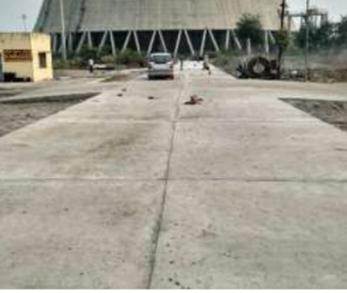




Climate Resilient Buildings: Role of AI and Sensors Redefining Sustainability



by:

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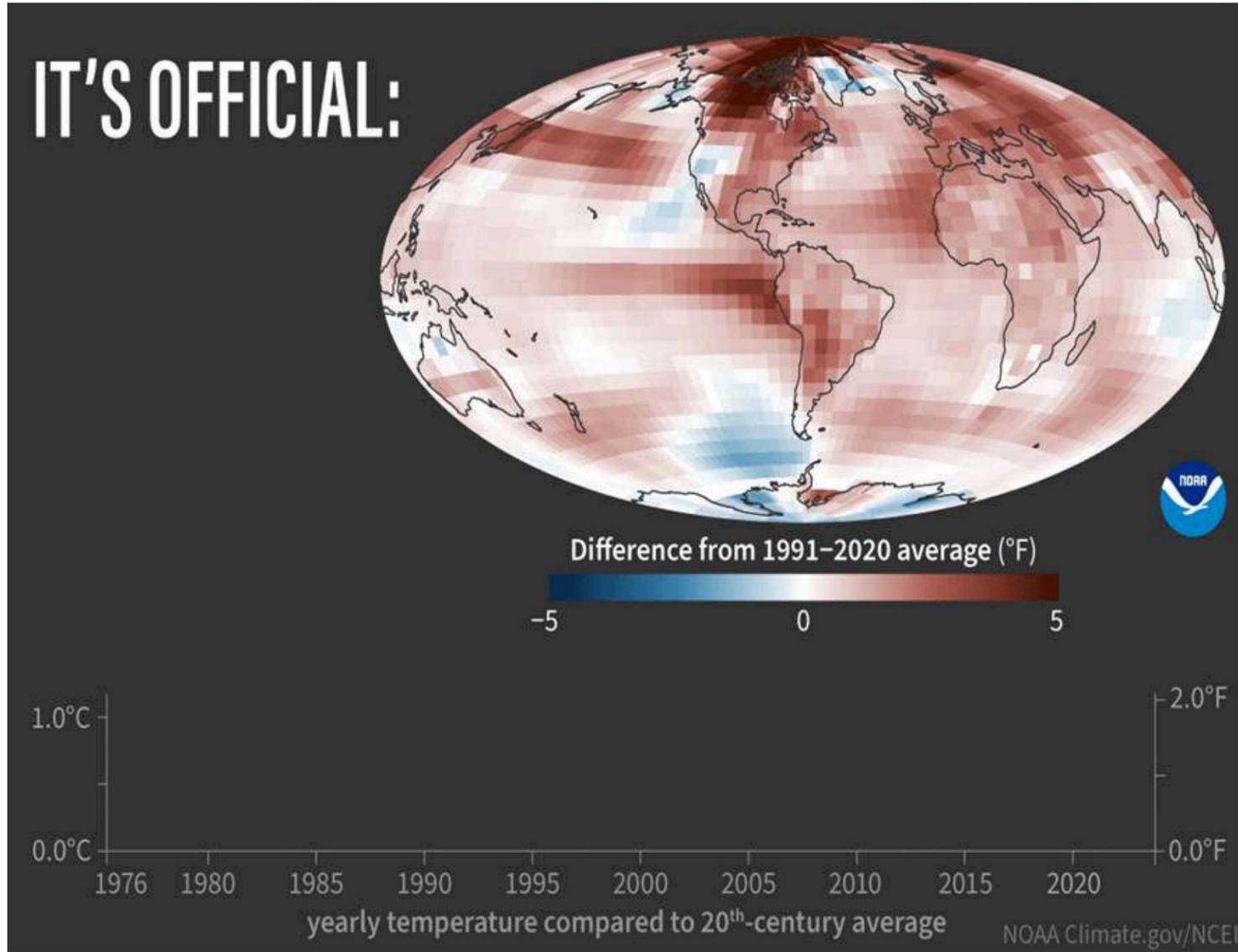


Technology and Innovation Conclave 2.0

Artificial Intelligence (AI) for Climate Action and Resilience

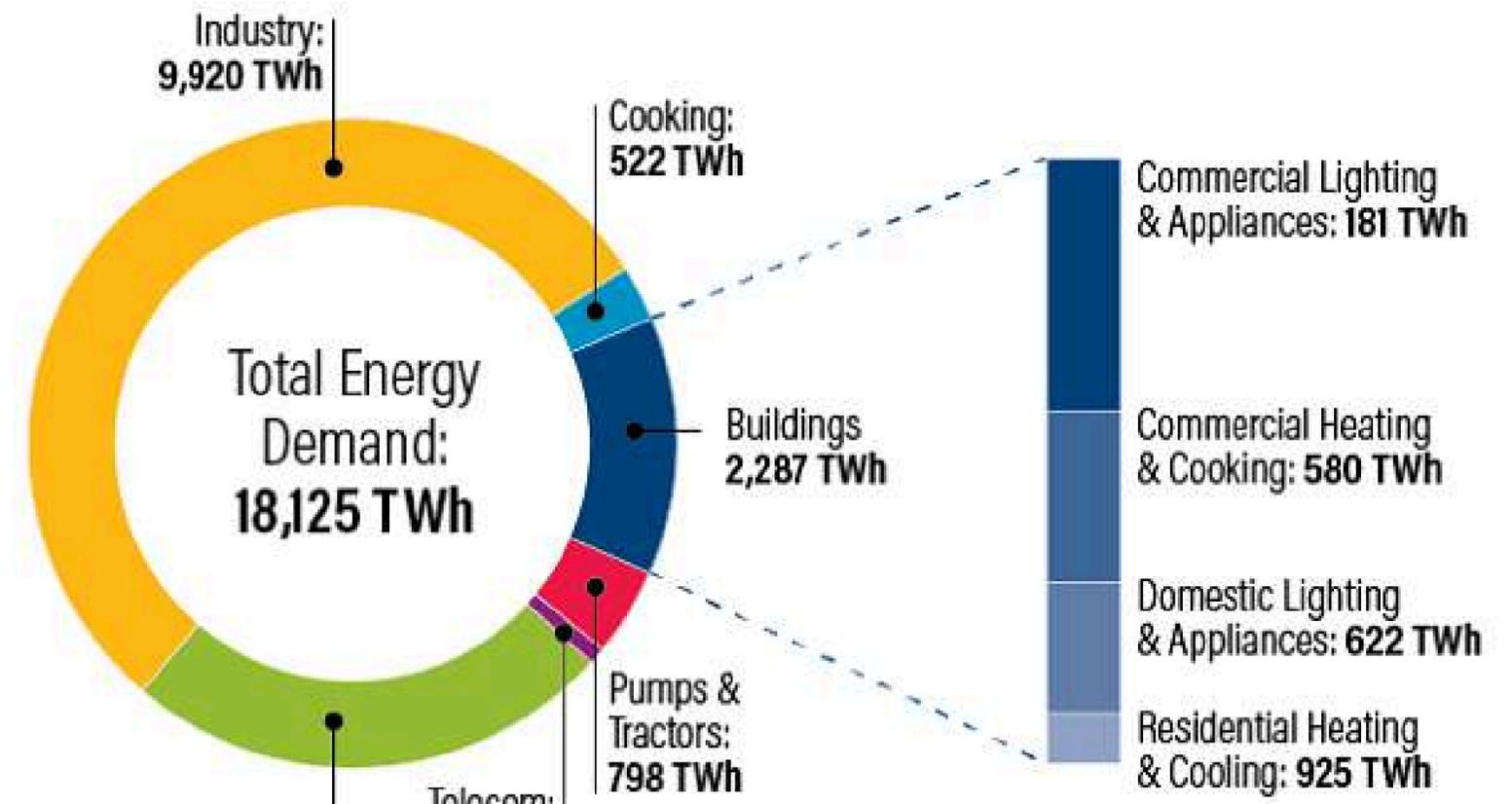
28-30 January 2026, organised by DSIR & APCTTT, at MoES, New Delhi

Global Warming & Climate Change



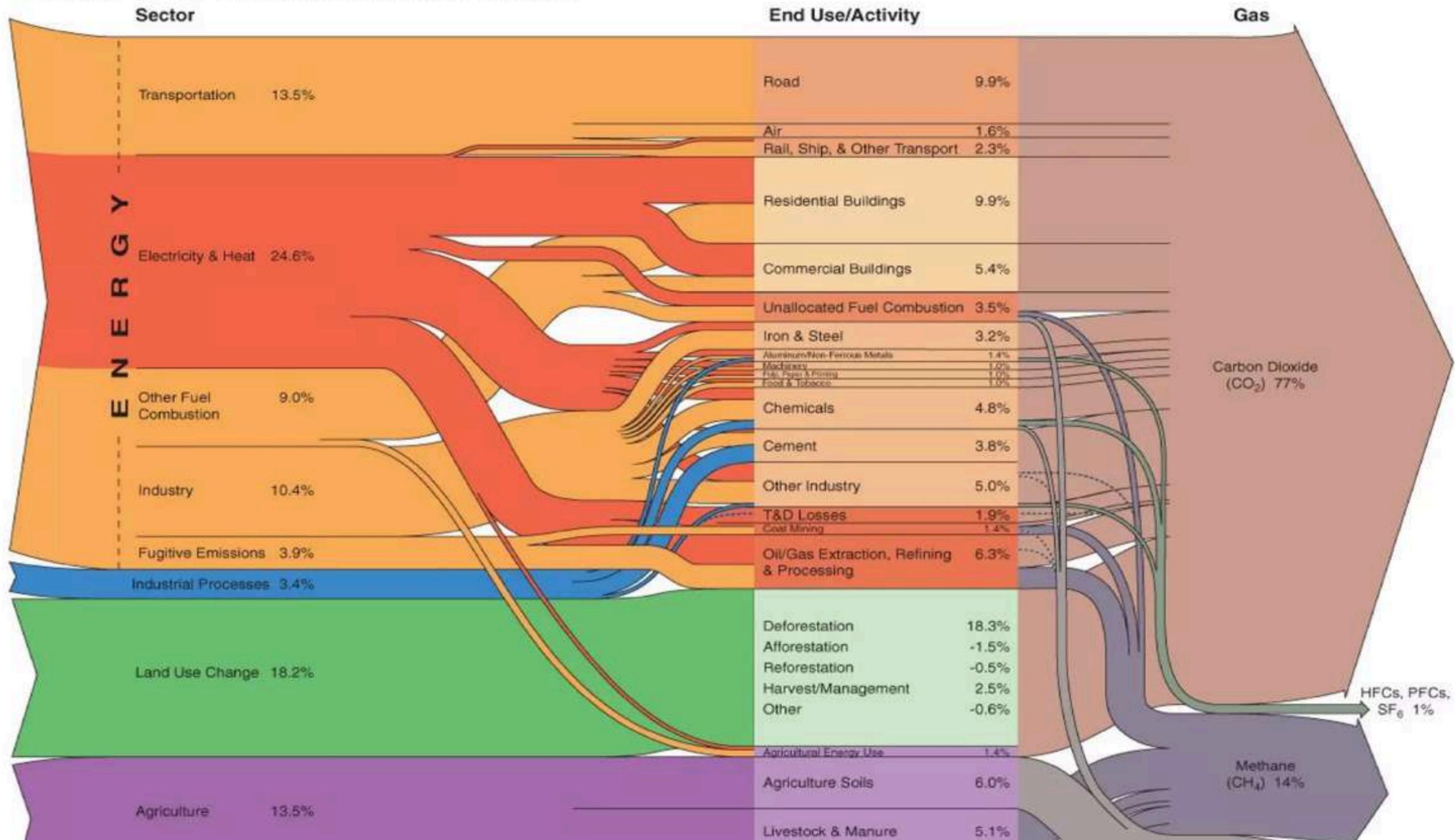
- Increased risk of collapse/ damage due to storms, snow, etc.
- Reduced building life time
- Deteriorating indoor climate
- Emissions from the production of buildings materials (cement, steel etc.), and building operation energy

The relentless surge of greenhouse gases ignites a scorching inferno, fuelling the rise of global temperatures and unleashing adverse climate changes.

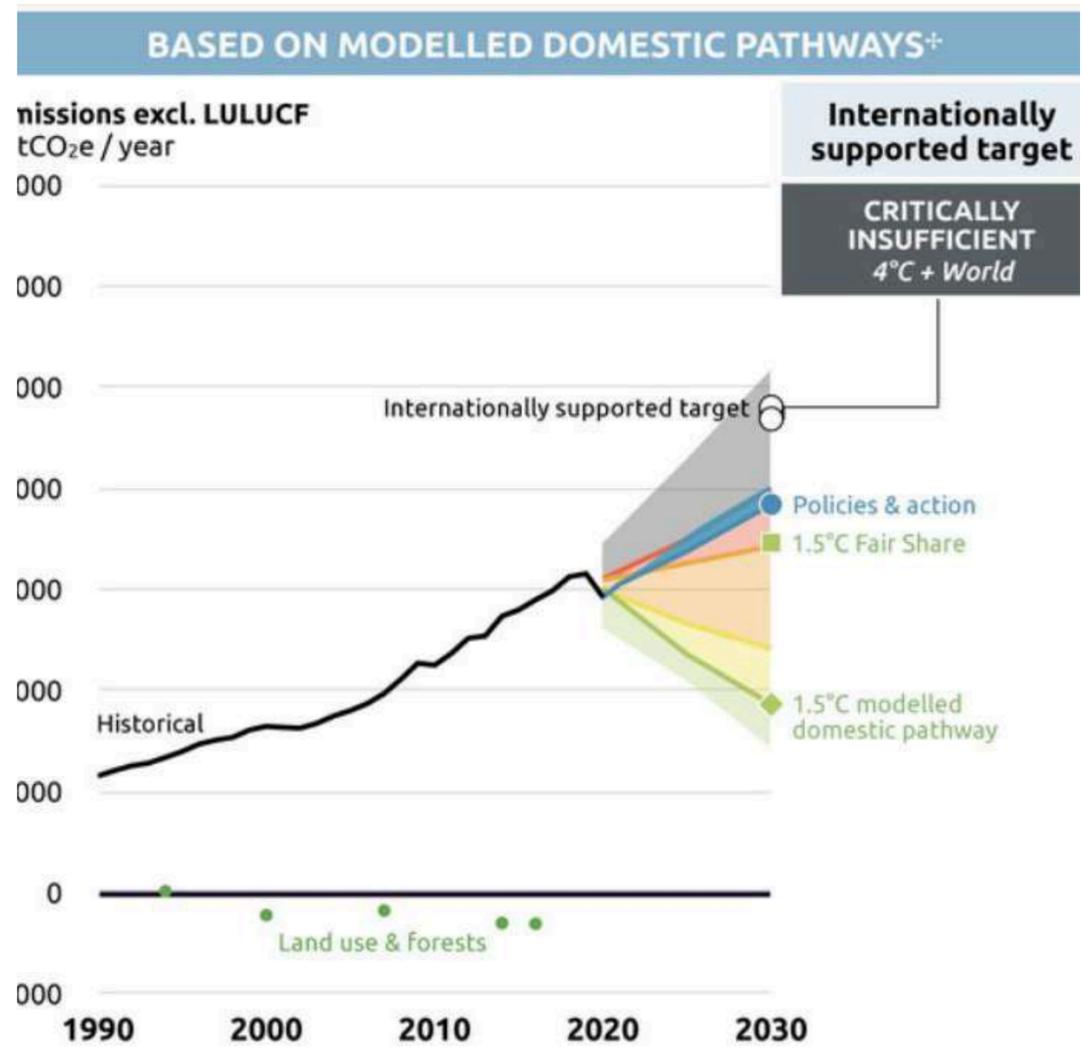


Who Creates Greenhouse Gases??

World GHG Emissions Flow Chart



COP 26 & India's Commitments



Current status of India

Source: Climate Tracker

Fulfill 50% Energy through Renewable Source

Reduce 1 billion Ton of projected Carbon Emissions

carbon Intensity down to 45%

Build Non-fossil energy to 500 GW

2030 Goals

Prof. S.K Singh CSIR-CBRI Source: India's CoP 26 Commitments



Net Zero Carbon Emission Building

2070 Goals

Source: India's CoP 26 Commitments

Sustainable Construction?

- Construction that has minimal impact on environment
- Reduce energy consumption of finished structures
- Using renewable and recyclable materials



Sustainable Design



Environment-friendly Materials



Climate resilient Construction



Durability



Indoor Environment Quality



Waste Reduction



AI-powered Systems

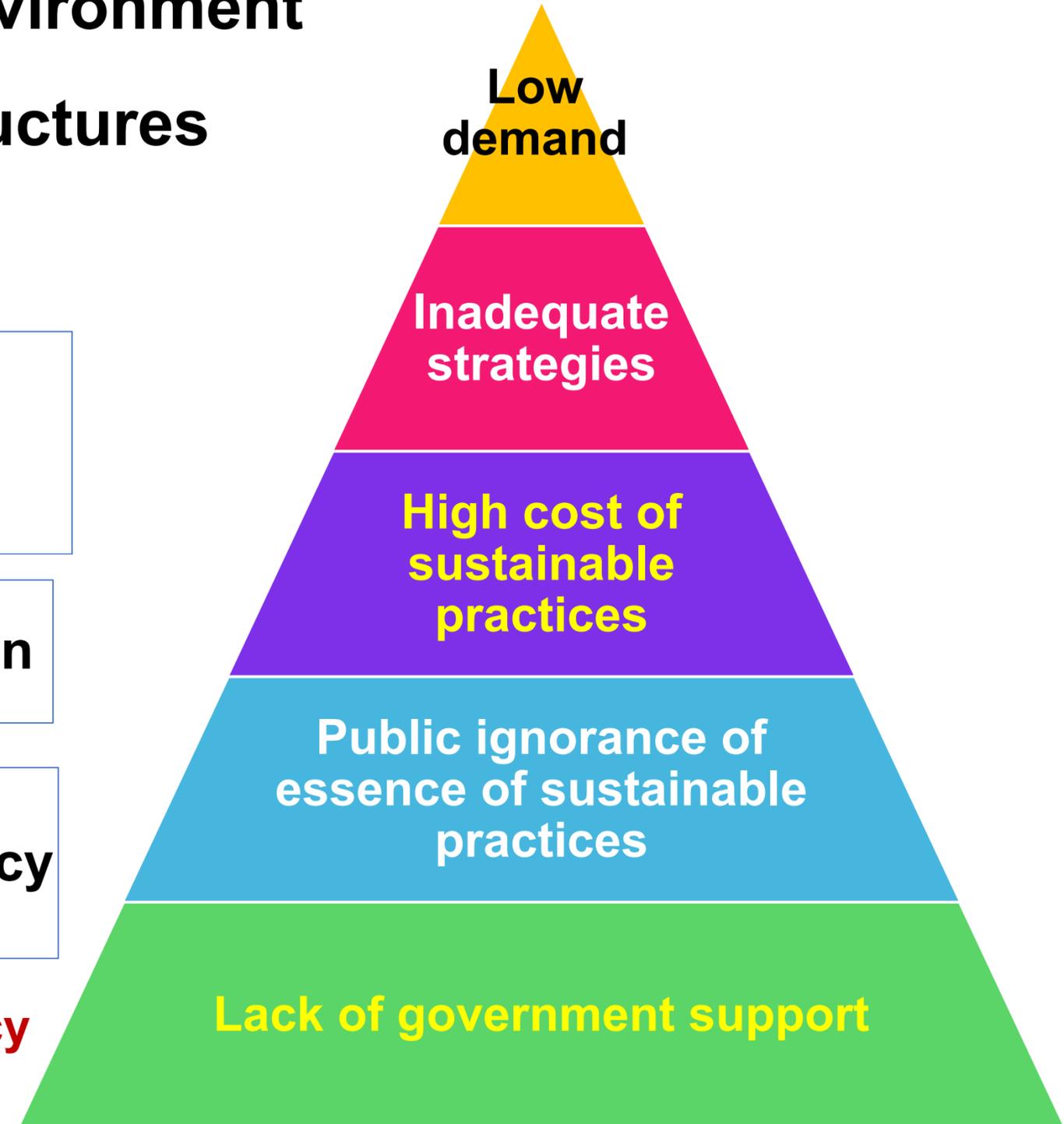


Water Efficiency



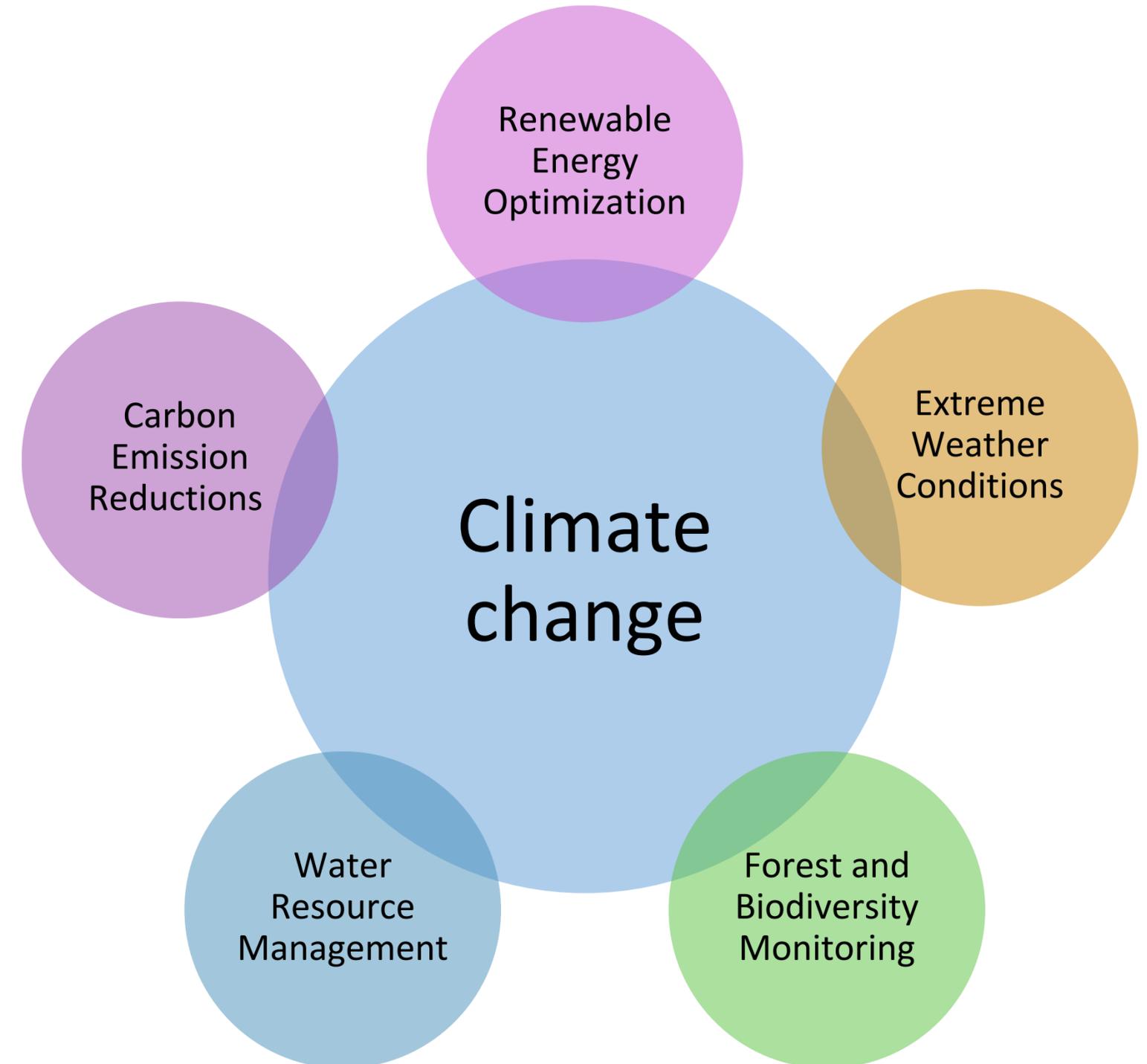
Energy Efficiency

Integrating whole life carbon resilience and resource efficiency



Role of AI in Climate Resilient Buildings

- AI uses data and machine learning to optimize building performance
- Predicts energy demand and optimizes HVAC systems
- Enables automated lighting and energy management
- Reduces energy waste and improves climate adaptability
- Supports predictive maintenance



AI Agents Contributing to Climate Change Mitigation

Role of Sensor in CRB

Heat wave & Power Outage: Existing Buildings

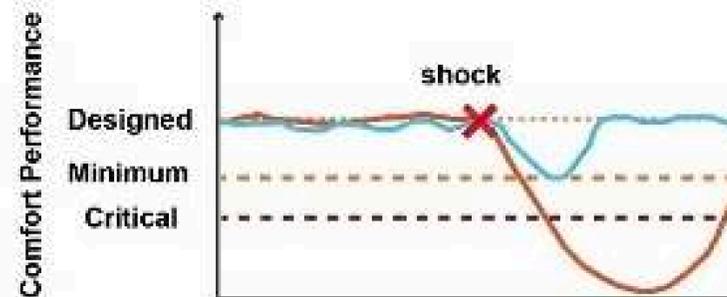


Resilient Performance Scheme

— Non-Resilient Building
— Resilient Building

Building Resilience Indicator

NOT ACCEPTABLE MARGINAL ACCEPTABLE



Disruption Events: Resilient Building Solution

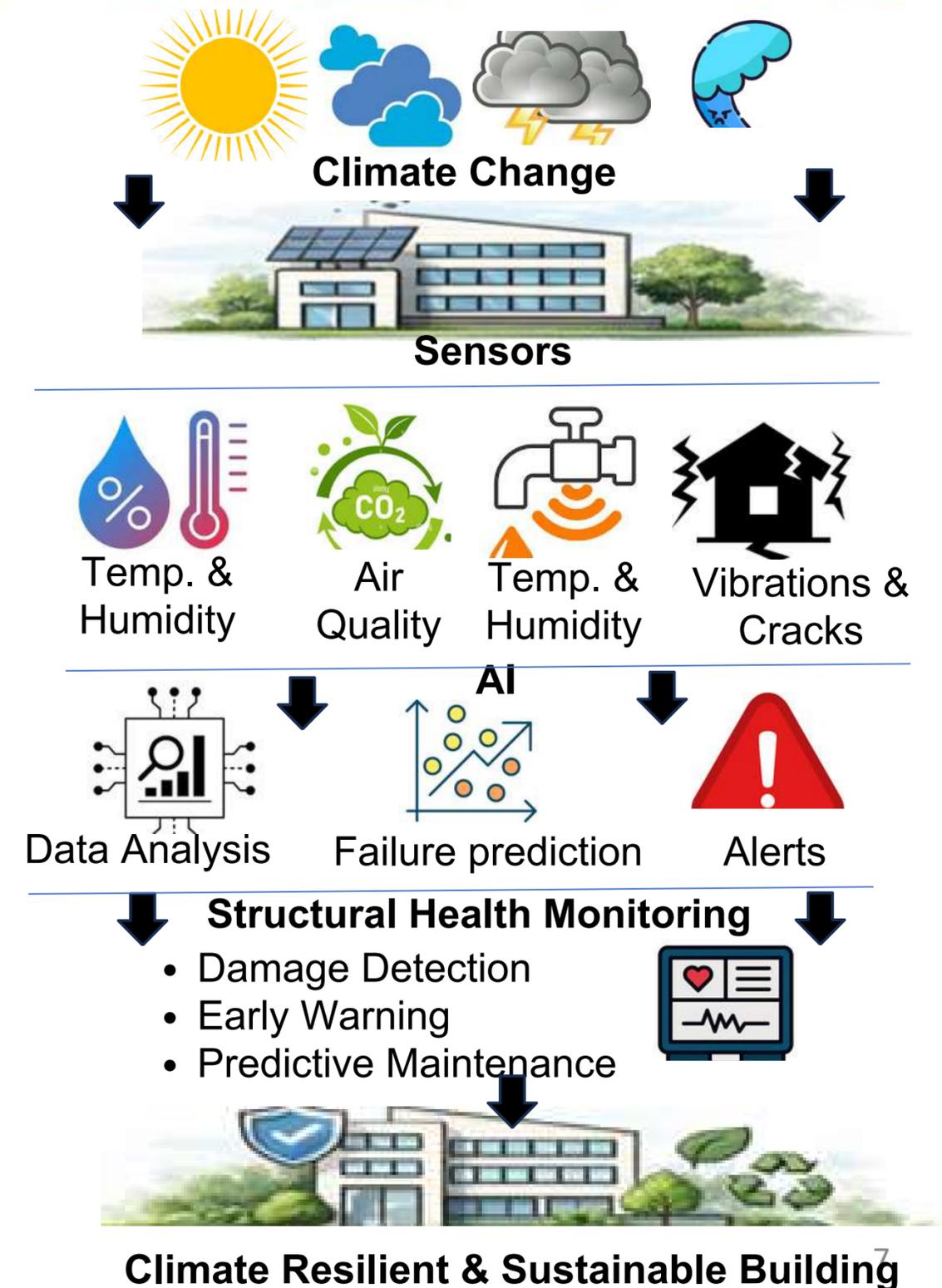


Sensors collect real-time data from buildings and their surroundings.

- Common sensors used in smart buildings
- Temperature and humidity sensors
- Occupancy sensors
- Energy consumption sensors
- Structural health sensors
- Sensor data helps in monitoring environmental conditions and detect risks early.
- Real-time sensing improves safety, efficiency and sustainability.

AI and Sensor for Structural Health Monitoring

- Exposure to extreme heat, humidity, storms, heavy rainfall, and flooding increases the frequency of climate-induced hazards due to global warming.
- Integration of solar PV systems, green infrastructure, and smart connectivity for energy efficiency, resilience, and environmental responsiveness.
- **Continuous Environmental Monitoring.**
- Machine learning models analyze sensor data for pattern recognition, climate impact prediction.
- **Risk management and optimizing HVAC, energy use, and water management.**
- **Occupant Health & Safety Monitoring.**



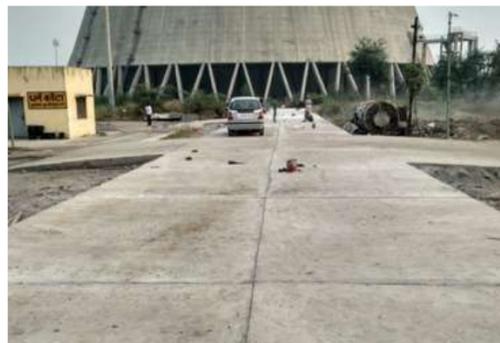
Climate Résilient Infrastructure Solutions

- Global production of cement is around 4285 million ton (IEA, 2024).
- Cement free construction is need of hour to reduce the GHG emission.

Cement Free Geopolymer Binder



GPC Road at CSIR-CBRI



GPC Road at Dadri



Geopolymer Road at NTPC Ramagundam



Pumping of GP-SCC



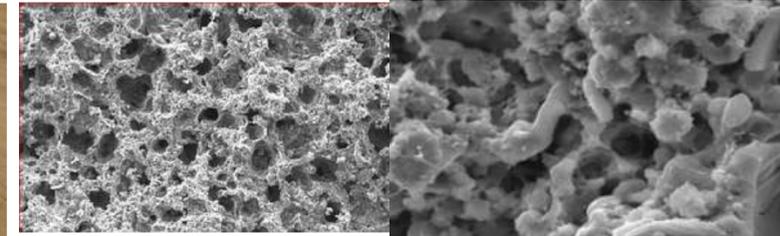
Precast RC plank
1.5 0.30X 0.06 m



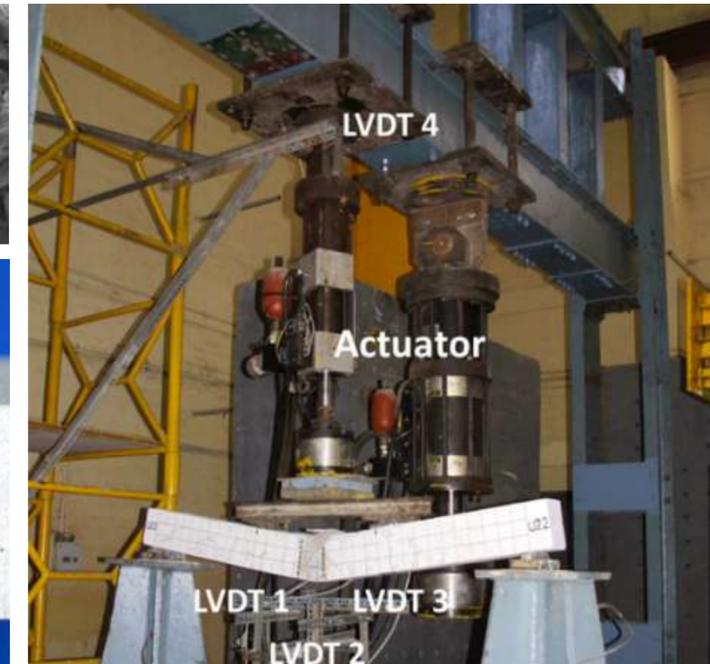
Precast RC joist
2.5X 0.15 X0.15 m



230 x 115 x 75 mm



Precast Building Products



Precast Geopolymer Concrete Plank

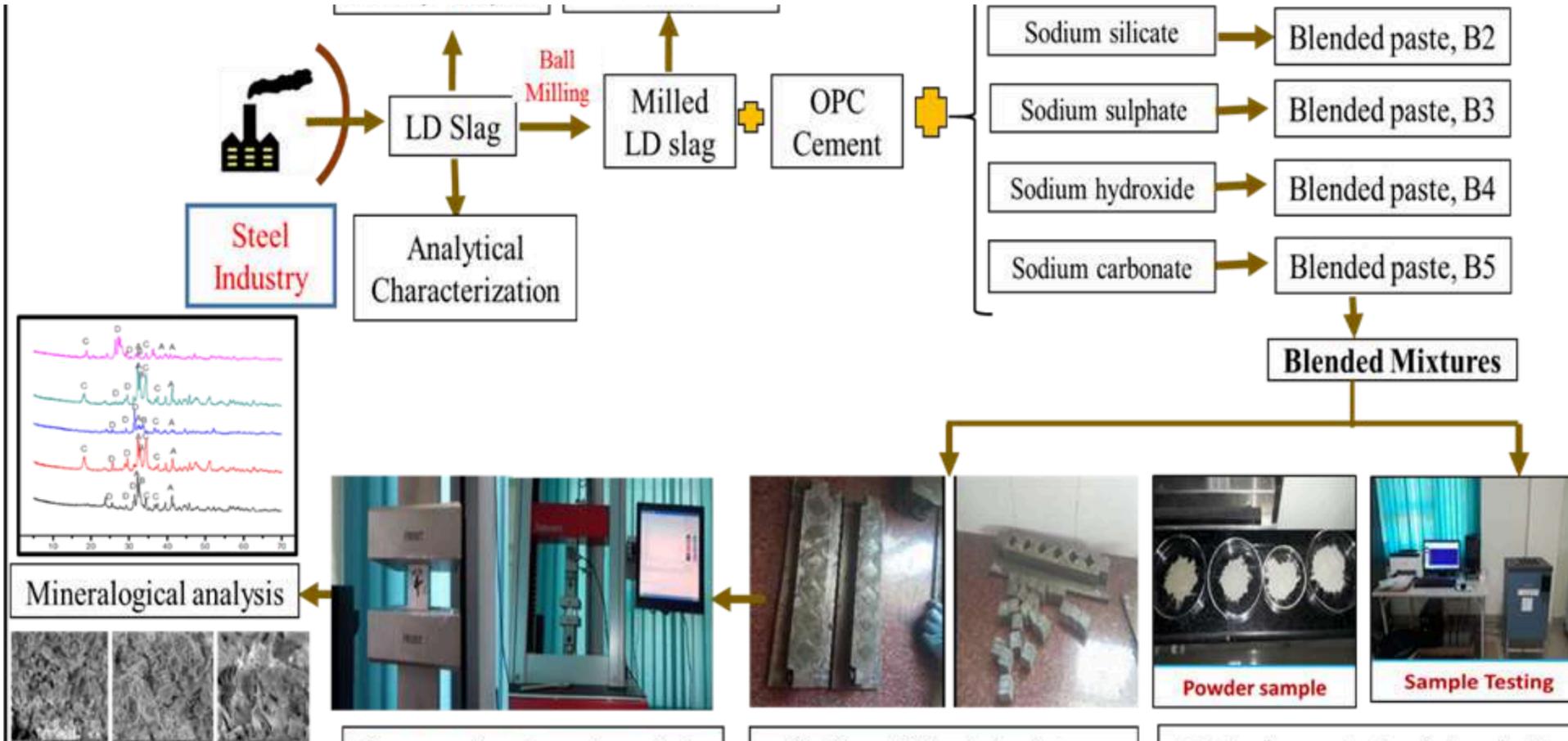
Climate Résilient Infrastructure Solutions

C&D wastes processing & utilisation



Climate Résilient Infrastructure Solutions

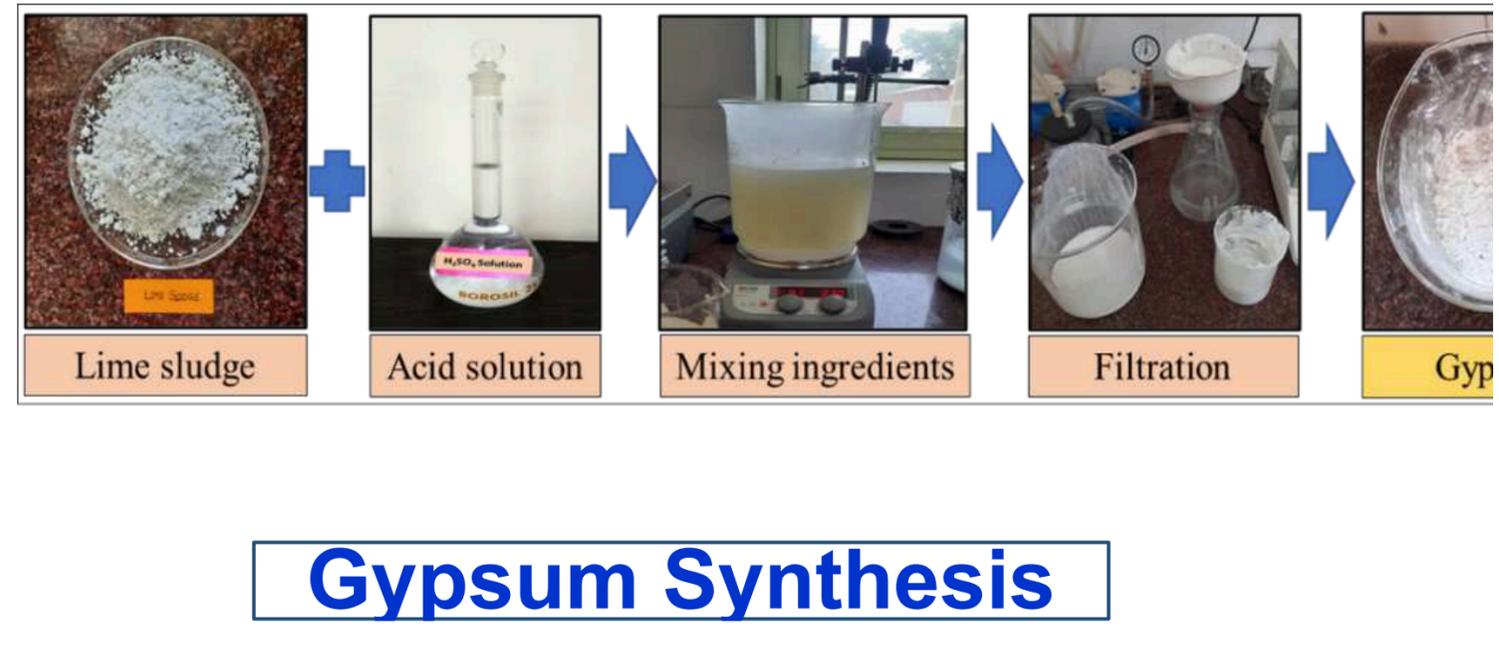
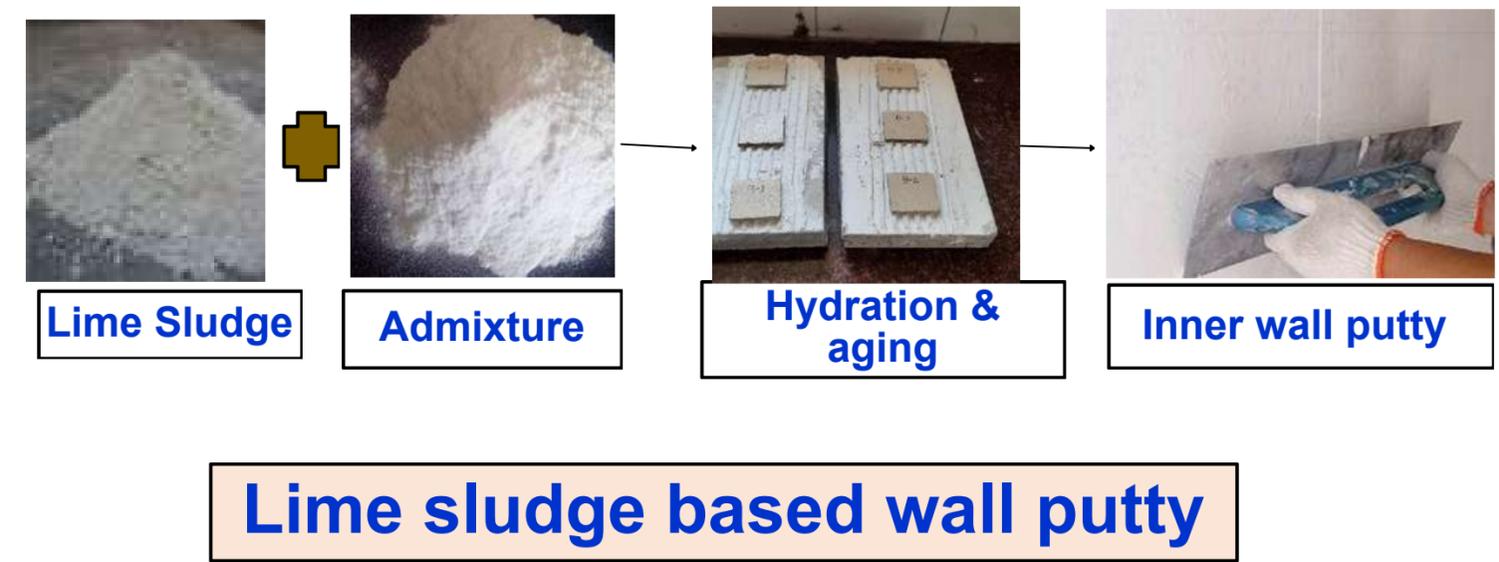
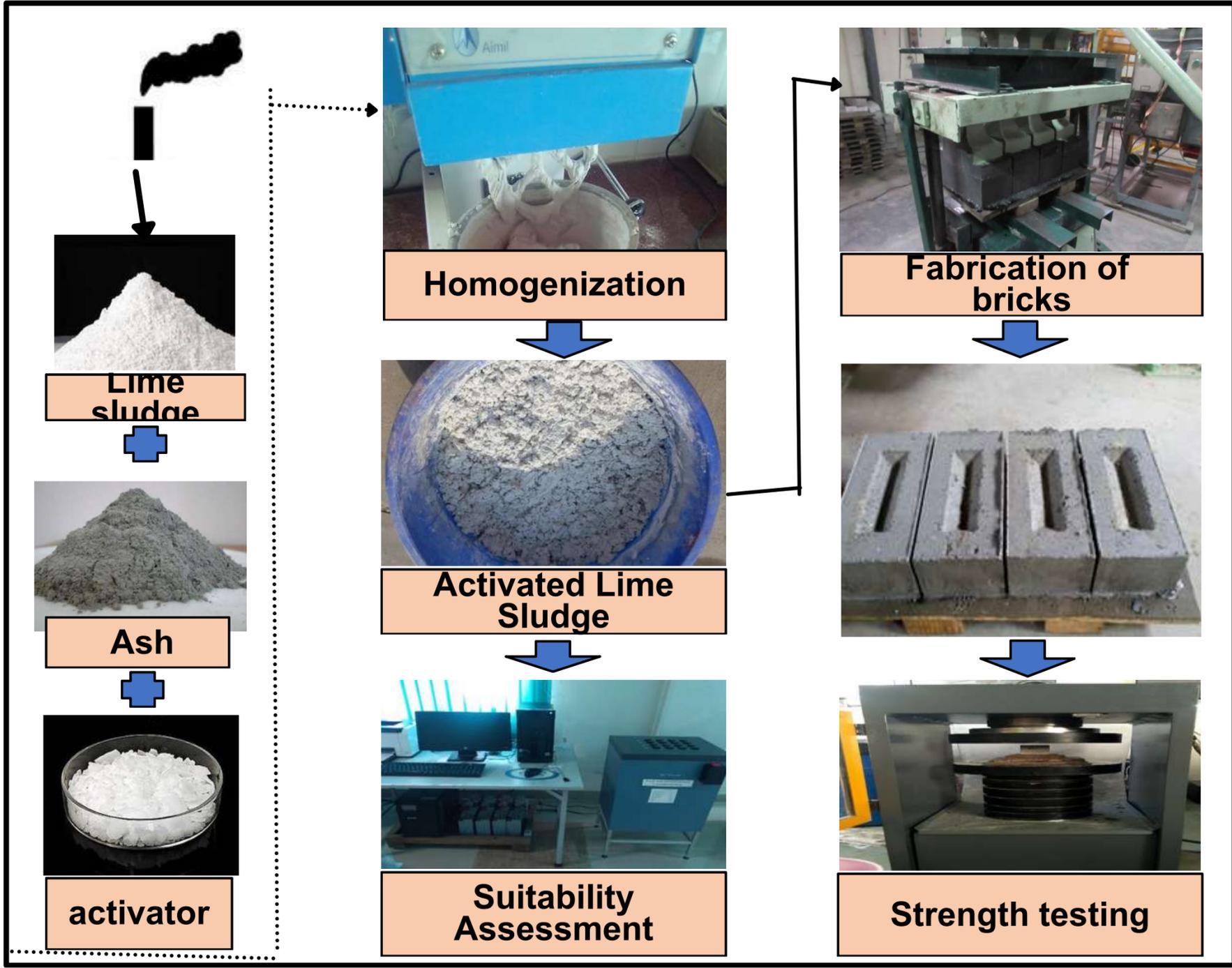
Sustainable Utilisation of Steel Slag in Construction



Steel Slag as Road-Making Aggregates



- India's first steel slag road at Hazira Surat in April 2022, using 100,000 tons of processed EAF steel slag aggregates.
- Joint-venture project by CSIR and AM/NS.
- Processed steel slag road is 30% cheaper than natural aggregates.



Climate Résilient Infrastructure Solutions

Thermal Performance Improved Precast Light Weight Composite Materials using Solid Waste

Raw Materials:

Cement, fly ash, Stone waste, EPS (sheet), EPS (beads), PUF, LECA, air entraining agent and polypropylene fiber



LECA



VERMICULITE



EPS Beads



Stone Waste

Development steps:



50 mm EPS Sheet with Basalt Fiber Connector



Laying of EPS Sheet with Basalt Fiber Connector



Casting of Wall Panel

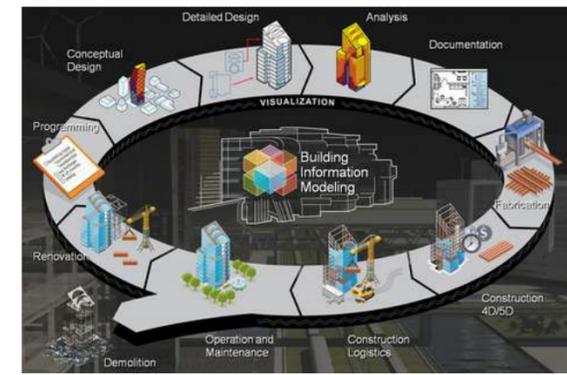
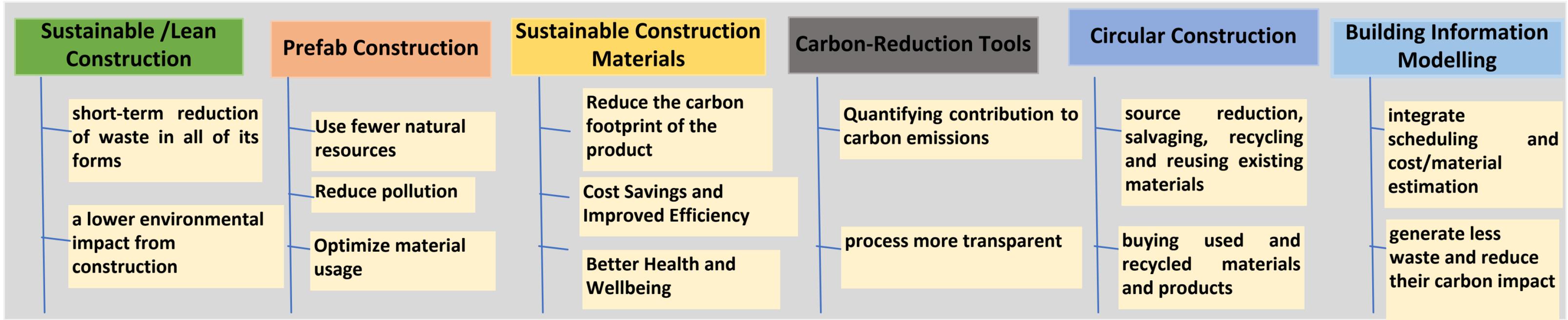
Benefits:

- # Lightweight
- # Good mechanical properties
- # Minimum requirement of surface finishes such as plaster work
- # Durable against aggressive environment
- # Thermal conductivity as per ECBC guidelines
- # Fire resistance
- # Sound Proof
- # Economical



Construction Ways

Processes for creating **built environment as eco-friendly and non-invasive** to the nature



Envelope Design

Optimum Orientation Form, Shape

Cooling Strategies

Daylighting and shading

Maximum Open area

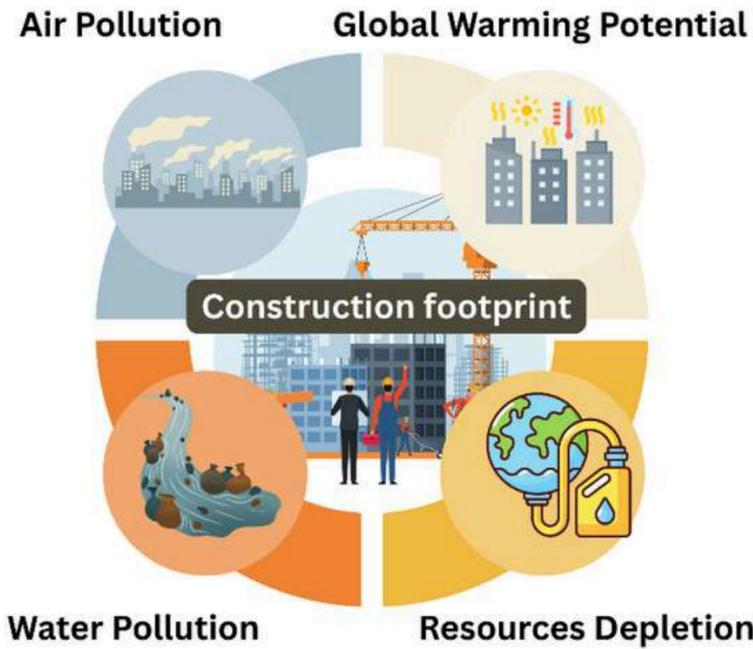
Right choice of local and native plants for landscaping

Thermal Comfort

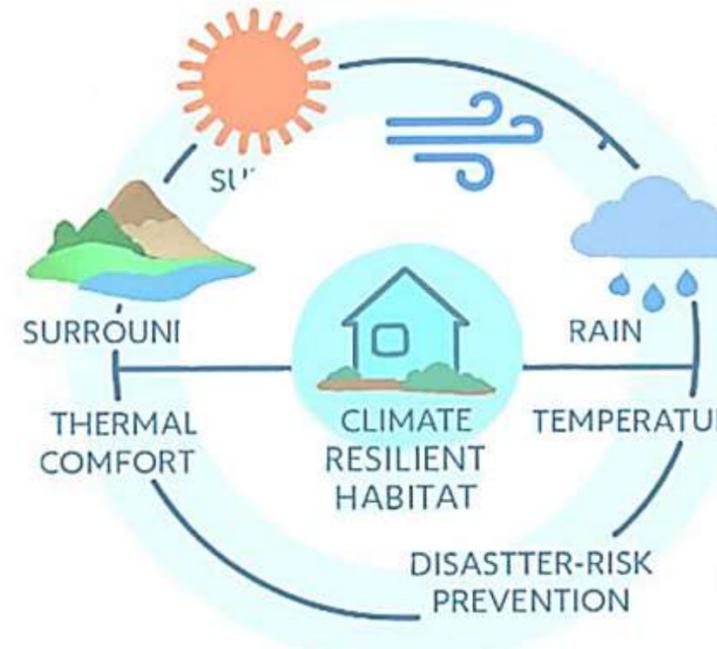
Natural Ventilation

Design Strategies for CRB Environment

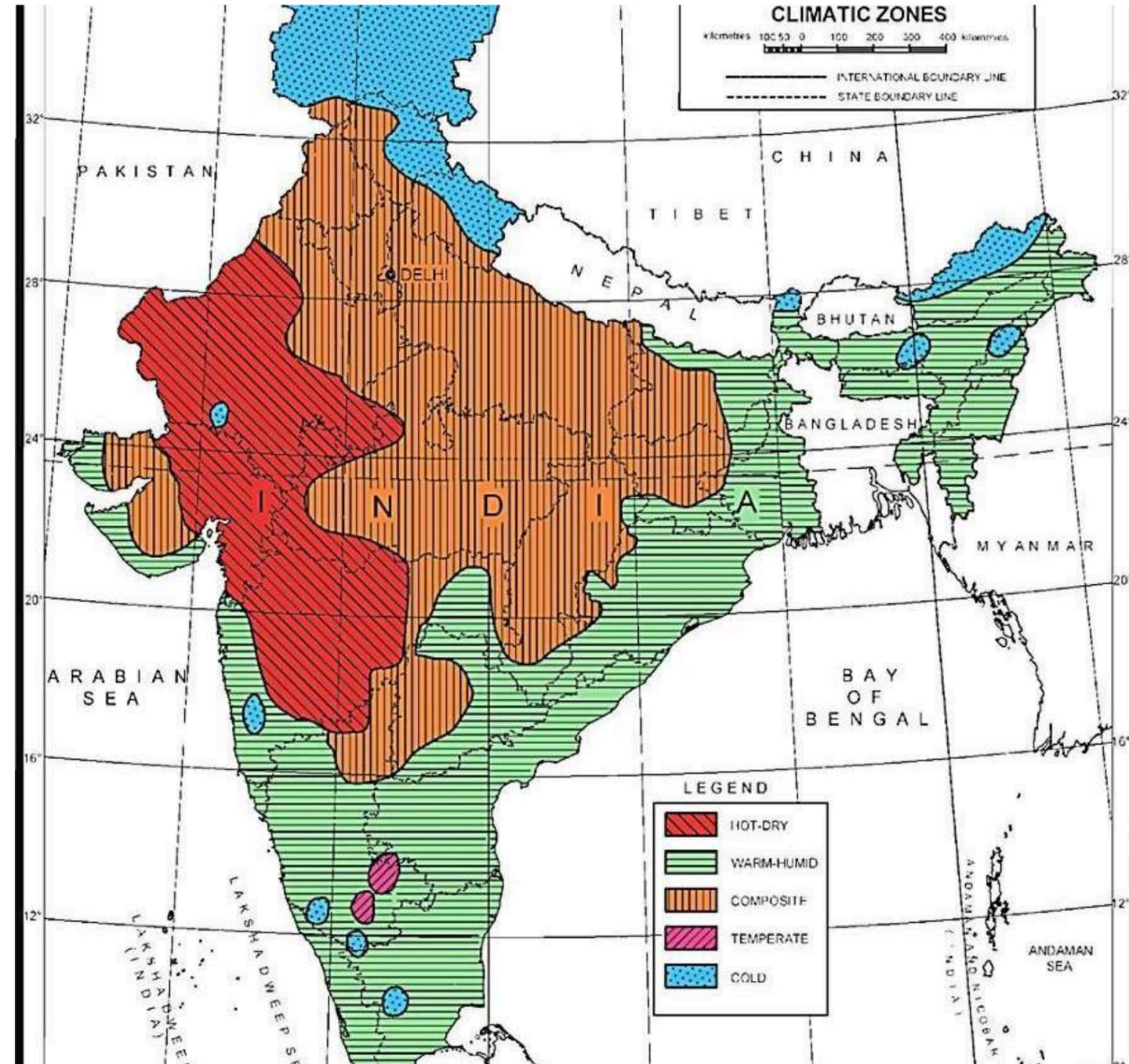
Construction Footprint



Sustainable Design Solutions



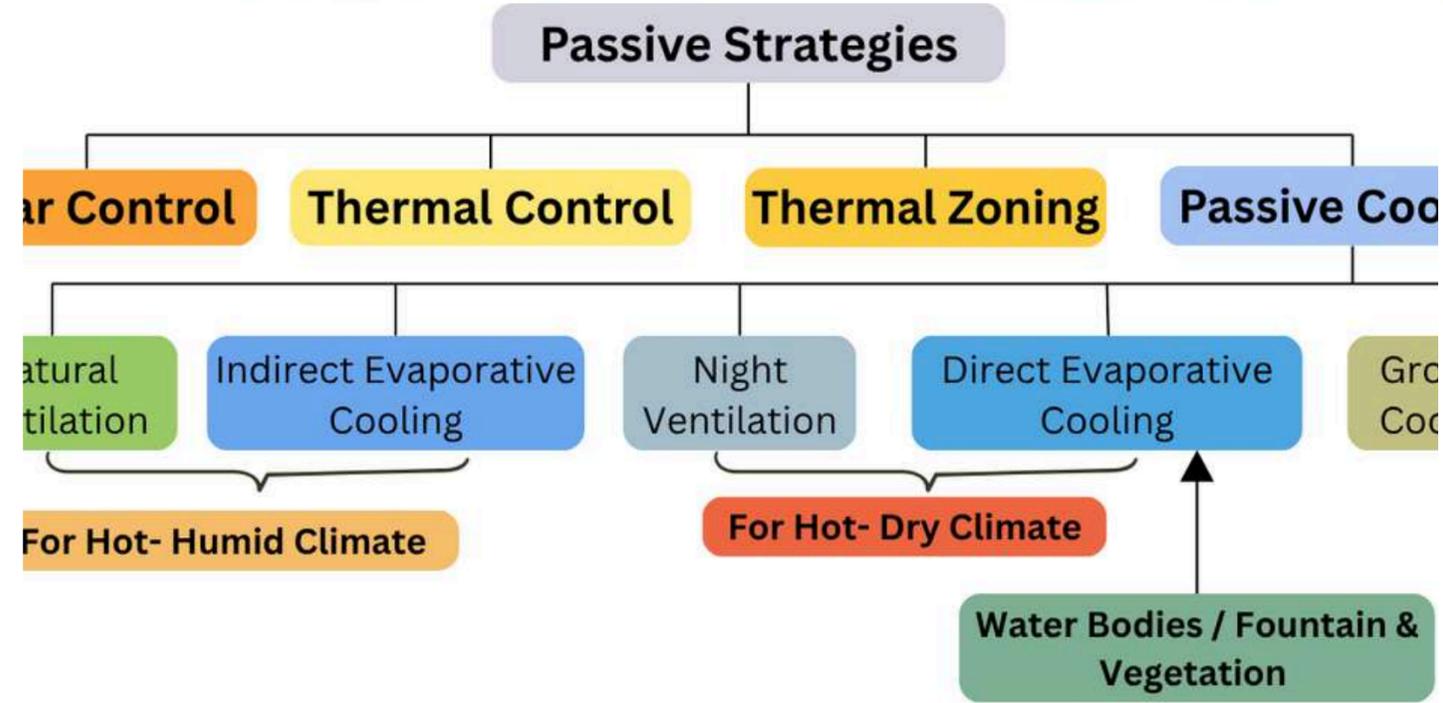
Climatic Zonation of India



Key Parameters for Climate Resilient Building Design



CRB- Passive Strategies

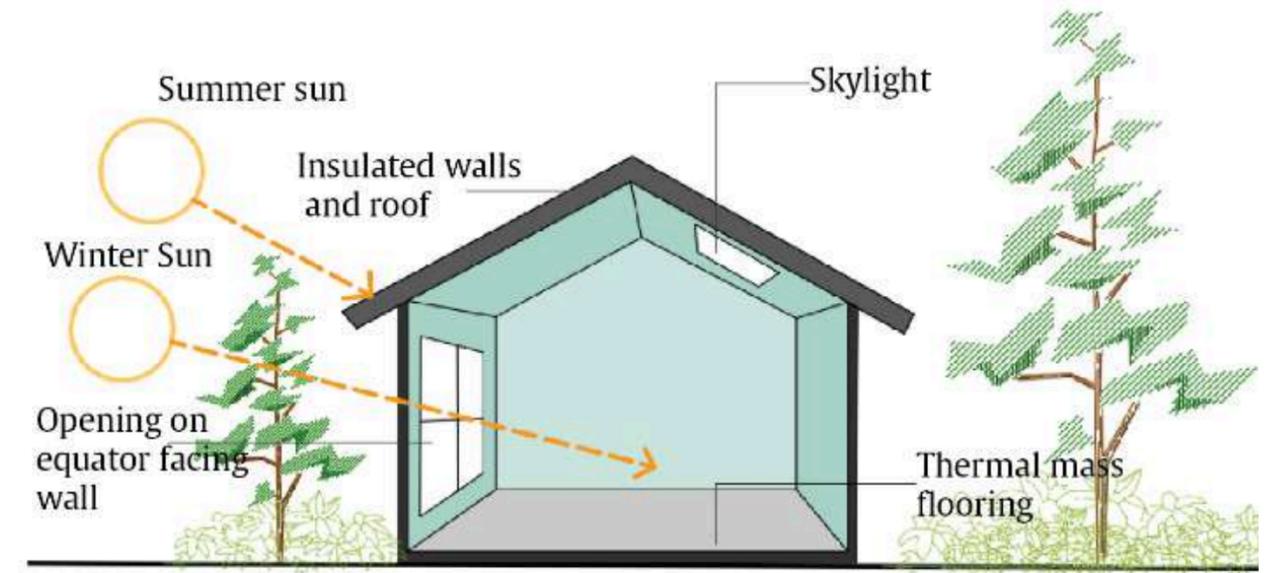


Maximise windows on the south side for optimal solar gain.



Provide **shading devices** to block low-angle summer sun but allow winter sun. Seal windows and doors tightly during winter to reduce heat loss. Ventilate only during the warmest part of the day.

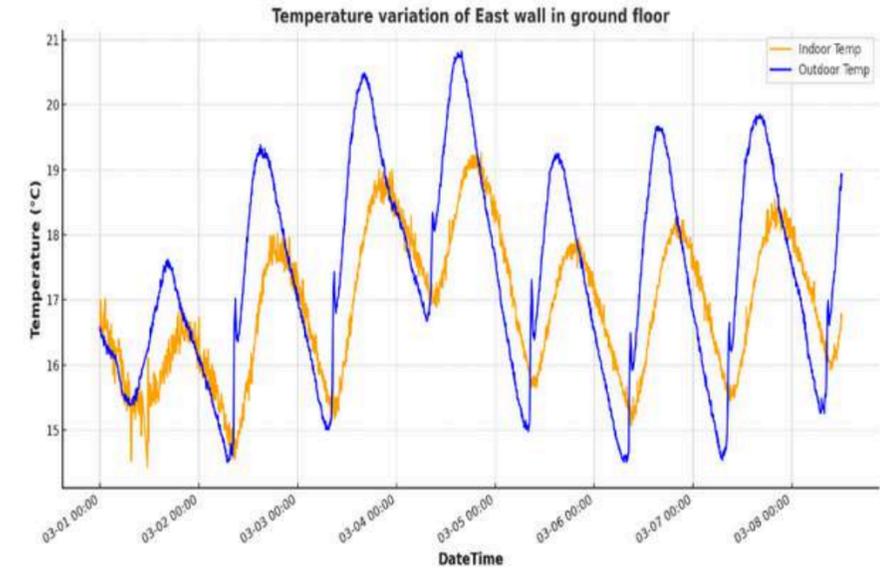
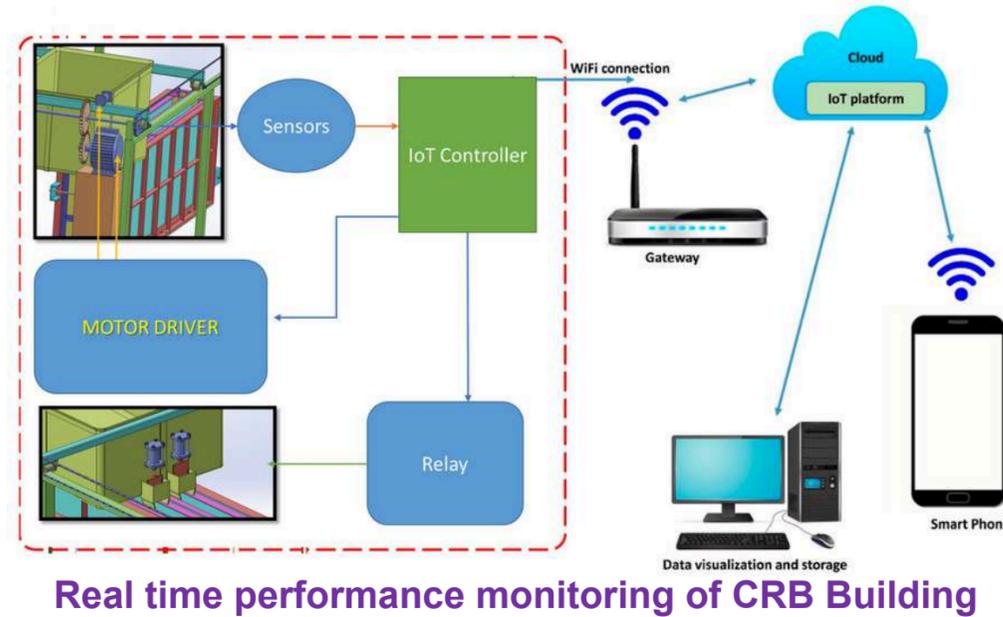
Provide wide **overhangs** to protect walls from snow and rain. Design eaves with proper drainage systems to prevent ice dam formation.



CRB- Demonstration in Roorkee

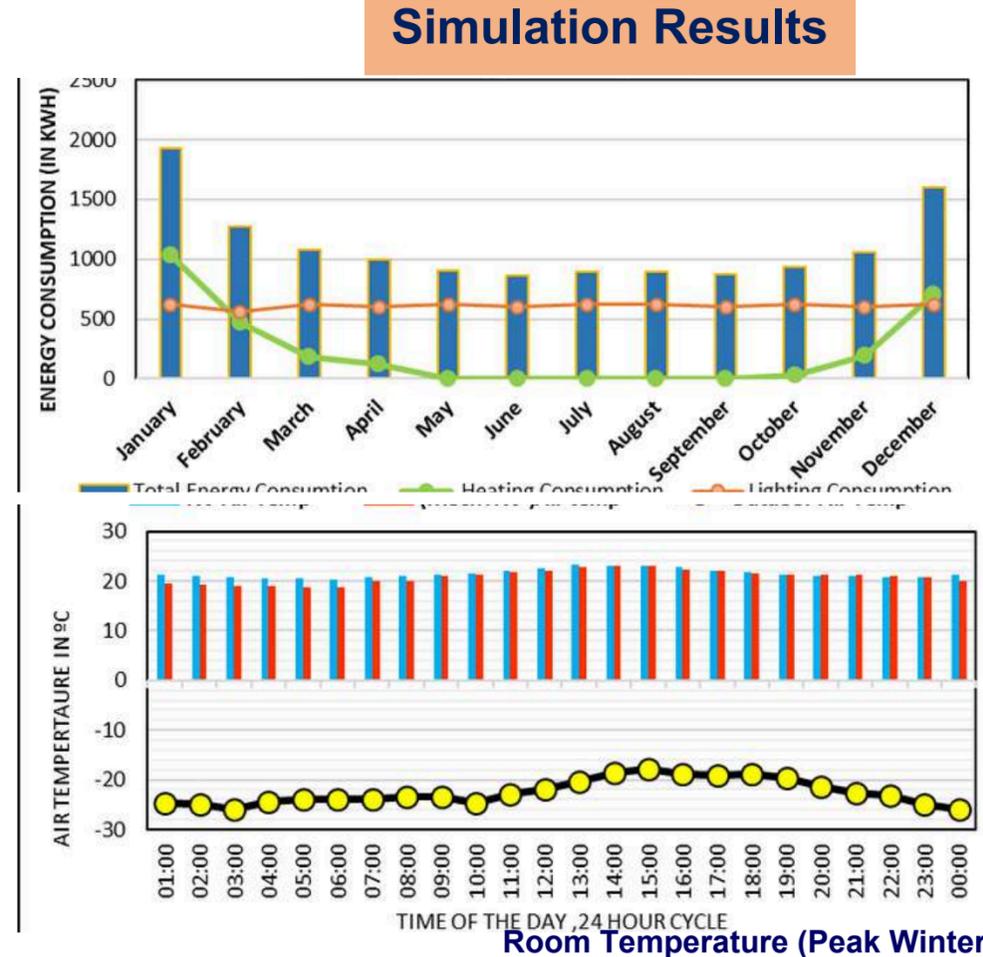
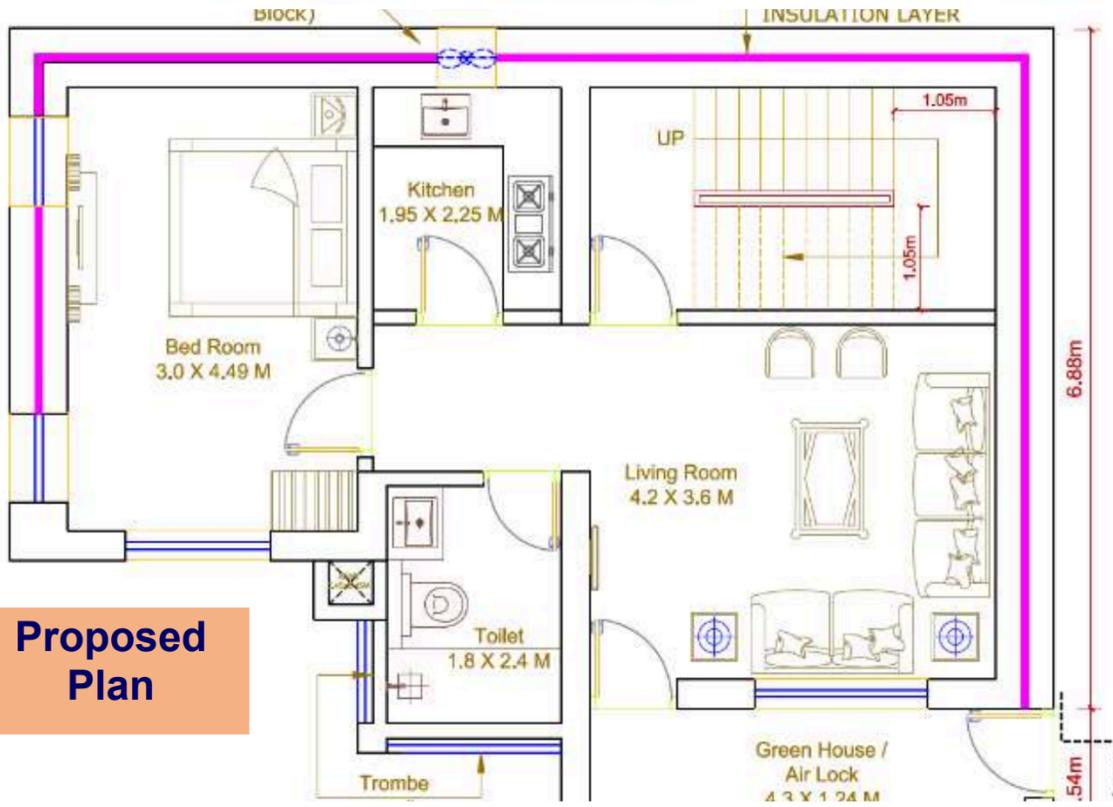
India's first Climate Resilient Building by CSIR-CBRI, specifically for regions with "composite climate"

- **Structural Framework**
- Cold Formed Steel Columns
- Hollow Box Section Beams
- Deck Slab
- **Walling unit**
- Expanded Polystyrene Concrete (EPS) Panels
- Agro-industrial Waste Concrete Panels
- Cellular Lightweight Concrete (CLC) Blocks



Demonstration of CRB in composite climate at Roorkee

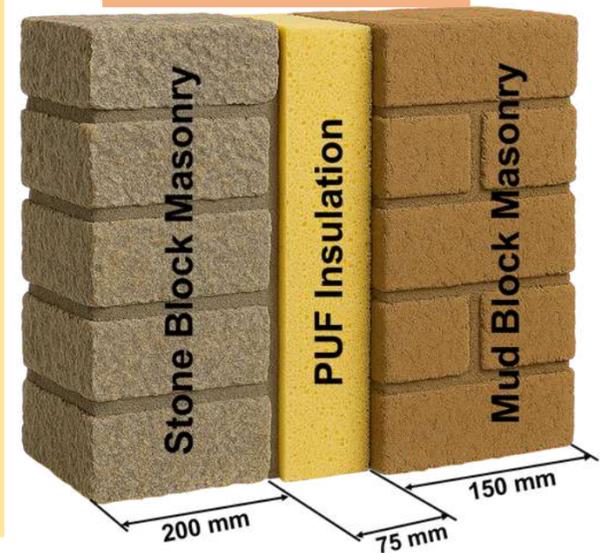
CRB- Demonstration in Leh



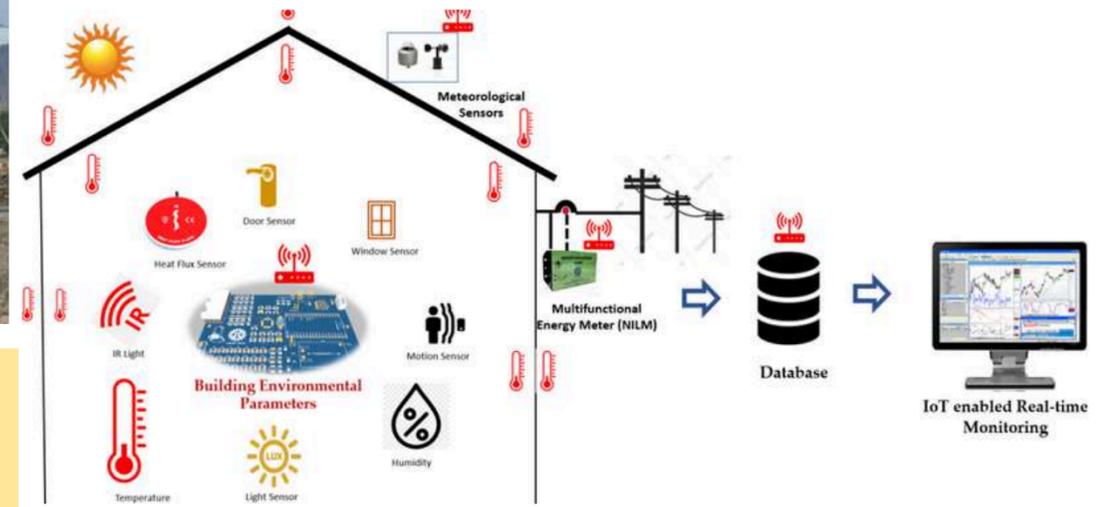
Building Features

- Climate resilient building planning
- Use of locally available materials
- Hybrid envelope systems
- Passive solar heated spaces
- Earthquake Resistance
- Water resistance envelope
- Superior Thermal properties

External Wall



Constructed Climate Resilient Building at ITBP, Leh



Real Time Thermal Performance Monitoring

Conclusions

helps in redefining circularity and sustainability in construction

optimises energy performance in construction/ operations

smart sensor with AI analytics enables real-time SHM

creates smart, adaptive buildings, enhancing thermal comfort

improves sustainability, safety, and efficiency

Thank You for your kind attention and questions!

For more information,

Website: <https://cbri.res.in/>

X: https://x.com/CSIR_CBRI

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For Partnership Interest, please

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