CASE STUDY 1-04: 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: Tropical 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 (m²)	-
Net Floor Area (m²)	1695
Thermally conditioned space area (m²)	0
Spaces with Natural Ventilation (with or without Ceiling Fans) Only (m²)	1363 (all apartments are naturally ventilated)
Total cost (€)	3 219 000 (all taxes included)
Cost /m² (€/m²)	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	-

ABC21 is funded by the EU's H2020 programme

PROJECT DESCRIPTION [1] [2] [3]

Figure 55: Northern Facade of the 'Niama' social housing building. Photo credits: N. Peyrebonne.

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 deRTAADOM 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.

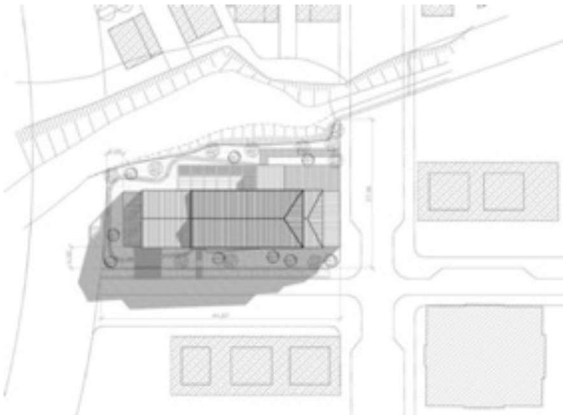
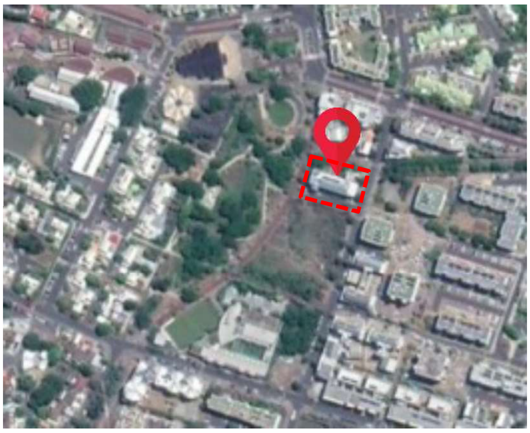


Figure 56: Master plan of 'Niama'. Design: Co-architectes.

Figure 57: Floor plan of the first floor of the Niama building [1]. Design: Co-architectes.

ABC21 is funded by the
EU's H2020 programme

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 vegetalised 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

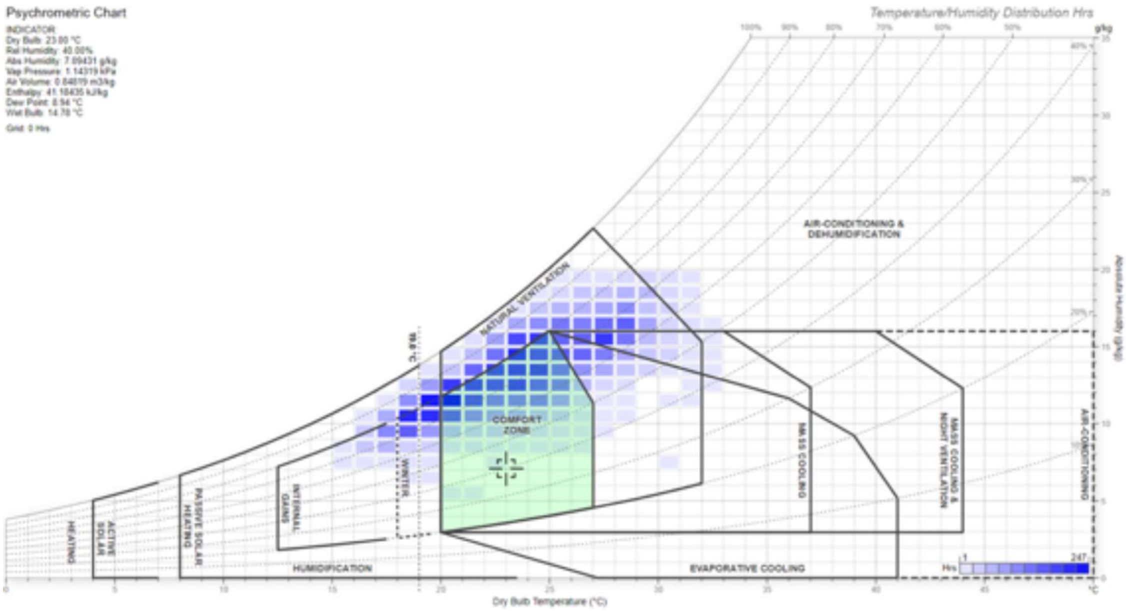


Figure 58: Givoni Bioclimatic chart for the climate of Saint-Pierre using Andrew Marsh tool. [4]

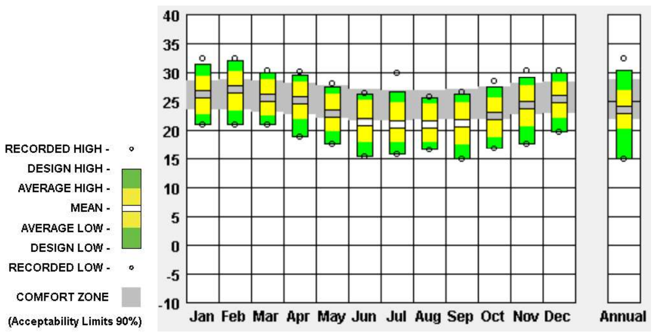


Figure 59: Temperature range by month for Saint-Pierre. Source: Climate consultant - Adaptative Comfort model [5]

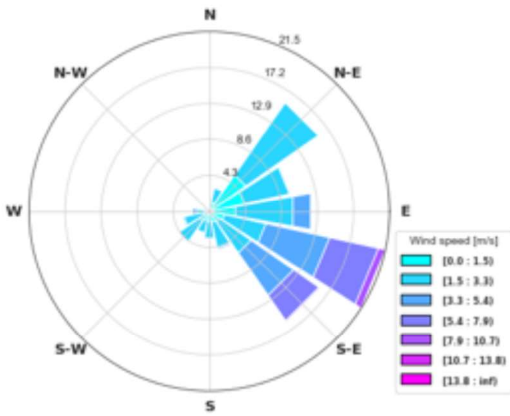


Figure 60:Annual wind rose for Saint-Pierre (Beaufort wind scale). [5]

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 18.6ºC: **20** CDD 26º: **171**

KEY BIOCLIMATIC DESIGN PRINCIPLES [1] [2] [3]	
Passive cooling strategy	Comfort ventilation 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.
Passive heating strategy	None
Solar protection	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.
Building orientation	The North/South orientation of the apartments allows to optimize sun protection and to maximize the effect of thermal breezes.
Insulation	The roof is composed of an insulated sheet metal complex "Mauka Brizz" (from ArcelorMittal) and 13mm of plasterboard. 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.
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	NA
Water saving and heat recovery on hot water drain	NA
Waste management	The building is equipped with a sorting for recyclable waste
Others features	The building is surrounded by native plants and benefits from its proximity to the new urban park, to public transport and bicycle path. 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.

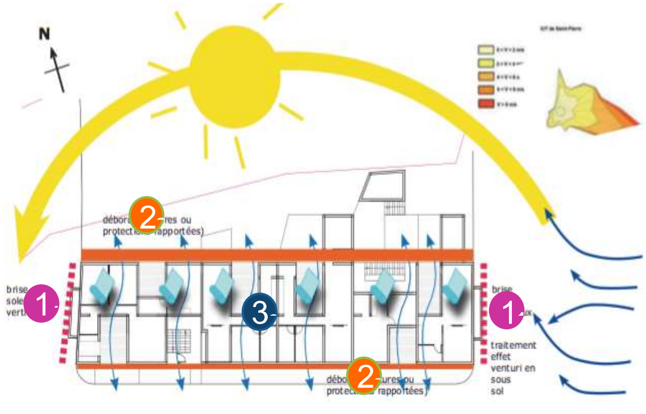


Figure 61: Bioclimatic strategies set up [1].
Design :Co-architectes

The passive solutions are described below:

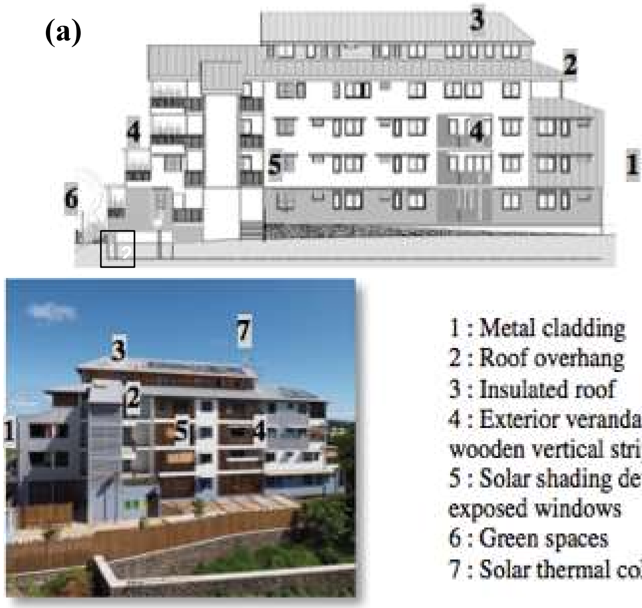
1: Fixed vertical solar shading, louvered shutter on the East side so as to protect from the morning sunlight and the trade winds; Pergola on the West side.

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.

(a)

(b)



1 : Metal cladding
2 : Roof overhang
3 : Insulated roof
4 : Exterior veranda with wooden vertical strips
5 : Solar shading devices on exposed windows
6 : Green spaces
7 : Solar thermal collector

Figure 62: (a) South Façade and (b) North Façade of 'Niama', Saint-Pierre, Reunion Island [1]. Design: Co-architectes. Photo credits: N. Peyrebonne.

Figure 63: 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 17,30m² 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 m²K/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 m².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 m².K/W
	Other floors: Insulated sheet metal complex Mauka Brizz (from ArcelorMittal) + 0,025m air gap + 18cm of concrete **Overall R-value:** 0,46 m².K/W

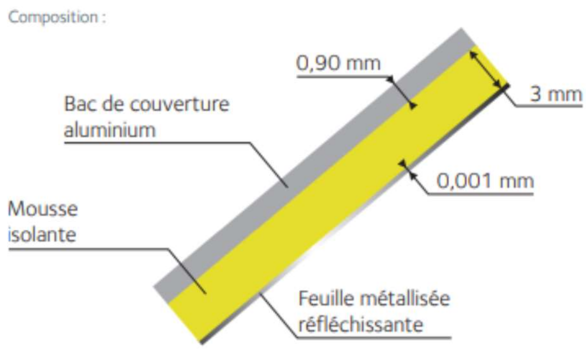


Figure 64: Mauka Brizz composition for hot climates (aluminium cover, insulating foam and metallised reflecting sheet). Design: @Arcelor Mittal

Figure 65: Exterior wall made with the Mauka Brizz system. Photo credits: N. Peyrebonne.

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 m² 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 66: 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 67 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 model): -
	2. Percentage of time outside an operative temperature range (Fanger model): -
	3. Degree-hours (Adaptive comfort model): -
	4. Degree-hours (Fanger comfort model): -
	5. Percentage of time inside the Givoni comfort zone of 1m/s: **cooling season: >80%** (see Figure 68 and Figure 69)
	6. Percentage of time inside the Givoni comfort zone of 0m/s: **cooling season: < 3%** (see Figure 68 and Figure 69)
	7. Number of hours within a certain temperature range: Hottest months of the cooling season (31th January to 8th April 2018)

Bedroom-First floor			Bedroom – Third floor		
Range	Nb of Hours	Frequency	Range	Nb of Hours	Frequency
Ta<26	**55**	4%	Ta<26	**0**	0%
26≤Ta<28	**660**	47%	26≤Ta<28	**620**	44,3%
28≤Ta<30	**605**	43%	28≤Ta<30	**760**	54,3%
30≤Ta<32	**80**	6%	30≤Ta<32	**20**	1,4%
Ta≥32	**0**	0%	Ta≥32	**0**	0%

Energy performance indicators	1. Energy needs for heating: **-** [kWh/m^2/year]
	2. Energy needs for cooling: **-** [kWh/m^2/year]
	3. Energy use for lighting: **-** [kWh/m^2/year]
	4. Energy needs for Sanitary Hot water: **-** [kWh/m^2/year]
	5. Total Primary energy use: **100.7** [kWh/m^2/year] (total Primary Energy Factor (PEF) equal to **3.3** for electrical energy from the grid)
	6. Renewable Primary energy generated on-site: **-** [kWh/m^2/year]
	7. Renewable Primary energy generated on-site and self-consumed: **-** [kWh/m^2/year]
	8. Renewable Primary energy exported to the grid: **0** [kWh/m^2/year]
	9. Ratio of renewable primary energy over the total primary energy use (with and without compensation): **- %**
	10. Delivered energy (from electricity bills) = **30,5** [kWh/m^2/year]
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 Air Quality indicators	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	A global satisfaction survey was carried out with the occupants in 2018. Thermal perception was evaluated according to a symmetrical 7-degree two-pole scale (from cold to hot). All the respondents felt neutral during the cold period while they globally felt hot during the summer, especially during the afternoon and the evening. The perception of air movement was also evaluated and perceived as neutral (neither still nor draughty). They found that natural ventilation is quite effective during the hot period and cited the lack of ceiling fans in the living room (only bedrooms are equipped with ceiling fans). Water infiltration issues and poor maintenance (ceiling fans, blinds) were also identified. Overall, the tenants are globally satisfied of their apartment with a score a 6.3 over 7 point with good natural daylight and air quality.

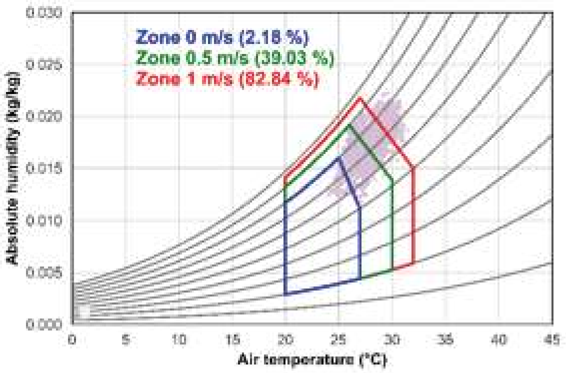


Figure 68 : Givoni bioclimatic chart obtained for a bedroom at the first floor, showing that only 2% of the points are in the 0m/s comfort zone while more than 82% are in the 1m/s comfort zone during the cooling season (31 January to 8th April 2018).

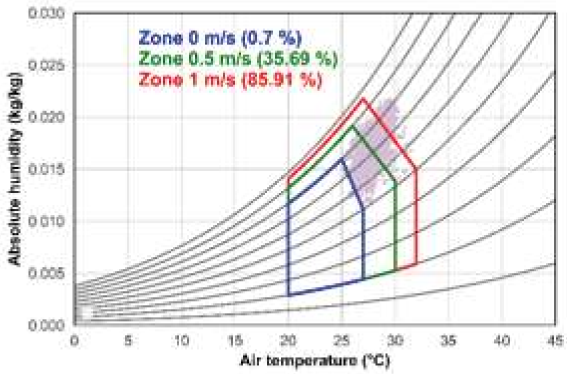


Figure 69 : Givoni bioclimatic chart obtained for a bedroom of the third floor, showing that less than 1% of the points are in the 0m/s zone while more than 85% are in the 1m/s comfort zone during the cooling season (31 January to 8th April 2018).

LESSONS LEARNED AND RECOMMENDATIONS	
Lessons learned	1. Use of local materials with low embodied energy and sustainable production (natural, reused or recycled) The choice of good quality material is of particular importance in achieving the goals of sustainable development in construction projects. 2. Building maintenance Proper and consistent building maintenance is essential for bioclimatic building in order to ensure comfortable conditions and makes it more durable over the time of the building. 3. Affordability and replicability of the buildings Only some passive bioclimatic systems or energy efficient systems could be replicable because of the use of a very elementary cooling system with natural ventilation.
Recommendations	1. Passive cooling and/or passive ventilation Buildings should be designed limiting privacy issues so as to be sure that the occupants can open the windows and that natural ventilation can correctly operate 2. Energy efficient systems All living rooms should be equipped with ceiling fans. The timer switch for the lighting control could be extended also to the private flats. 3. Use of local materials with low embodied energy and sustainable production (natural, reused or recycled) The use of local and natural materials in the project would have been recommended. It would be better to use natural materials for insulation instead of polystyrene.

BUILDING STRENGTHS AND WEAKNESSES

Strengths

	
Passive Design	**Energy Efficiency**

Weaknesses

1. The lack of ceiling fans in the living room (only bedrooms are equipped with ceiling fans);
2. Water infiltration issues and poor maintenance (ceiling fans, blinds);
3. Rapidly degrading construction materials;
4. Privacy issues due to the windows of the bedrooms overlooking the common corridors of the building.

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.