

CASE STUDY 04: NIAMA | LA REUNION



GEOGRAPHICAL AND CLIMATE INFORMATION

Location	Ravine Blanche, Saint-Pierre, La Réunion, France
Latitude; Longitude	-21.337417747378176, 55.46382756587495
Climate zone (Köppen–Geiger classification)	Aw: Equatorial savannah with dry winter

BUILDING INFORMATION

Building Type	RESIDENTIAL - Collective Social Housing
Project Type	New construction
Completion Date	End of year 2014
Number of buildings	1
Number of storeys	4
Total Floor Area (m ²)	-
Net Floor Area (m ²)	1695
Thermally conditioned space area (m ²)	0
Spaces with Natural Ventilation (with or without Ceiling Fans) Only (m ²)	1363 (all apartments are naturally ventilated)
Total cost (€)	3 219 000 (all taxes included)
Cost /m ² (€/m ²)	1 899
Performance Standards or Certification	RTAADOM (Thermal, Acoustic and Ventilation Regulation in the overseas department)
Awards	None

STAKEHOLDERS

Building Owner/ Representative	SIDR (Social landlord)
Architect / Designer	Co-Architectes - peyrebonne@co-architectes.com
Construction manager	BTB
Environmental consultancy	-
Structural Engineer, Civil Engineer	Integrale Ingénierie
Product Manufacturer	-
Certification company	-



PROJECT DESCRIPTION [1] [2] [3]



Located in the eco-neighbourhood of 'Ravine Blanche', in Saint-Pierre, La Réunion, 'Niama' is a new social housing operation that was completed in the end of the year 2014. Niama is compliant with the Thermal, Acoustic and Ventilation French Regulation for the overseas territories (in French: Réglementation Thermique, Acoustique et Aération or RTAA DOM). The RTAADOM is applied to the design of new residential buildings only and requires mandatory rules concerning thermal, acoustic and ventilation performances. The four-storey building includes a total of 19 units. The building includes passive features such as cross natural ventilation and solar shading devices so as to enhance thermal comfort while reducing energy consumption.

Figure 49: Northern Facade of the 'Niama' social housing building. Photo credits: N. Peyrebonne.

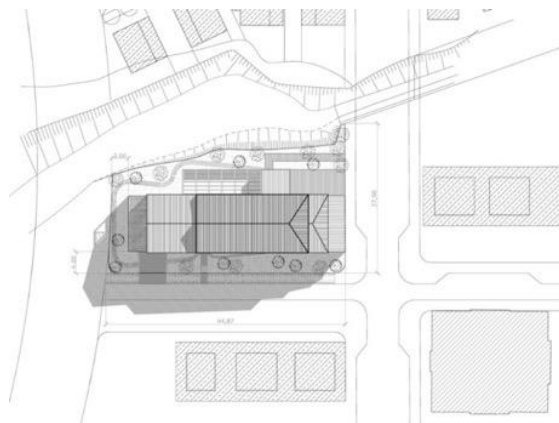


Figure 50: Master plan of 'Niama'. Design: Co-architectes.

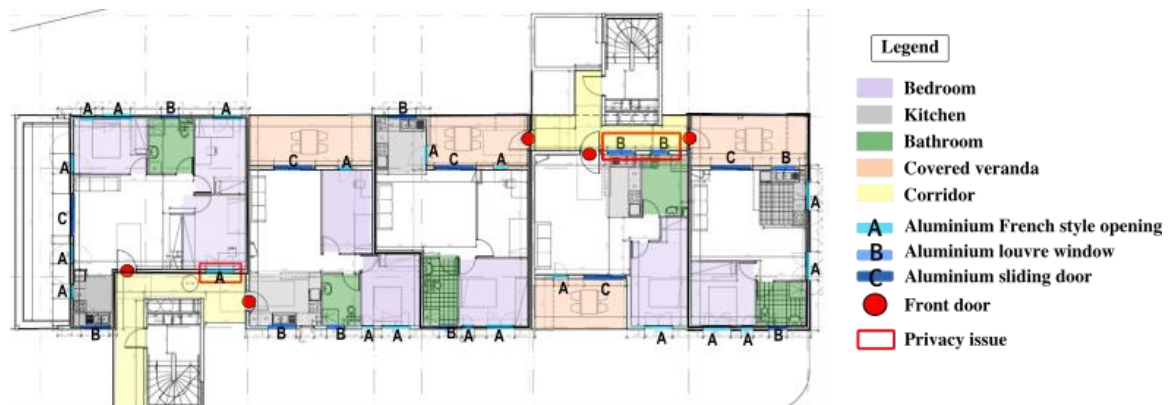


Figure 51: Floor plan of the first floor of the Niama building [1]. Design: Co-architectes.

SITE INTEGRATION



Niama is closed to a new urban park, both part of an urban renewal program that aims at restructuring the neighbourhood and connecting it to the city center. The new park, which was part of the process of urban tissue restructuring of the neighborhood, is a green lung for the city of Saint-Pierre. Niama has been harmoniously integrated between the vegetated area of the new park and the mineral area of the existing buildings. The building is surrounded by native plants and trees. The East facade of the building is more mineral with light-coloured painted walls and metal cladding whereas on the urban park side, it is the wood materials that prevail.

CLIMATE ANALYSIS

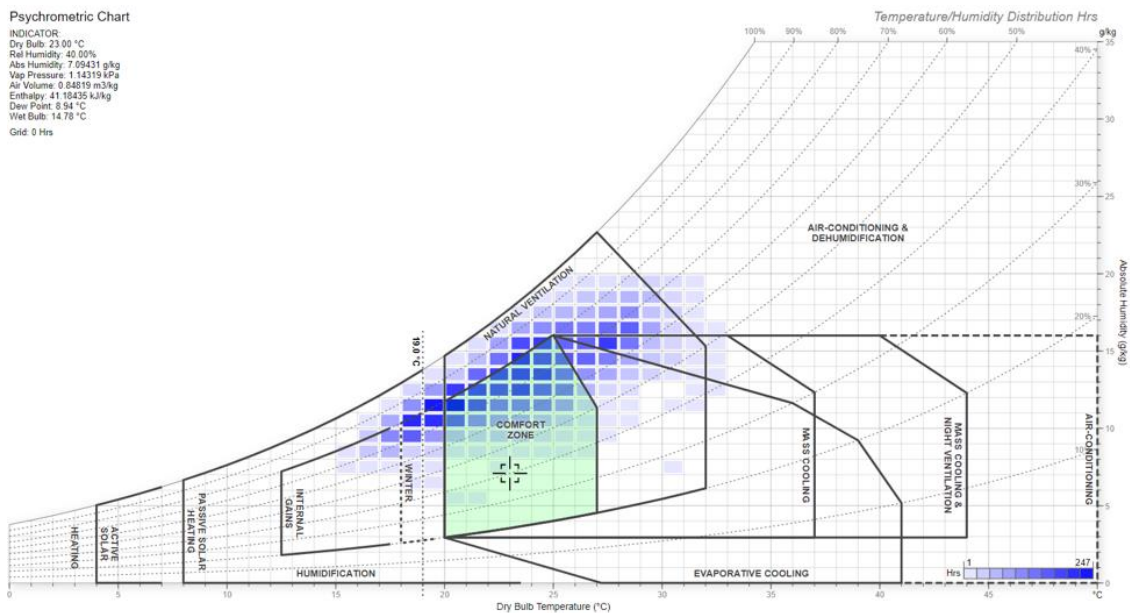


Figure 52: Givoni Bioclimatic chart for the climate of Saint-Pierre using Andrew Marsh tool. [4]

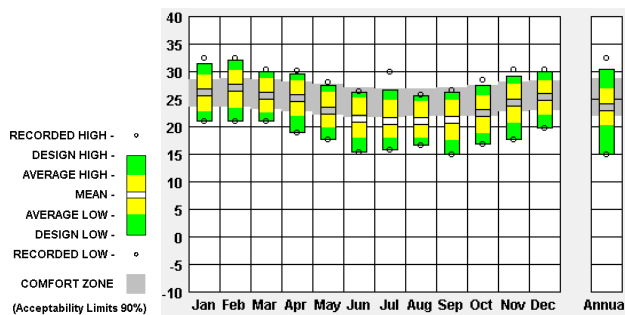


Figure 53: Temperature range by month for Saint-Pierre. Source: Climate consultant - Adaptive Comfort model [5]

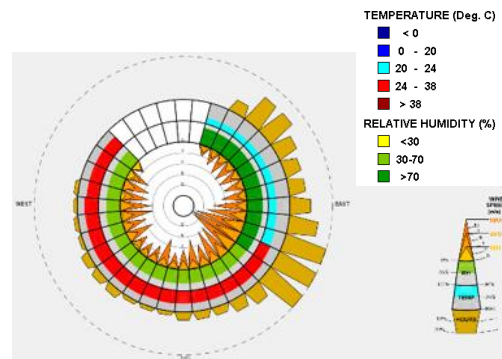


Figure 54: Wind rose for Saint-Pierre [5]

Global horizontal radiation (Avg daily total) Min (month) / Max (month)

Min: **3 933** Wh/m² (Jun)
 Max: **7 580** Wh/m² (Dec)
 Mean: **5 750,25** Wh/m²

Annual Degree-Days for weather classification according to ASHRAE Standard 169-2020	HDD 18°C: 9 CDD 10°C: 4977
Annual Degree-Days for the Adaptive Comfort Base Temperature according to the ASHRAE 55-2017 for 80% of acceptability	HDD: 158 CDD: 8
Annual Degree-Days for a static comfort temperature approach	HDD 18.6°C: 20 CDD 26°: 171

KEY BIOCLIMATIC DESIGN PRINCIPLES [1] [2] [3]

Passive cooling strategy	<p>Comfort ventilation</p> <p>The building is naturally cross ventilated thanks to its optimal orientation and the use of glass louvers located on opposite facades, with a high porosity.</p>
Passive heating strategy	None
Solar protection	<p>Main facades and windows are solar protected thanks to fixed vertical or horizontal solar protection depending on the orientation. The exterior facades of the lowest storey are made in light painted concrete. The two last storeys of the building, which are more solar exposed, are covered in wood or clear sheet metal siding facade. Solar absorptivity is low and prevents overheating of exposed parts. Exterior verandas also aim at preventing the sun from entering the building.</p>
Building orientation	The North/South orientation of the apartments allows to optimize sun protection and to maximize the effect of thermal breezes.
Insulation	<p>The roof is composed of an insulated sheet metal complex "Mauka Brizz" (from ArcelorMittal) and 13mm of plasterboard.</p> <p>Concerning the exterior walls, each floor is composed of different materials according to the facade orientation and the sun exposure. The walls on the first floor are composed of 2cm of expanded polystyrene and an air gap of 0,5 cm. On the last floor, the walls are insulated thanks to 2cm of wood, 3cm of expanded polystyrene and an air gap of 10cm.</p>
Vegetation	The building is surrounded by native plants and benefits from its proximity to the urban park.
Natural daylighting	Large windows allow to benefit from natural lighting.
Use of local and embedded materials	None
Water saving and heat recovery on hot water drain	-
Waste management	-
Others features	<p>The building is surrounded by native plants and benefits from its proximity to the new urban park, to public transport and bicycle path.</p> <p>The building includes an underground car park so as to maximise the vegetation and common areas around the building while reducing the heat island effect due to asphalt pavement.</p>



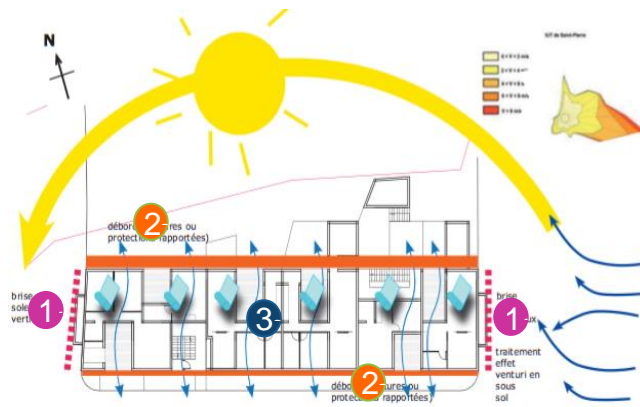


Figure 55: Bioclimatic strategies set up [1].
Design :Co-architectes

The passive solutions are described below:

- 1: Fixed vertical solar shading, louvered shutter on the East side so as to protect from the morning sunlight and the trade winds; Pergola on the West side.
- 2: Solar protection measures on the main facades include simple roof overhang, fixed horizontal solar shading and sun and rain protected exterior veranda.
- 3: Inside porosity is maximized by the use of louvers on opposite facades, allowing cross natural ventilation.

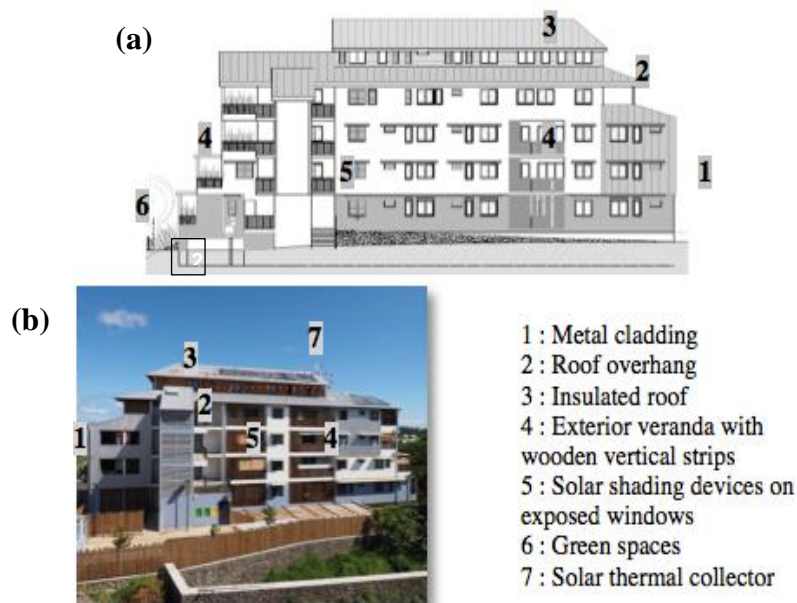


Figure 56: (a) South Façade and (b) North Façade of 'Niama', Saint-Pierre, Reunion Island [1]. Design: Co-architectes. Photo credits: N. Peyrebonne.



Figure 57: Solar protection strategies [3]. Photo credits: N. Peyrebonne.

INFRASTRUCTURES and REGULATIONS to enable SUFFICIENCY ACTION

Dressing code	Informal dressing, adapted to the season, is welcome and promoted (e.g. short trousers and short leaves in hot periods): Yes
Protected bike parking and showers	Yes The building includes a bike parking of 17,30m ² on the first underground level Ratio with number of users: -
Ceiling fans	In every room, even those conditioned: No Ceiling fans have only been installed in the bedrooms but not in the living rooms.
Lighting system fractioned to allow using light only in zones occupied and where daylighting insufficient	In every room, even those conditioned: No The building is equipped with timer switch for the lighting control in the common areas (corridor, car park, exterior)
Space and facilities for line drying clothes (especially important in residences, hotels, sport facilities...)	In every room, even those conditioned: Yes The exterior verandas with the vertical wood strips provide an optimal space for drying clothes.
Book of instruction for correct use of the passive features (windows, solar protections, water savings) and active (lighting...) in order to promote sufficiency and efficiency actions	Available through leaflets and posters at relevant places, online, etc: Unknow

BUILDING FABRIC AND MATERIALS

Roof	Type: Gable roof Materials: Insulated sheet metal complex Mauka Brizz (ArcelorMittal) + 13mm of plasterboard Overall R-value: 1,8 m ² K/W
Windows	Different types of windows: Aluminium French style opening windows, aluminium jalousie window and aluminium sliding door Window-to-wall ratio (WWR) : Superior to 20% on the main facades U-value: - Visual transmittance: -
Walls	Exterior Walls are composed from the outside to the inside: First floor (NSE orientation): 0,18m of concrete+ 0,02m of expanded polystyrene+ air gap of 0,005 m+0,013 m of plasterboard Overall R-value: 0,73 m ² .K/W Last floor (NSEO orientation): 2cm of wood+3cm of expanded polystyrene+ air gap of 10cm+1,3 cm of plasterboard Overall R-value: 1,06 m ² .K/W Other floors: Insulated sheet metal complex Mauka Brizz (from ArcelorMittal) + 0,025m air gap + 18cm of concrete Overall R-value: 0,46 m ² .K/W



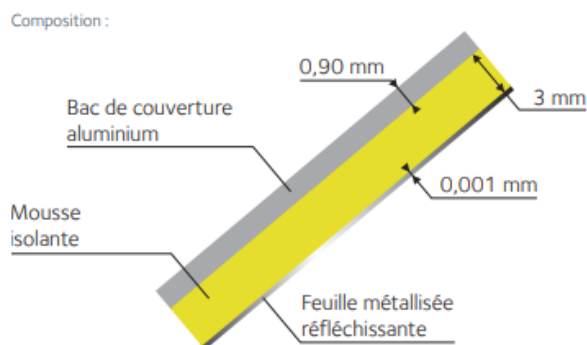


Figure 58: Mauka Brizz composition for hot climates (aluminium cover, insulating foam and metallised reflecting sheet). Design: @Arcelor Mittal



Figure 59: Exterior wall made with the Mauka Brizz system. Photo credits: N. Peyrebbonne.

ENERGY EFFICIENT BUILDING SYSTEMS [3]

Low-energy cooling systems	None The installation of ceiling fans and the design of the building so as to enhance cross natural ventilation and reduce direct solar heat gain allow to avoid the use of mechanical cooling systems.
Low-energy heating systems	None
Ceiling fans	All apartments are equipped with highly efficient ceiling fans, installed in the bedrooms: Type: Hunter Industry 2 BN - 1CF/10m2. Size diameter (cm): 132 Power: 16 to 70W 3 speeds with wall control
Mechanical ventilation / air renewal	None
Domestic Hot Water	Domestic hot water for all the units of the building is produced thanks to 40 m ² of solar thermal collectors. Individual water tanks are installed in each apartment.
Artificial lighting	Exterior and car park: PALERMO T5 - 2*49W Hallway and stairway: Downlight Jumbo Tridonic 2*42W Controls: timer switch
Control and energy management	The common areas are equipped with timer switch for the lighting control.



Figure 60: Energy efficient systems installed in the building

RENEWABLE ENERGY [3]	
PV	None
Solar thermal	Yes EZINC - Model E23HP-V Total area= 40m ²
Wind	None
Geothermal	None
Biomass	None



Figure 61 Solar thermal solar panels are installed on the rooftop of the building for the production of hot water

BUILDING ANALYSIS AND KEY PERFORMANCE INDICATORS

Thermal comfort indicators

1. Percentage of time outside an operative temperature range (Adaptive)
2. Percentage of time outside an operative temperature range (Fanger)
3. Degree-hours (Adaptive)
4. Degree-hours (Fanger)
5. Percentage of time inside the Givoni comfort zone of 1m/s: **>80%** (see Figure 62 et 64)
6. Percentage of time inside the Givoni comfort zone of 0m/s: **< 5%** (see Figure 62 et 64)
7. Number of hours within a certain temperature range : Cooling season (1st-02 to 31th-03)

Bedroom-First floor			Bedroom – third floor		
Range	N° of Hours	Frequency	Range	N° of Hours	Frequency
<26	55	3,93%	<26	0	0,00%
26≤T<28	660	47,14%	26≤T<28	620	44,29%
28≤T<30	605	43,21%	28≤T<30	760	54,29%
30≤T<32	80	5,71%	30≤T<32	20	1,43%
T≥32	0	0,00%	T≥32	0	0,00%

1. Energy needs for heating (kWh/y/m2)
2. Energy needs for cooling (kWh/y/m2)



Energy performance indicators		3. Energy use for lighting (kWh/y/m ²)	
		4. Energy needs for Sanitary Hot water (kWh/y/m ²)	
		5. Total Primary energy use (kWh/y/m ²)	
		6. Renewable Primary energy generated on-site (kWh/y/m ²)= 0	
		7. Renewable Primary energy generated on-site and self-consumed (kWh/y/m ²) = 0	
		8. Renewable Primary energy exported to the grid (kWh/y/m ²)= 0	
		9. Ratio of renewable primary energy over the total primary energy use (with and without compensation) (%)= 0	
		10. Delivered energy (kWh/y/m ²) (from electricity bills) = 30,5	
	Acoustic comfort indicators		1. Airborne sound insulation
			2. Equivalent continuous sound Level
		3. HVAC noise level	
		4. Reverberation time	
		5. Masking/barriers	
Visual comfort indicators		1. Light level (illuminance)	
		2. Useful Daylight Illuminance (UDI)	
		3. Glare control	
		4. Quality view	
		5. Zoning control	
Indoor Quality indicators	Air	1. Organic compound	
		2. VOCs	
		3. Inorganic gases	
		4. Particulates (filtration)	
		5. Minimum outdoor air provision	
		6. Moisture (humidity, leaks)	
		7. Hazard material	
Users' feedback		-	

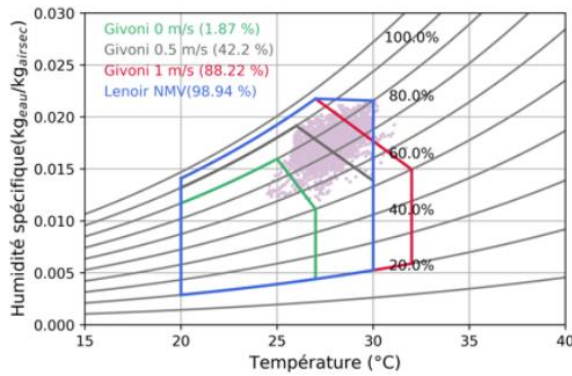


Figure 62 : Givoni Diagram obtained for the first floor, showing that less than 1% of time is in the 0m/s zone and more than 85% of time in the 1m/s comfort zone in the cooling season (1st Feb. to 31st March 2018).

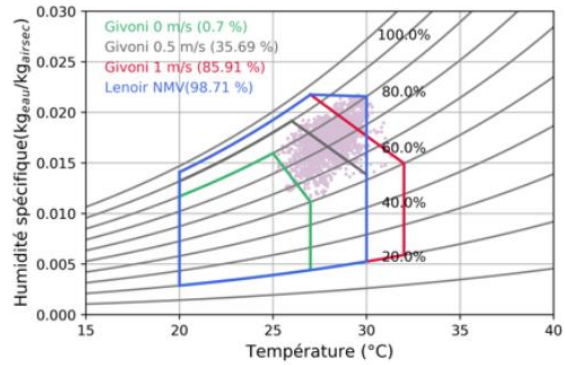


Figure 63 : Givoni Diagram for the third floor, showing that less than 1% of time is in the 0m/s zone and more than 85% of time in the 1m/s comfort zone in the cooling season (1st Feb. to 31st March 2018).

LESSONS LEARNED AND RECOMMENDATIONS

Lessons learned -

Recommendations -

BUILDING STRENGTHS AND WEAKNESSES

Strengths



Passive Design



Energy Efficiency

Weaknesses

-

REFERENCES

[1] Grosdemouge Virginie, et François Garde. 2016. « Passive design in tropical climates: Key strategies implemented in a French certified sustainable neighbourhood ». In PLEA 2016 Cities, Buildings, People: Towards Regenerative Environments.

[2] <https://www.envirobat-reunion.com/fr/portail/357/observatoire/46884/fiche-envirobat-reunion-niama-saint-pierre-co-architectes.html>

[3] <https://www.construction21.org/france/case-studies/h/niama.html>

[4] PD: Psychrometric Chart n.d. <https://drajmarsh.bitbucket.io/psychro-chart2d.html>(accessed May 7, 2021).

[5] Milne (UCLA) M. Climate Consultant 6.0. n.d. <http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php>.