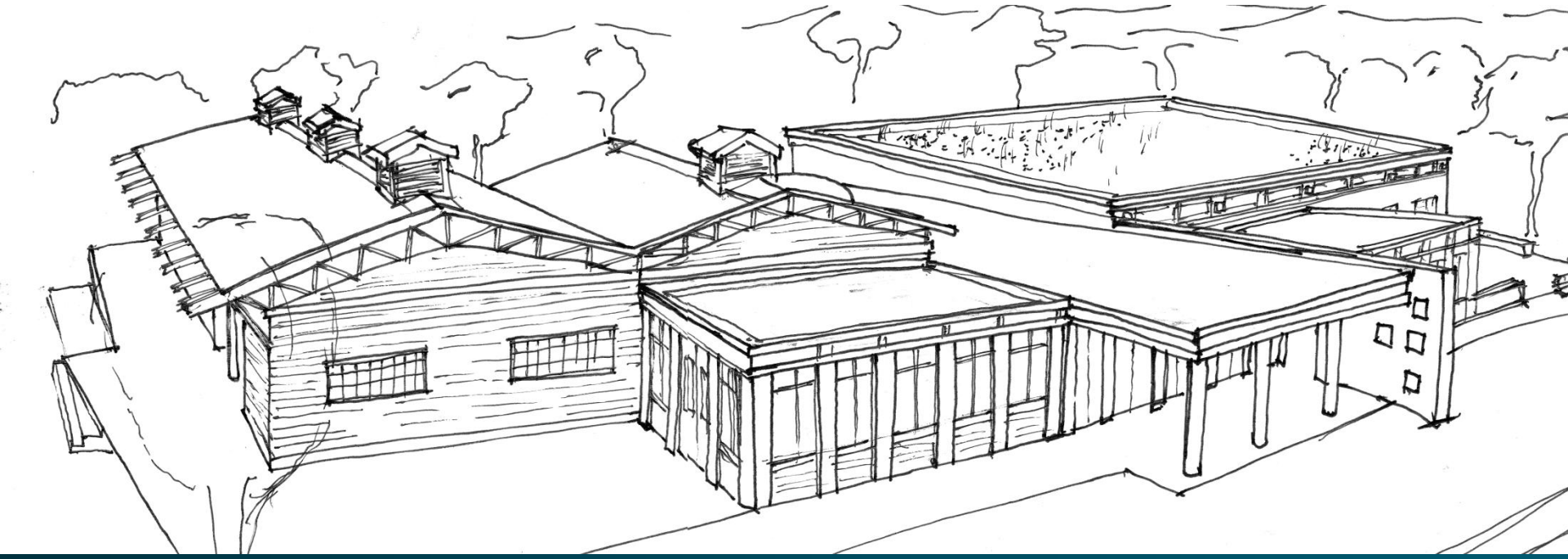

The Scales of Sustainable Design in Developing Nations:

Design of Akilah Institute in Rural Rwanda

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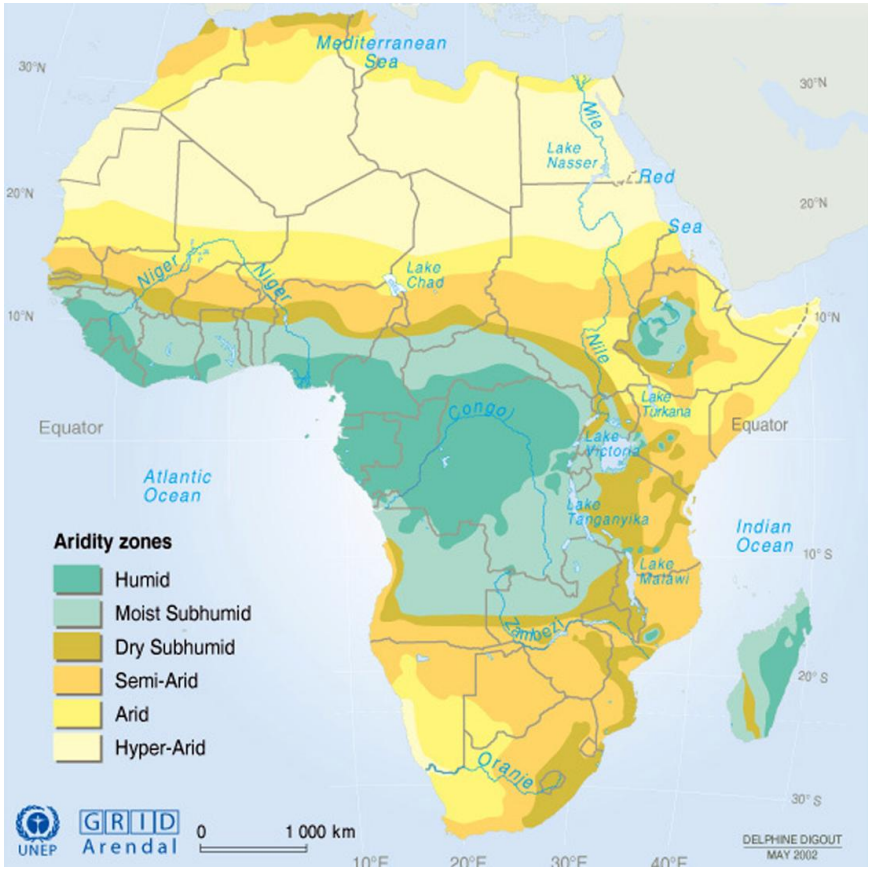
Agenda

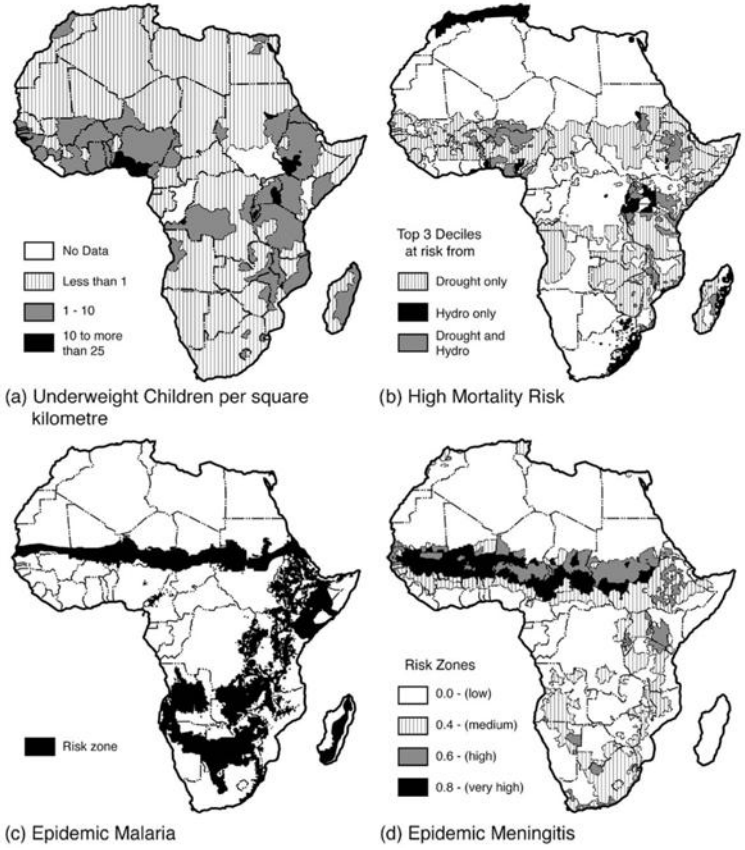
- Impact of Climate Change in Africa
- Impact of Climate Change in Rwanda
- Renewable Energy Resources
- Akilah Institute – Phase I Design
- Akilah Institute – Phase II Design

- To investigate the means by which built-environment professionals can mitigate the effects of climate change and natural disaster.
- To respond to an equatorial climate with high temperatures, intense solar exposure, sporadic rain fall, and increased seismic activity.
- To provide sustainable access to clean energy, water, and food.
- To improve community knowledge and capacity of local resources through the introduction of sustainable building methods and renewable energy technologies.
- To work with local organizations and other relief agents to develop solutions to create sustainable communities and stimulate market development.

Impact of Climate Change in Africa

Impacts And Vulnerabilities Associated With Climate Change In Africa





Source (L): World Meteorological Organization (WMO), United Nation Environment Programme (UNEP), *Climate Change 2001: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Source (R): Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, 2007: Africa. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof,* P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

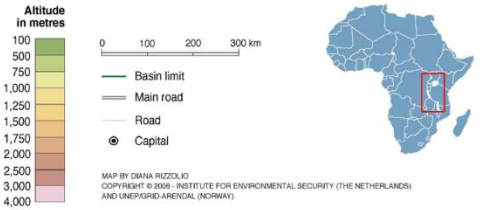
Impacts And Vulnerabilities Associated With Climate Change In Africa

East Africa:

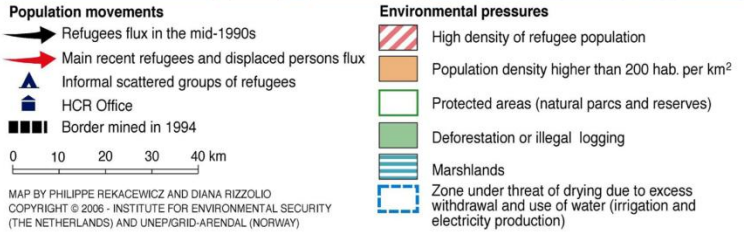
- Rainfall is likely to increase in some parts of East Africa, while other regions are likely to experience increased droughts.
- Previously malaria-free highland areas in Ethiopia, Kenya, Rwanda, and Burundi could experience increases in Malaria with increasing risk of transmission.
- Ecosystems impacts on mountain biodiversity could occur. Declines in Fisheries in some major Eastern Africa lakes could occur.

Source : Adapted from: Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, 2007: Africa. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof,* P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Water Basins

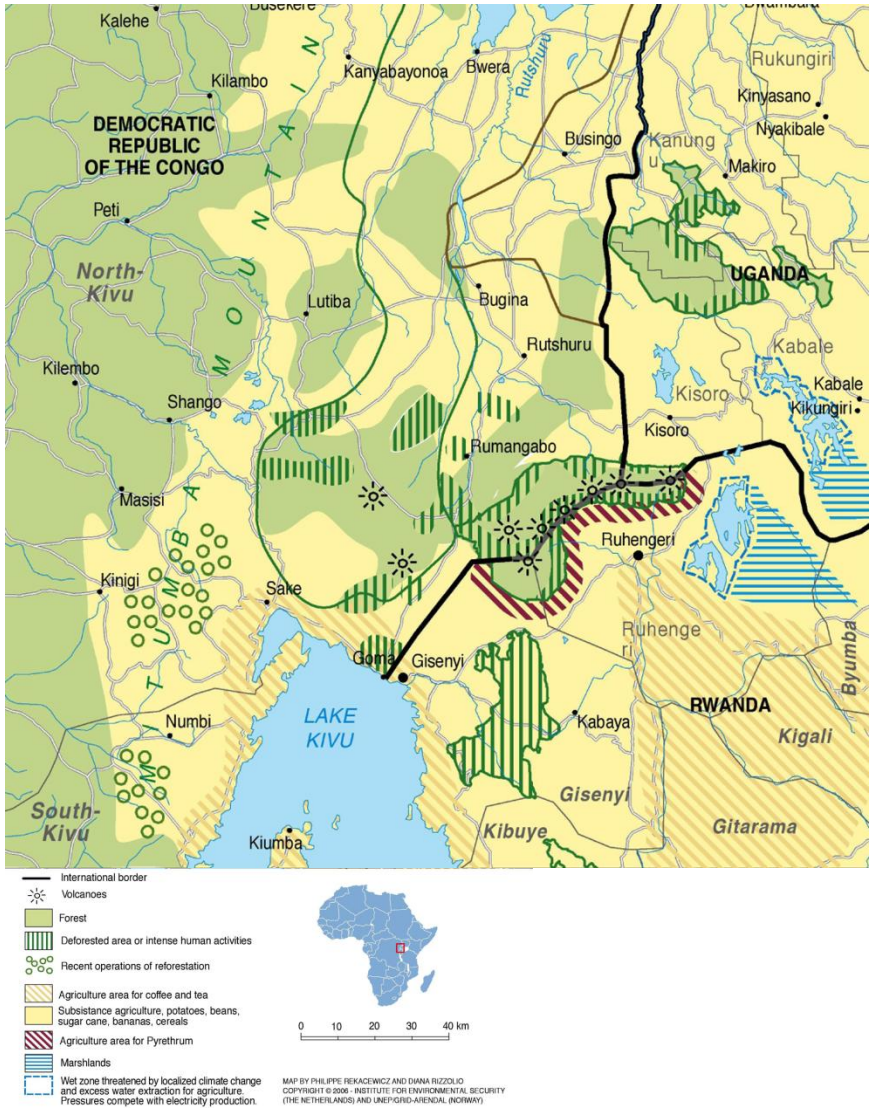


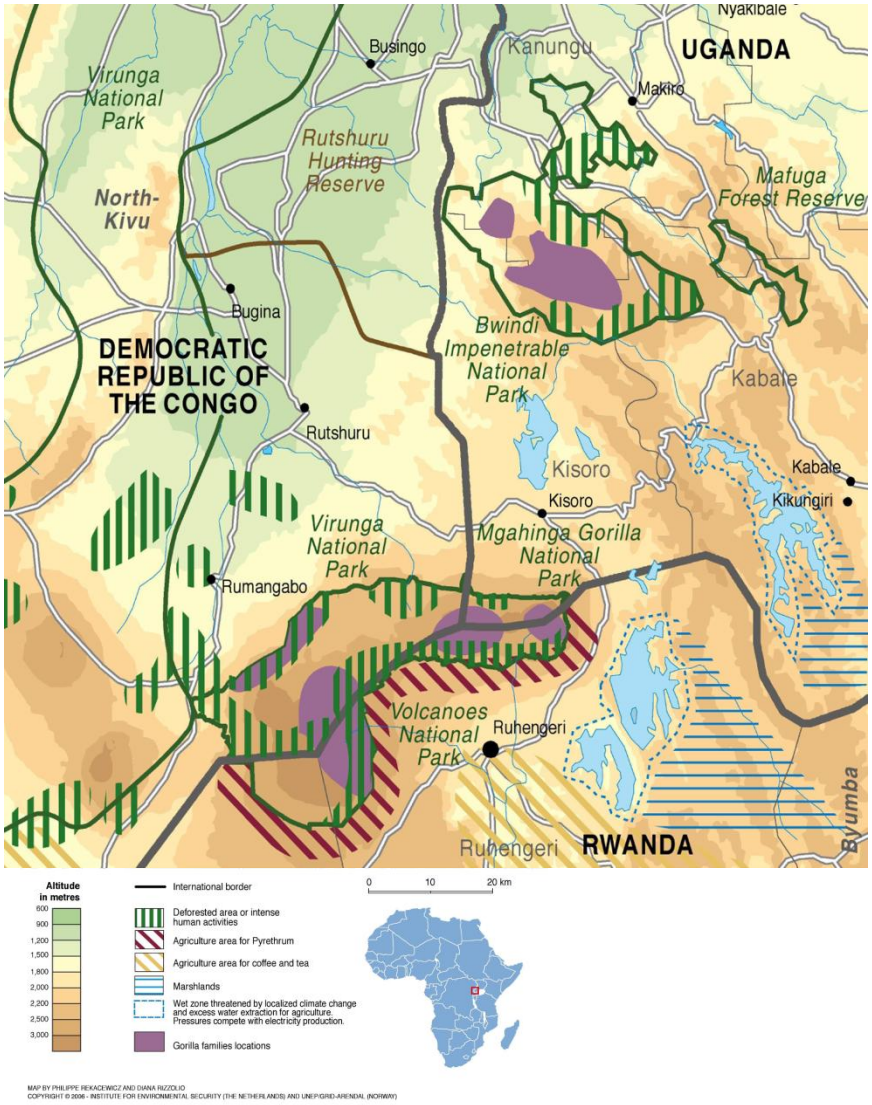
Population Movements & Environmental Pressures



Source: Institute for Environmental Security (IES) Field Survey; United Nations High Commissioner for Regugees (UNHCR); *International Campaign to Ban Landmines (ICBL),* www.ibcl.org/lm; Spatial data produced by FAO Africover

Land Use and Cover

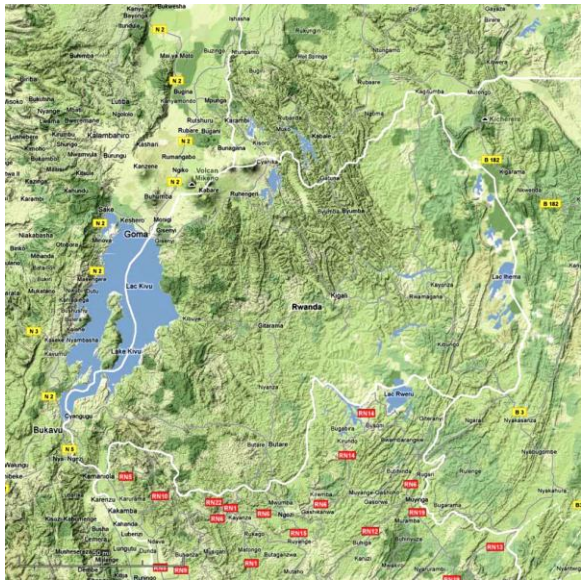


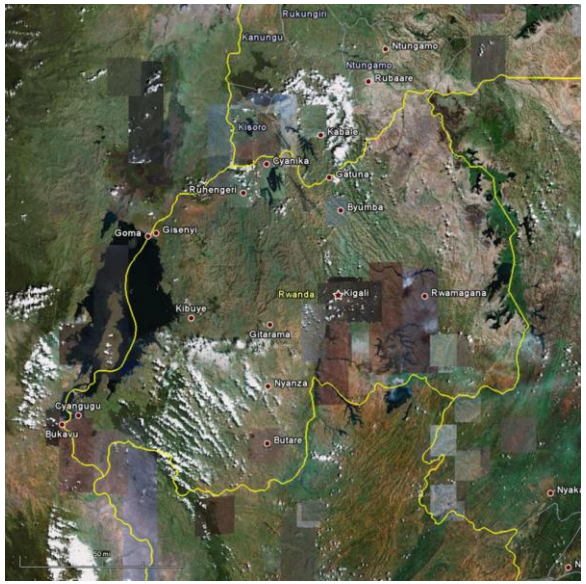


Source: Institute for Environmental Security (IES) Field Survey; United Nations High Commissioner for Regugees (UNHCR); *International Campaign to Ban Landmines (ICBL),* www.ibcl.org/lm; Spatial data produced by FAO Africover

Impact of Climate Change in Rwanda

Overview



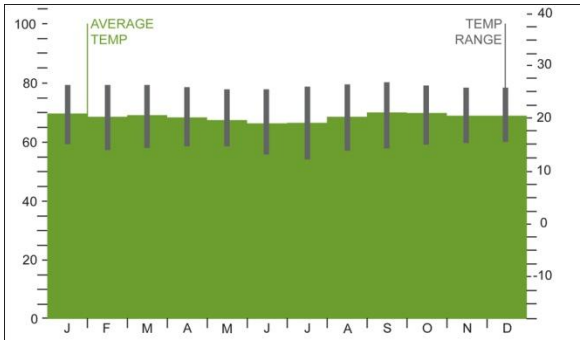


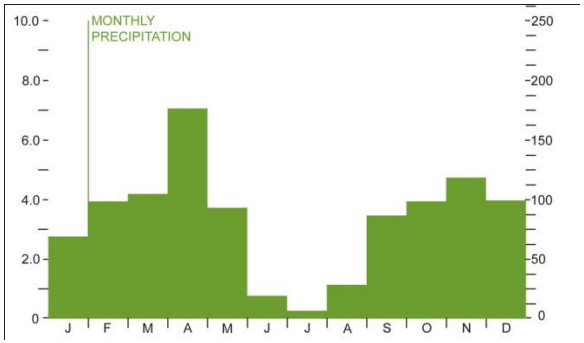
Climate: temperate: two rainy seasons; mild in mountains with frost and snow possible.

Terrain: mostly grassy uplands and hills; relief is mountainous with altitude declining from west to east.

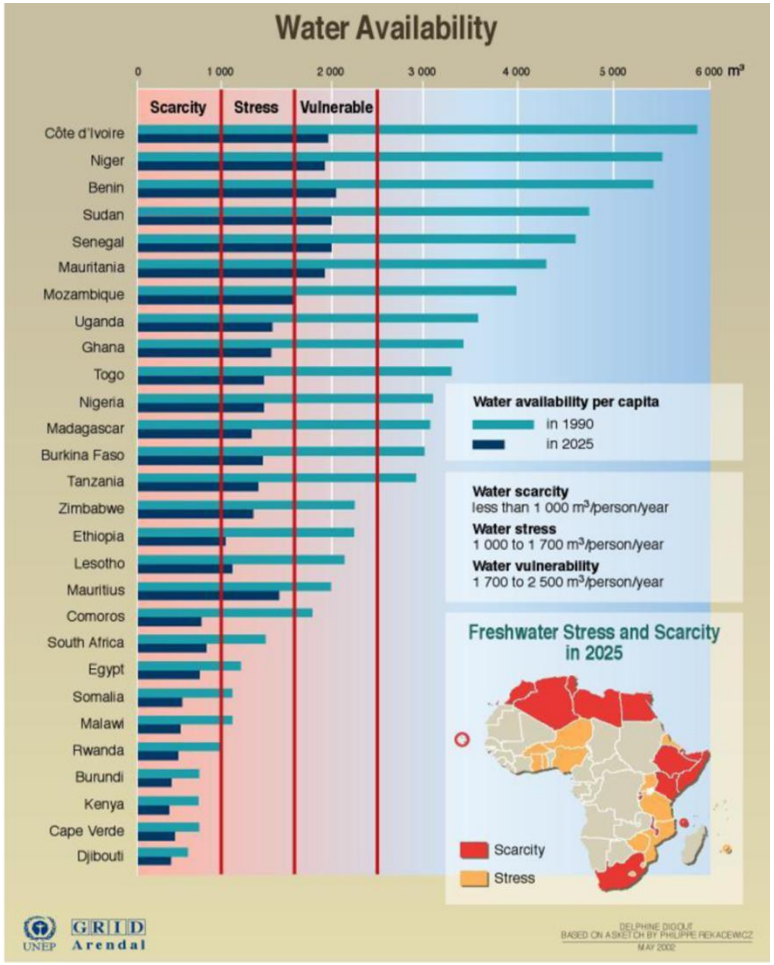
Access to Electricity: 5% of population (10,746,311)

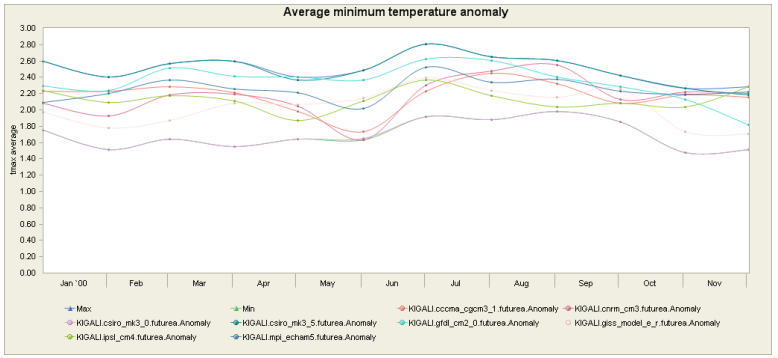
Forms of Electricity:
Biomass (Wood, Agriculture Byproduct) – 85%
Fossil Fuels – 9%
Hydropower – 5%
Solar – <1%
Wind – 0%

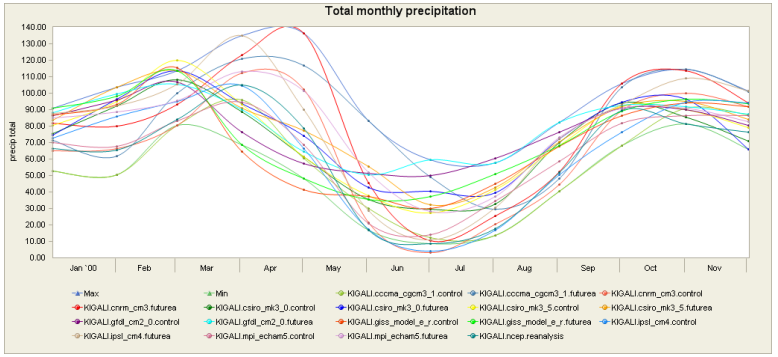


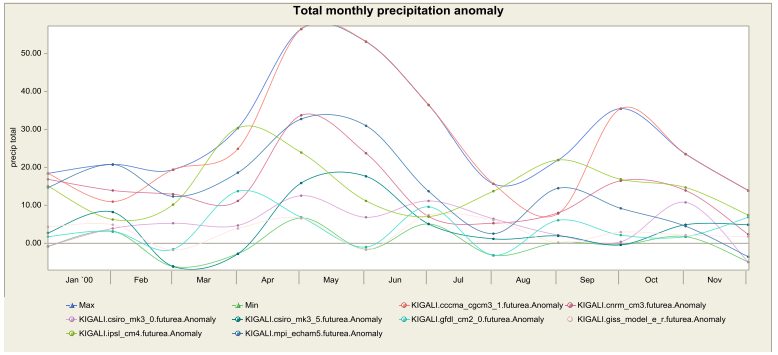


Current and Possible Future Variations in Temperature and Precipitation in Rwanda









Source (L): United Nations Economic Commission for Africa (UNECA), Addis Ababa; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

Source (R): Watkiss, Paul; Jane Olwoch, Tom Downing, Jillian Dyszynski. *Economic Impacts of Climate Change in Rwanda*. Department for International Development; DEW Point; Stockholm Environmental Institute. 23 February 2009.

Current Impacts and Vulnerabilities Associated with Climate Change in Rwanda

City Impressions of the Street in Kigali, Rwanda

Unpaved Streets within the Urban Area

Rusumo Falls before Rugezi's Degradation, 2000

Rusumo Falls after Rugezi's Degradation, 2005

Crop Failure due to Draught (2005, East Province)

Crop failure due to Floods (2007, West Province)

Destruction of Property (2006, North Province)

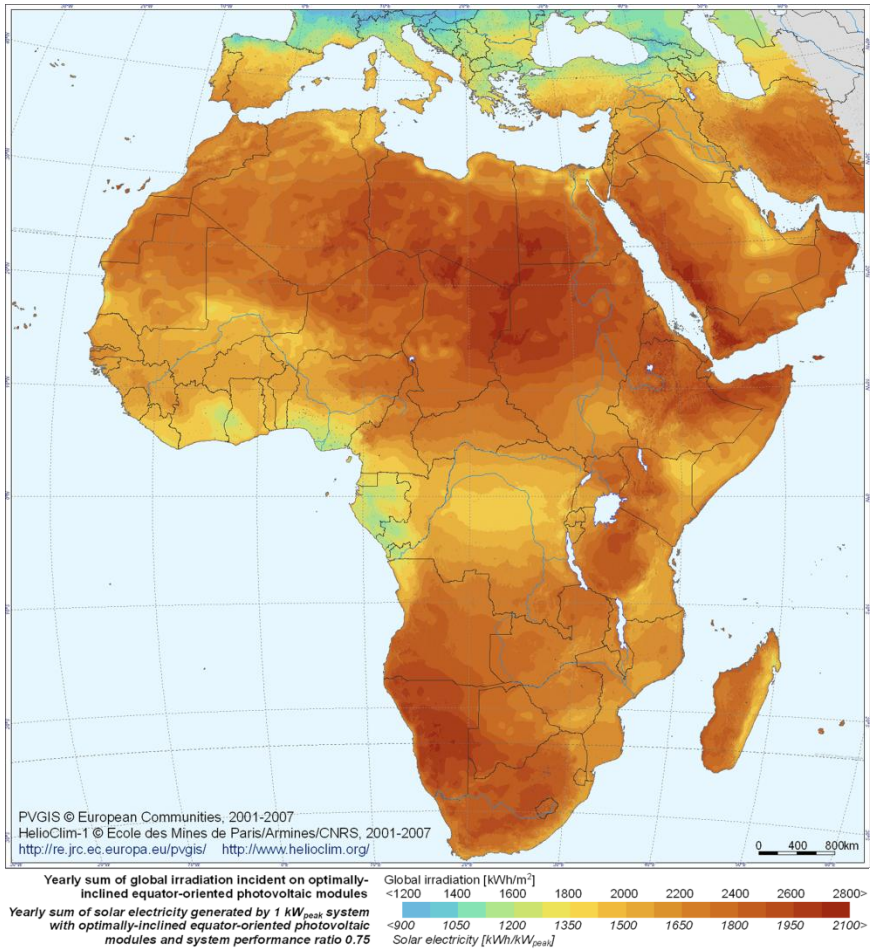
Destruction of Property (2007, West Province)

Source: Henninger, Sasch. *Urban Climate and Air Pollution in Kigali, Rwanda.* The Seventh International Conference on Urban Climate. 29 June – 3 July 2009, Yokohama, Japan.

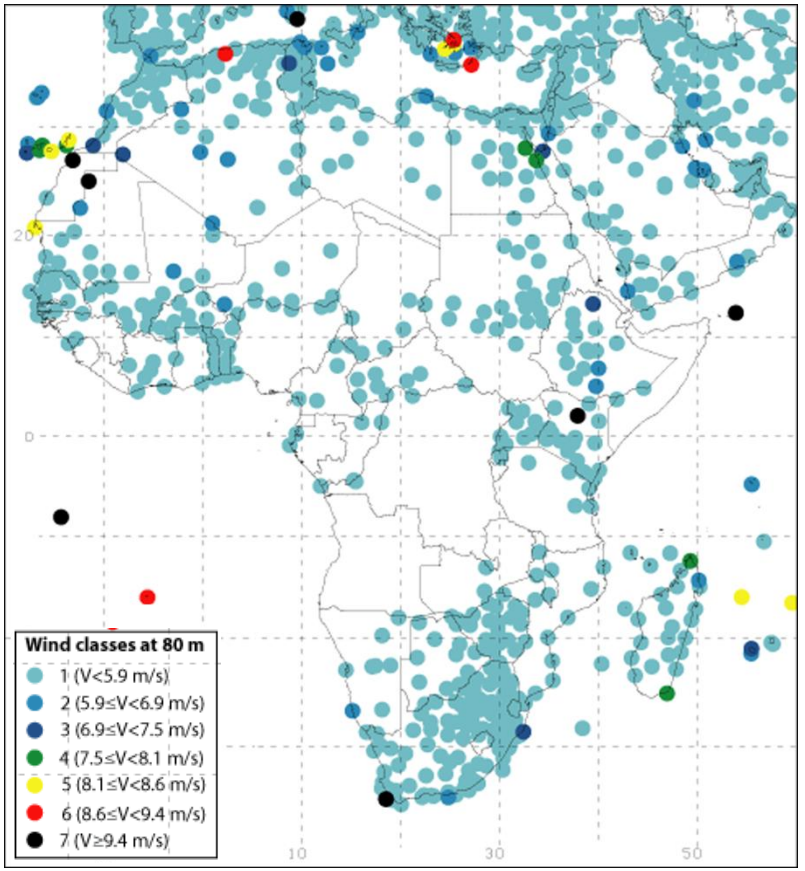
Source: Dr Rose Mukankomeje. Impact of Climate Change in Rwanda. 2009.

Renewable Energy Resources

Solar Energy Potential in Africa



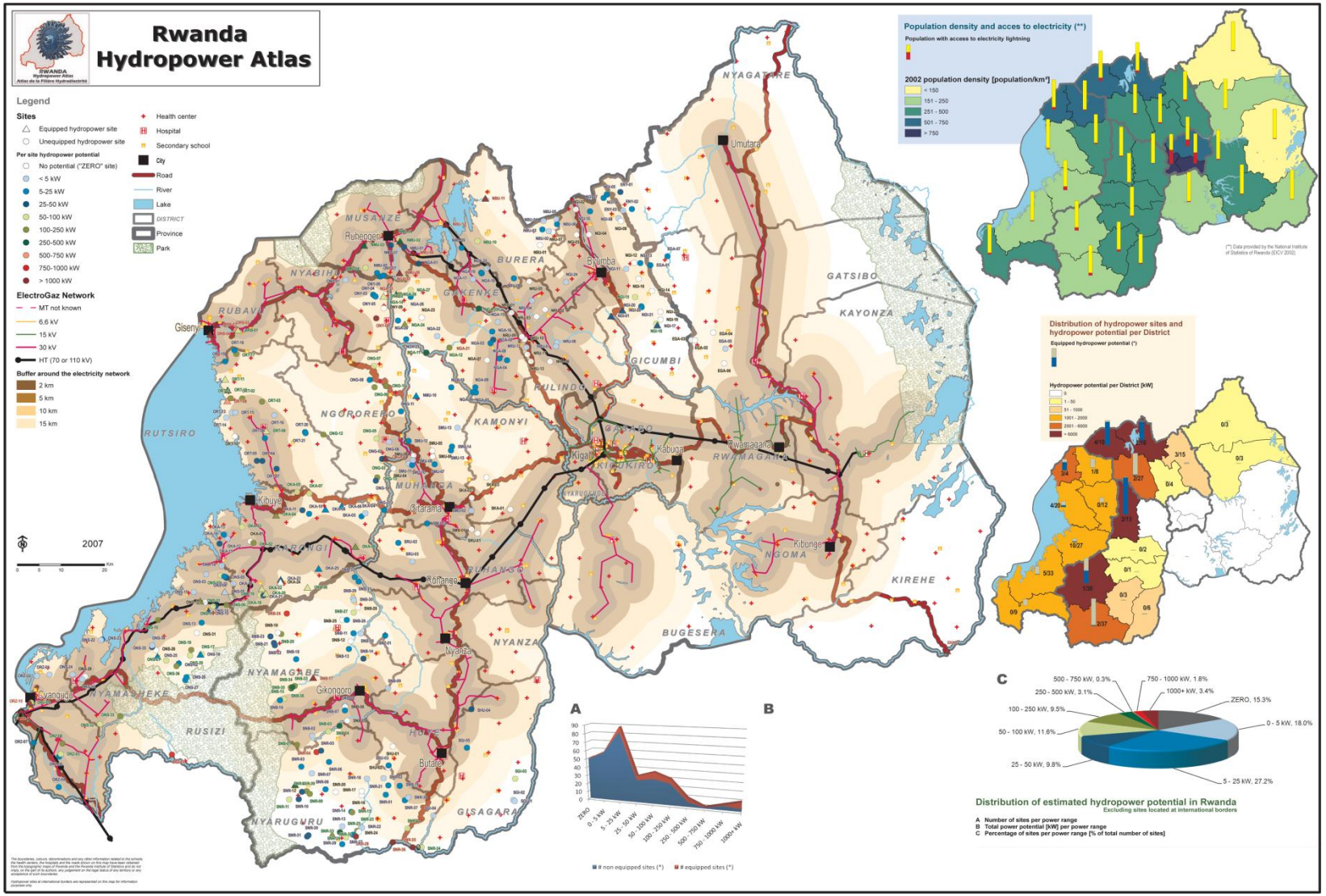
Wind Energy Potential in Africa



Source (L): Huld T., Šúri M., Dunlop E., Albuisson M, Wald L (2005). Integration of HelioClim-1 database into PVGIS to estimate solar electricity potential in Africa. Proceedings from 20th European Photovoltaic Solar Energy Conference and Exhibition, 6-10 June 2005, Barcelona, Spain, http://re.jrc.ec.europa.eu/pvgis/.

Source (R): Archer, Cristina L. and Mark Z. Jacobson. Evaluation of Global Wind Power. Journal of Geophysical Research, Vol. 110, D12110, doi:10.1029/2004JD005462, 2005

Hydropower Atlas of Rwanda

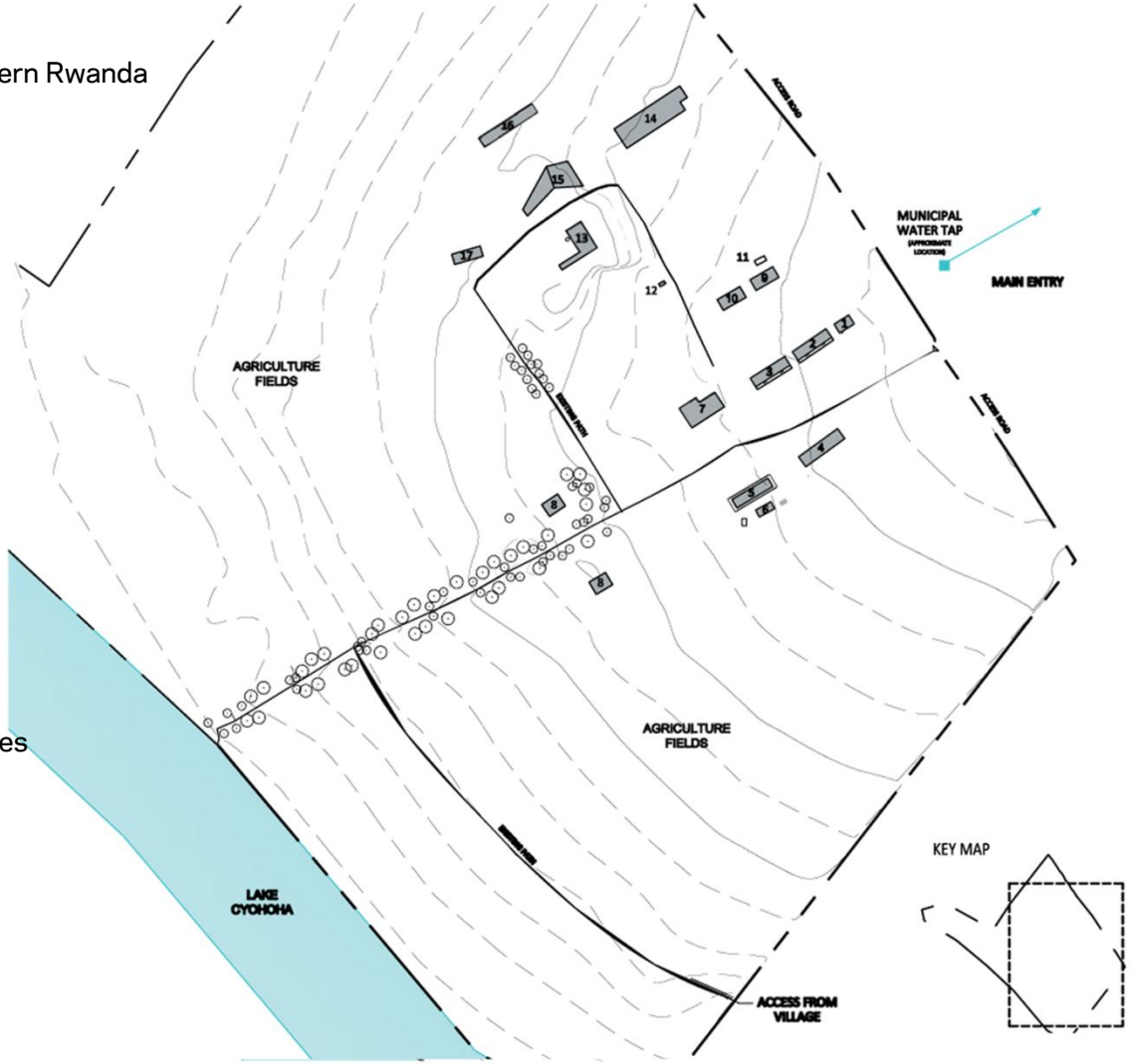


Akilah Institute - Phase I Design

Campus Renovation - Site Plan

Location:
Bugesera District, Southern Rwanda
Latitude 2.25 S
Longitude 30.125E
Altitude 1500m

Existing Buildings
1. Classroom Building
2. Classroom Building
3. Classroom Building
4. Kitchen
5. Administration
6. Storage
7. Outdoor Classroom
8. Staff Housing
9. Girls Dormitory
10. Girls Dormitory
11. Showers
12. Pit Latrines
13. Generator Building
14. Boys Dormitory
15. Agricultural Structures



EXISTING CAMPUS AREA CALCULATIONS

BOYS' DORMITORY *	m^2
TOTAL BOYS' DORM AREA	547
GIRLS' DORMITORY 1	m^2
BED AREA	82
CLOSET	5
CLOSET	5
TOTAL	93
GIRLS' DORMITORY 2	m^2
BED AREA	82
CLOSET	5
CLOSET	5
TOTAL	93
TOTAL GIRLS' DORM AREA	370
CLASSROOM 1	m^2
CLASSROOM A	61
CLASSROOM B	61
TOTAL	122
CLASSROOM 2	m^2
CLASSROOM A	61
CLASSROOM B	61
TOTAL	122
CLASSROOM 3	m^2
CLASSROOM A	51
TOTAL CLASSROOM AREA	295
OUTDOOR WORKSHOP	m^2
SPACE A	18
SPACE B	28
SPACE C	19
TOTAL WORKSHOP SPACE	65
CAFETERIA / KITCHEN	m^2
CAFETERIA	101
KITCHEN	41
STORAGE	9
TOTAL KITCHEN/CAFE	151
ADMINISTRATION BUILDING *	m^2
TOTAL ADMINISTRATION BUILDING	120
GENERATOR BUILDING	m^2
SPACE A	13
SPACE B	13
SPACE C	12
SPACE D	12
SPACE E	12
SPACE F	33
SPACE G	33
TOTAL GENERATOR BUILDING	128
TOTAL CAMPUS AREA	1676 m^2

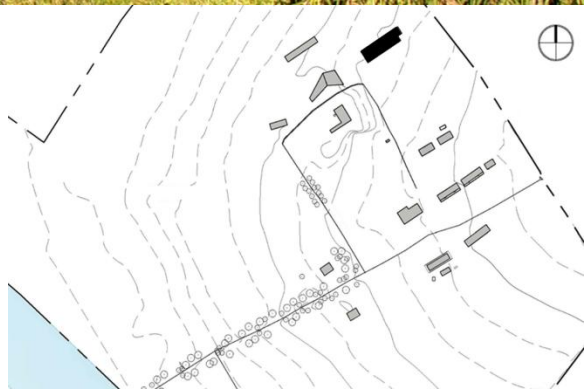
* = Individual room areas within the building are not available for these buildings
NOTE: The area for the existing staff housing on campus is not available.

Campus Renovation – Existing Classrooms

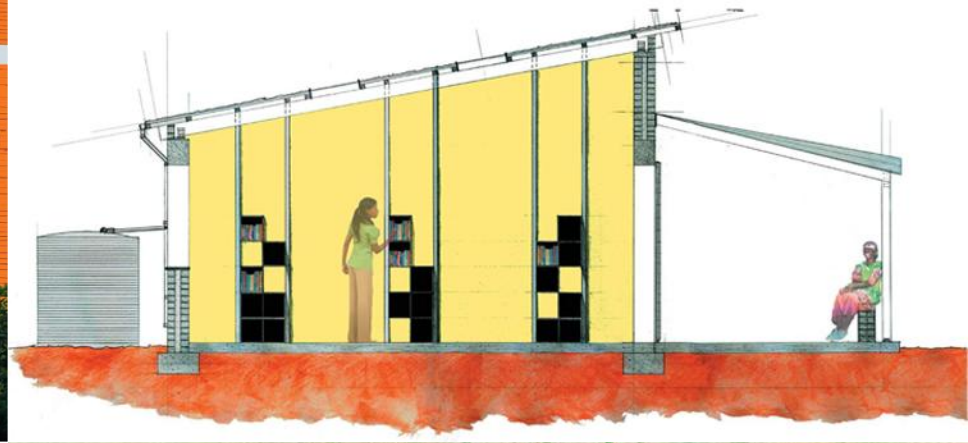
Campus Renovation – Existing Kitchen & Cafeteria

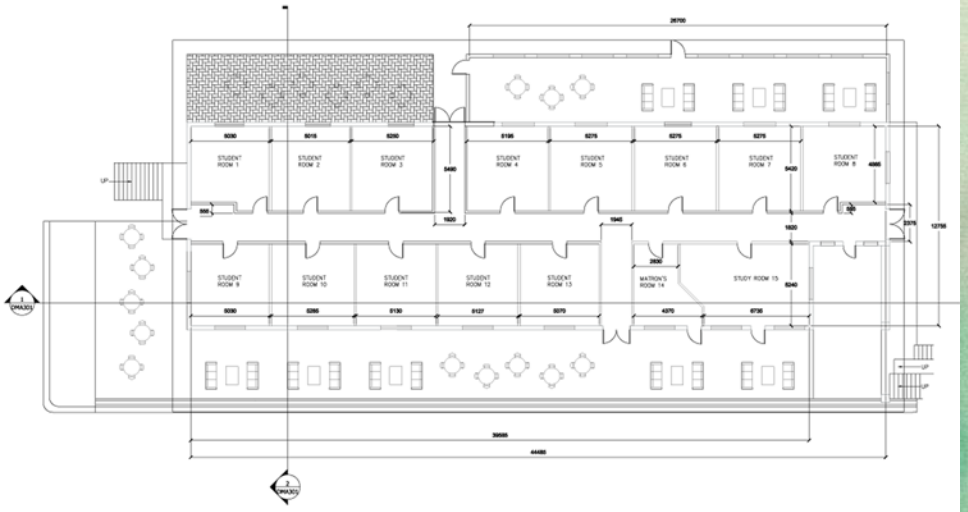
Campus Renovation – Existing Administration

Campus Renovation – Existing Dormitory



Campus Renovation – Proposed Design





Akilah Institute - Phase II Design

Culinary Institute - Site Plan

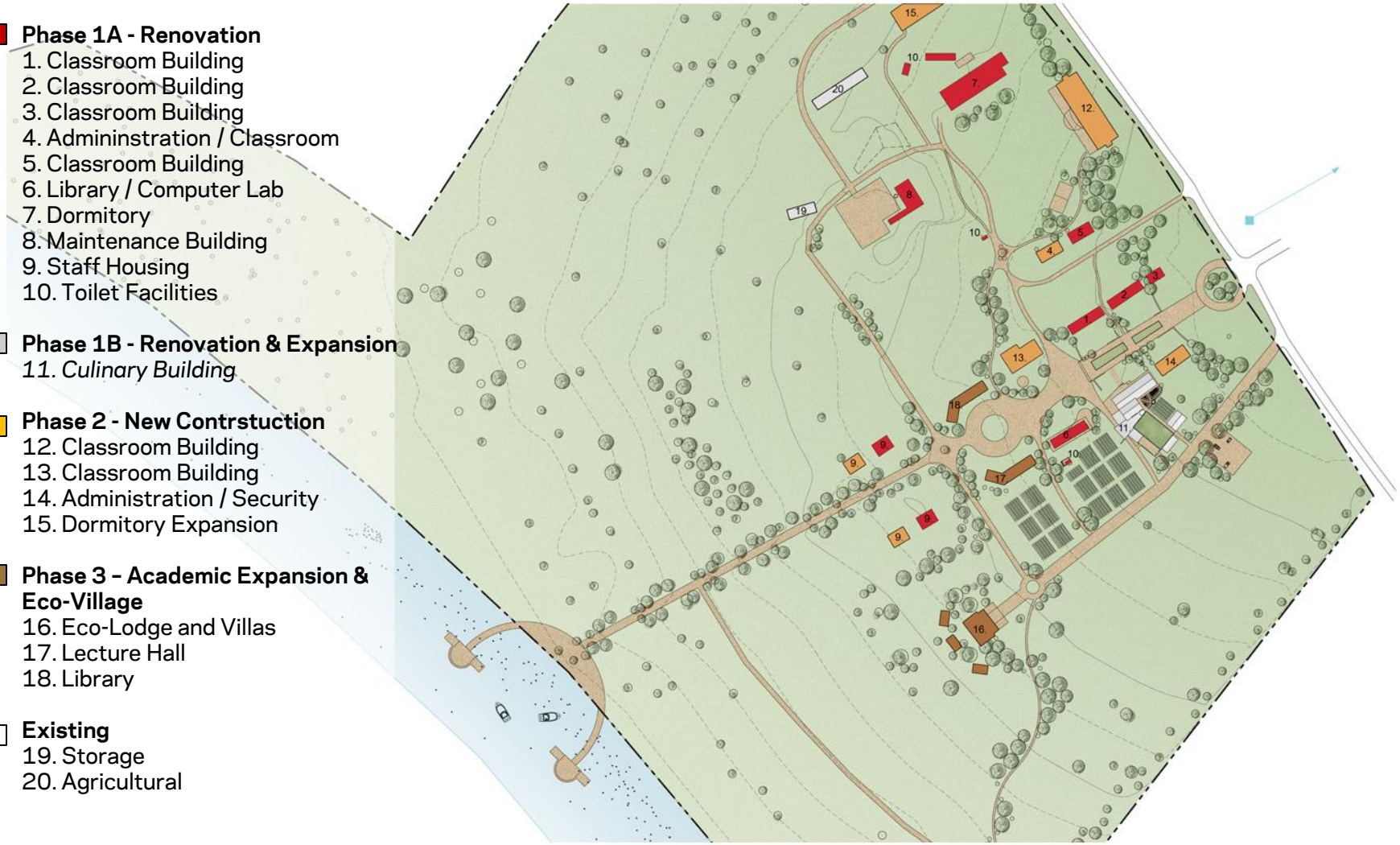
Phase 1A - Renovation
1. Classroom Building
2. Classroom Building
3. Classroom Building
4. Admininstration / Classroom
5. Classroom Building
6. Library / Computer Lab
7. Dormitory
8. Maintenance Building
9. Staff Housing
10. Toilet Facilities

Phase 1B - Renovation & Expansion
11. Culinary Building

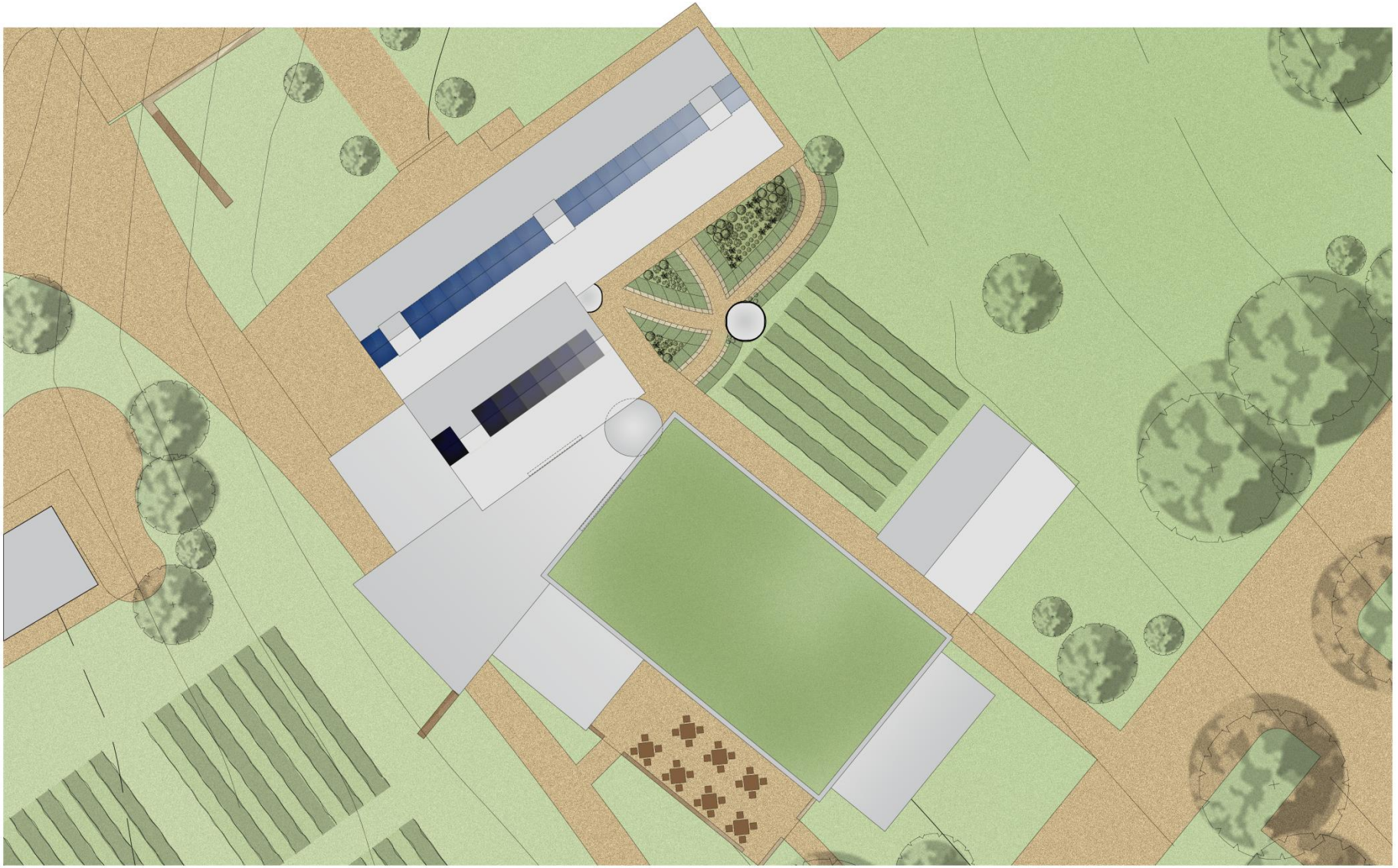
Phase 2 - New Contrstuction
12. Classroom Building
13. Classroom Building
14. Administration / Security
15. Dormitory Expansion

Phase 3 – Academic Expansion & Eco-Village
16. Eco-Lodge and Villas
17. Lecture Hall
18. Library

Existing
19. Storage
20. Agricultural



Culinary Institute - Roof Plan & Gardens

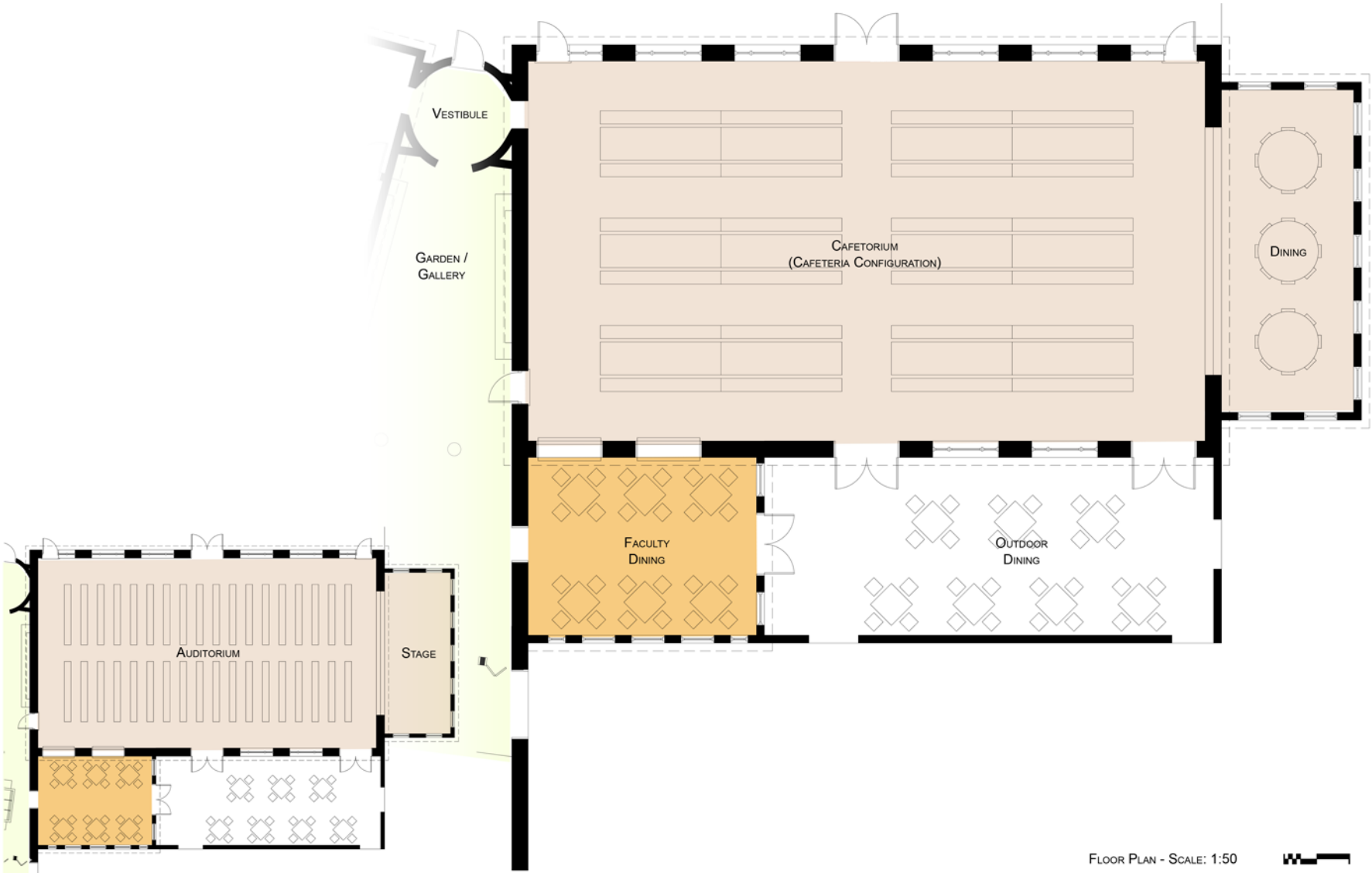


Culinary Institute - Floor Plan

Culinary Institute – Enlarged Floor Plan

Floor Plan - Scale: 1:50

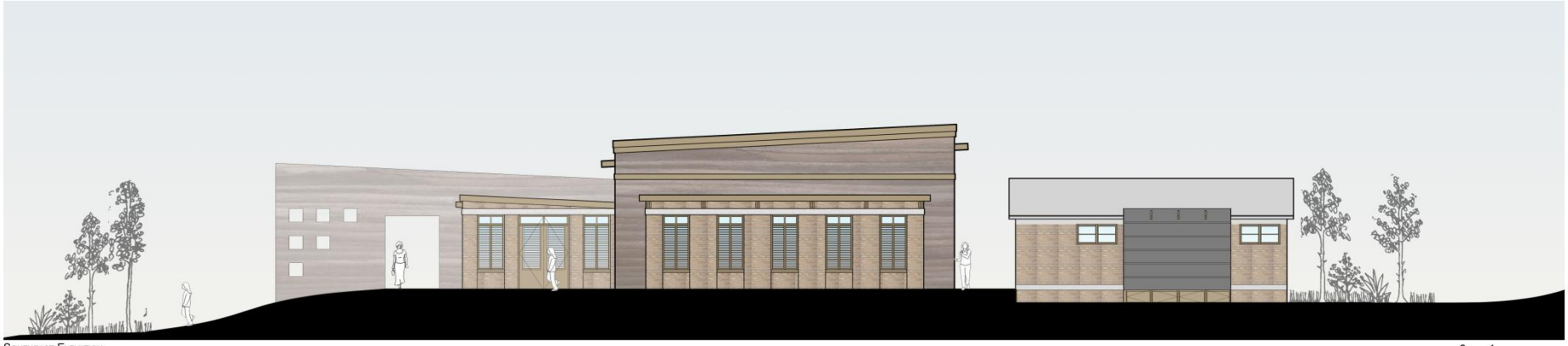
Culinary Institute – Enlarged Floor Plan



FLOOR PLAN - SCALE: 1:50

Culinary Institute - Elevations

Southwest Elevation



Southeast Elevation

Elevations - Scale: 1:50

0 1
0.5 2

Culinary Institute - Elevations

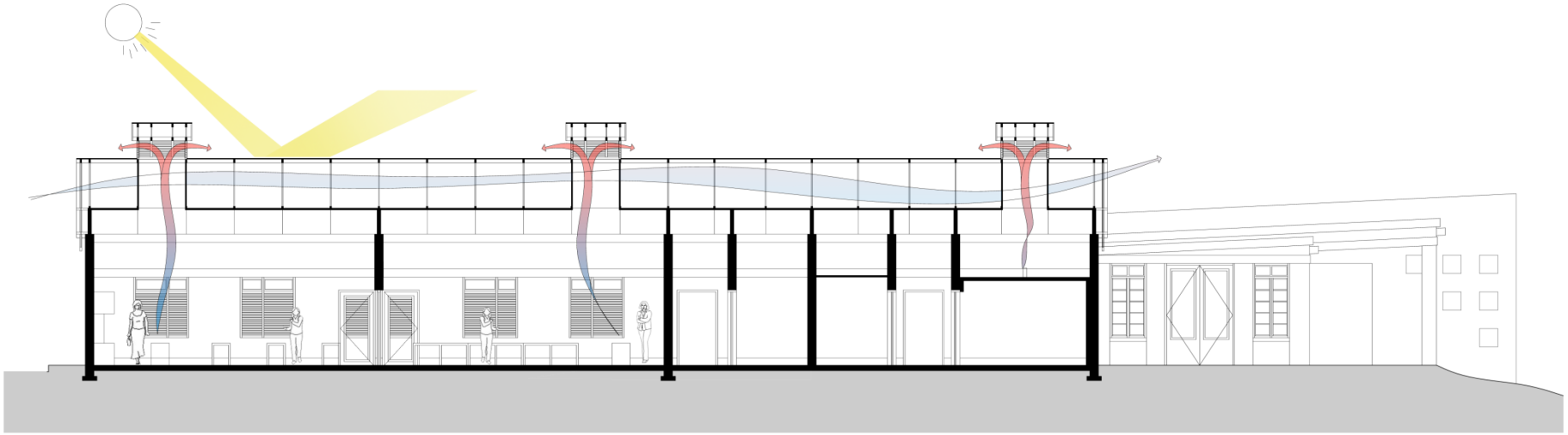
Northwest Elevation

Northeast Elevation

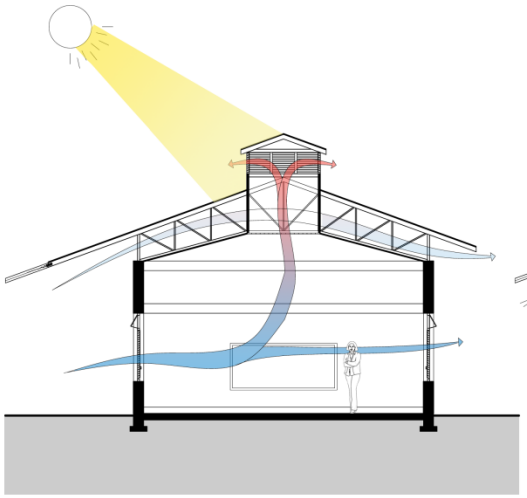
Elevations - Scale: 1:50

0 1
0.5 2

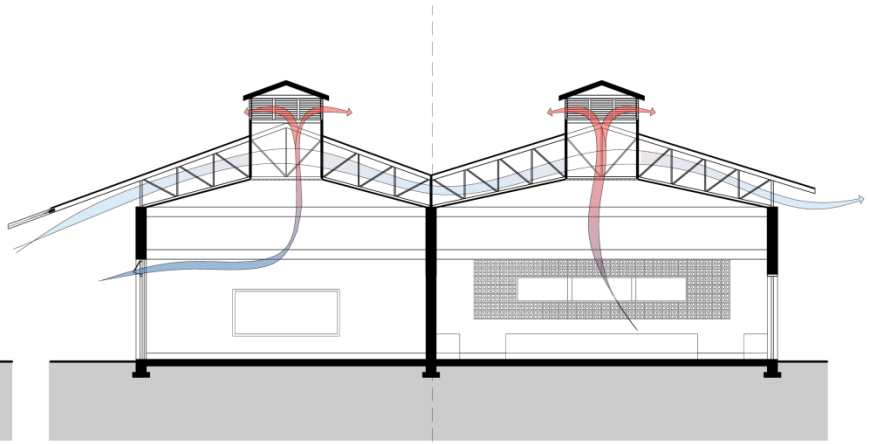
Culinary Institute - Sections



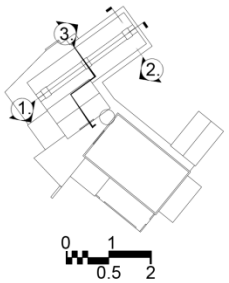
1. Culinary Sections



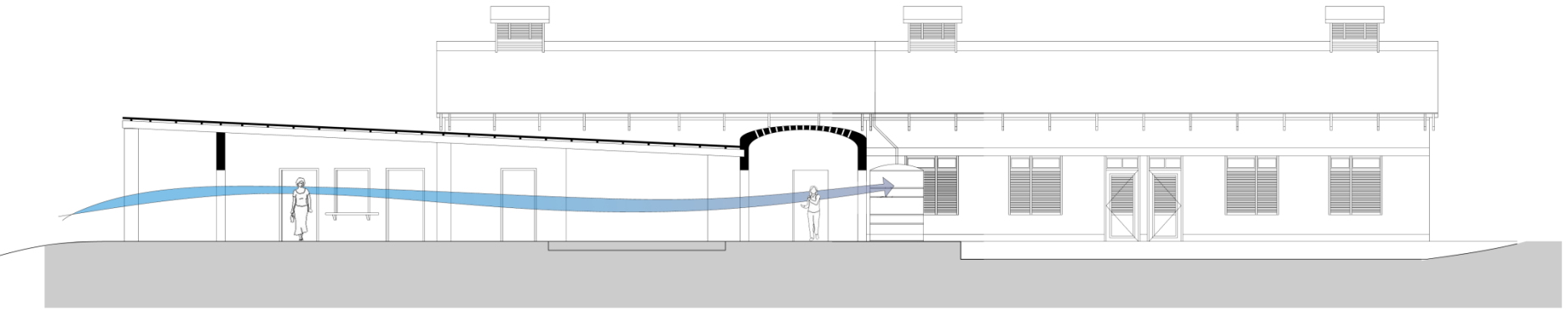
2. Culinary Section



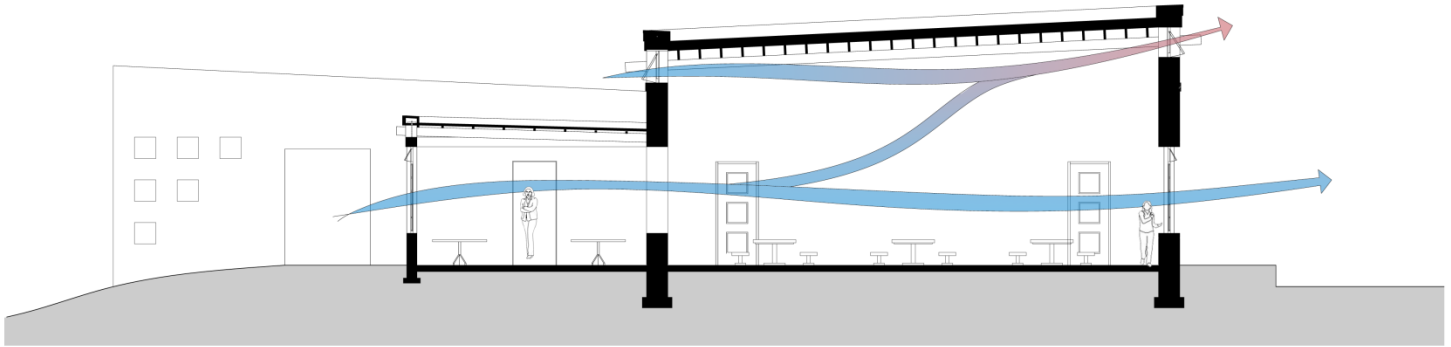
3. Culinary Section



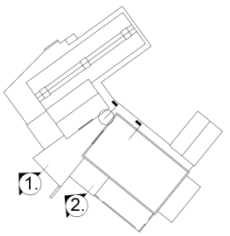
Culinary Institute - Sections



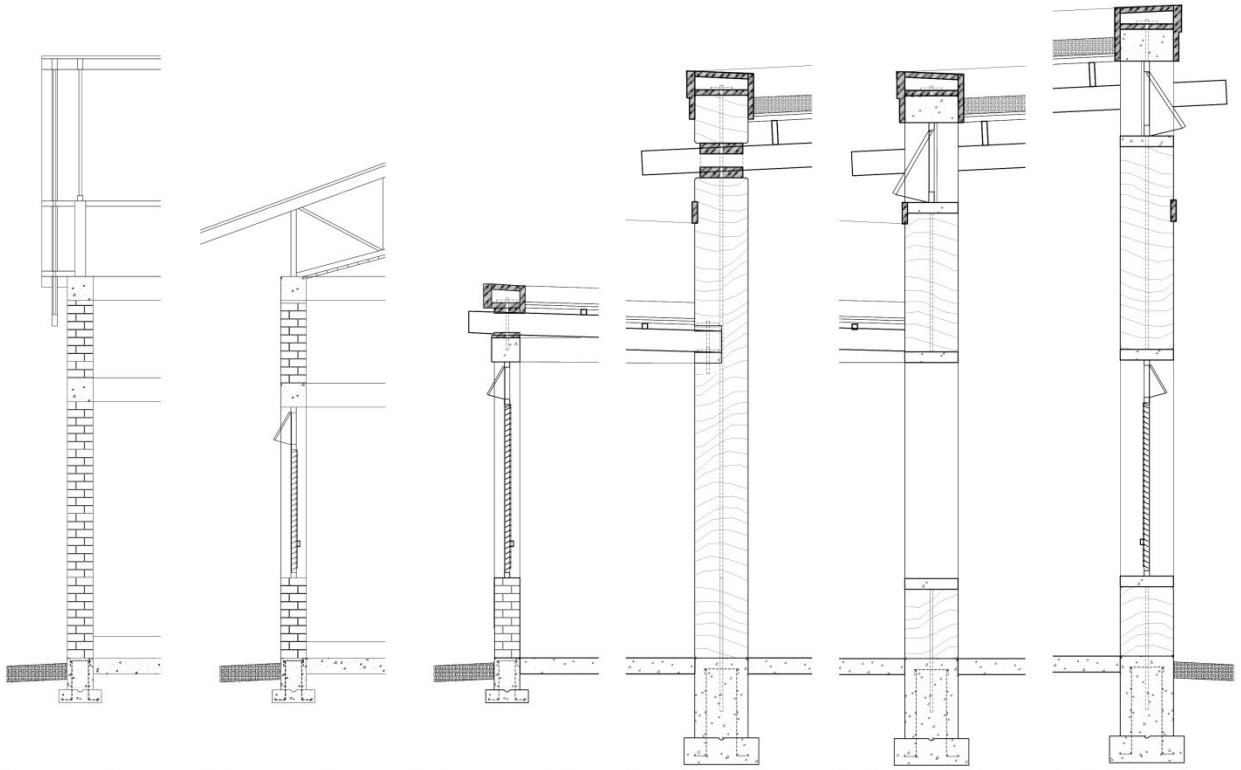
1. Culinary Sections



2. Culindary Section

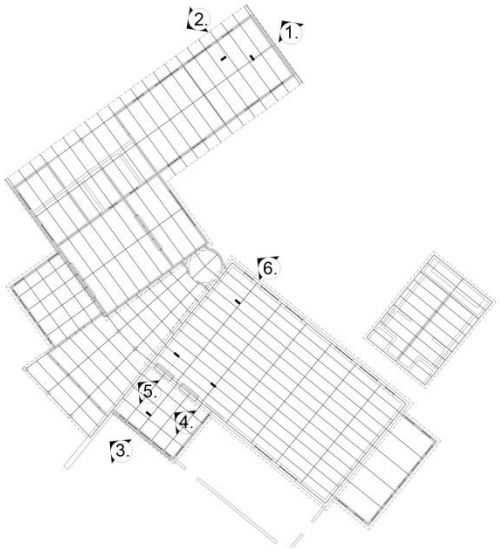


Culinary Institute - Sustainable Construction

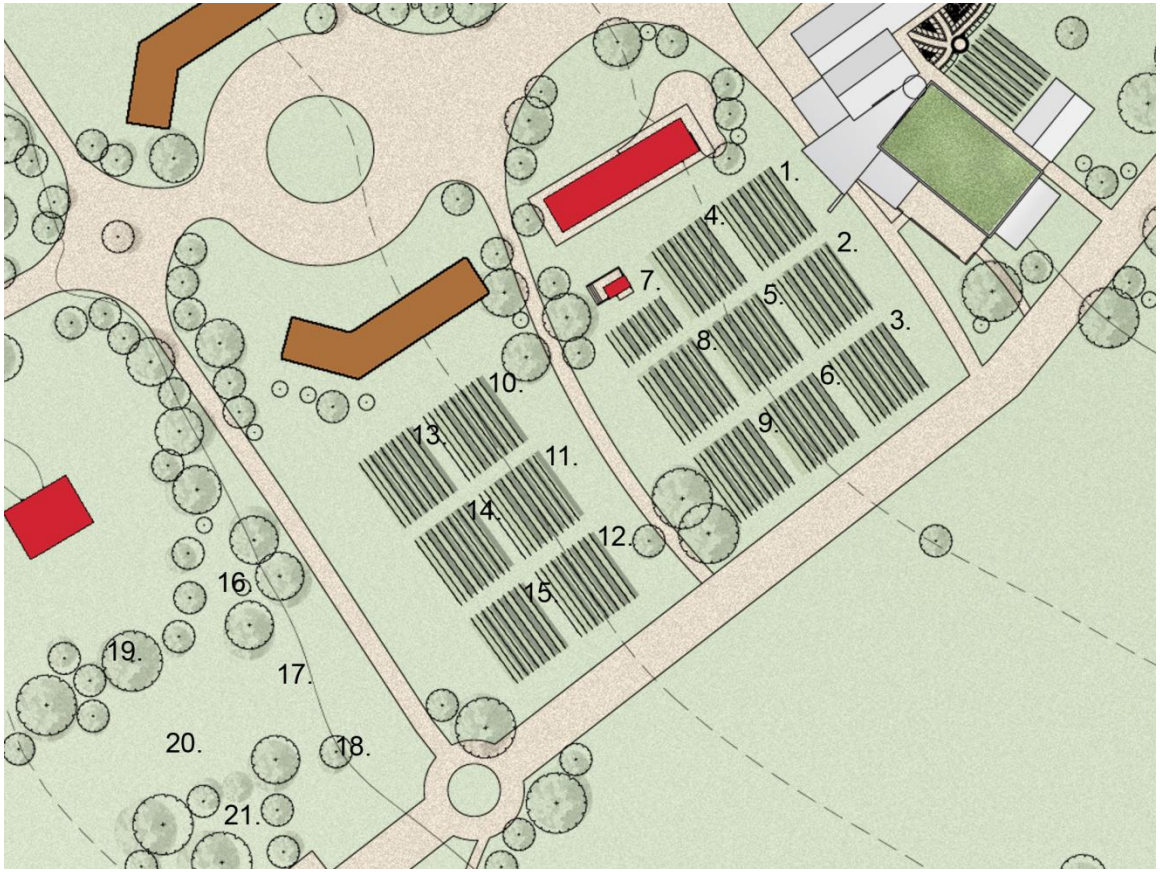


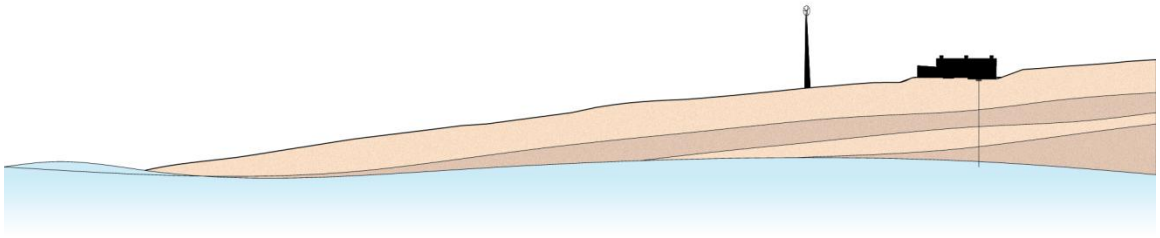
1. Section thru Burnt Brick / CEB
2. Section thru Burnt Brick / CEB
3. Section thru CEB
4. Section thru Rammed Earth Wall
5. Section thru Rammed Earth Wall
6. Section thru Rammed Earth Wall

Sections - Scale: 1:20

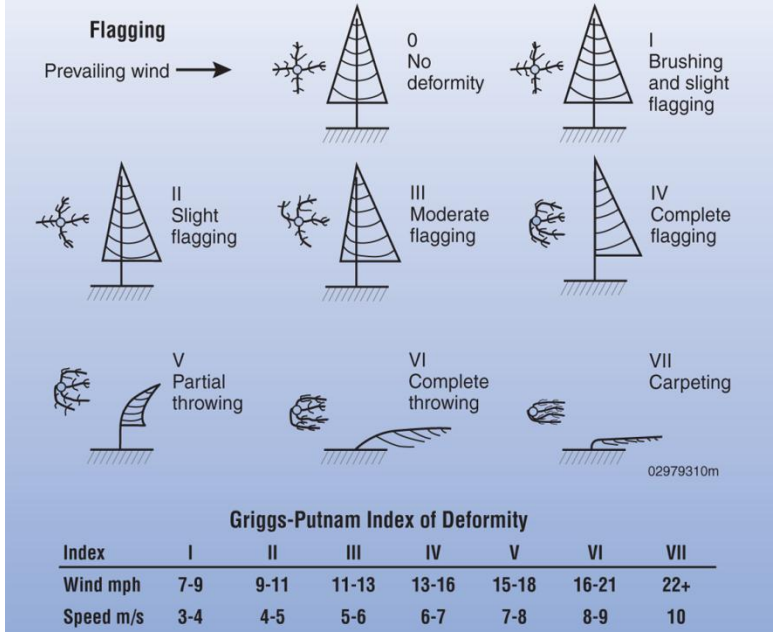


Culinary Institute - Agricultural Resources



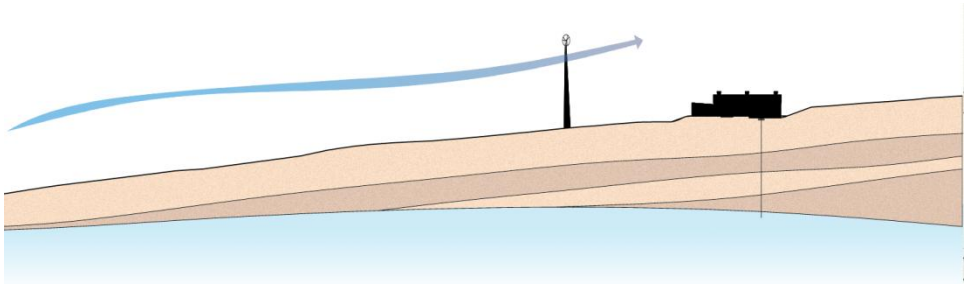


Culinary Institute - Renewable Energy Resources – Wind Studies

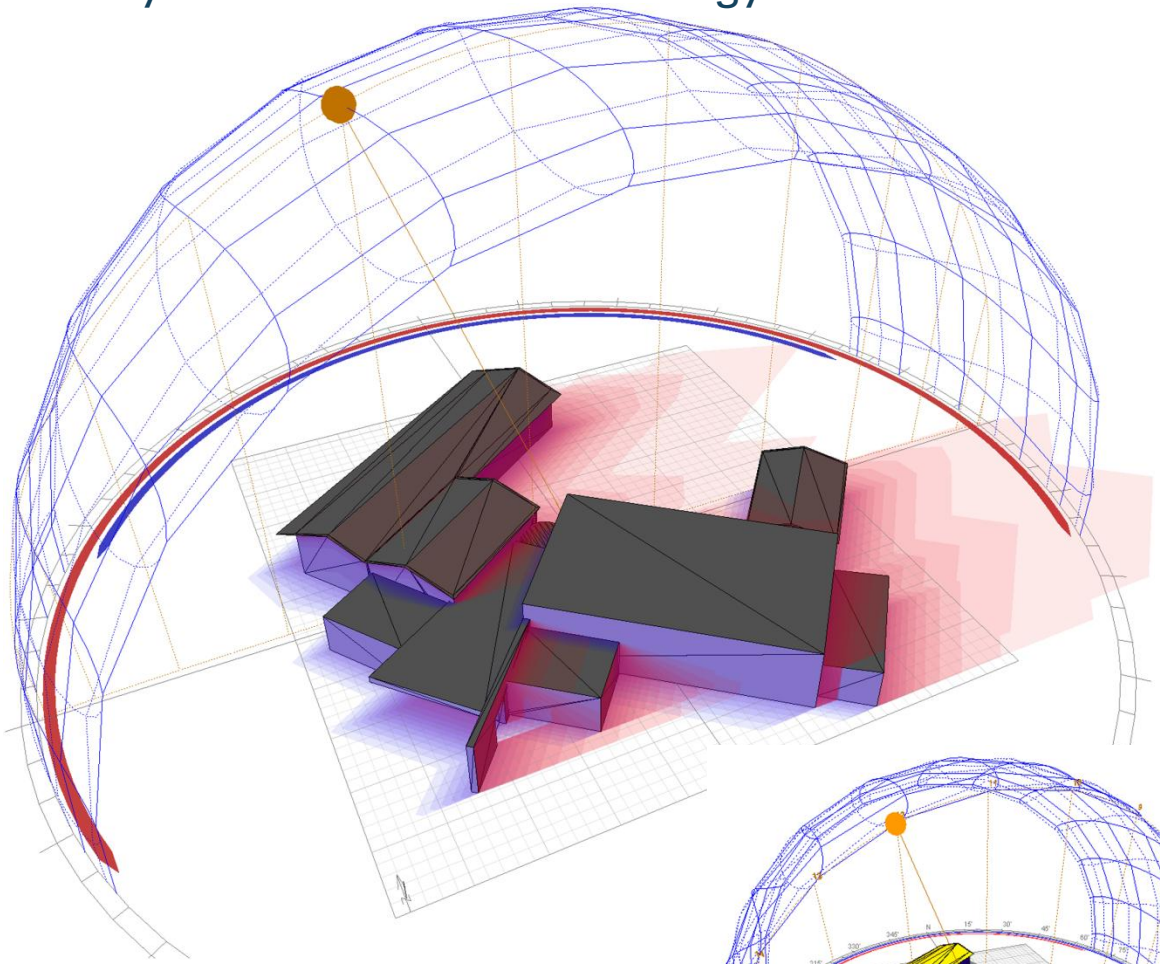


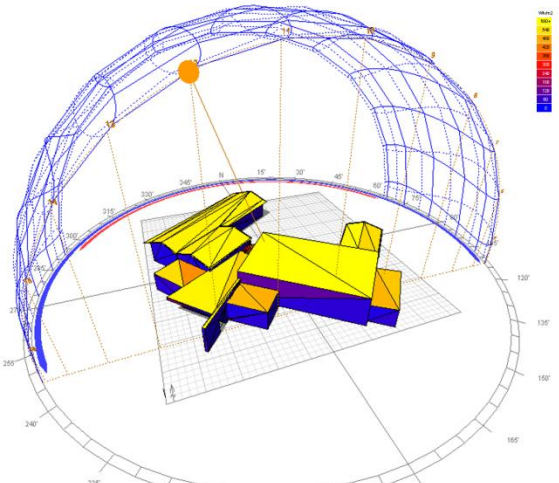
Griggs-Putnam Index of Deformity

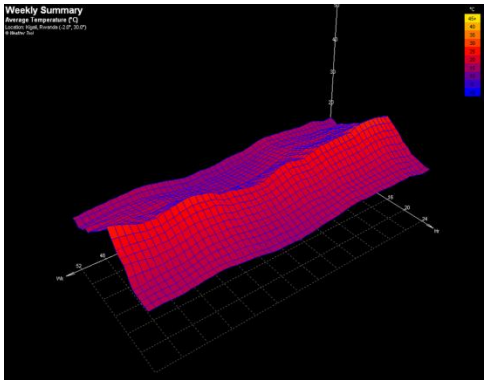
Index	I	II	III	IV	V	VI	VII
Wind mph	7-9	9-11	11-13	13-16	15-18	16-21	22+
Speed m/s	3-4	4-5	5-6	6-7	7-8	8-9	10

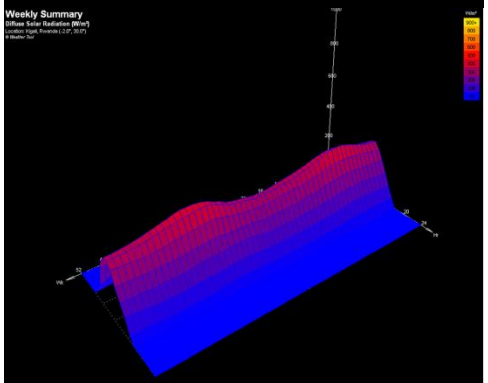


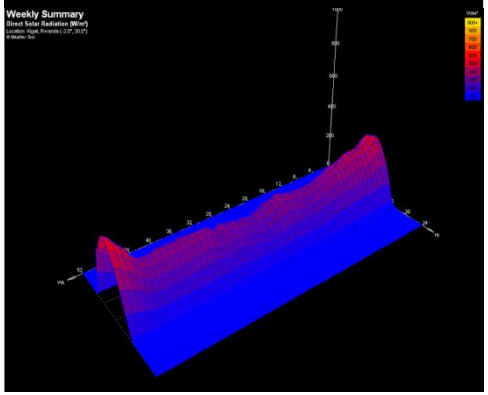
Culinary Institute - Renewable Energy Resources – Solar Studies



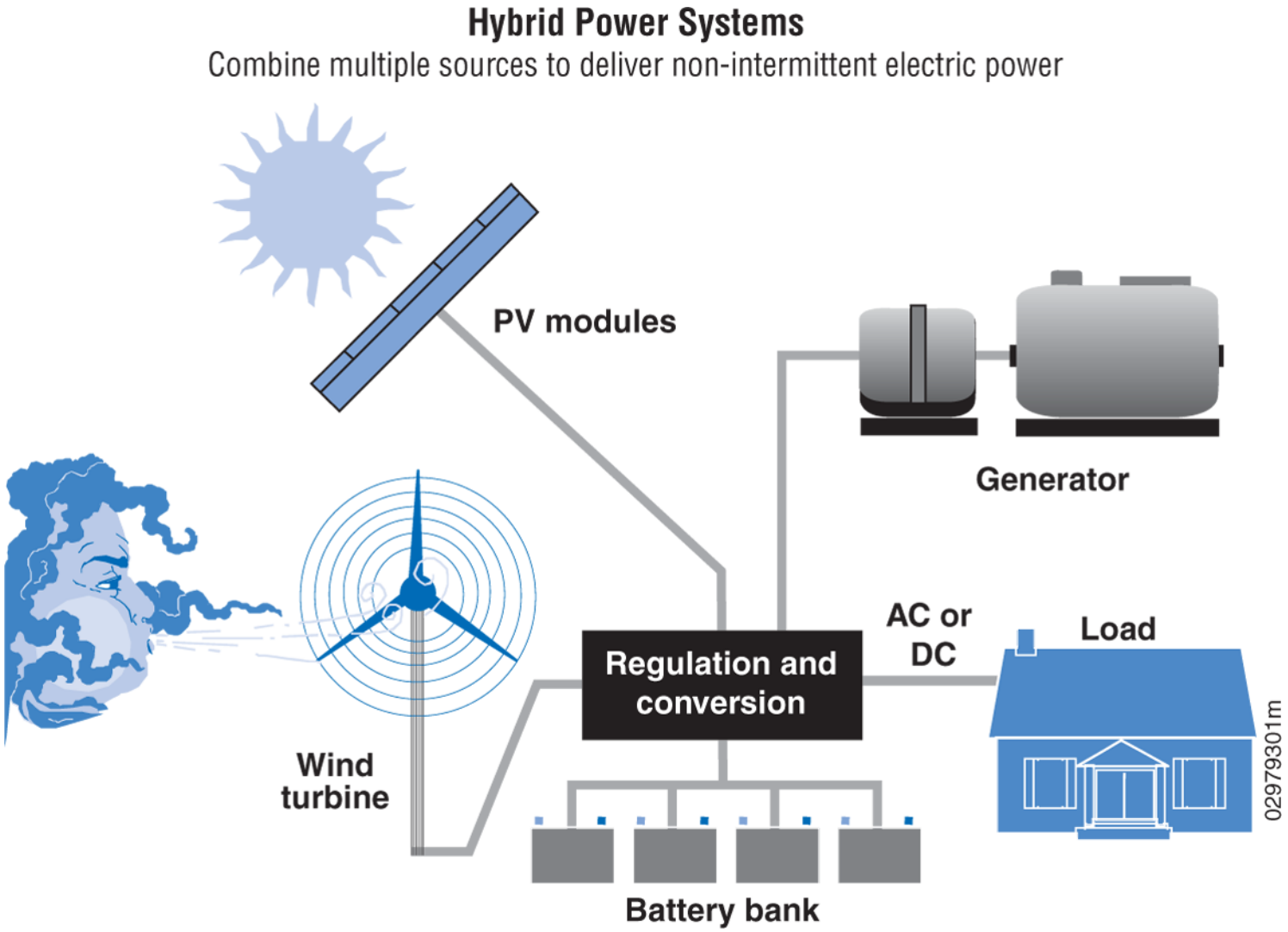








Culinary Institute - Renewable Energy Resources – System Design



Source: Illustrations produced by the U.S. Department of Energy (DOE)

- A built-environment professional's role is not merely limited to building infrastructure, but also includes the development and empowerment of communities through interaction with them and cooperation with all other relief professionals.

- The introduction of sustainable building methods and renewable energy technologies in communities that are at risk to the increasing impact of climate change will allow for proper adaptation.

- Continued education and training on the use of resources and infrastructure development will enable development and mitigate the impact of climate change.

- As Akilah Institute continues to develop, the economic model must be studied so that a sustainable strategy can be replicated to apply to other organizations and regions.

- Solar energy economy needs support from the international community and the development of a wind atlas for the country will help enable the Rwandan government to develop a wind power network throughout the country.

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