Policy recommendations

of the 2016 Student Energy Forum theme groups

for sustainable urban energy politics
in Hong Kong

Disclaimer

This paper was written by participants of the Student Energy Forum jointly organized by Konrad-Adenauer-Stiftung (KAS) and Hong Kong-America Center (HAC) in April 2016. The contents of this paper, including argumentation, recommendations and suggestions, do not necessarily reflect the positions of KAS and HAC.

Preliminary Proposals for Promoting Renewable Energy in Hong Kong

Written By

Karen Leong klkleong@connect.ust.hk
Peiye Zhu amilyzhu@link.cuhk.edu.hk
Sunyu Park sypark@connect.ust.hk
Wenyu Wang claviy@live.com
Yin Yung Wong natasawongyinyung@gmail.com

Background

Renewable Energy (RE) is developing slowly worldwide, but steadily gaining the status of conventional energy. More countries are realizing the future potential in RE due to the depletion of coal, oil, and gas reserves and their carbon emissions. Countries like Iceland have even proposed the idea of '100% Renewable Energy', meaning shifting the total global primary energy supply to renewable sources.[1] The UK also has announced the closure of all coal-fired power plants by 2025, and a new OECD proposal would cut off financing for 85% of coal-fired plants.[2]

Despite these international developments, only a meagre 0.01% of Hong Kong's power supply is currently sourced from renewable energy. Due to economic costs, lack of space and legal restrictions on utilizing Hong Kong's indigenous environment, no future fuel mix plans have been announced that promote RE.

Is it really impossible for RE to become Hong Kong's conventional source of energy? This paper will propose four possible methods for promoting RE in Hong Kong, and provide recommendations to relevant Government departments.

[1] '100% Renewable Energy' from Wikipedia,
<https://en.wikipedia.org/wiki/100%25_renewable_energy>

[2] Martin Kaiser, 'COP 21: The Destination Is 100 Percent Renewable Energy for All'
<http://www.greenpeace.org/usa/cop21-the-destination-is-100-percent-renewable-energy-for-all/>

Executive Summary

There are four possible approaches for transforming Hong Kong into an RE economy:

First, from a technological perspective, promoting state-of-the-art RE would not only be supported by civil society, but would also encourage funding for research and development of RE improvement. Future development should focus on maximizing the small-scale decentralized RE facilities which have already made a successful start in Hong Kong. To maximize RE, encouraging innovative technology, such as RE integration with green buildings, should be an important priority. .

Secondly, progressive policy support, including tax incentives for use of electric vehicles, and an energy trade scheme (ETS), is important in reducing carbon emissions and in creating incentives for companies to undertake RE innovations.

Third, RE education for all age groups can play a significant role in helping both the public and private sector realize the potential for RE in facilities around them. Education should be carried out by the Government, commercial entities, and NGOs as well as schools and individuals.

Last, given Hong Kong's geographical constraints, the relatively inexpensive labor available nearby on the Mainland, and its large land resources, should be leveraged to provide Hong Kong with a platform to develop RE. Moreover, in 35 years' time Hong Kong and China will be more united politically, which would pave the way for smooth co-operation. Hong Kong – Mainland cooperation will not always be smooth, but it is out of the scope of this paper to address this problem in detail. .

Proposed Strategies

1. Technology Perspective

Promoting state-of-the-art RE technology would gain social support and hence encourage funding for research and development of RE improvement.

According to the Electrical and Mechanical Service Department of HKSAR, renewable energy is divided to 4 categories: Solar Power, Wind Power, Energy from waste, and other technologies[3]. The first two categories – Solar Power and Wind power have been widely discussed and most of the existing small number of RE facilities in Hong Kong use these 2 technologies. Given that 43% of land area in Hong Kong is under statutory protection (which not only helps maintain the rich biodiversity, also enhances the carbon dioxide absorption capacity of Hong Kong) [4], geographical constraints hinder the pace of shifting fossil fuel to renewable energy. In response to this, waste-to-energy facilities have been or are being constructed at present, such as the sludge treatment facilities in Tuen Mun, and the Organic Waste Treatment Facility in Siu Ho Wan. Before the construction of these facilities, waste was simply deposited in landfills. Now, in some instances, wastes are treated and used for power generation.

The current waste-to-energy facilities help to improve the environmental performance of waste. They help to fully utilize the organic waste, reduce the burden of landfills and produce less methane and carbon dioxide at the same time. However, currently, the public does not really know much about this technology and its environmental benefits. The Hong Kong government can help public understand the current development of RE technology and benefits of using RE at places like the Organic Waste Treatment facility. RE can thereby gain popularity and hence, more funding for research and development can be raised for RE related technology, such as solar PV panels and wind turbines. Further RE technological improvement is likely, which will enhance show the prospects for shifting our fuel mix towards RE in the coming decade.

2. Policy Perspective

To fulfill the goals of reducing carbon emissions and raising energy consumption efficiency, the Government should play an active role in regulating the energy market, and more progressive policies should be implemented.

[3] Electrical and Mechanical Services Department of HKSAR, “Hong Kong Renewable Energy Net”, <http://re.emsd.gov.hk/eindex.html>

[4] Environmental Protection Department of HKSAR, EPD Website, <http://www.epd.gov.hk/epd/english/climate_change/greening.html >

(1) Tax Burden

In 2014, Hong Kong's Ministry of Finance and the State Administration of Taxation jointly issued a Circular on Implementing Coal Resource Tax Reform. According to this circular, a resource tax on coal would be calculated on the basis of price rather than production volume across the whole country, with rates ranging from 2% to 10%. Even though this is a good starting point, such measures are far from adequate. To meet the needs of sustainable development, higher taxes should be imposed on coal and gas fields, reaching 10% to 15% of the overall price.

(2) Aligning stakeholder's economic interests

There needs to be an orchestrated effort to align economic interests of the key economic stakeholders who currently control most of the current technological infrastructure. Dividing up ownership of companies' grid systems could address the balance of interests among the existing ones. In particular, performance of these stakeholders needs to be monitored on a regular basis which can help policy makers formulate measurable goals and determine achievable targets towards an environmentally sustainable city. With measurable performance indicators for environmental sustainability, the regulators of relevant policies would be able to monitor regularly and to implement incentive and control mechanisms for reducing GHG emission under an optimization framework.

(3) Provide electric vehicles at reasonable prices

Hong Kong, with its relatively small geographical size and large population, has a strong incentive to promote electric vehicles. In addition to this, the relatively high temperatures in the winter help to maintain the operation of electric vehicle batteries.

Ever since the registration tax for EVs was waived by the Hong Kong Government in 1994, the Government has shown great interest in developing electric vehicles. But the numbers of EVs have increased slowly. The Government could provide electric vehicles to local citizens at reasonable prices by developing the relevant technology with the help of tax exemption for research on EVs.

3. Education Perspective

Renewable Energy is a new concept for many Hong Kong people, who have no idea of how the renewable energy actually function. We recommend that the Government take the initiative and educate citizens of all age groups.

For children (kindergarten to Primary students), interactive workshops should be organized regularly in order to help them understand more about renewable energy. For instance, workshops could illustrate the difference between a regular light bulb and a LED light bulb. Also children can design their own wind turbines and learn about how the wind turbine creates energy. It is crucial to educate the kindergarten and Primary kids about renewable energy, so they will have some basic concepts of renewable energy in their mind. For Secondary school students, we propose that the school should take students on field trips to visit the wind turbines in Lamma Island and to see solar panels in Hong Kong. Schools can also organize field trips to the sludge treatment facilities, so that students could know more about the sewage

treatment projects in Hong Kong. We think that the government should emphasize educating children and young people, as they are the future decision makers. If children they know about the importance of using renewable energy, they may choose to consume renewable energy even if it is more costly than fossil fuels.

In addition, the Government should also organize environmental workshops and forums for the public, so that Hong Kong people can know more about the projects that the EPD or other governmental departments are working on. If possible, the Government could also set up organizations to teach the skilled workers and electricians how to make their own solar panels, so that they could develop green electricity and they may be able to produce their own energy one day.

Moreover, we propose that business sectors should take responsibility for introducing RE technologies into the commercial buildings and offices. In addition, non-governmental organizations should set up forums in order to educate the public about the how renewable energy is collected in Hong Kong and other countries.

There are 1,291,048 registered companies in Hong Kong; it would have an impact if most of these companies could participate in creating renewable energy. We propose that the NGOs cooperate with commercial companies to try to develop on-site projects, such as putting transparent solar panels[5] in the windows of the companies.

4. Corporation Perspective

There are two main reasons for Hong Kong to cooperate with Mainland in the renewable energy development. First, geographical limitations and legal constraints in Hong Kong restrict use of country parks. Even if the restrictions of exploitation are removed, the cost of building infrastructures and objections from local people are big problems. Second, close cooperation with mainland can help pave the way of smooth integration 35 years later.

There are three possible ways of cooperation:

(1) Hong Kong investments in RE in Mainland

Investing in RE power station on mainland creates a Win-win Framework. Projects would be run in form of a Hong Kong-Mainland partnership. Production and profits should be shared between the two parties. Hong Kong can utilize the cheap labor and geographical advantages of the mainland to develop technologies and also to see how much it may be possible for Hong Kong to rely on the energy generated by these sites. The Mainland can benefit from Hong Kong's technologies and finance support.

(2) Cooperation With Local Governments

Hong Kong is negotiating an Emission Trading Scheme with Guangdong province to

[5] According to Michigan State University research team, a truly transparent solar panel is finally created— a breakthrough that could soon usher in a world where windows, panes of glass, and even entire buildings could be used to generate solar energy. Until now, solar cells of this kind have been only partially transparent and usually a bit tinted, but these new ones are so clear that they're practically indistinguishable from a normal pane of glass.

exchange technologies and to make joint efforts in coping with climate change. Under the background of decentralization, cooperation with local governments is crucial for Hong Kong.

(3) Setting up a Pilot RE Region

RE is the way of the future due to the limited storage amount of fossil energy and to growing environment concerns. Setting up a pilot RE region and developing ahead of other cities or countries would gain Hong Kong leverage when negotiating with the central Government, and would also help support its long-term development. Hopefully, the pilot RE region can create a favorable public image for Hong Kong..

During the cooperation process, certain problems need to be considered: first, lack of basic infrastructure. If Hong Kong wants to use the energy generated by its RE stations in mainland, it can use the current grids, build new ones or buy assets from mainland companies. Second, loss of energy. Energy will be lost during transmission. Future technologies should be able to reduce the loss; Third, energy security problem. Too much reliance on energy importation may be unacceptable for some Hong Kong people. Sharing ownership may be a way to handle this problem. Also, Hong Kong can minimize the risk of power interruption by developing different grid roads and maintaining a diversity of RE.

Conclusion

To conclude, this paper examines RE in four dimensions: technology, policy, education and cooperation. There are still many other possible methods to transit Hong Kong into an RE economy. We should keep up with new trends in RE and try our best to make contributions in RE development in the future.

Renewable Energy Team
17 Apr 2016

Using Data to Empower People:
How to Use Data to Change Daily Behaviour in Energy Consumption

Student Energy Forum 2016

Innovative Energy Idea Team

Bosco Heung Wai Chan (chanheungwai@gmail.com)
Giosue Bochicchio (bochicchiog@susqu.edu)
Inna Ameshava (i.amesheva@gmail.com)
Jen Seung Yeon Lee (jsylee12@connect.hku.hk)
Tin Tin Kao (tintink@connect.hku.hk)

Overview

The Hong Kong government has been consistently investing in green technologies and infrastructure to uphold its commitment to decreasing carbon emissions and securing renewable energy sources. However, a sole reliance on technology and infrastructure may not be sufficient to curb increasing rates of energy consumption. Such developments must be supplemented by energy-saving practices of the public to ensure sustainable rates of energy consumption in the long run.

Recent statistics have indicated that buildings account for 90% of the city's electricity usage (Environment Bureau, 2015, p. 7). Therefore, it is imperative to encourage energy-saving practices among building users, in addition to retrofitting, to meet Hong Kong's target of 40% reduction in energy intensity by 2025 (Environment Bureau, 2015, p. 7). To do so, we must **enhance the users' accessibility to, awareness of, and reactivity to their energy consumption data.** Implementing the use of smart meters in buildings could help track and report energy consumption in a timely and user-friendly manner.

Policy recommendation

We propose **launching a smart-meter pilot in UGC-funded universities** to establish a community-level system of tracking and reporting energy consumption. Not only will the initiative lead to actual reductions in energy consumption, but it will also induce long-term energy-saving habits among students and provide a richer database for an efficient allocation of energy conducive to an appropriate planning of renewable energy usage.

If the pilot is proven successful, it could be **replicated** by self-funded educational institutions, private residences or commercial buildings that wish to begin a collective and comparative reporting of their energy consumption. The smart meter technology could also be **expanded to the public at large**. 'Smart-meter dashboards' could be installed in main areas of the city or 'travel-smart meters' could be installed on public transportation to increase the public's access and reactivity to energy consumption data.

Objectives

The specific objectives of the pilot are to:

- **Increase energy-saving habits** of university students, faculty, and the visiting public by increasing their self-awareness of energy consumption.
- **Induce long-term behavioural changes** of the aforesaid stakeholders by engaging them in comparative reporting of energy consumption.
- **Establish a community-level energy tracking and reporting system** that can be readily adopted by other institutions, residences or commercial buildings.
- **Compile a richer database of energy consumption rates** to better manage peak time demands and to assist in appropriate planning of renewable energy usage.

Meeting the above objectives would lead to collective benefits such as:

- Efficient peak demand management
- Active user engagement
- Democratisation of energy data

Background

Current usage of smart meters in Hong Kong

The initial use of smart meters was implemented by CLP Power in November 2013 (Cheung, 2012). In its 18-month pilot, CLP installed smart meters in 3,000 homes and 1,400 SMEs in New Territories and Kowloon (Cheung, 2012). The impact of the pilot remains unknown since the data of the pilot have not been released publicly. However, the pilot provided a perspective that saving energy through installation of smart meters could be much cheaper than building new power stations.

CLP covers about 80% of Hong Kong's population (Ko, 2014). While the utility company already operates more than 2.5 million energy meters, as well as sensors that detect information such as the amount and quality of energy consumed, the public's use of smart meter technology remains limited. Though CLP's launch of 'Eco Optimizer 2.0' enabled its customers with online accounts to receive personalised home energy reports and compare their reports with those of 100 other households, the majority of the local population is not engaged in active reporting and comparing of energy consumption (SCMP, 2015).

Smart meter technology is a type of Internet-of-Things (IoT) improvement aimed at producing more sustainable, cost-effective and eco-friendly energy patterns. According to Wayne Pales, "This is an end-to-end network, an example of IoT that leverages the principles of machines to machines technology" (Ko, 2014). Smart meters enable instantaneous feedback to end-users so that they can adjust their energy demand accordingly. Smart meters could also lead to extensive costs savings on behalf of utility companies as the latter would no longer have to physically deploy staff to read the meters at individual premises – data will be automatically recorded, thus avoiding human error and staff costs.

Although CLP launched 'Smart Grid Experience Centre' in 2011 to educate the public and raise awareness of smart grid technologies, it has not taken an active stance in expanding the scale of the current smart grid. In view of the advantages of smart grid technologies, there is much potential to expand the usage of smart meters in Hong Kong. The energy, costs, and staff savings realised by all parties involved make the case for universal deployment of smart meters in Hong Kong strong. It thus emerges as a win-win solution that would enable Hong Kong to meet its environmental commitments, while doing so in a cost-effective manner.

Behavioural changes in energy consumption

Although the public's awareness of climate change has been increasing with the recent feat of COP21 and the growth of information-sharing platforms, **"attitude-behaviour gap"** (Young et al., 2010, p. 22) persists in Hong Kong; compared to its Western counterparts, the majority of the public falls short in recycling and green consumption. The difficulties of translating their environmental concerns into actions arise predominantly from financial reasons and knowledge gaps.

While governments commonly use financial incentives for increasing the public's green practices, instilling a sense of **environmental citizenship** is in fact more conducive to long-term behavioural changes, for a change in attitude becomes an imprint from which behaviours arise (Young et al., 2010, p. 21). In addition to fostering environmental citizenship, applying **social pressure** has been proven effective in inducing green behaviours.

In an experiment conducted by graduate students in California in 2003, energy consumers were most likely to turn off the air conditioning when subjected to the sign that stated *"…your neighbours said that they turned off their air conditioning… please join them…"* than one that stated *"…you could save 54 dollars a month… turn off your air conditioning…"* (Laskey, 2013). Similarly, when residents in private housings received bills that directly compared their energy usage with their neighbours', they began to save energy immediately, resulting in the reduction of almost three terawatt hours of electricity in 2014 (Brown, 2015). Opower, a US software company that partners with utility companies to issue bills in the form of personalised home energy reports, reported that communicating customised information and energy-saving tips increased customers' reactivity to the utility and led to reduction in electricity consumption (Brown, 2015).

The tangible impact of social pressure on green behaviours in the local context has been shown at **New College**, a dormitory at the University of Hong Kong (HKU). The installation of smart meters on all residential floors enabled a display of real-time energy usage and quantifiable savings on individual screens. By comparing energy consumption between the floors and crowdsourcing energy-saving ideas, the dormitory was able to **reduce its overall electricity usage by 20% within five weeks** (HKU New College, 2015).

Similarly, Green Campus Committee in Korea has launched a smart meter programme across six universities, now to be expanded to 20 universities; the initiative was aimed at collecting, analysing, and visualising electricity, gas, and water consumption on campus (Park, 2015). Notably, Myeong Ji University's real-time tracking of electricity consumption accessible to all students via the university website has led to 15.9% reduction in electricity consumption on campus (Park, 2015).

<u>Why a smart-meter pilot at universities?</u>

As aforesaid, **personalised reporting of data** and **social pressure arising from comparative reporting** can lead to immediate and lasting changes in energy consumption habits. Local universities are ideal for launching a smart-meter pilot not only due to their ability to spread to educational values to students and the public at large, but also because students are ideal subjects for assessing the relationship between energy sensitivity and consumption habits:

First, students are generally **more responsive to environmental issues** than other occupational groups. This is because they spend a significant amount of time on the internet, where many energy and climate change discussions take place (DeGolyer, 2013, p. 2).

Moreover, tertiary students tend to be **more concerned about the impact of climate change** due to their age; they believe that their generation and their children's generation will be most directly affected by the impact (DeGolyer, 2013, p. 119).

Lastly, students living in dormitories are categorised as **non-bill payers**[1], hence it is possible to assess their level of energy sensitivity in relation to changes in their attitude rather than their financial concerns (DeGolyer, 2013, p. 88).

[1] Since 2012, university dormitories in HK require payment for air conditioning only, not for lighting and sockets (LWS College, 2015).

Implementation

The pilot would be launched incrementally across UGC-funded institutions. HKU or CUHK would be an ideal candidate for the initial launch since their dormitories, New College and Lee Woo Sing College respectively, have already implemented a smart-meter programme.

After identifying suitable companies for the supply of smart meters and reporting services[2], the following steps will be taken:

1. Installation of smart meters in all dormitories

- Installation for each floor (of fifteen rooms) will take approximately one day. The meters will also be installed in common areas such as the pantry.
- Residents will familiarise themselves with the installed meters and the relevant software (e.g. mobile application) immediately upon installation.
- While waiting for the completion of installation throughout the dormitory, sustainability consultants may be deployed to facilitate residents' usage of the meter.

2. Initiation of self-tracking and comparative reporting within and between dormitories

- Residents will be instructed to keep track of their electricity consumption from air conditioning and lighting in their individual rooms and common areas.
- Every week, all floors will be required to report their electricity consumption. The best and the worst floors will be recognised
- Every month, evaluation of energy usage and crowdsourcing of ideas by residents and sustainability consultants will take place to devise and promote energy-saving ideas.
- Monthly comparisons will take place between dormitories. Awarding the best dormitory will encourage competitive behaviours among residents.

3. Reporting the impact of the pilot to the university at large

- After running the pilot for two months across all dormitories, the results of the pilot can be communicated to the university through seminars or meetings with board members, sustainability managers, estates office, or other relevant offices or departments.
- The results could also be communicated to non-resident students through environment or sustainability-related courses in the academic curricular,
- Such reporting may encourage the installation of smart meters on-campus (e.g. a campus-wide 'smart-meter dashboard' that tracks the energy usage in the main area of the campus) or in off-campus housings of students, faculties and the visiting public.

4. Expanding the pilot to other universities

- Other universities can implement the system and engage in comparative reporting. Self-funded universities with dormitories may also launch the pilot.

Other considerations

Funding: although universities may be able to secure funds from alumni or private donors, the lack of funding may delay the installation of smart meters and may not allow comparative reporting to take place in parallel. Also, ongoing costs of reporting services must be considered, covered by either dormitory fees, university funding or government subsidy. Extra costs may be incurred from hiring administrative personnel or sustainability consultants for organising and conducting meetings for comparative reporting.

[2] Blue Sky Energy Technology was responsible for launching the pilot in HKU New College.

Future implications

Once the pilot is successfully realised in all local universities, it may be replicated in other institutions and private residences. It would be feasible to replicate it in primary and secondary schools to maximise the educational value of the pilot.

The ultimate goal would be to launch the pilot in **commercial buildings** to initiate a larger reduction in energy consumption. For corporate clients, the government may need to provide **monetary incentives** to make energy efficiency investments more alluring, particularly by lowering inhibitive upfront costs. Monetary incentives will also complement existing policies such as appliance standards and energy codes and enable the overcoming of market barriers for cost-effective technologies. The following incentives may be considered:

Monetary incentives

Rebates to corporate buildings for installation of energy-efficient equipment

Rebates to consumers during peak demand periods

Currently, the increased demand of energy during the summer has forced CLP to utilise an old power plant that is relatively less efficient in terms of energy production and also pollutes the environment. CLP can send texts or app messages to alert users during the peak hours that the peak-hour usage will incur a higher electricity bill, and thereby encourage them to be energy-thrifty (e.g. unplug cables from sockets or turn up the air conditioning temperature in order to lower their electricity bills). For every X amount of energy saved, CLP will also rebate X amount so as to reduce the need to regenerate the energy-inefficient power plant.

Electricity tariffs: higher charges at peak times and reduced charges at night

Through the widespread installation of smart meters, CLP can better predict peak times for electricity usage. It is suggested that electricity tariffs can be implemented, with differential electricity charges at differing periods of electricity usage: day tariffs, night tariffs, and peak tariffs. The differential cost will encourage users to reduce electricity consumption during the hours with higher tariffs.

Smart meter fund as a subsidy

The initial upfront cost of installing smart meters discourages companies from investing in them. However, by creating a smart meter fund with subsidies, the government can encourage otherwise reluctant companies to install smart meters.

Non-monetary incentives

Prize award

A Corporate Social Responsibility (CSR) Prize may be awarded to companies with the highest energy transparency and reductions in electricity consumption. The added social prestige and potential financial returns associated with such a prize would incentivise companies to further engage in energy consumption reduction measures.

Social incentives:

Just as in the pilot, energy usage maps in public areas, on a website or in a mobile phone app would give social pressure for corporate entities to engage in energy reduction strategies. Since companies have a vested interest in bolstering their corporate image, this would be an effective non-monetary incentive for companies to engage in energy reducing behaviours.

References

Brown, N.P. (2015). The risk of inaction. *Harvard Magazine.* Retrieved from http://harvardmagazine.com/2015/05/the-risk-of-inaction

Cheung C.F. (2012 Nov 14). CLP Power's smart meters will track power use. *South China Morning Post.* Retrieved from http://www.scmp.com/news/hong-kong/article/1081864/clp-powers-smart-meters-will-track-power-use

CLP. (2015). *Smart grid experience centre.* Retrieved from https://www.clp.com.hk/en/community-and-environment/community/visit-to-clp/smart-grid-experience-centre

DeGolyer, M. E. (2013). *Energizing Hong Kong: A Comprehensive Study of Hong Kong People's Attitudes Towards Power and Climate Change, 2013*. Civic Exchange.

Environment Bureau. (2015) *Energy Saving Plan for Hong Kong's Built Environment 2015~2025+*. Retrieved from http://www.enb.gov.hk/sites/default/files/pdf/EnergySavingPlanEn.pdf

HKU New College. (2015, October 15). *Blue Sky x New College – Empower Your Energy* [Video file]. Retrieved from https://www.youtube.com/watch?v=Ukjn6pg26OE

Ko, C. (2014 May 7). CLP powers novel customer services with smart metering. *Computer World Hong Kong.* Retrieved from http://cw.com.hk/feature/clp-powers-novel-customer-services-smart-metering

Laskey, A. (2013, February) *Alex Laskey: How behavioural science can lower your energy bill* [Video file]. Retrieved from https://www.ted.com/talks/alex_laskey_how_behavioral_science_can_lower_your_energy_bill/transcript?language=en#t-290802

LWS College. (2015). *Hostel Smart Meter*. Retrieved from http://www.ws.cuhk.edu.hk/green-life/energy-saving/hostel-smart-meter

Park, N.C. (2015, March 6). *Assessment Report of the Committee of Gyeonggi-do Green Campus Association of 48 universities*. Retrieved from http://www.ekn.kr/news/article.html?no=125407

Reducing electricity consumption doesn't mean a loss of comfort and convenience. (2015 Nov 13). *South China Morning Post.* http://www.scmp.com/native/tech/topics/premier-living/article/1877857/reducing-electricity-consumption-doesnt-mean-loss

Young, W., Hwang, K., McDonald, S., & Oates, C. J. (2010). Sustainable consumption: green consumer behaviour when purchasing products. *Sustainable development*, *18*(1), 20-31.

Prepared for: After COP21, Student Energy Forum
Held at Hong Kong University of Science and Technology
April 9, 10 2016

Electric Bus Development
A Policy Proposal

By:
Gladys Tong Ka Sik
Kelvin Lam Ho Yin
Charlie Fang
Angustus Lee
Xu Meng

1 Introduction

There is a global trend toward use of the electric bus to reduce carbon emissions. In the 2015 COP 21 Paris Agreement (Sustainable Innovation Forum), governments agreed to set a goal of limiting global warming to less than 2 degrees Celsius compared to the pre-industrial level. We are going to suggest ways to cope with COP21: that is, to reduce carbon emissions in Hong Kong by introducing the electric bus to Hong Kong. The main purpose introducing the electric bus to Hong Kong is to reduce carbon emissions and other air pollutants on the streets and roads of Hong Kong, to help make Hong Kong a cleaner and more energy efficient city.

When we consider our current situation, we can easily see that traffic congestion is a major traffic problem in Hong Kong. And there are frequent traffic jams, in which vehicles emit pollutants such as sulphur dioxide and nitrogen oxides even though they are not travelling, a complete waste of fuel.

The technology used in the electric bus has greatly improved. In 1990, the battery used for electric vehicles was so heavy that it significantly increased the workload of the vehicle. However, nowadays, the battery efficiency and life have been greatly increased.

Our policy advice and suggestions follow: .

2 Policy Advice

2.1 Urban Planning

Electric bus, as a new transportation mode in New Development Areas

The electric bus, like other electric vehicles, requires an infrastructure on the street to provide 'fuel' supply – that is, battery charging stations. These would be hard to construct in high density urban areas, where complicated transportation systems and roadways are already in place. Therefore, in order to build the required infrastructure, the New Development Areas that the Government is now proposing should provide space for the infrastructure needed for electric vehicle development and also provide a medium scale area for technological trials.

Electric Bus Rapid Transport Development(e-BRT)

eBRT is a well-known transportation mode, especially in the Northern America, that provides a special Right of Way (RoW) for to buses, such as bus-only lanes, queue jump lanes and transit signal priority. EBRT could be distinguished from current local bus services in term of operating cost and efficiency.

The success of eBRT in other parts of the world suggests that a similar system here could result in efficient public transportation and zero road carbon emissions. EBRT transportation could be free from the congestion problem and enhance efficiency. It is always important to maintain a variety of transportation means. However, although much of Hong Kong's recent transportation policy has focused on the current goal of developing a mass-transit oriented future, there has not been sufficient attention to developing eBRT.

The Electric Bus as an Intermediate Public Transport

Since Hong Kong is now in the direction of a mass-transit city, the role of the bus must experience a reform. We recommend using the electric bus as an intermediate public transport to link up households and the mass transit system. Since electric buses currently entail long charging hours and short traveling time, electric buses are more suitable to run short distance routes, and therefore could be a good new way to take up the role of intermediate public transport, especially in new development areas.

2.2 Finance

Ways to attract Investment and Funding

There are various ways to attract investment and funding from the private sector to support the development of renewable and green transportation. In view of the high cost of electric buses, we believed that Government should devise means of attracting more investment from outside sources rather than relying solely on the bus companies.

First, public donations could be introduced as a way to attract investment in electric buses. Through this donation, parties or a company can get the right to name a bus station. According to their location, visitors flow rate and other factors, analysis could be made and thus bus stops could be organized to different levels accordingly(i.e. Level one, two or three, where one is a remote station and three is the most prestigious category). The amount of donations would be set differently according to the level of station.

Possibilities would be:

- 1. One-off donation
  Making a one-off donation of 3000,000 hkd can would secure the right to name a level one bus station. A one-off donation of 5000,000 hkd would carry the right to name a level two bus station. A one-off donation of 8000,000 hkd would give the right to name a level there bus station. And so on.
- 2. Donation by installments
  Making a donation by installments with total amount of 3000,000 hkd would provide the right to name a level one bus station. Installment donations totalling of 5000,000 hkd earns the right to name a level two bus station. Making a donation by installments with total amount of 8000,000 hkd would provide the right to name a level there bus station. And so on.

Another way to set the amount of donations can be by auction. This method not only can stimulate the vitality of the market, it could also promote renewable energy and sustainable transport and thus raise the public awareness in this issue.

Support Funding from the Government

Every year, bus companies need to buy new buses in order to replace retired buses. This is the time that we should encourage the bus companies to replace the traditional buses with electric buses. However, the high cost of electric buses discourages the private companies from switching. In order to encourage a transfer from traditional buses to electric buses, we recommend that the government provide special support funding to bus companies to offset the extra cost of electric buses. By doing so in a way that make the cost of electric bus and tranditional bus more or less similar, bus companies will be motivated to reform their bus fleets.

2.3 Governance

Renewal of Licenses (Franchise): Carbon Emission as a criteria

When bus companies apply to the Government to renew their franchises, the Government should consider carbon emissions as an important criteria. Companies using electric buses would be more likely to receive favorable consideration.

<u>New Technologies for Electric bus charging</u>

Right now, one of the major challenges of electric bus is the charging issue. Currently, charging can only be done in a proper charging station, which limits the feasibility of electric bus. Also a major challenge for double deck electric bus is the limited volume of the battery, which cannot support an air-conditioned double-deck electric bus. More technological inventions are yet needed to solve these problems. One promising technology is wireless induction charging. Wireless induction charging allows vehicles to charge the car's battery while driving along the road; therefore drivers of electric vehicles would be able to travel a long distance without needing to stop and charge the car's battery. If this could be adopted to Hong Kong, it could be possible to solve the problem of charging of double deck electric bus. Therefore, we believed that the government should invest more in researching this new technology.

Figure 1 Photo showing the trial of wireless charging system in England (Cr. Highways England)

Figure 2 Illustration of the wireless charging system in England (Cr. Highways England)

3 Overall Feasibility assessment

According to the "*Public Consultation on Future Fuel Mix for Electricity Generation(2014)*"from the Environment Bureau, the current energy fuel mix is listed in the Table 5.1. Although the Environment Bureau-proposed 2020 fuel mix for electricity generation from "*Public Consultation on the Future Development of the Electricity Market*" is 50% natural gas and 25% nuclear power, according to the government's recent briefings, the capacity expansion for natural gas power plant may only be able to achieve 45% but not 50% of the total power generation, thus the fuel mix for 2020 have been adjusted as Table 5.1.

Table 5.1 Fuel Mix and CO_2 intensity of electricity by 2014 and 2020

	Coal (%)	Gas (%)	Nuclear/Import (%)	CO_2 Intensity (kg/kWh)
2014	54	23	23	0.65
2020	25	45	30	0.21

Based on IPCC's CO_2 emission factors, and general efficiency for coal/gas fired power plants (34%for coal, 50% for gas), the CO_2 intensity of power generation in HK can be roughly estimated. By 2020, the CO_2 emission to generate each kilo watt hour of electricity will drop to one third of 2014 level. In other words, running the same electric bus for the same distance in the same speed in 2020 will emit 68% less CO_2 than running it on 2014.

Thus, the time frame for electric bus development appears to be just before, and then after 2020. To efficiently reduce CO_2 with lower cost, aggressively replacing diesel buses with electric buses after 2020 is be recommended, especially given that the current technology for electric bus is still not sufficient to satisfy the market requirements in Hong Kong.

According to this principle, three phases of electric bus development are proposed as follows:

Short-term (2016-2020):
1. We recommend use of electric buses on public transport routes with current technology in suitable areas; in these trial areas the bus companies can monitor problems and seek solutions, to prepare for wider use. To minimize traffic congestion problems, some areas with lower traffic flow could be considered first for electric bus lanes, such as the routes connecting new towns to MTR stations, and shuttle buses on university campuses (such as CUHK). Another factor that should be considered as a priority of choosing electric bus routes is air pollution. High population density areas with building walls trapping air pollutants will cause significant health impact on pedestrians, so these areas also should be given priority in developing electric bus routes.

2. We recommend encouraging electric bus replacements for school/kindergarten/hospital shuttle buses. Passengers in these vehicles are particularly vulnerable to air pollution.. Donations from the public and from parents of schoolchildren could supplement government subsidies for school buses. .

3. Research and innovation. Technology innovation for double-decker electric buses should be conducted by the bus companies within this period. Other new technologies (e.g. Wireless charging system) can provide opportunities of further electric bus development in HK in the future.

4. We recommend replacement of some of the double-decker buses with single-decker buses on routes where there are relatively few riders. The extension of the MTR system should reduce the numbers of vehicles on the road, which in turn will reduce the requirement for bus

capacity. This could provide further space for single-decker electric bus development, with current technology.

Medium-term goals (2020-2030):

1. Replacing all the single-decker buses with electric buses (>10% of overall buses).

2. Trial runs for double-decker electric buses, as long as the new technology for charging, collecting problems and seeking for solutions, get ready for aggressive double-decker buses replacement.

3. Investment and testing of new electric bus technology.

Longer-term goals (2030-2050):

1. Zero emission (only electric buses) in the high population density area, such as Causeway Bay, Central, TST, Mong Kok, etc.

2. Development of other potential clean vehicles: e.g. hybrid buses, hydrogen buses, CNG buses, and others.

After COP 21: Student Energy Forum
Hong Kong 2016

Energy-Saving Strategies in the Mass Transit Railway
A Proposal

CHUNG Sum Yue, Natalie
FAN Huiying, Fizzy
HOU GuoLong
NGAI Wing Ki, Winky

Executive Summary

Our team aims to promote energy conservation for the public transportation means with highest percentage ridership in Hong Kong - the Mass Transit Railway (MTR). Although most of the energy used by the MTR is consumed in operating the trains, the energy consumption in stations cannot be neglected. Thus, measures are suggested to improve energy efficiency in both segments. For operations, enhancing efficiency in electricity generation and introducing regenerative braking system is the main foci. For station design, facilities including escalators, screen doors and billboards are proposed to be modified for more efficient use of energy. On the other hand, new inventions targeting utilization of kinetic energy, converting it to electrical energy, are recommended for further investigation.

Contents

1. Introduction

According to the Hong Kong Government's Energy Saving Plan, energy consumption in Hong Kong increased by 1.1% on average annually from 1990-2012. During 2012, the total energy consumption already reached 287,970 TJ (Terajoule, a unit of energy) in 2012 (Environment Bureau, 2015a). It is known that the increasing energy consumption actually generates climate change problems, including environmental damage, extreme weather conditions and health impacts (Environment Bureau, 2015b). The Transportation sector, as one of the most important contributors to energy consumption, should have the responsibility to cut the energy use.

2. The background of HK and Study Objective

Hong Kong has a hilly landscape and a large number of outlying islands. The geographical characteristics and expanding population require that the Hong Kong government use land resources as efficiently as possible. The fact is that 90% of all personal travel is done by public transport in Hong Kong, leaving little room to generate more public transport trips that are converted from private car journeys. So it is much more important to focus on improving the efficiency of public transport rather than increasing the percentage of usage, which is already so high. It is believed that MTR is a more sustainable transport mode in city. But actually, in Hong Kong only 47% of personal travel is done on the Mass Transit Railway (MTR). In 2014, the MTR total energy consumption was 1,880GWh, equivalent to 4% of total energy consumption in Hong Kong. Thus, there is still large room for making MTR more popular and improving the energy efficiency of the MTR service. This study, therefore, will deeply analyzed the problems of MTR and provide recommendations in order to help mitigate climate change.

3. Current Problems of MTR

The increasing energy consumption of MTR is a matter of concern. Although encouraging MTR ridership can reduce roadside emissions, there is still a high amount of emission from the power plants that produce electricity used by the MTRA. Consider that the total energy consumption in 2014 was 1,881,469 MWh (1,880GWh). If the average energy consumption per passenger-km can be reduced by 1%, 18,000MWh of electricity can be saved every year.

As noted, despite its contribution in reducing roadside emission, MTR produces emission in the process of energy generation. According to the Life Cycle Assessment, the most prominent energy consuming part is operation of the system, "transport operations"(See Exhibit.1) While the total energy consumption by the MTR is inevitably increasing due to newly established lines and stations, the energy per passenger-km can still be substantially reduced. In fact, the MTR successfully cut down its energy consumption per passenger-km by more than 19% in 2014, and its

goal was to reach 21% by 2020.(MTR, 2015) In this report, we will focus our efforts on per passenger-km energy saving in the operation of the whole system covering both trains and stations.

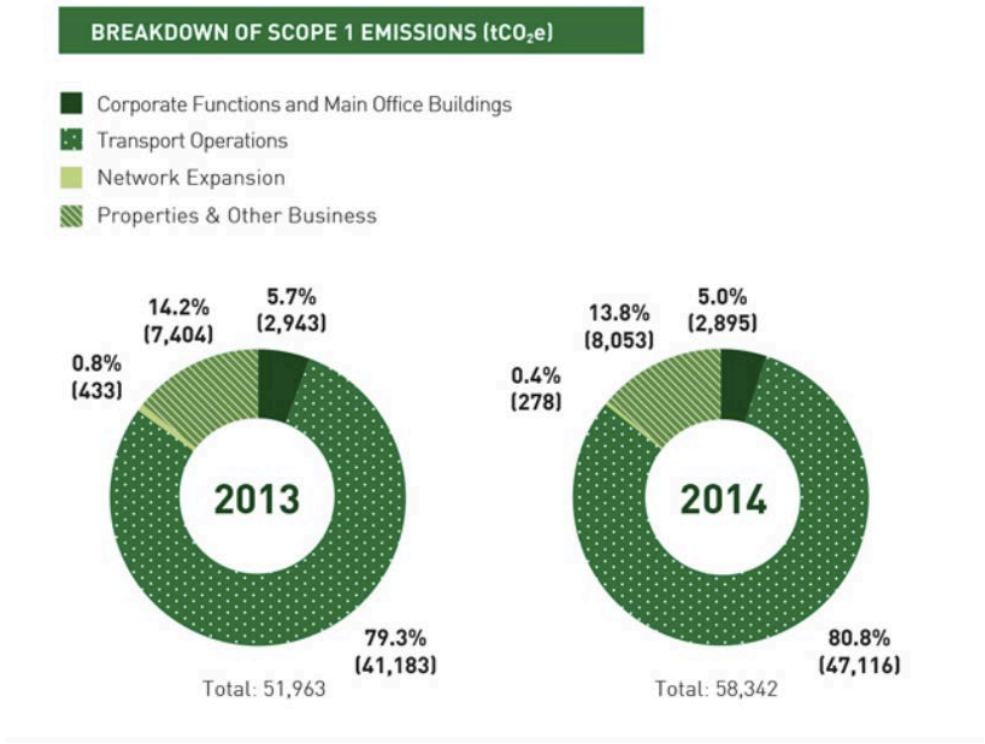

Exhibit.1.

4. Solutions

4.1 Improving energy efficiency in operations

To save energy in train operations, three aspects are discussed in this paper, namely facilities, system operation, and techniques. Firstly, it is possible for us to reduce the energy waste at braking since the energy used to stop trains can be captured for additional use. Current technology allows 45% of the energy used to brake to be recaptured. However, Hong Kong can also learn from foreign examples. For example, in Madrid, Metro de Madrid has reduced electricity consumption by installing state-of-the-art static energy accumulators that enable braking energy to be used to start other trains, as well as a train movement simulator that optimizes train speed so as to ensure that saved energy and coasting speed are optimal. Another method is to exploit the time that trains coast, that is, when they are going downhill or preparing to slow down for upcoming stations, and the driver puts the engine into neutral to save energy. At the same time, it is possible for us to have pedestrian management, especially during peak hour, that to ensure that the service can be run smoothly without disturbance by the people. A research conducted in Chile found that there is a significant effect on the Passenger Service Time where traffic management measures are applied (Seriani & Fernandez, 2015). The study suggested that for those crowded stations, separated doors should be used for passenger to board and alight. According to the research, 31-82% of the Passenger Service Time can be saved. Secondly, handrails should be placed in the middle of the

doorframe since it can split the passenger flow into two one-way lanes, thus reducing the chance of people colliding.

4.2 Energy saving in the stations

Design of the stations

We recommend a more sustainable design of stations. If a station is not underground, it can be designed to be a half open-air or open-air in order to reduce the use of air-conditioning. For example, at the Atocha Station in Madrid, there is a special design that features a botanical garden in the station where many tropical trees are planted. This green garden can help reduce the station's temperature, and thus help cut the energy used in air-conditioning. Moreover, the design can help capture natural light during the daytime, thereby reducing the energy used for lighting.

Utilities in the station

There are various electrical utilities in the metro station that may consume a huge amount of energy. In order to reduce the energy used, a survey should be carried out. Firstly, LED can be further implemented in stations, advertisements and new trains that to reduce the energy used in lighting, since LED can provide energy savings of up to 40 per cent compared to conventional light bulbs. LED lights can last up to 50,000 hours, which is two and a half times longer than conventional bulbs. Moreover, we recommend that Photo Sensor Control be applied so that redundant lights are switched off automatically on sunny days. Furthermore, platform screen doors can be used for minimizing the cooling volume of air conditioning on platform and for reducing the piston effect[1]. To make good use of the temperature gradient when the outside temperature is below 22 degrees, extractor fans can be used to create negative pressure in the station, allowing cooling ambient air to be drawn into the station, thus reducing the cooling demand.

4.3 Kinetic energy conversion with new inventions

In addition to reducing energy consumption, strategies for generating energy can be proposed to create new clean energy sources. There are several new inventions for turning kinetic energy to electricity.

Smart-Handle (see photo)

Whenever people pull the handle, kinetic energy will be converted into electrical energy, which will be used directly to power the lighting of each train. Campaigns can be launched to encourage people to pull the handle as an exercise during the train ride. Despite its apparent infeasibility due to little amount of energy generation resulted from each pulling, the accumulative effect is considerable given the huge amount of passengers using MTR everyday. In fact, this idea is easily implemented considering that there is no need for energy storage. By converting kinetic energy directly into electricity in use, a reasonable level of efficiency can be reached in this proposal with low cost for installation.

---

[1] Piston effect (活塞效應): "*The piston effect means the uniform airflows caused by the motion of trains in a tunnel*" (Morii,2006)

Motion sensor and pressure sensitive electricity generator on the escalator

Most MTR stations in Hong Kong are built underground, where escalators connect the exit with the platforms. The minor potential energy changes of a large number of people stepping on the escalators can be fully utilized by installing pressure sensitive electricity generators on the floor plates of escalators. The accumulative electricity converted from changes in gravitational potential energy of passengers' stepping, like the "Smart Handle" case, is considerable when fully utilized. A motion sensor is needed. No energy storage system need be adopted; the electricity generated would be used directly to power a motion sensor in the escalator, which controls the speed of escalators' movements with regard to the motion above the escalator. When there are no people present, the escalator will be become static. And excess energy, if any, can be used again for lighting in the stations. According to our observation, the speed of escalators is positively related to the crowdedness of the station. The higher the speed, the larger the potential of energy saving and the more people stepping on the generator, the more energy generated for cutting down energy used in powering motion sensor. Ultimately, the pressure sensitive electricity generator will be able to sustain the motion sensor, which conditions the speed of the escalator. And a reduction in energy consumption is achievable. For implementation, a pilot scheme could be done at the most populous stations, such as Admiralty and Kowloon Tong Stations.

Rotary type entry/exit gates

The mechanism is similar to electricity generation, with human power replacing steam to push the 'turbines', generating electrical energy from kinetic energy. A chargeable battery can be installed at the base, along with a motion sensor and a transformer.

5. Conclusion

COP21 is a revolutionary milestone in combating climate change. After COP21, it is time for Hong Kong to set clear goals and targets to a low-carbon society. The MTR sustainability report reflects the continuous efforts of MTR in bringing a green future for Hong Kong, such as large-scale replacement of LED light in train compartments. However, we still see the possibility in pushing the boundaries still further. We hope that the government can collaborate with the MTR to implement materialize some of the above recommendations, constructing a more sustainable future for all.

References

Environment Bureau. (2015a). Energy Saving Plan: For Hong Kong's Built Environment 2015-2025+. Retrieved from http://www.enb.gov.hk/sites/default/files/pdf/EnergySavingPlanEn.pdf

Environment Bureau. (2015b). Hong Kong Climate Change Report 2015. Retrieved from http://www.enb.gov.hk/sites/default/files/pdf/ClimateChangeEng.pdf

Information Services Department. (2015). Hong Kong: Transport Facts. Retrieved from http://www.gov.hk/en/about/abouthk/factsheets/docs/transport.pdf

Morii, N. (2006). Piston Effect. Nihon Kikai Gakkai Nenji Taikai Koen Ronbunshu. Vol.2 (p241-342). Retrieved from https://web.archive.org/web/20120217004746/http://sciencelinks.jp/j-east/article/200622/000020062206A0880005.php

MTR. (2015). Sustainability Report: Life of the City. Retrieved from http://www.mtr.com.hk/en/corporate/sustainability/2014rpt/pdf/mtrfull2014.pdf

Seriani, S., & Fernandez, R. (2015). Pedestrian traffic management of boarding and alighting in metro stations. Transportation research part C: emerging technologies, 53, 76-92.