1IoT White Paper

I. Abstracts

40% of world's energy is consumed by commercial buildings. A study conducted by Hong Kong Energy together with Hong Kong department of Environment found that 90% of the city's electricity is consumed by buildings with commercial / office buildings representing 66%. Air conditioning accounts for 30% of end use consumption alone.

Figure 3 Electricity consumption by sector, 2012

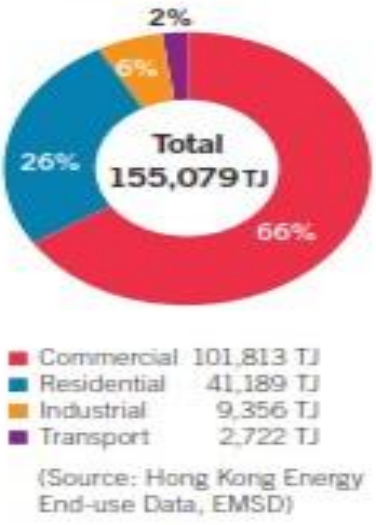
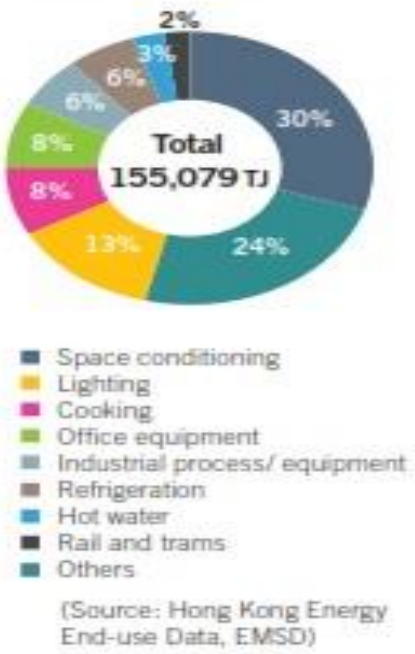


Figure 4 End-uses of electricity in Hong Kong, 2012[7]



Over the years since 2005, there has been considerable drain to Hong Kong Energy infrastructure especially in the summer where transformers overloads are a frequent occurrence. Hong Kong's China Light Power since 2011 have started even providing incentives to customers to lower consumption in peak hours but this campaign has shown no impact in end user consumption.

Hong Kong since 2012 has launch an Energy savings plan with focus on replacing old existing appliances to energy saving appliances in the city and has since shown a decrease of energy use of 15% as of 2015. This however is not enough to meet the target of reducing energy footprint by 40% by 2025 and lessen the strain on Hong Kong's power supply systems.

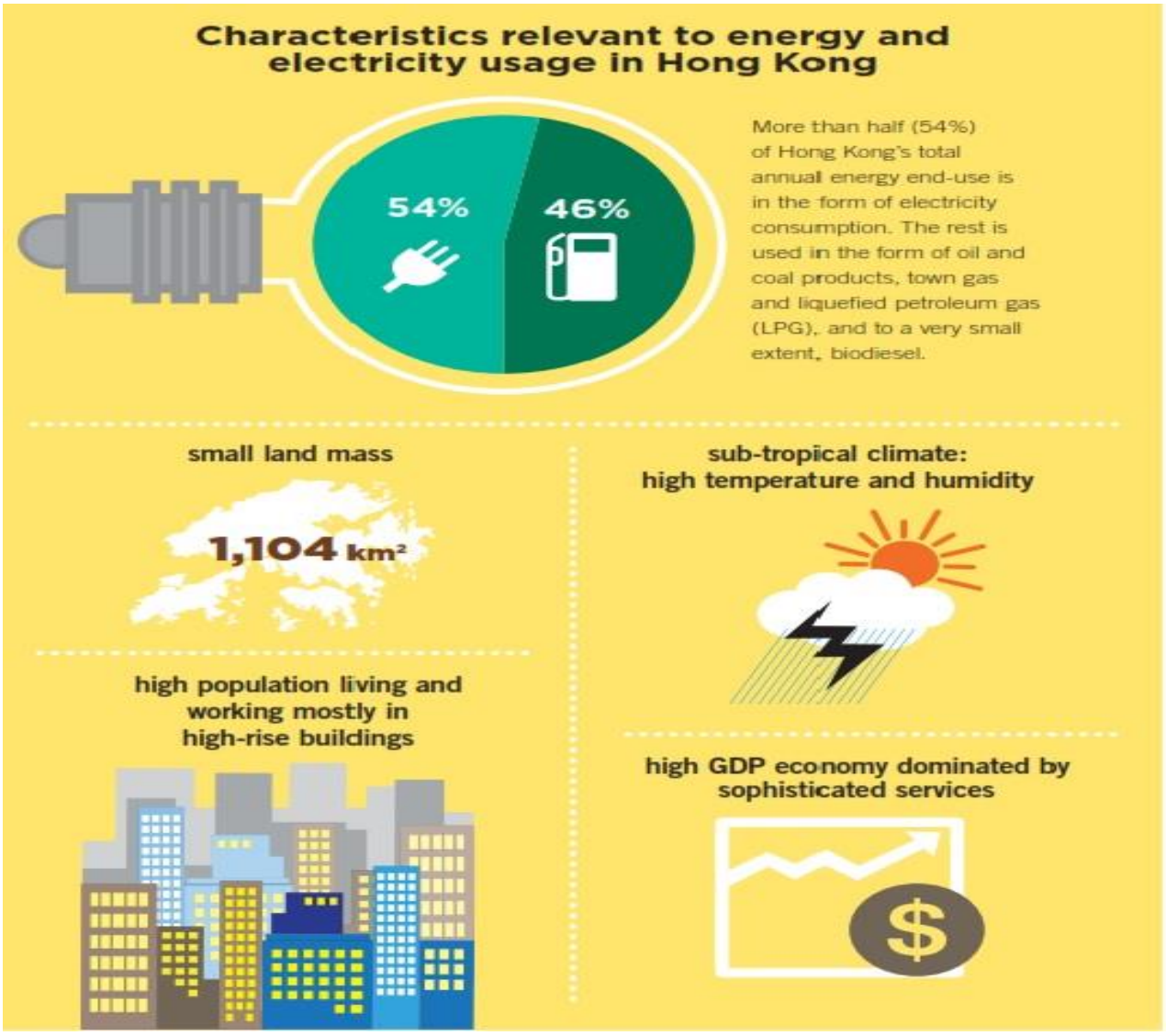
As for China, statistical information have been very scant about Energy Footprint and strain to Energy infrastructure. But through evaluation of our series of interviews conducted in 2017 in the cities of Shenzhen and Guangzhou the situation is worse than that of Hong Kong where at least there are penetration made for Automated Building Management Systems and Variable Air Volume (VAV) HVAC systems. 90% of Mainland China's Buildings both Commercial and Residential do not even deploy any of these advance automated energy sustainable systems in their premise. Buildings predominantly utilize traditional HVAC systems with Chillers and Boilers setup on the rooftops.

The purpose of this white paper is to present the potential of deploying Industrial Internet of Things Energy Management Systems in Commercial Buildings and Industrial Factories in both Mainland China and Hong Kong as a means of reducing strain to Energy infrastructure.

II. Introduction

IoT (Internet of Things) systems has proliferated globally since the advent mobile communication infrastructure such as IPv6 has become more advance and affordable to deploy. The ease in accessibility and availability of IP capable devices has enabled the large scale deployment of autonomous IoT ecosystems in urban environments creating the term of Smart Cities.

As urban population especially in Asia has continued to grow, the current energy infrastructure to support the population growth has been inadequate unless further investment in new power plants are made. For a city like Hong Kong where the ratio of population density to square meter is one of the worst in the world, investing in new power plants is not an answer to this issue. The city have to be greener in both near and long term in order to be sustainable.



Though not as bad as Hong Kong's population density, Mainland China cities of Beijing, Shanghai, Guangzhou and Shenzhen also exhibits the same issues as Hong Kong where urban population have continuously grown over the years. In normal times, the answer will be to increase the building of power plants to support urban infrastructure but due to coal based power plant's impact to pollution of the environment and while nuclear energy pose exposing the public to risk as exemplified in Chernobyl, Three Mile Island and Fukushima incidents, the most sustainable solution is to find green solutions to manage energy consumption in urban areas.

Today, IoT technology for energy saving has been focused on Smart Home usage. There has not been a successful deployment of IoT in Commercial use case as the biggest challenge has been its cost structure. For Commercial Building deployment of IoT Energy Management System, it must meet a criteria of able to actually save cost for the company after implementation and annual support fees are accounted for.

Underpinning argument is that with today's technology it is indeed possible to build an IoT Energy Management System that provides relevant solutions to meet Commercial viability challenges required by Commercial Buildings and thereby assisting governments to achieve reduction of energy in the biggest end user of electricity.

III. Application / Case studies

A. The Applicable Use Case Synopsis

One Labs formulated that the best way to get commercial adoptability of IOT EMS solution in real use case is that device must utilize low power technology for Machine to Machine (M2M) connectivity. This means that the solution cannot utilize Wi-Fi, which leaves Zigbee, Thread or 2.4 Ghz Low-power as the only methods that can be used. Zigbee is the most popular M2M communication protocol in use but this requires a license fee to be paid yearly and based on SKU.

In this use case, the technology will be applied on Private Sector Commercial and Industrial Properties such as Office Towers, Shopping Malls, Hotels and Manufacturing Factories. Commercial and Industry properties provide the largest opportunity for the case study as 40% of energy is wasted with just having appliances being left on after regular working hours or closing time. The app's direct users are identified as Landlord's employees, Property Management Facility Managers (including repair and maintenance), Tenants and their employees and Factory employees including Machine operators. The app must be easy to use with no need of training and while implementation of the device must be simple and can be executed by local certified electrician within a 5 minutes duration.

The main products are smart lights attached to each lighting fixture, smart outlets which can optimize and convert any appliances plugged into smart device and smart vent which ensure temperature is just right for every room radius. The smart vent is managed by smart thermostat found with the smart hub which will collect data to be use for big data analytics.

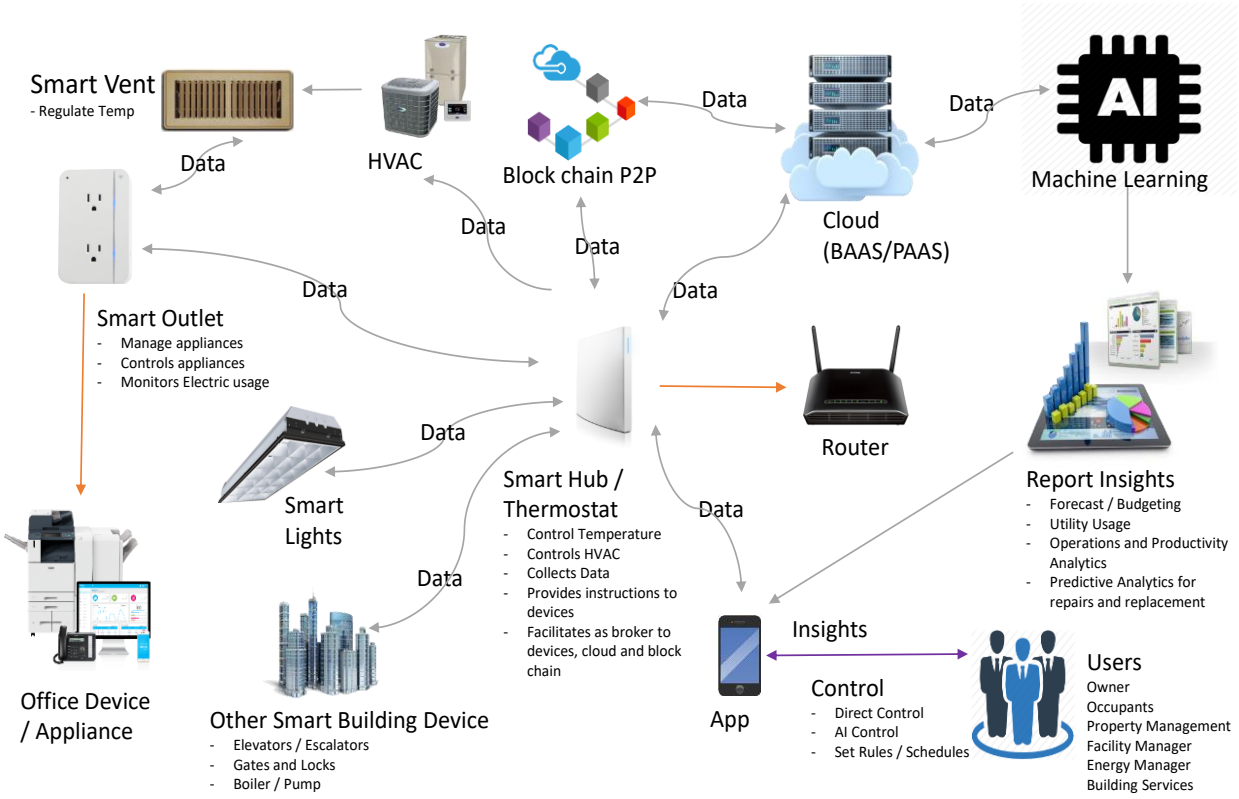
The Smart Lights are small fixtures attached to the ceiling lights which will provide app users the ability to directly control each light they want to. For office workers, employees doing overtime can turn on their cubicle lights and artificial intelligence will manage the minimum lights required to accommodate remaining employees in the office to be able to navigate to the washroom, corridors and the elevators.

Smart Outlet can be complemented by the Smart Powerbar if needed. App users can control turning on and off any appliances any time and even remotely. Part of the Smart Outlet will include components that can sense electric currents similar to the ones found on a smart meter, this will enable the outlet to measure energy used by appliances and provide deep machine learning to study how many hours have the appliance been operating and assess when repair / replacement will occur providing what is necessary to deliver predictive analytics.

The Smart Vent allows app users to directly control the temperature or let AI manage the room temperature ensuring it is just right all the time everywhere. App users can connect to the thermostat or view the temperature on the room any time anywhere.

All the devices can easily be customized to customized existing buildings architectural and structural configurations. Overall, rules and schedules can be set by the facilities manager or the tenant and depending if the area to be managed, one rule takes precedent over the other. The automated rules

will be triggered based on schedule for example regular working hours versus afterhours. This ensure that energy waste is reduced drastically and the savings will be reflected in the monthly utility bills.



The architecture above shows the smart lights, outlet and vent are connected to each other via 2.4 Ghz low-power communication protocol. The data are stored in both the device peer to peer blockchain nodes and with only the essential information streamed to the smart hub data collector device. The smart hub is connected directly to the router either via Wi-Fi or wired connection. One single smart hub can support between 1,000 to 10,000 devices in the premise. The smart hub then relays the information to the cloud MQTT where particular information is utilized for big data machine learning and reporting. Other information such as daily 24-hour weather and temperature data are also stored in big data environment. Energy Audits executed during the project assessment will define Artificial Intelligence rules. Since only a few smart hubs are required in this design, 1IoT shows it can minimize the cloud bandwidth requirements making this solution feasible for Commercial adaptation.

B. Problem and Challenges

There are two key problems and challenges in this solution design. The first being that blockchain technology is still unproven as a data storage system. There are multiple ledger designs available in open source but major issues in performance have proven to be challenging. Currently there are no blockchain protocol that is advance enough that can be utilized. So, in this case, One Labs have instead focused on enhancing the MQTT topix data structure to ensure data information are clean and structured in the smart hub ensuring only necessary information are travelling through the cloud bandwidth.

One Labs' blockchain team continues working on smaller use case to ensure when technology is maturing enough it should can be utilized in time when the smart vent and smart thermostat is ready to be introduced in the market.

The second case pertains to the cost concerns of a typical commercial or industrial property. A detail breakdown of a typical Commercial Building's Operating expense must be examined carefully in order to factor these into the solution.

Figure 1: **Average total operating expense per office rentable square foot by U.S. private-sector building type**
(Avg. $ per office rentable sq. ft.)

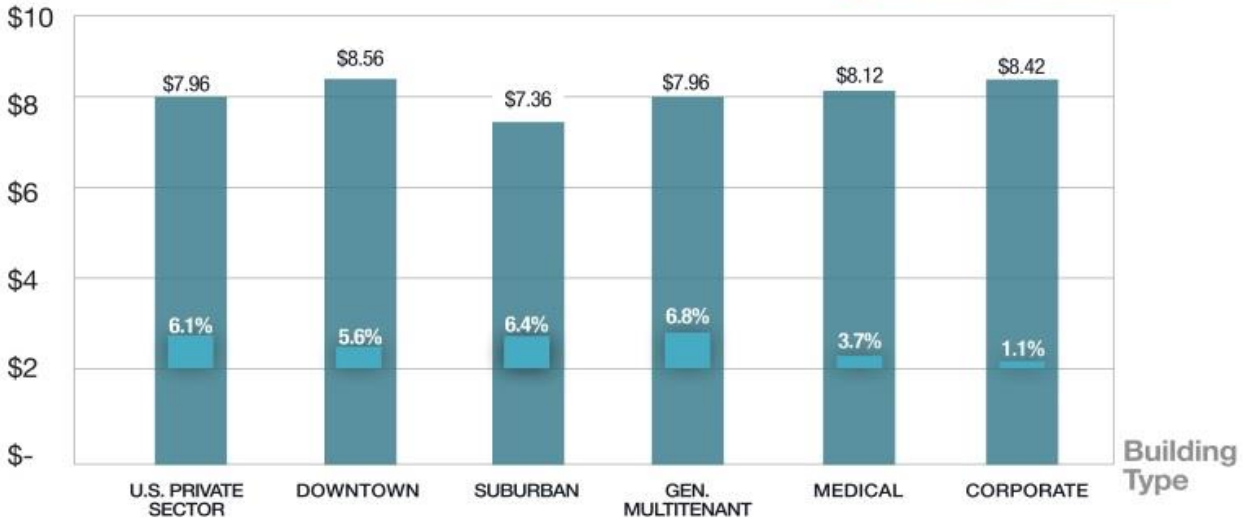


Figure 2: **Average operating expense per office rentable square foot by U.S. private-sector building type**
(Avg. $ per office rentable sq. ft.)

As shown below, a normal Office Tower's utilities account for between 29.5-32% of its operating expense with a year over year average increase of 3.5 - 7.9% in utility cost due to adjusted inflation.

Despite the proliferation of Building Management Systems in developed nations like the US, the impact since 2009 to 2014 has not shown any significant decrease in utility cost for the average commercial buildings. Below showcase the Breakdown of Operating Expense per Commercial Buildings.

Figure 3: **Average utility expense per office rentable square foot by U.S. private-sector building type**

(Avg. $ per office rentable sq. ft.)

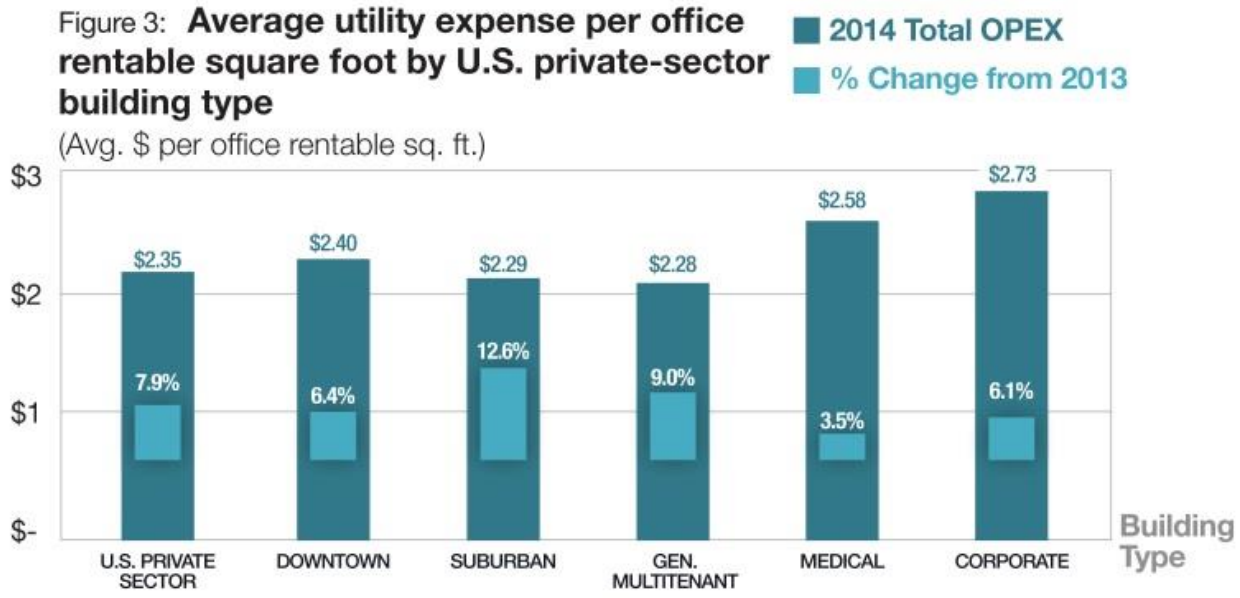
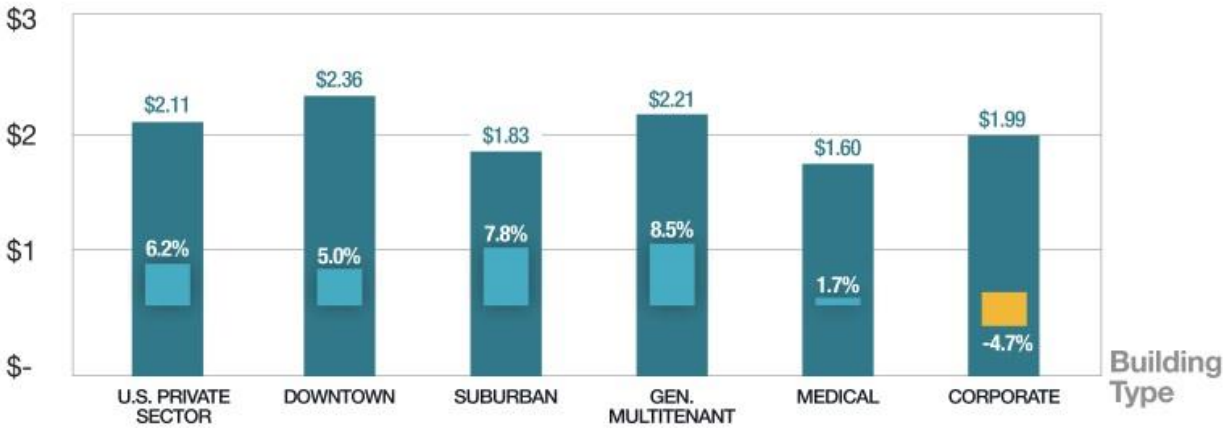


Figure 4: **Average repair/maintenance expenses per office rentable square foot by U.S. private-sector building type**

(Avg. $ per office rentable sq. ft.)



An IoT Energy Management System Solution must be able to lower overall OPEX cost not just utility but must also have an impact on building maintenance cost especially with older buildings the cost have continued to rise due to wear and tear. For businesses, especially for industrial manufacturing factories, one of the most important concern is disruption of their operations while solution must be certified safe without risk of fire hazard. As per requirement needs to be a relevant solution, the Artificial Intelligence provided by the smart device must deliver predictive analytics that can ensure business operations are not disrupted.

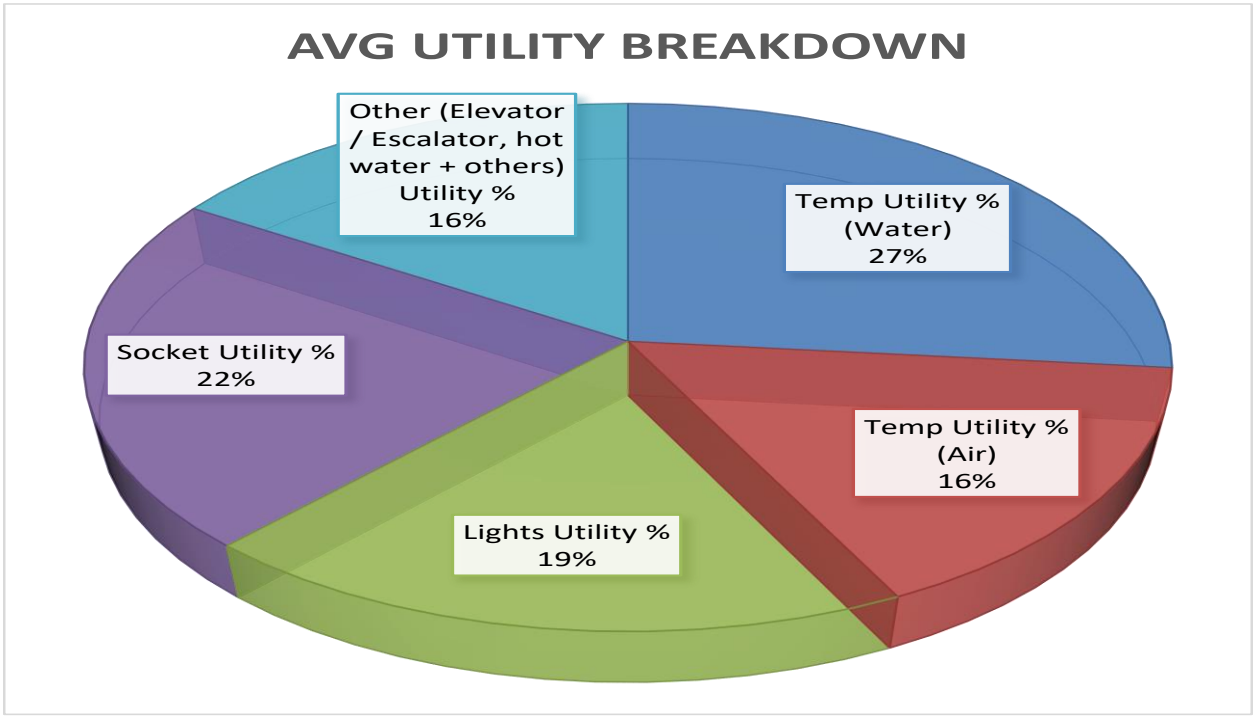
C. Direct Interview / Survey Study

To understand the cost concerns on the ground, One Labs conducted direct interviews between the periods of July 26 to August 4, 2017 for its product 1IoT. The objective of the study is understanding the market needs and the applicable use case as demanded by its potential customers. To do the interview, One Labs have chosen 9 Mid to Large Commercial Buildings located in Hong Kong, Mainland China Tier 1 cities of Shenzhen and Guangzhou. The result is that One Labs was able to separate the features it offers to must have, satisfiers and nice to have segments while solidifying its pricing strategy aligned to customer product value. The subjects are all older buildings with the newest being at least 3 years old. The mid-market older building in maintenance and refurbishment market alone comprise a $13 Billion USD market on its own. All subjects acknowledge that due to new city regulations they are actively seeking potential sustainable technology that can achieve 10% Return on Investment in 24 months. Of the buildings studied only two subjects all in Hong Kong have deployed Building Management Systems.

Below are the Subjects involved in the study with detailed information on the building:

Potential Customer	Building	Classification of Facility	Location	BMS_Flag	VRV_Flag	Currency	Utility Cost Public Area/ month	Utility Cost Tenant Area/ month	Combined Cost/month
Fung Properties	Centennial	Office Tower	HK	0	1	HKD	$ 30,769.23	$ 169,230.77	$ 200,000.00
Fung Properties	Spinners	Office Tower	HK	1	0	HKD	$ 153,846.15	$ 846,153.85	$1,000,000.00
Fung Properties	LiFung Tower	Office Tower	HK	0	1	HKD	$ 80,000.00	$ 440,000.00	$ 520,000.00
Swire Properties	Berkshire House	Office Tower	HK	1	1	HKD	$ 244,215.69	$ 285,784.31	$ 530,000.00
Cheng Dou Electronics Factory	Cheng Dou Electronics Factory	Factory	SZ	0	0	RMB			$ 47,500.00
Dongbao	Dongbao	Office Tower	GZ	0	0	RMB	$ 218,873.00	$ 256,127.00	$ 475,000.00
PangYuGuangChang (AEON Mall)	PangYuGuangChang (AEON Mall)	Shopping Mall	GZ	0	0	RMB	$ 1,585,033.00	$ 2,646,851.22	$4,231,884.22
广州市奔达雅酒店	广州市奔达雅酒店	Hotel	GZ	0	0	RMB			$ 784,177.00
Hotel 2	Hotel 2	Hotel	GZ	0	0	RMB			$1,801,589.00
Average							$ 385,456.18	$ 774,024.53	$1,065,572.25

Potential Customer	Building	Combined Cost USD / Year	Temp Utility % (Water)	Temp Utility % (Air)	Lights Utility %	Socket Utility %	Other (Elevator / Escalator, hot water + others) Utility %	square meter	Device per Square meter
Fung Properties	Centennial	$ 306,905.37	28%	17%	23%	22%	10%	35,000	0.747
Fung Properties	Spinners	$ 1,534,526.85	28%	17%	23%	22%	10%	140,000	0.747
Fung Properties	LiFung Tower	$ 797,953.96	28%	17%	23%	22%	10%	70,000	0.747
Swire Properties	Berkshire House	$ 813,299.23	24%	15%	27%	26%	7%	73,700	0.747
Cheng Dou Electronics Factory	Cheng Dou Electronics Factory	$ 86,363.64	30%	15%	13%	27%	15%	25,000	0.747
Dongbao	Dongbao	$ 863,636.36	22%	16%	27%	23%	12%	75,000	0.747
PangYuGuangChang (AEON Mall)	PangYuGuangChang (AEON Mall)	$ 7,694,334.95	27%	18%	15%	15%	25%	275,000	0.747
广州市奔达雅酒店	广州市奔达雅酒店	$ 1,425,776.36	26%	14%	10%	20%	30%	130,000	0.747
Hotel 2	Hotel 2	$ 3,275,616.36	26%	14%	15%	20%	25%	170,000	0.747
Average		$ 1,866,490.34	27%	16%	20%	22%	16%	110,411	0.747



D. Key Points about the subject

- Avg. Square Meter of the subject buildings = 110,411 Square Meter
- Avg. device per square meter = 0.75
- Avg. estimate of project implementation cost = $2,861,604 USD
- Avg. annual utility fee = $1,866,490 USD
- Avg. Savings rate in utility fee post implementation cost and annual fee = 18%

E. The Findings

The findings from the interview shows that if the pricing strategy aligns with the customer's product value then there is legit applicable use case for IoT EMS devices. Even for buildings with BMS systems already installed the IoT EMS devices have shown that it can reduce energy usage even further and is viewed as a complimentary solution.

From study and interviews with Facility Management, Landlords and Tenants of the 9 commercial properties, One Labs team found out that managing temperature is not simple. To determine accurate temperature has two factors namely water side and air side. Thermostat adjust temperature on the water side of HVAC's chillers and boilers. It is then up to the air vent which should then adjust the temperature based on how many people in the room. In a normal building such as those in Shenzhen and Guangzhou where there are no BMS system, all temperature is managed by hand through manual hard switch on thermostat. Any person can determine the temperature of the room and in an office setting since letting employees have direct control of the thermostat is not feasible, it is the duty of the facility manager's team to manage thermostat hidden in the ceilings of the offices in a building that has central air system. This task is usually done around 7-8 am. For the Hong Kong buildings that features BMS, the BMS can only manage the automation process of the water side temperature but the problem persists on determining the accurate proper temperature in rooms. This cannot be done unless through air ventilation something outside of BMS system capabilities. Currently there are nothing in the commercial and industrial market that can manage temperature accurate through the air ventilation side. Such system requires a complementary smart thermostat that is made for buildings something not in the market at all as all smart thermostats like Nest are designed only for houses as it controls temperature via furnace system not via central HVAC. It is to the surprise of the team that even for buildings with BMS, Facility Management still need to manage thermostats manually every morning as BMS are not capable of controlling air vents. Here the discovery to the real root cause to why commercial buildings in Hong Kong and China are oftentimes much colder and hence consequently waste more energy than they supposed to be. A study made by Hong Kong government after mandating that government offices should be managed strictly at 25 degrees all the time that energy which it forecast can be saved resulted instead of energy wasted as power saved up ended in powering employee's personal electric fans. The fans created noise pollution and hazards of electric wires in the office floor causing some employees to trip. The result of the case study has determined that temperature cannot be adjusted accurately as people in the room fluctuates very frequently. It is due to this, that facility management companies in all commercial buildings in Hong Kong determine that it is better to be colder than too hot as employees can carry coats as tradeoff for a more comfortable and albeit safer work environment.

While for lighting and outlet control, the buildings interviewed in China are all manually managed and this result to having to balance of hiring more resource staffing to patrol after hours or to accept wasted energy. By accepting the later strategy that means florescent lights which normally last 20,000 hours being turned on must be replaced much earlier. For BMS installed Hong Kong buildings, the savings was minimal as due to lighting zones in BMS were too big. On top of adhering to government regulations of corridors and elevator area must always be lit, in afterhours most buildings in Hong Kong since overtime is prevalent, no lights are shut even if there are only 5 employees left on the floor.

F. Limitations of Building Management Systems

In the interview, buildings with BMS have provided One Labs Team a tour of the building and how the system works. The facility management teams were candid with us about the pros and cons of the system. The biggest complain so far is the prohibitive cost which is estimated to be between $15 – $22 USD per square meter in implementation and monthly fee of $11 USD per device (there are 0.75 device for each square meter) on top there is a third-party management fee to maintain the BMS system. A discussion with the finance department and it was clear that BMS never resulted in a positive return on investment. The large zone areas ensure that reducing electric consumption waste is limited. The web app provided is designed for engineers and cannot be used by normal tenant employees. Since BMS systems have been evolving since the 1980s, the focus in the automation of boilers and chillers areas where the building's most intensive engineering design is centered on, has already reached its peak design. Any further improvement of the system require implementation on only new buildings exclusively and cost to attain more efficiency requires even higher investment. In time of such global economic stagnation, such investment demand is not feasible for most property management companies and building developers. Property management companies and landlords instead are opting to seek alternative solution from investing in new BMS platform to gain sustainability and to further maintain older assets longer.

G. Real World Applicable Use Case

After the interview study, One Labs have presented the 1IoT solution to the property management, landlords and some tenants. The feedback was overall very positive. The facility managers and tenants are happy about having a mobile app. For tenants, the mobile app can empower their employees to control individual lights while assist in conserving energy as Artificial Intelligence automates energy audit findings on appropriate minimal lights to be lit in corresponding scenarios of employee overtime during afterhours. If the employees forgot to turn off the office lights they can do so at the comfort of their own home. Facility Management has seen the potential that it can reduce labor of patrolling and climbing into office ceilings to adjust thermostats of air vents. The convenience on top of AI able to recommend temperature based on temperature in hallway, adjacent rooms and weather helps the facility staff to adjust temperatures accurately as the information gathered by the smart vent is very accurate. Landlords also see the potential where cost in areas such as maintenance and repairs can be cut with advent of predictive analytics and the app able to manage multiple facilities easily. The landlords in the three buildings in Hong Kong believe that the device solution with its pricing can assist them to recuperate from losses in old BMS investment. Overall the assessment is that IoT EMS system can drastically cut 39-40% of utility waste in an instant, ensure fluorescent bulbs can last longer and the smart vent can ensure that right temperature is maintained constantly making the office environment much more pleasant and employees more productive. Most importantly the price point match to what

they are aiming for, 10% return on investment with 10 to 20% annual savings in utility fees for all parties. For execution, the expectation is to deliver the solution in 1 to 3 implementation periods and set up done by local certified electrician to ensure it is done safely as possible. In the long-term due to the apps' flexible design of facility management can manage multiple locations in different cities, regions and continent, the Landlord and Tenants gets a pleasant surprise that their operating cost in maintenance and repair also goes down as the staffing needs can be downsized. This additional savings outside of cutting utility fees assist in increasing the incentive for commercial property to adopt the technology.

IV. Conclusion

The government's aims for sustainability and private sector's requirement for a positive cost benefit solution has always been in sharp contrast to each other. One Labs custom cloud MQTT, automated Platform as a Service and its unique solution design that minimize IoT data cluttering the cloud bandwidth has enable to deliver a product that meets market demand and target price point resolving the issue that is holding back mass adaptation of IoT EMS solutions. One Labs is enthusiastic to announce that the long awaited minimal valuable product demonstrator prototype is about to be launched next month in November. One Labs will be demonstrating the capabilities of the 1IoT technology in Shenzhen with a pilot project to proceed afterwards. One Labs is looking forward to re-write the use case after a real world implementation has been conducted.