State-of-the-Art HVAC for African Healthcare

Samuel Jacobs (PrEng) | SAFHE 2026 | Southern African Healthcare Conference

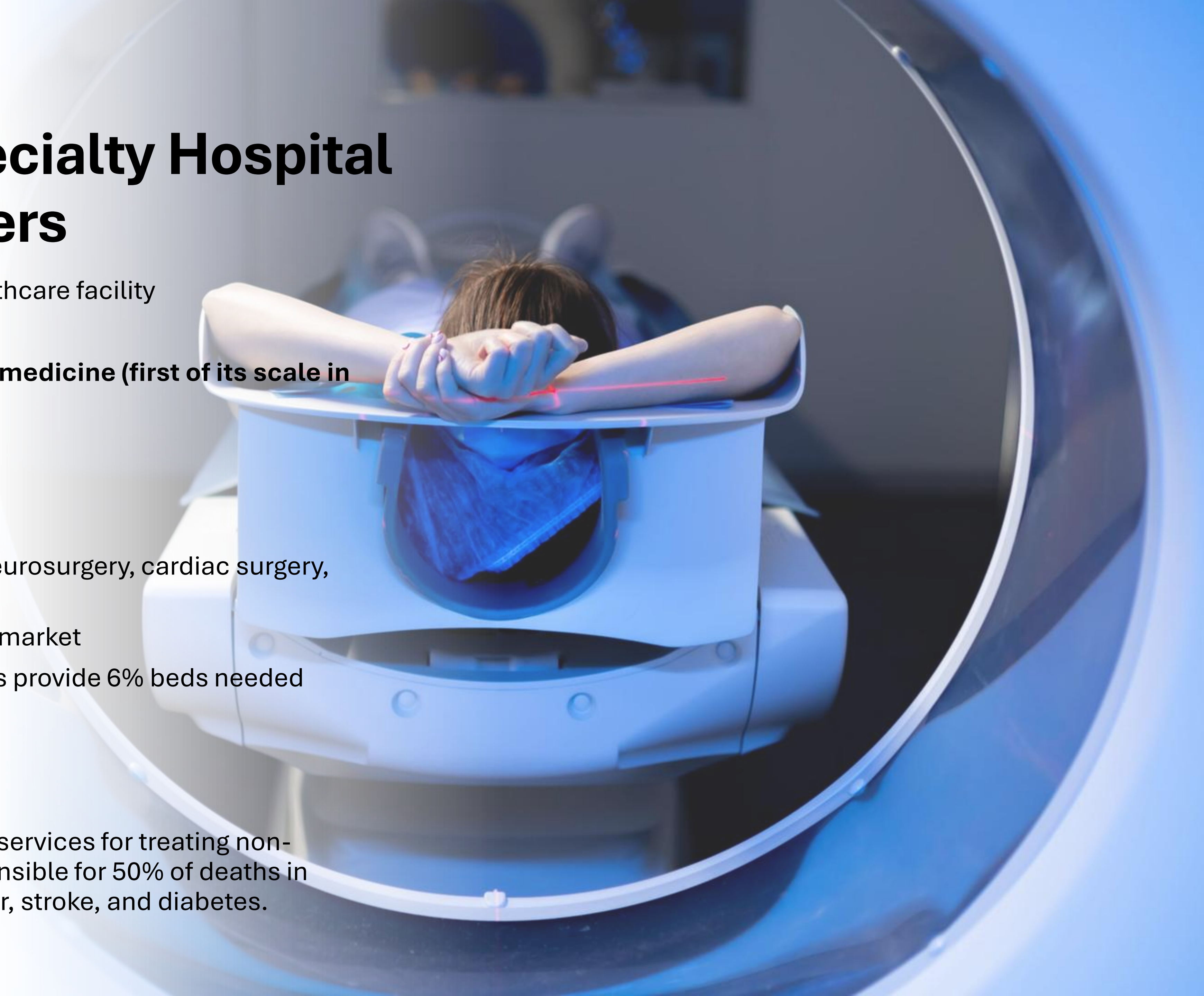
Hybrid Chilled-Water and VRF System for a Multi-Specialty Hospital in Addis Ababa

Delivering State-of-the-Art Healthcare in Ethiopia

- Samuel Jacobs: Mechanical Engineer (PrEng), WSP Group Africa
- Mechanical lead: HVAC, Medical Gas, Wet Services
- ~350-bed, 40,000 m^2 multi-specialty hospital in Addis Ababa
- Positioned to become one of the most advanced private healthcare developments in Ethiopia
- Client requirement: State-of-the-art, aligned to internationally recognized standards.
- I will discuss:
  - how the HVAC system design responded to the challenges presented

A True Multi-Specialty Hospital and Why It Matters

- Designed as a full multi-specialty healthcare facility
- Includes:
  - **Imaging, radiology and nuclear medicine (first of its scale in region)**
  - oncology treatment
  - 9x operating theatres
  - ICU & critical care
  - Orthopedics, spine treatment, neurosurgery, cardiac surgery, etc.
- Addresses an underserved healthcare market
- According to WHO, Ethiopia’s hospitals provide 6% beds needed
- Reduces reliance on:
  - international medical travel
  - external specialist facilities
- New facility provides critically needed services for treating non-communicable diseases that are responsible for 50% of deaths in Ethiopia including heart disease, cancer, stroke, and diabetes.



Standards and Guidelines Driving the Design

- Multiple international standards applied:
  - ASHRAE 170 – defines healthcare ventilation & environmental control
  - HTM 03-01 – focuses on specialized ventilation & infection control
- Selected as agreed standard with client
- These standards were driven by:
  - client’s requirement for international performance
  - early-stage input from international healthcare planners
- Represent best practice for patient safety and system reliability

Where International Standards Meet African Reality

- Standards assume:
  - reliable utilities (such as water)
  - stable power supply (AVR)
  - strong installation and maintenance capability
  - no imported equipment and logistics challenges
  - facility has multi-disciplinary balance

- Additional requirement:
  - EDGE certification (discussed later)

- Core challenge:

Deliver international performance within a constrained operating environment

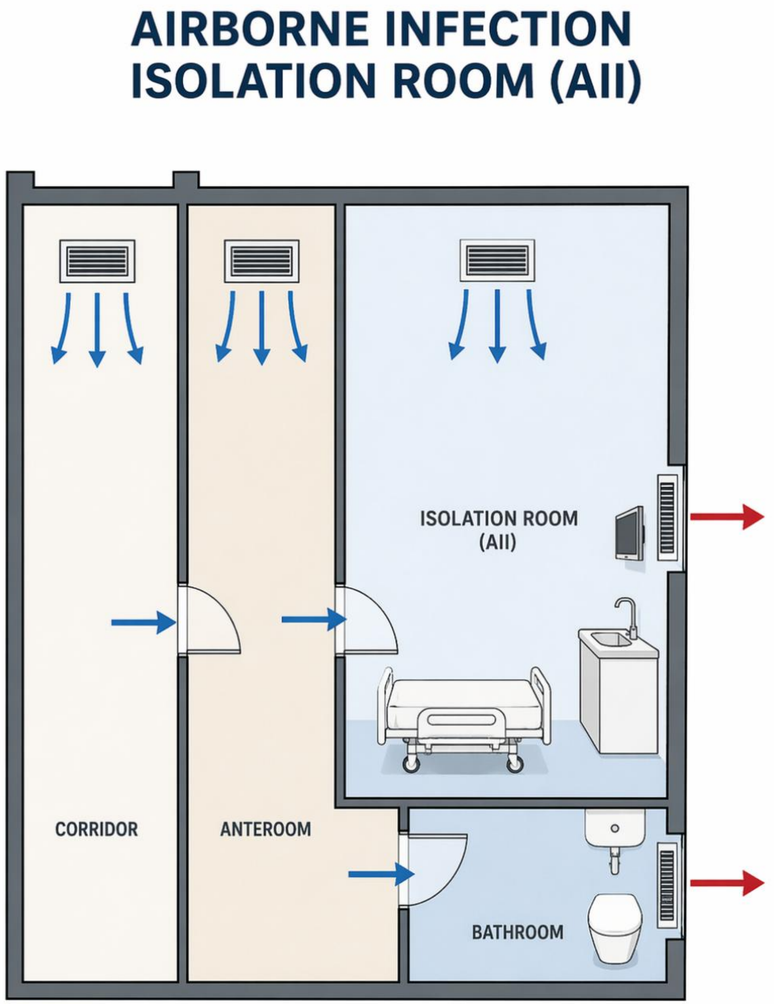
Why HVAC Matters

- HVAC is a clinical system, not just comfort:
  - infection control (airflow + filtration)
  - pressure cascading (containment)
  - environmental stability (treating patients + running equipment)
- Requirements and loads vary significantly across departments

- Need for:
  - flexibility
  - efficiency
  - resilience

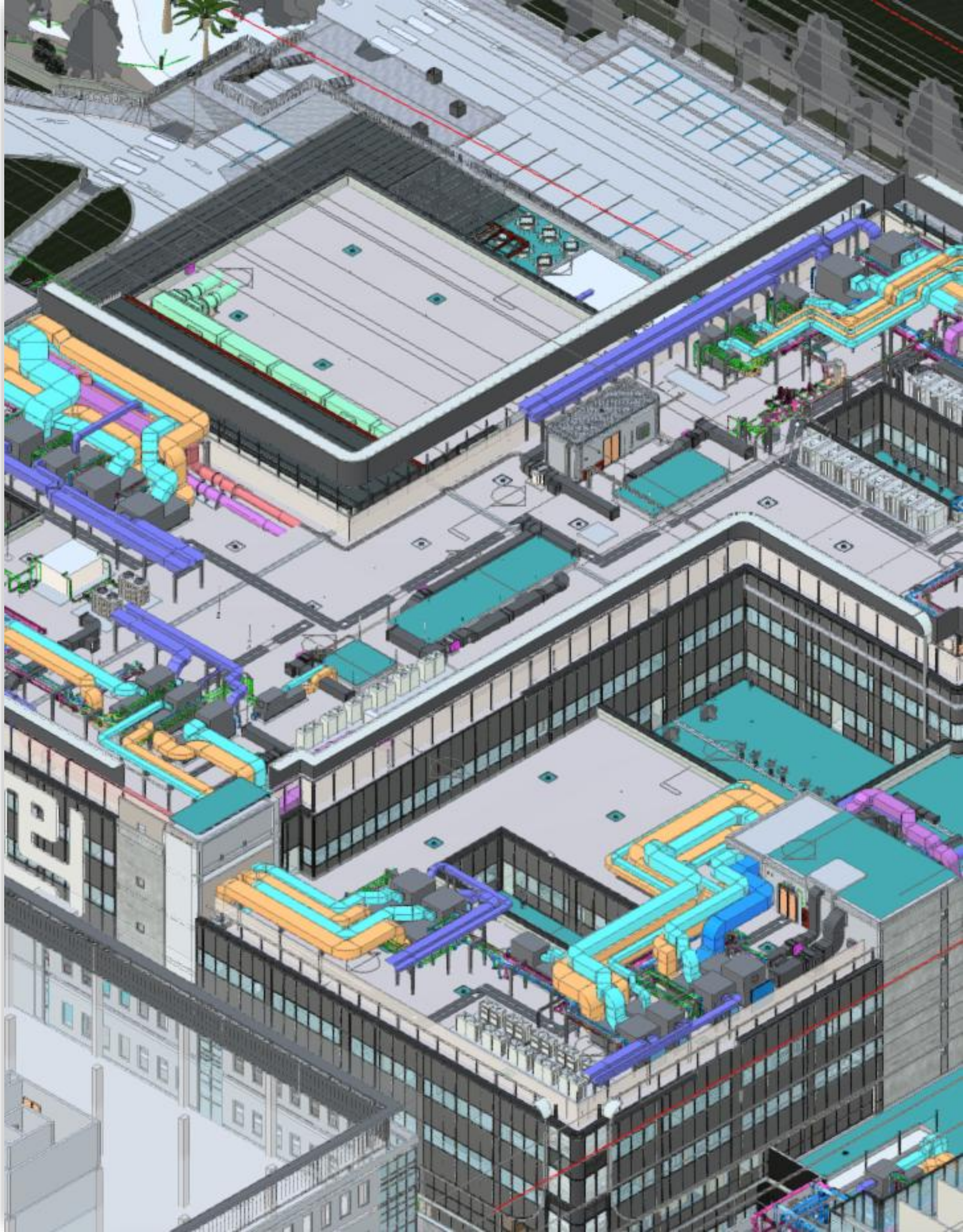
- Our key observation:

Not all loads behave the same → cannot be served by one system



Design Strategy: Decoupling the System

- Separate load types:
    - ventilation (clinical requirement) - CHW AHU System
    - base thermal load - TABS
    - variable thermal load - VRF
- Assign each to the most effective system
- Reduce reliance on air-only and water-based systems
- Maintain strict control where required and enable flexibility elsewhere



Air Systems: Pressure Cascading Driving Airflow, Safety and Design

- Usually handles full HVAC requirements
- Our chilled-water AHU based system sized for:
  - **fresh air quantity (not for base heat loads)**
  - temperature & **humidity** (TABS cannot manage humidity)
  - **filtration (HEPA where required)**
  - **infection control, via:**
    - **supply air (SA)**
    - **extract air (EA)**
    - **leakage paths (doors, gaps)**

- Governing principle:

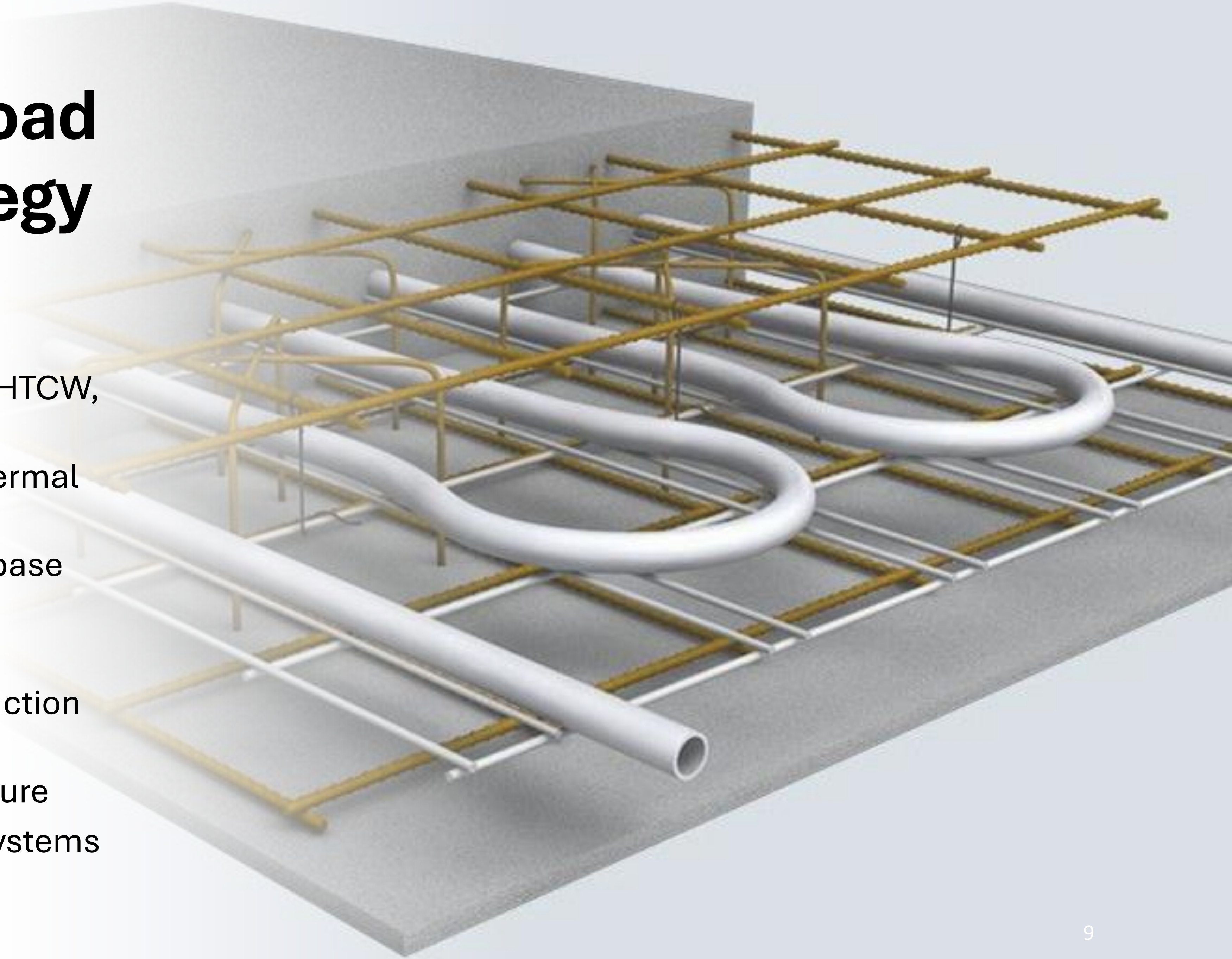
Air flows from clean → less clean spaces

- Key relationship:

Pressure Difference → Airflow → Contamination control

Coordination with architects and clinicians was essential for staff, patient and material flows

TABS: Base Load Cooling Strategy



- Embedded pipework in structural slab circulating HTCW, no dehumidification
- Uses building mass for thermal storage
- Radiant cooling removes base load
- Typical performance:
    - ~25 W/m^2 heat extraction
- Operates continuously to stabilize building temperature
- Reduces demand on air systems

Why TABS Works in This Context

- Building has high thermal mass → ideal for radiant systems
- Decouples ventilation from cooling
- Reduces peak cooling demand and improves energy efficiency

Largely conventional plumbing systems

VRF: Flexibility and Control

- TABS runs continuously but lacks flexibility
- VRF provides room-level temperature control where required
- Responds to:
  - occupancy variation
  - departmental differences
  - need for constant pressure systems

- Good local support for many systems

Sustainability And EDGE Certification

International Finance Corporation
WORLD BANK GROUP

- EDGE targets reductions in resource use:
  - energy
  - water
  - materials
- HVAC design contributes through:
  - reduced peak loads (TABS)
  - efficient systems (VRF) and reduced water demand from CHW system
  - intense coordination contributions to façade specification and clinical layouts
- Performance:
  - 20% saving targeted in each area (when benchmarked against a local standard hospital)
  - preliminary certification achieved alongside

Exemplifying achievement in the following areas:

35%
Energy Savings

21%
Water Savings

24%
Less Embodied Carbon in Materials

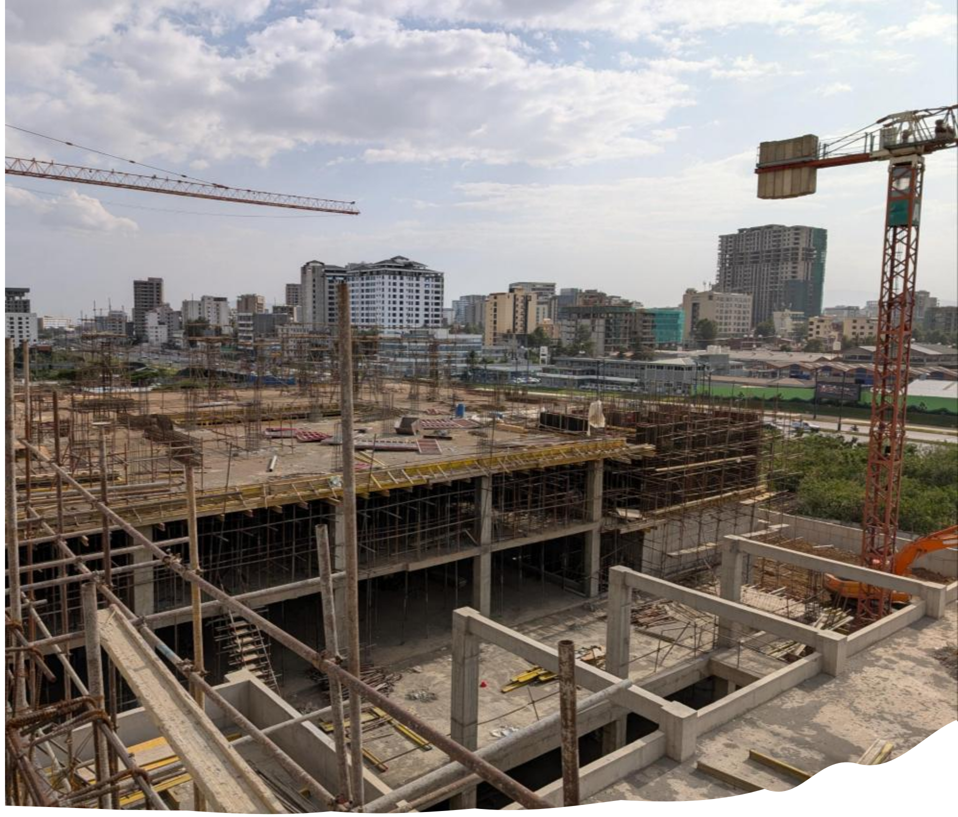
270.42 tCO_2/year
Operational CO_2 Emissions

185.99 tCO_2/year
Operational CO_2 Savings

Key Takeaways

- State-of-the-art does not only refer to technology
- It can be achieved by cleverly identifying the problems faced and ensuring that systems:
    - perform clinically
    - operate reliably
    - respond to real-world conditions

Success comes from integrating these effectively



THANK YOU

Questions?

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