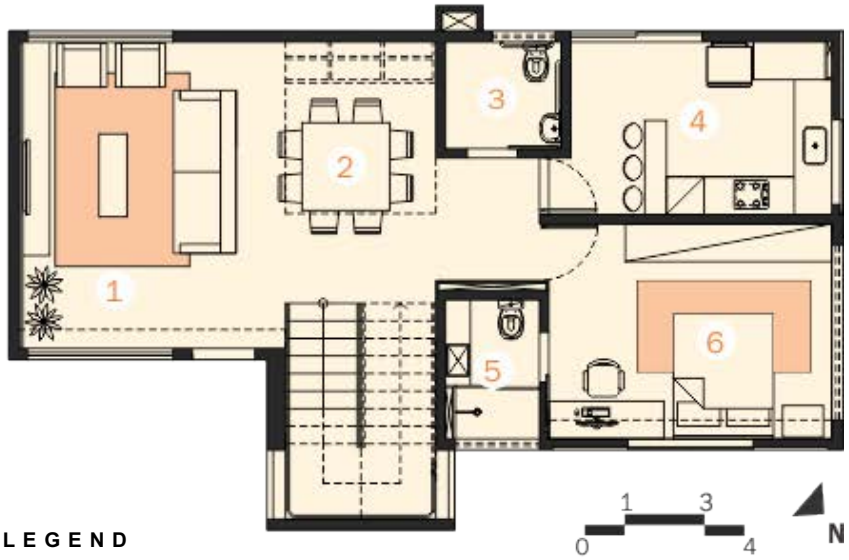
GROUND FLOOR – COMMERCIAL LAYOUT



LEGEND

1. Open office/s 2. Conference room/ 3. Bathroom/ 4. Kitchen/ 5. Executive office bathroom/ 6. Executive offices

GROUND FLOOR – RESIDENTIAL LAYOUT



LEGEND

1. Living Room/ 2. Dining Room/ 3. Bathroom/ 4. Kitchen/ 5. Master Suite Bathroom/ 6. Master Suite

Renderings Courtesy of LarVerdeLar

ARCHITECTURAL DESIGN- FLEXIBILITY

CHALLENGE

Given its location in a residential area, the Espaço LarVerdeLar building must conform to two possible uses:

- First, a building for company headquarters occupied by the service provider company and owner Controle Prestação de Serviços.
- In the future, the building must be able to convert to a single family residence.

SOLUTION

In order to increase the lifetime of the building, and avoid any negative environmental impacts that would come from building renovations, the project was designed to be easily convertible into a residential space.

The building is designed to easily transform into a home without renovation with the following dedicated spaces:

- 3 bedrooms
- Living room
- Dining room
- Kitchen
- Recreation area
- Garage
- Storage space
- Cleaning material facility – outdoor laundry room

Should a future owner want to install air conditioning equipment, the position and location of evaporators and condensing units is already defined in the building design, including proper electric installation points so that renovation is not needed to upgrade the space.

The building includes an access ramp on the sidewalk and garage, ensuring that any visitor with reduced mobility can use the space. The building was designed to allow full mobility for wheelchairs. As such, the restrooms and offices are handicap accessible.

SUSTAINABLE SITES

PERMEABILITY

Permeability is the water infiltration capacity of the soil. LEED aims to reduce impermeable surfaces through rainwater management credits that manage runoff. Impermeable surfaces reduce the ability of water to filter back into the earth, instead flowing across hard surfaces, picking up pollutants and flowing into sewer systems or nearby waterways. Local legislation does not define a permeable area percentage for construction projects, but the project team determined that at least 80% of the total area would be covered by permeable materials:

- Total Area: 206.4 m^2 (2221.67 sq. ft.)
- External Gardens: 36 m^2 (387.5 sq. ft.)
- Permeable paving: 28 m^2 (301.4 sq. ft.)
- Green Roof (vegetated): 103 m^2 (1108.68 sq. ft.)

HEAT ISLAND

Heat islands are defined as thermal gradient differences between developed and undeveloped areas. The heat island effect is a common phenomenon in dense urban areas, hard impermeable surfaces contribute to localized heat trapping and increase temperature. The green roof was designed to be 75% covered with vegetation and covered 9% by solar photovoltaic panels. For the 69 m^2 of exposed ground area, 36 m^2 are covered with gardens and 28 m^2 with permeable pavement.

These strategies result in about 80% of total area covered by materials with low potential for heat absorption, reducing the project's contribution to the heat island effect. The project earned 2 of 2 possible points for the Heat island reduction credit.

EROSION & SEDIMENTATION CONTROL

LEED v4 requires projects to reduce pollution from construction activities by controlling erosion, waterway sedimentation and airborne dust. Since Governador Valadares relies on the already environmentally sensitive Rio Doce as its only water source, it was important that the project minimize negative environmental impacts on the river.

To control erosion and sedimentation, the project included these strategies:

- Fencing around the building site with a retaining wall
- Protecting culverts with retaining wall
- Restricting vehicle access to site to prevent carrying solids in the wheels

Image Courtesy of LarVerdeLar

80% **of total project area is covered by materials with low potential for heat absorption**

LOCATION & TRANSPORTATION

Governador Valadares is located approximately 330 km (198 miles) northeast of the sixth largest city in Brazil, Belo Horizonte. Governador Valadares is home to about 270,000 residents and is a major trade, mining, and industrial center.

The project earned 9 of 18 points in the Location & Transportation LEED credit category. Within an 800 m (0.5 mile) of the building are various uses that reduce the need to move using automobiles, contributing to 5 of 5 points earned for the Surrounding density and diversity of uses credit. Walkable amenities include bakeries, drugstores, schools, churches, supermarkets, grocery stores, and restaurants.

The location of the Espaço LarVerdeLar building site favors the use of public and alternative transportation, as the building is served by 3 bus stops all within a distance of 400 m (0.25 mile). The project encourages cycling to and from the building by providing 8 bicycle racks - 4 inside the garage (pictured below) and 4 outside of the building - and a locker room with a shower for all occupants to use. The closest arterial road has a dedicated bike lane, providing security and mobility to cyclists. The project earned 4 of 5 points for the Access to quality transit credit.

Number of Daily Trips	
Weekday	144
Weekend	10

8 Bike parking spaces in Espaco LarVerdeLar

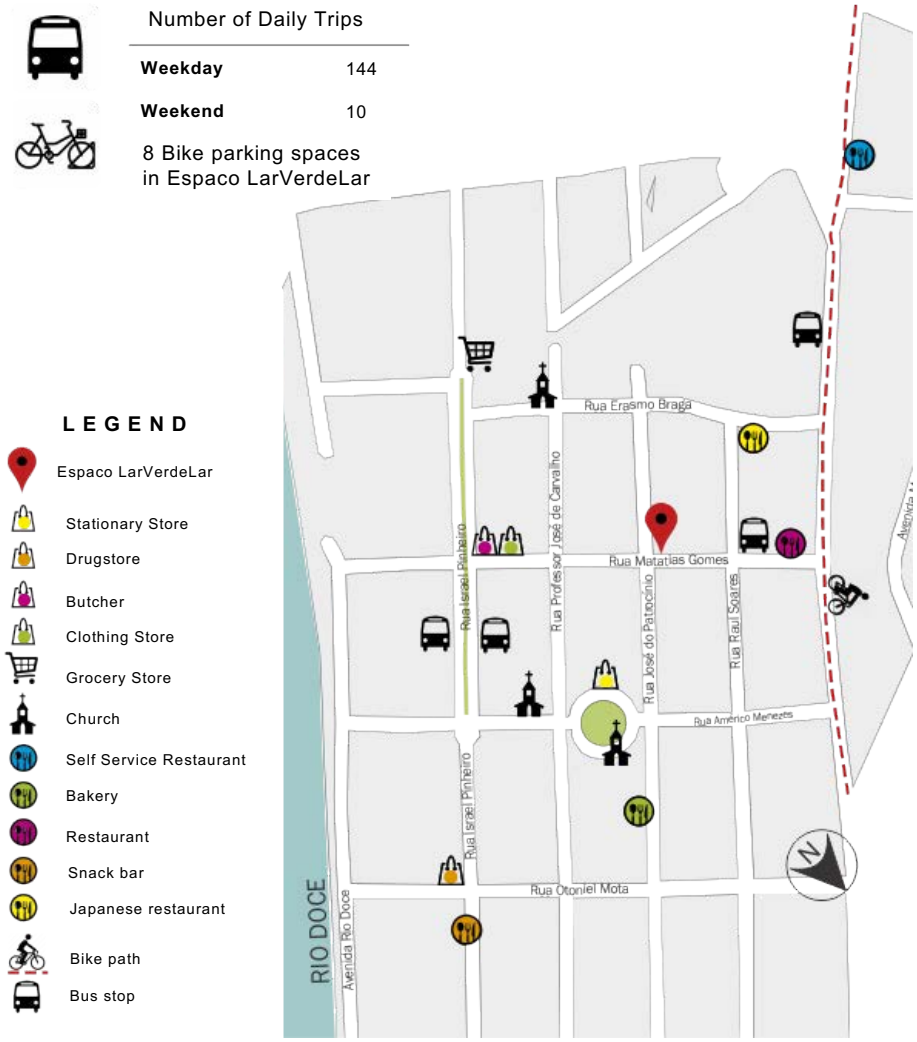


Image Courtesy of LarVerdeLar

Image Courtesy of LarVerdeLar

ENERGY & ATMOSPHERE

CHALLENGE

Designing the building without mechanical ventilation initially posed a major challenge for the project team. The energy model found that the energy performance of the proposed building was 82% more energy efficient than the reference model, according to criteria established by ASHRAE 90.1-2010. The proposed project was estimated to consume 1,982.5 kW/year, about 82% less energy than the 11,067.4 kW/year consumed by the reference model. The project earned 18 of 18 points for the Optimize energy performance credit, a significant contribution to the 24 of 33 points earned in the Energy & Atmosphere LEED credit category.

DEMAND REDUCTION

The project prioritized reducing energy demand as much as possible. Bioclimatic architecture was a key strategy to reduce demand by maximizing natural light, using materials with low heat absorption, using cross ventilation, creating shadowed elements, installing solar water heating, and installing automatic controls for light fixtures. These strategies reduced energy consumption by eliminating the need for ventilation and cooling, which accounted for 35.4% and 5.7%, respectively, in the reference model.

LIGHTING

To make the space brighter, the project team considered the impact that interior paint options would have on the need for lighting. The team chose paint with a 85% light reflectance value for the ceiling and paint with a 75% light reflectance value on the walls. Light reflectance value measures the percentage of light reflected by the painted surface. The higher the percentage, more light is reflected thus reducing lighting demands. The floor materials and color ensure 34% reflectance. Lighting in the building is outfitted with 100% LED lamps, all with a very low lighting power density (LPD) of 6 M/m^2. To avoid waste of energy, controls activate and shutdown the lights automatically at 8 pm. Occupancy sensors control lamps in areas of infrequent occupants like the hallways, restrooms and stairs. Workstations have individual task lighting with dimmers, allowing occupants to adjust the light to their needs. The outside lights are turned on and off by photocells, which detect light and turn on at night, and are automatically shutdown at 11 pm.

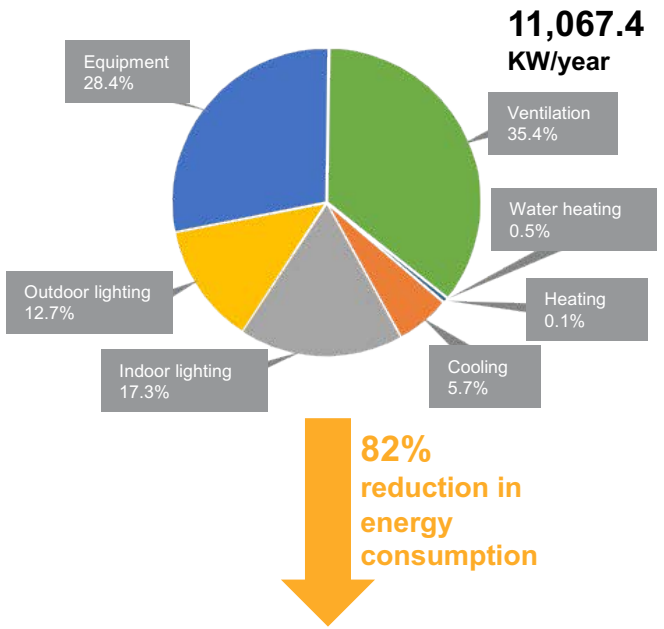
RENEWABLE ENERGY

The energy model indicated that after energy demand reduction strategies, the building would consume approximately 5,627 kWh/year. The 8 photovoltaic panels on the roof were projected to produce about 3,644 kWh/year, resulting in a 65% reduction in energy consumed from the power distribution company. It was estimated that only 1,982.5 kWh/year would be bought.

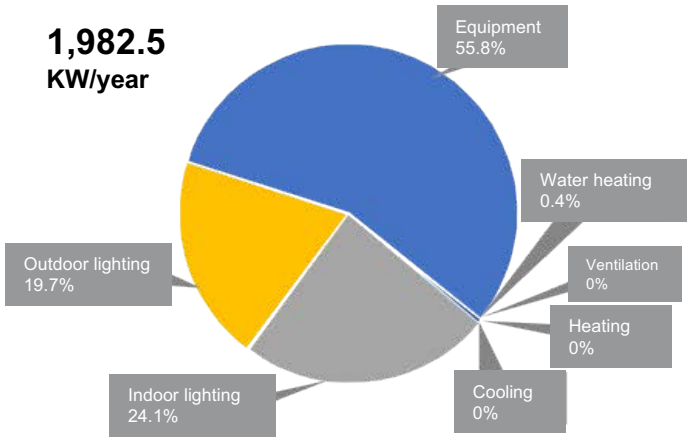
SOLAR HEATING

To avoid spending energy to heat water for showers, the project installed a solar water heating system, made by 2 solar collectors and a 300L boiler. The capacity/dimensions of the system took into consideration that, in the future, the showers may be used by a family of five.

REFERENCE MODEL



PROPOSED MODEL



MATERIALS & RESOURCES

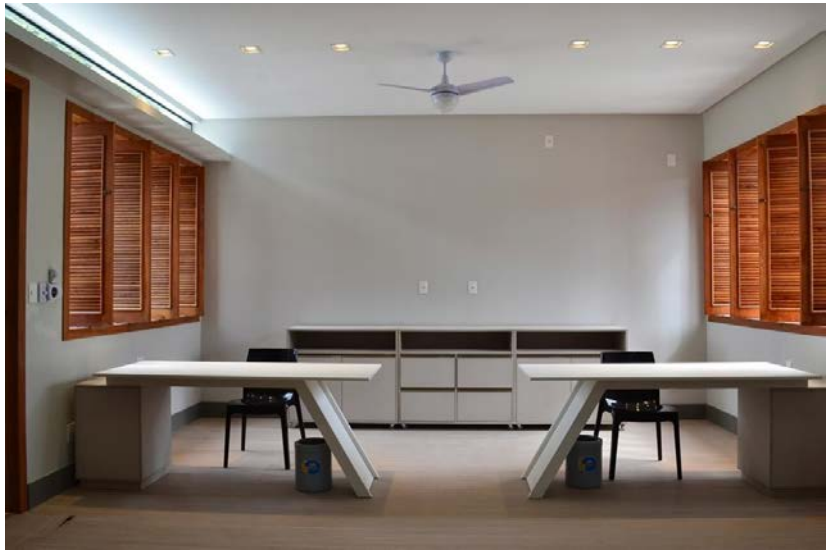


Image Courtesy of LarVerdeLar

Image Courtesy of LarVerdeLar

To drive transformation in the Brazilian green building market and assist project teams, Green Building Council (GBC) Brazil offers a list of materials and companies: http://www.gbcbrasil.org.br/listagem-membros.php?cod=30

CHALLENGE

Brazil's green building projects face challenges to incorporate sustainable materials for LEED projects. The LEED v4 Materials and Resources credits represent a more complete picture of materials and products, but project teams struggle to find materials that fulfill the Materials & Resources credit category. "To meet LEED v4 requirements, I needed to use 20 different products from 5 different companies, but in Brazil there are hardly 20 different materials or companies," says the project's LEED Consultant, Vitor Tosetto, "For the LarVerdeLar project we were only able to use one credit compliant material, the flooring. Today, we can find more materials but it is still a challenge." Though unable to earn additional credits, the project team still searched the market for manufacturers that prioritize sustainability and incorporated these into the project where possible.

FLOORING

The project found a flooring made from 97% natural materials, including renewable and recycled material components. The flooring selected is used in all indoor areas that are considered non-wet environments. The main ingredients on the flooring are linseed oil, from the flax plant; wood flour made from production waste; and jute, a fiber used widely in flooring. The flooring manufacturer is committed to transparency in their products, using Life Cycle Assessment (LCA) to determine and measure the impacts of products throughout their life. The Environmental Product Declaration (EPD) is published in a 3rd party verified report to verify claims and encourage transparency in test results and measurements.

GREEN ROOF

The green roof is one of the main strategies contributing to the building's thermal comfort, allowing the project to meet thermal comfort standards without an air conditioning system. The project team found a green roof product available in modular and flat mounting systems: modular was used for the 1st floor and garage covering and the flat was used on the urban kitchen over the office space.

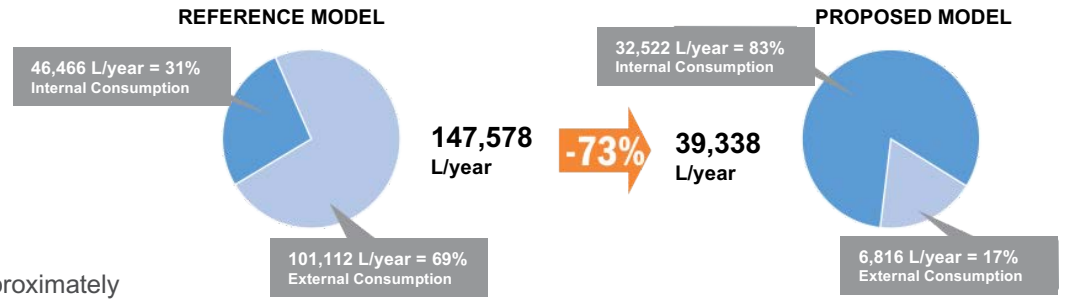
Advantages of the green roof selected:

- Lightweight – replaces heavy and voluminous materials
- Promote Air Circulation – air layer below allows for improved thermal performance
- Drainage – quick outflow during strong rains
- Reinforced structure – 'X' design promotes better load distribution on inclines
- Irrigation ready – easy passage for piping and hoses

WATER EFFICIENCY

CHALLENGE

The city of Governador Valadares draws water from one source, the Rio Doce, which has not fully recovered from contamination when an iron mining dam burst into the river. In recent years, Brazil has seen an increase in the frequency and severity of drought events. These water quality and quantity issues were considered when designing the building.



SOLUTIONS

Reference models determined that a comparable building would use approximately 147,578 liters of water per year, 69% of which would be consumed externally, primarily on irrigation. The project team set out to dramatically reduce the building's water consumption, developing 4 strategies to achieve this goal: reduce irrigation demand; capture rainwater for use on-site; reduce indoor water use; and continuously monitor consumption and performance during occupancy for continued improvement. With these strategies, the project reduced projected water use by 73% and earned 8 of 11 possible Water Efficiency LEED credits.

REDUCE IRRIGATION DEMAND

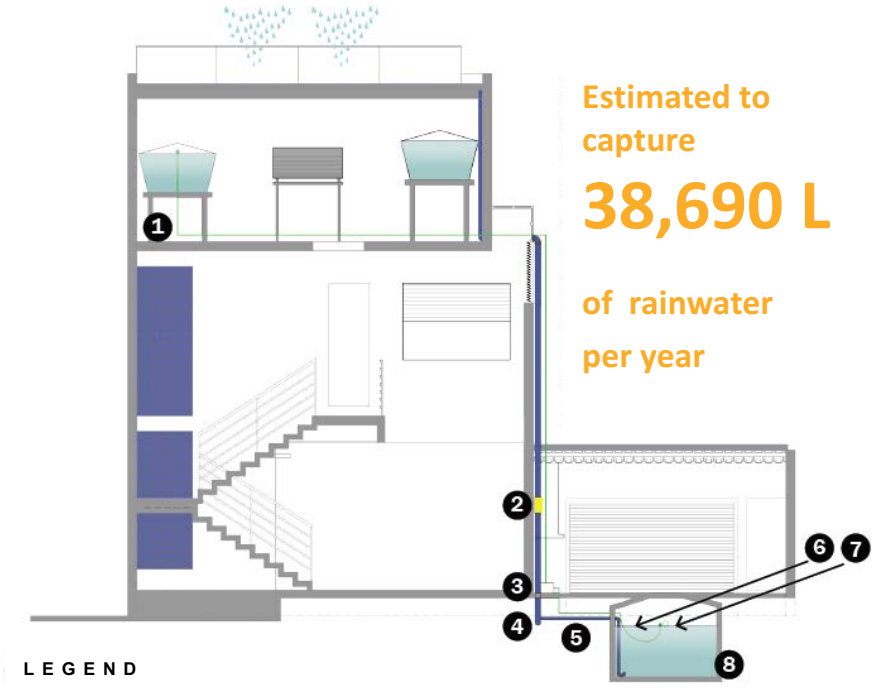
Modeled outdoor water use went from 8,426 L/year to 568 L/year, a 93% reduction, by planting native or adapted species that require little water and implementing drip irrigation and rainwater harvesting The xerophilous plants, plants adapted to dry climates, demand minimal water and maintenance. Grass was ruled out as an option for the project since it is not local and is high maintenance. To maintain selected plants, the project opted for an underground irrigation system, avoiding water loss by evapotranspiration and promoting maximum water absorption at the roots. The system is automated through a soil moisture sensor and central control, avoiding excess watering.

RAINWATER HARVESTING

Rainwater is captured from the roof and stored in cisterns to meet irrigation needs for the site and supply toilets, reducing demand on potable water. Through water reduction strategies, the proposed model estimated 39,338 L of water used per year. The rainwater harvesting system is estimated to capture 38,690 L of water per year, able to supply 98% of the building's expected water use.

LOW FLOW FIXTURES

The average annual indoor water use modeled as the reference model estimated an average annual consumption of 46,466 L/year. By selecting the best available low flow toilets and using rainwater for toilets, indoor water consumption fell to 32,522 L/year.



LEGEND

1. Irrigation point/ 2. Descent filter/ 3. Rainwater pump/ 4. Discharge filter/ 5. Filtered rainwater/ 6. Suction bridge/ 7. Extravasor – control for overflow/ 8. Water cistern

Image Courtesy of LarVerdeLar

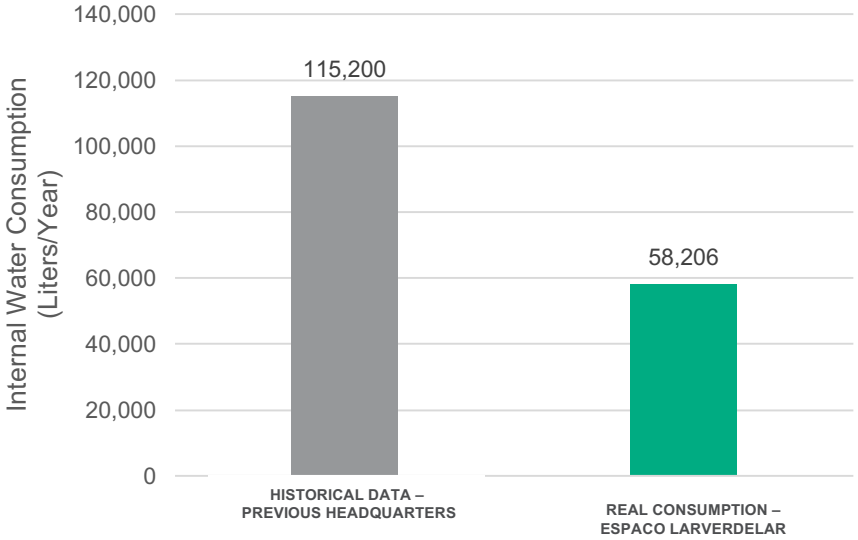
ONE YEAR PERFORMANCE UPDATE

INTERNAL WATER CONSUMPTION

Considering the consumption of internal water only (that comes from the toilets, taps, showers and washing machine), Espaço LarVerdeLar consumed 58,206 L in the first year of operation, above the proposed model estimate of 32,522 L/year. In comparison with the previous headquarters office (Historical Data), the building owner has reduced water use by 51%. The use of low flow taps, waterless urinals and use of rainwater to supply the toilets accounts for the majority of this reduction in water use. This analysis does not consider water used for irrigation (see right).

The project's commitment to ongoing performance monitoring and evaluation allows occupants to see water use throughout the building. Though the building has consumed more water than both the reference model and the proposed model projected (page13), the occupants are now aware of where water use is the highest and can adjust accordingly to reduce future consumption. As the saying goes, "you can't manage what you can't measure."

51% reduction in internal water consumption compared to previous office space



DETAILED WATER CONSUMPTION

For the first year, total water consumption of Espaço LarVerdeLar totaled around 182,335 liters. The total rainwater collected in the first year came to 36,386 liters. Rainwater supplied 17% of total building water use, primarily used for irrigation and toilets. The building's irrigation system is 100% automated, relying on sensors to determine when the plants are in need of water. Nevertheless, the great variation of the water consumption for irrigation is attributable to attempts to adapt water flow for new plant growth. Unfortunately, there were problems of adaptation of the species chosen for the green roofs, specifically with the peanut grass (Arachis repens). In March 2018, a different species, the purple lambari (Tradescantia zebrina), was planted as a replacement

The estimated total water, indoor and external, use for the building was more than anticipated for the project due to challenges with the irrigation and the green roof. Rain water collected is close to the estimated amount, at 36,386 liters per year. This is able to supply 17% of the total water consumed in the first year. Moving forward, the project will reduce water use outdoors through improved irrigation practices and indoor by reducing occupant use through educational materials and prompts.

DETAILED WATER CONSUMPTION & COLLECTION (liters)

Month –Year	Irrigation (external)	Toilets (internal)	Faucets & Showers (internal)	Rainwater collected
Apr-17	16,589	900	2,482	1,557
May-17	6,836	965	3,766	1,444
Jun-17	11,275	934	2,563	1,033
Jul-17	5,429	939	3,807	194
Aug-17	8,644	1,225	3,791	85
Sep-17	10,088	917	4,926	631
Oct-17	13,786	799	4,317	801
Nov-17	5,845	840	4,279	6,685
Dec-17	11,755	1,049	5,888	7,983
Jan-18	11,145	950	3,760	3,542
Feb-18	8,731	644	3,362	6,059
Mar-18	14,006	1,055	4,048	6,372
TOTAL	**124,129**	**11,217**	**46,989**	**36,386**

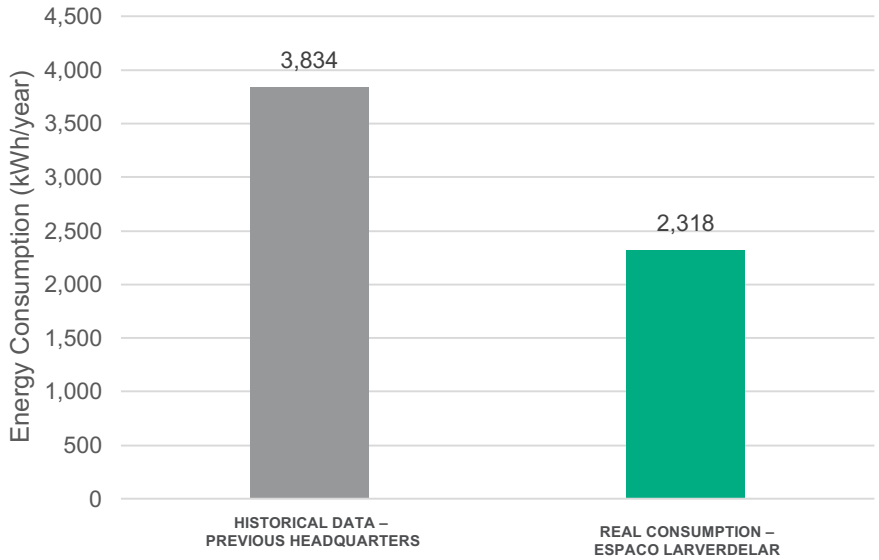
ONE YEAR PERFORMANCE UPDATE

ENERGY CONSMPTION

Espaço LarVerdeLar is designed to consume as little energy as possible, relying on bioclimatic design strategies, demand reduction, and energy efficiency. The reference model considered that the regularly occupied spaces would use air conditioning and all the energy consumed would come from CEMIG, a Brazilian power company headquartered in Belo Horizonte, the largest city in the state of Minas Gerais.

The reference model for energy consumption resulted in 11,067 kWh/year (page 11), while the proposed model resulted in1,982.5 kWh/year. When comparing the actual consumption of energy with the reference model, where air conditioning would have required a large amount of energy, energy demand of the project was still reduced from 11,067 kWh/year to the actual consumption of 2,318 kWh/year. The previous headquarters contained an air-conditioning unit and relied on CEMIG for all energy use. In relation to the previous headquarters, Espaço LarVerdeLar reduced energy consumption by 39.5% in one year of operation.

39.5% reduction in energy consumption compared to previous office space



ENERGY GENERATION

During the first year of operation, in every month, Espaço LarVerdeLar produced more energy than it consumed. The average production of renewable energy by the 8 photovoltaic panels (260W each) on the roof was 250 kWh / month. Therefore, the owner always paid the minimum value of the light bill and generated of credits in kWh. The credits were used to reduce the value of the light bill of the control owner's private house. As a result, the payoff was over 100%.

DETAILED ENERGY PRODUCTION & CONSUMPTION (kWh)

Month – Year	Energy Produced	Building Consumption
Apr-17	236	207
May-17	190	188
Jun-17	189	159
Jul-17	186	169
Aug-17	257	198
Sep-17	280	211
Oct-17	268	189
Nov-17	234	184
Dec-17	310	229
Jan-18	326	222
Feb-18	250	145
Mar-18	311	217
TOTAL	**3,036**	**2,318**

ONE YEAR PERFORMANCE UPDATE

OPERATING COSTS

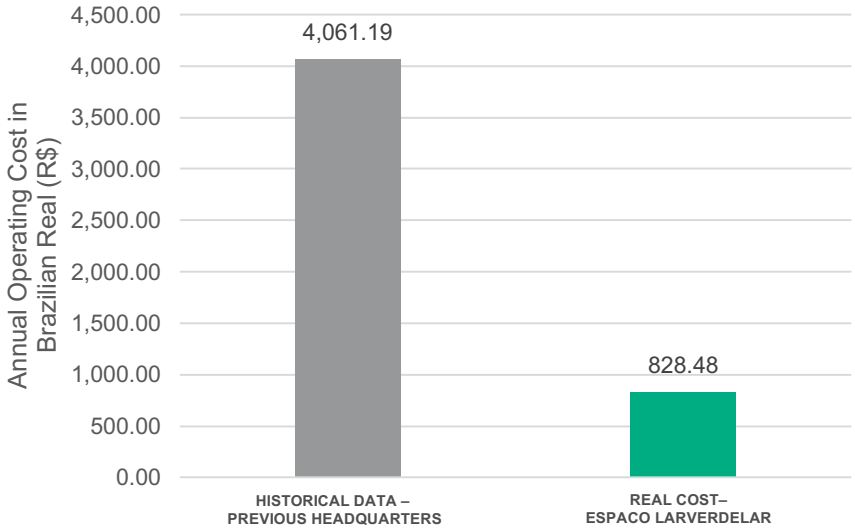
Analyzing only the water and energy bills, one year performance data shows that the company has reduced operating costs by 79% per year compared to the the previous Controle Prestação de Serviços headquarters space. In a one year period, the Espaço LarVerdeLar has an average monthly operating cost of 69.04 R$ (Brazilian Real), down from 338.43 R$ per month in the previous space.

The data shows a 92% savings in operating costs between the reference model and the actual building performance. Based on the one year performance data, it is estimated that the payback period is 5.5 years.

5.5 year payback of total investment

3,232.71 R$* saved per year compared to previous office space

(*835 USD)



79% reduction in operating costs compared to previous office space

CONCLUSION

After evaluating the water and energy consumption performance of the first LEED v4 building in Brazil, the real and significant economic gains are clear. The environmental benefits include increased energy efficiency, reduced greenhouse gas emissions. The building reduced demand on potable water sources while avoiding the energy and chemical treatment required for water treatment.

As for the payback, or return on investment, it is important to emphasize that the economic gains with a sustainable building go far beyond the water and energy bills. Controle Prestação de Serviços has benefited from higher employee productivity, brand enhancement, and increased resale value on the building. If these additional benefits were accounted for in financial terms, the additional investment in sustainable building would be reflected in a shorter payback period.

As the first LEED v4 building in all of Brazil, Espaço LarVerdeLar serves as an inspiration for any building project, large or small. The project is proof that green building strategies result in economic, environmental and social benefits for all.

For more information (in Brazilian Portuguese): http://espaco.larverdelar.com.br

OPERATING COSTS (in Brazilian Real R$/Year)

Month-Year	Reference Model	Historical – Previous Headquarters	Real Cost
Apr-17	1,050.19	390.39	127.27
May-17	773.11	327.02	83.24
Jun-17	696	302.48	102.44
Jul-17	676.88	296.18	60.83
Aug-17	680.9	301.65	86.27
Sep-17	701.62	309.57	99.26
Oct-17	830.5	328.86	41.67
Nov-17	898.81	381.87	17.24
Dec-17	813.84	350.72	93.27
Jan-18	807.49	346.03	47.82
Feb-18	914.99	345.89	14.84
Mar-18	984.02	380.53	54.32
TOTAL	**9,828.35**	**4,061.19**	**828.48**