Sustainability and Efficiency in Building Design - CASE STUDIES

For Health Sub Centres, Wellness Centres, Primary Health Centres and Community Health Centres

SELCO Foundation | 2020

SELCO Foundation

SELCO Foundation is a 10 year old organisation that engages in field-based R&D, evidence and ecosystem building for deployment of clean energy solutions that alleviate poverty in tribal, rural and urban poor areas. The organization works closely with practitioners in the social sector, energy entrepreneurs and partners from various developmental sectors.

SELCO Foundation is an open source platform with a network of research and development labs that implement and disseminate sustainable social innovations through an ecosystems approach.

Model Subcentre design and implemented by SELCO Foundation in partnership with Karuna Trust in YK Mole, Karnataka

Background

Globally the building sector accounts for more electricity use than any other sector, 42 per cent.[1] Healthcare Infrastructure requires continuous functioning without interruption, which leads to ranking them to be the second most to use a large amount of energy in the building sector.

A study on emission of CO2 from different types of buildings in England was recently conducted. The study has shown that 8 buildings out of the top 10 most polluting buildings are healthcare facilities.2 A study undertaken by Energy Conservation Building Code (ECBC)3, India demonstrates that Indian healthcare facilities have a potential to conserve 42% of the energy consumption by implementation of energy efficient measures.

The health sector has a critical role to play in taking measures to improve the energy consumption benchmarks. At the onset, this can be done by looking at the active energy needs of the health centres in the forms of appliances and technologies used in health centres for provision of various services. But more importantly, it has been found that significant improvements can be made in the lighting and cooling needs of the health centre if the building is designed appropriately.

Thus, SELCO Foundation follows an integrated approach which sets benchmarks for both passive and active lighting and cooling through interventions in:

- **Efficiency in Building Design**
- **Efficiency in Appliances**

Such an approach would not just result in improved efficiency benchmarks for the healthcare facilities and reduced energy consumption, but also result in overall impact such as:

- Improved well-being for staff as well as in-patients
- Confidence in staff in being able to delivery quality service
- Climate resilience against heat stress and other environmental factors like flooding, cyclone, earthquake etc

[1] UNIDO, Energy Efficiency in Buildings: Module 18
[2] https://www.theguardian.com/environment/2010/jan/01/government-public-building-co2-audit accessed on 1-2-2019
[3] Energy Conservation Building Code,(ECBC) 2017
[4] Tulsyan, A., Dhaka, S., Mathur, J., And Yadav, J.V., 2012. "Potential of energy savings through implementation of energy conservation building code in Jaipur City, India"" Energy and Buildings.

What are Low Energy Spaces?

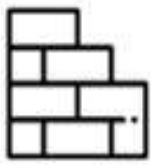
Shelters that have ample amount of natural lighting, cross ventilation or air circulation and are well insulated from the heat and cold to promote thermal comfort for habitation indoors are inherently low in their consumption of energy.

"Improved thermal comfort and reduced energy consumptions for health centers across geographies and climatic conditions"

How do you achieve reduced energy consumption through built spaces?

Efficient Spatial Design

Planning, shape, orientation and shading – to limit or enhance solar heat gain and capture air movements of the micro climate



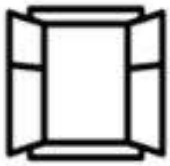
Material and Insulation

Treating the envelope and building with materials with appropriate U-value in response to local climatic conditions

Adaptivity to local social contexts and needs

Energy Efficient Appliances

Wattage, location, type, reflectors and products to optimise the active and passive system designs



Design of Fenestrations

Size, location, type and accessibility of doors, windows, ventilators etc

Physiological and physical benefits to occupants of the space

Case Study: Health Unit without Labour Room

Climatic Conditions and User Behaviour

Location: YK Mole, Karnataka

Temperature: 39°C to 19°C (60% Humidity)
Climate – Hot and Dry
Wind direction - SW and NE

Building Gross Area: 1092 sq. ft.
Building age – constructed March 2019

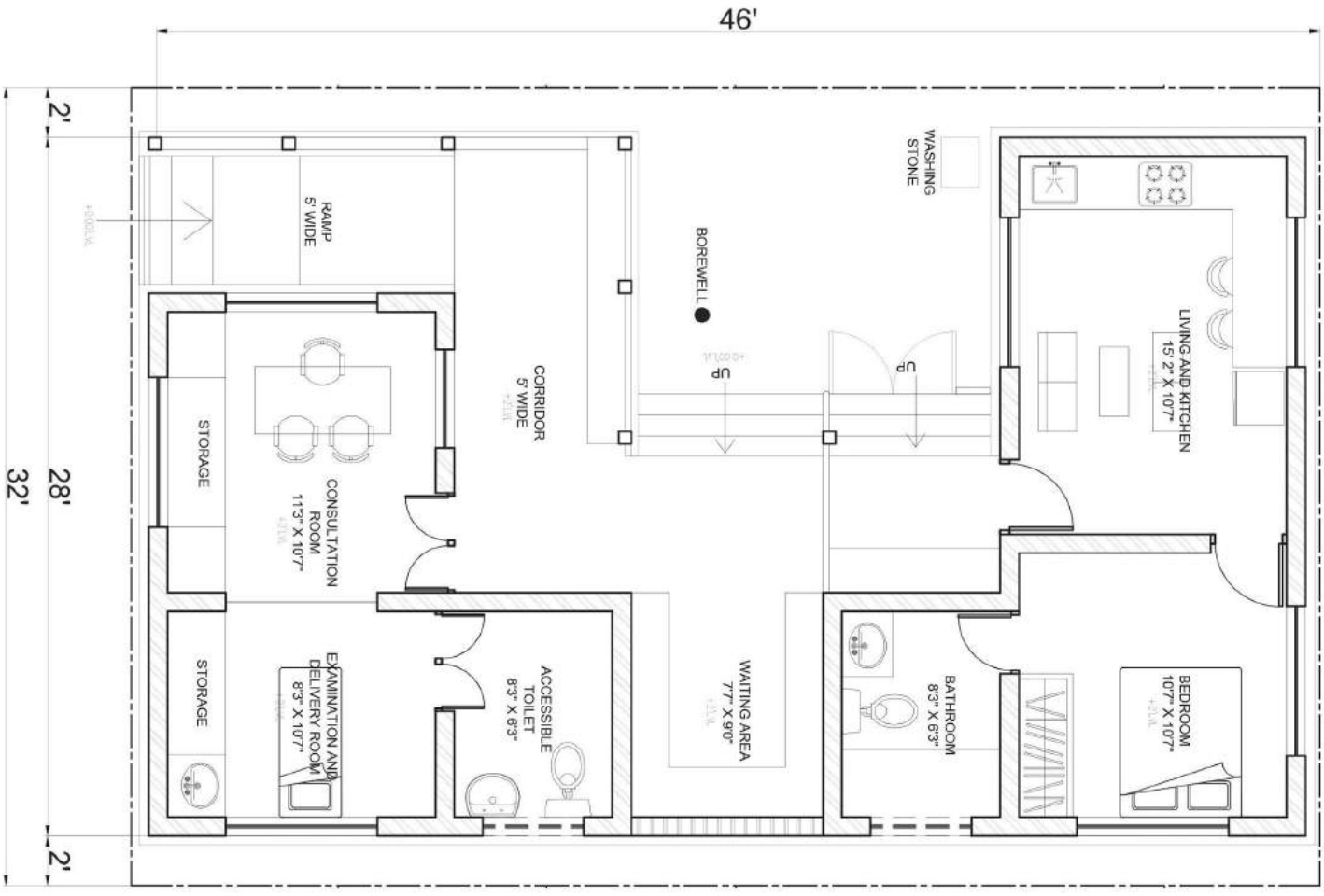
Occupancy: 1 ANM

Building Use: Health Care/ Residential

Number of Floors: Ground only
Number of rooms and areas - 6

Day time occupancy (6am to 5pm)
Kitchen areas(R), Examination/ Delivery room, waiting areas (SC)

Night time occupancy (5pm to 6am
- Bedrooms and Living room(R)



Overall reduction in energy consumption for **lighting*** **- 87%**
Overall reduction in energy consumption for **fans** - **88%**

Each Panel - 75 Wp (Efficient Centre)

Each Battery - 150Ah (Efficient)

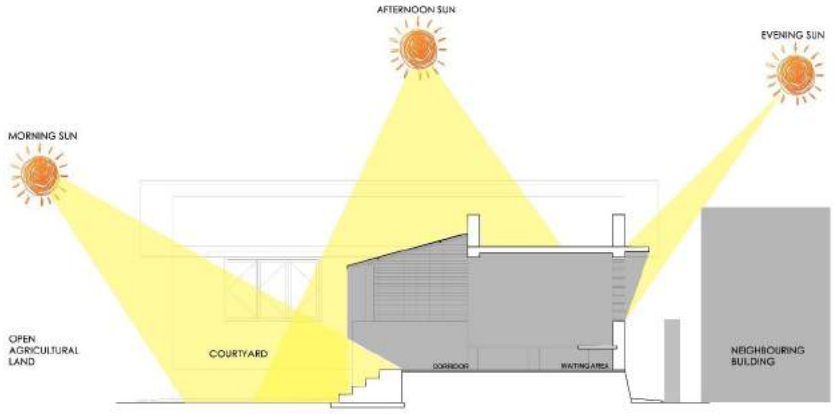
Each Panel - 100 Wp (Inefficient Centre)

Each Battery - 200Ah (Inefficient)

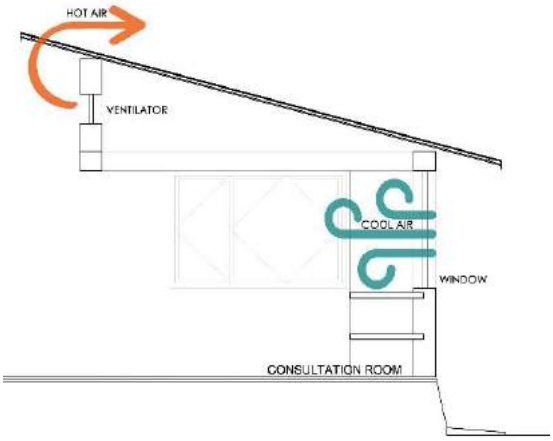
The main characteristics of the building envelope are highly-efficient walls and roof which allow delayed heat transfer into the building. Structure designed has high thermal resistance, especially during the hottest month with temperature variance of 2-4°C

Construction methods followed based on materials that can be sourced are,

- Roofing insulation with air cavity between Bison Board and Color coated sheets which creates a barrier for heat transfer.
- Shading of verandahs and courtyard and chajjas over windows to further cool the building



Solar Gain throughout the day



Ventilators and air gaps in the roof for hot air to escape

Other General notes:

1.All the doors to be 1.2 m wide for universal accessible.

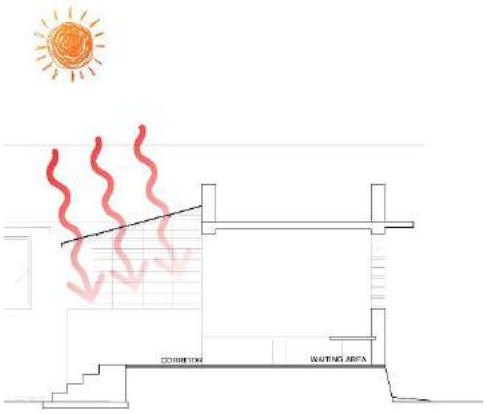
2. Windows to be placed based on the direction.

North direction to have larger windows –
1.2 m x 0.9 m

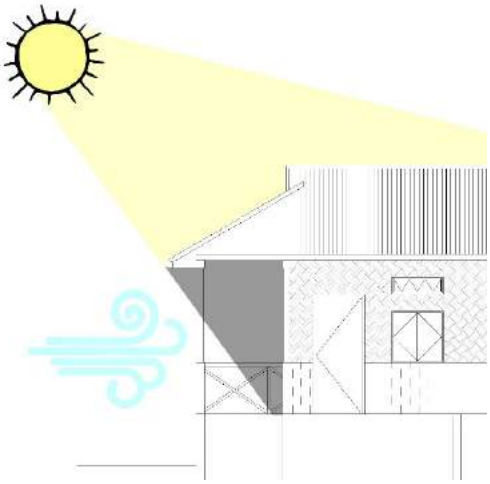
South direction to have longer windows with -Horizontal overhang

East and west side to have smaller windows with Horizontal and vertical fins.

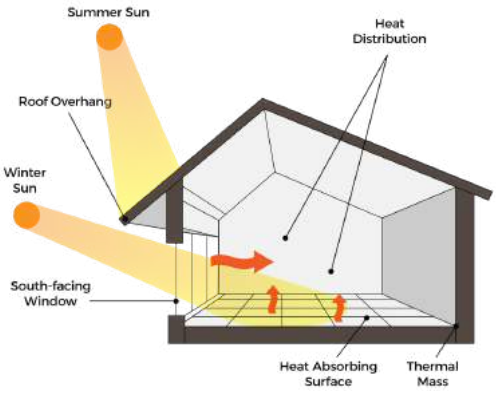
3. Ramp to be built considering 1:15 ratio for the slope.



For Hot and Dry climate



For Warm and Humid climate



For Cold climate

Case Study: Health Unit with Labour Room

Climatic Conditions and User Behavior

Location: Keba, Arunachal Pradesh

Temperature Range: 28°C to 16°C (45% RH)
Climate - Warm and Humid Tropical
Wind direction - SW and NE

Building Gross Area: 1,400 sqft
Building age – constructed January 2018

Occupancy: 2 ANMs (+ 4 family members)

Building Use: Health Care/ Residential

Number of Floors: Ground only
Number of rooms and areas - 8

Day time occupancy (6am to 5pm)
- Kitchen areas(R), Examination/ Delivery room,
- waiting areas (SC)

Night time occupancy (5pm to 6am)
- Bedrooms and Living room (R)

Construction type

- Composite with (in-situ) Load bearing Cement Blocks walls (for delivery room and toilets only)
- Timber Framework and Bamboo in-fills walls
- CGI roofing was insulated with bamboo false ceilings to reduce heat stress

Masons local to Keba were used in the construction of the centre.
Materials were procured from the local villages or from the nearest town of Pasighat.

Model Sub Centre design and implemented by SELCO Foundation in partnership with Karuna Trust in Keba, Arunachal Pradesh

Overall reduction in energy consumption for **lighting*** - **79%**
Overall reduction in energy consumption for **fans** - **85%**

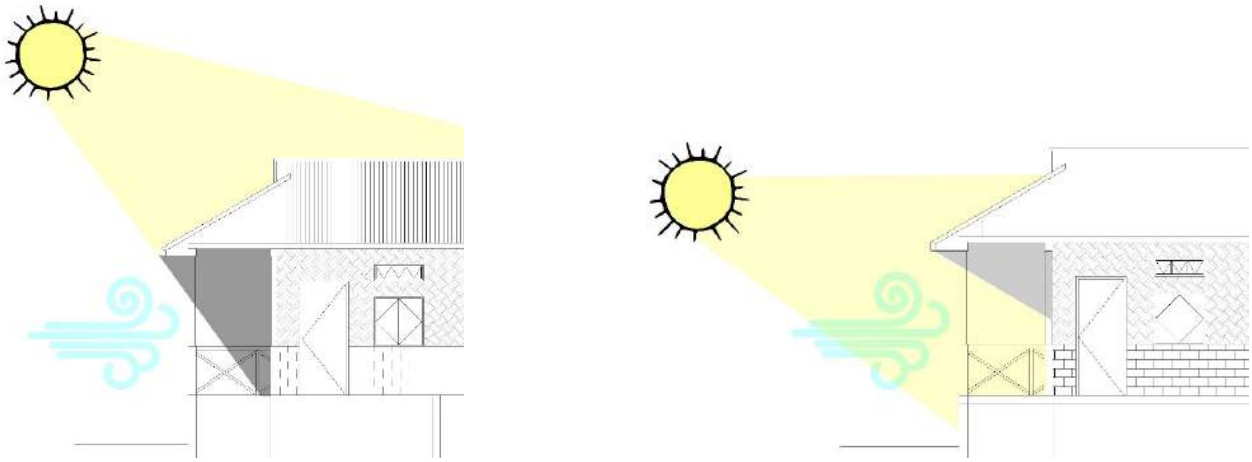
Efficient infrastructure and appliances

Each Panel - 100 Wp (Inefficient infrastructure and appliances)

Each Battery - 200Ah (Efficient)

Each Battery - 150Ah (Inefficient)

Material quality of the centre



Summer and winter solar gain diagram

Case Study: COVID Care Hospital with Staff Quarters

Climatic Conditions and User Behavior

Location: Masarhi, Bihar

Temperature Range: 14°C to 32°C (33% RH)
Climate - Composite
Wind direction - NW and SE

Building Gross Area: 5500 sq ft
Building age – constructed August 2020

Occupancy: 6 bed IPD
2 Procedural rooms
15 staff accommodation rooms

Building Use: Health Care/ Residential

Number of Floors: First floor of existing hospital and new greenfield construction

Day time occupancy (6am to 5pm)
- OPD, Examination room
- waiting areas (SC)

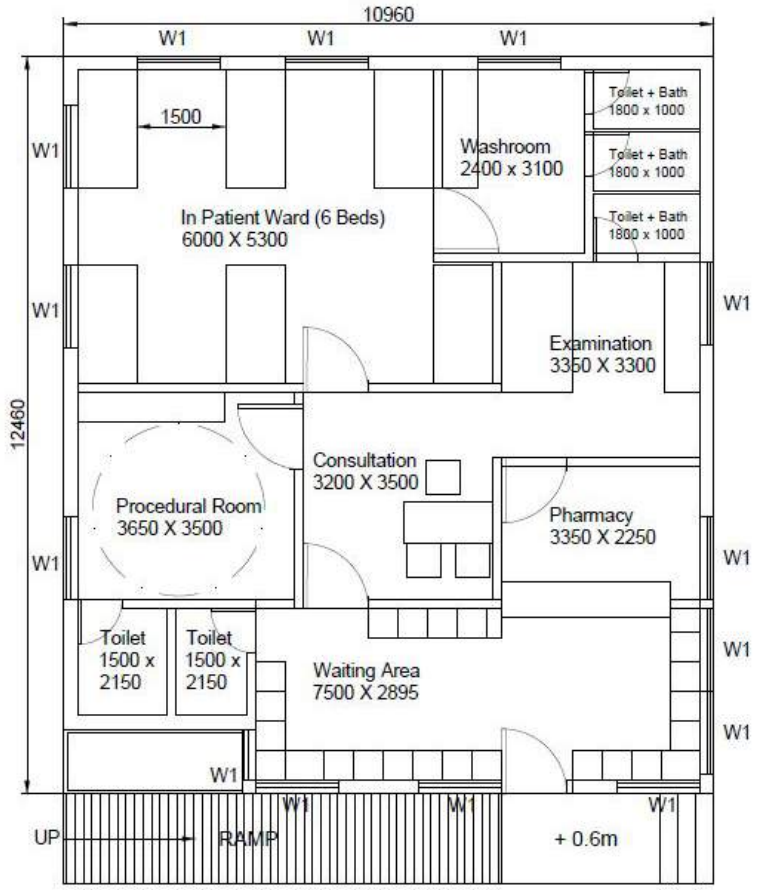
Night time occupancy (5pm to 6am)
- Staff units and IPD Ward

COVID19 pandemic disrupted systems around facilitation of healthcare. With more in-residence staff tending to COVID patients, there was a need for staff accommodation along with beds dedicated for other non-COVID care needs.

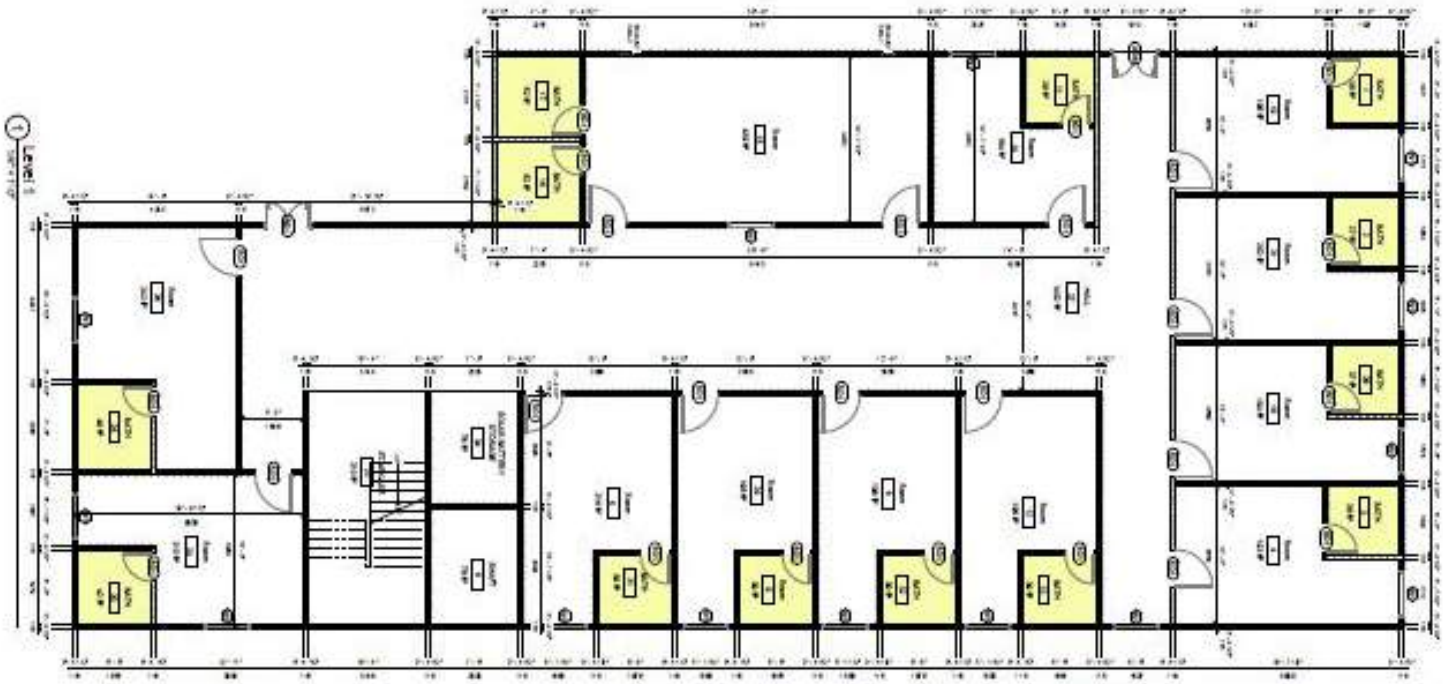
Markets, workforces and transport for building material were limited during the lockdown and timelines to build were short. Hence, a prefabricated construction solution (warehouse constructed and assembled on site) built 5000+ sqft in 2 months. The walling infills were made from agro-fiber that insulated the building and protected from heat stress

Model COVID CARE VISTEX HOSPITAL
design and upgradation by SELCO Foundation in partnership with Doctors For You, Patna, Bihar.

Floor Plan for IPD /OPD



Layout for staff quarters



Overall reduction in energy consumption for the Hospital-**58.34%**

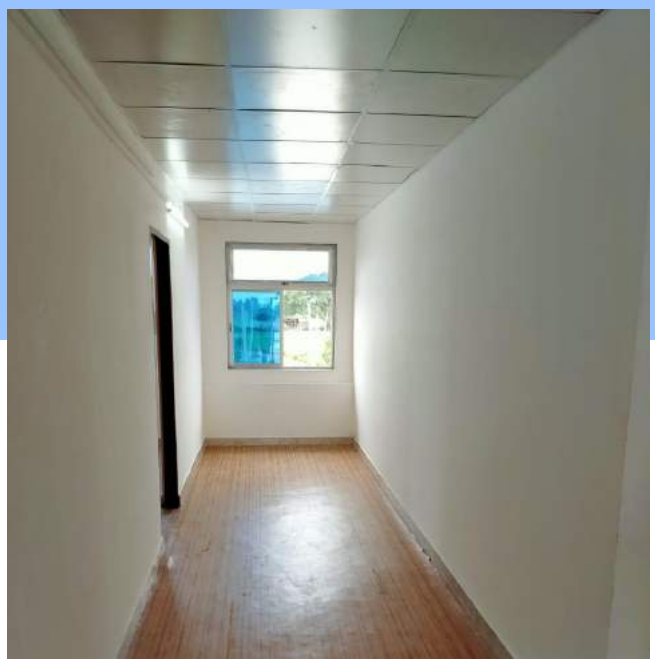
Efficient infrastructure and appliances

Each Panel - 1000 Wp* (Inefficient infrastructure and appliances)

Each Battery - 150Ah (Efficient)

Each Battery - 150Ah (Inefficient)

System	Efficient appliances with Green Building Design	In-Efficient appliances with Green Building Design	In-Efficient appliances with standard typical building designs
Total Load Connected	4290 W	5749 W	5749 W
Total Units Required	21.8 Units	30.63 Units	52.34 Units
Solar Panel Capacity	12 kWp	16.2 kWP	26 kWp
% of Savings (Energy)	28.82% (solution without energy efficient appliances and with green building design) 58.34% (savings with both- energy efficiency and green building design)		



100% ECO friendly walling and flooring compressed Agri Fibre panels which is manufactured using the crop residue which provides better insulation (U = 0.716 W/m2 K) compared to conventional walling and flooring panels.

Incremental building solution to improve the efficiency of Health centers

Incremental building solutions which can be added to upgrade the existing health care centers to improve the quality of the space with respect to natural lighting, ventilation and the thermal comfort leading to early recovery of the patients.

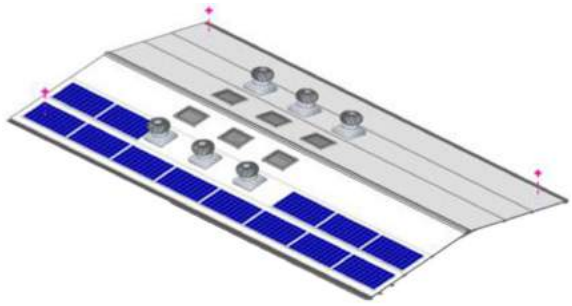
Namely,

1. Addition of Skylights and Turbo Ventilators to the roofing.
2. Windows with exhaust fan.
3. Cool roof solutions like cool roof paints, Modroof and false ceilings.

Airlite at a tribal maternity ward

Modroof - Prefab Roofing solution

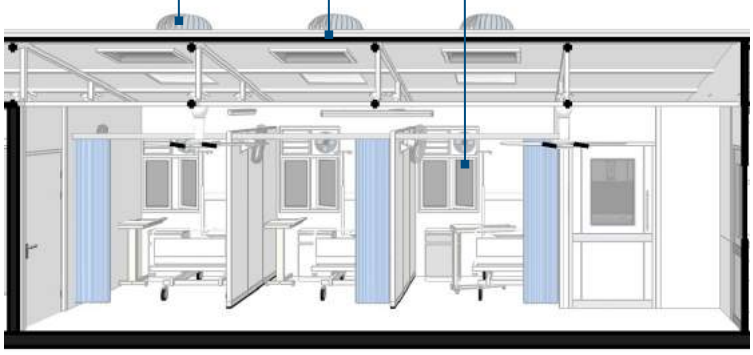
False ceiling - Bamboo matt boards to reduce the heat gain



Roofing with Skylights and Turbo Ventilators

1.Turbo Ventilator

2.Insulated Roofing



Ward

3. Window with Exhaust Fan

Case Study: Multipurpose Flood Relief Shelter Quarantine Centre for Covid Care

Climatic Conditions and User Behavior

Location: Maneswar Block, Sambalpur, Odisha

Temperature Range: 38°C to 19°C (75% RH)
Climate - Warm and Humid Tropical
Wind direction - SW and S

Building Gross Area: 3,000 sqft
Building age – constructed August 2020

Occupancy: 500-1000 people at a time.

Building Use: Multipurpose Relief Shelter
Number of Floors: Ground + 1
Number of rooms and areas - 9

Day time occupancy (6am to 5pm)
- 6 Halls, 1 Kitchen, 1 Dining, Toilets

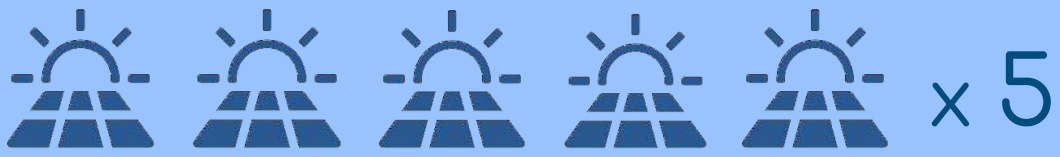
Night time occupancy (5pm to 6am)
- 6 Halls, 1 Kitchen, 1 Dining, Toilets

Model Multipurpose Flood Relief Shelter at Maneswar renovated by SELCO Foundation

Overall reduction in energy consumption- **62%**

x 2

Efficient infrastructure and appliances

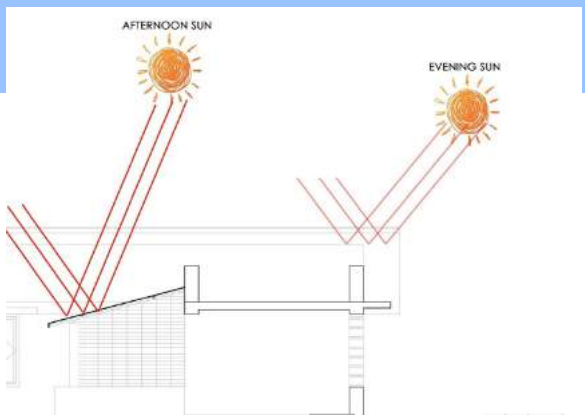


x 5

Each Panel - 100 Wp (Inefficient infrastructure and appliances)

Each Battery - 200Ah (Efficient)

Each Battery - 150Ah (Inefficient)



Cool roof paint for the outer envelope to reduce the heat gain through roofing.

Imagesource:https://www.americanweatherstar.com/what-are-the-benefits-of-a-cool-roof/

SELCO Foundation's Role

Guidelines and processes for mapping out typologies along with existing healthcare ecosystem stakeholders in place (enabling factors)

Guidelines and processes for designing and implementing appropriate technical and financial interventions at regional levels (District and State)

- Selection and procurement of efficient appliances,
- Design and procuring appropriate need-based sustainable energy systems
- Design and execution of green built environments for the health value chain, enterprise/vendor selection
- Financial modelling and evaluation (financial and ownership design for maintenance and servicing)

Capacity Building across the Value chain and Health-Energy Nexus

Inputs for National and Global Policies with respect to Health-Energy Nexus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