IHL029 - ITE College East

Sustainable Cities Challenge

HOUGANG MALL

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Introduction

"Just keep moving forward."

Item	Direct emissions from source	Input	Conversion Factors	Carbon Equivalent ($kgCO_2e$)
Electricity from Supplier	Natural Gas Plant	6372900 kWh	0.4057 kg CO_2/kWh	2,585,486
Water	SP Bill	69360 kL	1.3 kg CO_2/kL	90,168
Waste	SP Bill	473190 kg	0.5614 kg CO_2 / kg waste	265,660
Total				**2,941,313**

Introduction

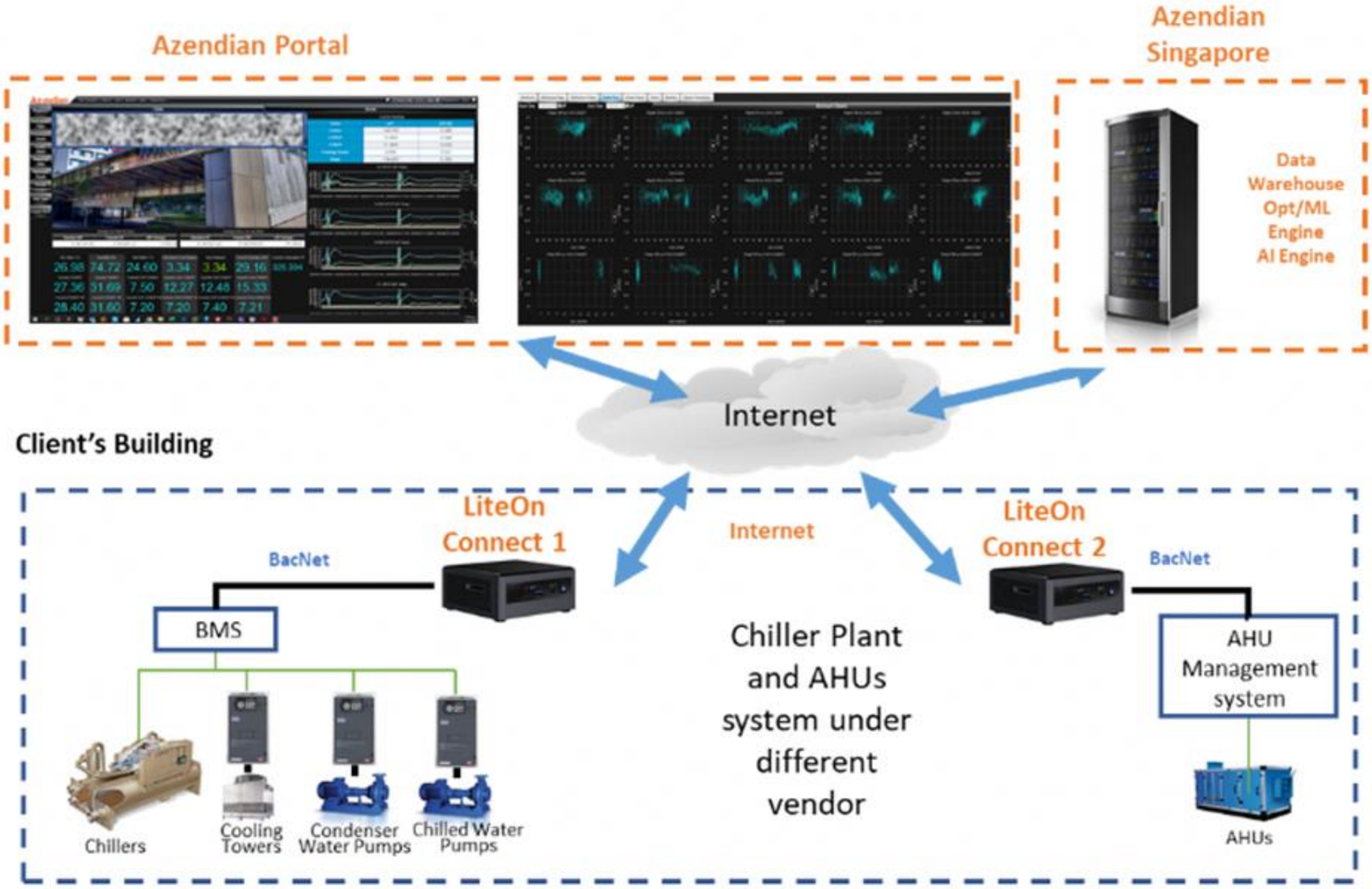
"Just keep moving forward."

There are many benefits to upgrade shopping mall to a sustainable shopping mall. Some of the numerous benefits includes the following:

1) Environmental Conservation
2) Cost Savings
3) Enhanced Brand Image
4) Improved Air Quality
5) Reduced Carbon Footprint
6) Attraction of Tenants and Retailers
7) Community Engagement
8) Resilience to Climate Change
9) Regulatory Compliance
10) Long-Term Value

Energy Efficiency

1.1 Chiller Plant Efficiency



Energy Efficiency

1.1 Chiller Plant Efficiency

To align with mandatory minimum energy efficiency requirement, Hougang Mall shall require achieving 60% energy savings to qualify for GM SLE rating certification.

	Benchmark for SLE	Proposed for Hougang Mall
Total System Efficiency (TSE)	0.9kW/RT	0.75kW/RT
Chiller Plant System Efficiency	0.6kW/RT	0.6kW/RT

Energy Efficiency

1.2 Air Distribution

Energy Efficiency

1.2 Air Distribution

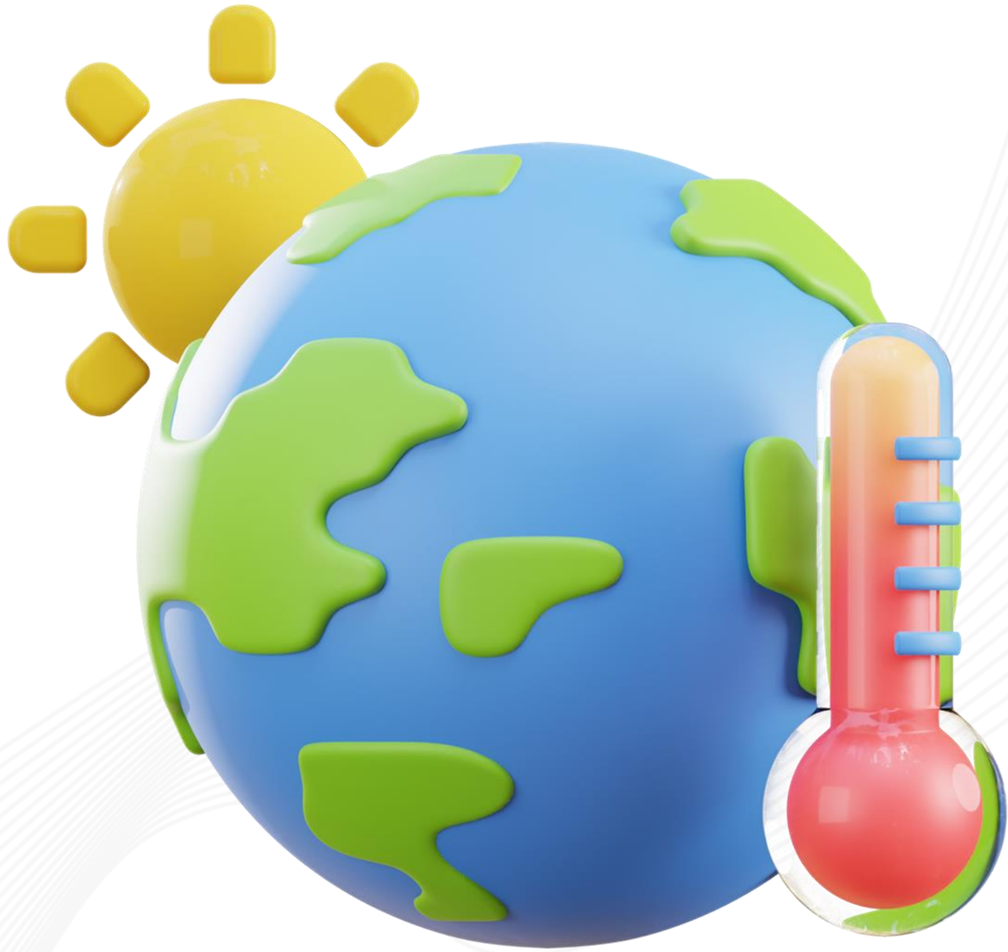
The target air distribution efficiency = 0.15 kW/RT. This can be achieved by replacing the existing air handling units (AHU) fans to EC (Electronic Commutation)/DC (Direct Current) fan.

	Benchmark for SLE	Proposed for Hougang Mall
Total System Efficiency (TSE)	0.9kW/RT	0.75kW/RT
Chiller Plant System Efficiency	0.6kW/RT	0.6kW/RT
Air Distribution System Efficiency	0.25kW/RT	0.15kW/RT

Energy Efficiency

1.3 Higher Set-Point Temperature

To further improve energy efficiency, the air-conditioning temperature set-point can be increased to 26°C at public or common areas. Every 1°C raised in set-point temperature, cooling load energy reduction between 8 to 9 % can be expected.



Energy Efficiency

1.4 Lighting Systems

Another area for energy efficiency improvement is to further reduce the lighting power density (LPD, W/m^2) by adopting high efficacy (Lumen/W) light fittings.

1.5 Energy Generation

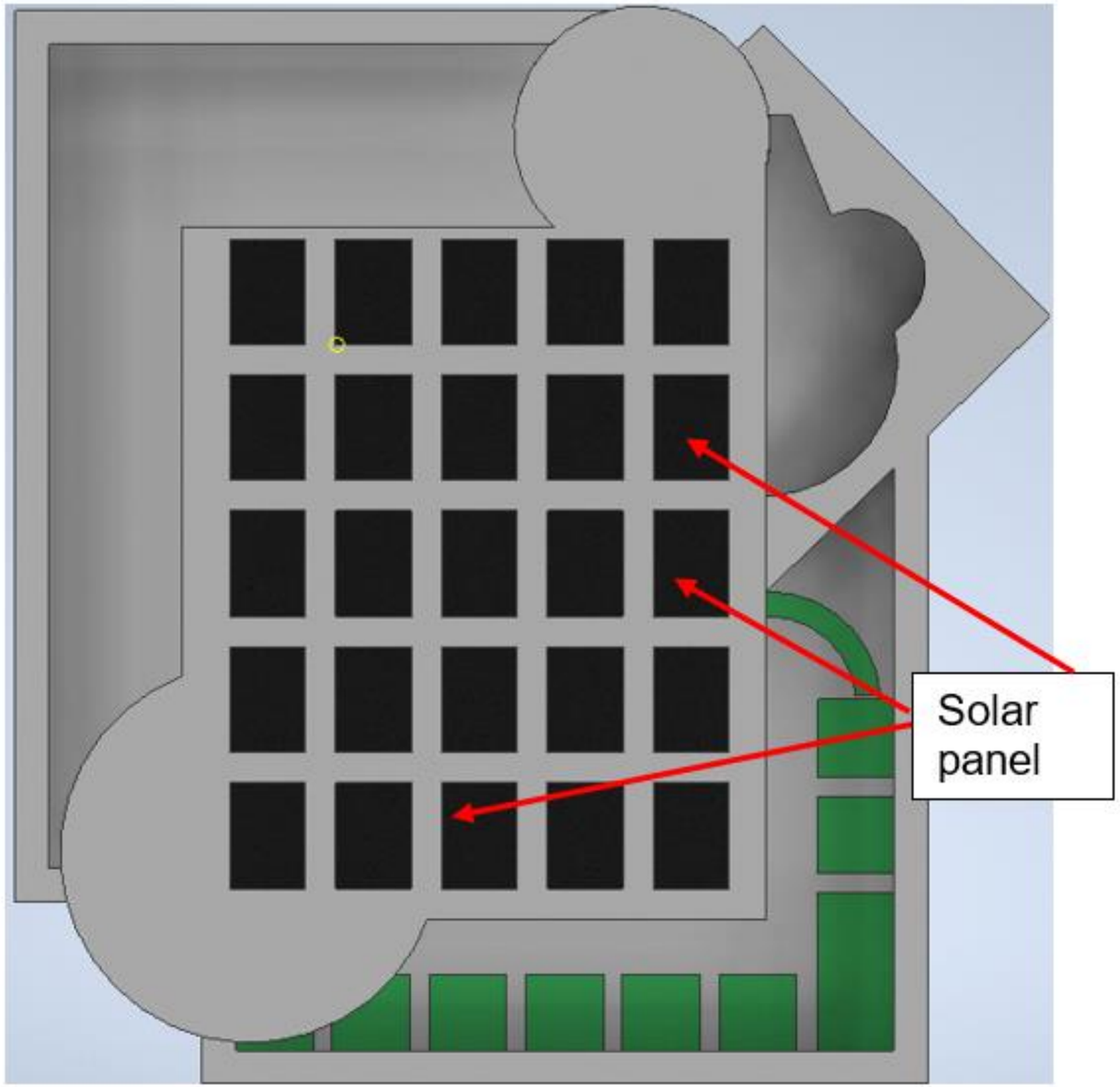
1.5.1 Solar Panel

Assume:

1. Solar panel installation area is around 500m^2.
2. Sunshine hours 100 hours/month.
3. One piece of solar panel area is 1m^2

Achievement:

Solar panel will generate 250000kWh per month



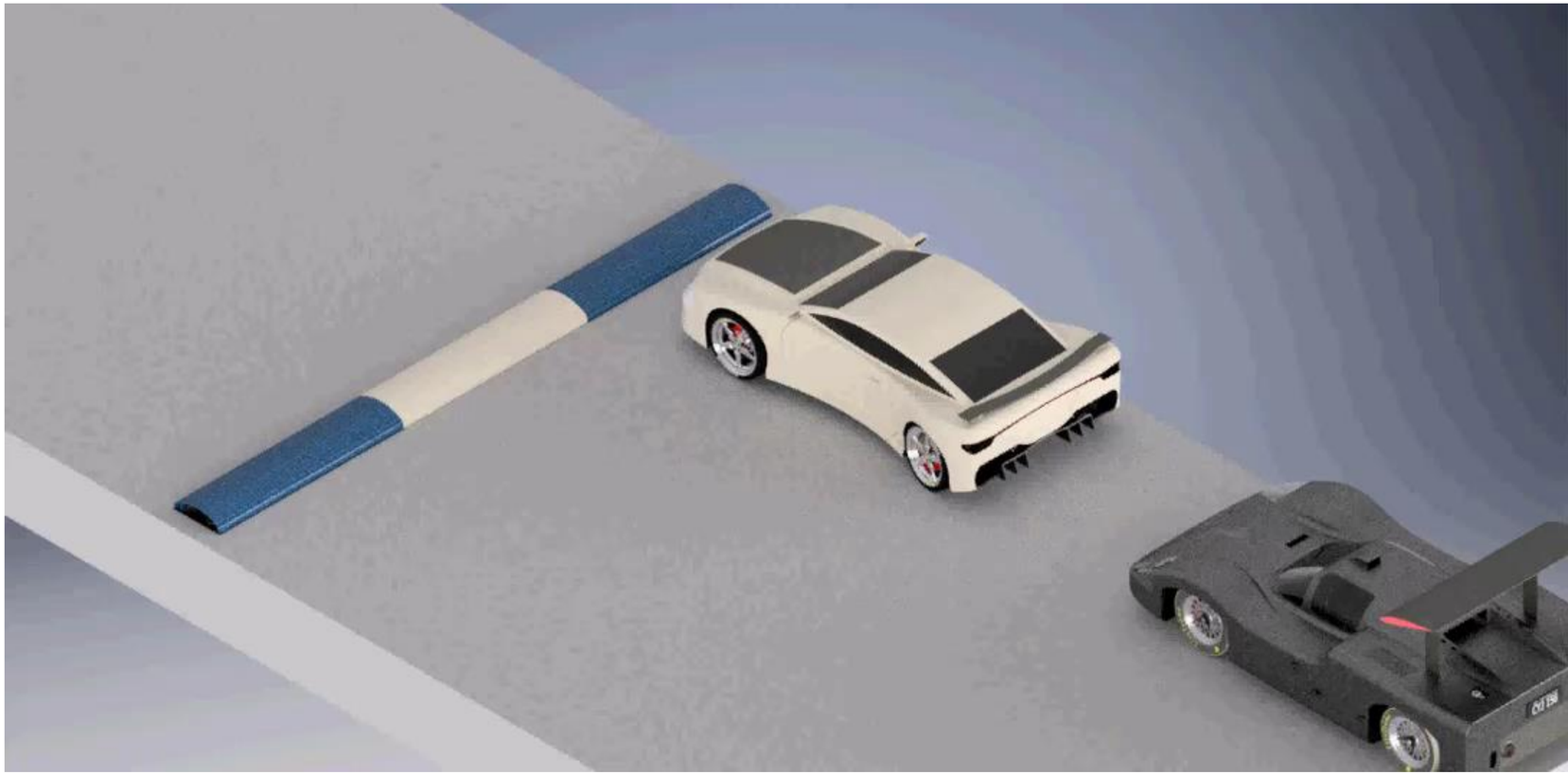
1.5 Energy Generation

1.5.2 Dyno-hump

Assume 0.1 million car enter/exit Hougang mall every month.

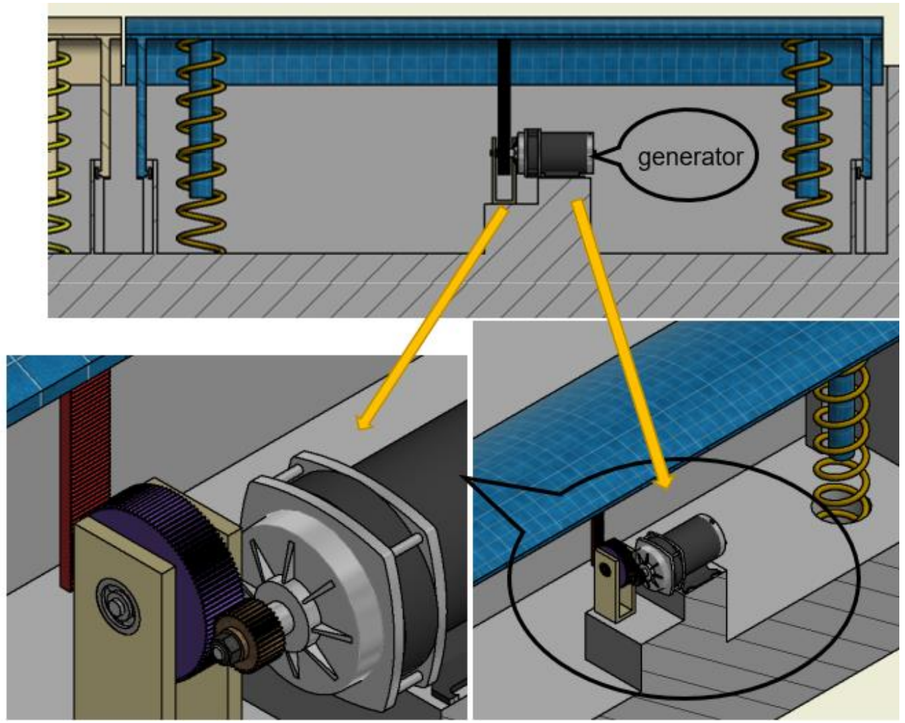
1.5 Energy Generation

1.5.2 Dyno-hump

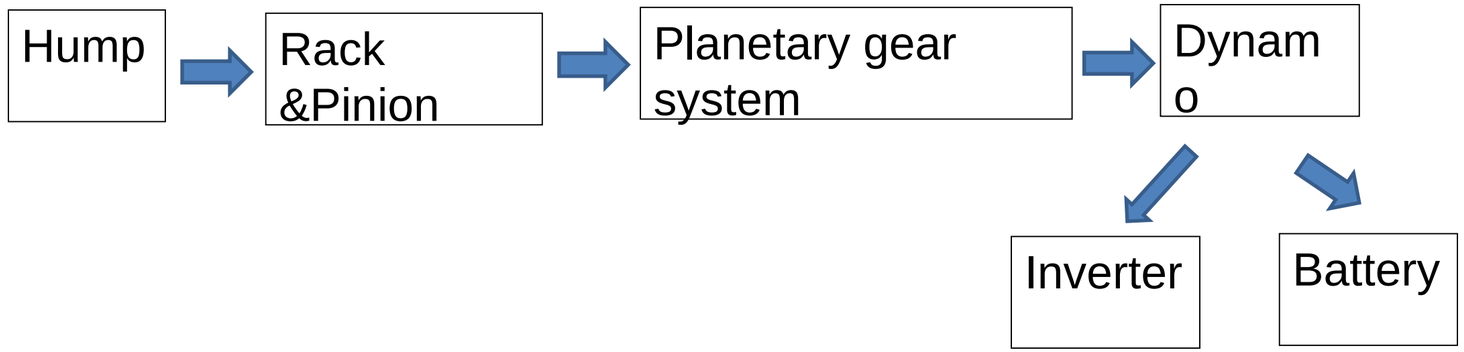


1.5 Energy Generation

1.5.2 Dyno-hump



Dyno-hump design



Working principle

1.5 Energy Generation

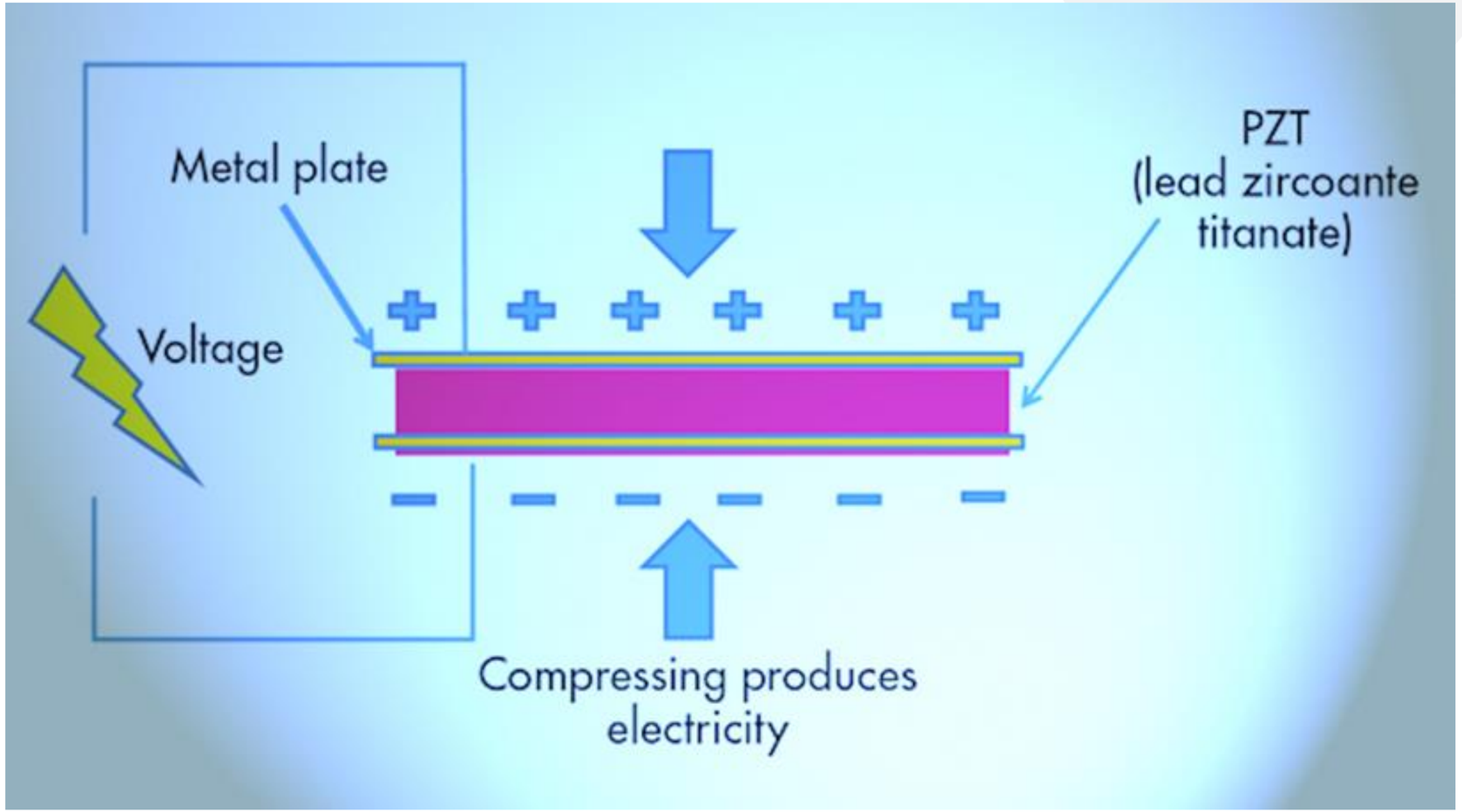
1.5.2 Dyno-hump

Achievement:

One-month electricity generation is
0.56kW x (3/3600)hour x (0.1×10^6) x 30 = 1400kWh.

1.5 Energy Generation

1.5.3 Piezoelectric generation



1.5 Energy Generation

1.5.3 Piezoelectric generation

Experiment:
one person walking 57 steps can generate 9.26×10^{-5} J = 2.57×10^{-11}kWh

Assume:
one month there are 1 million shopper traffic and each person walks about 1×10^{6} steps in the mall.

Achievement:
Generate energy 2.57×10^{-11}kWh x 10^{6} x 10^{6} / 57 = 0.45kWh per month

Energy Efficient

1.6 Double-slope hollow glazed roof

Propose:
Using double-slope hollow glazed roof to replace the existing glass roof

Assume:
The glass roof area is approximately 30% of the total roof area.
The temperature of the mall is set at 26 degree.

Achievement:
The temperature of the inner surface decreases by about 3.66% which is approximate 1 degree. In turns saving 8% of energy consumption for aircon.

2 Water Efficiency

2.1 Water tap maintenance

Achievement:

10L water saving per month

2 Water Efficiency

2.2 Recycling of grey water

Proposal:

Collect the grey water such as rain water and water from washing hand or vegetable to flush toilet or water the plant proposed for the roof top,

Achievement:

it is estimated to save 30% of water usage which is 3468kL (11560kL x 30%).

3 Vertical and Roof Top Greenery

3.1 Vertical wall greenery

Assumption:
The façade area suitable to build green wall is about 8% of floor area.

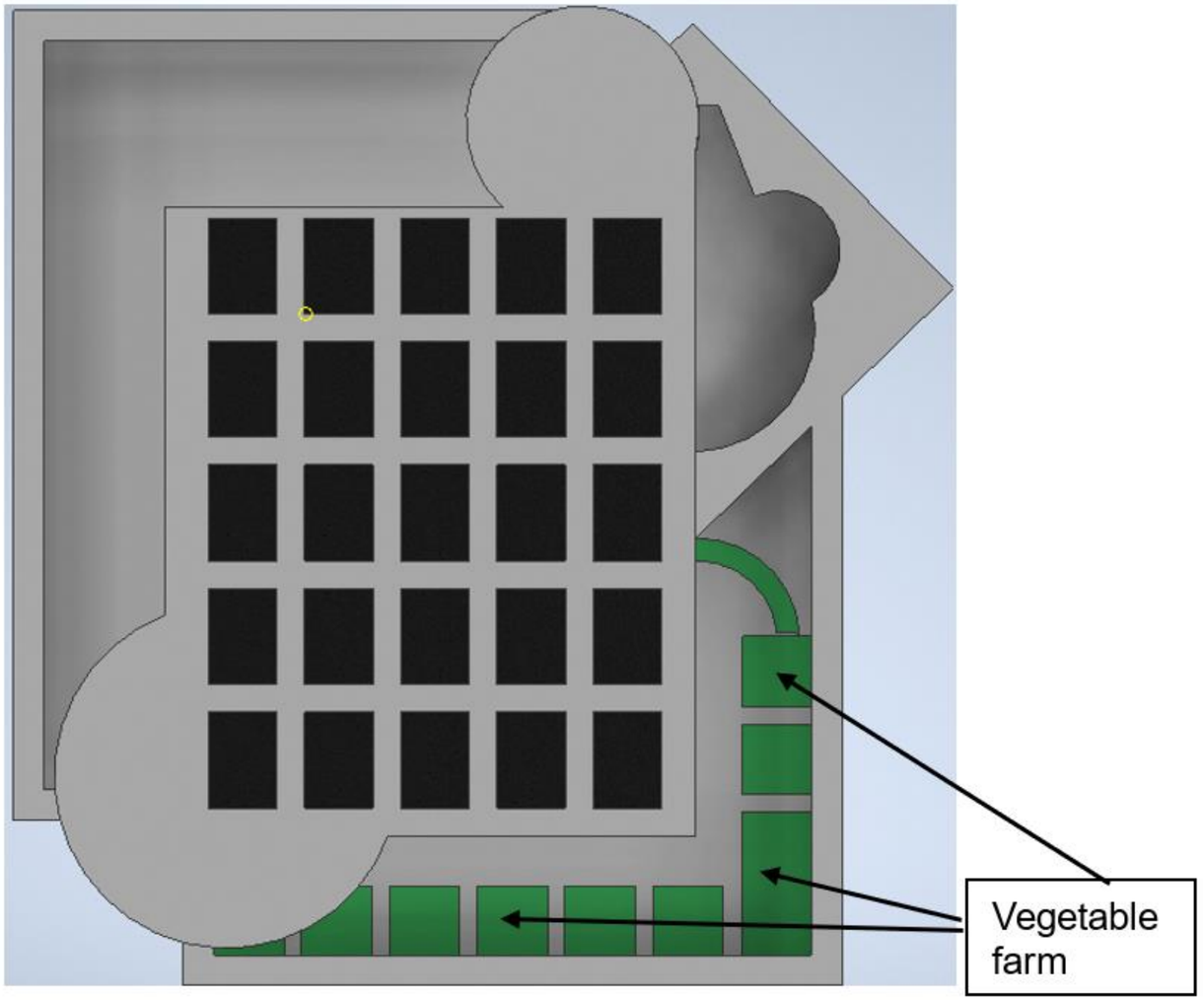
Achievement:
Save 1.92% of the total amount of electricity used

3 Vertical and Roof Top Greenery

3.2 Roof top greenery

Proposal:

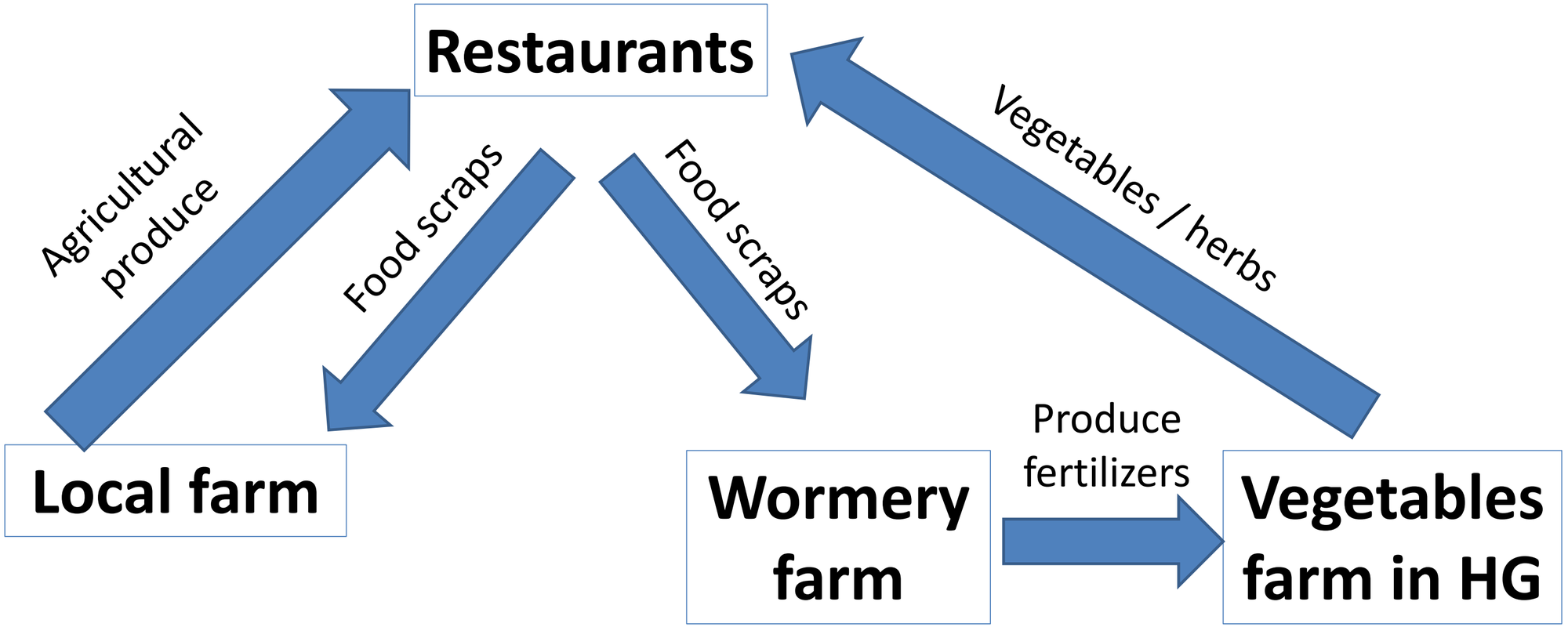
Planting vegetables on the roof.



4 Waste Management

4.1.1 Animal Feed

Proposal:



4 Waste Management

4.1.2 Anaerobic Digestion

Proposal:

compress and dry food wastes using induction heating

4 Waste Management

4.1.1 and 4.1.2

Assumption:
80% is food waste

Achievement:
Cutting food waste by roughly 80% which is about 50474 kg.

4 Waste Management

4.2 Waste classification and recycling

Assumption:
20% is food waste

Achievement:
Cutting non-food waste by roughly 50% which is about 7887 kg.

5 Summary

5.1 Energy Efficiency

Proposed Ideas		**Generation & Deduction**
Aircon	1.1 – 1.3, 1.6, 3.1, 3.2	The energy efficiency can be reduced about 68% + 8% + 1.92% = 77.92%
Lighting	1.4	5.5%
Electricity generation	1.5	250000kWh + 1400kWh + 0.45kWh = 251400.45kWh (per month)
Total deduction		**83.42%**

a. The overall electricity consumption over a six-month period will be approximately 6372900kWh x (100% -83.42%) = 1056627kWh.
b. The amount of electricity generated over a six-month period is 251400.45kWh x 6 = 1508403kWh.

5 Summary

5.2 Water Efficiency

Proposed Ideas	Deduction
2.1	0.01kL
2.2	3468kL
Total	**3468.01kL**

The total water use over a six-month period will be approximately 48552kL.

5 Summary

5.3 Waste Management

Proposed Ideas	Deduction from the proposed idea
4.1	50474kg
4.2	7887kg
Total	**58361kg**

The total amount of waste burned over a six-month period will be approximately 123024 kg.

5 Summary

5.4 Carbon Equivalent after implementation of our proposal

Item	Input	Conversion Factors	Carbon Equivalent ($kgCO_2e$)	
			Implemented	Before
Electricity from Supplier	1693917kWh	0.4057 kg CO_2/kWh	687222	2585486
Electricity from solar / generator	1508403kWh	0.4057 kg CO_2/kWh		
Water	48552 kL	1.3 kg CO_2/kL	63118	90168
Waste	123024 kg	0.5614 kg CO_2 / kg waste	69068	265660
Total			**819408**	**2941313**

That carbon equivalent can reduce 72%.

Thank You

Annex: Carbon footprint calculator

Item	Remarks	Input		Coversion Factors		Carbon Equivalent (kgCO2e)
		Quantity	Unit	Quantity	Unit	
Scope 2:	**Indirect Emissions from purchased energy**					**428,674**
Electricity from Supplier - Natural Gas Plant	Natural Gas Plant	1056627	KWh	0.4057	kg CO2/kWh	*428,674*
Electricity from solar/ Carbon neutral sources	Zero carbon	1508403	kWh	0	kg CO2/kWh	*0*
Scope 3:	**Indirect Emissions from supply chain (Not under Company control)**					**132,186**
Water Consumption- Potable Water	SP Bill	48552	m3	1.3	kg CO2/m3	*63,118*
Waste Disposal - General Waste	SP Bill	123024	kg	0.561422507	kg CO2 / kg waste	*69,068*

6 References

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