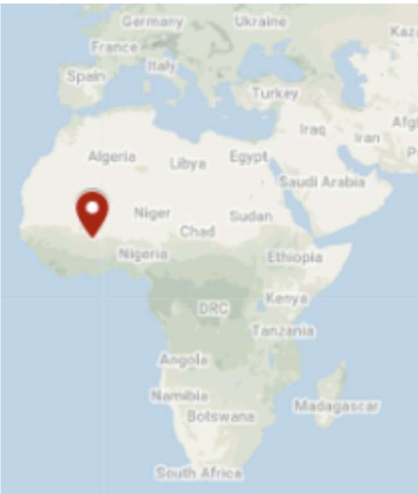
CASE STUDY 2-06: BURKINA INSTITUTE OF TECHNOLOGY | BURKINA FASO



GEOGRAPHICAL AND CLIMATE INFORMATION	
Location	B.P. 322, Koudougou, Burkina Faso
Latitude; Longitude	12.218139628590144, -2.378258705093982
Climate zone (Köppen–Geiger classification)	BSh: Hot semi-arid steppe
BUILDING INFORMATION	
Building Type	Educational
Project Type	New construction
Completion Date	2020
Number of buildings	1 (6 modules)
Number of storeys	1
Total Floor Area (m²)	1000
Usable Area (m²)	54 per classroom / 378 in total
Thermally conditioned space area (m²)	0 m^2
Spaces with Natural Ventilation (with or without Ceiling Fans) Only (m² of usable area)	378
Total cost (€)	Unknown
Cost /m² (€/m²)	Unknown
Performance Standards or Certification	None
Awards	None
STAKEHOLDERS	
Building Owner/ Representative	Stern Stewart Institute & Friends
Architect / Designer	Kéré Architecture - Diébédo Francis Kéré
Construction supervisors	Diébédo Francis Kéré, Nataniel Sawadogo, Jaime Herraiz Martínez
Landscape design	Kéré Architecture
Structural Engineer, Civil Engineer	-

PROJECT DESCRIPTION

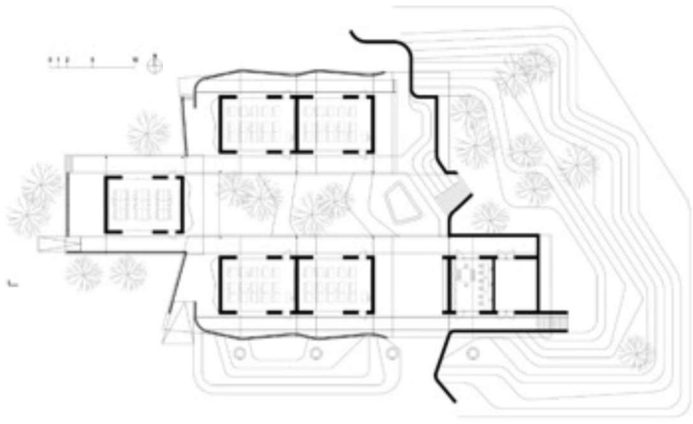


Figure 79 : Ground floor plan of the Burkina Institute of Technology. The modular structures are arranged to form a central courtyard. © Kéré Architecture

The architecture of the Burkina Institute of Technology is composed of a series of repeated and easily replicable rectangular elements, that house classrooms, lecture halls and auxiliary spaces. The modules are orthogonally aligned to zigzag, to always create a courtyard. This arrangement allows the campus to expand incrementally according to its needs. Each module of the building has been poured and cast in-situ into large formworks.
Two conference rooms were created later but these are not part of the study.

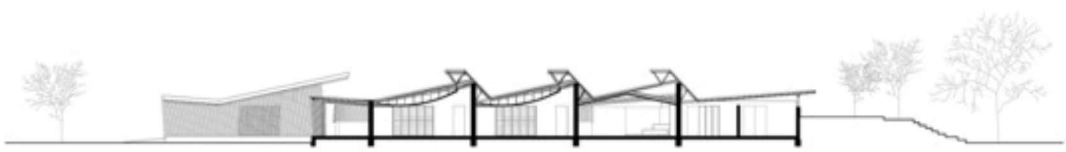


Figure 80 Section of the Burkina Institute of Technology. © Kéré Architecture

SITE INTEGRATION

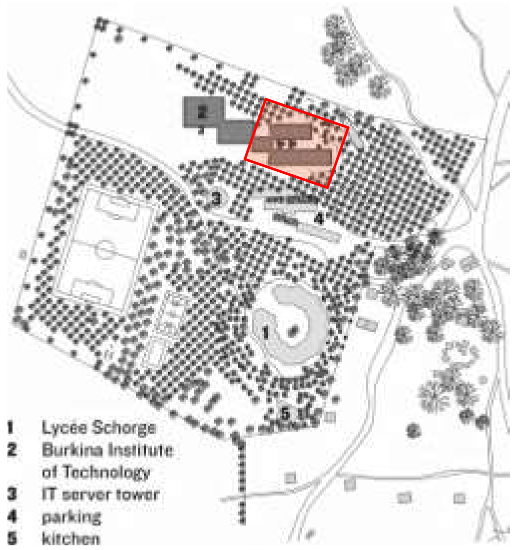


Figure 81 : (a) Aerial view (Source: Google Map) and and (b) site plan of the BIT.

The building is located on a desert flood plain of the city of Koudougou, in Burkina Faso. The site is characterized by a low building density and very little vegetation. The facility is an extension of the Schorge High School campus designed by the same architectural firm during a previous collaboration with the Stern Stewart Institute.

CLIMATE ANALYSIS

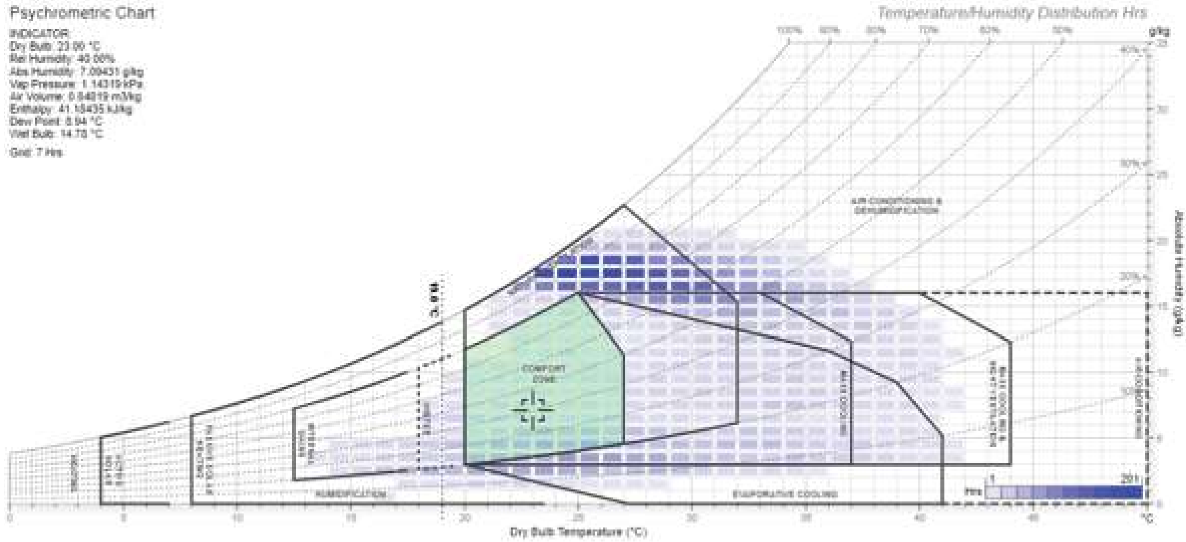
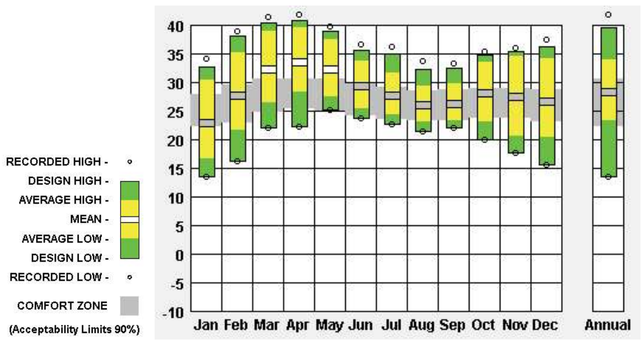


Figure 82: Givoni Bioclimatic chart for the climate of Koudougou using Andrew Marsh online tool [2]. Weather data are extracted from the PVGIS tool of the jrc for the 2007 – 2016 period.



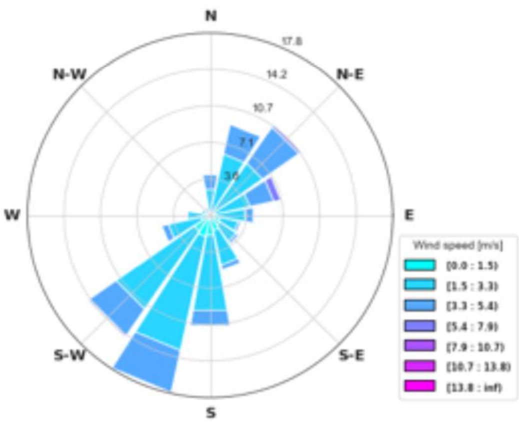


Figure 83: Temperature range by month for Koudougou, Burkina Faso (Source: Climate consultant – Adaptative Comfort model).

Figure 84: Wind rose for Koudougou, Burkina Faso

Global horizontal radiation (Avg daily total) Min (month) / Max (month)	Min: **5 685** Wh/m² (July) Max: **6 844** Wh/m² (May) Mean: **6 228,2** Wh/m²
Annual Degree-Days for weather classification according to ASHRAE Standard 169-2020	HDD 18°C: **8** CDD 10°C: **6 698**
Annual Degree-Days for the Adaptive Comfort Base Temperature according to the ASHRAE 55-2017	HDD: **72** CDD: **387**
Annual Degree-Days for a static comfort temperature approach	HDD 18.6ºC: **13** CDD 26º: **1 197**

KEY BIOCLIMATIC DESIGN PRINCIPLES	
Passive cooling strategy	Comfort ventilation Nocturnal convective cooling Thermal mass The modules are placed in a staggered formation to enhance airflow in and around the building. The large and adjustable wood louvers present on the walls allow the buildings to be naturally ventilated. In addition, the repetitive profiles on the roof allow for openings at the back of each module to naturally release warm air from the top through stack effect.

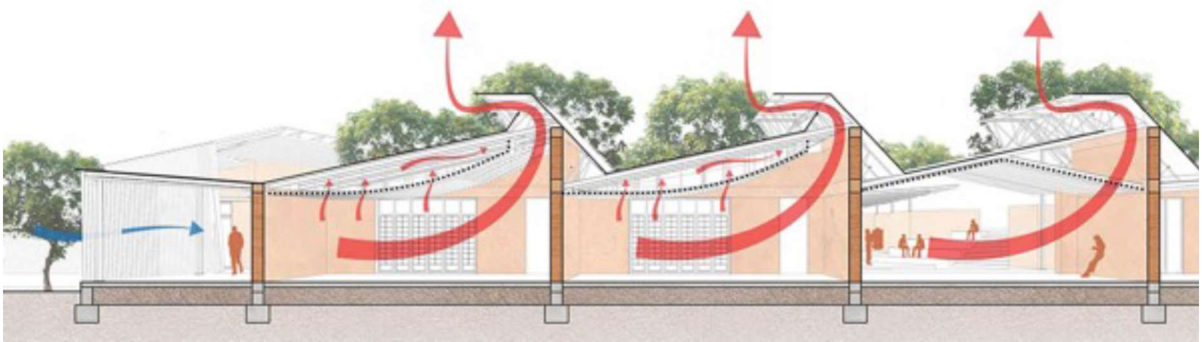


Figure 85: Section of the building showing the ventilation strategy.

Passive heating strategy	High thermal mass of the walls
Solar protection	Around each classroom are shaded corridors and walkways, framed by screens of locally sourced eucalyptus wood.
Building orientation	The lamella façades of the modules are North / South oriented.
Insulation	The massive clay walls of 35cm contribute significantly to cooling down the interior spaces.
Vegetation	The building is surrounding by a vegetable garden and trees such as mango, kapok, banana, papaya and baobab. Over 2,000 tree seedlings, planted by pupils and students as part of the institution's ecological commitment, will create a forest around the campus in a few years. This varied and rich landscape helps prevent flooding. A bench surrounds each seedling to protect it, and will create a comfortable spot in the shade.
Natural daylighting	Hung ceilings, made of local eucalyptus wood, brighten the interior spaces and the large openings with adjustable wood louvers allow enough light to enter the interior.
Use of local and embedded materials	The main structure of the building is made from poured local clay, cast in-situ, combined with concrete. Local eucalyptus wood has been used to cover the hung ceilings inside the rooms and to create the exterior "screens" that protect the classroom, the corridors and the walkways from direct solar radiation.
Water saving and flood management	An extensive landscape design has been planned in order to protect the building during the rainy season, since the site is located on a flood plain. The principle is based on channelling and storing water into a large underground tank, that is later used for the irrigation of the mango plantations present on the campus.

Waste management	Unknown

Figure 86: View of a corridor between the classroom and porous skin in eucalyptus wood © Kéré Architecture

Figure 87 : View of the classroom through the louvered openings © Kéré Architecture

Figure 88 : View of the interior ceilings made of local Eucalyptus wood.

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** Ratio with number of users: **-**
Ceiling fans	In every room, even those conditioned: **No**
Lighting system fractioned to allow using light only in zones occupied and where daylighting insufficient	In every room, even those conditioned: **Yes**
Space and facilities for line drying clothes (especially important in residences, hotels, sport facilities…)	In every room, even those conditioned: **No**
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.: **Yes**

BUILDING FABRIC AND MATERIALS	
Roof	The roof is composed of (from outside to inside): ▪ Metal sheet ▪ Air gap ▪ Eucalyptus wood (hung ceiling)
Windows	Unglazed windows Wood louvers
	Window-to-wall ratio (WWR): -
Walls	The **exterior and interior walls** are both composed of local **clay combined with concrete** and then poured and cast in-situ into large formworks of **35 cm.**

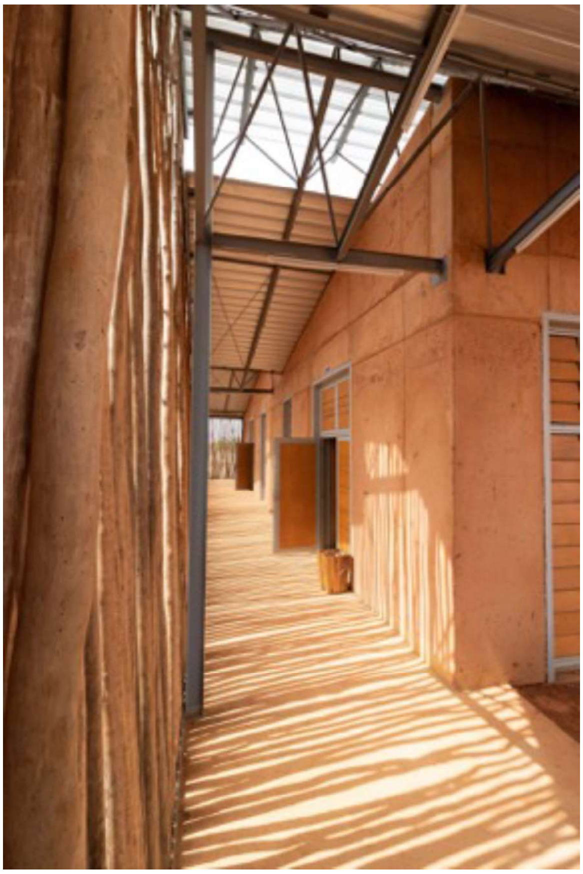


Figure 89: Roof openings allow warm air to be released. © Kéré Architecture

Figure 90: The modular structures are arranged to form a central courtyard. © Kéré Architecture

Figure 91: Eucalyptus wood was used to create a porous skin around the building to create a sense of unity with the rest of the campus. © Kéré Architecture

ENERGY EFFICIENT BUILDING SYSTEMS	
Low-energy cooling systems	None
Low-energy heating systems	None
Ceiling fans	None
Mechanical ventilation / air renewal	None
Domestic Hot Water	None
Artificial lighting	Fluorescent tubes
Control and energy management	None

RENEWABLE ENERGY	
PV	Type of technology: polycrystalline (Poly-Si) Efficiency:1kWp/m^2 Total Peak power installed :84.314 Kw Surface: 895.75m^2 Azimuth (degrees from south tilt angle):10°
Solar thermal	None
Wind	None
Geothermal	None
Biomass	None

Figure 92: Ground mounted solar PV system of the BIT.

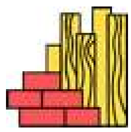
BUILDING ANALYSIS AND KEY PERFORMANCE INDICATORS	
Thermal comfort indicators	1. Percentage of time outside an operative temperature range (Adaptive)
	2. Percentage of time outside an operative temperature range (Fanger)
	3. Degree-hours (Adaptive)
	4. Degree-hours (Fanger)
	5. Percentage of time inside the Givoni comfort zone of 1m/s
	6. Percentage of time inside the Givoni comfort zone of 0m/s
	7. Number of hours within a certain temperature range
Energy performance indicators	1. Energy needs for heating (kWh/y/m2)
	2. Energy needs for cooling (kWh/y/m2)
	3. Energy use for lighting (kWh/y/m2)
	4. Energy needs for Sanitary Hot water (kWh/y/m2)
	5. Total Primary energy use (kWh/y/m2)
	6. Renewable Primary energy generated on-site (kWh/y/m2)
	7. Renewable Primary energy generated on-site and self-consumed (kWh/y/m2)
	8. Renewable Primary energy exported to the grid (kWh/y/m2)
	9. Ratio of renewable primary energy over the total primary energy use (with and without compensation) (%)
	10. Delivered energy (kWh/y/m2) (from electricity bills)
	1. Airborne sound insulation

Acoustic comfort indicators	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	-

LESSONS LEARNED AND RECOMMENDATIONS	
Lessons learned	The Kéré's team was able to take advantage of the experience gained during the construction of the "Naaba Belem Goumma" secondary school. The walls of the different modules were made of local clay cast on-site in large formworks. This innovative construction method offers the advantage of being faster and more flexible than traditional clay brick construction. As a result, the construction was completed in a very short time.
Recommendations	-

BUILDING STRENGTHS AND WEAKNESSES

Strengths

			
Passive Design	**Local Materials**	**Replicability**	**Affordability**

Weaknesses

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REFERENCES

1. https://www.kerearchitecture.com/work/building/burkina-institute-of-technology-bit
2. https://www.dezeen.com/2021/06/29/kere-architecture-burkina-institute-of-technology-architecture/
3. https://www.architectural-review.com/buildings/laying-down-roots-burkina-institute-of-technology-in-koudougou-burkina-faso-by-kere-architecture