



Advancing Net Zero Ideas Competition

Stage One Submission

Applicant Code **151624**



Design Management Response to Project



Designers engaged as stakeholder for long term sustainability performance – Post-Construction bonus / penalty scheme



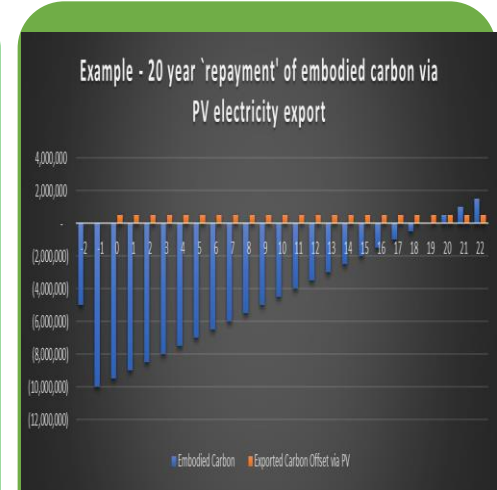
Dual minimised embodied carbon + sub-zero-carbon impact, WITHOUT GREENWASH – high reliance on offsite PV installation (discounting nuclear Small Scale Reactor prospects)



Liability of Contractor to implement specified performance requirements- no excuses



Tenant / owners pledge to attain obligated consumption & performance / efficiency



Offset embodied carbon with export of scheme PV within target 20 year post-construction period.

Design & Construction Rewards / Penalties linked to Performance-in-Service Obligations

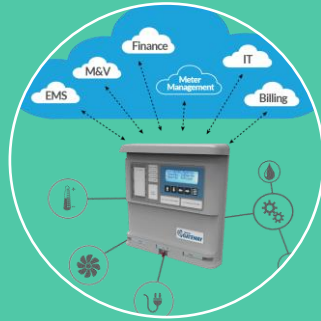
Stakeholder Engagement



Designer, FM Operator, Contractor & Tenants contractually obligated via lifecycle annual penalty / bonus to attain long-term zero carbon performance (shortfall demands purchase of carbon offset)



Real-time feedback to occupants on prevailing impact of building use.



Tenant, front of house & central metering transparency – all utilities inc cooling as real-time kWh at time-of-use CoP.



Tenant carbon-budget lease provisions / innovative staff 'carrot & stick' motivation to participate.



Focus on individual 'carbon account' – energy use at work + motivate walking, cycling /electric cycles vs. car or public transport etc



Stakeholder representatives in Sustainability Committee – It's not just a building owner or building manager issue!

Low Carbon Construction

Prohibit site Diesel generator power for construction stage – utility supplier should provide a temporary supply as condition for future permanent electricity sales ! – Precedents in India Practice should apply in HK !

Recycled sawn concrete blocks from demolition used for non-structural heavy thermal mass internal building fabric (in tandem with passive cooling / fabric high thermal inertia for radiant comfort / scope for smart-grid demand intermittent load shedding of cooling plant)

Use of bamboo / other proven low carbon building elements for doors, furnishings etc.

GURUGRAM NEWS

EPCA directs strict ban diesel gensets from Oct 15, pollution at construction sites to be monitored

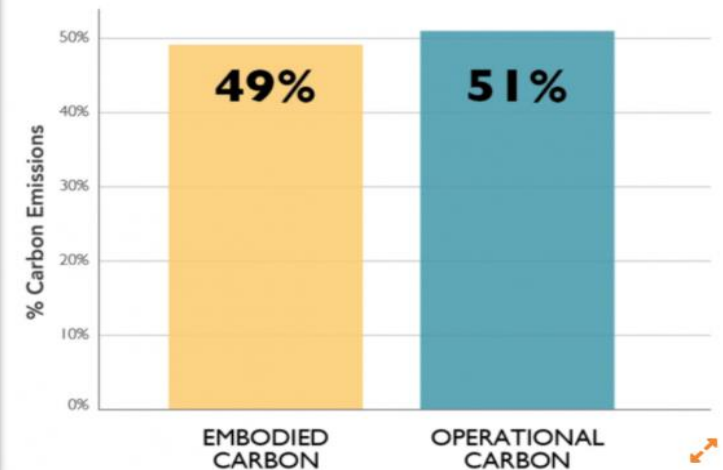
The chairman of the Supreme Court-appointed Environmental Pollution Control Authority (EPCA), which is tasked with control and prevention of air pollution in Delhi-NCR, has issued a “most urgent” directive to the chief secretary, Haryana, as well as the Haryana State Pollution Control Board, on Thursday evening after a meeting.

Hindustan Times, Gurugram | By Prayag Arora-Desai
UPDATED ON OCT 09, 2020 07:42 AM IST

Moveable/ re-usable bamboo composite interior wall panels to allow future floor plan re-arrangement.

Insulation & all other building elements optimise embodied vs. operational service life carbon impact- elements identified & reviewed – lifecycle stance considers reduced operational impact of proposed zero carbon electricity.

Total Carbon Emissions of Global New Construction from 2020-2050 Business as Usual Projection



© 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

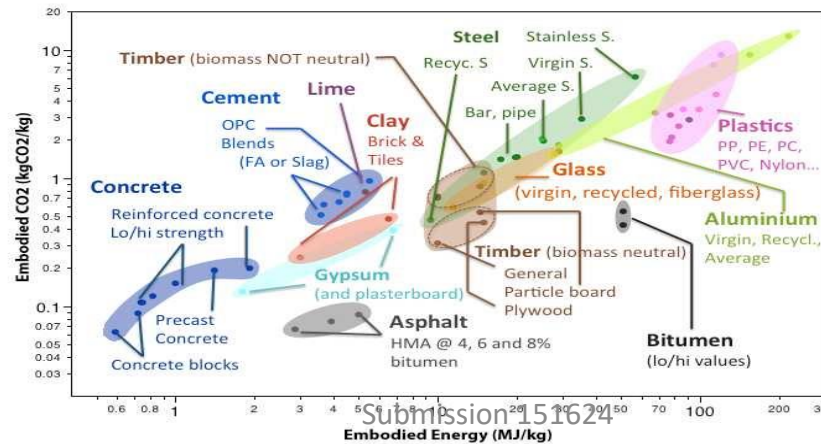
In the first 30 years of a building's operational life, 50% of its total carbon emissions are still due to embodied carbon (Source: an-Architect-Image.png Architecture 2030)

1. Eco audit

Assess energy / CO₂ over life



2. Design



Passive + Active Building Measures Proposed

Proposed measures & Best Practices now exist **BUT** DISRUPTIVE TRANSFER WHERE REQUIRED - MAYBE NOT NORMAL YET IN HONG KONG / TRANSFER FROM AEROSPACE & AUTOMOTIVE INDUSTRIES ETC NEEDED !

COST – EFFECTIVENESS & PRACTICALITY OF PV & ELECTRICAL STORAGE ETC IMPROVING RAPIDLY – *IT CAN MAKE ECONOMIC SENSE !!*



Provision of dormitory modules – Japan style micro accommodation pods

- Live at work = work at home
- Save duplicated home & work energy use + reduce commuting
- Campus style integrated on-demand accommodation.



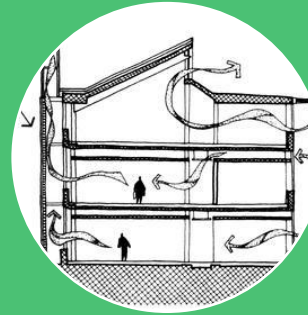
Green roof integrated with PV - IF proven microclimate 'bi-solar' benefit on raised PV efficiency exceeds-

- Parasitic energy use in irrigation?
- Energy loss from condensate + rainwater resource?



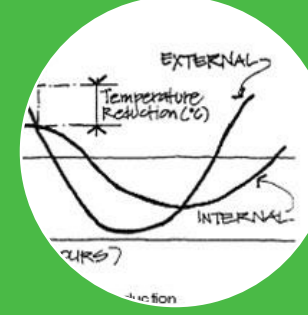
Envelope Objectives

- Low Perimeter Infiltration
- High Thermal Insulation (Envelope of cooled areas inc 24 hour area to day-only boundaries)
- Vapour barriers avoid insulation & fabric degradation



Locate WC areas against perimeter at site prevailing downwind facades

- Allow low pressure (controlled) exfiltration
- Combination of PAU pressure + external façade wind forces
- Eliminate fan power – no ductwork energy losses
- Prospect of Venturi-effect / solar chimney controlled / augmented performance



Building Fabric Thermal Weighting Objectives

- Lightweight fast response for Intermittent areas
- Heavyweight for stability / thermal storage in continuously used space



Minimise glazing heat transfer

- Challenge HKBD glazing area limits – minimised fenestration
- Triple-glazed argon-filled low emissivity glazing with thermal-break frames
- Façade shading measures / bris-soleils / maybe actively deployable
- Consider nocturnal insulated shutters for any 24 hour MVAC working areas
- Photochromatic shading

Radical shake-up of work/life interface. Building minimises demands on external energy resources.

Achieving Sub-Zero Carbon Energy at the Site

Site constraint on solar irradiated surface area - optimise PV in conjunction with solar thermal mix.

Without HK supplier of 'zero carbon' electricity, procure off-site location for sufficient PV array for 24x7 support adequate for peak annual building demands + 'payback' of embodied carbon via export.

(Bio-Diesel oil in HK is in reality reliant on Palm Oil feedstock with dubious ecological supply trail undesirable as means to claim Zero Carbon !)

Logical descending order of 'zero carbon' energy delivery to site:

- 'Use of System' tariff via electricity utility company network.
- Private cable if feasible from PV array location + night LiPeO4 battery storage
- Shuttle LiPeO4 'battery trucks' (include for overnight energy discharge)
- Hydrogen or SNG electrolysis & shuttle delivery of optimally stored hydrogen (cryogenic / compressed) for co-gen /fuel cell use & waste heat (or direct fired) adsorption chillers. Emerging technology to improve on electrolysis & fuel cell energy 'round trip' efficiency

Submission 151624

Eco-friendly biodiesel from palm oil?

Can palm-oil biodiesel can reduce greenhouse gas emissions

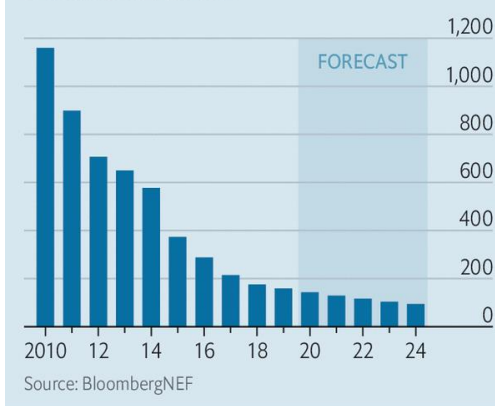
Date: February 27, 2020

Source: University of Göttingen

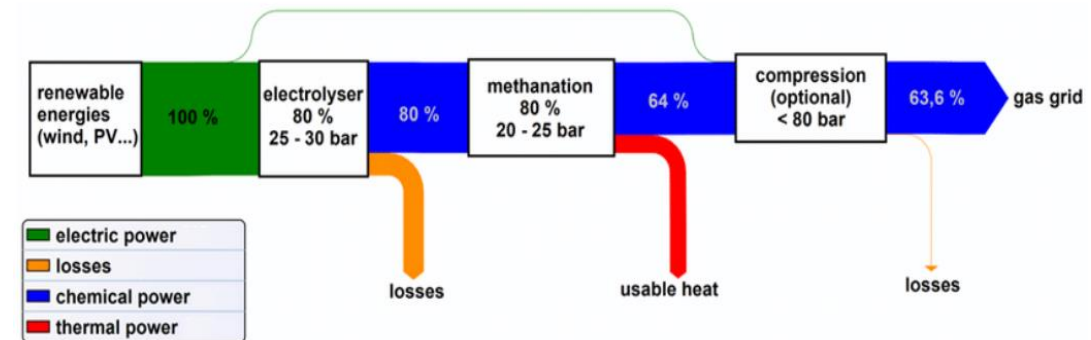
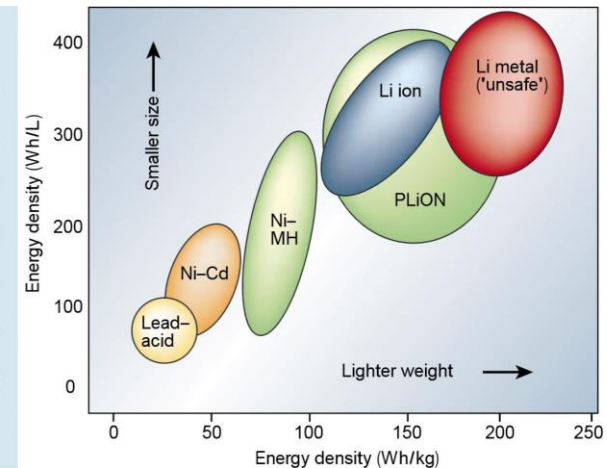
Summary: Vegetable oil biofuels are increasingly used as an alternative to fossil fuels despite the growing controversy regarding their sustainability. In a study, researchers investigated the effect of palm-oil biodiesel on greenhouse gases for the entire life cycle. They found that using palm oil from first rotation plantations where forests were cleared for palms leads to an increase in greenhouse gas emissions compared to fossil fuels.

Share: [f](#) [t](#) [p](#) [in](#) [e](#)

Lithium-ion battery-pack price
Constant 2018 \$ per kWh

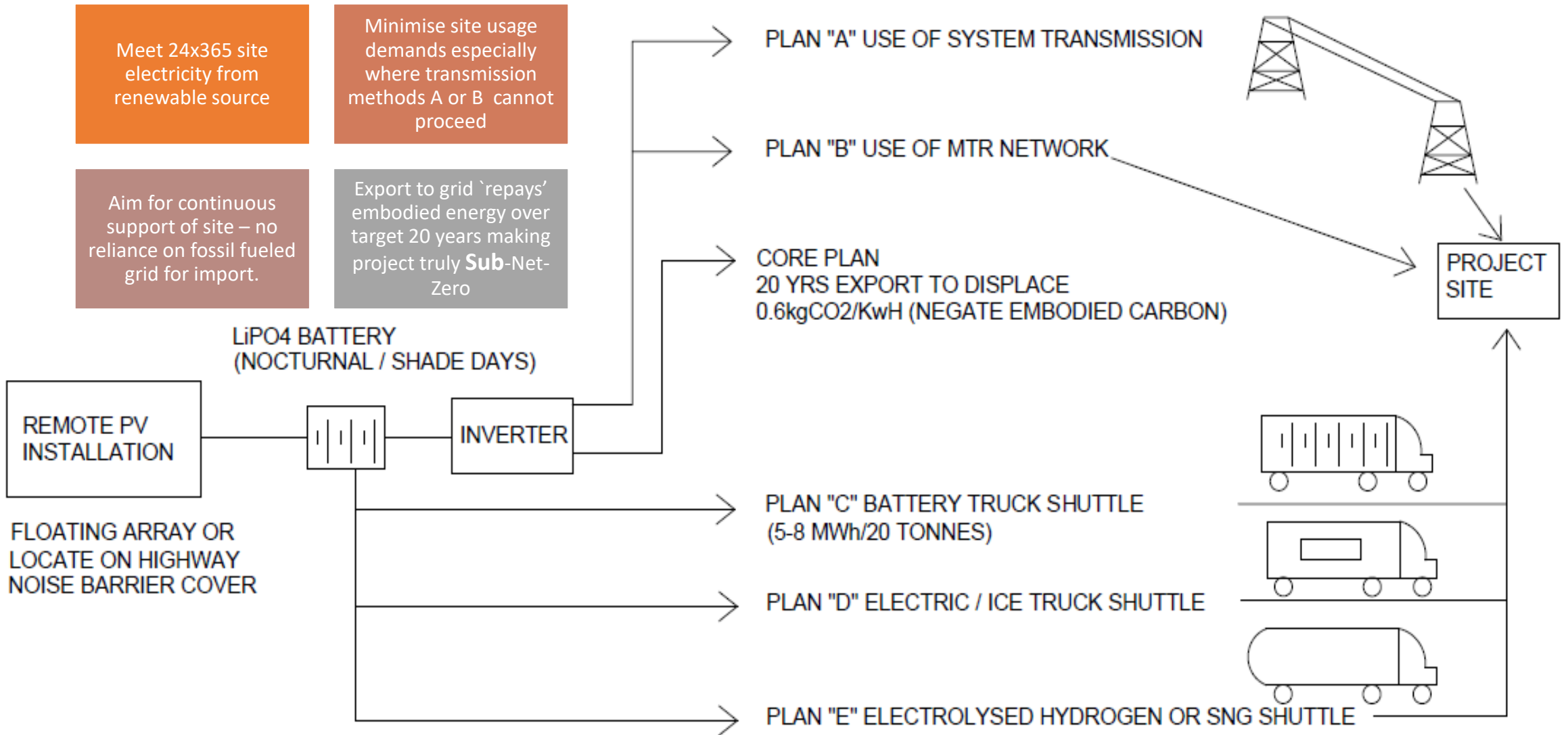


The Economist



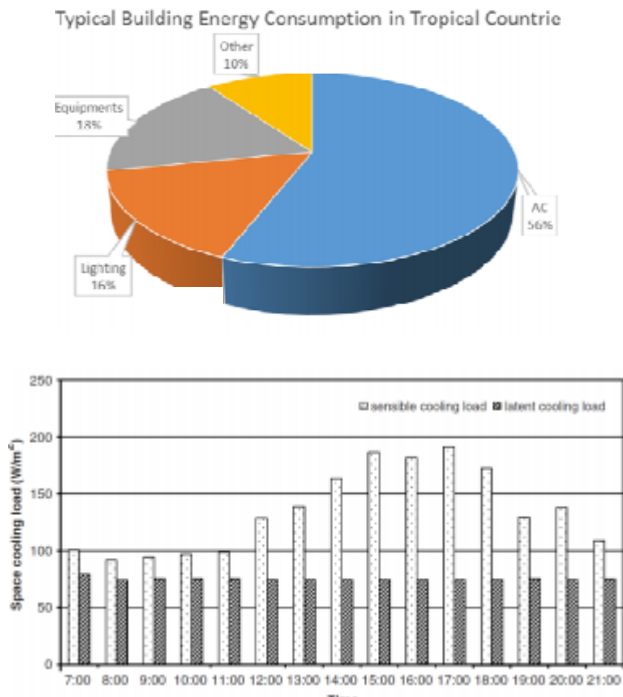
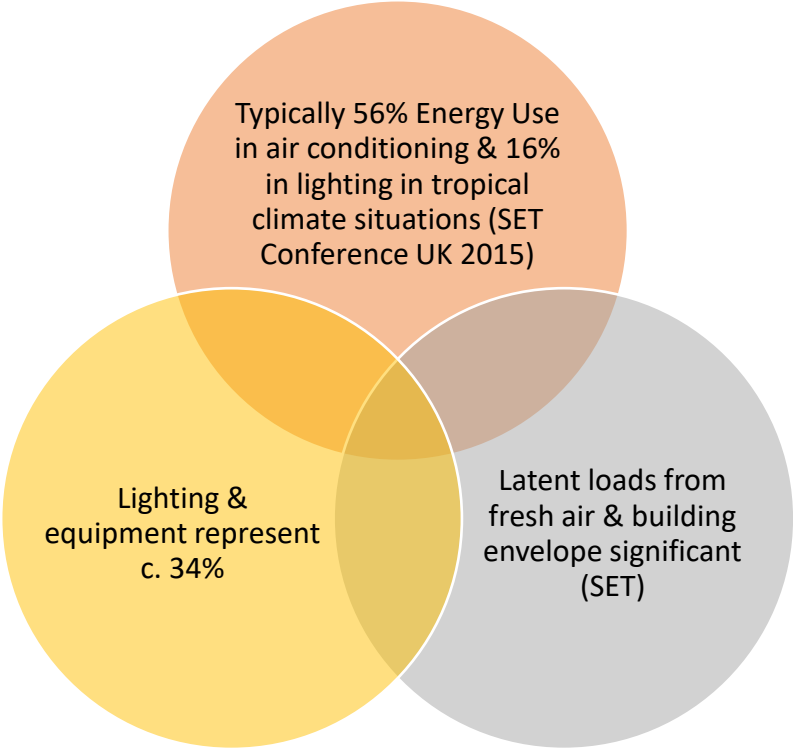
Sankey diagram for the synthesis of SNG based on renewable electricity

(Graphic: Researchgate.com)



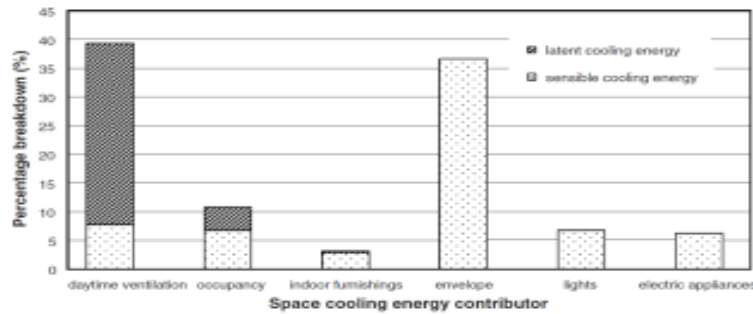
OFF-SITE SUB-ZERO CARBON ELECTRICITY SCHEME

Reducing Specific Energy Use – Major action areas to meet sub-100 kWh/m2 per year target



IT / Data Centre Areas

- High Efficiency IT
- In-Rack Liquid / DX Cooling
- Prospective First Stage Cooling as High Grade heat resource for Liquid Desiccant Dehumidifier Regen



(Graphics from SET 2015 paper - Adrian R KATILI, Rabah BOUKHANOUF, Robin WILSON)

Reduce MVAC Loads – Fresh Air, Fabric Gains, Lighting & IT,

Effective Extract to Match Available Fresh Air AND Keep Envelope Positively Pressurised.

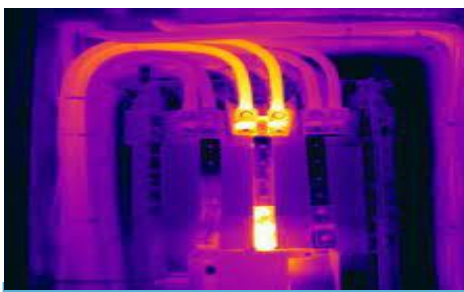
Increase MVAC Central Plant Efficiency

Increase Delivery Efficiency of MVAC

Tackle ALL areas of Energy Use – P&D, Vertical Transportation etc



Avoiding wind turbine greenwash – site exposure critically assessed to justify



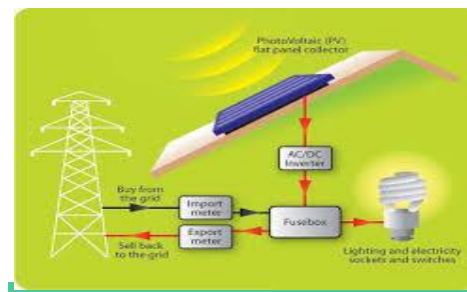
Upsized cables to reduce I^2R losses

Electrical Features

Integrated PV wall cladding, paving where shading minimal



PV to compete justifiably with justifiable solar thermal to suit collector space



Selective surplus PV / wind electricity storage or export

DC power network where charger losses exceed additional I^2R impact of ELV power distribution.



Provision for periodic high output UV sterilisation – out of hours / controlled deployment

Task lighting / reduced area lighting / auto-dim zonal lighting (challenge CIBSE area lighting norms). Optimised natural fenestration / use of automated electro-dimming glazing.



LV configured to allow non-disturbing automatic transformer/bus coupler operation - Isolate transformers in low-demand periods. (cut TX standing losses).



Interconnection points for battery storage, co-gen, or renewable hydrogen fuel cell feed-in.

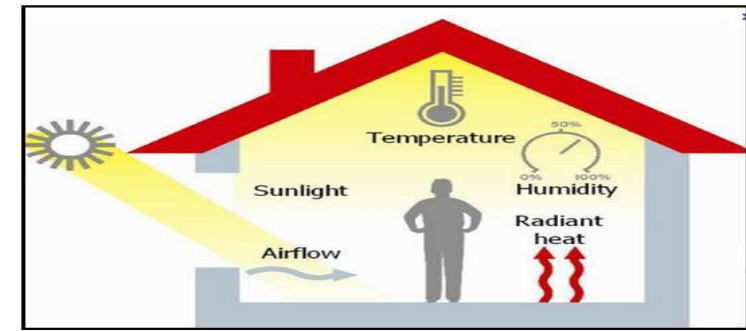


Extensive distributed networked power analysers + scope for 'smart' grid derived demand side management / load shedding interfaces.



Off-site PV array. 'Use of System' tariff should be mandated in HK else explore private cable / battery truck shuttle / hydrogen hydrolysis / SNG , with on-site fuel cell / co-gen approach to electricity supply at building.

Human Comfort Approach to Indoor Environment



Promotion of climate-related business attire – NO SUITS

Seasonal / external ambient-driven setpoints

Black-bulb + enthalpy sensor weighting basis for control feedback – not just dry bulb!

Furniture materials promote comfort – mesh seating etc

Inbuilt chilled seating / plug-ins for personal cooling vests etc

Consider localised ultrasonic adiabatic zone cooling

Personalised microclimate approach – let's replicate our car climate control !

Localised DC comfort fans

Control of particulates & contaminants – surface treatments, high MERV filtration, UV etc

Radiant cooling biased to work-stations

Out-of-hours mould protection by 'pulse' dehumidification

Low humidity primary air

- Low supply air temperatures
- 'Free-reheat' runaround coils / heat pipes
- Liquid desiccant dehumidification considered

Self-learning BMS energy minimization algorithms for parameter settings & plant combinations

Optimum Start & Stop
MVAC Control (“OSC”)

Lunchtime
temperature
setback

Tariff change time chilled water
temperature reset

- Raise CHWT before end of high rate
- Lower CHWT before end of low rate

Chilled water setpoints
offset by ambient enthalpy
compensation routine
(self-learning slope for max
system CoP)

Cooling tower CDW temp
control by floating enthalpy
/ wet bulb temperature.
Offset control basis (values
adjusted by overall plant
CoP performance)

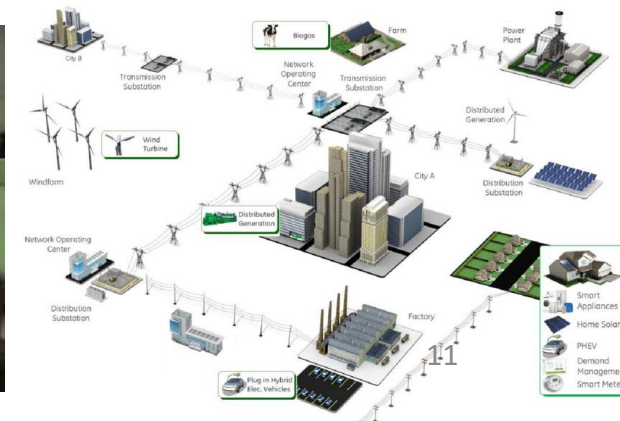
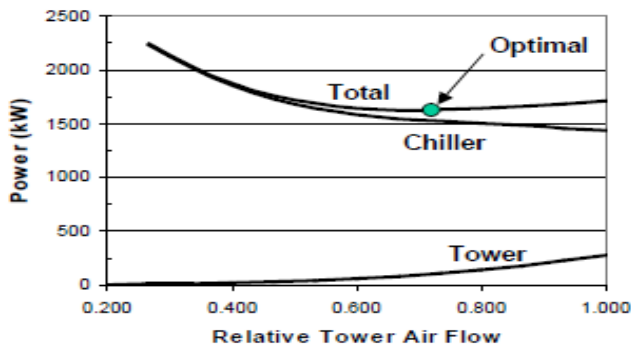
Seawater / Cooling towers
/ Both selection by
minimised pump+ CT fan +
chiller power requirements.

Central chilled water pump
operation / DP setpoints
driven by

- Distributed pumping needs
- Minimum chiller flow-rate
protection

‘Smart Grid’ readiness

- Temperature resets
- Short duration stoppages
- EV charger current control
- Fridges / communal appliances



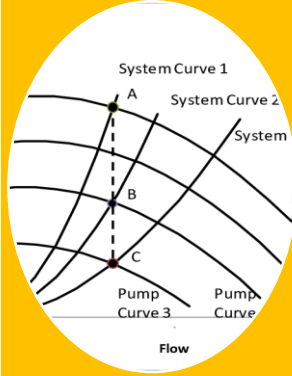
Central chilled water plant & distribution



Oil-free variable speed chillers OR absorption chillers fuelled by PV-derived hydrogen from off-site PV array hydrolysis unit



Justified use of:
(1) cooling tower with static regain diffusers
or
(2) sea water
or
(3) Best prevailing choice of (1) + (2) for heat rejection.



Chiller selection maximises feasible chilled water & CDW flow rate turndown ratios.



Distributed pumping in preference to throttling based flow control

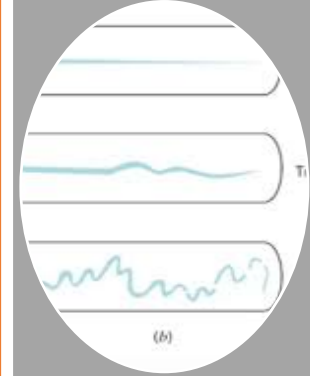


In-series PAU to radiant panel delivery to maximise CHW DT

In-Series chiller operation at high load for improved CoP



Prospective eutectic phase change cooling storage (say 10 Deg.C) for pre-cooling return water. (Design study required to conclude if of benefit)



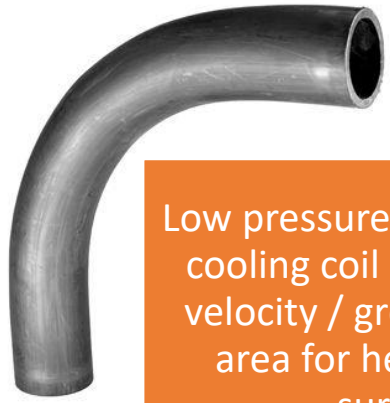
Ultra low velocity pipework design, prioritised bend avoidance & low Cd transitions + laminar flow objectives



Chilled water wetting agents & sidestream filtration

Systematic inclusion of all proven efficiency enhancement techniques – plant + control + distribution.

Reducing Parasitic Fan & Pump Loads



Low pressure drop chiller & cooling coil design – Low velocity / greater surface area for heat transfer surface

Low height cooling towers to reduce lost static head

Avoiding bends / using large diameter bends / smooth transitions

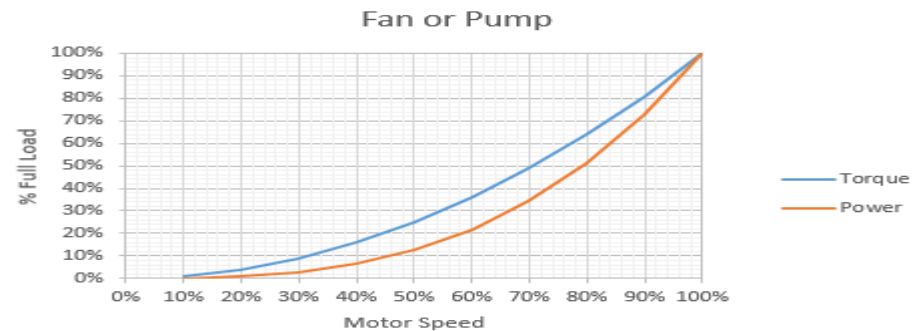
Increased duct and pipe diameters – >30% velocity reduction target = 50% power reduction



Embedded pumping approach for secondary circuits – NO THROTTLING

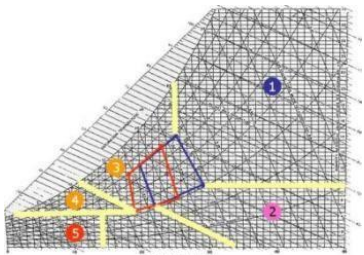
Cube Laws & demand-driven flow rates + wide design temperature differences from in-series PAU + radiant coils cuts flow & pumping energy

EC pump & fan motors, plug fans etc



MVAC in a Post-Covid Era

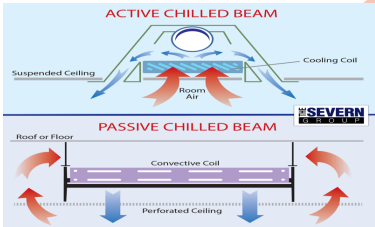
Evolving views Q2 2021 that high air-change approach does not really address viral spread. Cellular approach / passive cooling appears justifiable route at this time.



- Summer comfort boundary
- Winter comfort boundary
- Approximate atmosphere condition
- ① Requires conventional air conditioning
- ② Requires humidifier
- ③ Requires dehumidifier
- ④ Requires air heater
- ⑤ Requires air heater and humidification

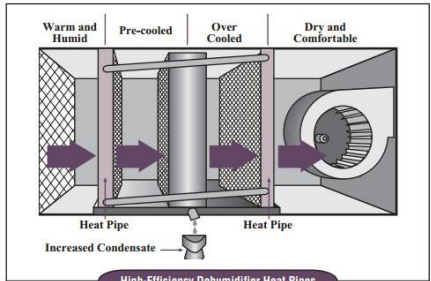


Verify net benefit of avoidance of washroom extract fans via proposed positively pressurised floorplate - selective (olfactory sensor controlled) else justify DC fan assisted outflow with facilitate heat recovery to incoming primary air. Consider use of isenthalpic spray cooler or latent thermal wheel to capitalize on proposed low RH / higher dry bulb indoor climate conditions (establish true annual gains vs fan-power impact).

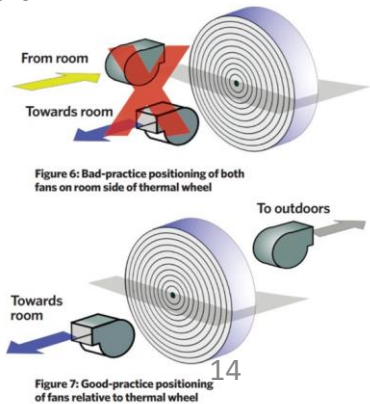
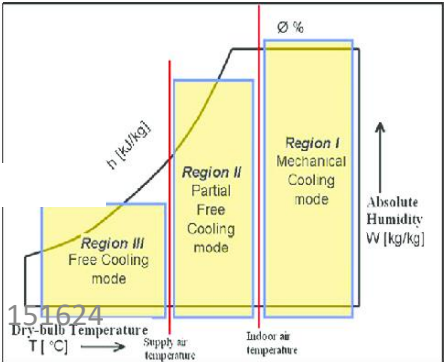


Personal cooling stations with localised micro-climate control as desking + quick fix plug-in connections or ice-cartridge units for water matrix cooled personal cooling jackets etc.

Air-side approach aligned with post-pandemic conclusions for optimum anti-viral performance – may not favour freely ventilated high air change rate winter ‘free cooling’ – ultra high CoP chillers at low cooling tower temperatures / availability of PV-derived electricity negates carbon impact of loss of traditional ‘free cooling’



Chilled water flow via in-series (1) low SAT free-reheat PAUs then (2) radiant panels/chilled beams/embedded cooling coils in heavyweight building fabric elements.



Post Covid 19 Epidemic Design Implications



Uptake of best available post-Covid design guidance in sketch design, detail design and FM planning.



Evolving opinions on air change rates / effectiveness of greater per capita fresh air.



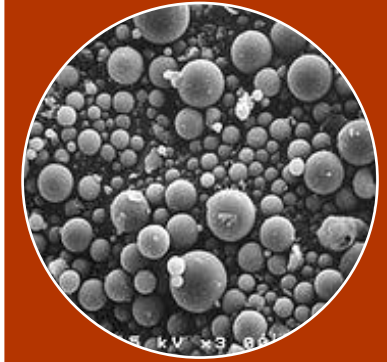
Clean room principles – particulate dilution by sterile air / unidirectional flow realities impact practicality and benefit / spread risks from simplistic high air change rate approach



MERV 18 /19 filter grades dictate large plant space provision to achieve low velocity / low pressure drop / help electrostatic particulate capture



Role of silane type or UV / catalytic surface treatments considered & compatibility included with architectural finishes - periodic re-application needs.



RH impact on aerosol residence times / effect on electrostatic still evolving – review conclusions at detail design stage.

Covid 19 pandemic must remind designers to apply Duty of Care obligations to protect building occupants!

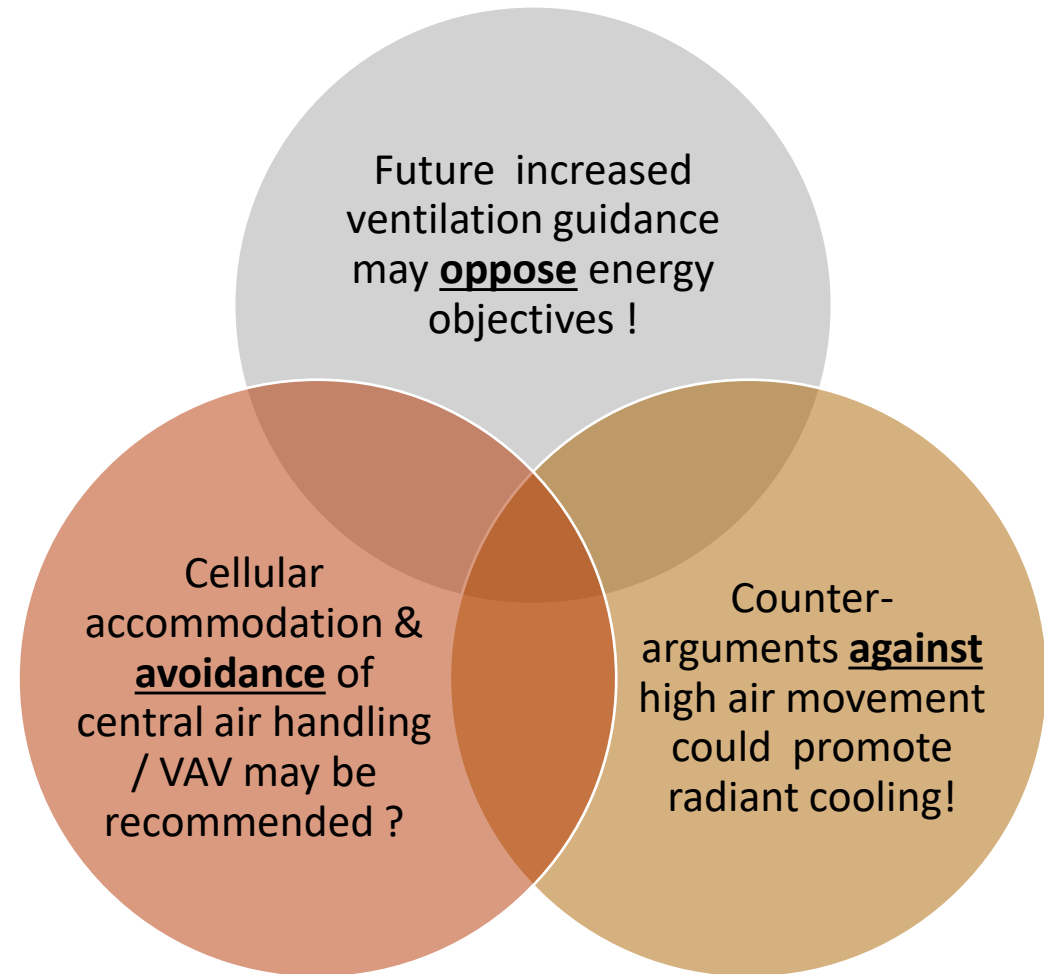
Covid Thoughts- Evolving Understanding from ASHRAE & Others (Q2 2020)



U.S. DoE Pacific Northwest National Laboratory study .

Aerosol & HVAC experts conclude rapid air exchange rapidly spreads virus-sized particulates.

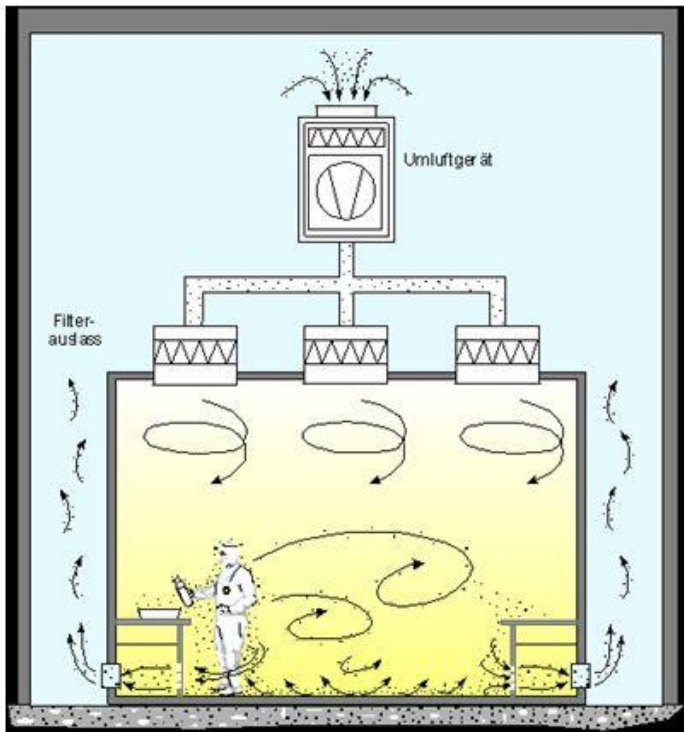
As reported in 'Building & Environment' journal.



Covid Thoughts- Air Filtration Dilution vs Unidirectional Flow – impracticality in commercial building environment favours radiant & passive cooling approach ?

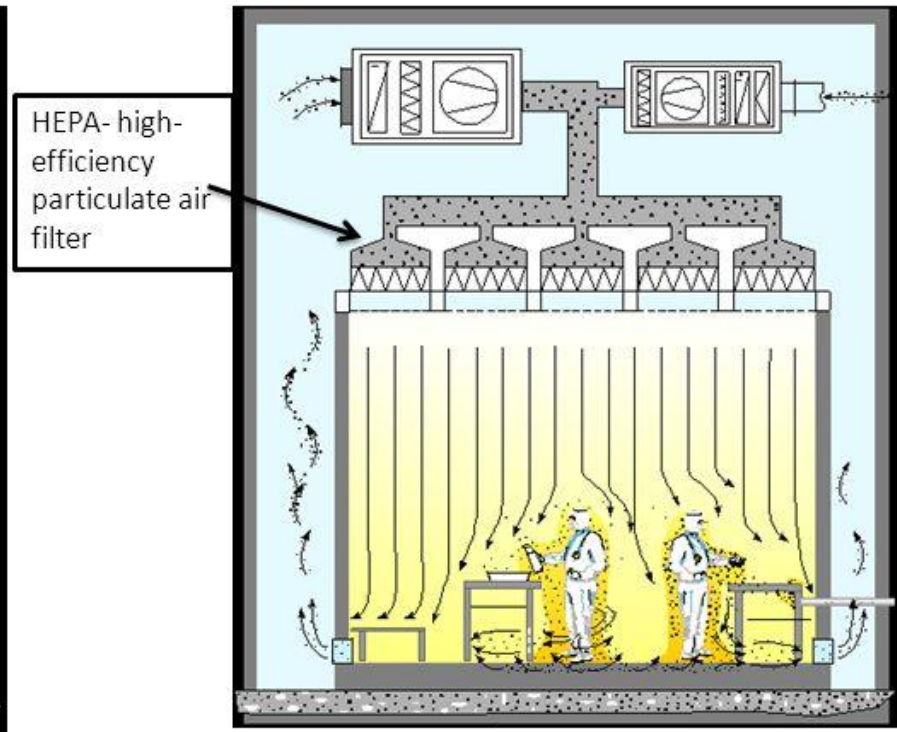
Principles of the Clean Environment

Non-unidirectional



"dilution effect"- non-parallel /non-uniform flow streams and velocities. clean air entering the room and diluting the contaminated air.

Unidirectional - Laminar

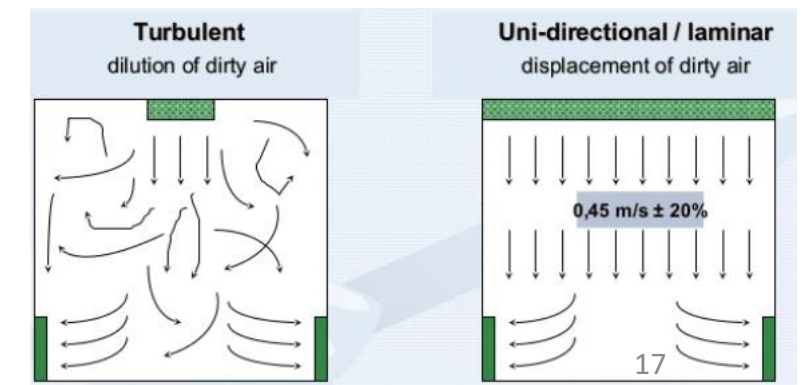


"piston effect"- where incoming clean air "pushes" contaminated air from the room

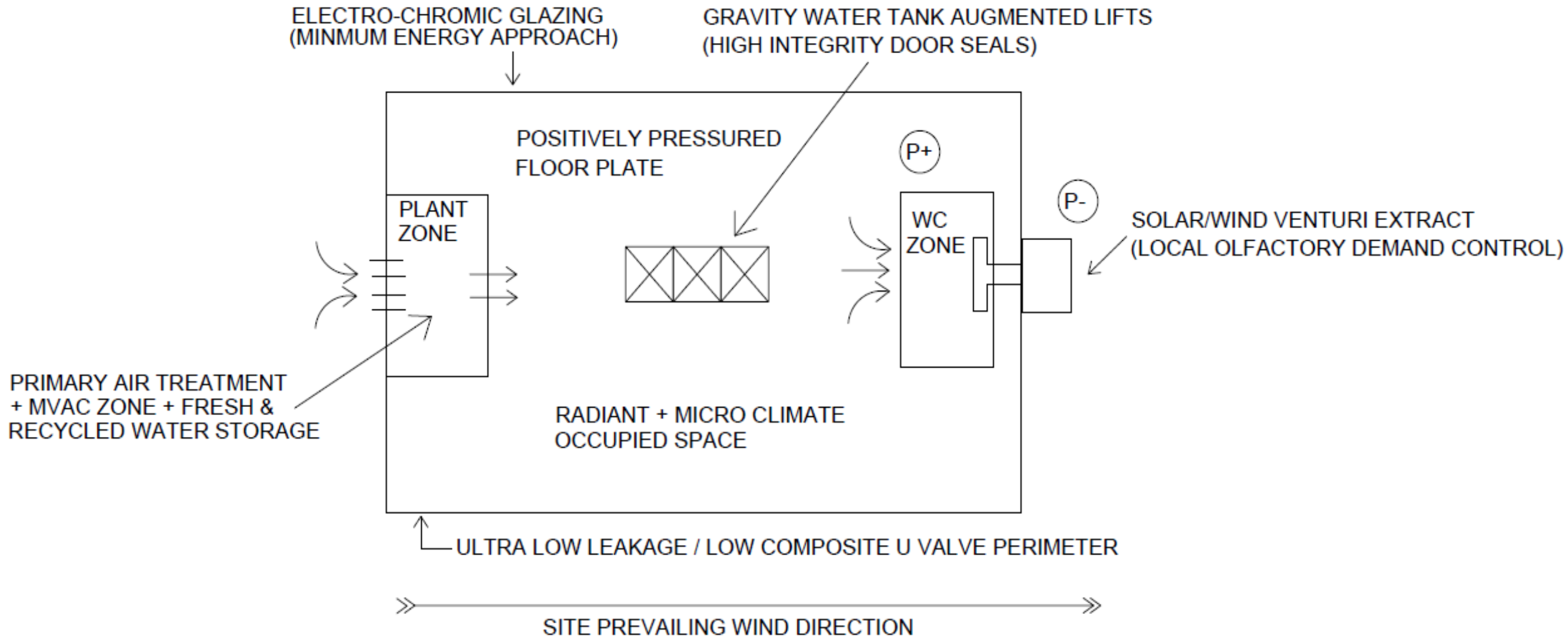
Implications for Controlling Spread of Pathogens !

Retrofit 'Air Cleaners' can only achieve Dilution

High Volume Unidirectional Flow necessary to Oppose Transfer of Pathogens within the Space



Typical Conceptual Floorplate

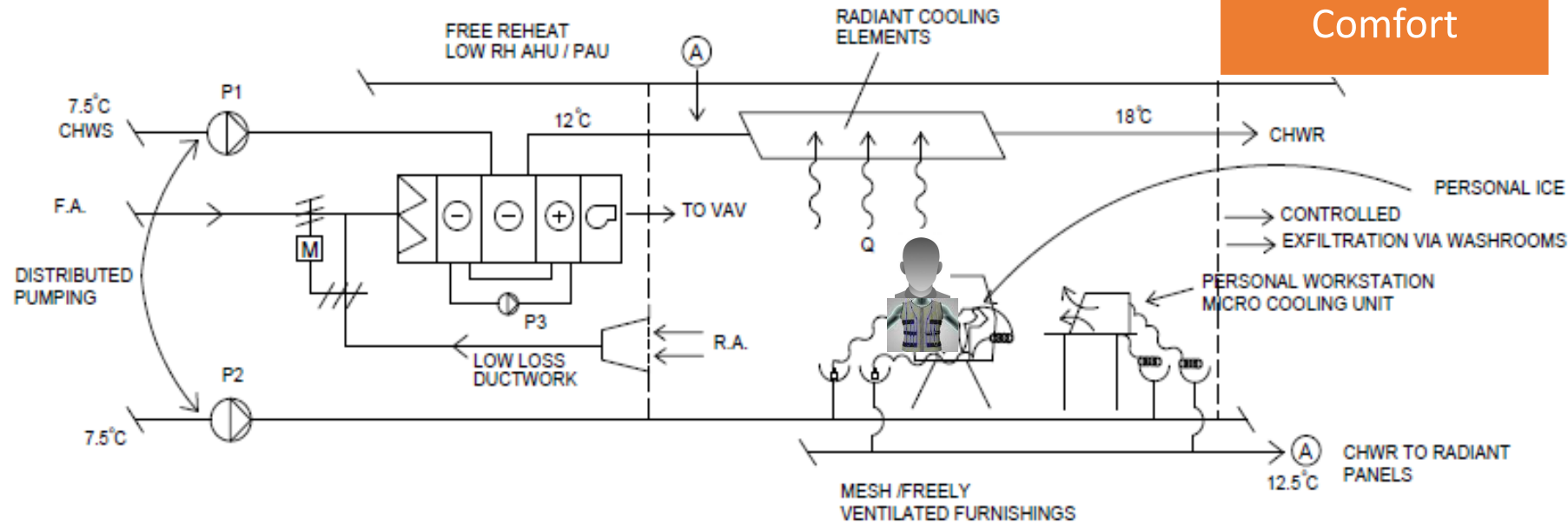


INDICATIVE FLOOR PLATE CONCEPT (NOT TO SCALE)

Submission 151624

Disruptive
Approach to
Comfort

FOCUS ON
MICRO-CLIMATE
NOT THE SPACE!



- WIDE CH.W. DT
- PERSONAL ENVIRONMENT CONTROL
- HIGH DRY BULB / LOW RH CONDITIONED SPACE
- BLACK-BULB + ENTHALPY CONTROL OF DISTRIBUTED PUMP TO P1
- P2 DEDICATED TO PERSONAL COOLING ; RETURN VIA RADIANT PANELS
- P3 FOR WATER CIRCUIT RAC (CAN BE HEAT PIPE)



PERSONAL COOLING VEST (INDICATIVE)

CONCEPT SPACE COOLING ARRANGEMENT

Submission 151624

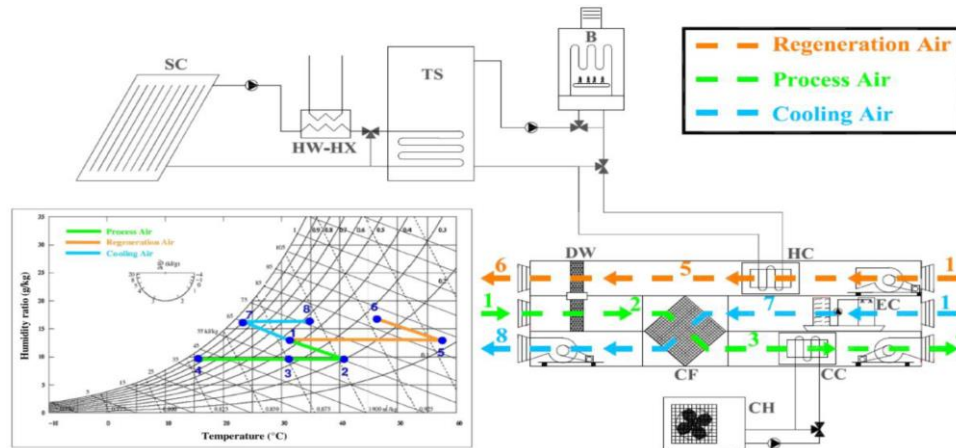
Tackling MVAC Fresh Air & Dehumidification

Avoid Excess Fresh Air –
strict CO2 demand-
control

Intent for warmer, but
more dehumidified Fresh
Air

Demand-Controlled Toilet
Extract within available
Primary Air AND Maintain
positive space pressure to
avoid infiltration

Multi-stage treatment of
fresh air – Proven +
Innovative Technologies

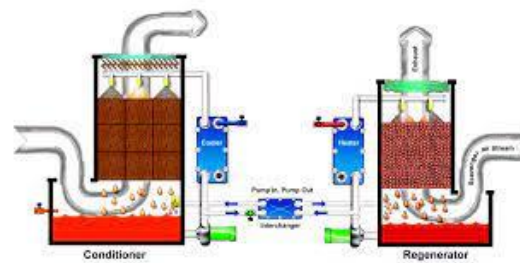


Pre-treatment dry cooling from indirect
evaporatively cooled airstream

Credit – MPDI 'Energies' 2016

Pre-cooling where advantageous from
toilet extract airstream (zero leakage,
likely no latent transfer !)

Consider solar-thermal regenerated
desiccant dehumidifier

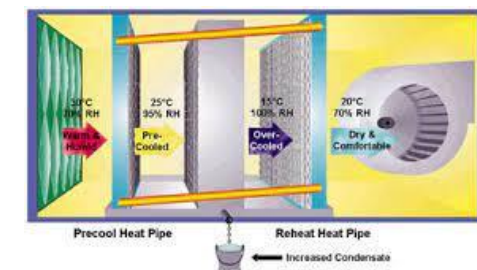


Credit Alfa Laval

Submission 151624

Credit HOVAL

Free-reheat low humidity primary air
suited to condensation margin needs of
radiant cooling



Credit Welcomair

Credit SET 2015

Our Own Experience Evaluating Condensation-Free Radiant Cooling in Hong Kong!

Primary Air-Based RH Control achieves positive 'condensation margin' at all times

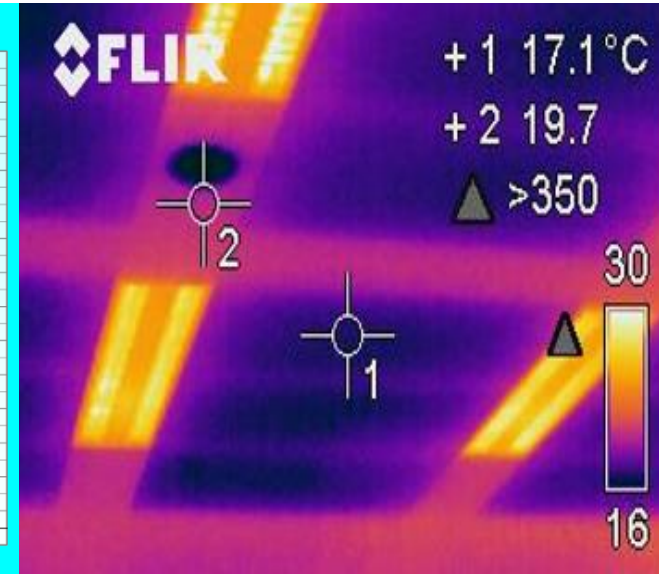
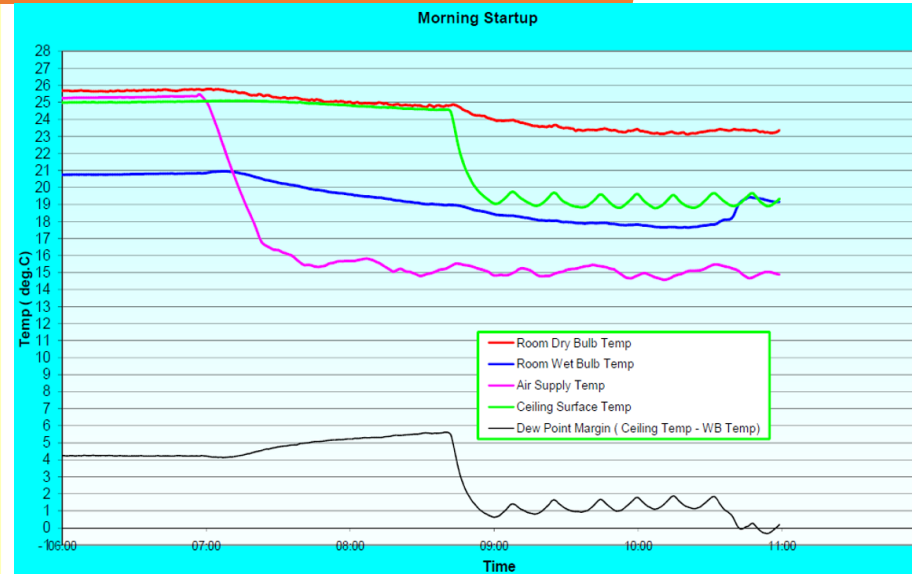
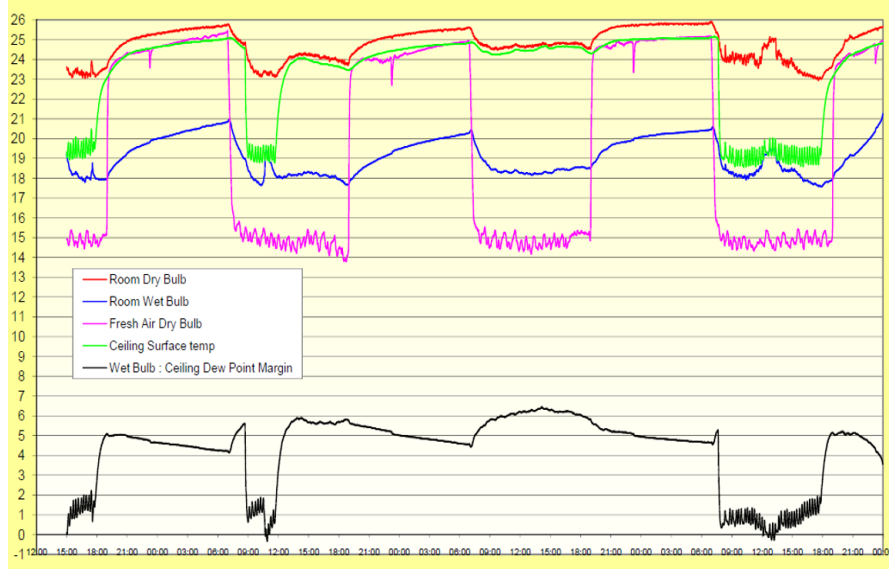
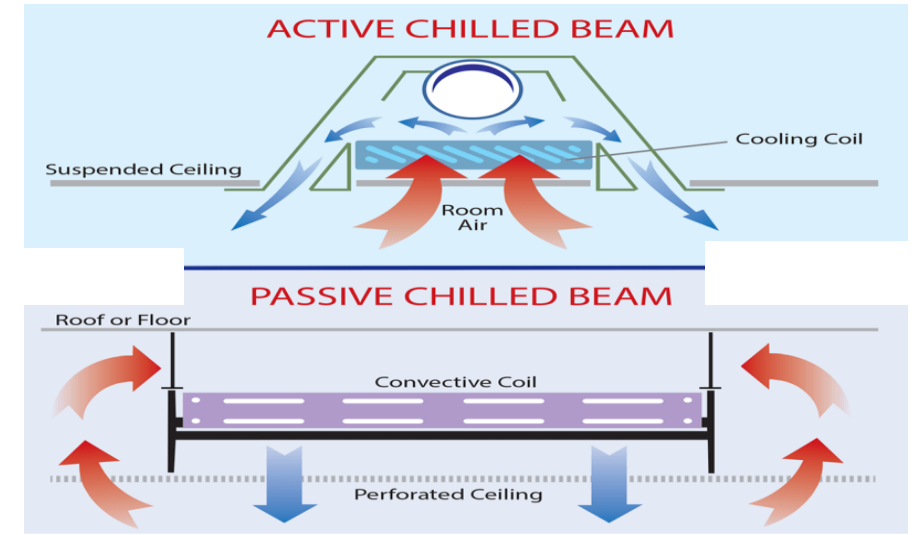
Preferred mixing circuit trim of Radiant Element / Convective Beam Temperature

Black-Bulb Control Philosophy preferred for radiant elements

Prime RH & 'Condensation Margin' Validation Testing (Simulated Latent Gains)

Verification of Step-Change load response (Morning Occupation etc)

Thermographic verification of balance / response to localised radiant gains



Anti Viral Control – Use of Immediate + Long Term Surface Treatment

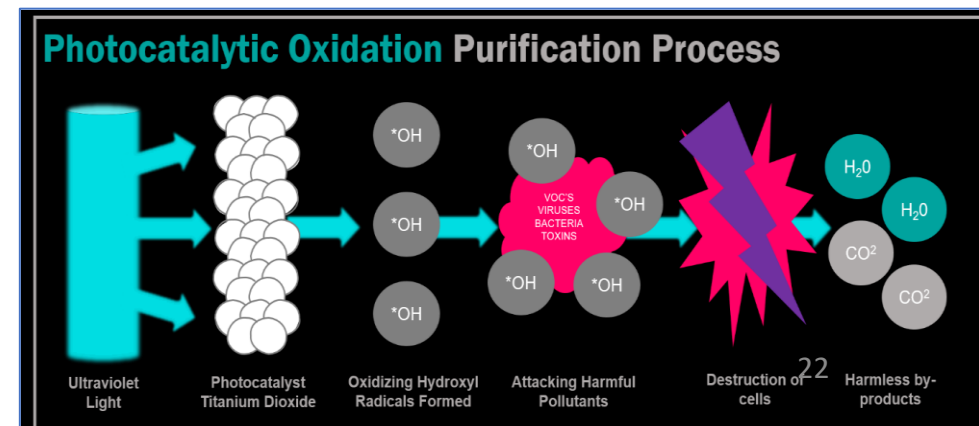
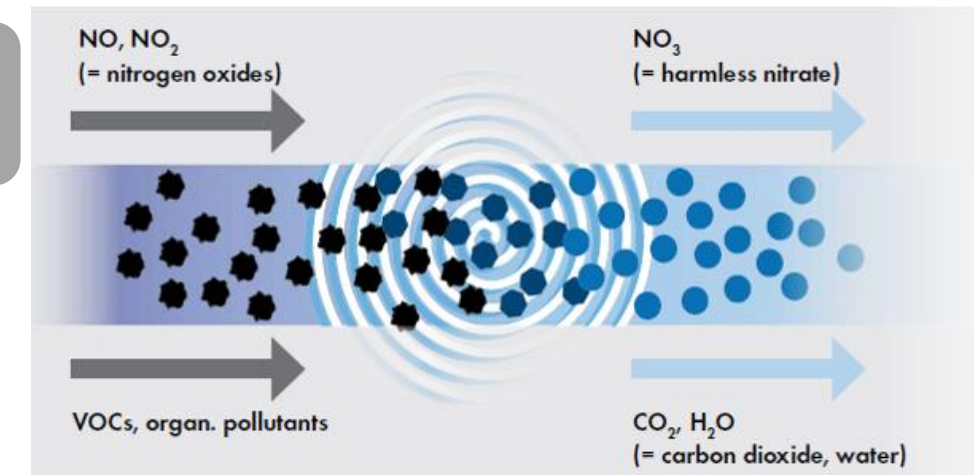
UV Sterilisation

- UV Light Irradiation kills bacteria, viruses & mould. Immediate benefit only at time of deployment

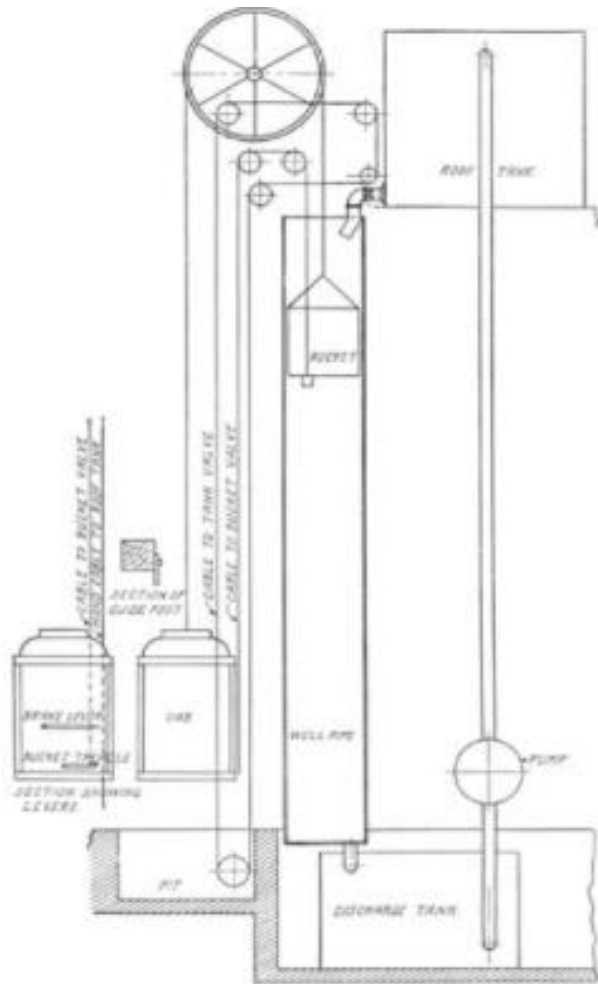


Photocatalytic Oxidation

- UV reacts with Catalyst (TiO_2)
- Forms reactive short-lived oxidising Hydroxyl Radicals (disinfect, sterilise, de-oderise)
- Fight pathogenic & non-pathogenic microorganisms.
- Hydroxyl radicals eliminate bacteria, mould, fungi, viruses, dust mites, allergens & harmful VOCs.
- O_2 molecules transformed to Ozone & Superoxide ions.



Vertical Transportation



Improved ambience of traditionally grim 'escape stairs' + use of passive structural cooling in stairwells encourages avoidance of lifts.

Supplementary gravity waste water powered / water tank counter-balance assisted lift for non-peak hours. (Proposed adaptation of patents by William Hale 1869 !)

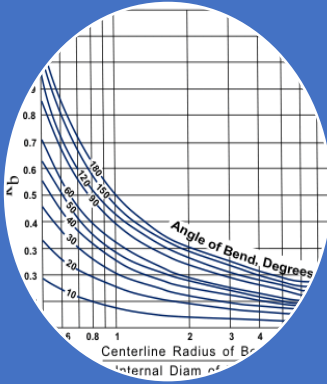
General use of latest generation direct-drive lifts with regenerative braking. Reduce highest speeds outside peak hours to reduce piston effect losses.

High grade thermal insulation of motor rooms / selective heat removal from motors & controllers to limit cooling requirements. Avoid traditional HK poor design simultaneous ventilation & high cooling loads for motor rooms !!

Plumbing



Storage tanks on-all floor - passive use of all available mains pressure to highest possible floors (parallel boosted feeds to maintain minimum reserves)



Optimised gravity water distribution - low loss pipework & plumbing fittings



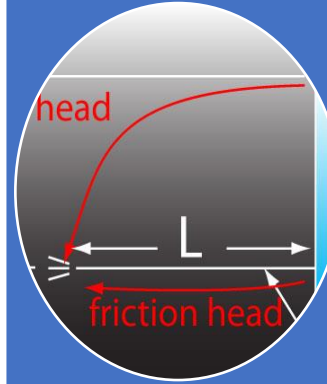
Variable speed pumping to higher floors / upsized tanks to allow time-of day / tariff aligned operation & load shedding.



Auto-taps, aerated discharge, low flow shower nozzles etc.



Instantaneous hot water systems - no hot water storage or circulation UNLESS PV pumped thermal solar hot water proven preferable to PV in available collector area.



MVAC condensate biased to sterilised cooling tower use / direct flushing use at highest available floors via optimised gravity feeds.



Local sea water source considered for flushing water IF energy input proven less than proven WSD site-specific levels.

Reduce Usage, Optimise carbon-impact of source selection, recycle, use gravity / recover energy.

Drainage – Minimise Volumes, Maximise value

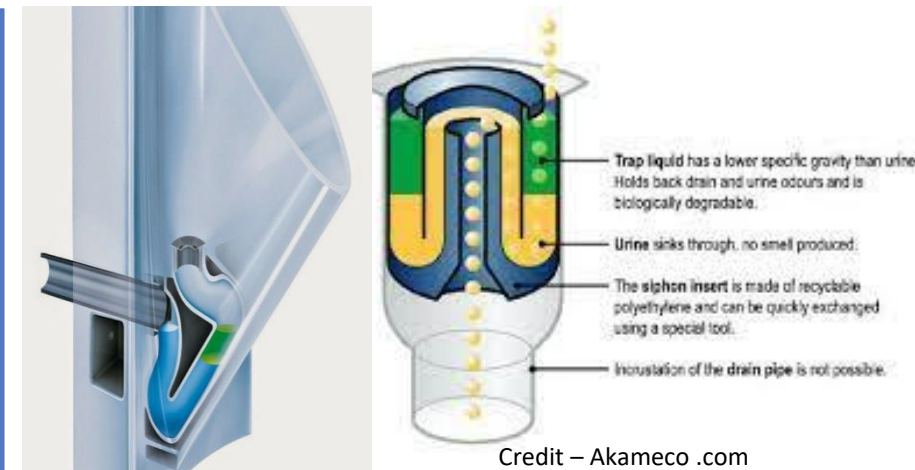
Storage tanks for grey water/ rainwater & condensate at strategic floors to maximise potential energy value / avoid pumps

Waterless urinals. (Provision for recirculating grey water filtration – ethical issues!)

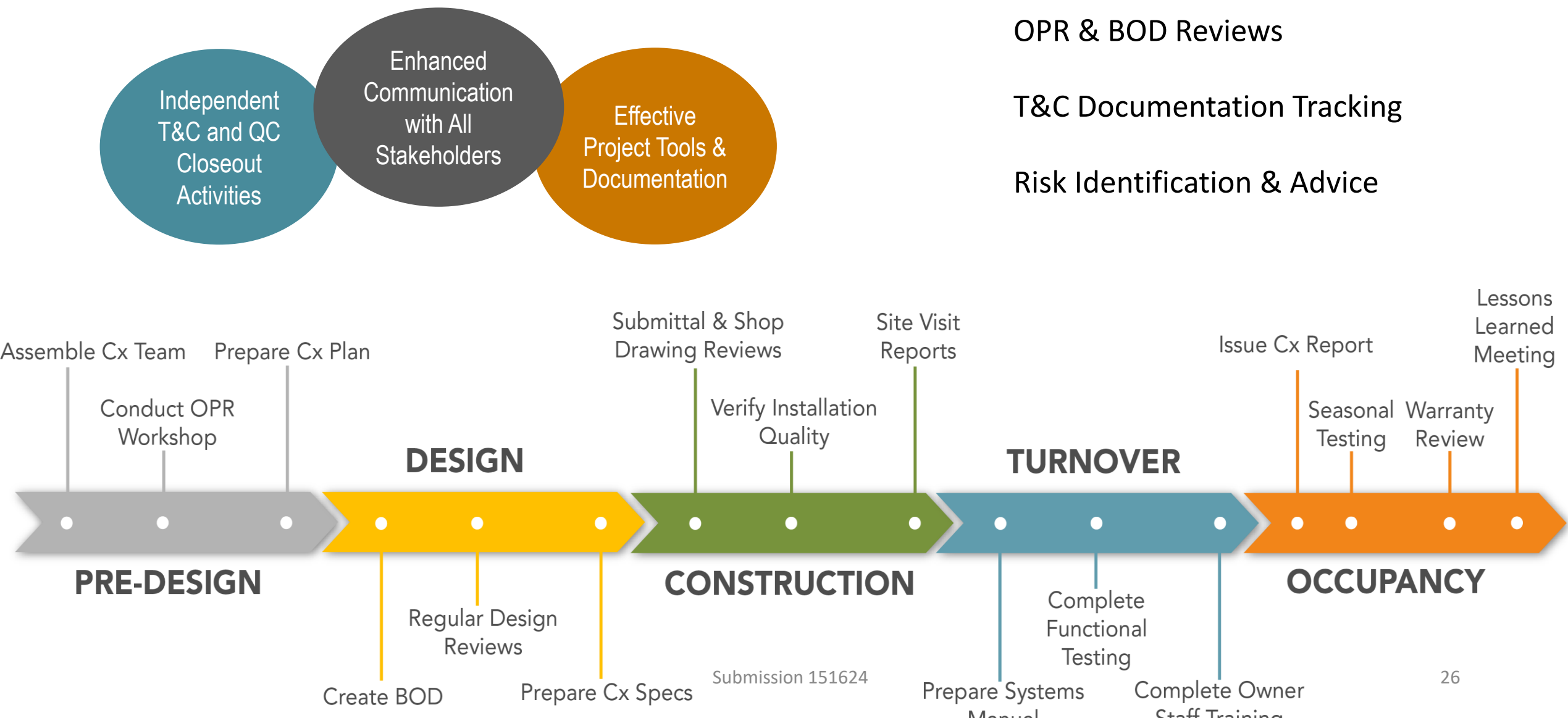
High Floor waste water / PAU condensate collection as power source for baseload (non-peak hour) counterbalanced passenger lift

MVAC condensate biased to sterilised cooling tower use / direct flushing use at highest available floors via optimised gravity feeds.

CT bleed, grey water recycling + rainwater for irrigation / flushing use IF study concludes net carbon benefits against site-specific impact of mains water.



Sequenced T&C Management Approach Vital to Lifecycle Performance



Selecting & Specifying T&C Protocols

Contract development of T&C Protocols:

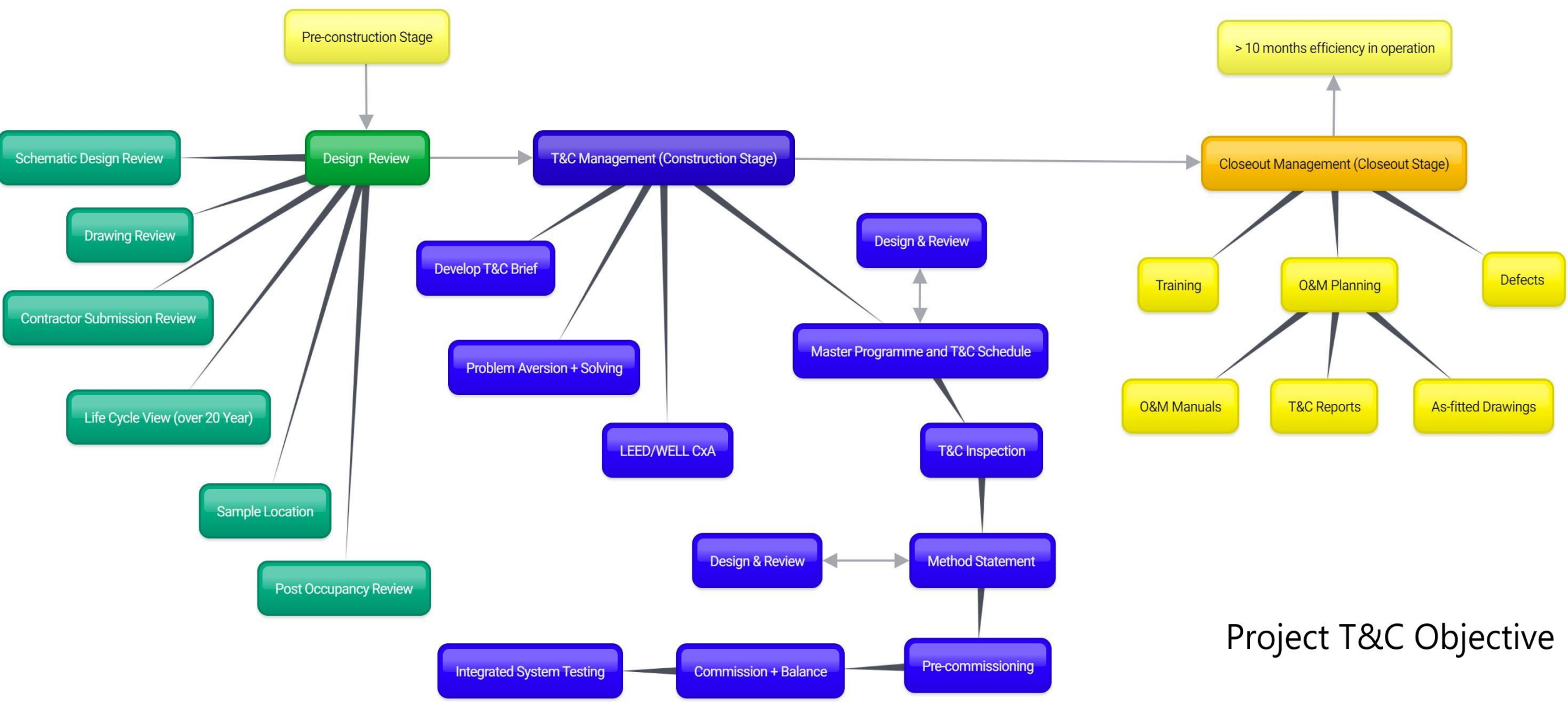
- Code compliant Pre-commissioning, Proportional Balance & Integrated tests.
- T&C Defined Tasks aligned with clear methodology MEP BMS
- LEED / WELL / BEAM Methodology & Protocols
- Optimised bespoke Manufacturer Procedures - Chillers etc
- Site-specific Integrated System / Performance Trials
- Into-Service Efficiency Trials & Optimisation – TWO Cooling Seasons



Submission 151624



Proposed Whole-Project Span of T&C Management

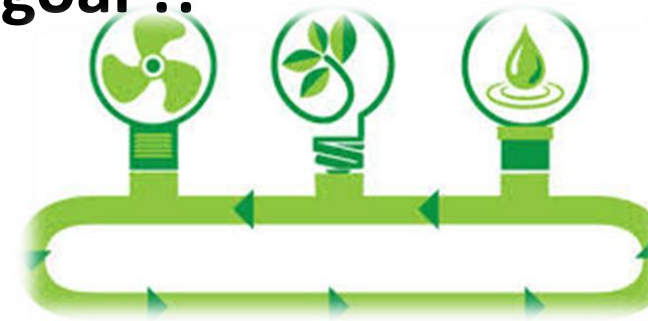


Project T&C Objective

Post-Occupancy Energy Efficiency Tracking –pre-requisite for Building Management Organisation & FM

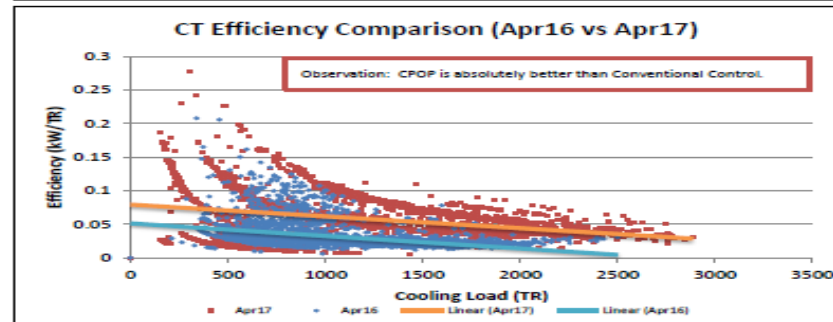
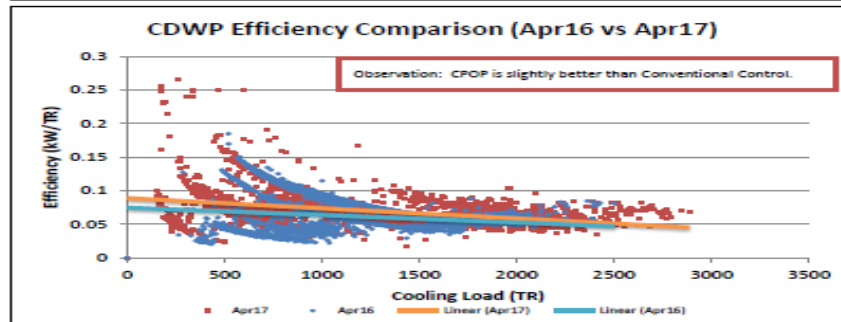
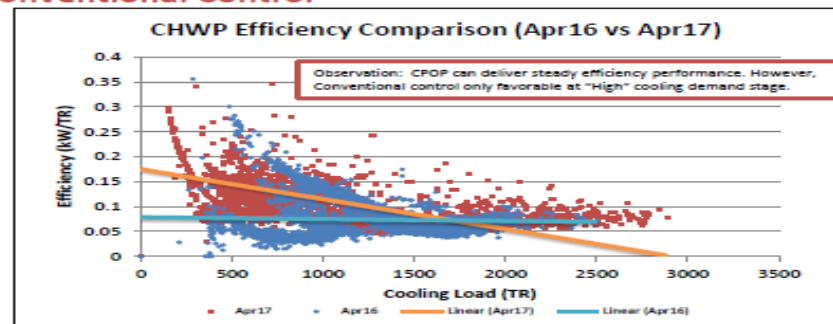
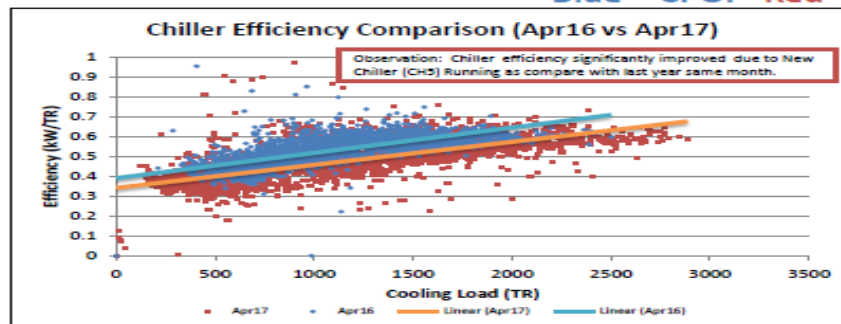
>30% Impact and fastest route to carbon neutrality ahead of 20 year goal !!

Post-Occupancy Continuous Commissioning as Core Operating Strategy - NO EXCUSES !



Chiller Plant Efficiency – Apr

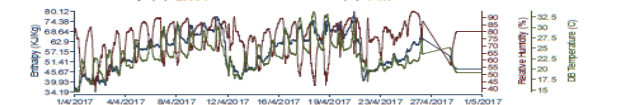
Blue = CPOP Red = Conventional Control



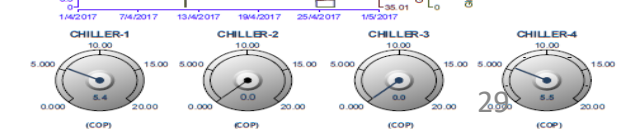
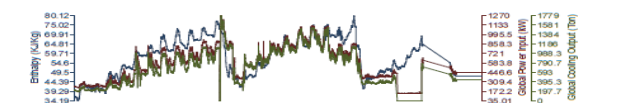
FACILITY MONTHLY ENERGY REPORT

Month of Report 16/05/2017 14:45:52

Ambient DB Temp (C) 23.04 Ambient RH (%) 74.9



GLOBAL CHILLER PLANT PERFORMANCE



Submission 151624

29

Summary and Conclusion

Practical solutions
proposed with lifecycle
outlook

Hybrid re-build / recycle
approach to structure

Services-dominated
functional architecture

Stakeholders locked in to
REPAYMENT of embedded
carbon

Disruptive intent to
challenge statutory bodies
and scheme of control
electricity where opposing
community sustainability

Innovation particularly for
off-site PV power delivery
and micro-climate cooling
methodology