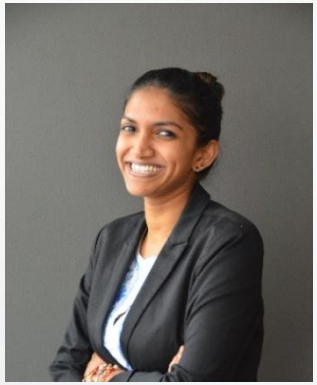
TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS



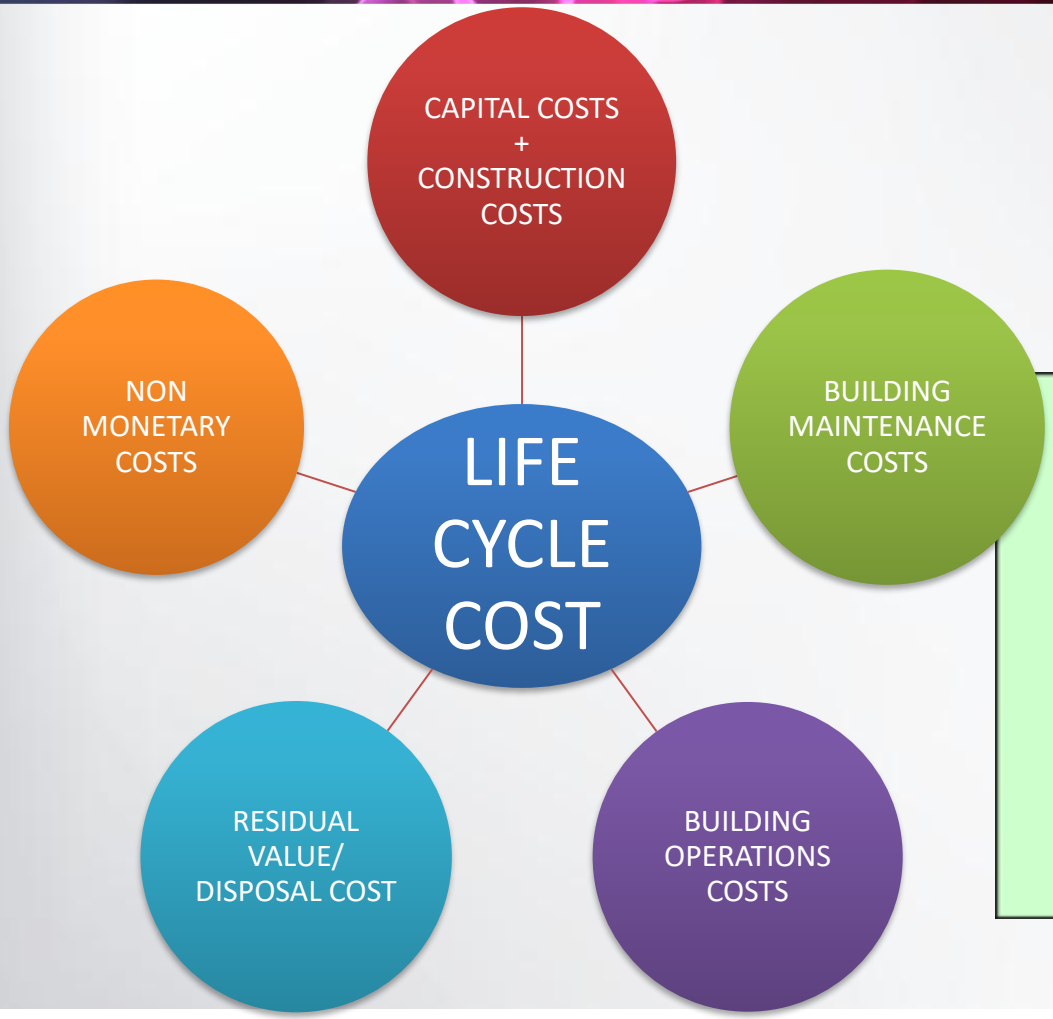
Sheena Moses
IEN Consultants, Malaysia
sheena@ien.com.my

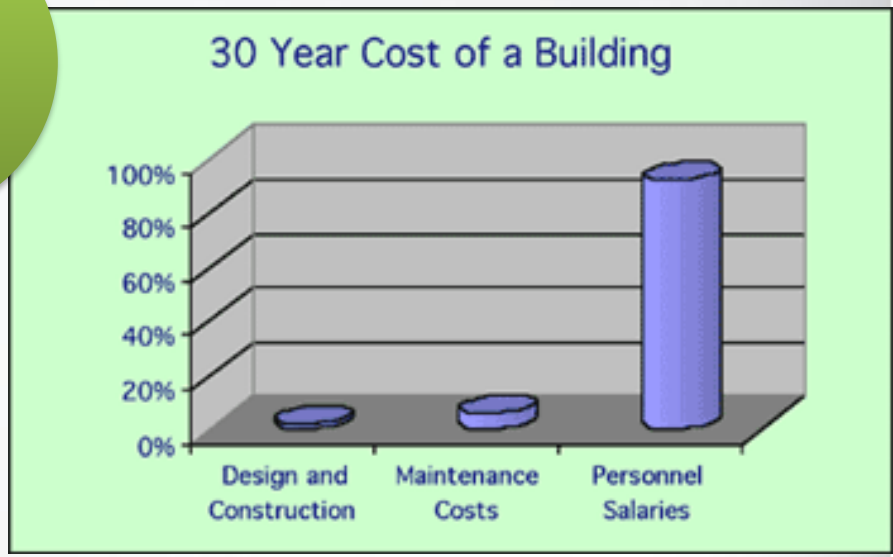
Green Buildings & Parks World 2017
Pullman Bangsar
17-18 January 2017

I | E | N CONSULTANTS

GREEN BUILDINGS & PARKS WORLD

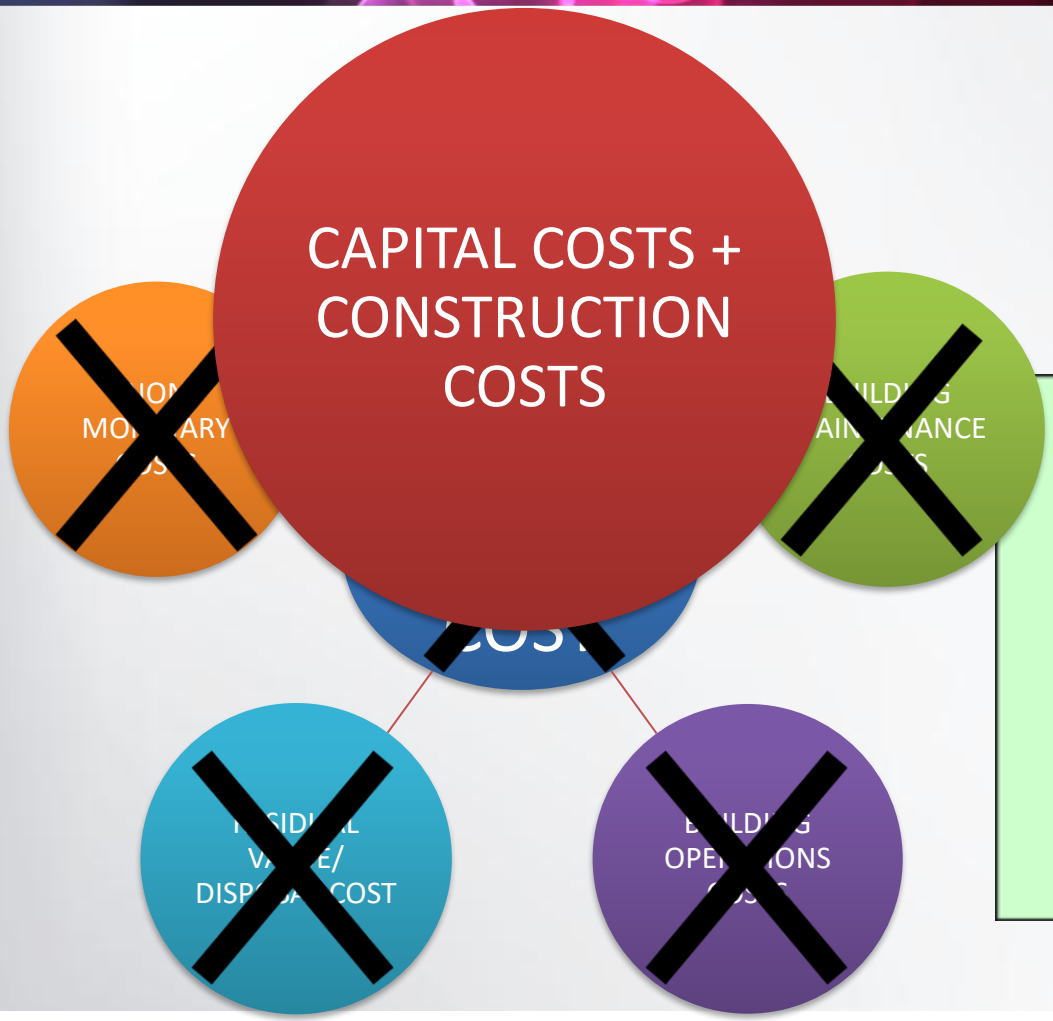
DEFINING "EXPENSIVE"

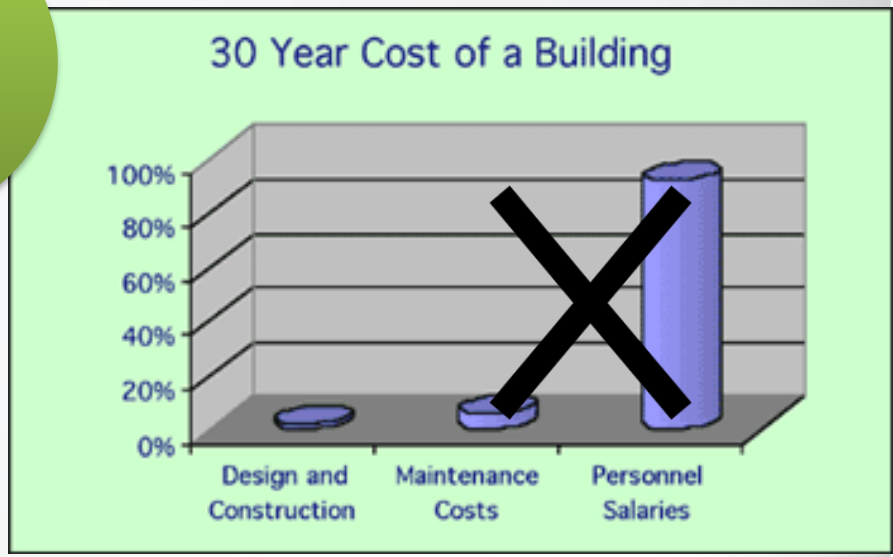




Source: Sustainable Building Technical Manual / Joseph J. Romm, 1994

THE MISUNDERSTOOD TERM "EXPENSIVE"…





TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

1. Integrative Process

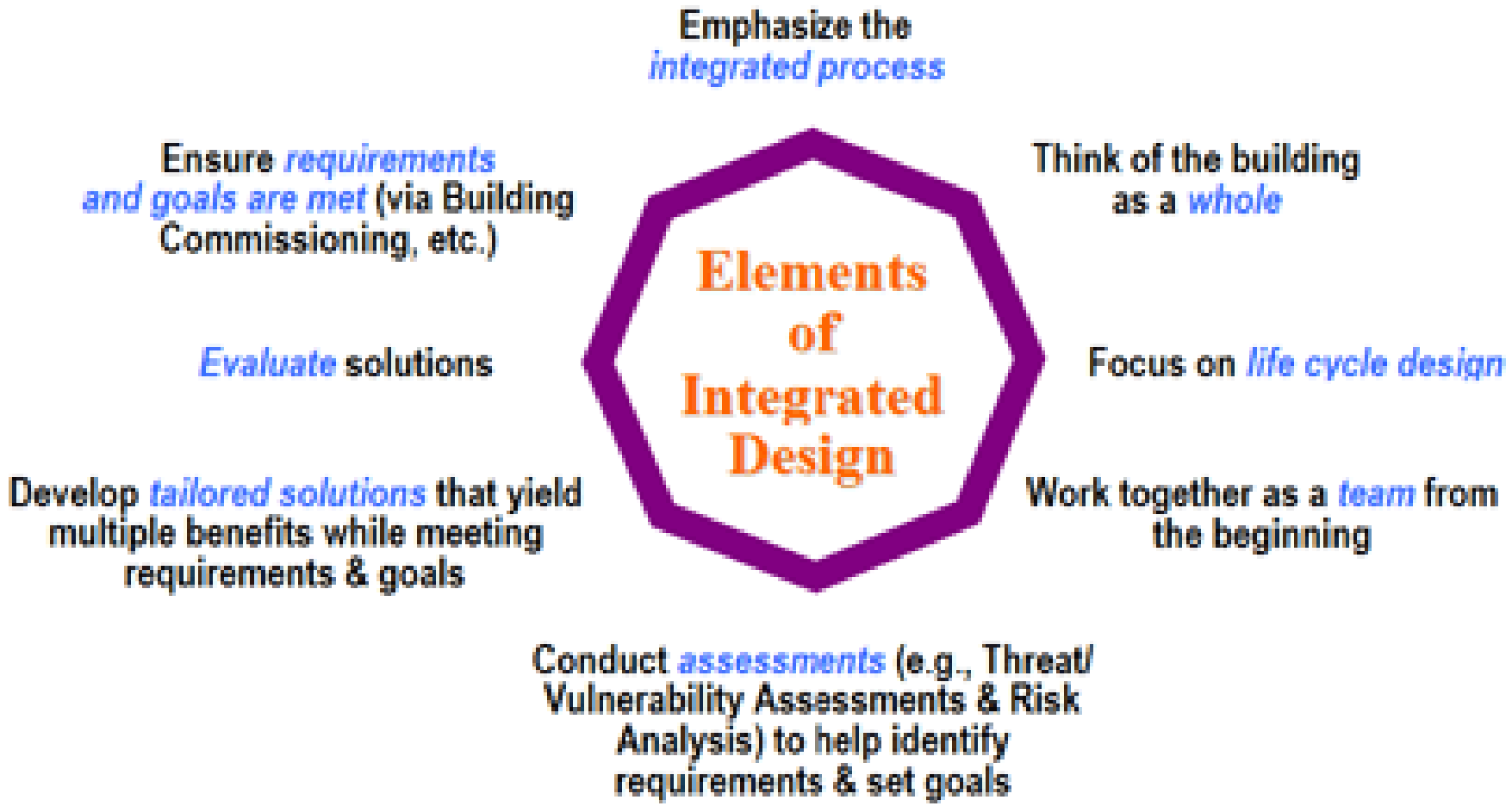
PROBLEM WITH OVERDESIGN OF BUILDINGS:

- Higher CAPEX
  (higher construction cost)

- Higher OPEX
  (higher operating cost)

Building owner

1. Integrative Process



GEO Building Integrative Process

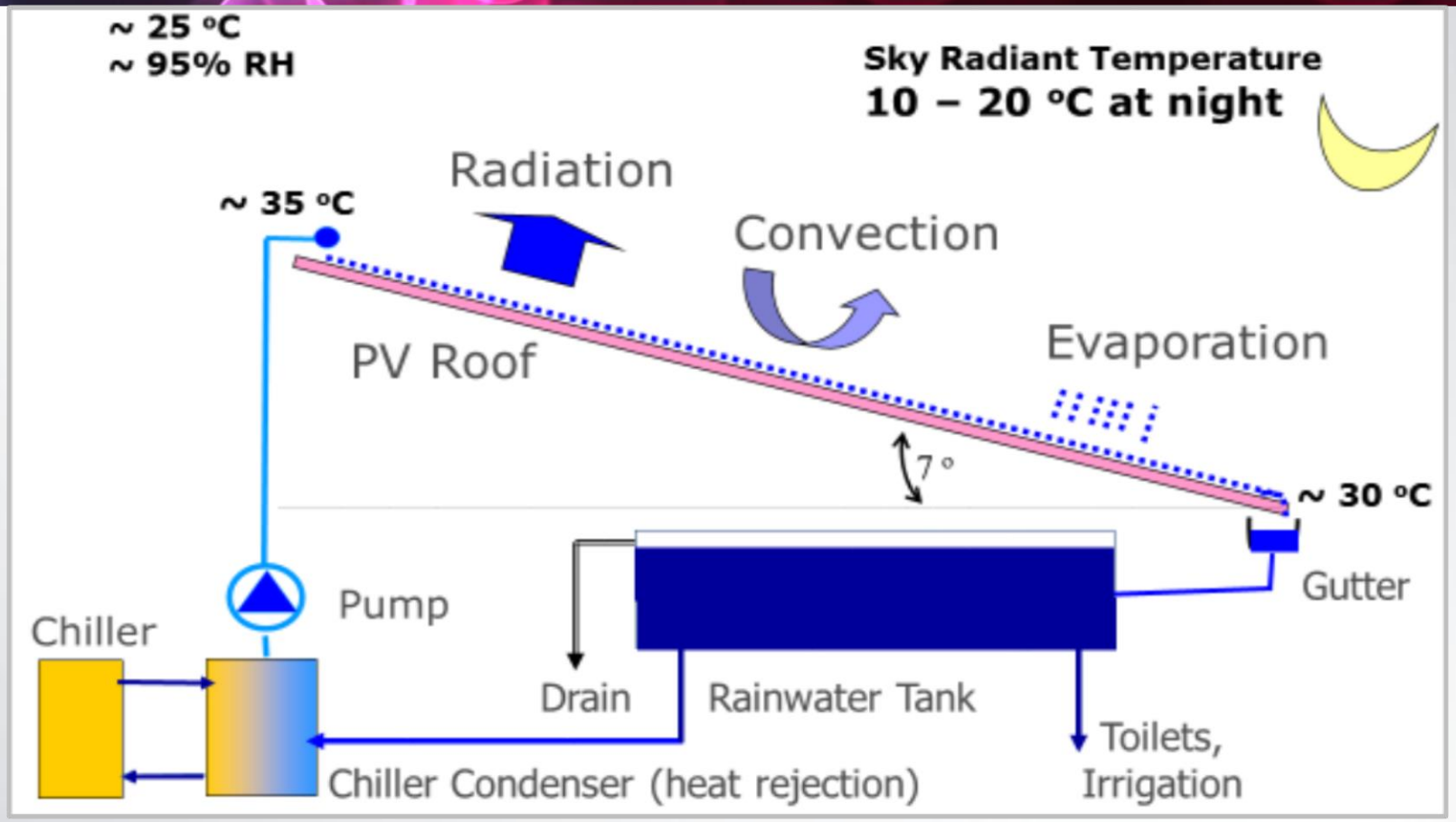
RIVER ROOF

PV is cleaned for 10 hours each night while condenser water runs across the roof!

I | E | N CONSULTANTS

GREEN BUILDINGS & PARKS WORLD

GEO Building Integrative Process



PV INTEGRATED ROOF+ RAINWATER COLLECTION + RIVER ROOF

(alternate cooling tower)

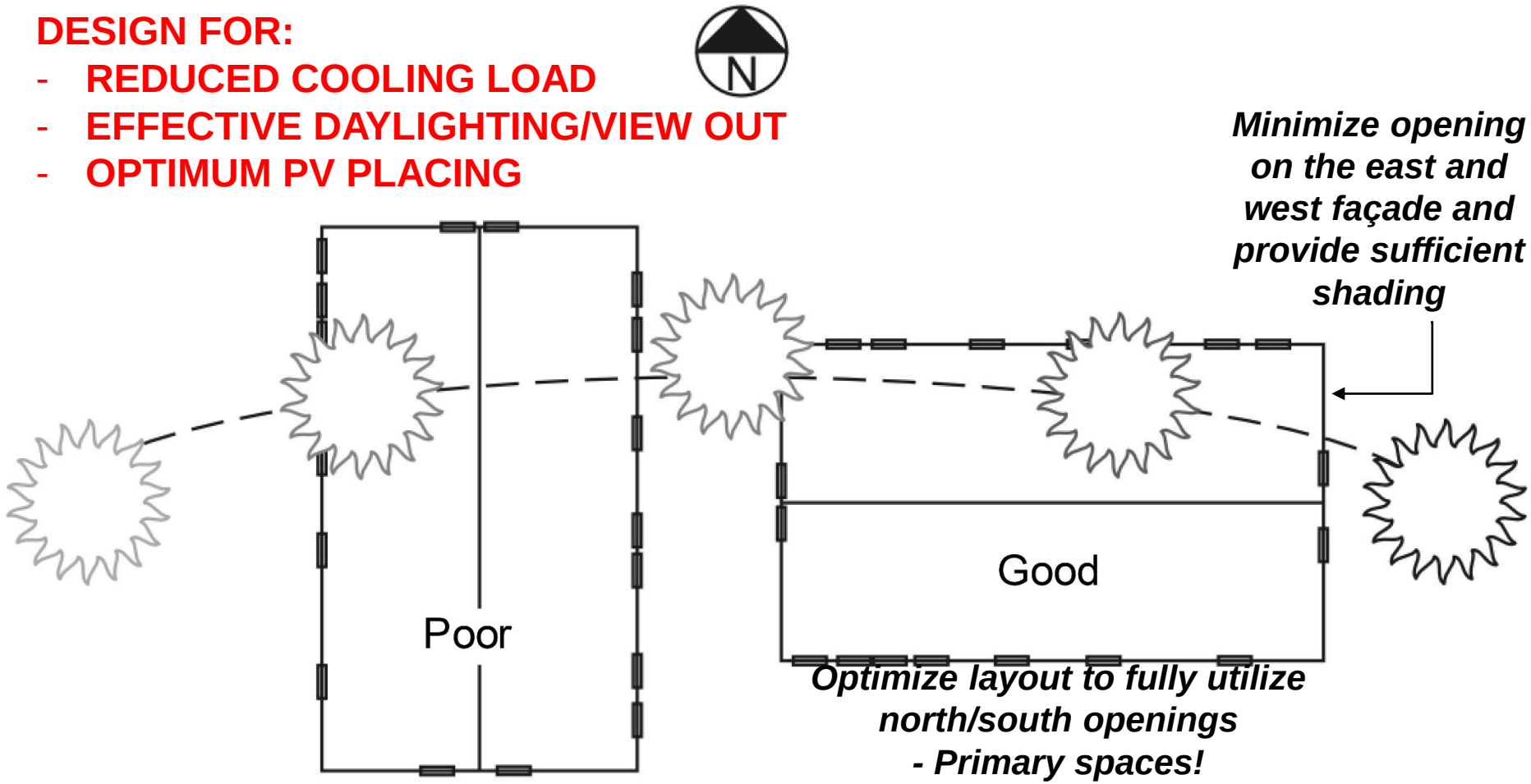
TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient HVAC System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

2. Optimizing Solar Orientation

DESIGN FOR:

- **REDUCED COOLING LOAD**
- **EFFECTIVE DAYLIGHTING/VIEW OUT**
- **OPTIMUM PV PLACING**

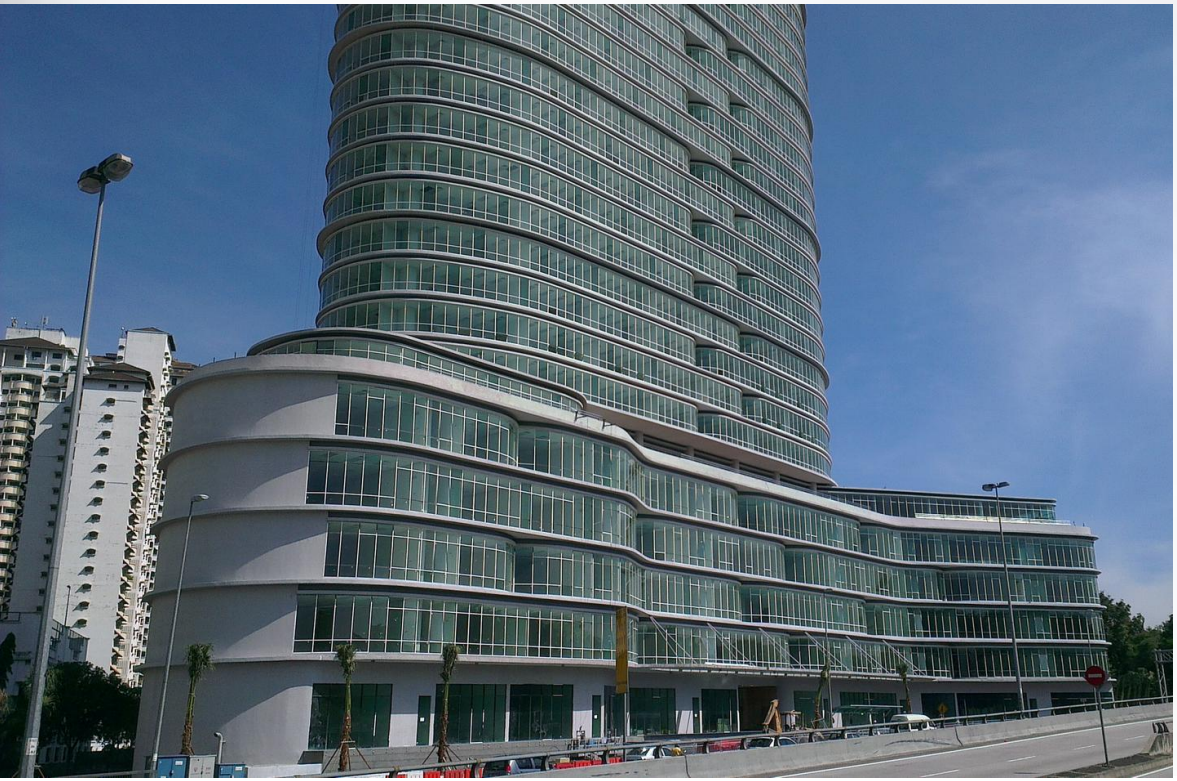


Minimize opening on the east and west façade and provide sufficient shading

Optimize layout to fully utilize north/south openings - Primary spaces!

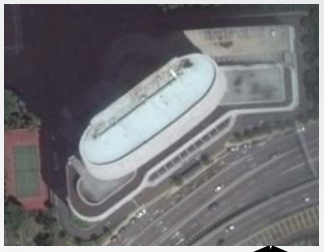
2. Optimizing Solar Orientation

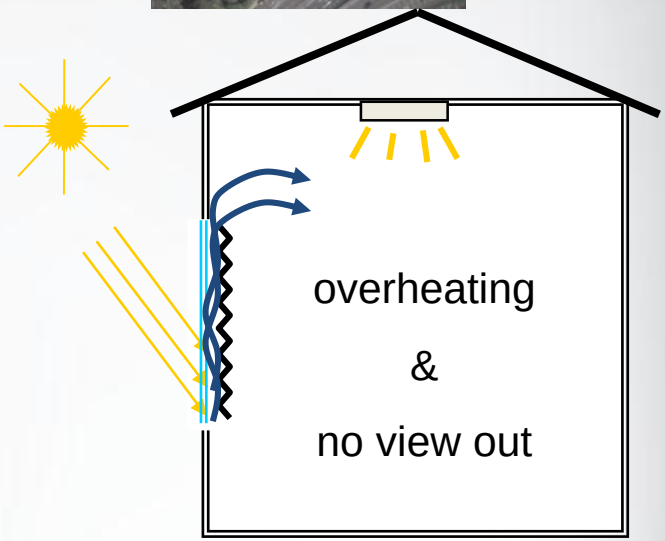
- VERY HIGH COOLING LOADS
- GLARY WORKSPACES THAT LEAD TO BLINDS PULLED DOWN



SELLING POINT:

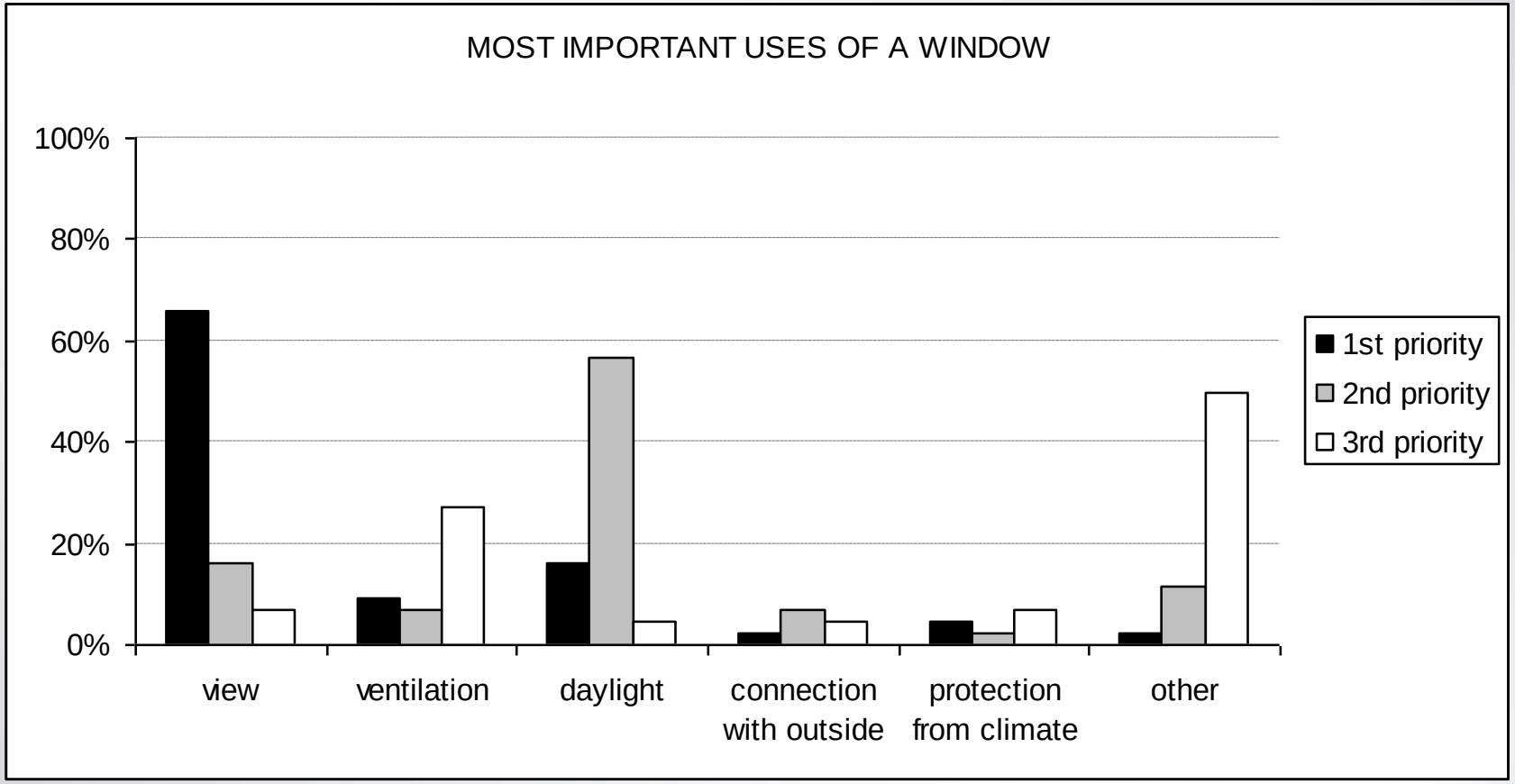
VIEW OUT!...but



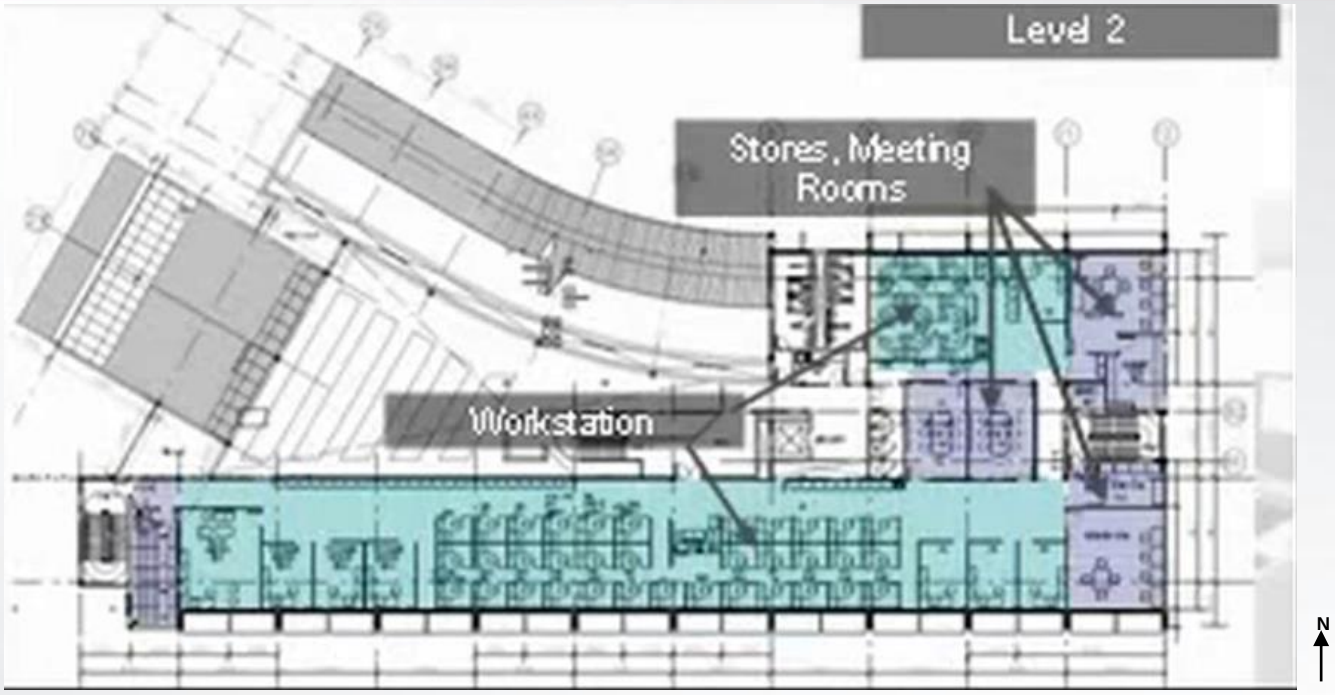


2. Optimizing Solar Orientation

What do people want from the window?
VIEW and DAYLIGHT



2. Optimizing Solar Orientation



GEO Building Case Study: Meeting Rooms, Facility Rooms, Stores located at building core or near east/west facade

Glazed facade ↓ + **Cooling Load** ↓ = **CAPEX** ↓ & **OPEX** ↓

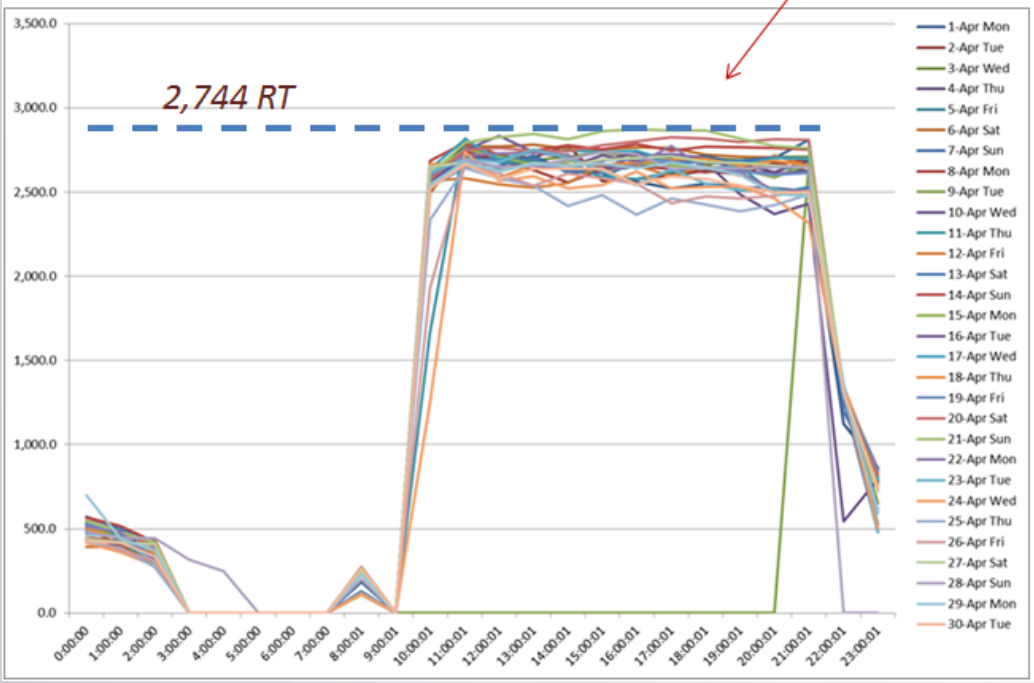
TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Design
2. Optimizing Solar Orientation
3. Energy Efficient HVAC System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

3. Energy Efficient HVAC Systems

LARGE POTENTIAL TO REDUCE CAPEX & OPEX!!

Measured cooling load
Malaysian Shopping Mall



Peak Cooling Rate = 40.9Btu/h.ft^2

which is only about **50%** of the design load!

Measurements match our energy simulations!

CAPEX Savings USD 500,000

Installed 5000 RT

Our proposal 4200 RT

Allows buffer for repair/ servicing of one chiller

Green Shopping List

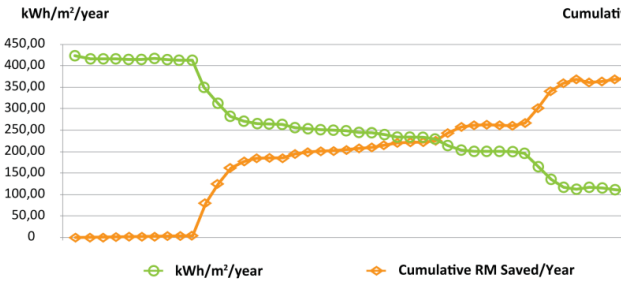
Shopping Mall Case Study

SUMMARY of all 42 items implemented:

Items	Descriptions	Total Building MWh/year	Tenant's MWh/year	Owner's MWh/year	Savings (MWh/yr)	Owner's kWh/m2/year	Running Cost/year	Cumulative MWh/year Saved	% Saved Cumulative	RM/year Saved per step	% Save per Step	Extra Budget Estimated (RM)
0	Base Case Grd Flr Doors 50% Open during Mall hours.	76,447	36,331	40,117		424	15,444,934					
1	4 nos of Revolving Doors proposed	75,952	36,331	39,621	496	419	15,254,052	496	1.24%	190,882	1.24%	300,000
2	Clear Glazing to Clear Low-E Single Glazing	75,900	36,331	39,569	52	418	15,234,221	547	1.36%	19,831	0.13%	361,871
3	Clear Low-E Glazing to High performance Dbl Glazing	75,848	36,331	39,518	52	418	15,214,343	599	1.49%	19,709	0.13%	904,678
4	Roof Insulation 25mm to 50mm	75,812	36,331	39,481	36	417	15,200,368	635	1.58%	13,974	0.09%	733,742
5	Roof Insulation 50mm to 100mm	75,785	36,331	39,454	27	417	15,189,958	662	1.65%	24,384	0.07%	1,760,981
6	Green Vegetated Roof	75,782	36,331	39,451	3	417	15,188,752	665	1.66%	1,206	0.01%	-
7	Brickwall to Aerated Light Weight Conc. 100mm	75,669	36,331	39,338	113	416	15,145,172	779	1.94%	43,580	0.28%	623,990
8	Brickwall to Aerated Light Weight Conc. 150mm	75,657	36,331	39,326	12	416	15,140,597	790	1.97%	48,155	0.03%	1,455,976
8a	Brickwall to Aerated Light Weight Conc. 200mm	75,649	36,331	39,319	8	415	15,137,632	798	1.99%	51,121	0.02%	-
9	VAV system instead of CAV system	69,627	36,331	33,297	6,022	352	12,819,204	6,820	17.00%	2,321,394	15.03%	-
10	CO2 sensor for fresh air intake for all AHU	66,091	36,331	29,760	3,537	314	11,457,543	10,357	25.82%	1,361,661	8.82%	750,000
11	Total Pressure 1000 down to 650 Pa. Larger Duct Sizes	63,180	36,331	26,849	2,910	284	10,337,054	13,267	33.07%	1,120,488	7.25%	-
12	Electronic Air Filter used for all AHU	62,029	36,331	25,698	1,151	272	9,893,910	14,418	35.94%	443,144	2.87%	1,400,000
13	Use of AirFoil Fan instead of Backward Curve for all AHU	61,506	36,331	25,176	523	266	9,692,638	14,941	37.24%	201,272	1.30%	300,000
14	Efficiency 1 motor for all AHU instead of Eff 2.	61,403	36,331	25,072	104	265	9,652,652	15,045	37.50%	39,986	0.26%	250,000
15	Heat Recovery Wheel for Cinema spaces only.	61,343	36,331	25,012	60	264	9,629,731	15,104	37.65%	22,921	0.15%	100,000
16	Chill Water Pump Head 30m down to 20m. Increase Pipe Sizes.	60,682	36,331	24,351	661	257	9,375,189	15,766	39.30%	254,542	1.65%	1,000,000
17	Chill Water Pump Head 20m down to 15m. Increase Pipe Sizes.	60,370	36,331	24,039	312	254	9,255,116	16,077	40.08%	120,073	0.78%	1,000,000
18	Chill Water Pump Efficiency 68% to 80%	60,230	36,331	23,899	140	253	9,201,079	16,218	40.43%	54,037	0.35%	108,000
19	Chill Water Motor Efficiny Type 1 instead of Type 2	60,204	36,331	23,873	26	252	9,191,204	16,243	40.49%	9,875	0.06%	270,000
20	Chill Water Constant Flow to Primary/Secondary variable	59,936	36,331	23,605	268	249	9,087,913	16,512	41.16%	103,291	0.67%	500,000
21	Condenser Water Pump Effciency 68% to 80%	59,623	36,331	23,292	313	246	8,967,515	16,824	41.94%	120,398	0.78%	50,000
22	Condenser Water Motor Efficiency Type 1 instead of Type 2	59,566	36,331	23,235	57	245	8,945,508	16,882	42.08%	22,007	0.14%	25,000
23	Condenser Water Pump head 35 down to 25m. Increase Pipe Size.	59,076	36,331	22,745	490	240	8,756,854	17,372	43.30%	188,655	1.22%	1,000,000
24	Condenser Water Pump head 25 down to 15m. Increase Pipe Size.	58,586	36,331	22,255	490	235	8,568,258	17,861	44.52%	188,596	1.22%	1,500,000
25	Cooling Tower Constant Speed to 2 speed Fan	58,479	36,331	22,148	107	234	8,526,994	17,969	44.79%	41,264	0.27%	112,000
26	Cooling Tower Constant Speed to variable fan speed	58,427	36,331	22,096	52	233	8,507,145	18,020	44.92%	61,113	0.13%	198,000
26a	Cooling Tower Fan Less, Constant Flow	58,170	36,331	21,840	257	231	8,408,233	18,277	45.56%	160,025	0.64%	150,000
27	Concourse Lights 35 W/m2 down to 20 W/m2	56,794	36,331	20,464	1,376	216	7,878,473	19,653	48.99%	628,672	4.07%	
28	Concourse Lights 20 W/m2 down to 10 W/m2	55,711	36,331	19,381	1,083	205	7,461,496	20,736	51.69%	1,045,649	6.77%	
29	Concourse Phillips 6.8W/m2 (200 lux)	55,368	36,331	19,037	344	201	7,329,188	21,080	52.55%	1,177,957	7.63%	3,331,361
30	Concourse Osram 7.0 W/m2 (200 lux)	55,389	36,331	19,058	1,405	201	7,337,390	21,059	52.49%	1,169,755	7.57%	2,871,613
31	Concourse Megaman 7.8 W/m2 (200 lux)	55,475	36,331	19,144	1,320	202	7,370,404	20,973	52.28%	1,136,741	7.36%	871,171
32	Concourse Night Light 10% down to 2.5%	55,422	36,331	19,091	53	202	7,350,068	21,026	52.41%	20,336	0.13%	Free. Management
33	Concourse Daylight Top Floor - 75%, 1st floor 75%, Grd 50%	55,109	36,331	18,778	313	198	7,229,611	21,339	53.19%	120,457	0.78%	1,400,000
34	Retail Lights & Small Power 100W/m2 down to 75W/m2	42,980	27,248	15,732	3,046	166	6,056,934	24,384	60.78%	1,172,677	7.59%	Free. Convince Retailer
35	Retail Lights & Small Power 75W/m2 down to 50W/m2	31,004	18,165	12,838	2,894	136	4,942,719	27,278	68.00%	1,114,215	7.21%	Free. Convince Retailer
36	Retail Lights & Small Power 50W/m2 down to 35W/m2	23,836	12,716	11,121	1,718	117	4,281,411	28,996	72.28%	661,308	4.28%	Free. Convince Retailer
37	Night Retail 30% down to 15%	21,938	11,249	10,689	432	113	4,115,276	29,428	73.36%	166,135	1.08%	Free. Convince Retailer
38	Chill Water Pump Head 25m. Condenser Water Pump Head 30m	22,400	11,249	11,151	-462	118	4,293,257	28,965	72.20% -	177,981	-1.15%	BaseCase Chiller
39	MS 1525 to Dunham Bush	22,168	11,249	10,919	232	115	4,203,985	29,197	72.78%	89,272	0.58%	1,957,975

% Saving per step
0.67%

% Saving in Energy
68.53%



Green Mark Score [Points]	Additional Cost [RM]	Saving / Year [RM]	Payback Period [Years]	Energy Index [kWh/m2/y]	Total Saving in Energy [%]
97.5	32,206,000	10,640,000	<3	133	68.53%

POTENTIAL: **68% energy savings** and **3 year payback time**

I | E | N CONSULTANTS

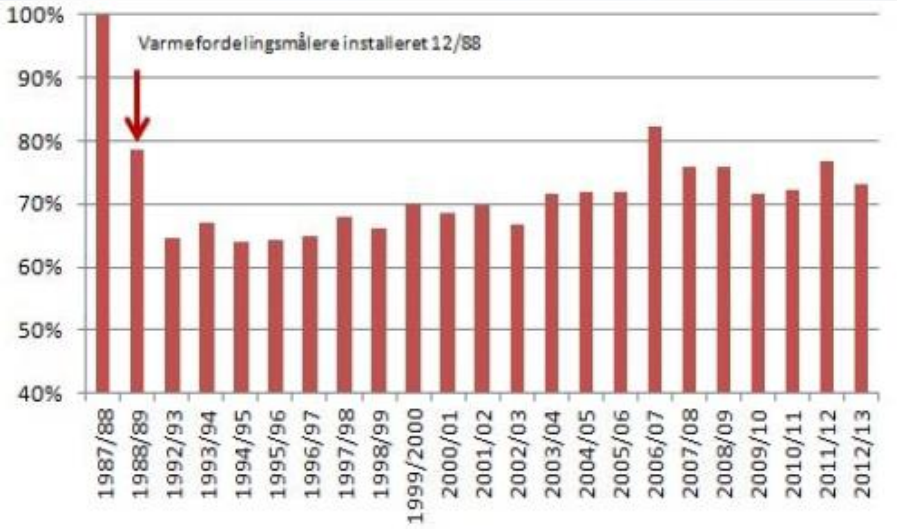
GREEN BUILDINGS & PARKS WORLD

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

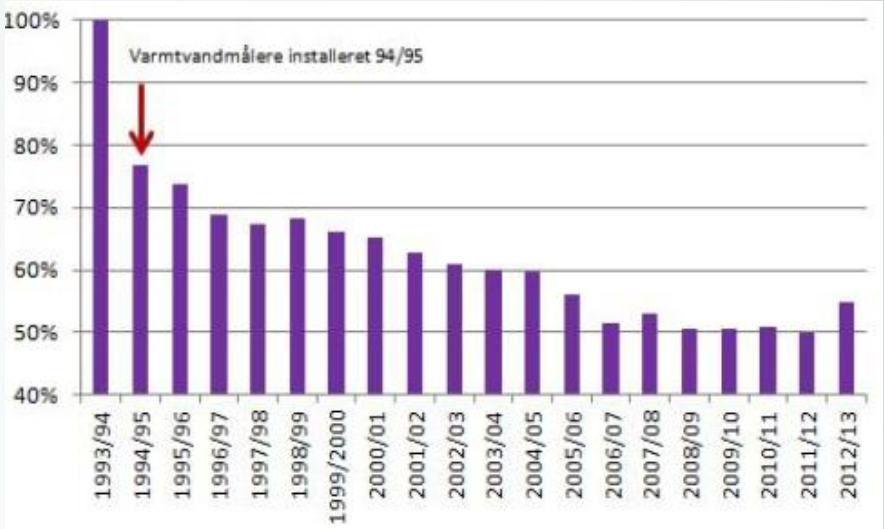
1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

4. Sub Metering

You Can't Manage What You Don't Measure



Reduction of 40% hot water after installing submeters



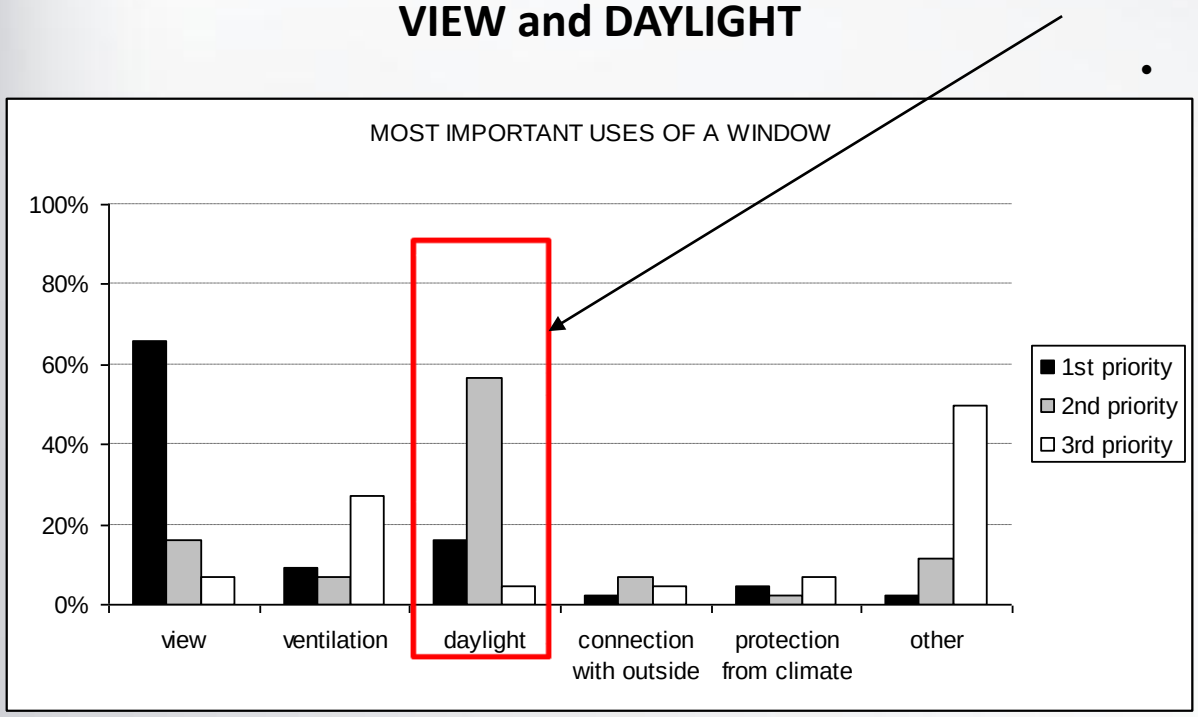
Reduction 30% room heating usage after installing submeters

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

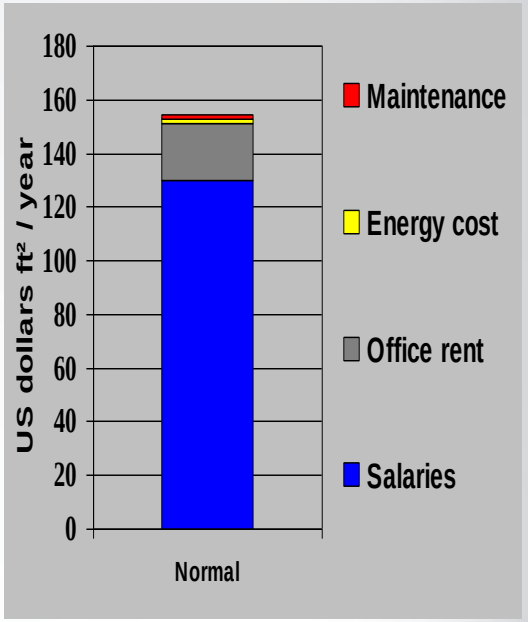
5. Effective Lighting Design

What do people want from the window?
VIEW and DAYLIGHT



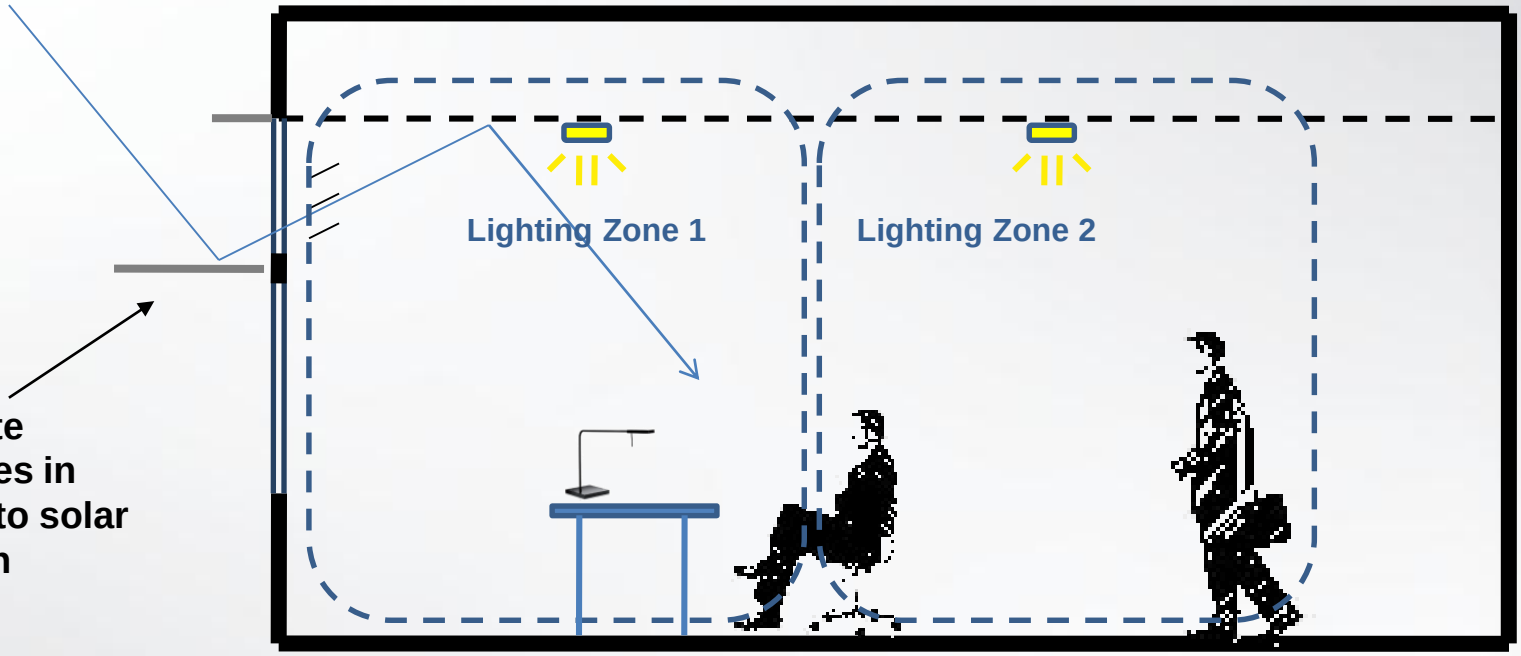
Increase of productivity:

- **Occupants prefer daylit worstations**
- **7-20% for students exposed to high daylight levels**
- **40% higher sale pr. m² in stores with skylights**



5. Effective Lighting Design

STRATEGY 01

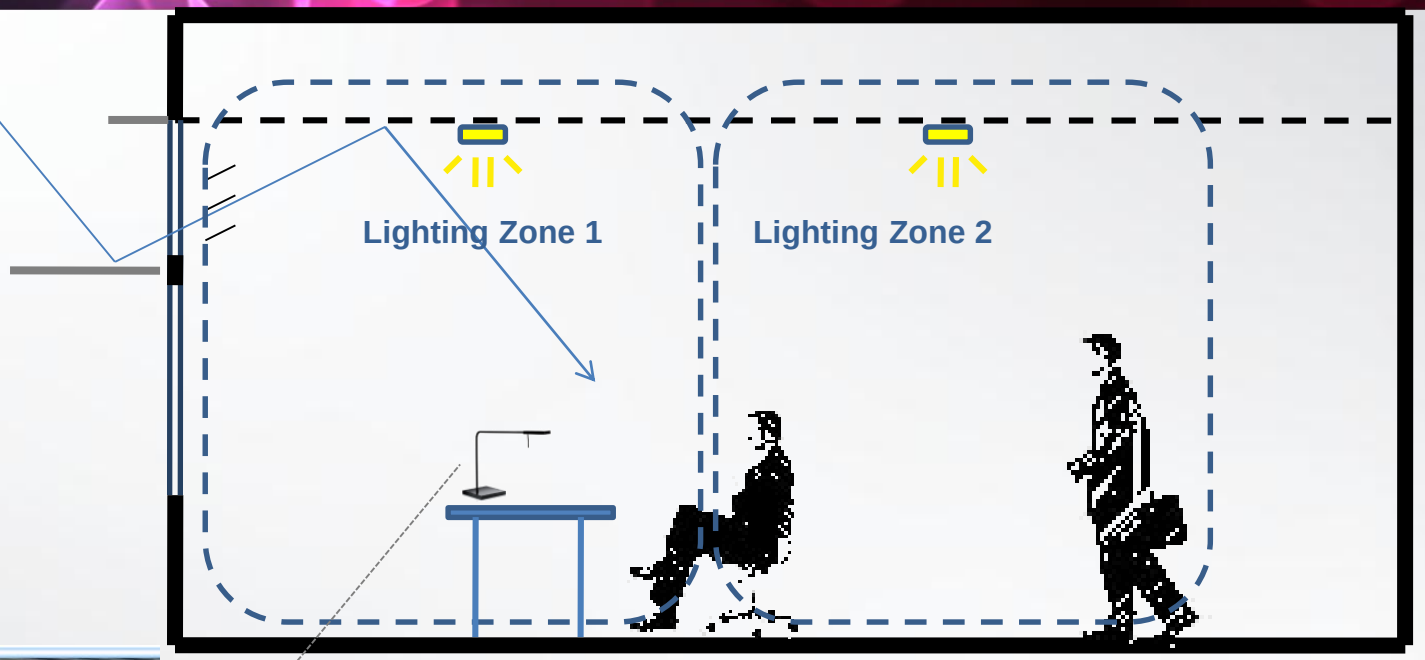


Incorporate lightshelves in response to solar orientation

+ Additional Circuiting for daylight responsive zoning
+ Lightshelves
- Lighting Energy
- Light Fitting Maintenance

5. Effective Lighting Design

STRATEGY 02



+ Sensors
+ Task Lighting
+ LED Light Fittings
- Lighting Energy (0.5w/m2 – 25x lower than MS1525)
- Light Fitting Maintenance

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

6. Natural Ventilation

WHY DO WE NEED TO VENTILATE?

Thermal Comfort

- Temperature
- Air Flow
- Radiant Heat (eg sunlight)
- Humidity

Natural Ventilation

Air Conditioned Space

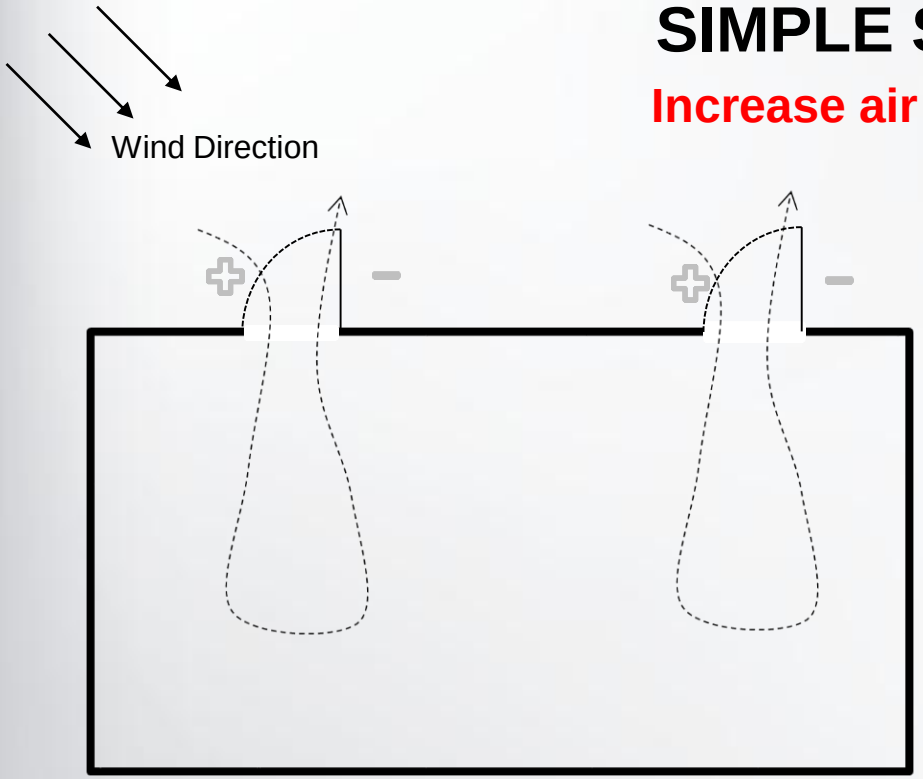
Indoor Air Quality

- CO_2 (indication of pollution in the air)
- VOC (Volatile Organic Compound)
- CO (Carbon Monoxide)
- NO_2 (Nitrogen Dioxide)
- Rn (Radon)
- Tobacco
- Dust

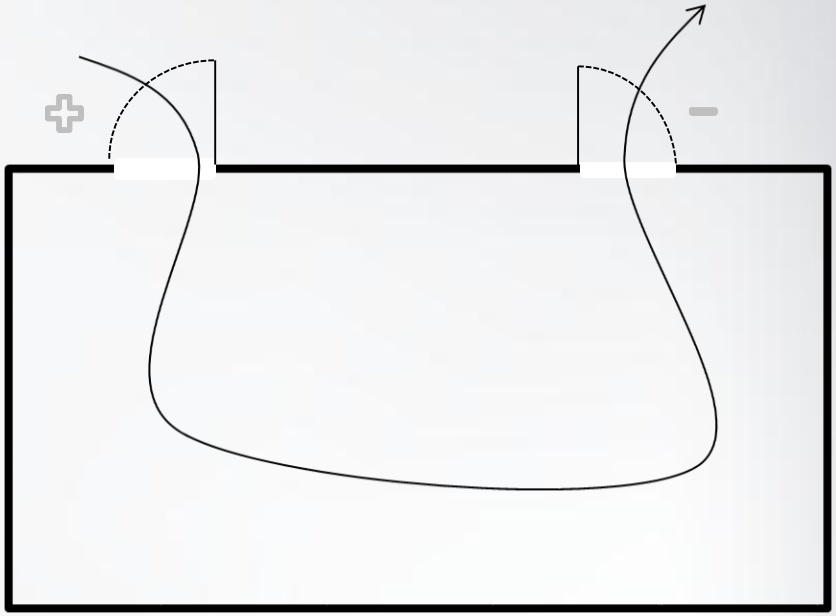
6. Natural Ventilation

SIMPLE STRATEGY

Increase air flow by 425%!!



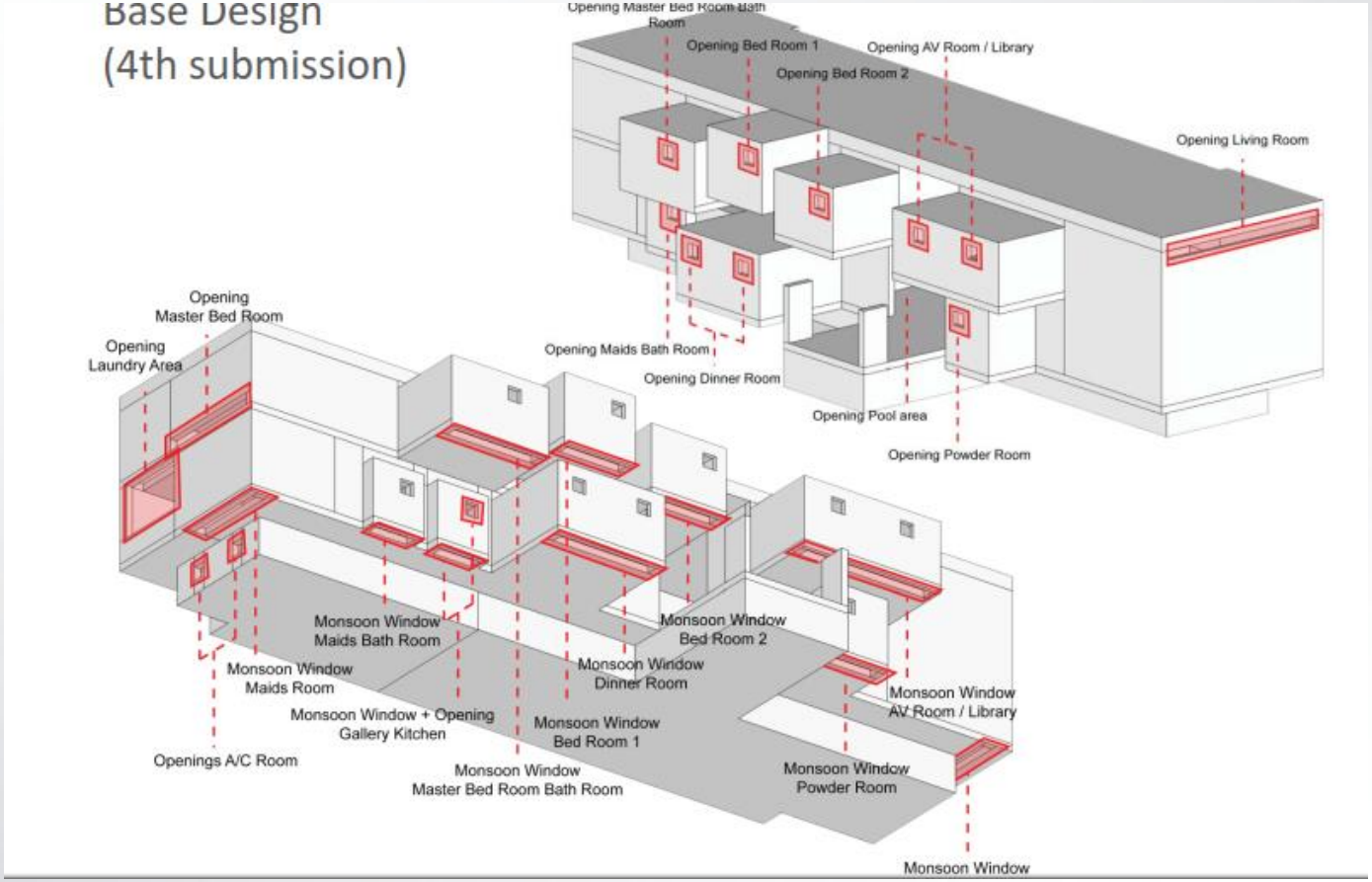
Both window hinges face the same direction.
Air cannot move significantly past the entire space



Both window hinges face opposite direction
for negative pressure to force air to pass through the entire space and out the other window

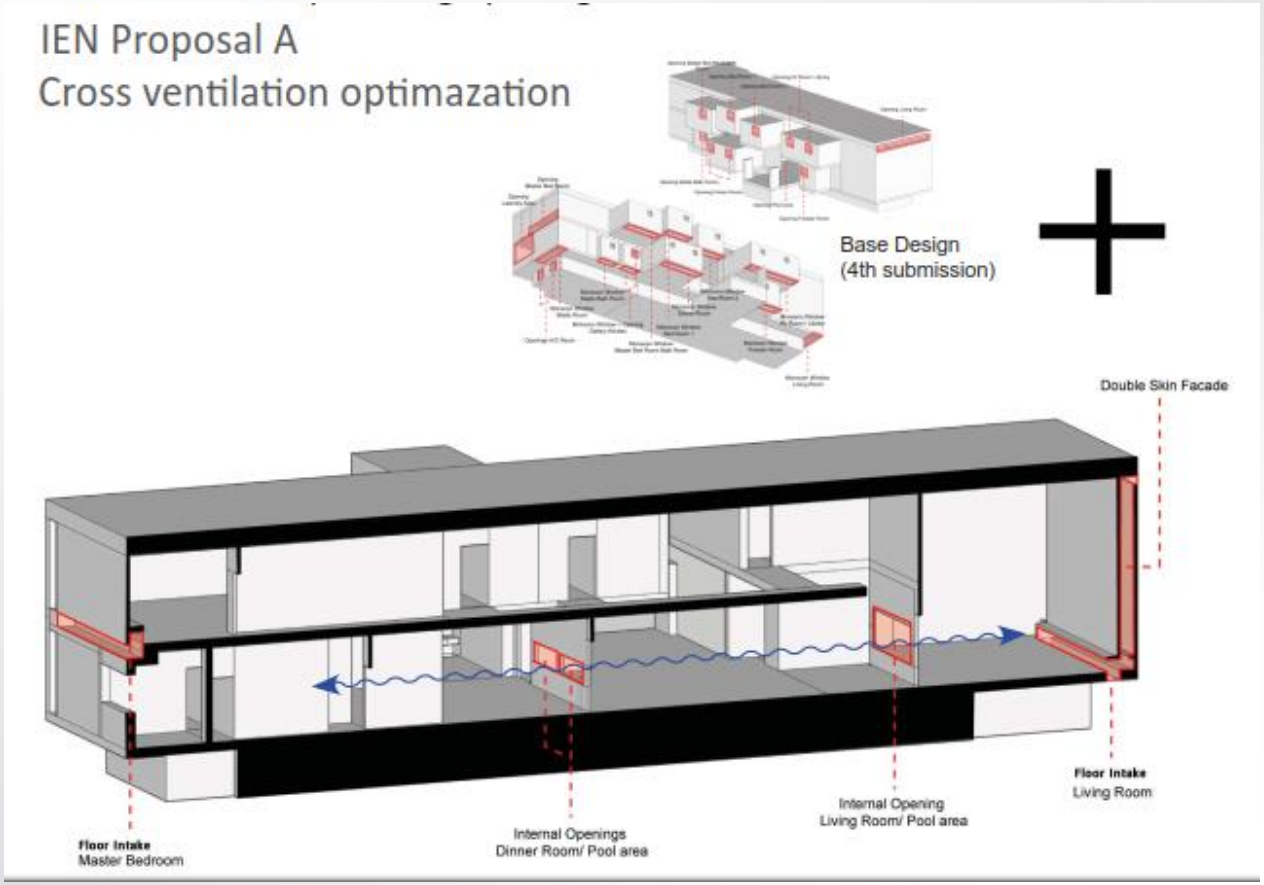
6. Case Study – Residential Building in KL

Optimizing Openings for Increased Air Flow



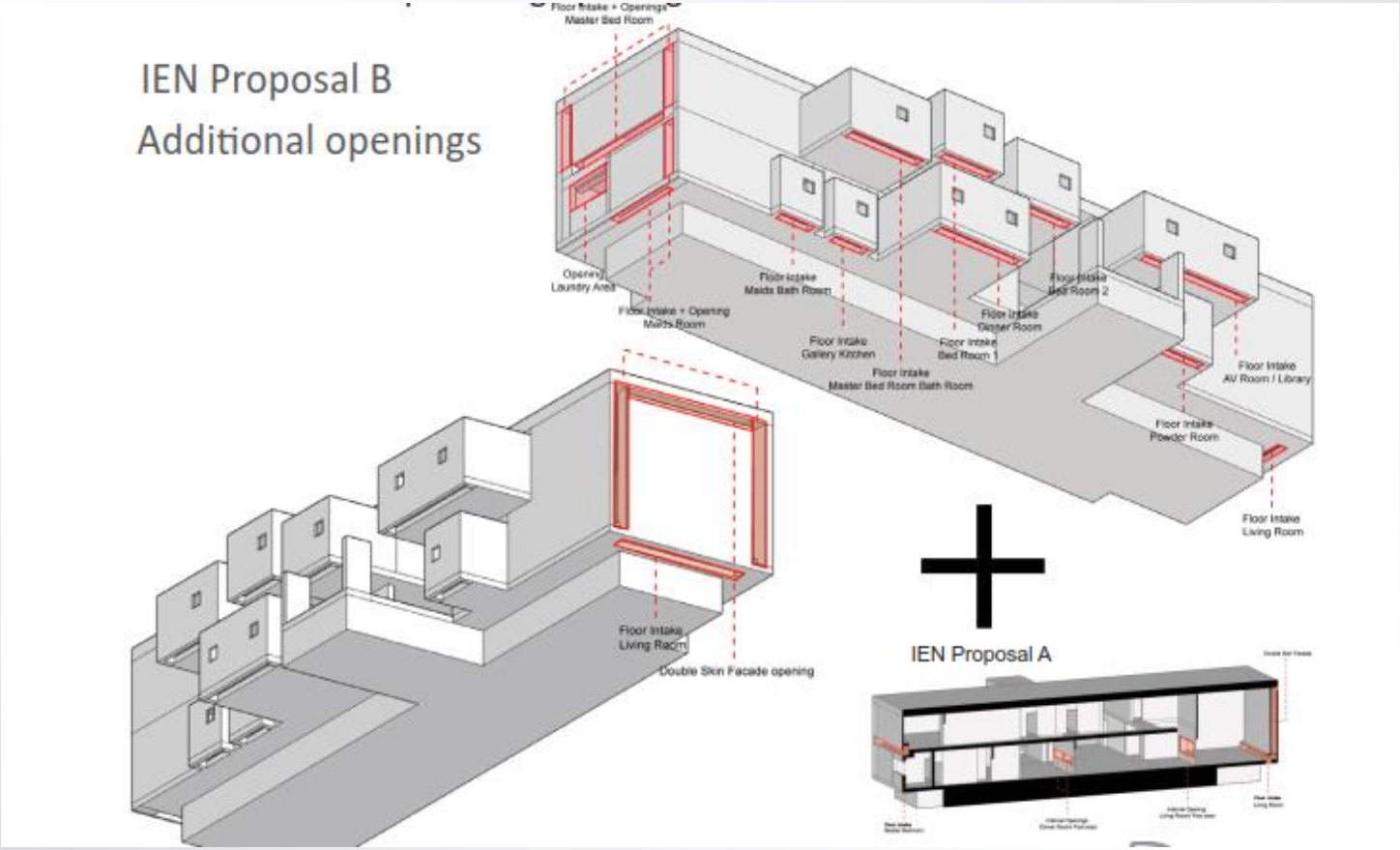
6. Case Study – Residential Building in KL

Optimizing Openings for Increased Air Flow



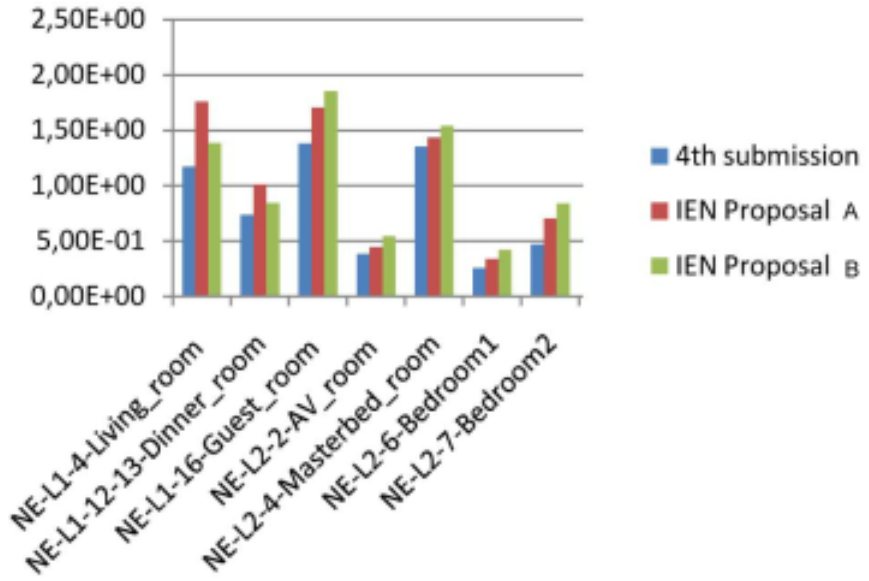
6. Case Study – Residential Building in KL

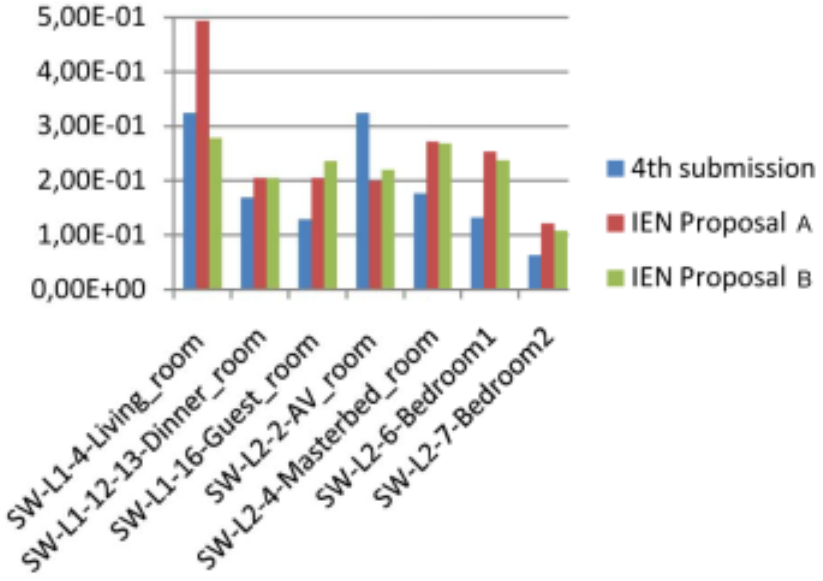
Optimizing Openings for Increased Air Flow



6. Case Study – Residential Building in KL

Optimizing Openings for Increased Air Flow





The summary shows a Natural Ventilation increasement of 20-30%

Higher Occupancy Comfort

Lower Energy Consumption by reduce the need of active cooling (A/C)

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

7. Protect Existing Greenery

TREES MAKE MONEY? HERE'S HOW:

- Up to 18% increase in property values with substantial matured tree cover
- Up to 22% increase in property values with tree covered undeveloped land acreage

POTENTIAL INCREASE IN DEVELOPMENT COST – 5.5%

*****_Study done by University of Washington_

FACT

At RM8000/matured tree, a 25-30% savings is possible from re-using existing matured trees

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

8. Low Impact Development

Open Grid Paving

Systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat

Bioswales

- **Increase in cost for landscaping materials**
- **Reduced stormwater infrastructure cost**
- **Increased developable space (OSD space)**
- **Increase in open space = increase in rental/sales**

TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

9. Solid Waste Management

LOW INVESTMENT COST!!!

REDUCE COST OF SENDING WASTE TO LANDFILL
AVOID BEING FINED!
DON'T BE A CRIMINAL! (AKTA 672)

9. Solid Waste Management

SERI RAJA CHULAN CONDOMINIUM CASE STUDY

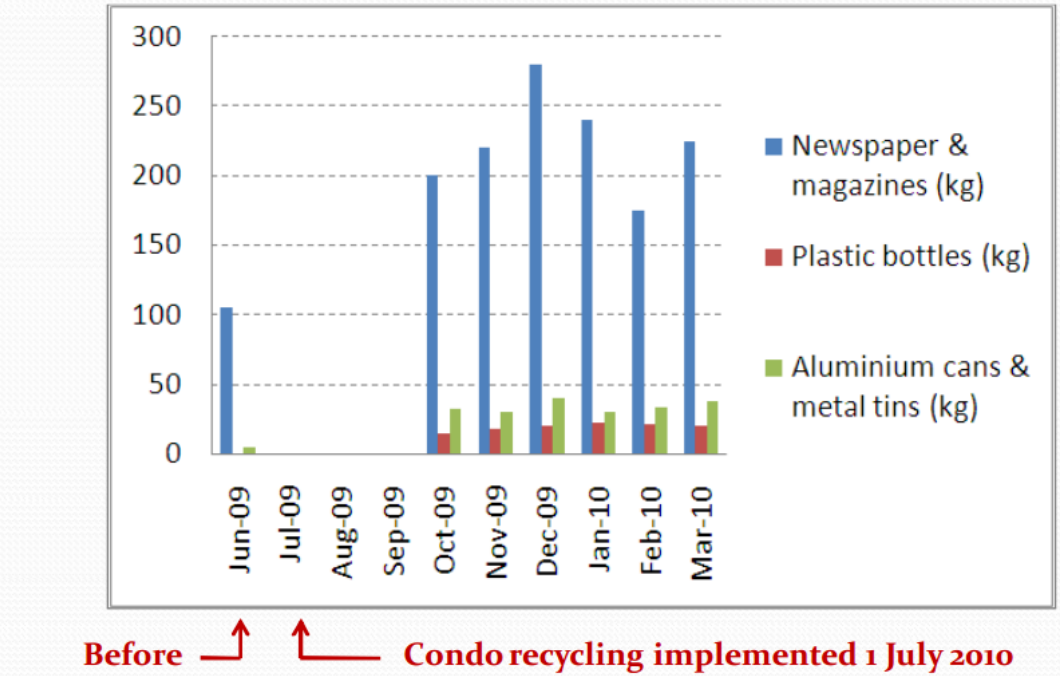
91 Units; 4 Units/floor - 1 trash room/floor; 23 Floors

Total Investment Cost for Recycling Bins + Communication Signages

RM675 = **RM7.40/unit**

Survey Indicates:
94% residents say recycling systems increase the attractiveness of the condo

MAKE YOUR CLEANERS YOUR RECYCLING HEROES!



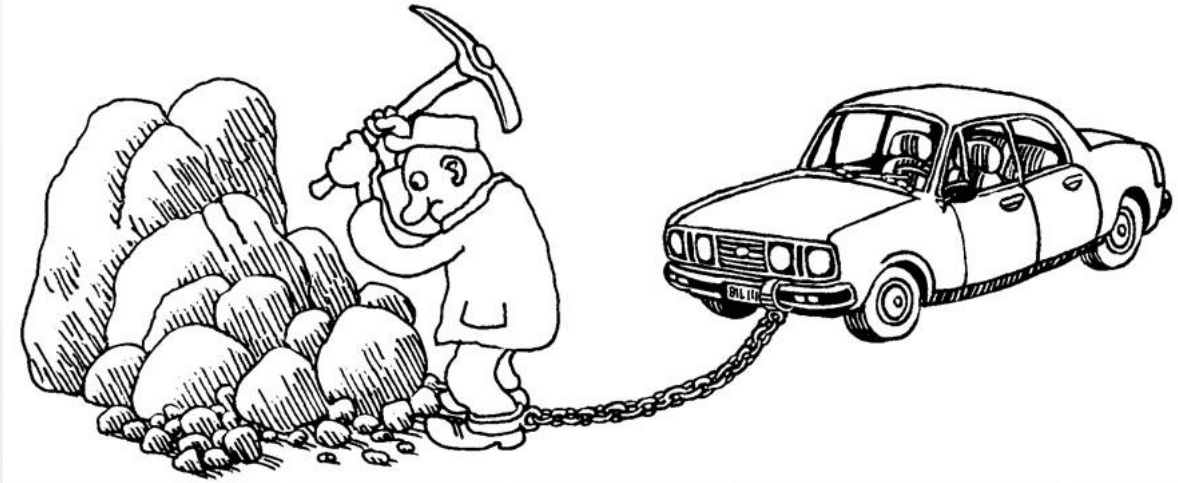
TOP 10 INEXPENSIVE GREEN BUILDING IDEAS & APPLICATIONS

1. Integrative Process
2. Optimizing Solar Orientation
3. Energy Efficient Hvac System
4. Submetering
5. Effective Lighting Design
6. Natural Ventilation
7. Protect Existing Greenery
8. Low Impact Development
9. Solid Waste Management
10. Access To Public Transportation

10. Access to Public Transportation

Shaded Walkways = **Reduced Dependency on Automobiles** = **Worker Productivity** + **Sales & Rental**

- ✓ Select sites close to public transportation
- ✓ Allocate space and cost for provision of bus/taxi stops close to building entrance
- ✓ Incorporate matured shaded tress and/or structural shade along pedestrian access



The average Danish car owner works more than one week per month in order to achieve the freedom a car provides.

10. Access to Public Transportation

JKRpH TL7.3: Penanaman Pokok Teduhan

Katakan;

Luas kawasan	= 11,300 m2
Tapak bangunan	= 5,605 m2
Keluasan bayang pada pukul 10am	= 1650 m3
Keluasan bayang pada pukul 3pm	= 1850 m3
Purata	= 1,750 m2

= 1,750 / (11,300 – 5605)

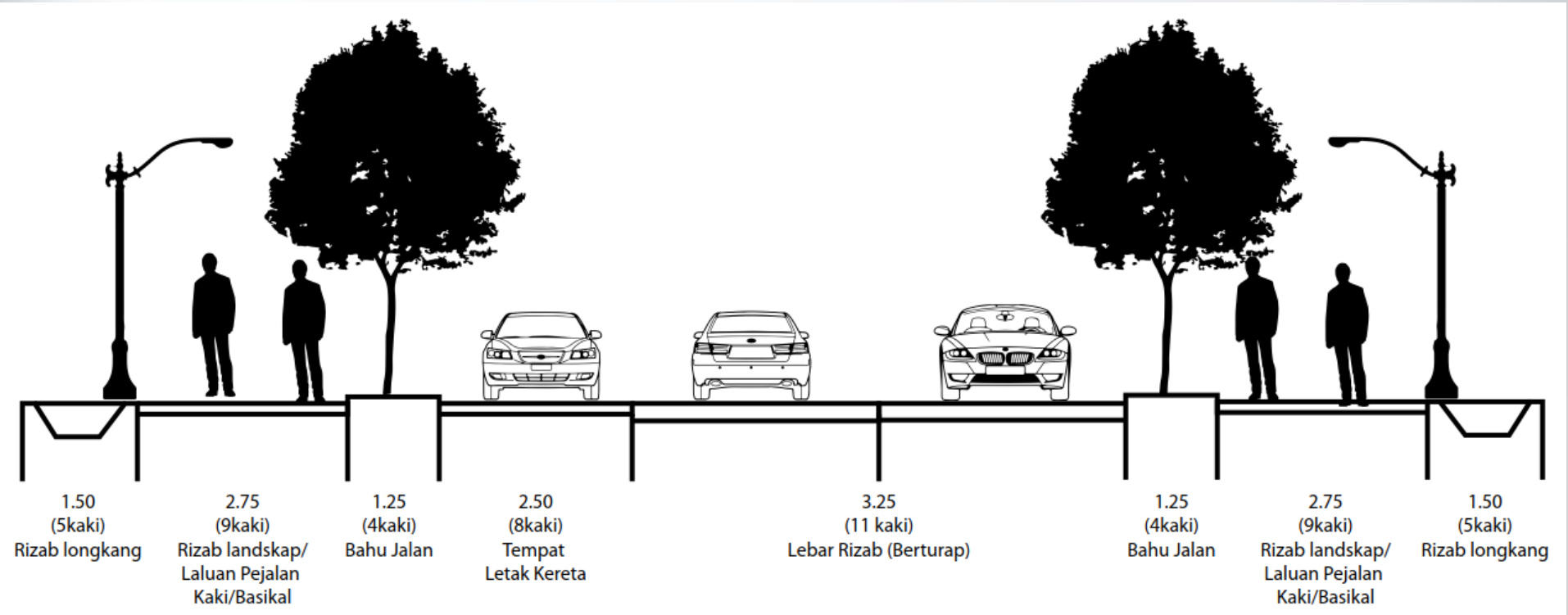
= 30%

Rajah 18 : Contoh kaedah mengira jumlah bayangan pokok

Dalam latihan ini, pereka menggunakan perisian *Sketchup* dengan mengaktifkan pilihan paparan bayang-bayang yang kemudiannya ditekap dalam keadaan paparan perspektif dan kemudiannya luas kawasan dikira daripada paparan pelan.

10. Access to Public Transportation

MyCrest IS5.1 – Accessibility to Public Transport – Covered Pedestrian Walkway



10. Access to Public Transportation

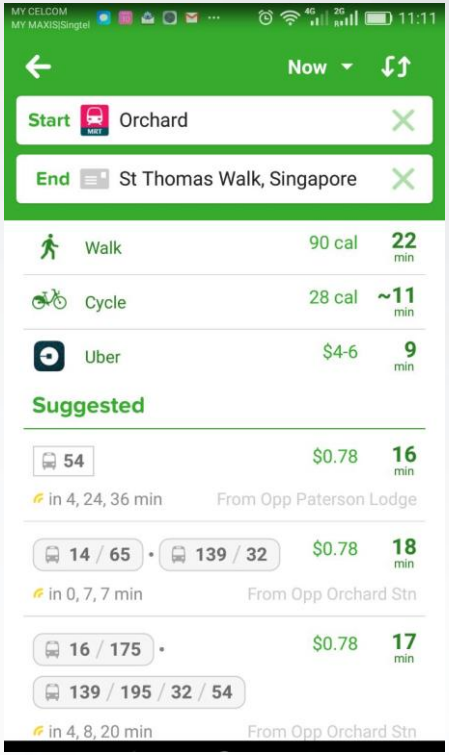
Kuala Lumpur Bukit Nanas – Dang Wangi Connection

LRT Taman Melati – Taman Melati Residential Area

10. Access to Public Transportation

ADDITIONAL INNEXPENSIVE EFFORTS

Provide Free Shuttle Service
to Train Stations



Develop Apps Informing Public
of Transport Alternatives

CONCLUSION

GOING GREEN ≠ EXPENSIVE

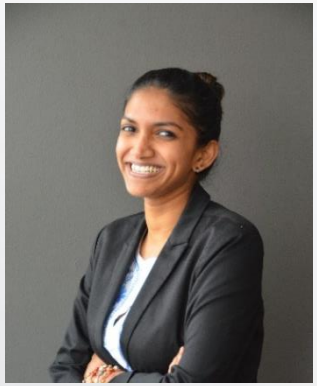
INVEST IN TIME!!

THE ENVIRONMENT IS WORTH YOUR EFFORT

I | E | N CONSULTANTS

GREEN BUILDINGS & PARKS WORLD

Thank you!



- Sheena Moses
- Green Building Consultant, IEN Consultants
- sheena@ien.com.my | +60123518477
- Singapore | Malaysia | China