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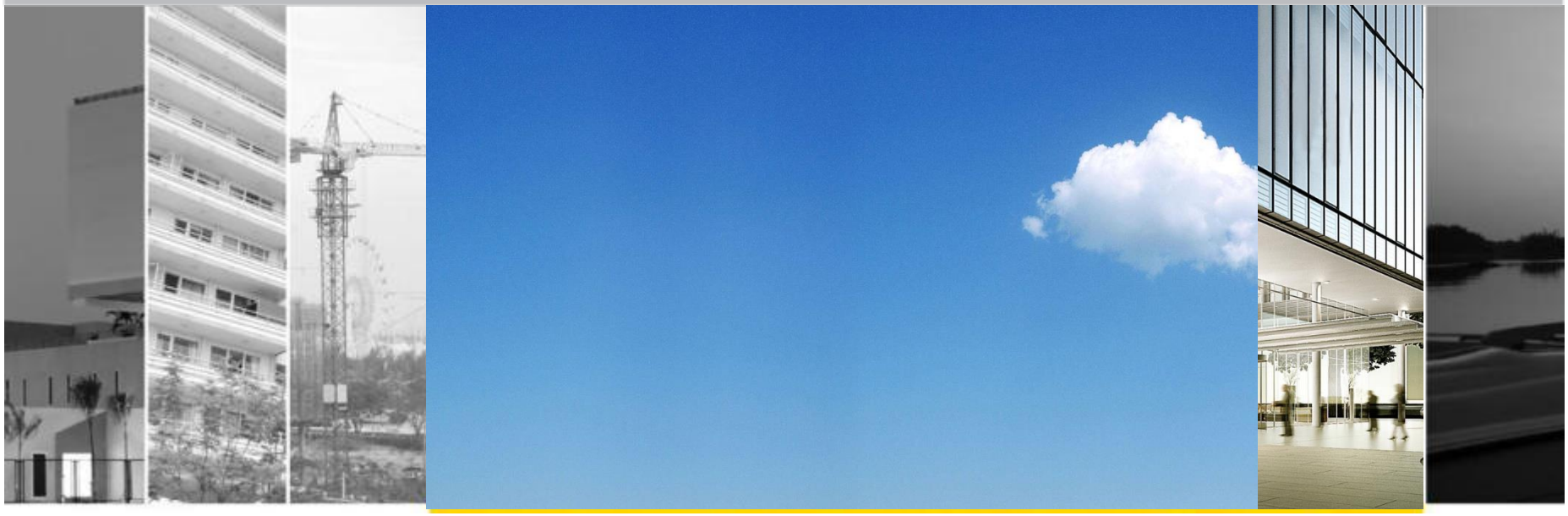

Key Performance Indicators …

Air Quality, Energy, Water, Light, Lifts, Internet, People.

March, 2017

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Indochine Engineering

Leading multi-discipline engineering consultancy (MEP/C&S) in South East Asia

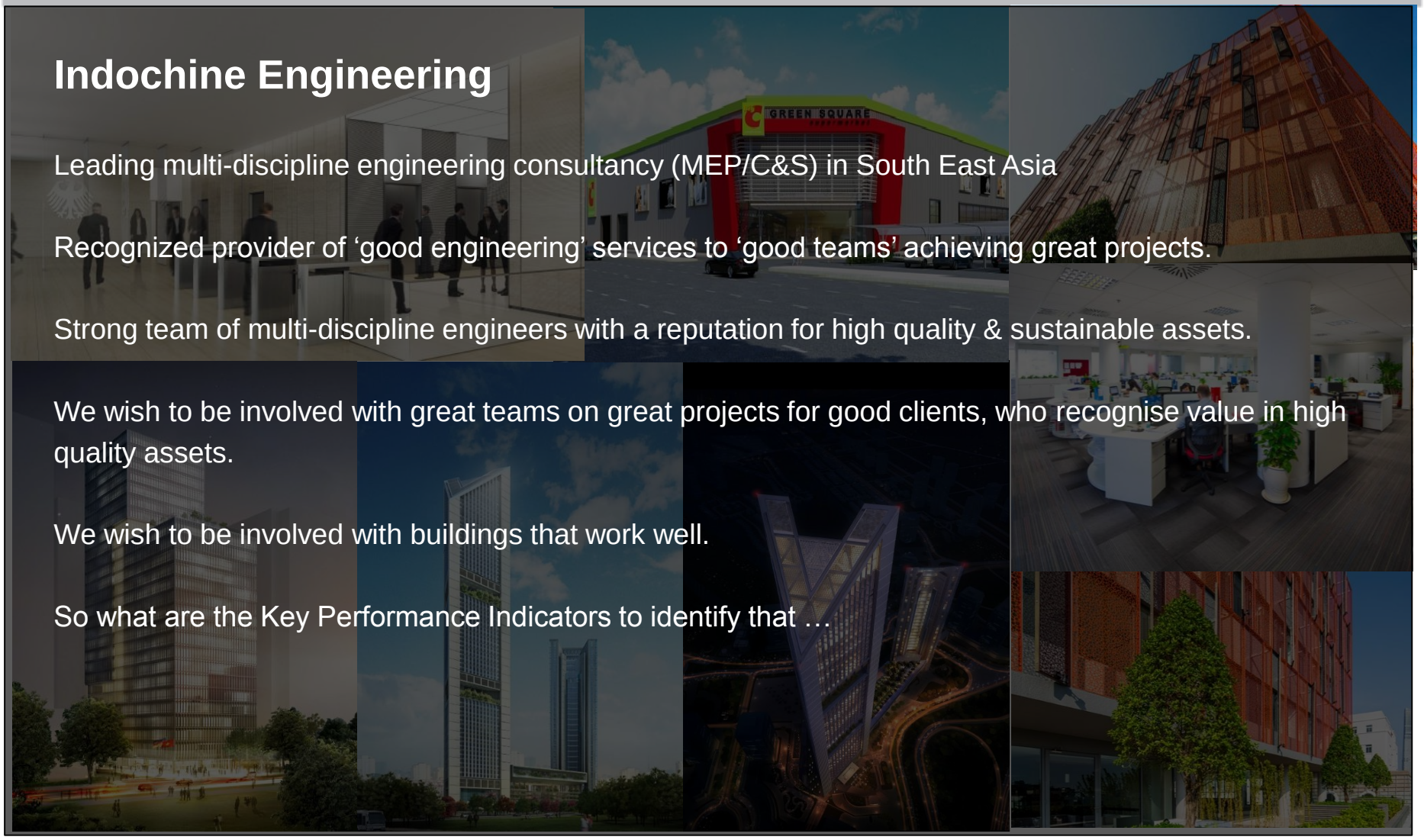
Recognized provider of ‘good engineering’ services to ‘good teams’ achieving great projects.

Strong team of multi-discipline engineers with a reputation for high quality & sustainable assets.

We wish to be involved with great teams on great projects for good clients, who recognise value in high quality assets.

We wish to be involved with buildings that work well.

So what are the Key Performance Indicators to identify that …



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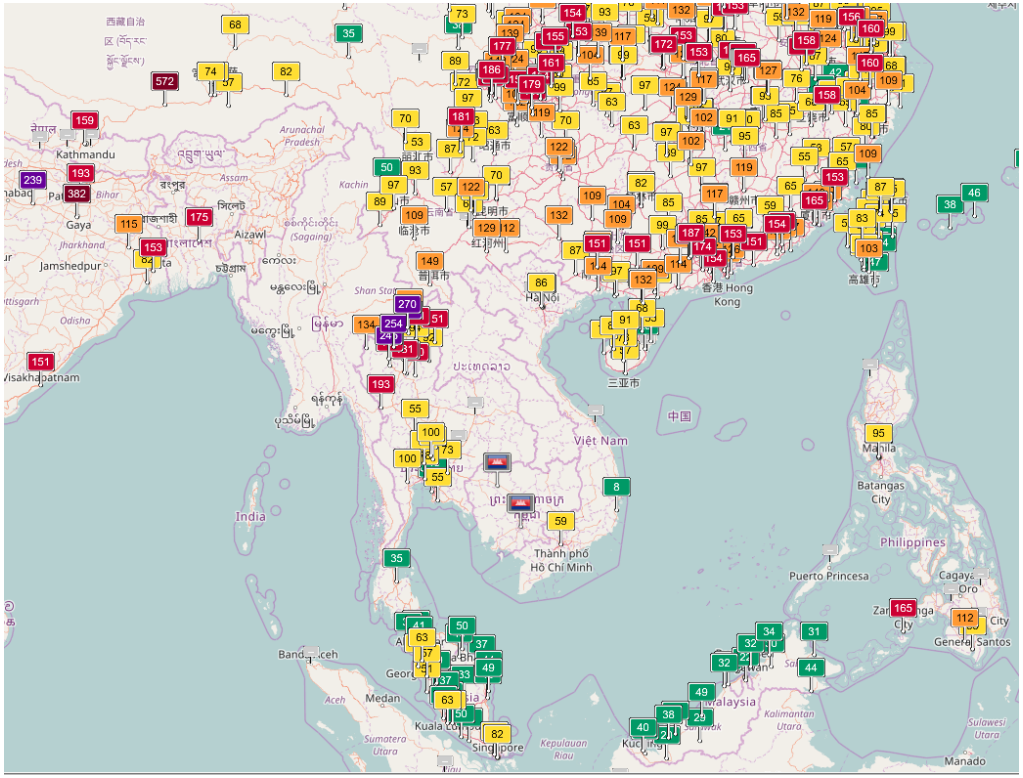
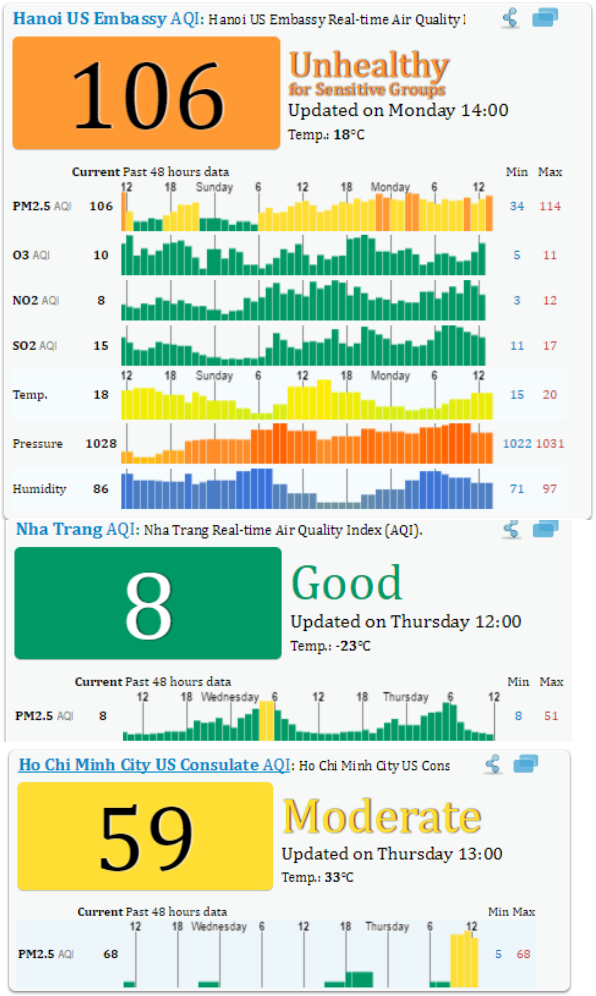
Air Quality

- Overview AQI





Source: http://aqicn.org/city/vietnam/ho-chi-minh-city/us-consulate/

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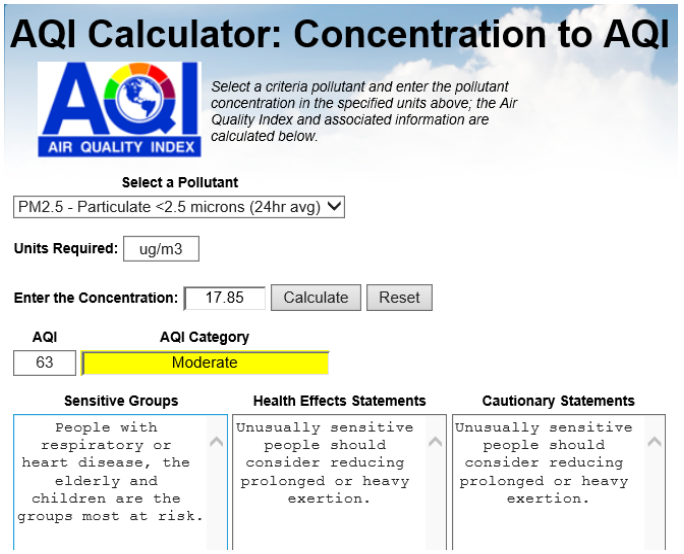
Air Quality

$$I_p = [(I_{hi}-I_{low})/(BP_{hi}-BP_{low})] (C_p-BP_{low})+I_{low}$$

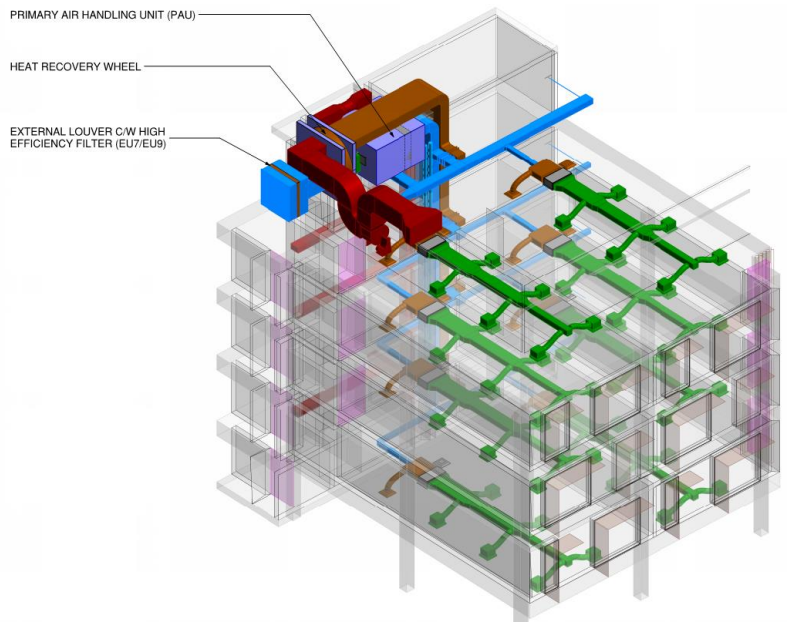
- The AQI is an index for reporting daily air quality, runs from 0 to 500.
- The purpose of the AQI is to help you understand what local air quality means to your health.
- The higher the AQI value, the greater the level of air pollution and the greater the health concern.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.



Air Quality

- Central air system with heat wheel and filtration



Recirculating air system

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Air Quality

Minimum Efficiency Reporting Value (MERV) is a standard that rates the overall effectiveness of air filters. Higher value MERV rating equates to finer filtration, meaning fewer dust particles and other airborne contaminants can pass through the filter.

Filter Comparisons (non-HEPA)				
These comparisons of filter rating systems are only approximate as the test methods are different.				
ASHRAE 52.2	ASHRAE 52.1		EU type	EN 779
MERV Designation	Arrestance	Dust Spot	Designation	Designation
1	<65%	<20%	EU 1	G 1
2	65-70%	<20%	EU 2	G 2
3	70-75%	<20%	EU 2	G 2
4	70-80%	<20%	EU 2	G 2
5	80-85%	<20%	EU 3	G 3
6	85-90%	<20%	EU 4	G 4
7	>90%	25-30%	EU 4	G 4
8	>90%	30-35%	EU 5	F 5
9	>90%	40-45%	EU 5	F 5
10	>95%	50-55%	EU 5	F 5
11	>95%	60-65%	EU 6	F 6
12	>95%	70-75%	EU 6	F 6
13	>98%	80-90%	EU 7	F 7
14	>98%	90-95%	EU 8	F 8
15	99+%	>95%	EU 9	F 9
16	99+%	>95%	EU 9	F 9
				EN 1822 *
16	99+%	>95%	EU 10	H10
* All EN 1822 tests at MPPS H = HEPA; U = ULPA				

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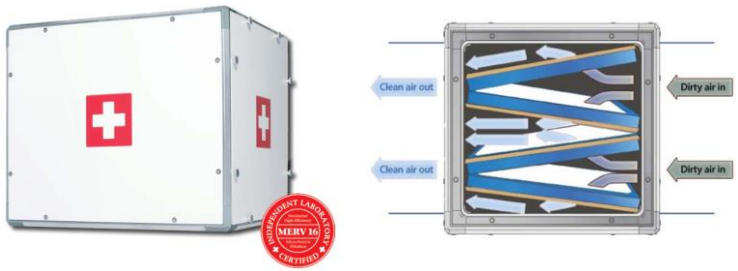
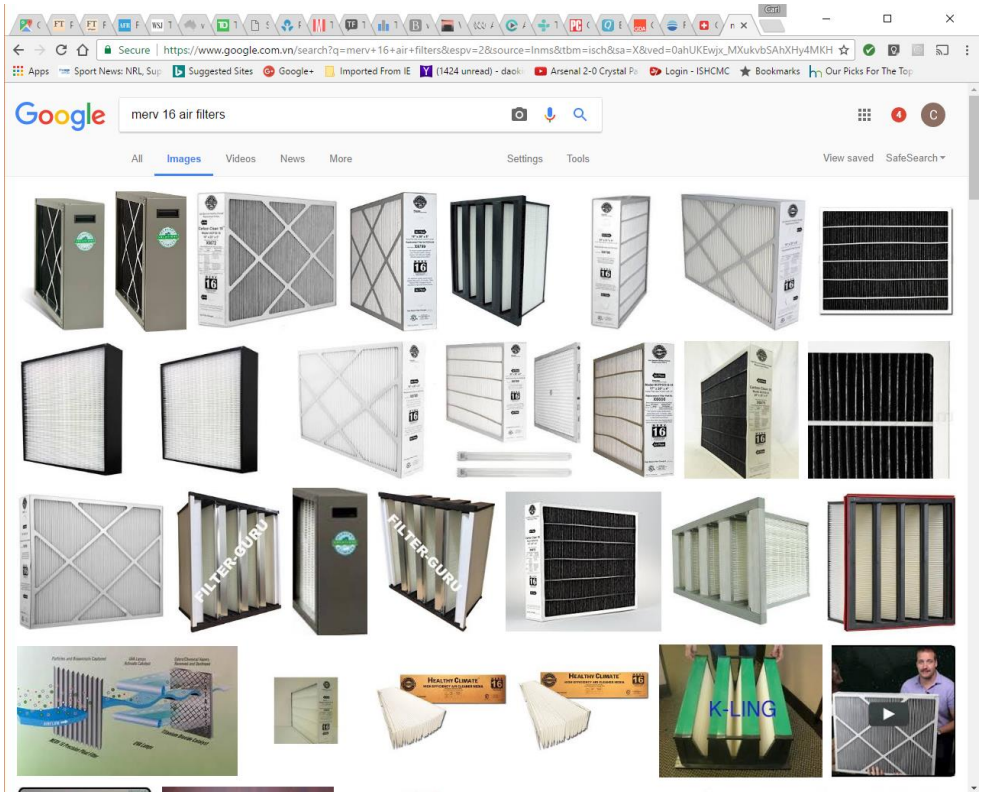
Air Quality

Filter MERV16/ EU9

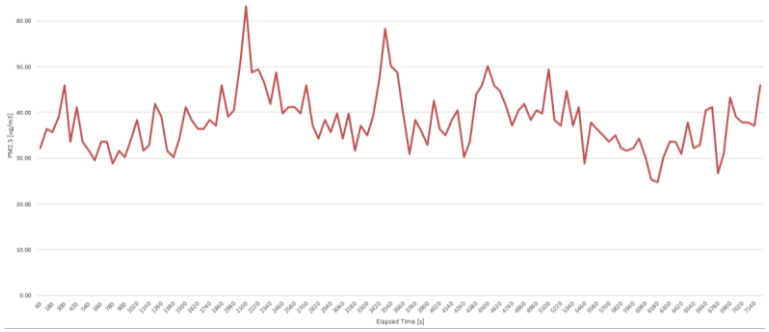


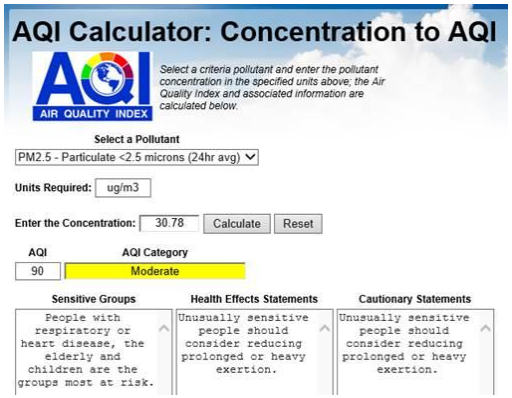


Air Quality

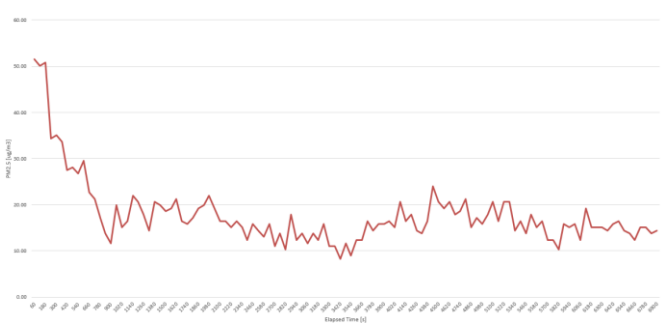
- Performance in ICE office and RMIT Hanoi

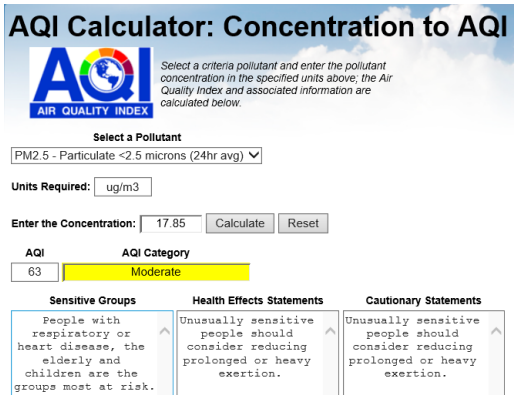
ICE OFFICE





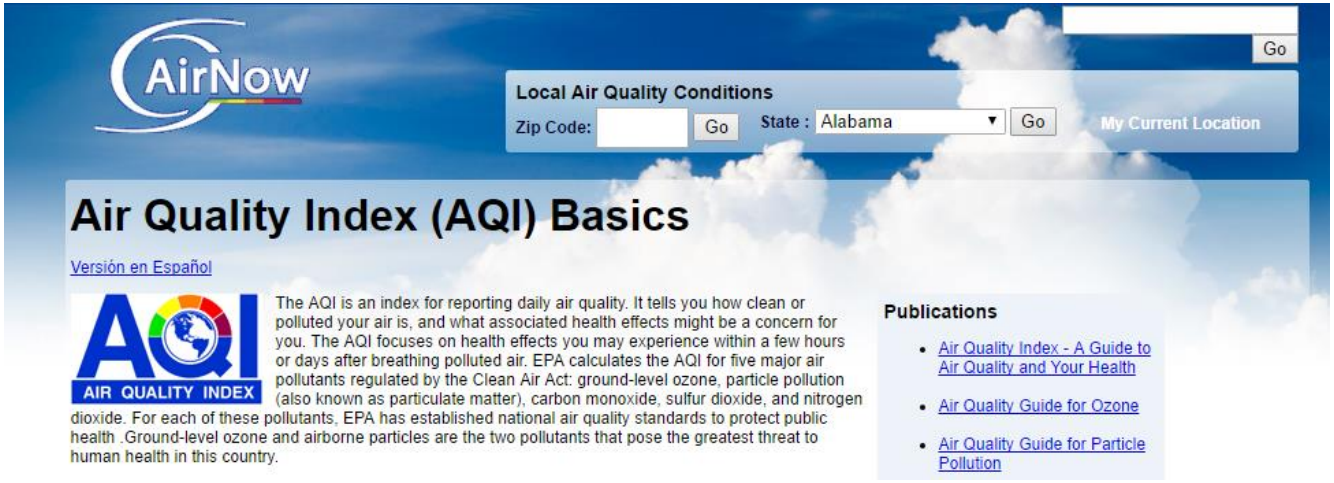
RMIT Hanoi





Air Quality KPI

- Have sufficient outside (fresh air) air for dilution of indoor air contaminants (CO2, dust, VOCs, odors)
- Centralise air handling plant (PAUs)
- Utilise heat recovery for energy management
- Modulate outside air based upon CO2
- Filter outside air G3 + EU7 or EU9 (equivalent to Merv 16)
- Target KPI AQI 50 to 100 for standard building and < 50 for leading standard.



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Typical Energy Baselines

Building Type	Building prototype	Energy use intensity [kWh / sqm-yr]	Energy use intensity [MJ / sqm-yr]
Office	Small office Medium office Large Office	103 117 105	372 421 378
Retail	Stand-Alone Retail Strip Mall	151 179	545 646
Education	Primary School Secondary school	151 126	545 452
Healthcare	Outpatient healthcare Hospital	396 373	1,424 1,341
Lodging	Small Hotel Large Hotel	210 441	756 1,588
Warehouse	Non-refrigerated	61	218
Food service	Fast-food Restaurant Sit-Down Restaurant	1,640 1,044	5,904 3,758
Apartment	Mid-rise Apartment High-rise Apartment	130 129	468 466

Source: ASHRAE Standard 90.1-2010 Final Determination Quantitative Analysis

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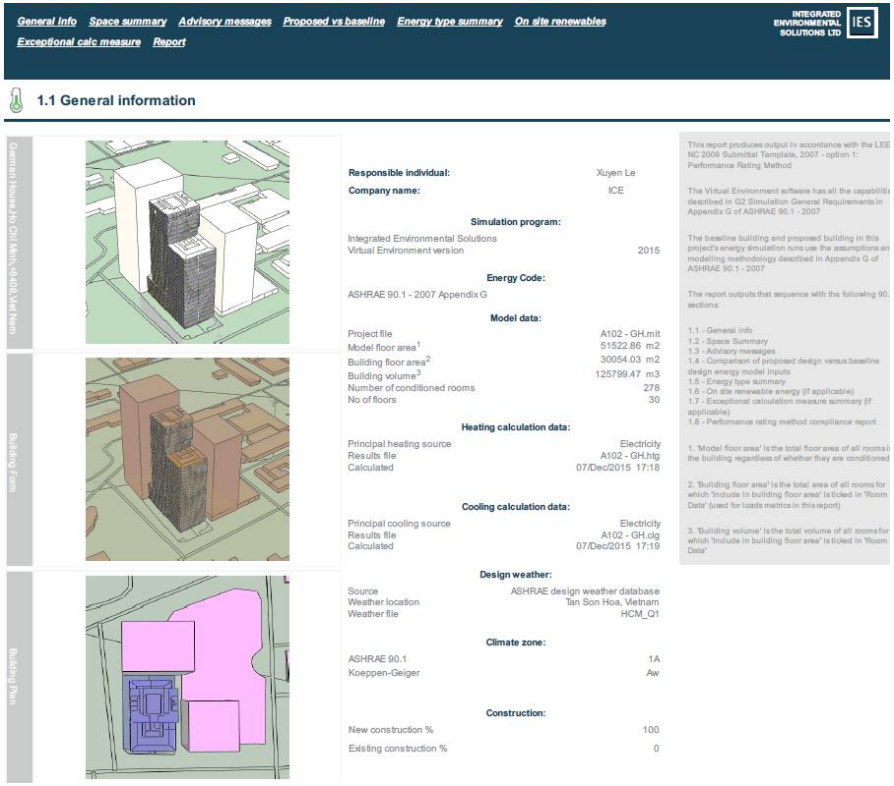
Energy Calculation



General info | Space summary | Advisory messages | Proposed vs baseline | Energy type summary | On site renewables | Exceptional calc measure | Report

INTEGRATED ENVIRONMENTAL SOLUTIONS LTD

1.1 General information

Responsible individual: Xuyen Le
Company name: ICE

Simulation program:
Integrated Environmental Solutions
Virtual Environment version 2015

Energy Code:
ASHRAE 90.1 - 2007 Appendix G

Model data:
Project file A102 - GH.mit
Model floor area[1] 51522.86 m2
Building floor area[2] 30054.03 m2
Building volume[3] 125799.47 m3
Number of conditioned rooms 278
No of floors 30

Heating calculation data:
Principal heating source Electricity
Results file A102 - GH.htg
Calculated 07/Dec/2015 17:18

Cooling calculation data:
Principal cooling source Electricity
Results file A102 - GH.clg
Calculated 07/Dec/2015 17:19

Design weather:
Source ASHRAE design weather database
Weather location Tan Son Hoa, Vietnam
Weather file HCM_Q1

Climate zone:
ASHRAE 90.1 1A
Koeppen-Geiger Aw

Construction:
New construction % 100
Existing construction % 0

This report produces output in accordance with the LEE NC 2009 Submittal Template, 2007 - option 1: Performance Rating Method

The Virtual Environment software has all the capabilit described in G2 Simulation General Requirements in Appendix G of ASHRAE 90.1 - 2007

The baseline building and proposed building in this project's energy simulation runs use the assumptions an modelling methodology described in Appendix G of ASHRAE 90.1 - 2007

The report outputs that sequence with the following 90. sections

1.1 - General Info
1.2 - Space Summary
1.3 - Advisory messages
1.4 - Comparison of proposed design versus baseline design energy model inputs
1.5 - Energy type summary
1.6 - On site renewable energy (if applicable)
1.7 - Exceptional calculation measure summary (if applicable)
1.8 - Performance rating method compliance report

1. 'Model floor area' is the total floor area of all rooms i the building regardless of whether they are conditioned

2. 'Building floor area' is the total area of all rooms for which 'Include in building floor area' is ticked in 'Room Data' (used for loads metrics in this report)

3. 'Building volume' is the total volume of all rooms for which 'Include in building floor area' is ticked in 'Room Data'

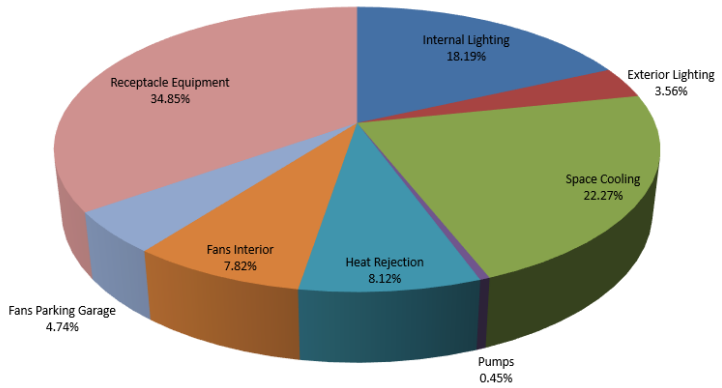
Gamuda Heroes Ho Chi Minh, 64/08, Viet Nam

Building Form

Building Plan

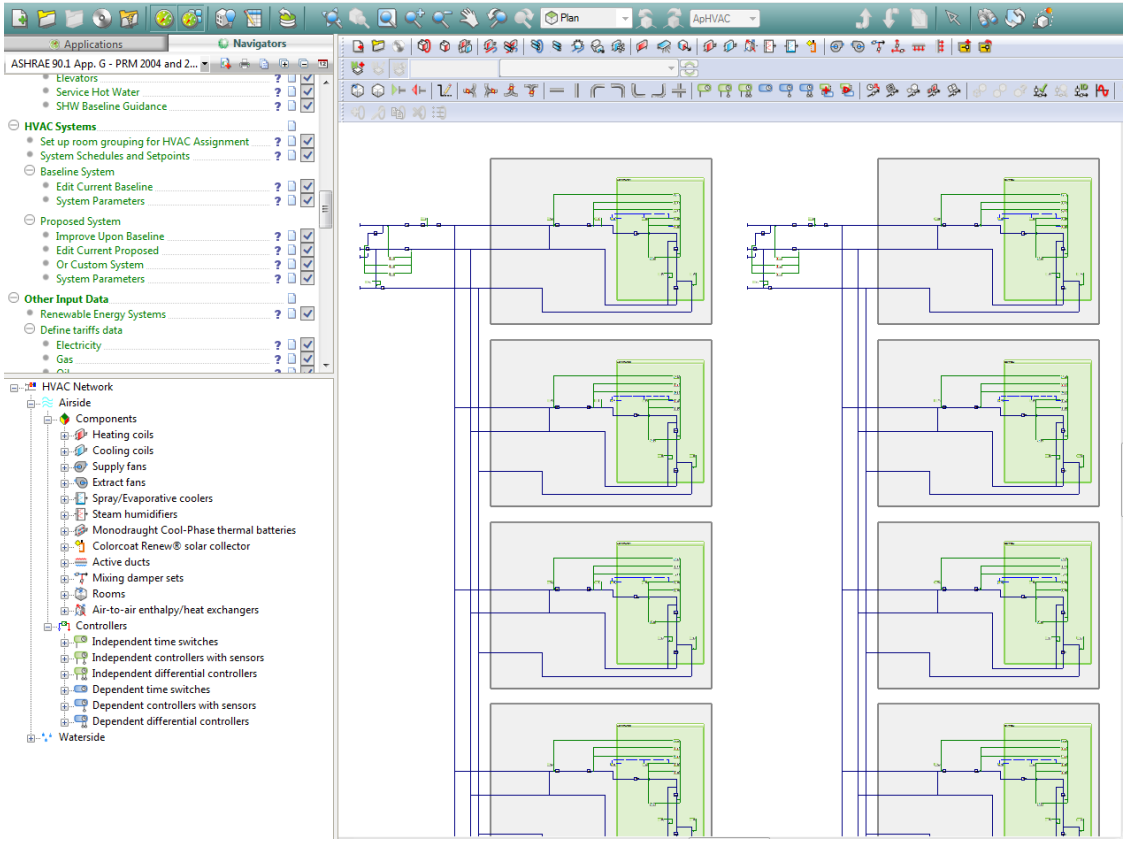
Annual Component Energy

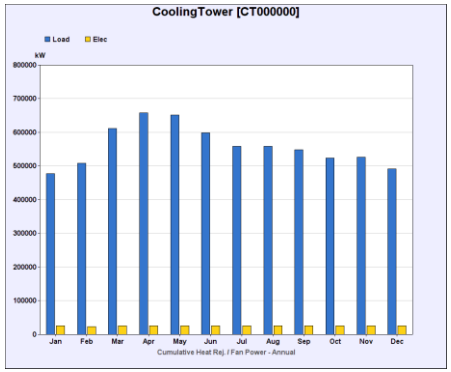
Category	Internal Lighting	Exterior Lighting	Space Cooling	Pumps	Heat Rejection	Fans Interior	Fans Parking Garage	Receptacle Equipment	Total
kWh	968,827	189,442	1,186,115	24,084	432,813	416,810	252,505	1,856,592	**5,327,188**

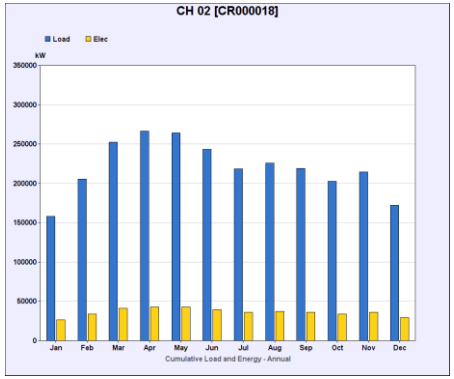


INDOCHINE ENGINEERING

Energy Calculation







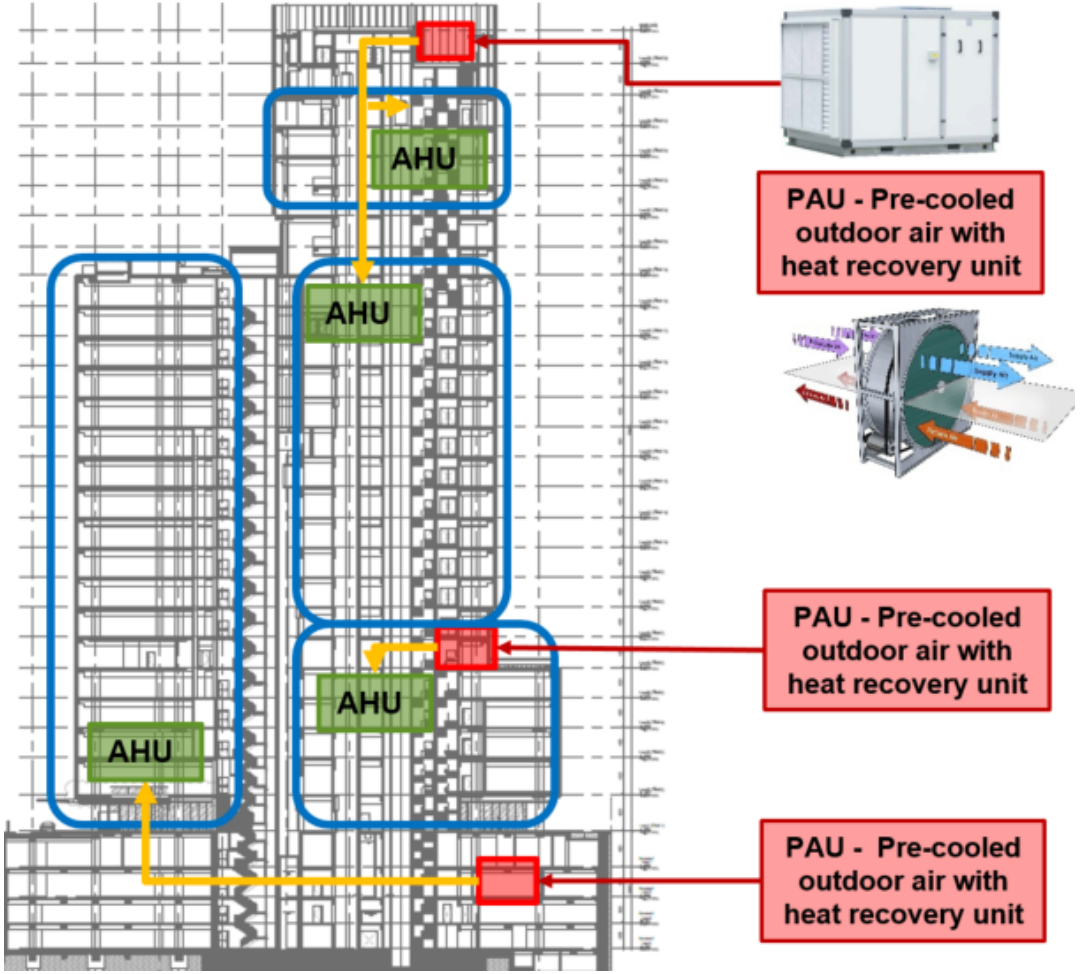
Ventilation – Heat recovery

Function

Transfers heat and humidity from incoming fresh air to outgoing exhaust air.

Savings

- Add 3% energy saving
- Payback in 0 years



High Efficiency Cooling

Function

Provides cooling with minimal energy use by employing the correct cooling system. Oversized equipment is very common is hot climates.

Benefits

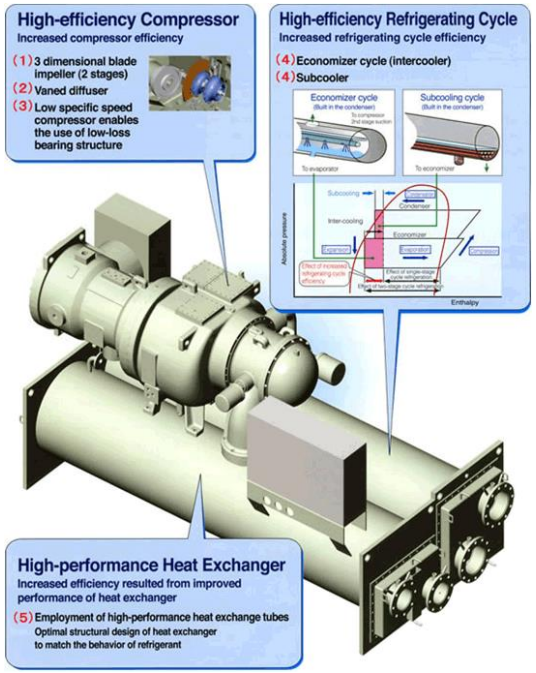
- Equipment spends most of the operation time within most efficient operating ranges.
- Reduced operation costs.

Drawbacks

- Higher level of maintenance may be required on larger projects.

Savings

- Adequately sizing equipment, especially chillers reduces energy consumption.
- Oversized equipment can use up to 30% more energy than adequately sized equipment.



Pump and AHU Control

Function

Ensures all pumps and AHU operate efficiently during part-load use.

Benefits

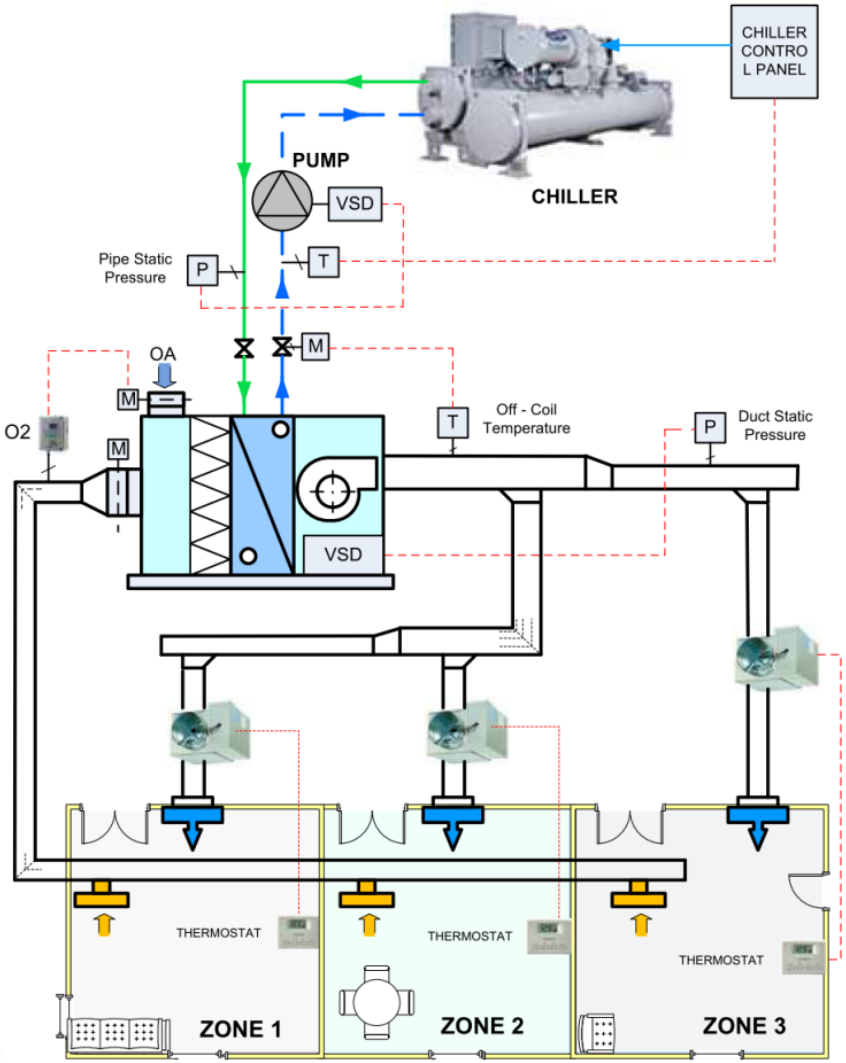
- Significantly reduces pumping and AHU energy.
- Significantly improves part-load performance of all building service systems.
- Improves occupant comfort and process performance.

Drawbacks

- Capital cost, based on the size of the AHU/pump motors.

Savings

- Payback is less than 1 year for large motors, up to 3 years for smaller motors.



BMS

Function

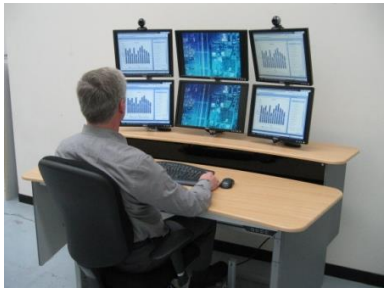
Controls lighting, air conditioning, media, telecoms, security, and other aspects of floors and similar spaces.

Savings

- Additional savings can be achieved with more advanced systems.
- Payback from 1-5 years.

Benefits

- Reduced wasted energy associated with bad habits and operating empty rooms.



Drawbacks

- Maintenance competency required.

Energy KPI

- Start with an economical design ….
- Manage solar and thermal loads
- Monitor and control outside (fresh) air
- High efficiency plant
- Efficient system integration
- Modern building management system
- Test & commission to verify
- Energy KPI – 30% below baseline … or nominally 150 to 170 kWh/m2/annum (office) … US$2.00/m2/month

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Water

Water consumption standard (l/person/day)

Description	BSRIA	Singapore (*)	Myanmar	TCVN 4513-1998	IHG	Accor
Houses						
Economic, local authority	120			100-150		
Medium, privately owned	120			150-200		
Luxury, privately owned	120			350-400		
Flats						
Economic, local authority	120	150	250	100-150		
Medium, privately owned	120	150	250	150-200		
Luxury, privately owned	120	150	250	350-400		
Offices						
Offices with canteen	45	45	49	10-15		
Offices without canteen	45	35		10-15		
Hotels						
2 star hotels	135	135		150-200		
5 star hotels	200		605 (l/guestroom)	250-300	560	550 (l/guestroom)

(*) Handbook on Application for water supply – Water supply Department Singapore

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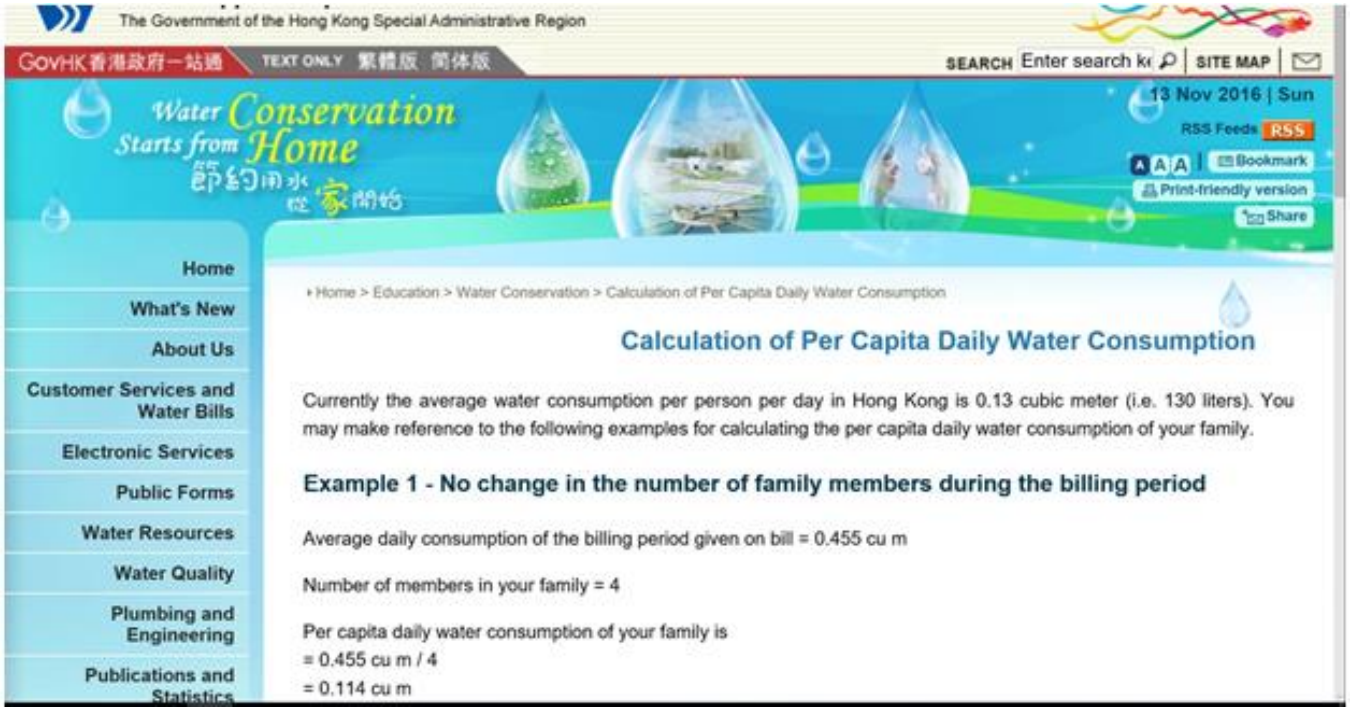
Water

Water consumption in HK

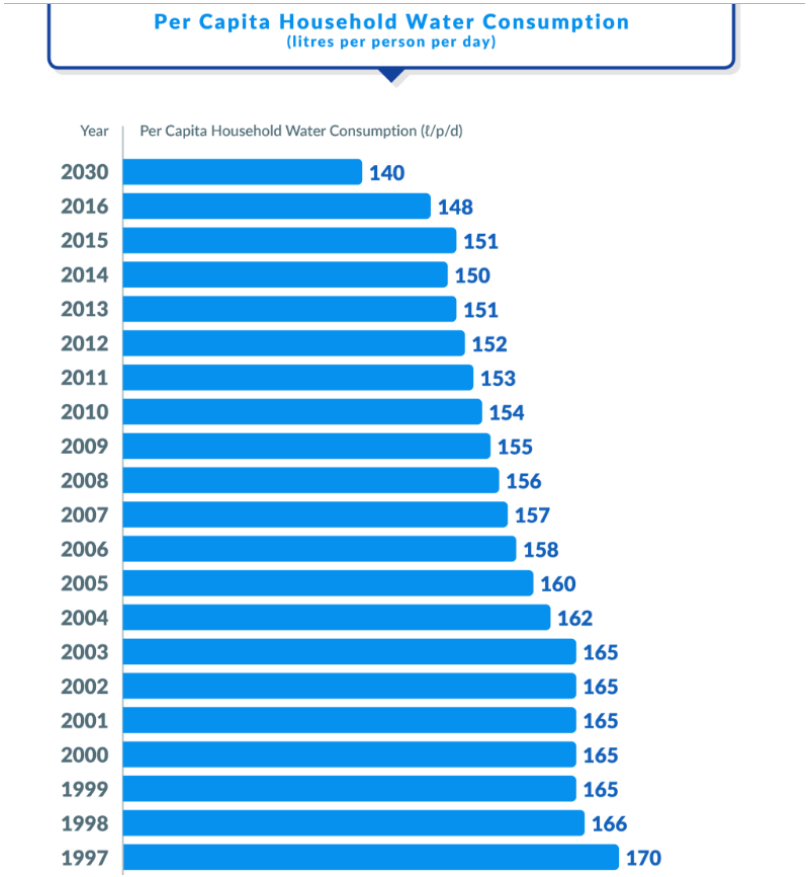
http://www.wsd.gov.hk/en/education/water_conservation/calculation_of_per_capita_daily_water_consumption/index.html



Water

Water consumption in Singapore

https://www.pub.gov.sg/watersupply/singaporewaterstory



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Water

Water consumption – In DaNang - Vietnam

http://www.iges.or.jp/files/research/scp/PDF/20151118/4_Nguyen_Mai.pdf

IV.CONCLUTIONS AND RECOMMENDATIONS

1. Conclusions

*** Water supply**

- The percentage of households, public buildings used tap water is high >95%.

- Average water use depends on the level of appliances and water use habits. Average water use counted for the whole city is 146 l/person/day.

- Most of data shows amount of water use in households and public buildings less than standard TCVN 33-2006, TCVN 4513-1988.

- Diagram of water supply that used in households is mostly the same, it is the water system with roof tank and in public buildings is Storage tank – Pum – Tank

*** Water drainage**

- The percentage of wastewater connected to sewer network of the city is low.(<50%)

- Public buildings: the amount of sanitary equipment is still less than the demand.

Water

Water consumption – From New Saigon Apartment (typical 3Bedroom Apart.)

No. of people: 4 persons

Water consumption per day: 117 l/p/d

Tiền nước sử dụng tháng: 03/2016 (*Water fee*)

Có 04 nhân khẩu được sử dụng trong định mức. Chi tiết nh

Chỉ số cũ (*Previous No*)	Chỉ số mới (*Present No*)	Lượng nước (m^3)	Đơn giá (đ/m^3) (Đã bao gồm VAT 5%)
01043	**01057**	**14**	
Định mức 1 (***First level***)		14	5,565
Định mức 2 (***Second level***)		-	10,710
Ngoài định mức (***Out of level***)		-	11,970
Tổng cộng tiền nước (***Total***)			

Quý khách hàng còn nợ các khoản tính đến ngày *31/03*

(The debts of last month)

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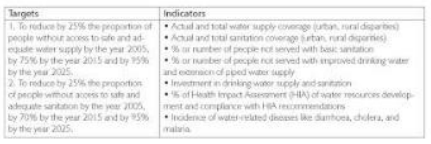
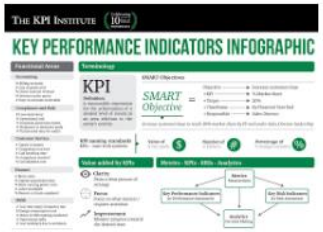
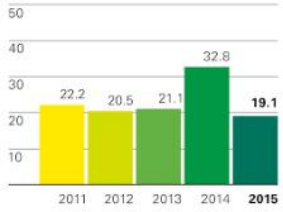
Water KPI

- Most ‘standards’ are conservative ….
- Storage is different than flow (maybe the latter is more important)
- Use water efficient appliances
- Consider grey water recycling
- Modern water management system
- Test & commission to verify
- Water KPI – allow 150 l/p/d, aim for 120 l/p/d , for res…. 35 l/p/d for offices, excl. process







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Water Quality

Parameter	WHO Standards	EU Standards	CIBSE	QCVN 1:2009/BYT	IHG Desirable Levels
pH	6.5-9.2	6.5-8.5	5.5-9.5	6.5-8.5	7-8
Conductivity (mS/m)	-	400	150	-	400
Chlorides	250	250	400	250	<50
Sulphates	200	250	250	250	<250
Hardness (ass CaCO3)	-	100		300	<100
Magnesium	-	50	50	-	<50
Sodium	250	175	-	200	<50
Potassium	-	12	12	-	<12
Aluminium	-	0.2	0.2	0.2	<0.2
Total Dissolved Solids (TDS)	1000	1500		1000	<500
Nitrates	45	50	50	50	0
Nitrites	-	0.1	0.1	3	0
Ammonium	-	0.5	0.5	3	<0.5
Phenols	0.001	0.0002	0.0002	0.001	0
Organic Chlorine Compounds	-	0.025	-		0
Pesticides	-	0.0001	0.005		0
Iron	0.3	0.2	0.2	0.3	<0.2
Manganese	0.05	0.05	0.05	0.3	<0.05
Copper	0.05	0.05	3	1	<0.05
Zinc	5	0.1	5	3	<0.1
Lead	0.5	0.04	0.5	0.01	0
Cadmium	0.01	0.005	0.005	0.003	0
Total Coliform (bacteria/100ml)	0	0	0	0	0
Total Ecoli (bacteria/100ml)	0	0	0	0	0

Potable water quality standard (ppm) or (mg/l)

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Water Quality

Parameter	City water supply in HCM (From BOO Thu Duc Oct 11th, 2016)	WHO Standards	QCVN 1:2009/BYT
pH	6.6	6.5-9.2	6.5-8.5
Conductivity (mS/m)		-	-
Chlorides	8	250	250
Sulphates	17	200	250
Hardness (ass CaCO3)	22	-	300
Sodium	1.32	250	200
Aluminium	0.53	-	0.2
Total Dissolved Solids (TDS)	80	1000	1000
Nitrates	1.39	45	50
Nitrites	0.039	-	3
Ammonium	0.04	-	3
Phenols	<0.001	0.001	0.001
Pesticides		-	
Iron	0.853	0.3	0.3
Manganese	0.0361	0.05	0.3
Copper	0.00548	0.05	1
Zinc	0.0199	5	3
Lead	0.001	0.5	0.01
Cadmium	<0.0004	0.01	0.003
Total coliform	0	0	0

City water quality in HCMC (ppm) or (mg/l)

Source: http://sawaco.com.vn/

Water Quality HCMC

However, water quality in HCMC is not stable because of:

- Pollution of source water from river

trash from the Nhieu Loc-Thi Nghe, the biggest canal in Ho Chi Minh City. Photo credit: Quang Dinh/Tuoi Tre

- The old piping system

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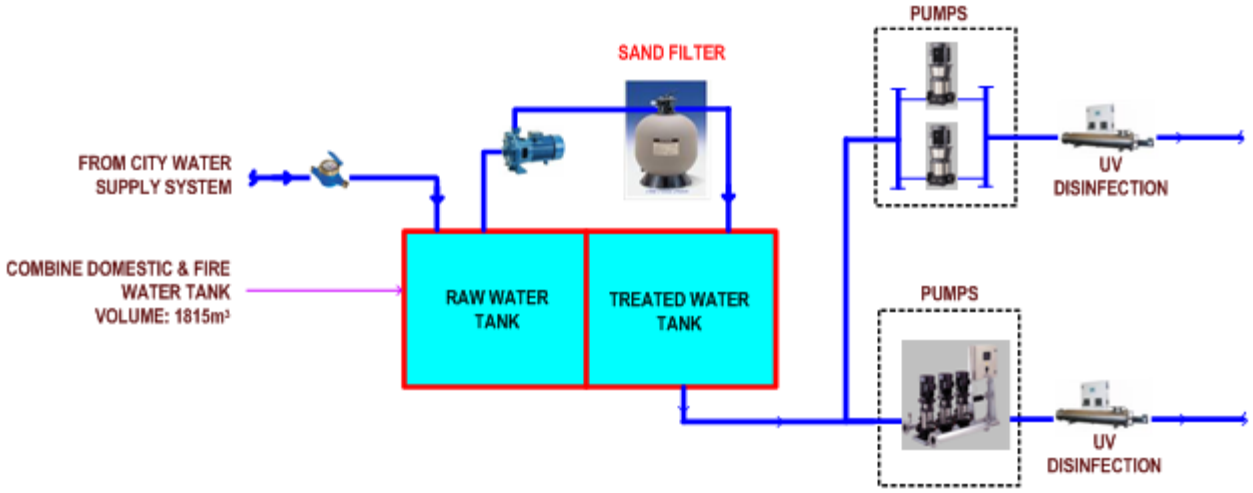
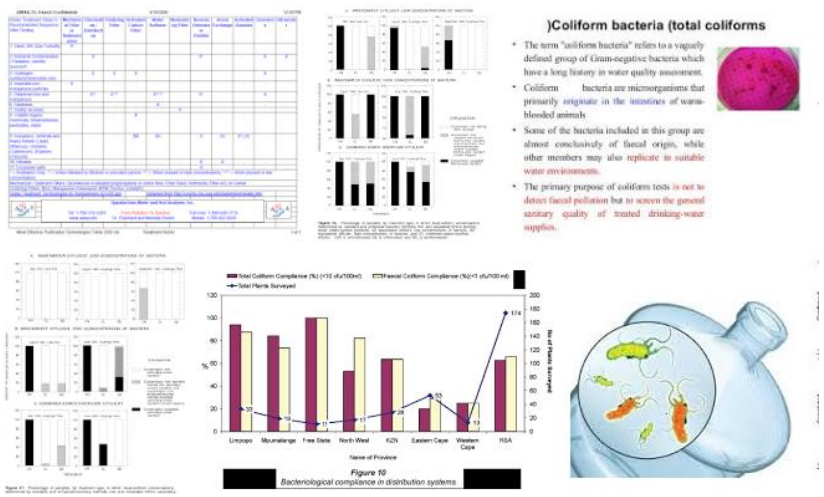
Water Treatment



Water quality after sand filtration and UV disinfection

Water Quality KPI

- Mains water is usually OK, but has slugs of bad water …
- Water treatment requirements are modest
- Maintenance is the problem … and regular testing regime required.
- Test & commission to verify
- Water KPI – Zero total coliforms, and trust in management!

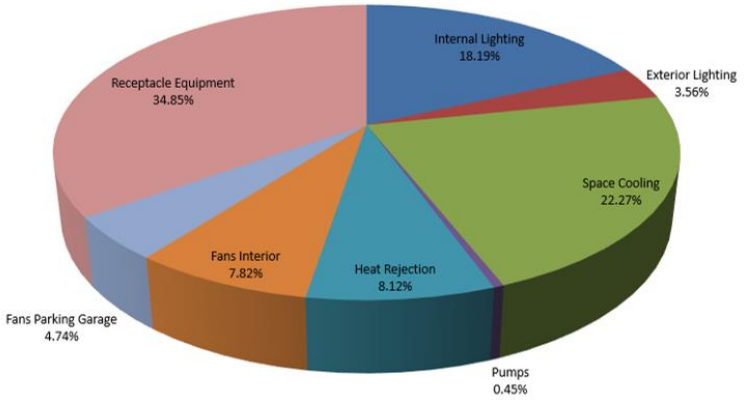


Light

Table 2.12. Mandatory requirements for lighting power density (LPD)

Type of building	LPD (W/m^2)
Offices	11
Hotels	11
Hospitals	13
Schools	13
Commercial and services buildings	16
Apartments	8
Enclosed, in-house, basement car parks	3
Outdoor or open (roofed only) car parks	1.6

LPD from QCVN09-2013



Energy lighting consumption

TABLE 7.1

CIE LAMP COLOUR APPEARANCE GROUPS

Colour appearance group	Colour appearance	Correlated colour temperature, K
1	warm	<3300
2	intermediate	3300≤5300
3	cool	>5300

NOTE: The term 'cool' used throughout this document equates to the colour appearance range designated 'cold' in ISO 8995/CIE S008/E.

Lamp Color Temperature

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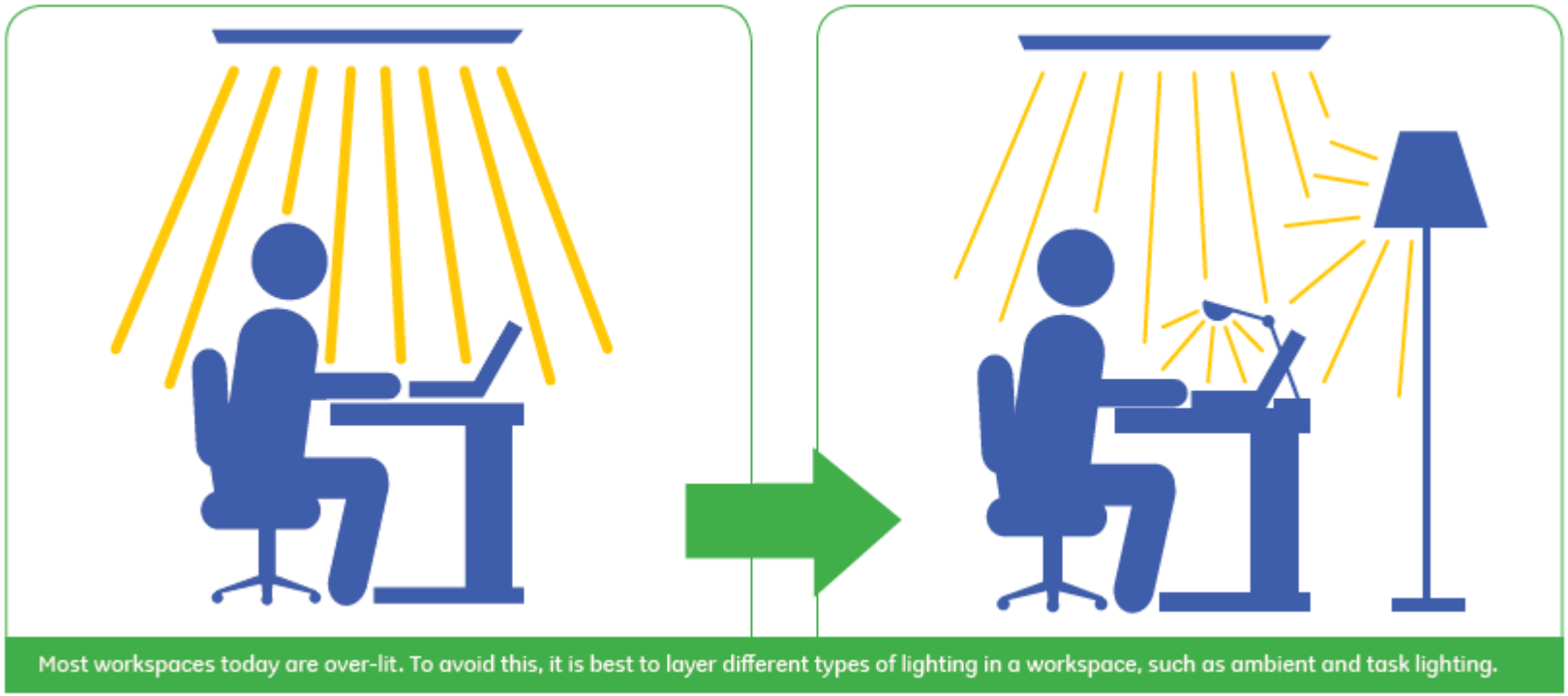
Light

Illumination level

Office – Screen based tasks, AS 1680.2 - 320lx



Trends are for lower levels of ambient lighting for better environmental performance

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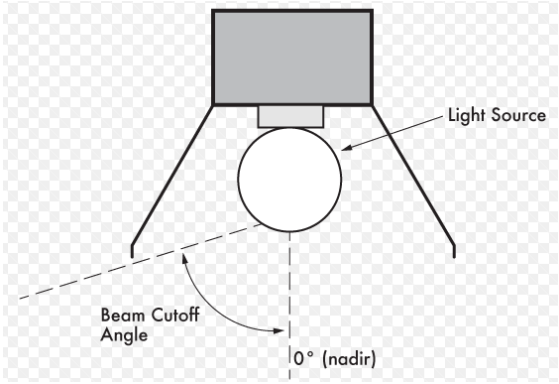
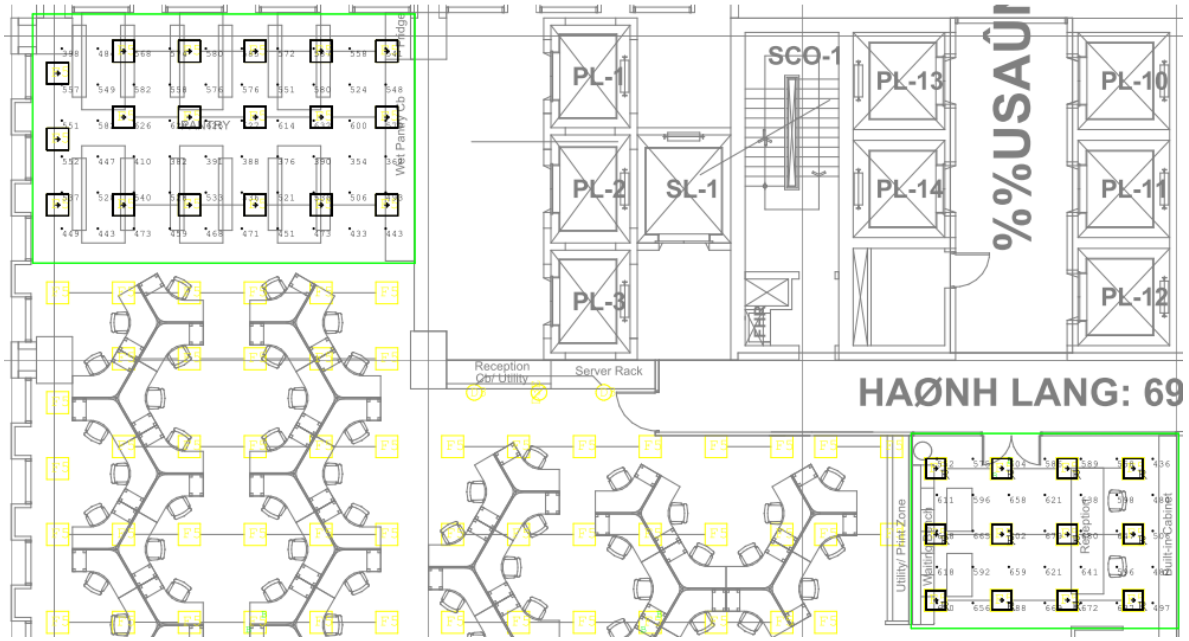
Light – Color rendering Index - CRI 80, - LED's offer excellent CRI's

Glare index – Office lighting for screen based tasks Maximum index 16.



Light – Typical Calculation – Pearl Plaza Office



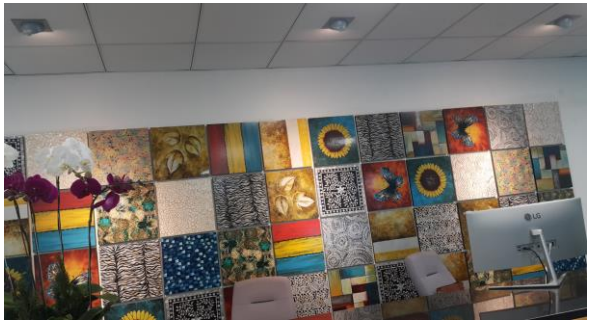
Calculation Summary

Label	CalcType	Units	Avg	Max	Min	Avg/Min
Kitchen_Workplane	Illuminance	Lux	516.31	632	354	1.46
Lobby_Workplane	Illuminance	Lux	607.86	702	436	1.40

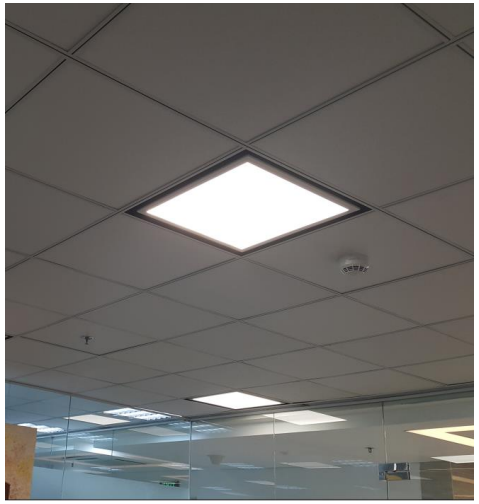
Light – Typical Installation

600x600
LED tube

LED Wall
washer
downlight



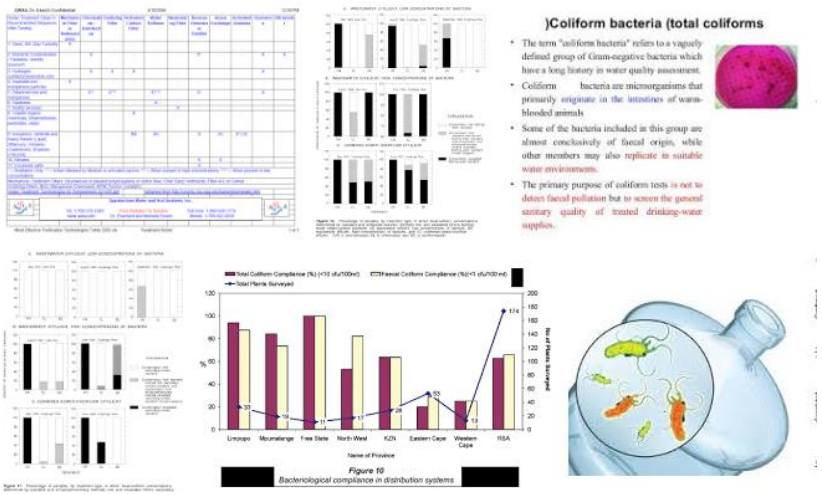
LED Panel



LED Panel with AC slot

Light KPI

- Market has arrived at LED 100% …
- Quality and lifecycle vary
- First cost is rapidly reducing.
- Test & commission to verify
- Light KPI – 8 W/m2, 110 lumens/W, 90 CRI, 2700 K



Lifts

- CIBSE Guidelines

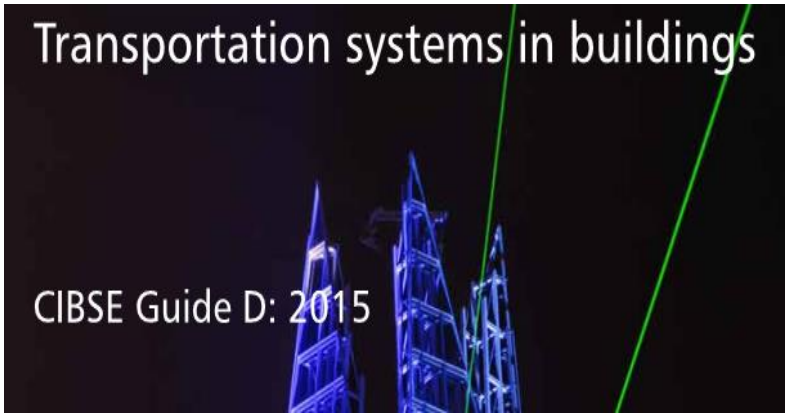


Table 3.7 Probable quality of service in office buildings

Interval (s)	Quality of service
<20	Excellent
25	Above average
30	Average
40	Below average
>50	Unsatisfactory

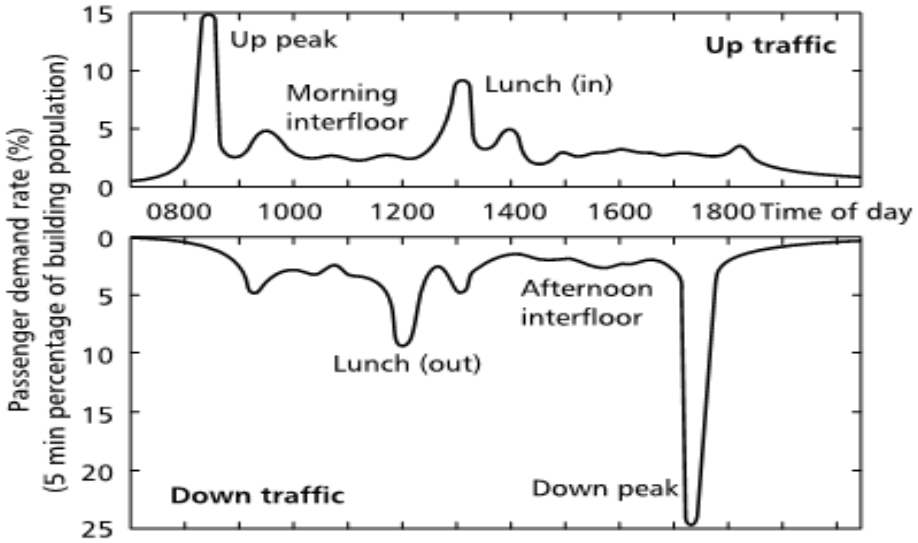


Figure 3.1 Passenger demand pattern showing four distinct classical passenger demands

Lifts

Key parameters

- quantity,
- speed,
- capacity,
- controls.
- occupant density

Lift Travel [m]	Rated speed [m/s]	Acceleration [m/s2]	Single floor flight time [s]
20	1.0	0.4-0.7	7
32	1.6	0.7-0.8	6
50	2.5	0.8-0.9	5.5
63	3.0	1.0	5.0
100	5.0	1.2	4.5
120	6.0	1.2	4.5
>120	>6.0	1.2	4.5

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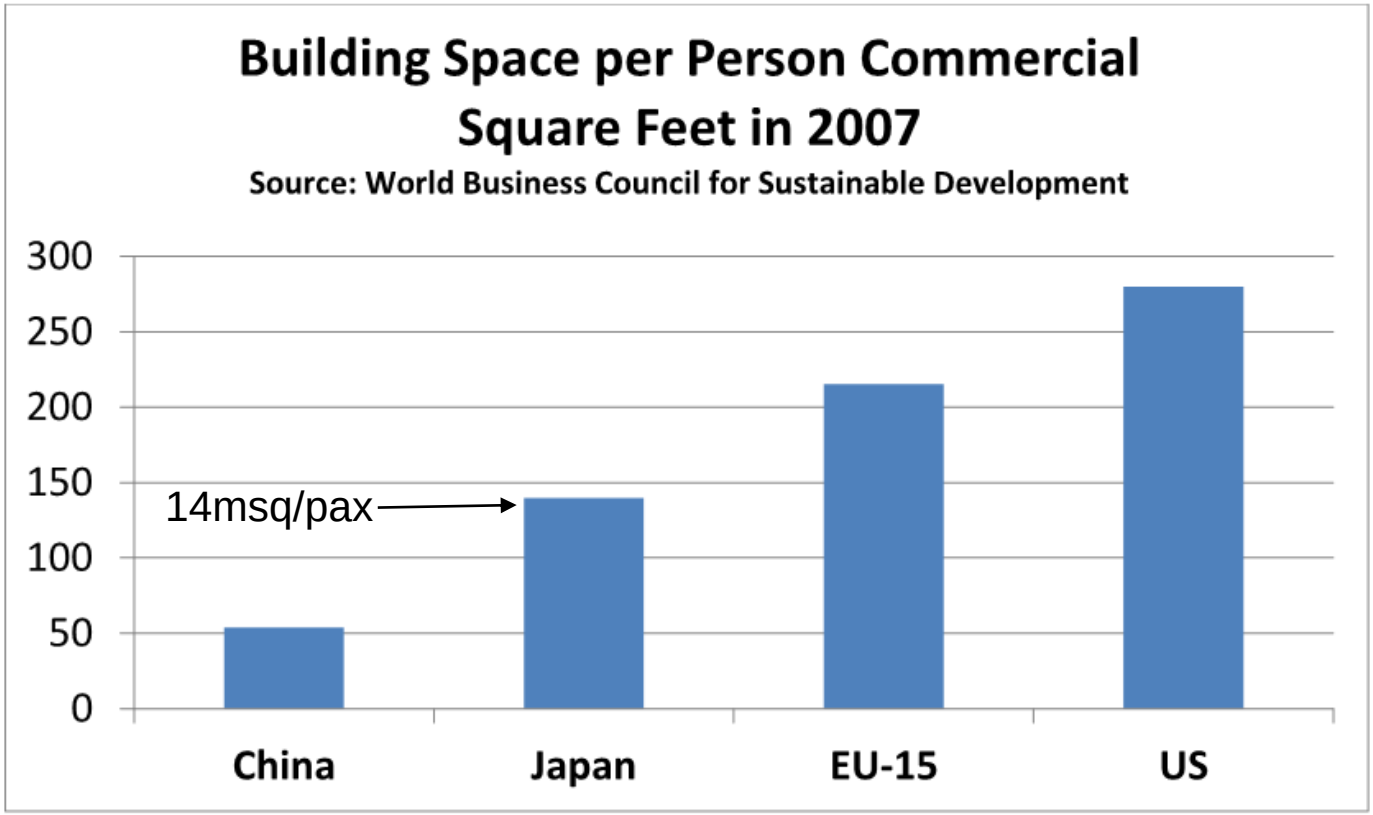
Lifts

- Building population density by region
- For Vietnam, we typically use 10 to14msq per person for mixed use commercial office buildings



30 msq/pax

25 msq/pax

20 msq/pax

15 msq/pax

10 msq/pax

5 msq/pax

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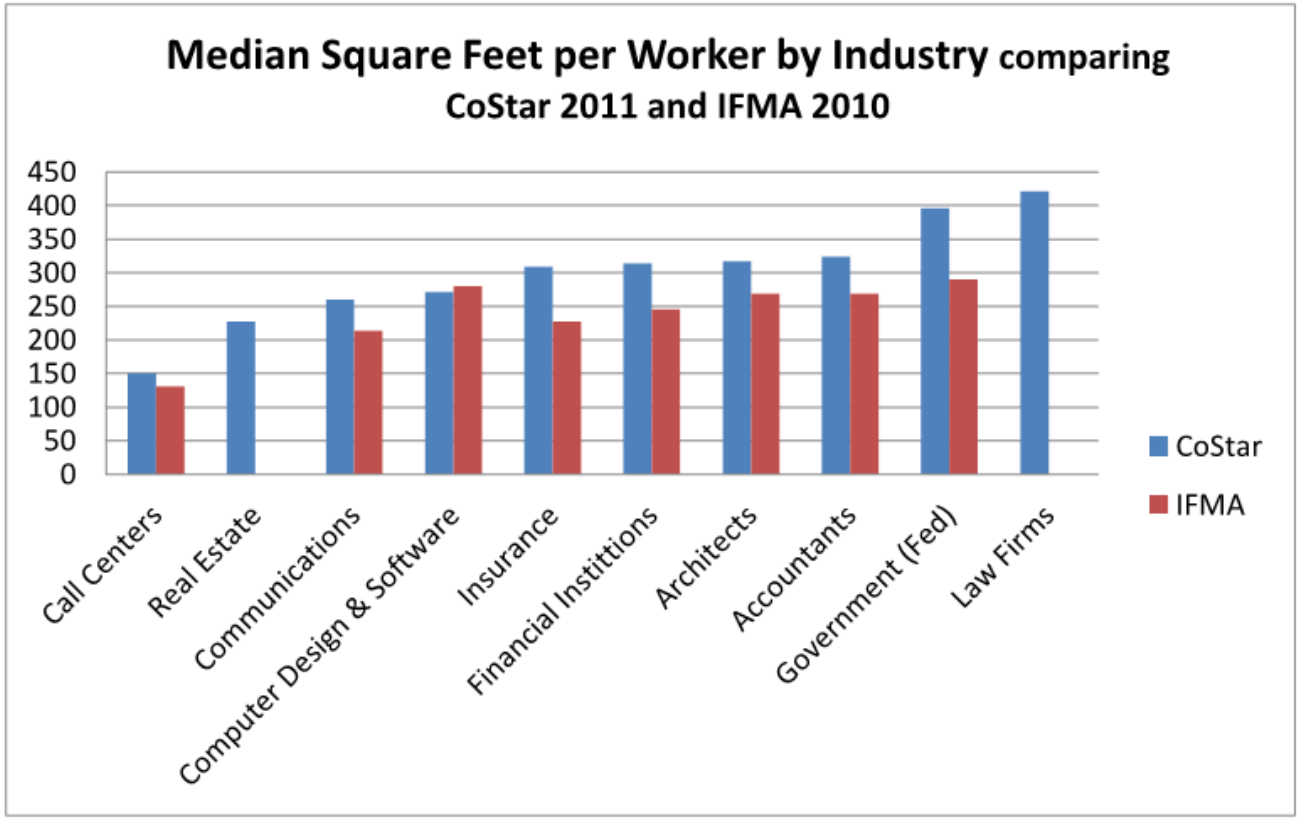
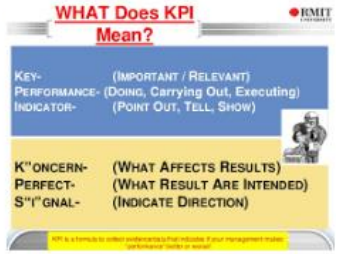
Lifts

- Building population density by industry (US data)



Lifts KPI

- Consider whether ‘beating the market’ or ‘achieving acceptable standards’ is your aim.
- Ensure sufficient number of lifts
- Ensure sufficient capacity (function of floorplate)
- Ensure lift speed (function of lift height)
- Ensure appropriate zoning and controls.
- For offices should really be looking for an interval of 30 to 40 seconds… using expected occupancy.



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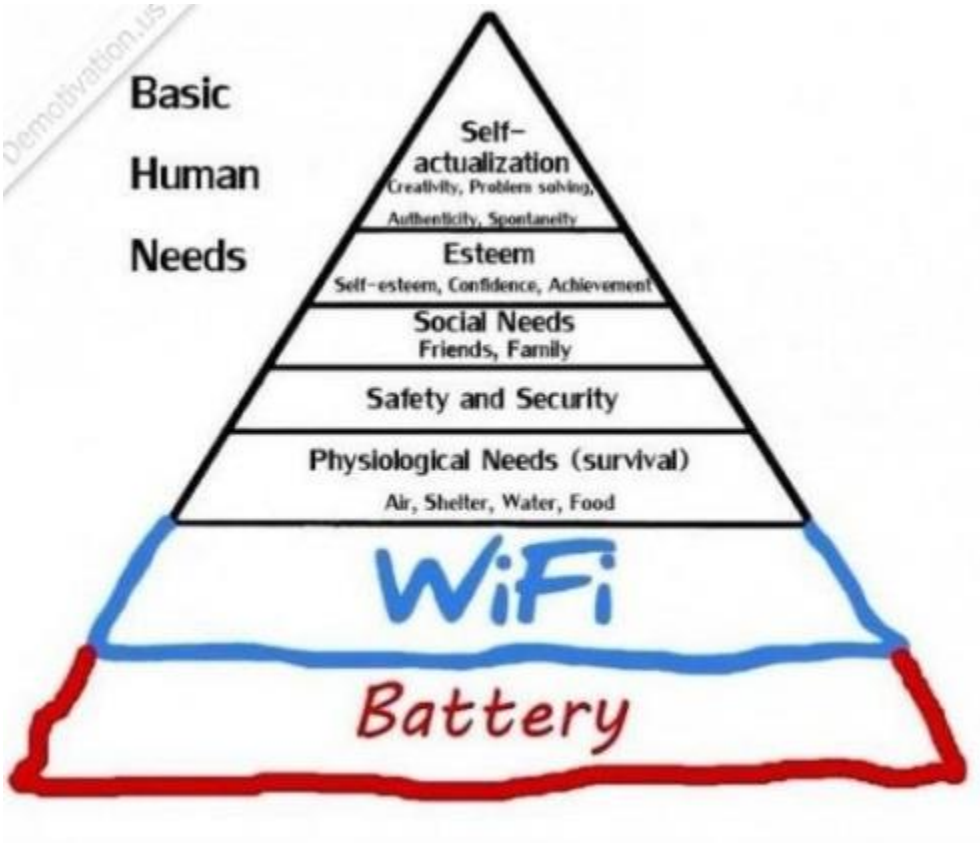
Internet



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Internet

- Performance requirements vary depending on task

Applications	Minimum Bandwidth	Latency Tolerance
Login to central server (authentication, download profiles, etc.)	< 1 Mbps	Low
Web access	< 1 Mbps	Medium
Email	< 1 Mbps	High
Streaming video	From 1 Mbps to 20 Mbps (High Definition)	Low – Medium
Classroom management	< 1 Mbps	Medium

Table 1 - Common Applications

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How Much Internet Bandwidth Does Your Business Need?

No Data? Follow the Education Sector

Broadband Access for Teaching, Learning, and School Operations	2014-15 School Year Target	2017-18 School Year Target
An external Internet connection to the Internet service provider (ISP)	At least 100 Mbps per 1,000 students/ staff	At least 1 Gbps per 1,000 students/staff
Internal wide area network (WAN) connections from the district to each school and among schools within the district	At least 1 Gbps per 1,000 students/staff	At least 10 Gbps per 1,000 students/staff

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Internet

Guests Are Winning the Battle Over Hotel Bandwidth

Hotel guests are devouring hotel bandwidth with increasing demands, The majority of guests now travel with 3x devices

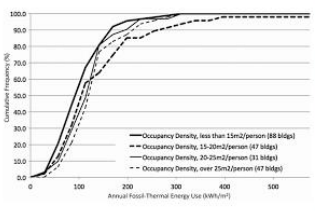
- 1 to 2 Mbps per guest room is current
- Typically a 1Gbps connection to the hotel site is minimum
- Band-width requirements projected to increase 4-fold over 5 years globally

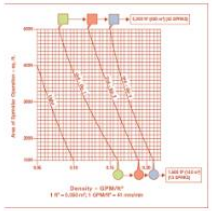
Internet KPI

- Fiber to the …. FTTX
- Multiple vendors
- Subscribe Diamond package(s)
- Speed…. 1 Gbps for hotel, 100 Mbps for office, (10 Mbps for home)

People

- Different people densities for architectural planning, lifts, ACMV, water etc
- Occupancy varies throughout the day
- Occupancy varies over the life of a building.
- Should be aware that performance will vary significantly with occupancy.
- Lifts may only be sized for 12 m2/p while occupancies will approach 6 m2/p, and that will likely remain a disconnect, increasing lift waiting times from 40 seconds to > 100 seconds.

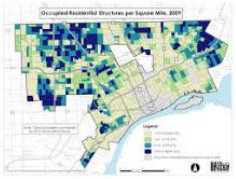




Level of Activity	Typical Application	Heat Gain / Person btuh SHG (qs)	LHG (ql)
Seated at rest	Theater	245	105
Seated, light work	Office	245	155
Moderate office work	Office	250	200
Standing, walking slowly	Retail Sales	250	250
Light bench work	Factory	275	475
Dancing	Nightclub	305	545
Heavy work	Factory	580	870

Occupant density (ppl/m²)	Number of people (ppl)
0.1	40
0.2	80
0.5	200
1.0	400
1.3	520

Arrive Sequence	1	2	3	4	7	5	6	8
Expected	1	2	3	4	5	6	7	8
Buffer-occupancy	0	0	0	0	1	1	0	0
RBD[0] = 6/8, RBD[1] = 2/8								



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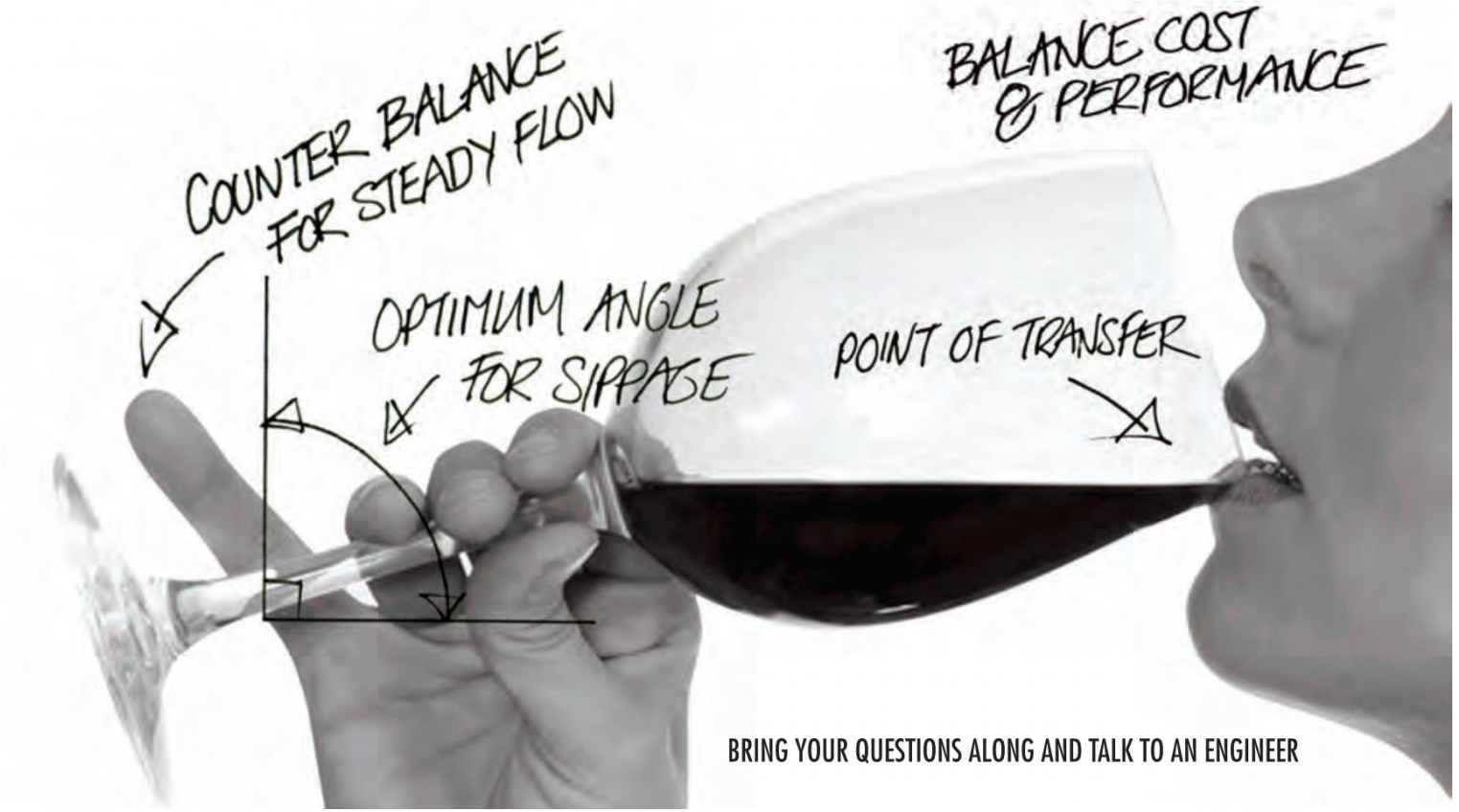
Summary

	KPI	Measure	Unit
Air Quality	AQI	50 to 100	(index)
Energy	ESD	150 - 170	kWh/m2/a
Water	ESD	150 residential 35 office	l/p/d
Water Quality	Health	0	Total Coliforms
Light	Comfort	8 110 90	W/m2 Lumens/W CRI
Lifts	Interval	30 to 40	seconds
Internet	Speed	100 office 1 hotel	Mbps Gbps
People	Density	10	m2/p

WINE & ENGINEERING CONNECTIONS

THURSDAY
5pm



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