Kigali, Rwanda

Towards Sustainable Cities and Neighborhoods
A New Neighborhood | Kigali, Rwanda

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Kigali, Rwanda
Site Location
Rwanda, Central Africa

Total Area: 26,000 km²
Population: ± 11 million
Capital: Kigali
“The Rwanda population is projected to increase from 10.5 million to 17 million in 2030”

Source:
http://www.statistics.gov.rw/publication/rphc4-population-projections
“Kigali’s master plan, prepared in 2013 by the Singapore-based firm Surbana, projects the city will be home to 4 million people by 2040”

Source:
“According to a 2012 City of Kigali study, the projected population increase and inadequacy of much of the city’s current housing stock mean Kigali will require 344,000 new housing units by 2022.”

Source:
Growth of Urban Area & Population in Kigali
Increased demand in housing and commercial

Rwanda Housing Authority
Integrated Development Project
RHA Unit Plan

3.5 Bedrooms
Outdoor Kitchen/WC

85 m2 total floor area

Cyclopean Stone
Foundation

Fired Clay Brick

Reinforced Concrete

Sawn Pine/Eucalyptus
Roof Frame

Corrugated Tin Roof
Gikomero Master Plan

Phase one:
- 156 units
- 190 new residents

Added amenities:
- Technology Hub
- Additional Sports Fields
- New School
- Cowsheds
Gikomero Master Plan

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Block of 39 units selected for analysis
Comparison: Daylighting

RHA protoblock

MIT protoblock

2720
Lighting Usage across five days in January

- MIT
- RHA
19% daylight saving
Thermal Comfort

Comfort Range 20-25°C
Overheating Hours
(0.3% of the year)

Comfort Range 20-27°C

2017

33 Overheating Hours

2050

1653 Overheating Hours
(20% of the year)
2080

4342 Overheating Hours
(50% of the year)
Cooling in 2080

27 °C  __________________________  210,233 kwh
29 °C  __________  117,773 kwh
31 °C  _____  56,962 kwh
33 °C  ___  28,958 kwh
35 °C  __  26,328 kwh
25% winds are higher than 2m/s

Most winds come from the south
Wind Ventilation Potential

Space between Brick Bond
2 m/s

1.02 Pa

-2.7 Pa

A New Neighborhood

Kigali, Rwanda
Peak flow inside = 2.5 m/s
“Although operating energy accounts for a much higher portion of CO2 and greenhouse gas emissions during the building lifecycle [2,15,17] (75%–90% operational compared to 10%–25% embodied carbon [14]), due to the negligible operational energy in Ugandan low-income housing, the embodied energy of building materials is key to evaluating the environmental impacts of the low-income housing sector.”

Hashemi, Cruickshank, and Cheshmehzangi, “Environmental Impacts and Embodied Energy of Construction Methods and Materials in Low-Income Tropical Housing.”

“According to Cabeza et al. [1], almost all available studies in the area of Life Cycle Assessment (LCA) and embodied energy have been carried out in developed countries, and there are no case studies in African countries. Ramesh et al. [2] also mention that most available studies on LCA are from “cold countries” where space heating is the major concern. There is therefore a clear gap in the literature regarding the environmental impacts and embodied energy of construction methods and materials in African countries.”
Electric Generation (15 yr Analysis)

Municipal Electric Grid  On-site Diesel Generation  Localized PV Generation
Loads (not considering cooling)

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<th>Equipment</th>
<th>Lighting</th>
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- 1.1 kWh/family
- 0.2 kWh/family

Total = 1.3 kWh/family or 0.325 kWh/person
Electric Grid (10,000 people)

Factors:

Distance to transport power to site - 8km
Distance to transport power on site - 12km
Cost of electricity - $0.32 / kwh
**Diesel Generation** (10,000 people)

**Factors:**

Diesel Generator Cost - $2,000,000 (for 200)
Distance to transport power on site - 12km
cost of fuel - $0.36 / kwh

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**Installation Cost**

- Diesel Generators
- On Site

- $2,000,000
- $235,000

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**Cost of Diesel Fuel**

Cost in U.S. Dollars

- $2,000,000
- $235,000

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Solar PV Generation (4 people)

Factors:

Potential Solar Radiation Generation
Amount of PV Area Coverage - 10% roof area
cost of PV system and Battery

Rwanda Sunpath

Solar PV Generation (4 people)

Installation Cost

- Battery
- PV Panel System

Cost in U.S. Dollars

- $8,000
- $3,000

Solar Radiation (kw)

PV Storage kwh

Surplus Energy

Deficit Demand

PV Surplus and Deficit

PV Generation

kw Demand
Energy Generation Normalized for 1 Person

Installation/person: Electric Grid ($35)  Diesel Grid ($223)  PV System ($2,750)

*not accounting for inflation or changes in price or technology
Lifestyle
Comparison: Daylighting

East West orientation and narrow floor plates increase day lighting potential.
Comparison: Density

RHA 4433

35 m²/per person

4.432/4.433

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2 story blocks
increase density

4.432/4.433
Comparison: Embodied Carbon

33.7m KgCO₂eq/m²

29m KgCO₂eq/m²

Shared walls and multi story construction reduces material per m² of building.
Comparison: Walkability

10 avg. walkability score

Shops, parks and pathways within the block increase reduces distance to amenities

63 avg. walkability score