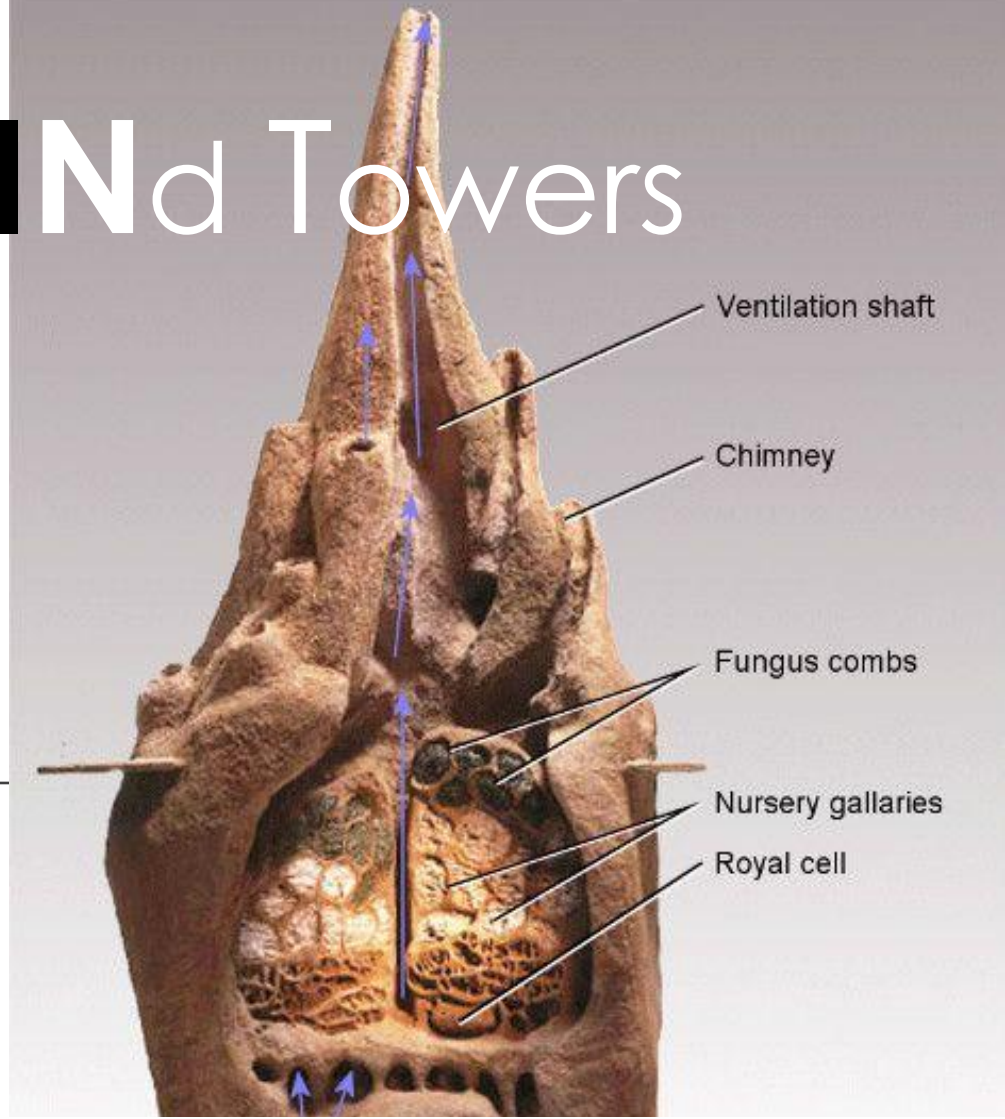
Urban **WIN**d Towers

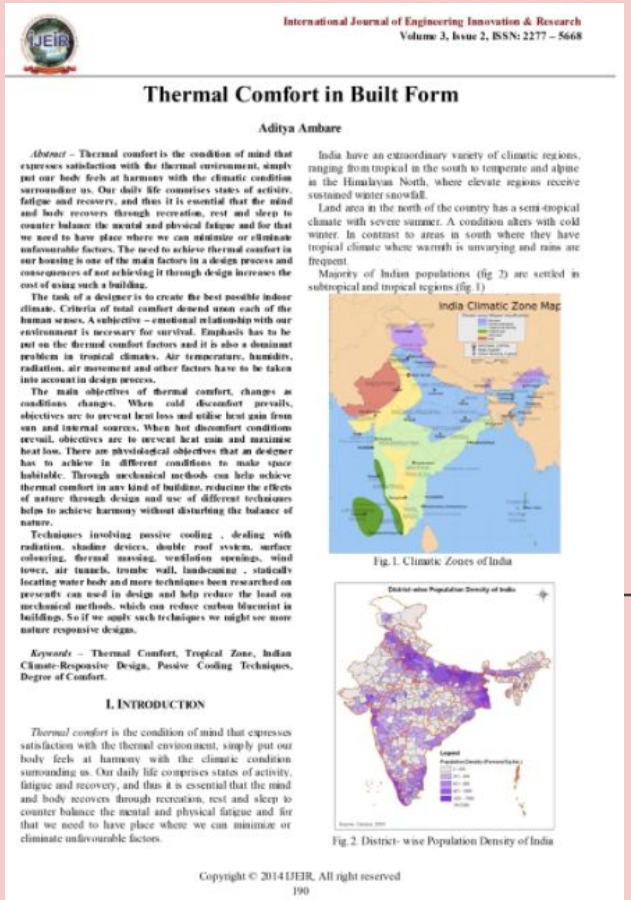


Studio 4A
Project

Creating Bio-Climatic Systems in Urban Heat Islands

Aditya Ambare

Motivation// @STUDIO4A *India*



International Journal of Engineering Innovation & Research
Volume 3, Issue 2, ISSN: 2277 – 5668

Thermal Comfort in Built Form

Aditya Ambare

Abstract – Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment, simply put our body feels at harmony with the climatic condition surrounding us. Our daily life comprises states of activity, fatigue and recovery, and thus it is essential that the mind and body recovers through recreation, rest and sleep to counter balance the mental and physical fatigue and for that we need to have place where we can minimize or eliminate unfavourable factors. The need to achieve thermal comfort in our housing is one of the main factors in a design process and consequences of not achieving it through design increases the cost of using such a building.

The task of a designer is to create the best possible indoor climate. Criteria of total comfort depend upon each of the human senses. A subjective – emotional relationship with our environment is necessary for survival. Emphasis has to be put on the thermal comfort factors and it is also a dominant problem in tropical climates. Air temperature, humidity, radiation, air movement and other factors have to be taken into account in design process.

The main objectives of thermal comfort, changes as conditions changes. When cold discomfort prevails, objectives are to prevent heat loss and utilise heat gain from sun and internal sources. When hot discomfort conditions prevail, objectives are to prevent heat gain and maximise heat loss. There are physiological objectives that an designer has to achieve in different conditions to make space habitable. Through mechanical methods can help achieve thermal comfort in any kind of building, reducing the effects of nature through design and use of different techniques helps to achieve harmony without disturbing the balance of nature.

Techniques involving passive cooling , dealing with radiation, shading devices, double roof system, surface colouring, thermal massing, ventilation openings, wind tower, air tunnels, trombe wall, landscaping , statically locating water body and more techniques been researched on presently can used in design and help reduce the load on mechanical methods, which can reduce carbon blueprint in buildings. So if we apply such techniques we might see more nature responsive designs.

Keywords – Thermal Comfort, Tropical Zone, Indian Climate-Responsive Design, Passive Cooling Techniques, Degree of Comfort.

I. INTRODUCTION

Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment, simply put our body feels at harmony with the climatic condition surrounding us. Our daily life comprises states of activity, fatigue and recovery, and thus it is essential that the mind and body recovers through recreation, rest and sleep to counter balance the mental and physical fatigue and for that we need to have place where we can minimize or eliminate unfavourable factors.

India have an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan North, where elevate regions receive sustained winter snowfall.

Land area in the north of the country has a semi-tropical climate with severe summer. A condition alters with cold winter. In contrast to areas in south where they have tropical climate where warmth is unvarying and rains are frequent.

Majority of Indian populations (fig 2) are settled in subtropical and tropical regions (fig 1)

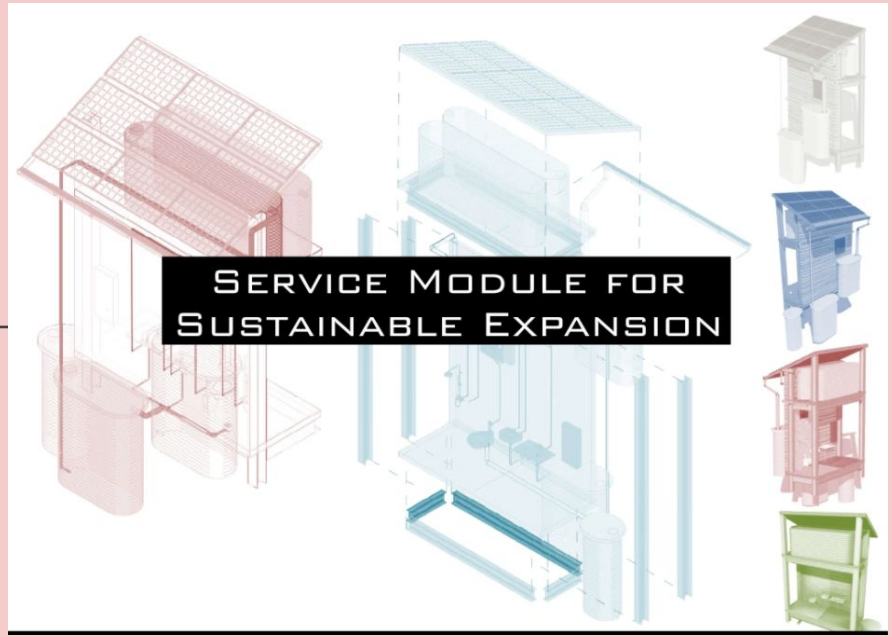
Fig.1. Climatic Zones of India

Fig.2. District- wise Population Density of India

Copyright © 2014 IJEIR, All right reserved

"Removing constant financial constraint after the construction of the dwelling is complete."





Idea :

What if by replacing a small proportion of bricks from a interior wall with terracotta bricks we can cool inner spaces ?

Idea :

What if by converting shafts of row housing into wind towers , we can create passive cooling system in middle of urban heat islands?

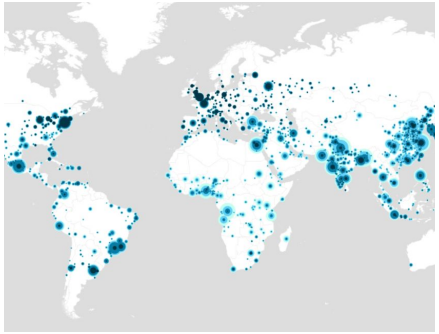
Idea :

Will architects of the future also design bricks specific to the site as well as the space to reduce cooling loads of the building?

Target:

Ending perpetual dependency on resource heavy **active HVAC** system in urban housing in response to growing **URBAN HEAT ISLAND EFFECT** with **PASSIVE EVAPORATIVE COOLING SYSTEM.**

Context :



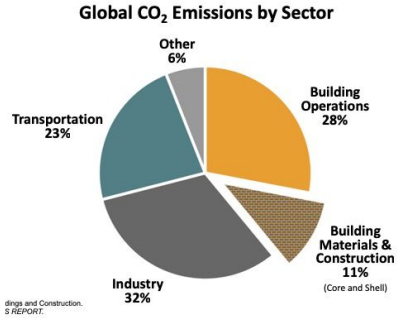
By 2050, the world's population is expected to increase up to 9.7 billion

UN The World's Cities in 2018 / data booklet



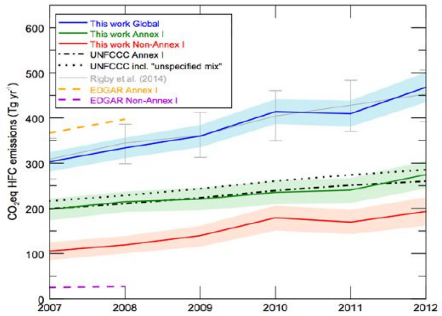
By 2050, 68% of population will live in urban areas

UN The World's Cities in 2018 / data booklet

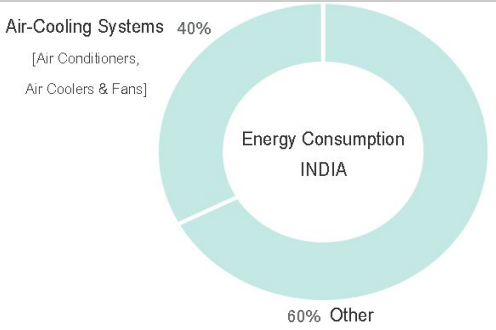


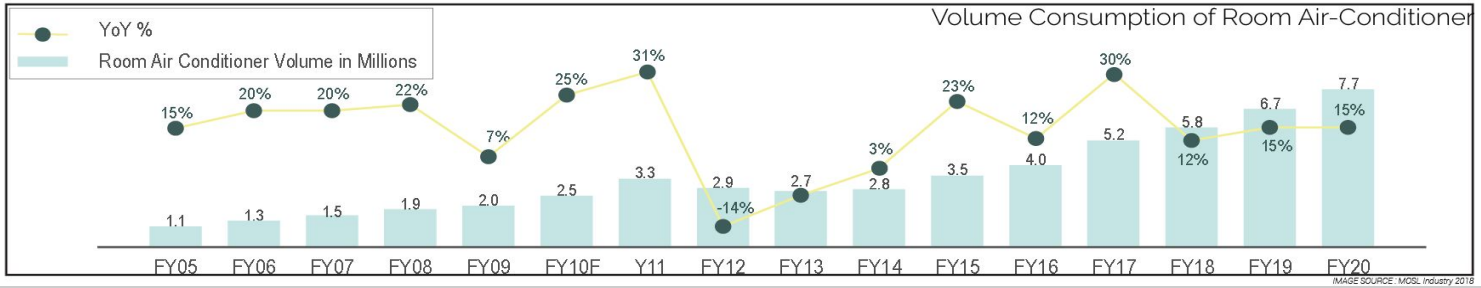
Construction Industry contributes upto 40% to Global CO2 Emissions.

Problem :



Energy use in cooling account for " around 10% of Global CO2 emissions already. "





Existing Urban housing lacks the flexibility of design and structural intervention once construction is done which makes users dependency on constant use of HVAC system permanent. This adds to constant economic constraint on the users living in these dense housings.

These buildings are also most difficult to renovate or demolish because of multiple shareholders which makes these constructions more permanent and constant contributor to HEAT ISLAND EFFECT.

Validation :

Oct 2020 // 2030 European Climate Target Plan

The Commission’s proposal to cut greenhouse gas emissions by at least 55% by 2030 sets Europe on a responsible path to becoming climate neutral by 2050 .

2 Oct, 2019 // Energy demand for cooling accounts for nearly 10% of global electricity used around the world.

Cooling systems rely on human-made Hydrofluorocarbons (HFCs), which could account for nearly 20% of climate pollution by 2050, if not phased down and replaced with existing alternatives

8 Nov 2019 // India’s Climate Change Policy: Towards a Better Future

The INDC has set a target of 175 GW of renewable energy by the year 2030 on the strength of the outstanding success of the National Solar Mission. It is reported that this capacity may well be achieved 10 years in advance. The government may raise India’s target to 227 GW for 2030. The target of achieving 40% of power from renewable sources by 2030 is likely to be achieved several years in advance.

16 May 2018 //Around 2.5 billion more people will be living in cities by 2050, projects new UN report

2018 //UNEP’s Sustainable Buildings and Construction Initiative (SBCI)are working to establish knowledge on the base-line emissions from buildings in India, highlight priority issues and opportunities for sustainable buildings and identify a network of experts that can contribute to the aims of Sustainable United Nations (SUN) and SBCI.

Solution // *Urban Wind Towers*

Outside Hot Air Inlet

Design of a wind tower system to reduce the wind velocity and its admission into the system

Steady and consistent wind flow through induced pressure difference to be prefered over direct outside wind.

Evaporative Cooling System

Module Based Design

Design of a wall system which facilitates evaporative cooling.

Methodology:

1. **Optimize the water quantity, Surface area and ideal wind speed**
2. **Optimize the interlocking pattern**

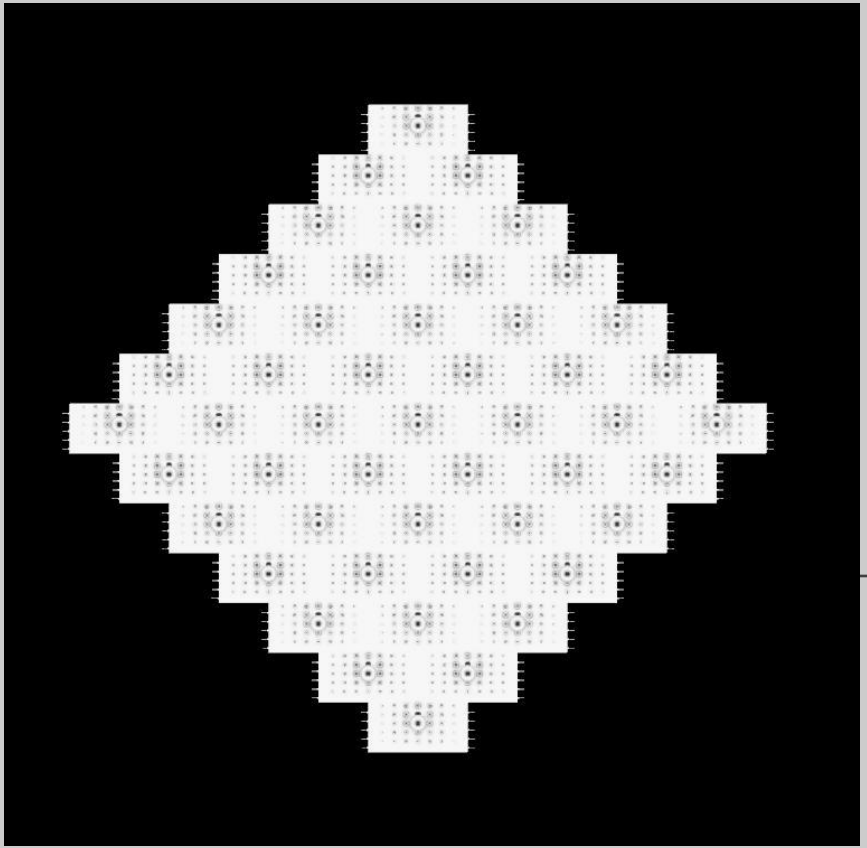
Inside Hot Air Outlet

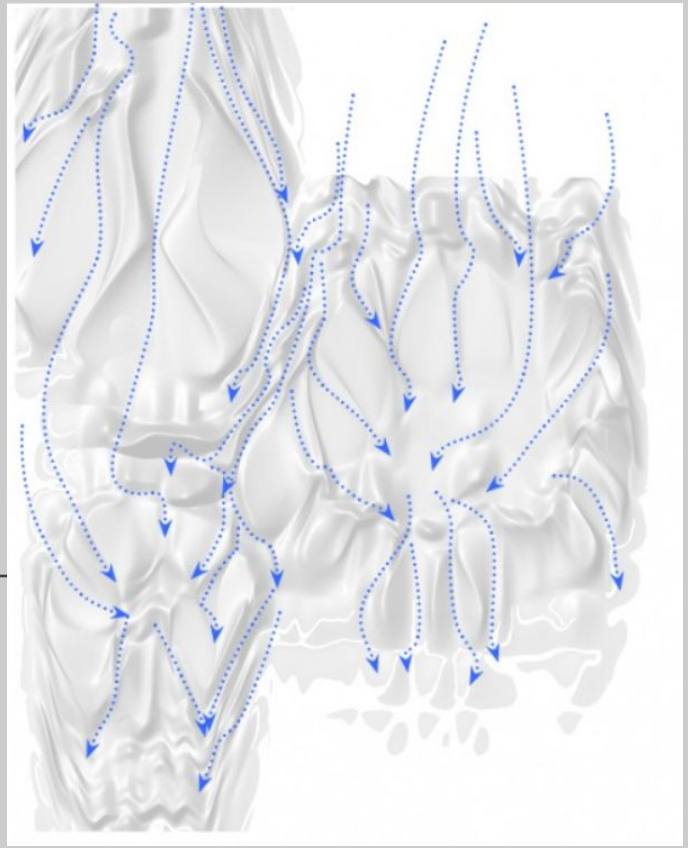
Design of an Exhaust system which can either release the hot air back into the system internally to the hot air inlet or to the outside.

**** These factors will influence the form of the building and vary as the height of the building.***

Incorporation into exisitng building system possibility arises due to existence for service and ventilation ducts in multi-storey buildings

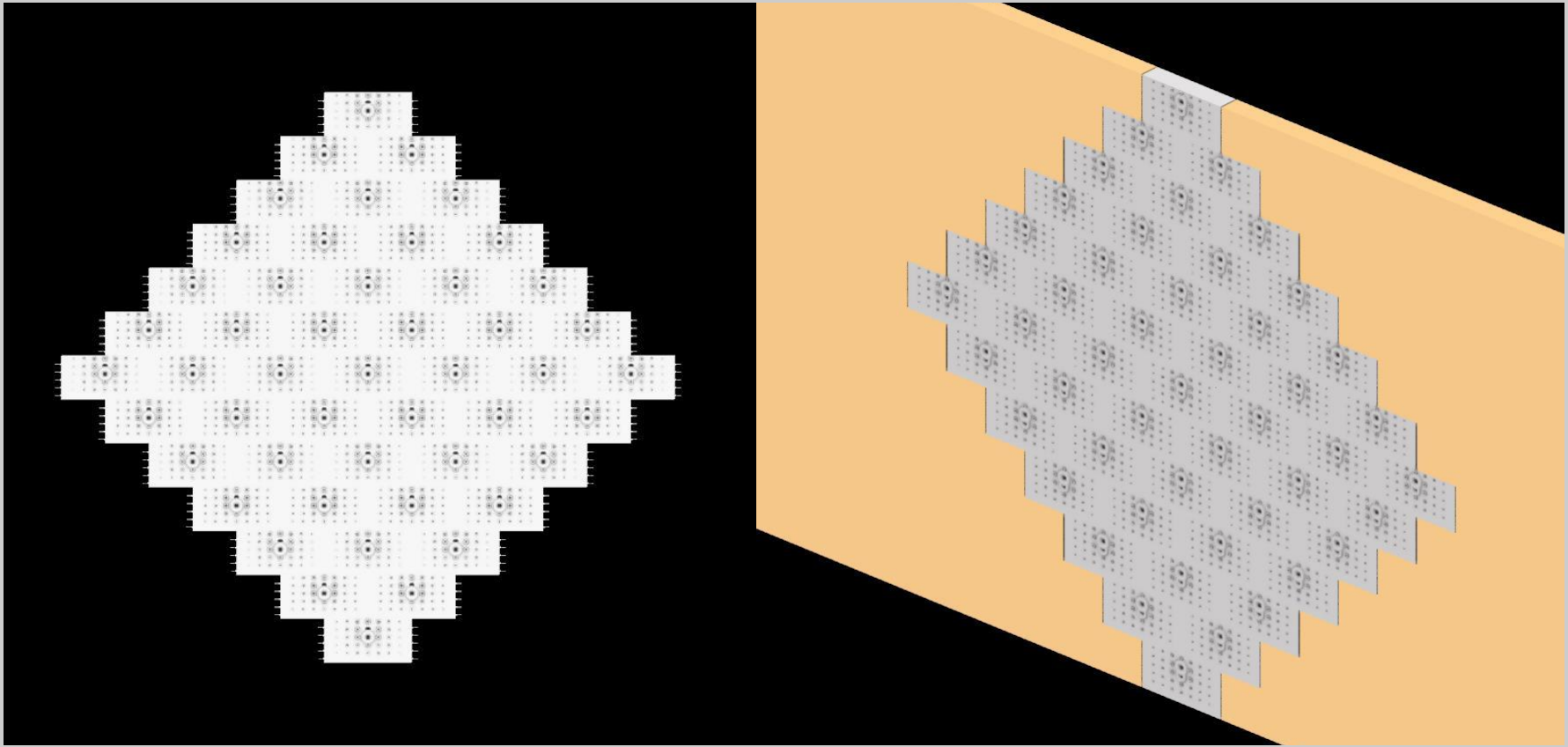
Solution // *replacing some bricks in interior walls for evaporative cooling*



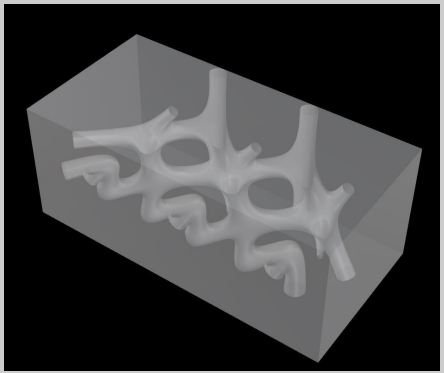


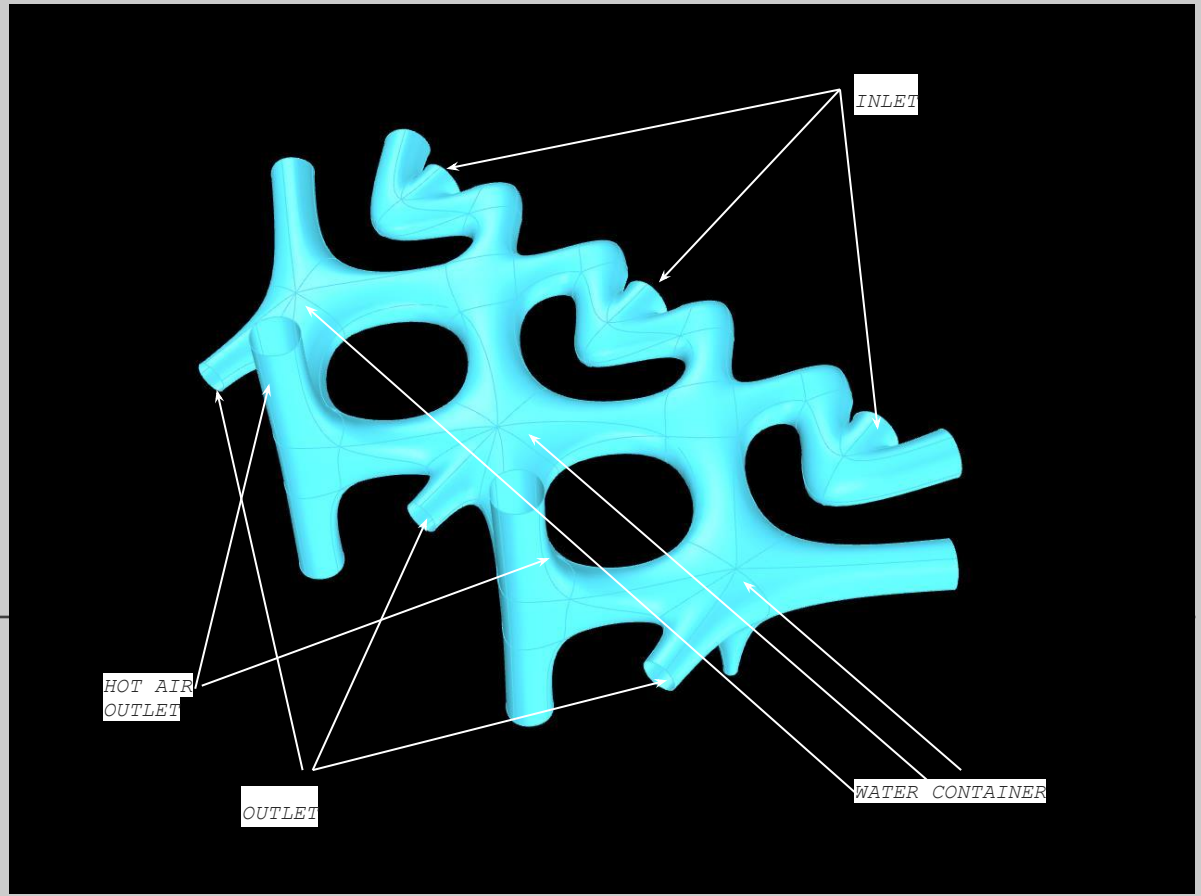
http://www.iaacblog.com/programs/hydro-responsive-dormancy/

Solution *// Materialization// replacing some bricks in interior walls for evaporative cooling*

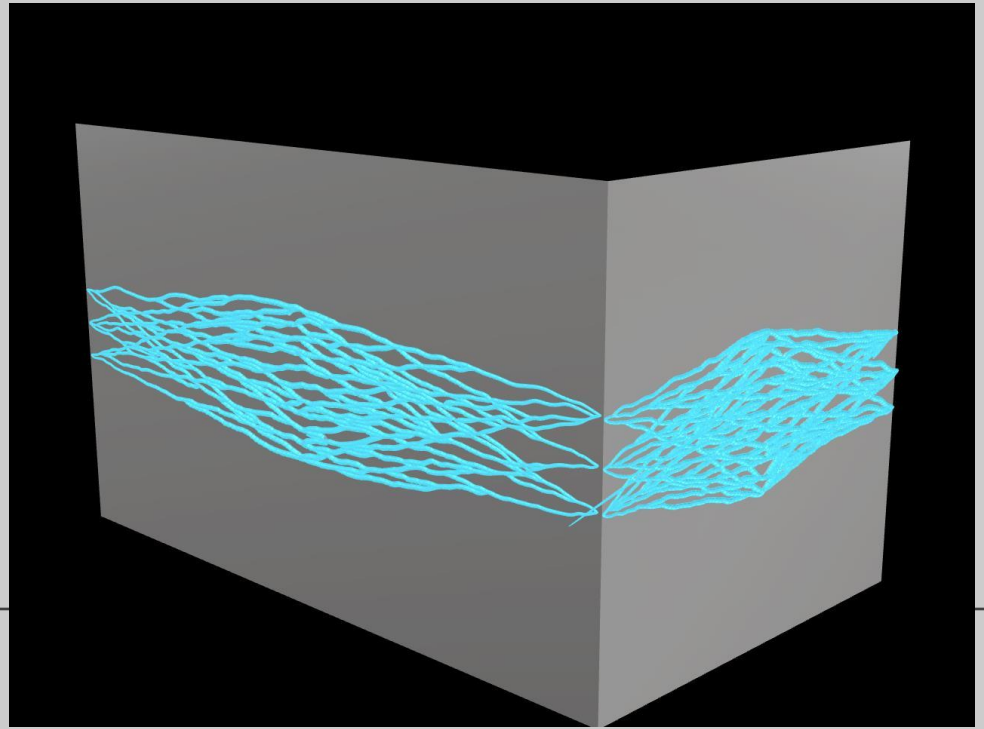


Solution *// Materialization// replacing some bricks in interior walls for evaporative cooling*





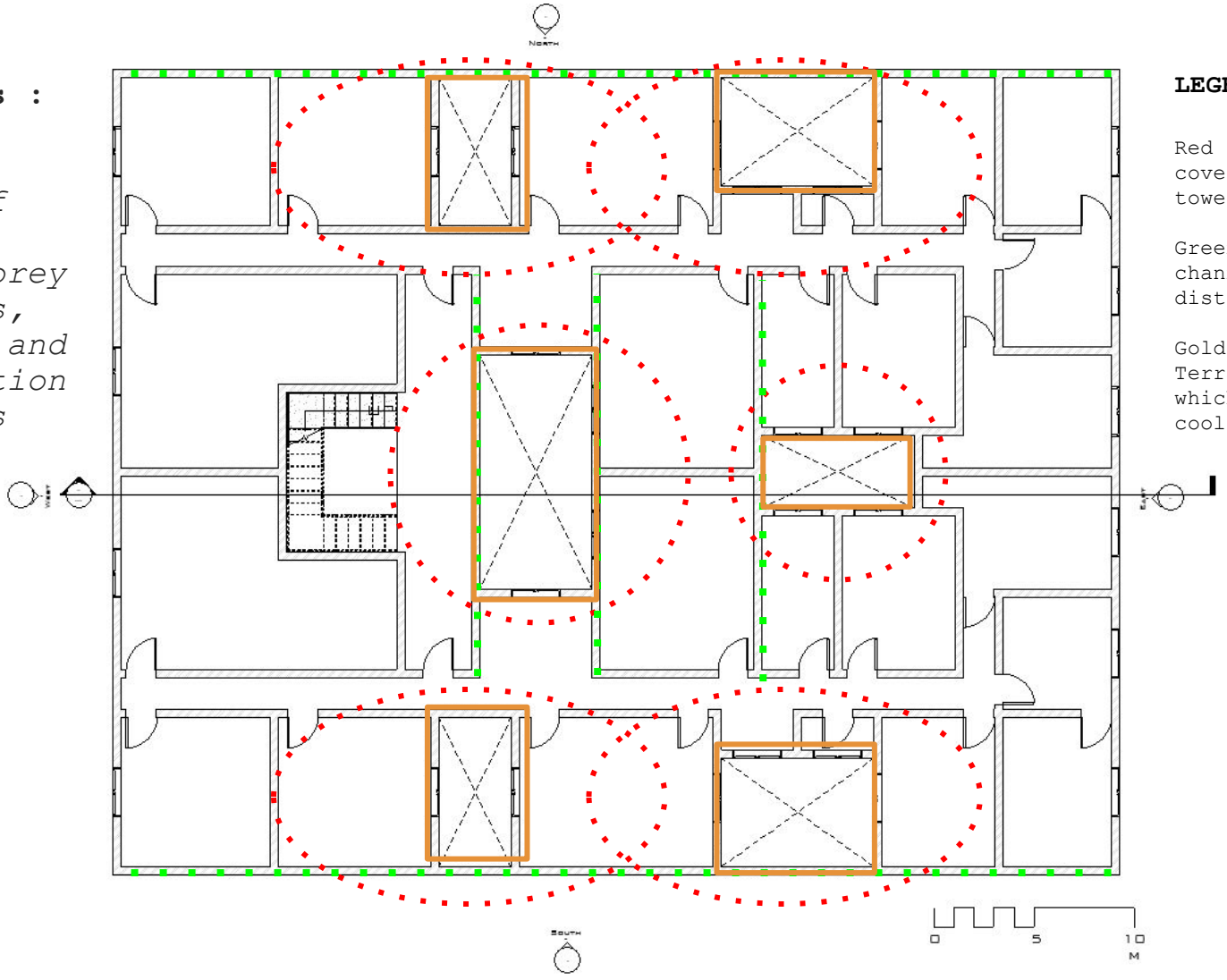
Solution //



Cool air from the terracotta bricks near the wind tower gets circulated to the inner areas through the channels bricks which are constructed in modular and replace specific bricks of the existing wall.

Target Customers :

Owners of Existing Multi-Storey Buildings, Builders and Construction Companies



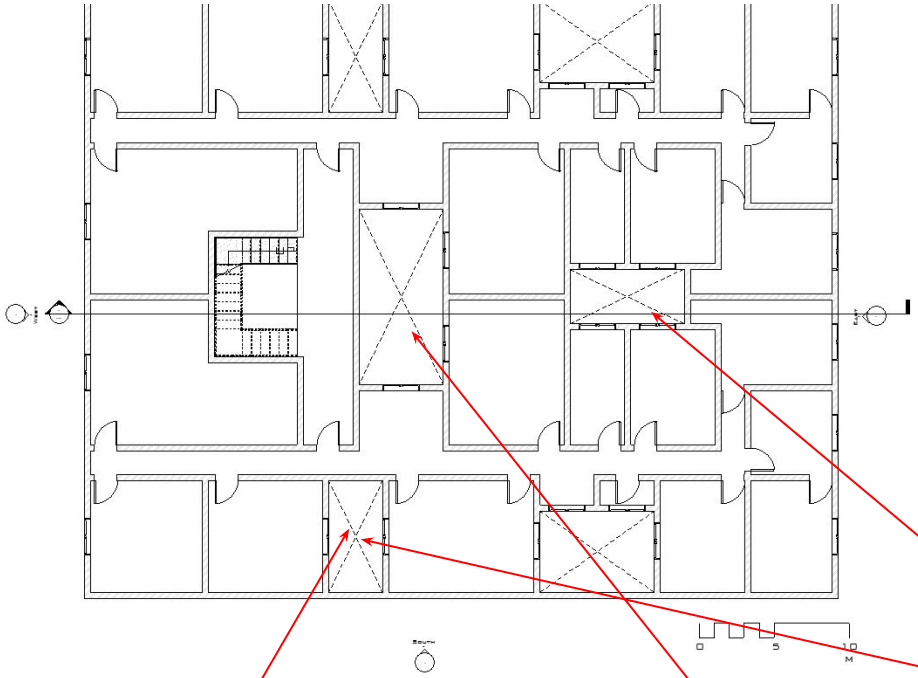
LEGEND:

Red lines : Space covered by wind tower

Green lines : Wall channels to distribute cool air

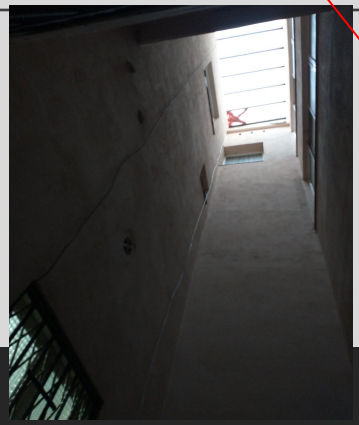
Gold Lines : Terracotta bricks which do evaporative cooling

Application// Retrofitting in existing high density row housing

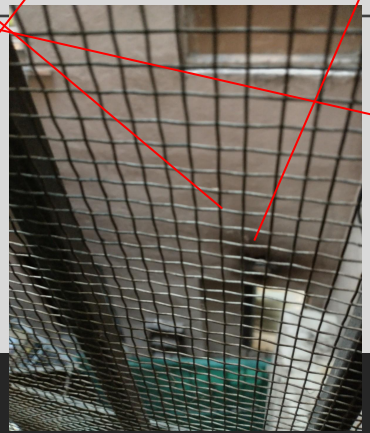


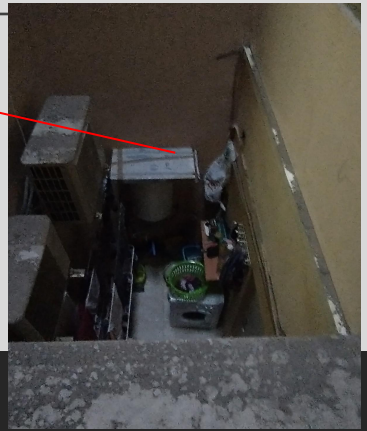




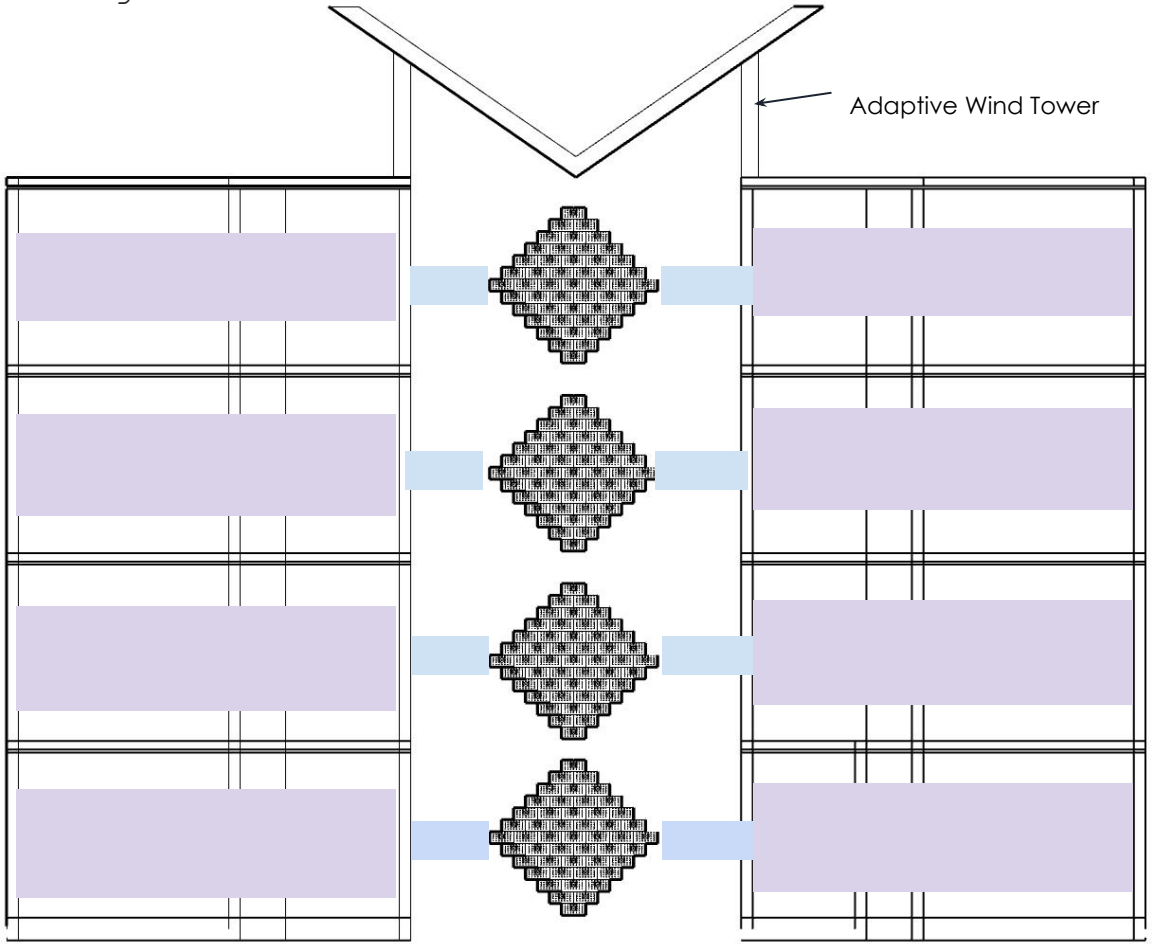








Solution // Adaptive Wind Tower to be facilitate the air into inner areas through retrofitting shafts



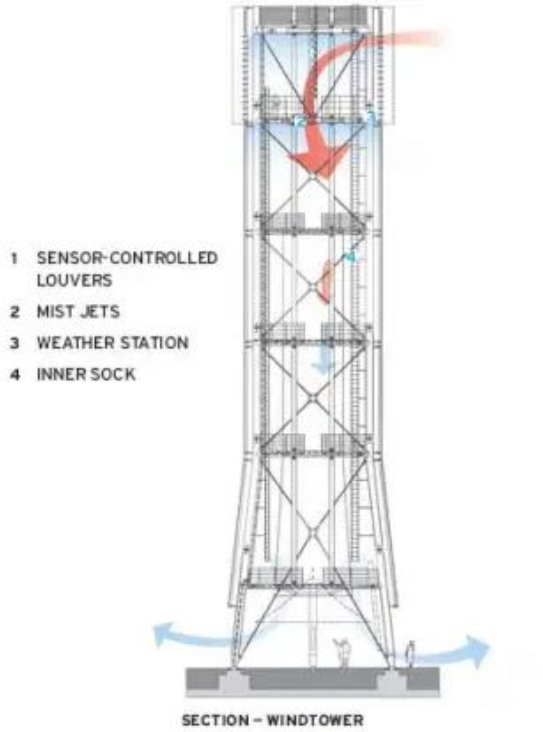
LEGEND

Black Area :
Evaporating Cooling Bricks

Blue Area :
Transfering Cooling Air

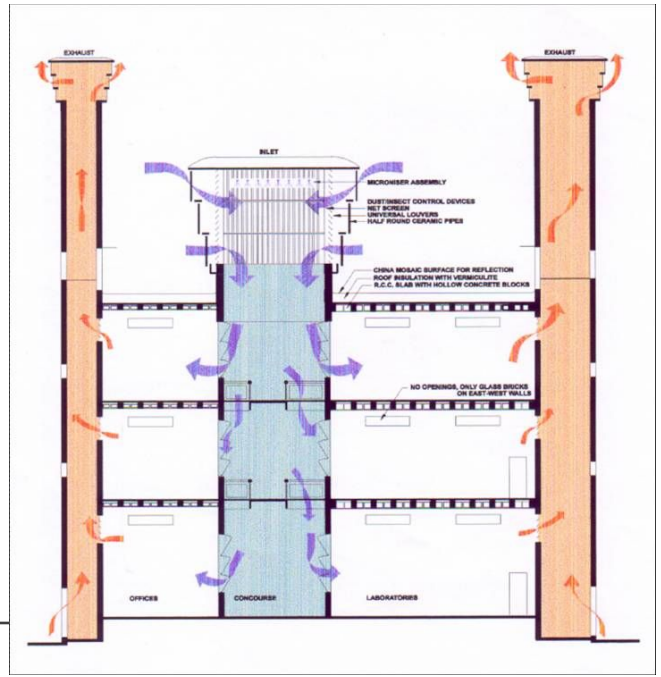
Purple Area:
CIrculating wall

Validation :



Masdar City's Wind Tower

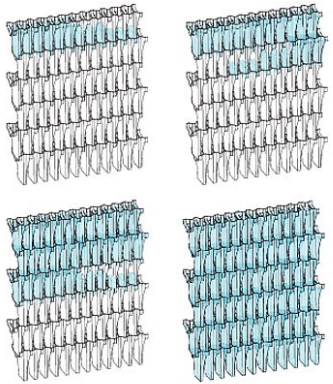
1. The wind tower is able to lower temperature by 5 degrees.
2. Have directional control for catching prevailing wind and directing the cooler wind to specific space
3. Can also reserve the phenomenon by use of electrical fans



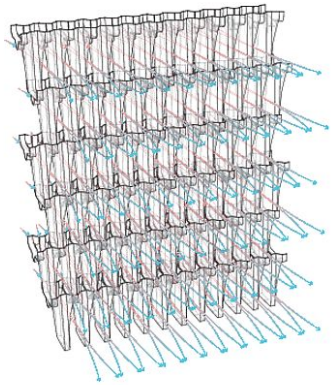
Torrent Research Centre, Ahmedabad, India

1. Passive Downdaught Evaporative Cooling reduces the relaince on mechanical equipments

Validation :



A section of the wall filling with water

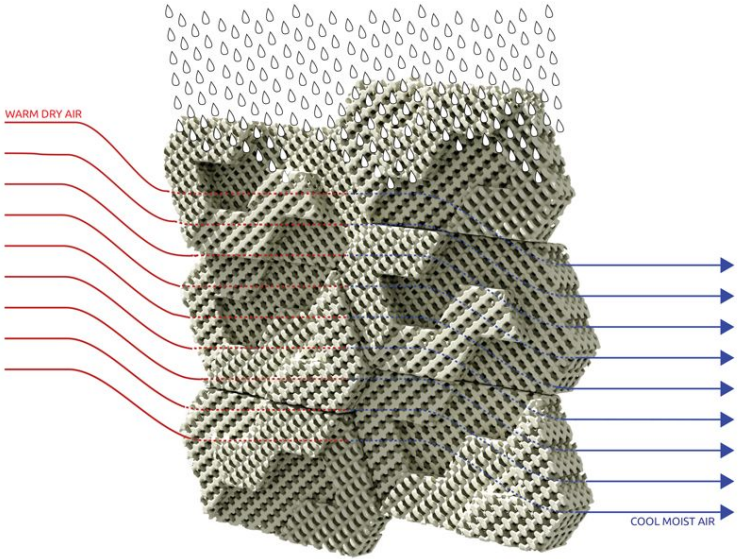


The cooling of air as it passes over the bricks

Cold Spot

Cold Spot is a project developed by students at the Harvard Graduate School of Design to manage heat gain through the innovative use of ceramics

https://www.climatecolab.org/contests/2014/urban-heat-island-effect/c/proposal/1313914

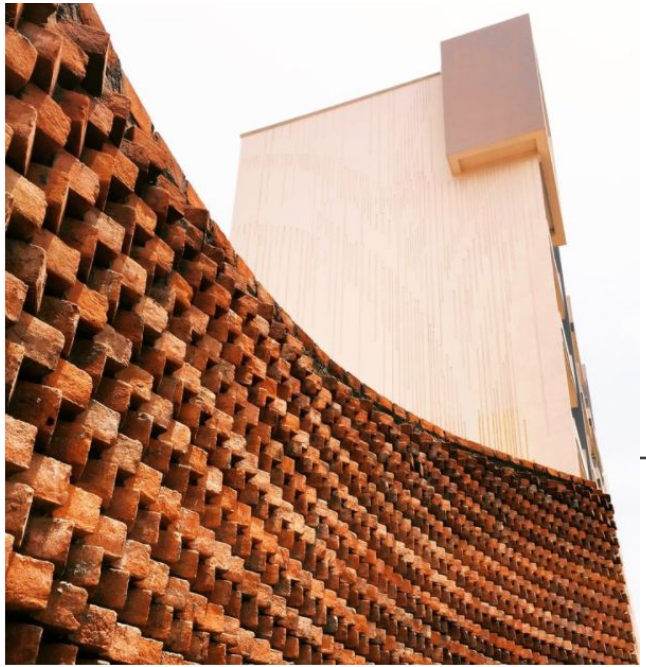


COOL BRICK by Emerging Objects

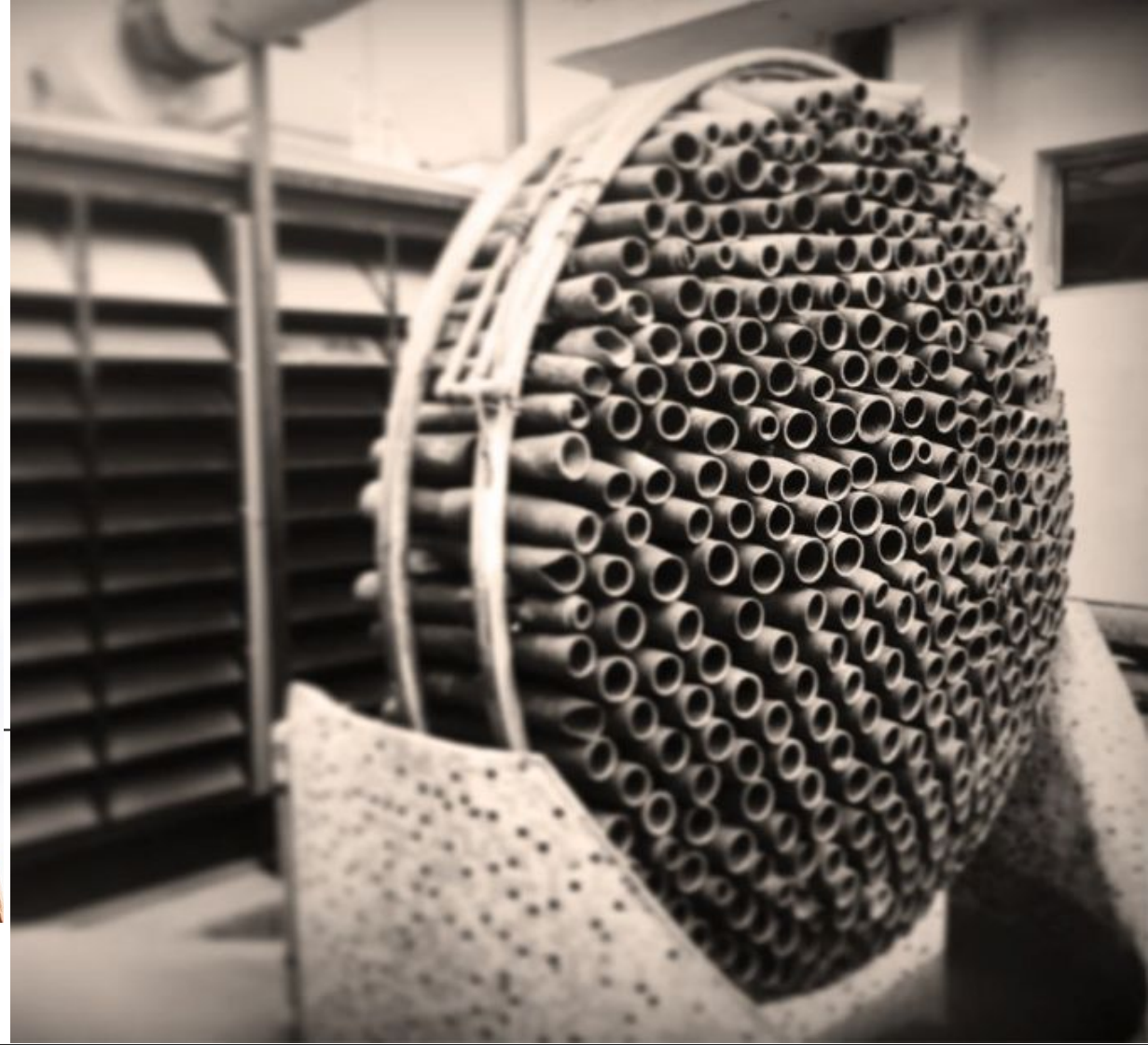
Working Principles of traditional techniques like Masrabhiya can be incorporated in design of smaller building elements like bricks which can lead to decentralized cooling systems

Validation :

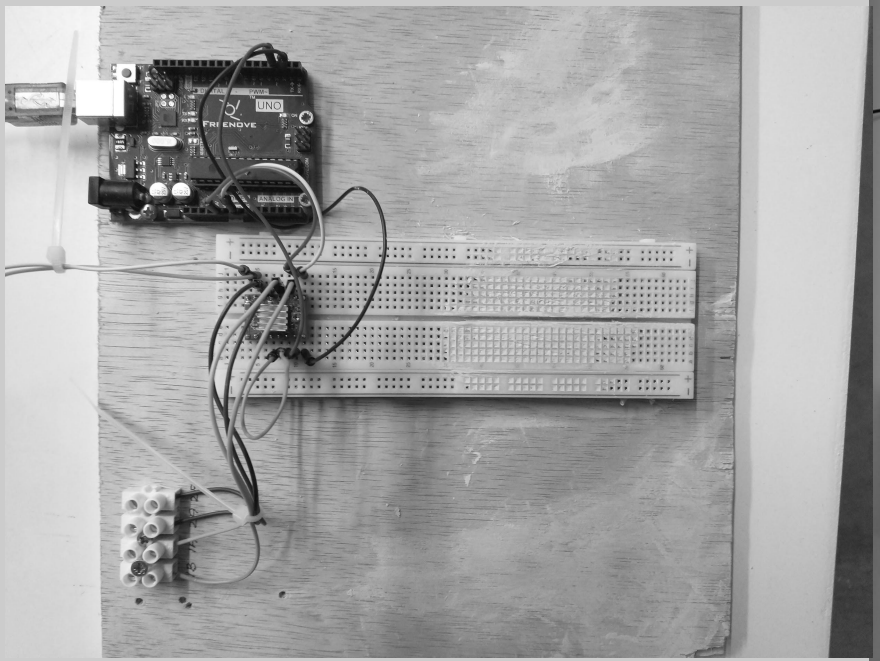
ANT Studio , New Delhi
Monish Siripurapu



Amar Heights



Further Validation :



Prototyping and Testing the Cooling Efficiency of the Proposed System.



Opportunity

Through the essential elements of the technology exists and have been used, they have been proposed in new buildings and mostly public buildings.

Which leaves the existing housing sector where majority of the population lives.

There are about 216 million dwellings in the EU and residential buildings represent about 75% of the 25 billion m2 floor area.

Market// TAM

Housing Construction Industry in Sub-Tropical Countries for example India, UAE, South East Asian Countries and Latin American others.

Population of India is 1,369,756,319 with 299,584,361 Households, majority of which are AC dependent and the number is expected to rise.

https://population.un.org/Household/index.html#/countries/356

Market// SAM

Construction Companies, Private Builders and Government Construction Sector

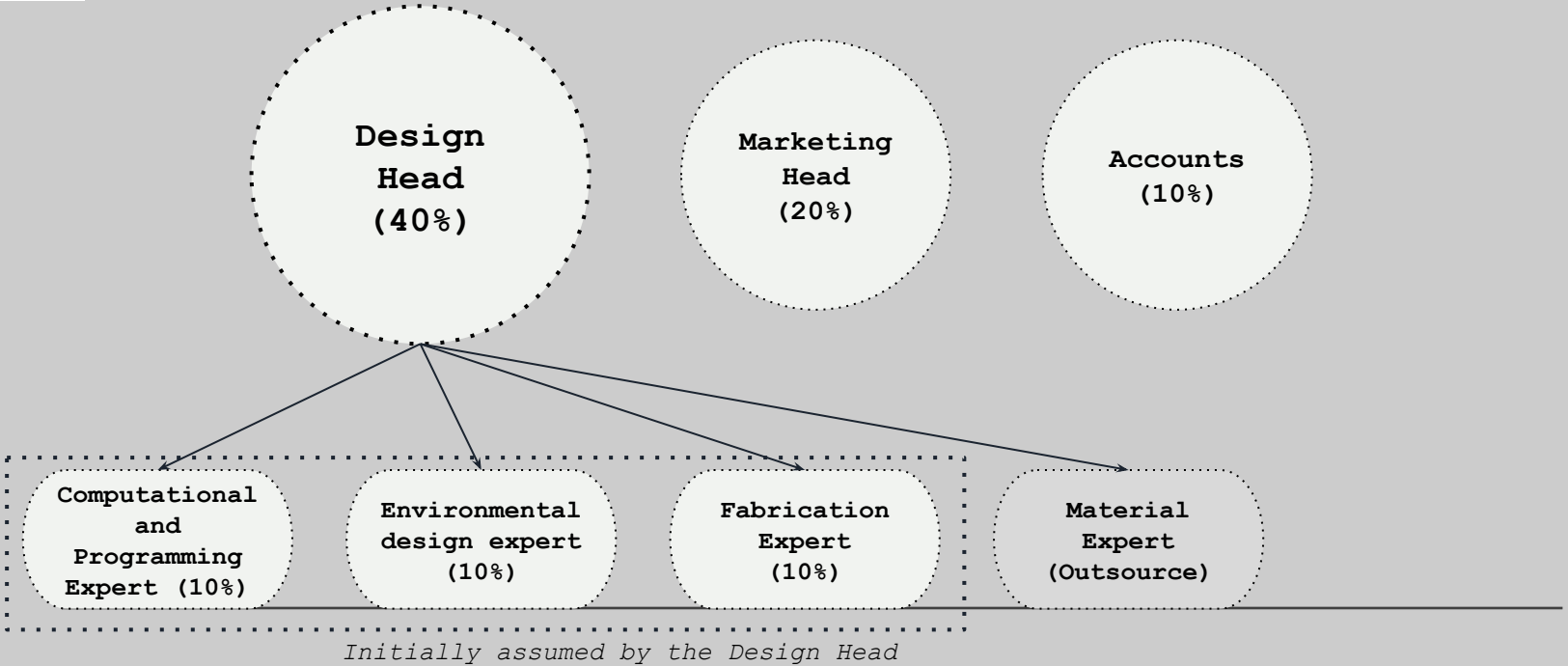
From $8,526.7 million in 2019, the Indian heating, ventilation, and air conditioning (HVAC) market size is expected to grow to $31,598.6 million by 2030, at a CAGR of 16.0% during the forecast period (2020-2030).

Market// SOM

Owners of Existing Urban Residential Buildings.

India’s manufacturing sector is growing to become the fifth largest in the world by 2020. Aided by the Indian government’s initiative of ‘Make in India’, the nation’s vision is to make the country a global manufacturing hub.

TEAM//


Design Head (40%)
Marketing Head (20%)
Accounts (10%)
Computational and Programming Expert (10%)
Environmental design expert (10%)
Fabrication Expert (10%)
Material Expert (Outsource)
Initially assumed by the Design Head

Implementation// *Research and Prototyping Groups to lead to Pivot project*

Based on the results and validation through the Proof of concept of the Design Process i.e. My Master's Thesis.

Additional Funding is required for further Research and Fabrication to push for Pivot Project . Additional funding of 6000 euros will be required to create a shaft with bricks and renting 3d printers to fabricate the terracotta bricks.

United Nations Environmental Council

European commission research and innovation

UNHABITAT

GRIHA India

// Business Model

Start with Pilot Project through the associations

Conferences and Exhibitions and Competitions

Open as Research and Architectural Studio

3 months

Workshops

Through associations with architectural schools or open workshops

6 months

Retrofit existing building

12 months

Services

Supervision of the construction

Brick Design and Configuration

Workshops

Material Research

Environmental Analysis

Design

Fabrication and Installation Strategy

Percentage of the profit is distributed to Experts based on the type of workshop

CFD

12 months

Machine Learning

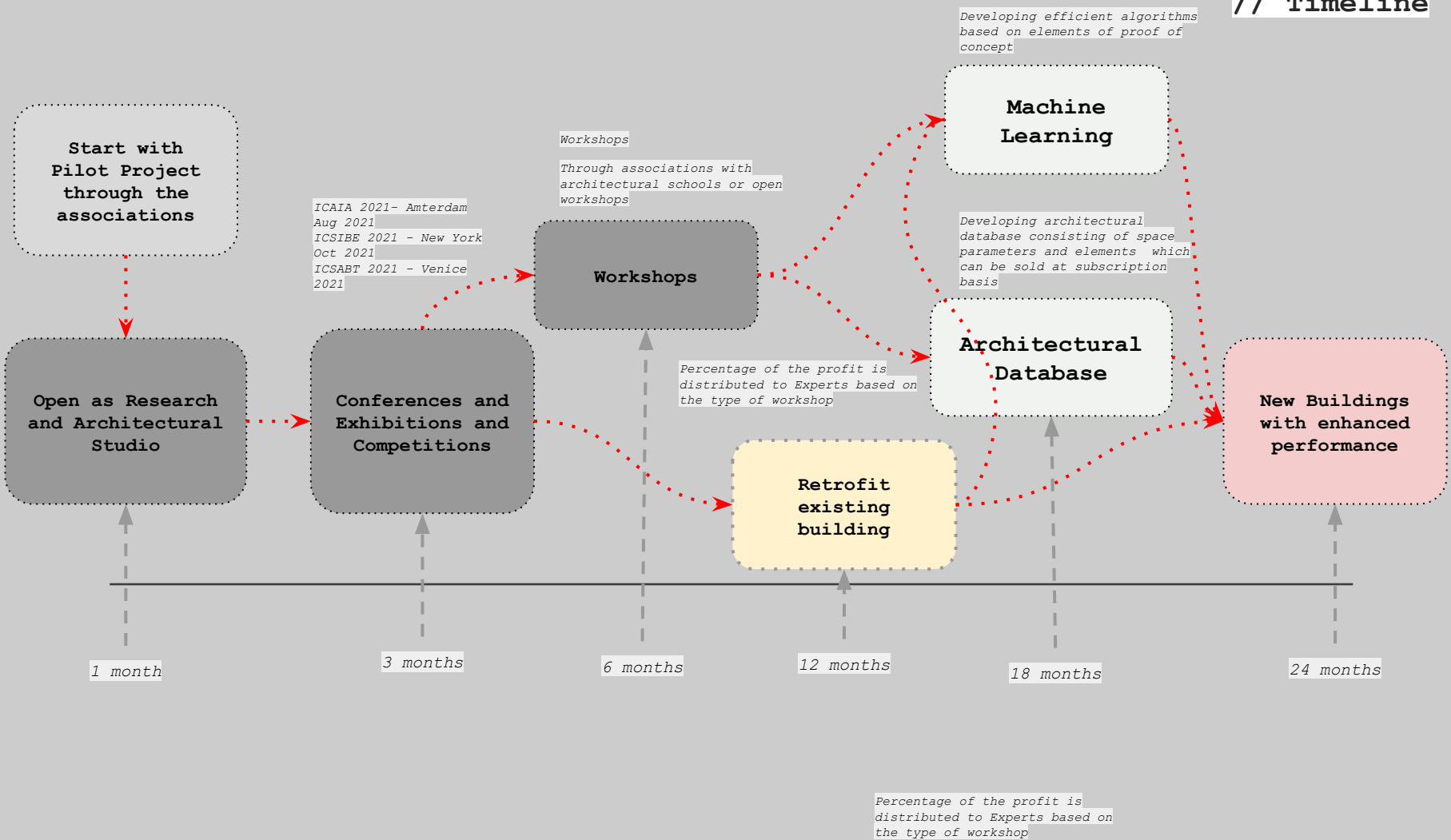
Developing architectural database which can be sold at subscription basis

Architectural Database

18 months - 24 months

New Buildings with enhanced performance

// Timeline



Percentage of the profit is distributed to Experts based on the type of workshop

Resources and Financing//

Educational Institutions for Research Facilities

1. IaaC Barcelona
2. Bartlett

FAB- Labs for fabrications support

Financial Backing from Environmental Agencies

1. United Nations Environmental Council
2. European commission research and innovation
3. UNHABITAT
4. GRIHA India

Active Users

Architectural Exhibitions

1. *ICAIA 2021- Amterdam Aug 2021*
2. *ICSIBE 2021 - New York Oct 2021*
3. *ICSABT 2021 - Venice 2021*

" As an Architect we have the most power and responsibility to change the future of our environment, one building at a time starting with one brick at a time."