St. Sidwell's Point

A Case for Passivhaus and Building Biology in Leisure Buildings

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Development Brief

An Urban Leisure Centre

- 25m competition swimming pool
- 20m community pool
- Children's confidence/play water
- Health and fitness centre (150 gym station and flexible studio)
- Café
- Children's soft play activity space
- Spa (including hydrotherapy pool, heat experience and treatment room)
- Rooftop terrace
- Environmental factors
- Contract = £35m

Project Team

Passive House Institute

KIER

SPACE . PLACE

GALE & SNOWDEN

RANDALL SIMMONDS

Baker Ruff Hannon

ARUP

LDĀDESIGN

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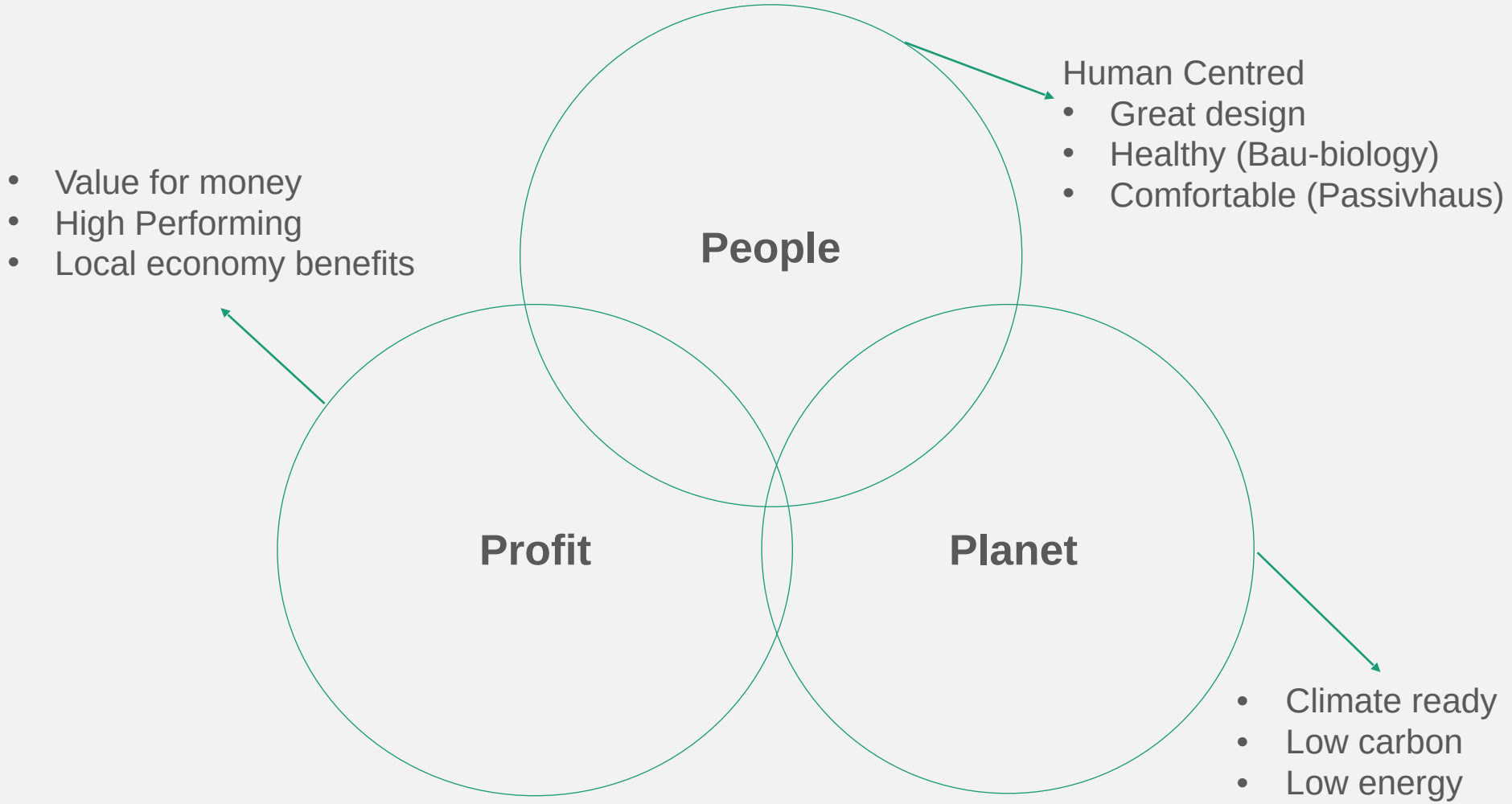
UNIVERSITY OF EXETER


Space & Place

Triple Bottom Line Approach

Triple Bottom Line Approach

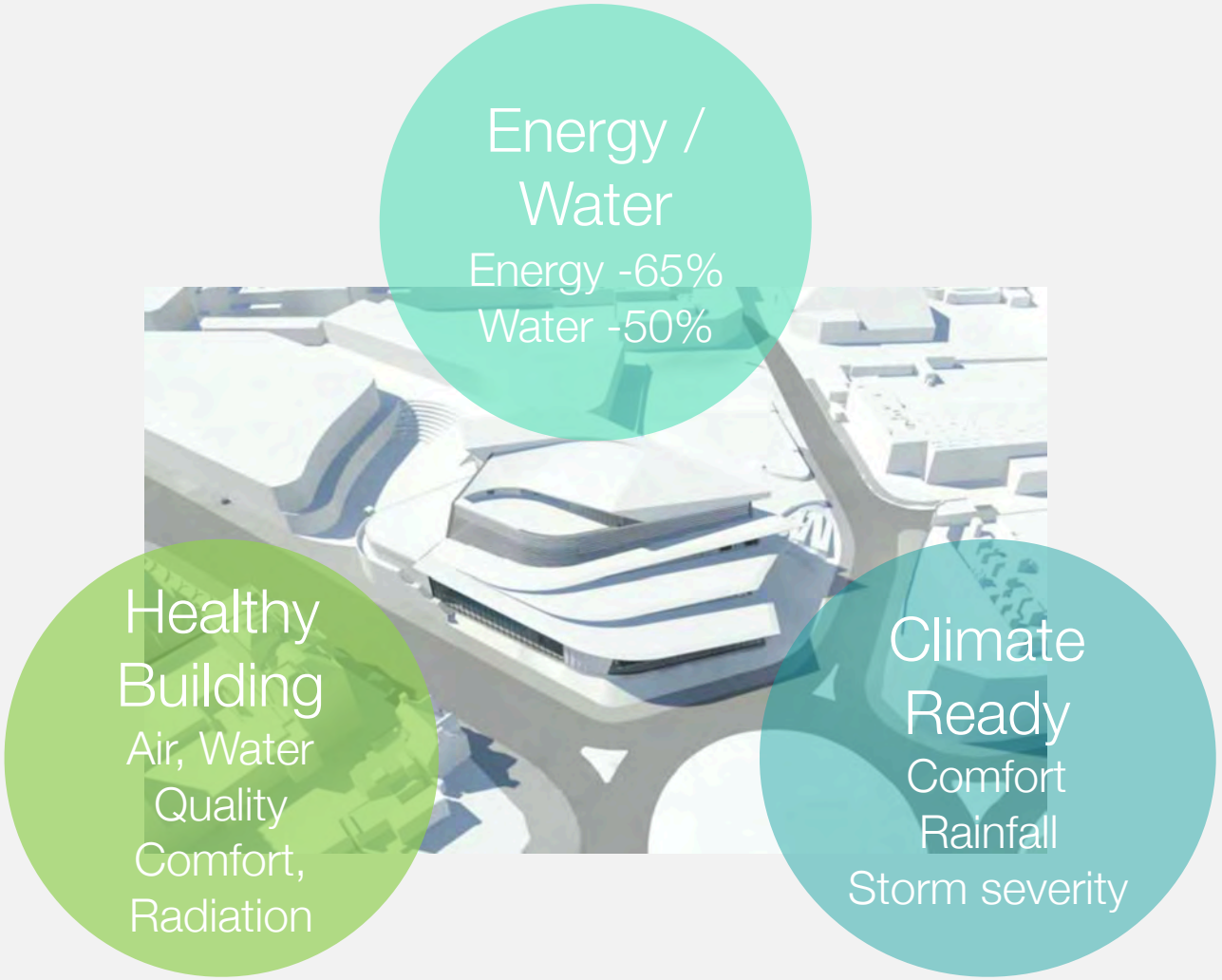


Human Centred
- Great design
- Healthy (Bau-biology)
- Comfortable (Passivhaus)

- Value for money
- High Performing
- Local economy benefits

- Climate ready
- Low carbon
- Low energy

Development Parameters



Case for Passivhaus, Climate Resilient & Healthy Leisure Centre

Passivhaus (energy)	Climate Resilient	Healthy
Passivhaus design ensures all energy uses are accounted for	Ensures good summer comfort without compromising energy performance	Ultra filtration and low chemical water treatment ensures healthier water quality and reduces risk of asthma
Outcome based performance parameters = reliable, scientifically proven energy savings	Business case assumptions delivered even when climate changes	High levels of comfort and water quality will increase user satisfaction and is expected to increase customer numbers
Reliable energy performance and running costs ensure economic viability and project delivers on business case assumptions	Low water use strategies reduce energy demand, costs and ensures resilience during droughts	High quality ventilation provides filtered outdoor air reducing indoor air contamination from particulates
	High quality air filtration maintains air quality and protects from increase in contaminates from particulates and pollen under future climate scenarios	Higher levels of natural light and human-centric/circadian lighting design promotes health and customer satisfaction

Energy Saving

- The Great Unknown: Energy Cost!
- Energy saving forecast: an energy cost reduction of 65%
- Conventional build - predicted utility costs: £57/m²/pa
- Passivhaus - predicted utility costs: £20/m²/pa

Annual Energy and Carbon Saving Potential

Carbon storage of 105 hectares (250 football pitches) of managed woodland

Emissions of 750 average UK cars (commuting 40 miles a day)

Total energy consumption of 350 average four person households

Enough to make 140 million cups of tea

Passivhaus Leisure Centre – Why?

- ✓ Energy Savings ‘pay’ for capital uplift in construction costs
- ✓ Enhanced internal environment should attract more customers and strengthen revenue potential
- ✓ High specification finishes and quality assurance will reduce life-cycle costs
- ✓ Climate Proofing the design mitigates against future retrofit requirements & running costs
- ✓ Compelling business case attracts investment / funding
- ✓ Publicity and PR opportunities

Passivhaus Leisure Centre – Why Not?

Leisure centres (and all buildings) should be enjoyed and cherished

✗ Not just about a physical space for certain activities

✗ Not just about saving energy

✓ A space to experience and an environment to enjoy

✓ Health and happiness enhancing

✓ Passivhaus = quality and comfort

✓ Passivhaus = Value for Money and makes the business case!

Environmental Factors

Client Brief

- Climate Ready Design
- Water Use
- Overheating
- Daylight
- Healthy Building
- Energy

Context…Criteria…Solution

Climate Ready Design

Context

- The climate is changing
- Majority of buildings constructed today will still be in use during the 2nd half of this century, performing under considerably different conditions
- Climate ready design increases resilience, extends useful life and economic viability
- Implementation from the outset will reduce long-term maintenance and energy costs
- Does not necessarily result in increased capital costs

Climate Ready Design

Criteria

- Adaptable
  - To meet future weather scenarios without compromising energy use or healthy building principles

- Optimised
  - Optimise design to consider future weather scenarios *and* current ones

Climate Ready Design

Solution

- Design for Comfort
  - Designs thermally modelled using IES and probabilistic future weather data from the Prometheus Project (2030, 2050, 2080 50th percentile high emission scenario)
- Water Management
  - Reduce water demand (50% reduction) and improve resilience to flooding (30% contingency)
- Construction
  - Detailing developed to cater for increased storm severity, increased driving rain and changes in ground water level

Water Use

Context

- Predicted future climate scenarios
- ~50% less rainfall in summer
- Longer periods of drought
- Typical swimming pool of comparable size – average water consumption ~70m^3/day or 26,000m^3/year
- Sufficient to sustain 140 households
- Base case – Pool Water Treatment Advisory Group (PWTAG) good practice guidance in combination with BS6465

Water Use

Criteria

- Reduce water demand by 50%

Water Demand

- Water treatment (dilution, refilling, backwashing)
- Evaporation from pool water
- Hygiene (showers, toilets)

Water Use

Solution

- Increased internal humidity (64% RH) to reduce evaporation rates – enabled by high-performance building envelope
- Water saving sanitary appliances
- Water saving filtration techniques
- Water harvesting from excess backwash water - flush WCs (100%)

Daylight

Context

- Natural light is an essential nutrient
- Day-lit environments increase occupant/user satisfaction, mood, productivity and comfort
- Provides mental and visual stimulation necessary to regulate human circadian rhythms
- Controls production of important hormones and vitamins, protecting from common diseases including diabetes, osteoporosis, hypertension, MS and others
- Energy savings on artificial lighting

Daylight

Criteria

- Offices
  - Average 5%, minimum 2%
- Swimming Pools
  - Average 5%, minimum 2%
- Dry Sports
  - Average 5%, minimum 3.5%
- Changing Rooms
  - Average 3%, minimum 1.5%

Daylight

Solution

- IES daylight factor modelling at Stage D
- Further modelling and advice on glare issues
- Window sizes and locations adapted and developed into Stage F1 designs

Healthy Building

Context

• Water Quality

- 45min swimming lesson, a child swallows about a pint of pool water
- UK pools – estimated 10-20 times higher parasitic infection than other EU countries
- Water normally treated with chlorine – highly toxic
- Nitrogen trichloride layer above pool surface
- Sand filtration with ‘flocculants’

• Radiation

- Human body controlled by weak electromagnetic fields
- Electrically charged particles in the body will align with external fields, oscillate and go into resonance
- Trigger stress response and symptoms
- Artificially generated EMFs or electrosmog will always affect life processes
- Static electric, static magnetic, ELF static, ELF electric, radio frequency

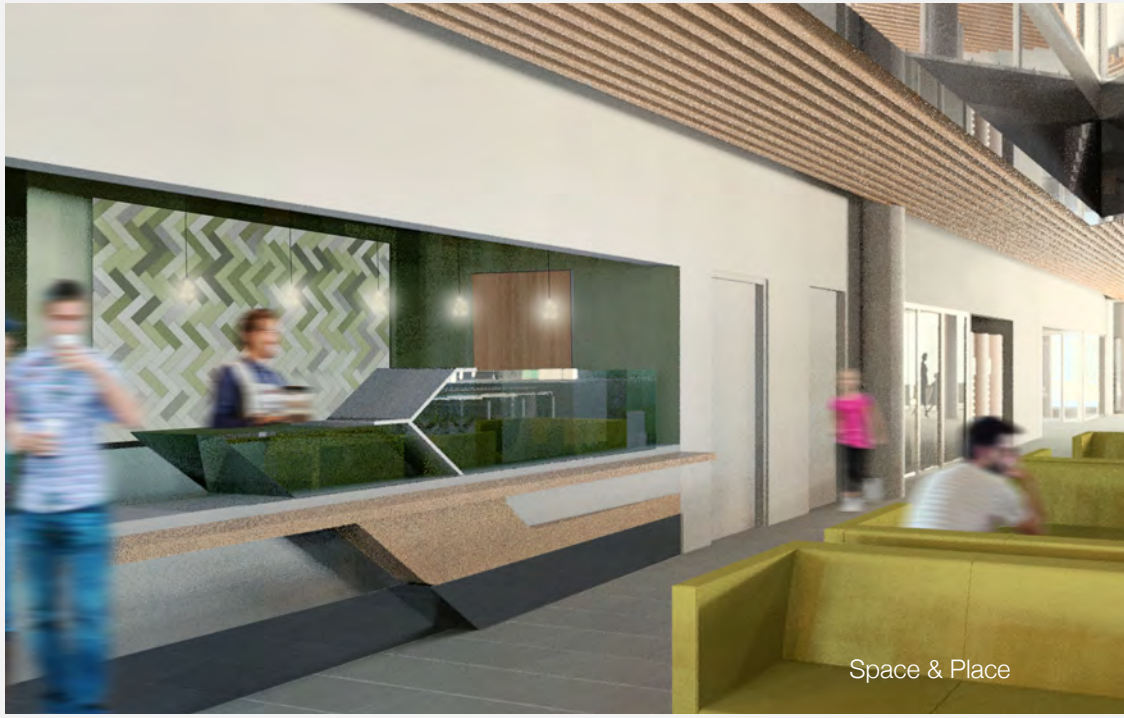
• Air Quality

- Some agents still used in general UK construction have been classified by the WHO as ‘carcinogenic’ (1) or ‘potentially carcinogenic’ (2B)
- Including: formaldehyde, benzene, polychlorinated biphenyls
- Most VOCs typically found in modern paints, glues and timber treatments are in the same category as tobacco smoke (1)

Healthy Building

Criteria

- Water quality
  - World Health Organisation drinking water quality
  - DIN19643 – German water treatment standard
- Radiation
  - Offices, treatment rooms and crèche to SBM 2015 Part A ‘no concerns’
- Air quality
  - Offices and crèche to SBM 2015 Part B ‘no concerns’



Healthy Building

Solution

• Water Quality

- Ultrafiltration
- No chemicals required (aside from cleaning)
- Compact plant size
- Capable of achieving 90-100% pathogen removal
- UV treatment – used in combination with ultrafiltration

• Radiation

- Following IBN best practice guidance to reduce EMFs
- Radial wiring
- Consider positions of cable runs and sockets
- Avoid two-way switches, looped lighting connections and dimmer switches
- Hardwired data and telephone connections

• Air Quality

- Material specification reflecting best practice guidance (IBN)
- Reduce off-gassing and indoor air pollutants
- Offices and crèche – natural or mineral building products specified
- Areas ventilated via CO_2 controlled mechanical ventilation set to 800ppm as advised by IBN

Overheating

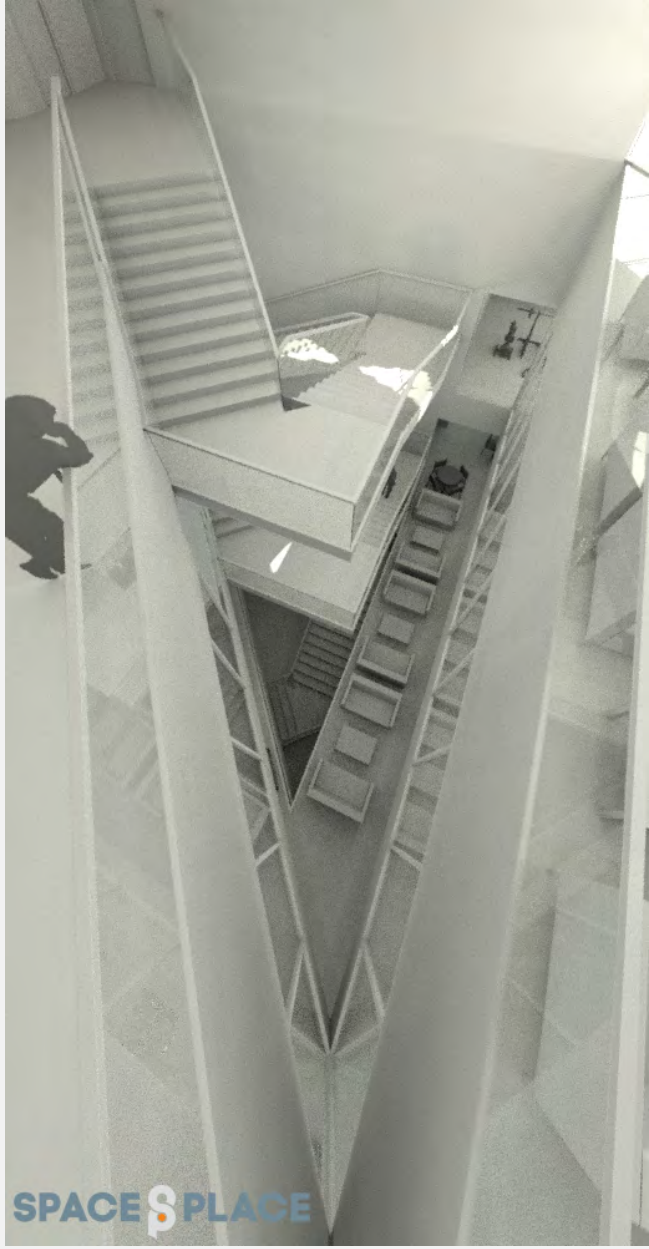
Context

- Comfortable internal environment
- Reduced reliance on air conditioning
- Avoid negative impact on cooling energy demand
- Avoid impact on economic viability

Overheating

Criteria

- Offices
  - 23 - 26℃
- Swimming Pools
  - 30 - 34℃
- Dry Sports
  - 14 - 16℃
- Changing Rooms
  - 24 - 25℃



Overheating

Solution

- Dynamic thermal model of Stage D design through IES
- Assess glazing ratios, shading and ventilations strategies in pool halls
- Optimised MVHR ventilation to pool halls, controlled via humidity and upper temperature limits
- Night cooling – AHUs in summer bypass mode and actuated windows (BMS-linked) to upper floors
- Natural ventilation strategy for summer – stack effect through stairwells
- Openable windows to all occupied spaces

Energy

Context

- Increased thermal comfort and air quality
- Reduced heating demand and energy costs
- Higher internal surface temperatures
- Reduced internal surface condensation risk
- Reduced maintenance costs
- Energy savings greater than 65% when compared to best practice pools

Energy

Familiar Values

- Passivhaus
  - Space Heating Demand <15kWh/m^{2}a
  - Peak Heating Demand <10W/m^2
  - Primary Energy Demand <120kWh/m^{2}a
  - Air Tightness @50Pa <0.6h^{-1}
  - Thermal Comfort, f_{RSI} >0.65 in Exeter


Chester Long Court | Gale & Snowden

Energy

Criteria

- Passivhaus Leisure Building

Fixed Energy Targets

- Space Heating Demand <60kWh/m²a
  - Pool Halls <40kWh/m²a
  - All other areas <20kWh/m²a
- Space Cooling Demand <22kWh/m²a
- Pool Water Heating Demand <73kWh/m²a
- DHW Heating Demand <56kWh/m²a
- Electricity <120kWh/m²a

Airtightness

- Air Permeability @50Pa <0.4m³/h/m²

Thermal Comfort

- Cool Temperate Climate Zone

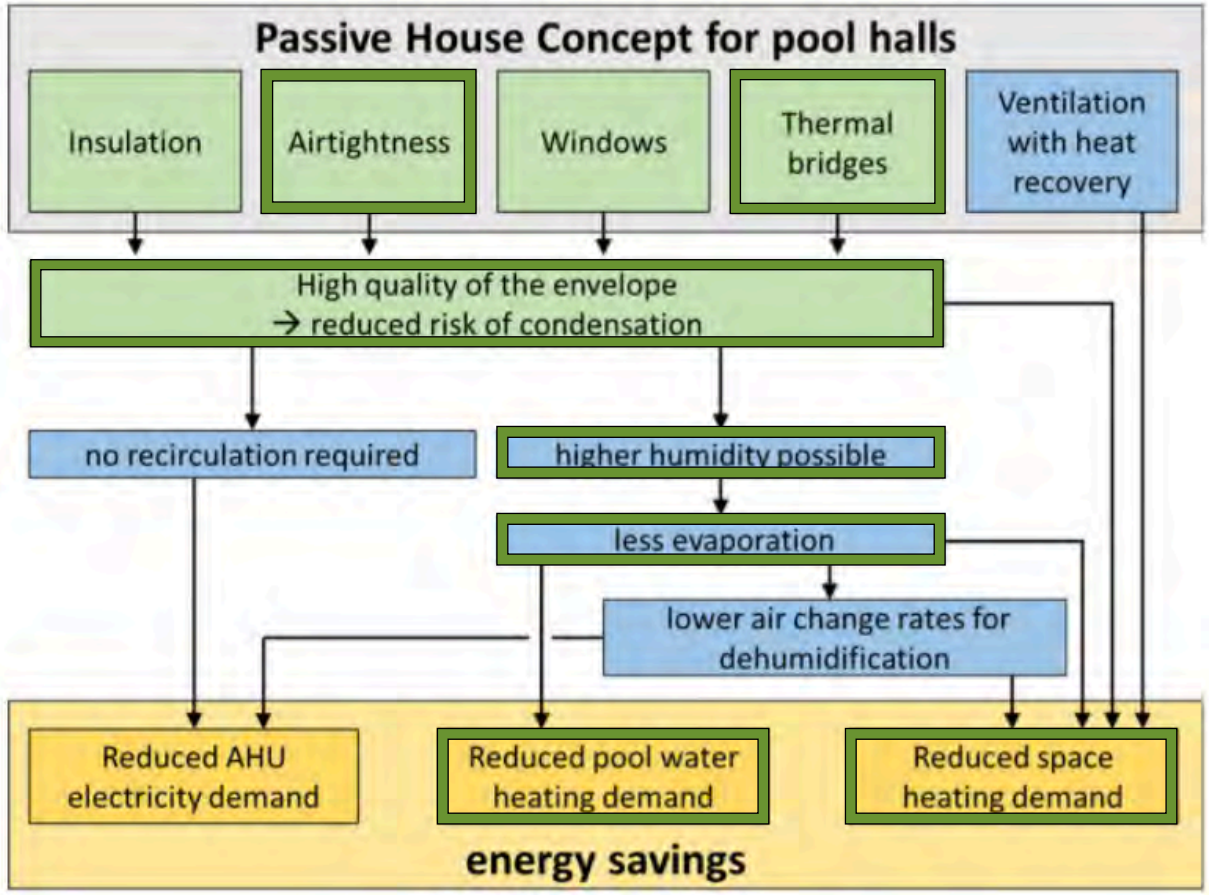
Energy

Solution

- High levels of insulation
- High performance windows, doors and curtain walling
- Compact building form
- Optimum solar orientation
- Optimised thermal bridges
- Highly efficient MVHR systems

- Internal thermal zoning
- Increased relative humidity to pool areas
- Waste energy from cooling system for heat

- High levels of airtightness



Passivhaus Institute

Airtightness

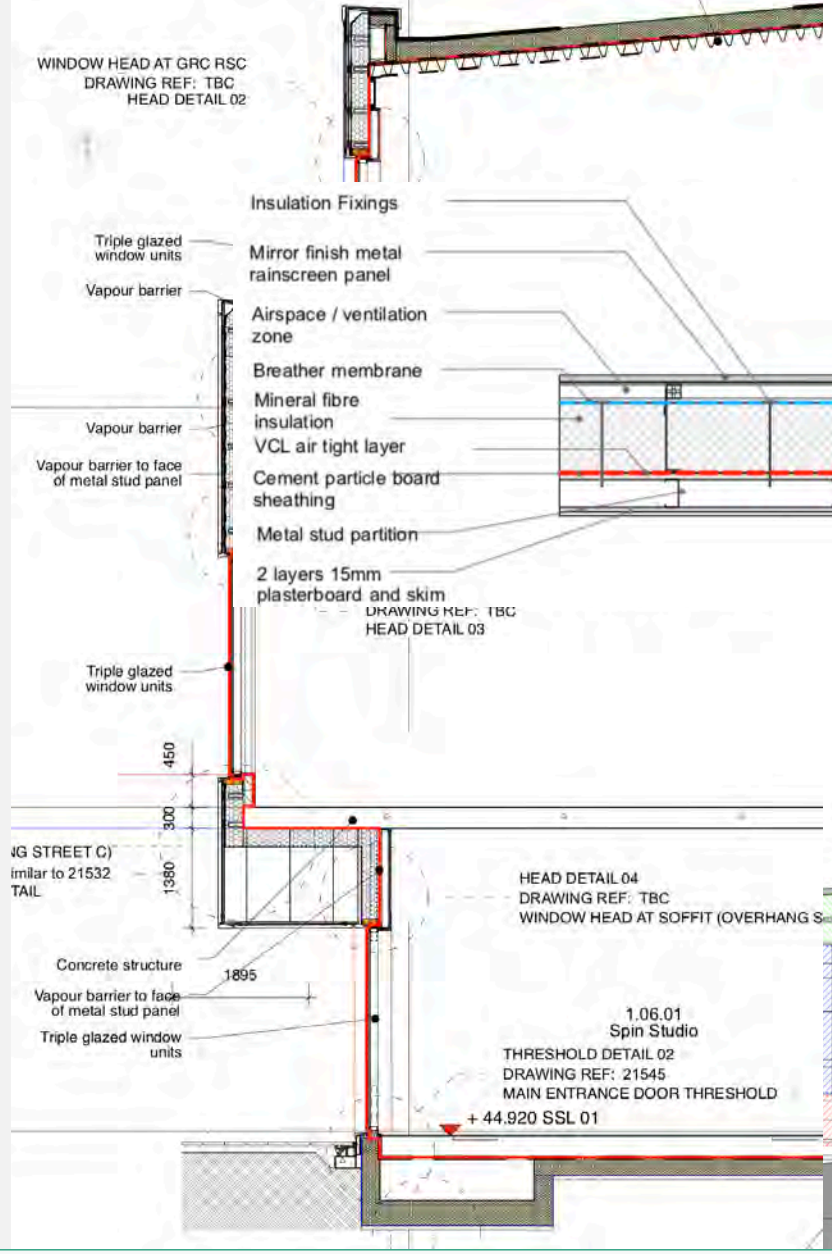
Airtightness Failure!

- Managing Risk of Airtightness Failure
  - Contractor hold point system for sub-contractor tasks
  - Isolated/sectional preliminary air tests as completed
  - Mock-up tests of the highest risk building assemblies
  - PHI-certified components wherever possible
  - Past experience of the design team
  - Involvement of the PHI throughout

Airtightness

Airtightness Strategy

- Airtightness Layers
  - Cast in-situ concrete frame
  - Curtain walling, windows and doors
  - Proprietary airtight tapes and seals
  - Vapour control membrane over plywood sheathing or CLT
  - Internal plaster to blockwork walls
  - Vapour-permeable airtightness membrane over cement particle board



Airtightness

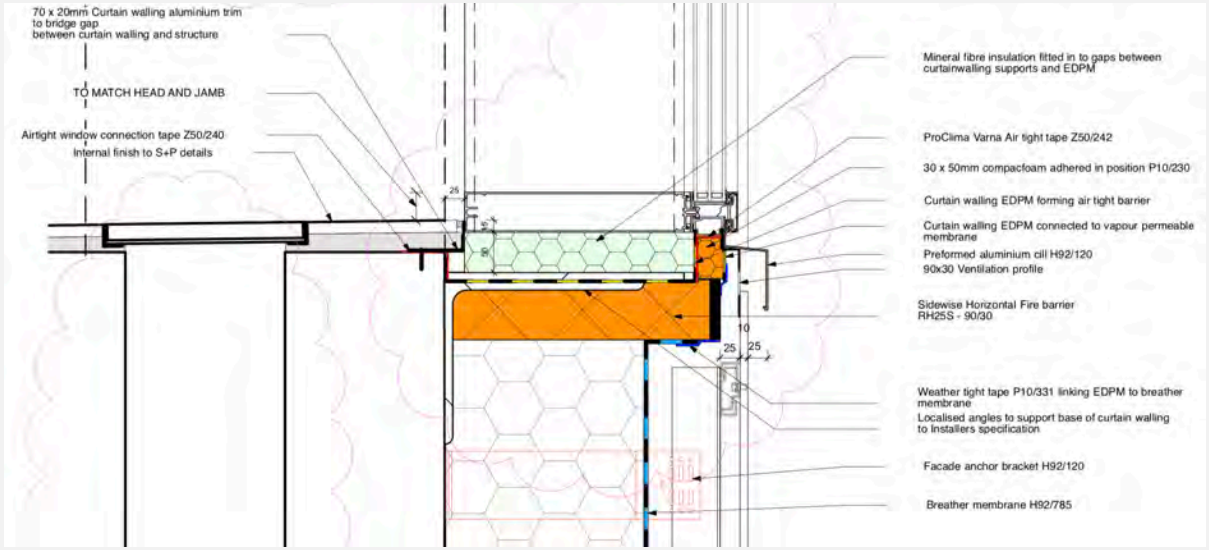
Airtightness Success?

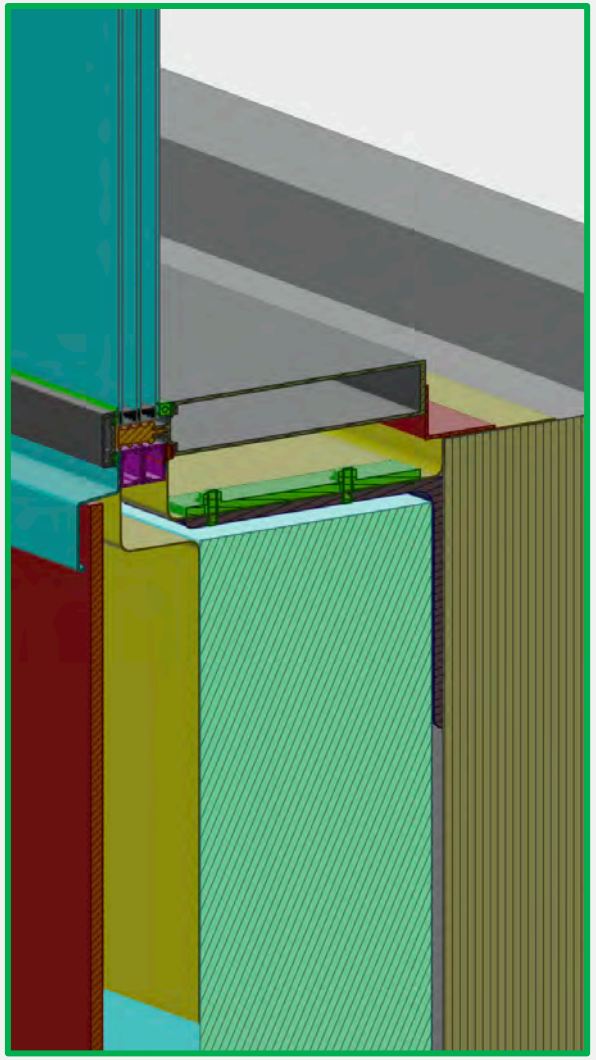
- Managing Risk of Airtightness Failure
  - Contractor hold point system for sub-contractor tasks
  - Isolated/sectional preliminary air tests as completed
  - Mock-up tests of the highest risk building assemblies
  - PHI-certified components wherever possible
  - Past experience of the design team
  - Involvement of the PHI throughout
  - *Contractors, suppliers, manufacturers… coordination throughout*

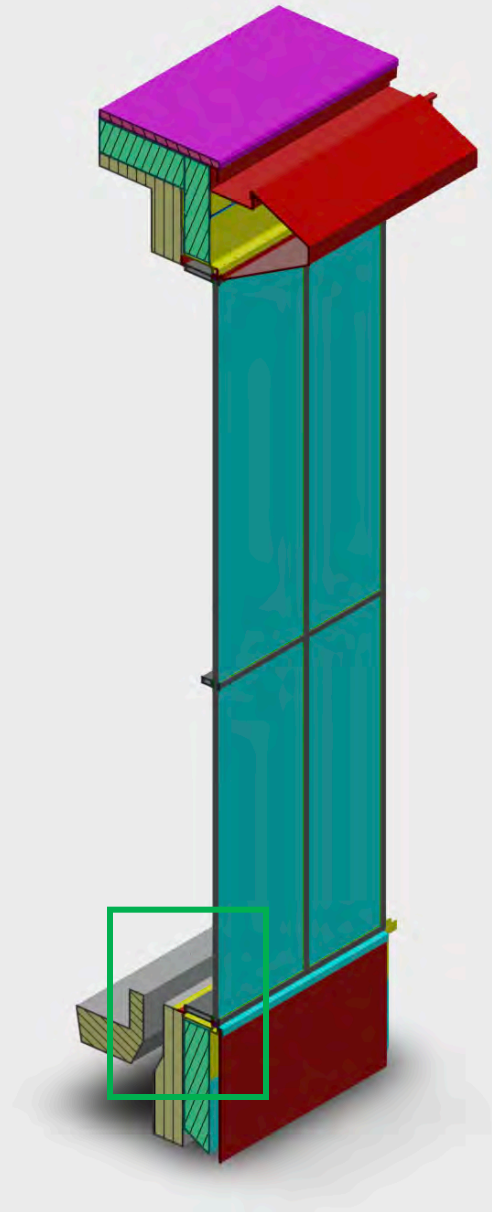
Airtightness

Airtightness Detailing

- *Curtain wall mullions?...*

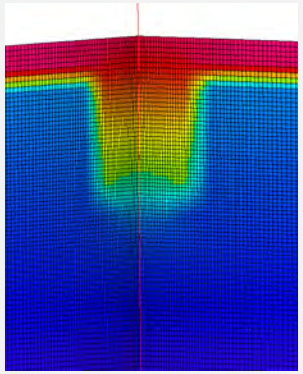


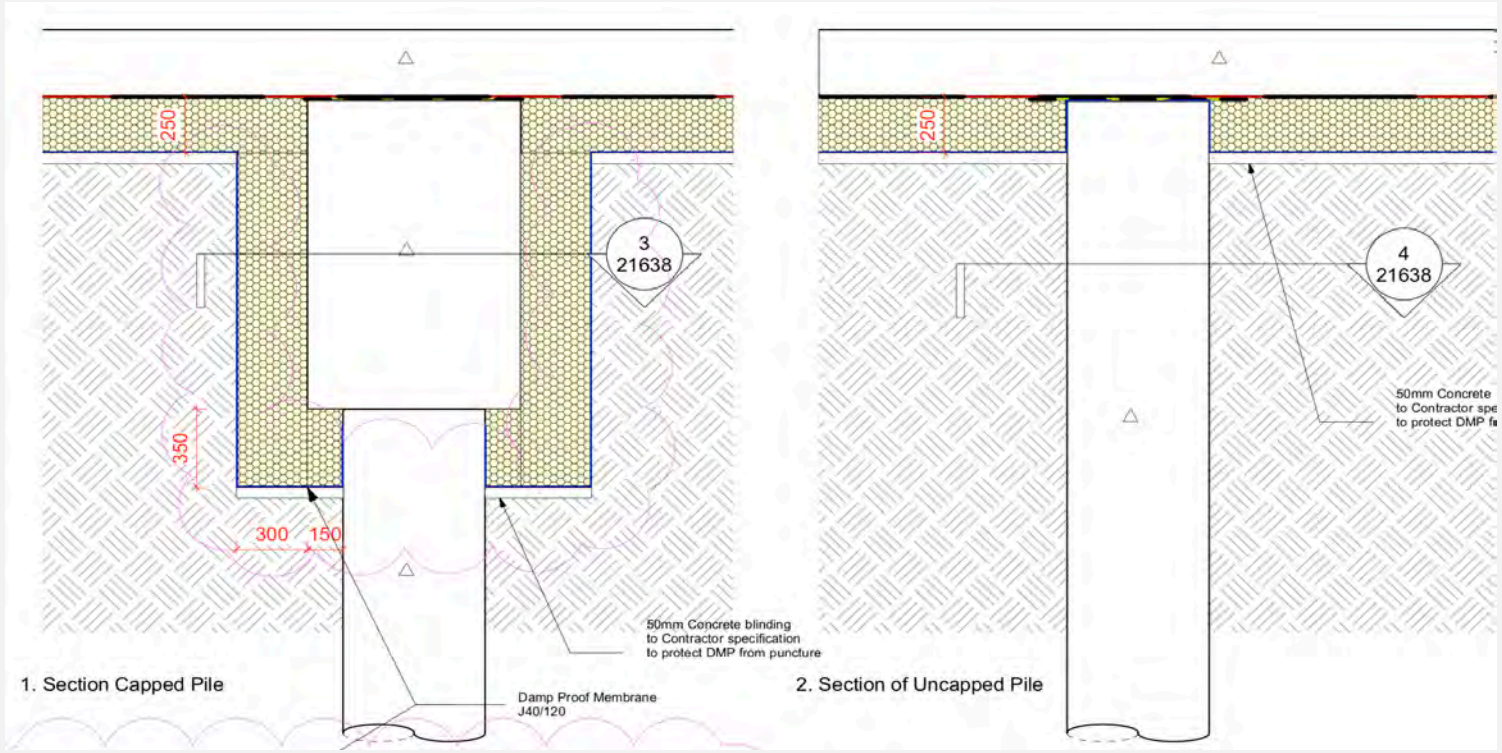




Update on Site Progress

Insulated Pile Caps





Thank you…

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