Shaping Sustainable Urban Futures

Reducing carbon emissions in Hong Kong: Insights from London' climate policy

WORLD GREEN ORGANISATION 世界綠色組織

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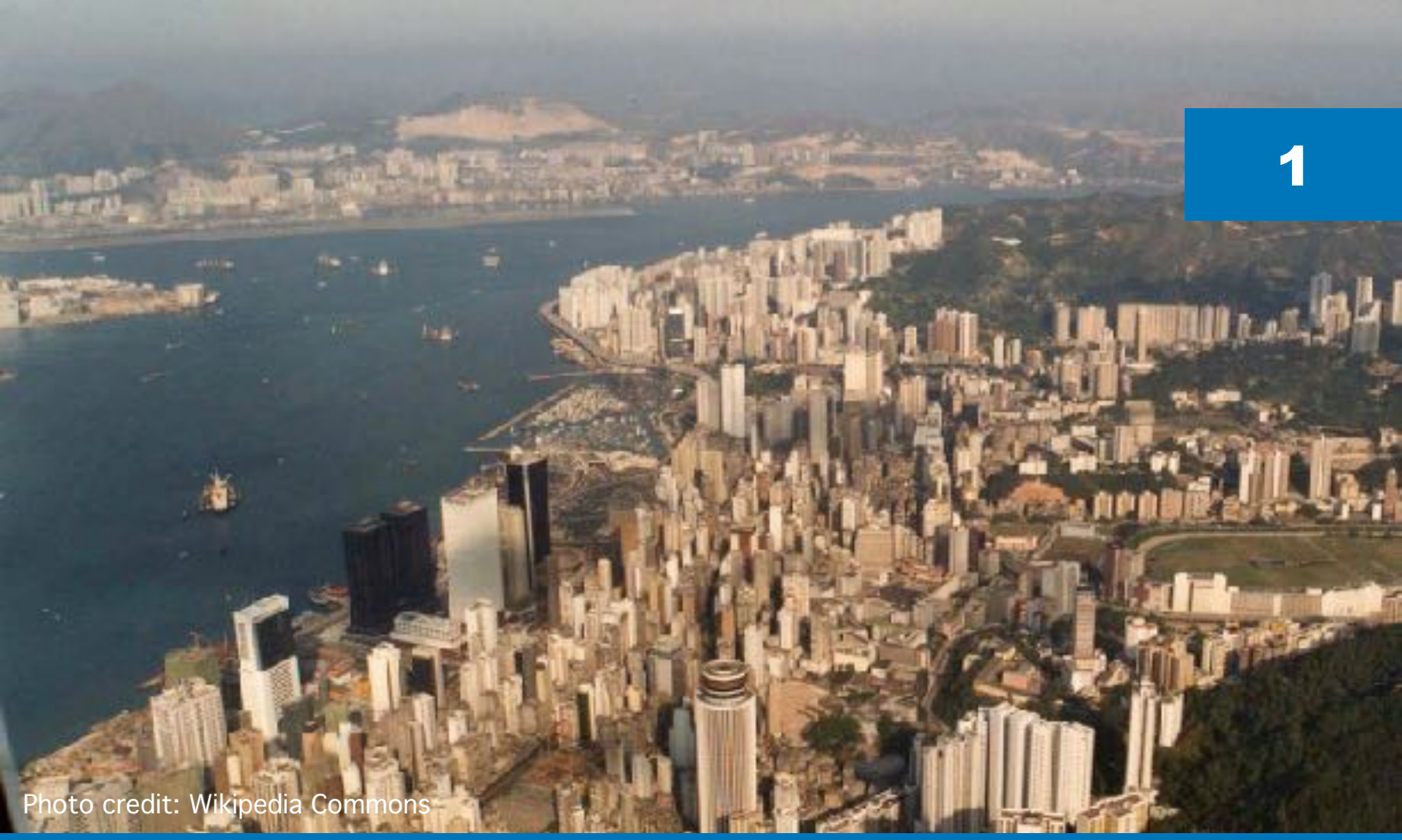

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Background

Key Messages

- Climate change will seriously impact Hong Kong's economy, society and environment. In this context, reducing GHG emissions will be critical.
- The energy sector is responsible of 70% of Hong Kong's GHG emissions, with buildings accounting for about 80% of the city's electricity usage. 16 other % of Hong Kong's GHG emissions are emitted by the transport sector.
- However, even though Hong Kong has operated a shift towards climate change issues by promoting energy efficiency and the greening of the fuel mix, serious governance challenges remain.
- By contrast, London's well developed climate governance structure and integrated approach could present opportunities for Hong Kong's sustainable future.

1.1. Why *Shaping Sustainable Futures* is needed

The human and economic costs of sea level rise and rising temperatures brought about by global warming will be considerable. Economic analysis of the costs of projected climate change impacts is still in its relative infancy, but early estimates suggest that at least hundreds of millions will be incurred in the costs of climate change, mitigation and adaptation (Tracy et al., 2007). Climate change impacts will deeply affect the public welfare of Hong Kong residents; rising temperatures are detrimental and even deadly to human health if the frequency of heatwaves increases. Projections from the IPCC estimate that heat-related deaths in Chinese cities could increase by 3.6 to 7.1 times current figures by 2050 (IPCC, 1997). Heat also creates everyday inconveniences such as uncomfortable working and commuting conditions, increased air-conditioning costs, and increased air pollution caused by increased reaction rates among atmospheric chemical pollutants (IPCC, 1997). Vector-borne diseases such as dengue fever and malaria would also rise in incidence due to favourable breeding conditions for mosquitoes. In all, untold health costs would result from cardio-respiratory illnesses, vector-borne diseases and the harmful health effects of excessive heat in surroundings (Tracy et al., 2007).

As a coastal city with high levels of urban development, Hong Kong is vulnerable to impacts from sea level rise. Climatic projections suggest that a 30cm rise in sea level by 2030 is probable in the Pearl River Delta (PRD) after accounting for the combined effects of relative sea level rise, estuary deposition and subsidence (Huang et al., 2004). Such a rise in level will inundate 1,100 km2 of land in the Pearl River Delta, adversely affecting Hong Kong (Guangdong Regional Meteorological Centre, 2007). The cost of upgrading and raising coastal defences to adequately address the 30cm sea level rise would cost 2.1 billion RMB, or about US$275 million. Extreme weather events, from storm surges to typhoons, could increase in frequency (Wong et al., 2007). Mitigatory infrastructure for such events will necessitate considerable costs as well.

Climate change trends also enact other mundane and everyday impacts that aggregate into significant repercussions. Transport systems such as rail networks can be disrupted by severe storms, leading to the closure of stations and great inconvenience as well as economic costs of lost productivity. this is especially the case given that public transport is the preferred mode of transport for Hong Kong residents (Environment Bureau, 2017). More frequent maintenance will be required for station infrastructure, mains and electricity networks that could be harmed by increased flooding. The potential extent of loss from infrastructural damage from climate-related causes is great due to the extensive spread and quality of infrastructure in Hong Kong (Tracy et al., 2007).

Figure 1: Breakdown of carbon emissions in Hong Kong by sectoral source. (Source: Environment Bureau, 2017)

Greenhouse gas (GHG) emissions are central to the aforementioned problems arising from climate change (Environment Bureau, 2015). The largest contributors to GHG emissions by sector, according to the Hong Kong Environment Bureau's Climate Action Plan 2030+ report, are: energy (70%), transport (16%), waste and others (14%). The single biggest group of contributors to energy consumption at the infrastructural level is buildings. Hong Kong's buildings account for about 90% of the city's electricity usage, and over 60% of its carbon emissions can be

traced to generating electricity for its buildings (Lo and Francesh-Huidobro, 2017).

1.2.Policy Issues

Against this background, the Hong Kong Government has operated a shift towards climate change issues in 2007, with the publication of the 2010 "Hong Kong Climate Change Strategy and Action Agenda, setting a 50-60% carbon reduction target (from the 2005 level) (Ng, 2011). This strategy relies on two pillars: improving energy efficiency, and greening the fuel mix (Ng, 2011). Its implementation and design, however, are flawed in at least three aspects:

- It lacks an **integrated approach** incorporating initiatives from several sectors (Francesh-Huidobro, 2012); targets are not taken into account in general planning and infrastructure (Ng, 2011)

- It lacks supporting **institutionalization and associated legitimacy** (Francesh-Huidobro, 2012); weak regulatory regime in terms of identifying sources of carbon emissions and developing effective and mandatory measures to reduce energy consumption (Ng, 2011), and insufficient involvement of civil society and a lack of climate change education (Ng, 2011). Civil society is still largely marginalised by government policy-making (Chu and Schroeder, 2010). Efforts undertaken during the last decade include:

    - **Environment and Conservation Fund**, but funding limited in scale and impact (project-based) (Mah and Hills, 2016)

    - **Council for Sustainable Development** to facilitate public engagement, with a proactive approach (outreach, gathering of public views and local knowledge;; however its action is impeded by strong vested interests (see above) and a lack of mechanisms to ensure that public inputs can be effective (lack of feedback mechanisms) (Mah and Hills, 2016)

- The spatial and sectoral distribution of climate change impacts has not been properly assessed, and the strategy has not been complemented by associated **adaptation measures** (Ng, 2011).

Overall, the literature (e.g. Francesh-Huidobro, 2012; Chu and Shroeder, 2010) highlights five factors conducive to effective climate action, with Hong Kong's strategy being deficient in at least areas (3), (4) and (5):

1. Emissions inventories that ascertain the potential for GHG emissions reduction and measure the performance of reduction measures

2. Adoption of clear GHG emissions targets and goals on which initiative for specific sectors of the economy can be based

3. Development of local climate action plans

4. Implementation and measurement of policies through a dedicated, empowered authority

5. Monitoring and verification of results and linkage of climate policy to overall sustainable development

Even if sufficient attention has been dedicated to the adoption of emissions targets (2) through the "Hong Kong Climate Change Strategy and Action Agenda" (2010) and the adoption of the "4T" scheme [source needed], scientists worry about the absence of consumption-based figures (Ng, 2011) in emissions inventories (1), therefore creating a gap in knowledge for policymaking.

1.3. London Climate Change Policy: Opportunities

Elsewhere, other cities have made breakthroughs in addressing the gaps plaguing Hong Kong's policies, of which London is a prime example. Situated in the south east of England, London is a capital city, the largest metropolitan area in the United Kingdom and one of the largest urban zones in the European Union. Similar in terms of physical and population size to Hong Kong, Greater London covers an area of 1572 square kilometres within which a population of 7.56 million resides. This amounts to a population density of 4807

inhabitants per square kilometre. Hong Kong has a population density of 6300 inhabitants per square kilometre, for comparison (Hong Kong Government, 2017).

Zero Carbon Britain (ZCB) in the UK, despite being scrapped on a national scale, is implemented for London as a city-wide policy. At the heart of British politics, London's ambitious and independently derived carbon mitigation targets set precedents for major cities across the UK. The mayor of London has demonstrated leadership in elevating climate change on to the policy agenda, formulating a set of well-coordinated and mutually supportive Local Environment policies, and mobilising resources from civil society, the business sector as well as academics. By 2025, London have pledged to cut carbon emissions by 60%, and maintain a trajectory towards zero net emissions (GLA, 2018). In order to successfully inspire and uphold progress in this field, an effective system must be in place which sympathetically caters to the interest of both the public and private sectors.

The Rise of London as a Climate Action Leader

London's current shift towards national prominence has its roots in the economic and political changes of the 1980s when deindustrialisation undermined non-metropolitan elites while the deregulation of finance allowed the growth of London as an international financial centre. The Greater London Authority (GLA) was established in 2000. It is a London governmental body composed of an elected Mayor and a 25-member assembly serving to represent public interest on vital issues such as housing, crime, the economy, transport and the environment (GLA, How we work for London , 2018). The Mayor of London serves as the voice of the capital, acting as a figure head to provide city-wide leadership and creating plans and policies which are then scrutinised by the Assembly (GLA, How we work for London , 2018).

This transparent system, which primarily serves (and is elected by) the people of London, is efficient in governing the capital as, being an elected body open to continual constructive scrutiny, it is put under pressure

to perform. The Assembly itself conducts investigations through its committees, regularly publishing any findings and providing recommendations and proposals geared towards improvement. The GLA work closely with other organisations in London government as well as local councils, central government, business and community groups. This allows for a tight connectivity and flowing dialogue between each of the 32 boroughs and ensures collective views can be considered and represented at a city-wide scale. The powers and responsibilities of the GLA were set down in the GLA Act 1999 and amended by the GLA Act 2007. Important changes to these powers were also made in the Localism Act 2011 (GLA, How we work for London , 2018). Arguably, the most effective element of the GLA Act is to determine the seven 'statutory' London strategies the Mayor must publish which regard: the Environment, Spatial Development (the London Plan), Transport, Economic Development, Housing, Culture, Health Inequalities (GLA, How we work for London , 2018).

Focus: Sustainable Development

The London Sustainable Development Commission (LSDC) is appointed by the Mayor and scrutinises and formally publishes reports on various London strategies. The LSDC is composed of individual experts from the economic, social, environmental and London governance sectors. Commissioners give their time voluntarily, promoting SD, embedding sustainability into London-wide strategies, and helping make sustainability a meaningful and understandable concept for all Londoners.

Since 2002 London has also developed the London Climate Change Partnership comprising over 30 organisations networking with over 200 others across the city to prepare London in the face of the impacts of climate change. The steering group for this body comprises representatives from the government, climate science, developers, finance, health, environment and communication sectors.

Emissions Targets

The London Climate Change Action Plan sets a target of a 60% cut by 2025 vis-à-vis the UK Climate Change Act 2008 target to reduce national greenhouse gas emissions by 80% below 1990 levels (about 77% below 2005 levels) by 2050. The sternness of the London figures derives from the deployment of a 'contraction and convergence' model in which by 2050 everyone in the world would be entitled to an equal share of emissions with the aim of atmospheric CO2 concentrations not exceeding 450 ppm. This entitlement is roughly equivalent to 2 tonnes of CO2 per person each year. London's citizens are responsible for 90 Mt CO2 per year, twice the 44 Mt CO2 that can be attributed to London under a production approach. A consumption-based approach is important for tackling climate change. It means we don't shift responsibility for reducing the carbon emissions of the goods we buy often from poorer countries, entirely on to them to solve or perhaps ignore. Londoners consume three times their fair share of the earth's resources.

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Best Practices in the Building Sector

Key Messages

- London's Energy Leap Project aims at improving the energy efficiency of existing buildings, including through retrofitting, and reducing fuel poverty.
- RE:NEW offers free support to housing organisations in the review of retrofit potential, the formulation of retrofit projects and the procurement of funding.
- RE:FIT has adopted a similar approach to energy efficiency to that of the RE:NEW scheme, but is applied to London's workplaces. It is an energy performance contracting framework (energy savings are guaranteed).
- London has also adopted a policy regarding new buildings, which have to respect the hierarchy "be lean, be clean, be green". In practice, all development proposals are required to submit an energy strategy.

In London, the building sector collectively accounts for around 78% of CO2 emissions. As 80 % of extant building stocks are likely to remain in place post 2050, it is imperative that an immediate effort is made to improve the energy performance of current buildings (2.1.) (as well as future constructs) in order to cut down both on costs and carbon (GLA, Energy in buildings, 2018). On the other hand, if the city is to move towards a greener future, London also needs to strengthen its regulatory regime for the construction of new buildings (2.2.). This challenge is being faced head on by the Greater London Authority, with an armoury of different approaches to reducing emissions and improving the livelihoods of London's tenants being employed.

2.1.Improving the energy efficiency of existing buildings

2.1.1. Overview

Energy Leap Project

London's homes have been built and developed over centuries. Therefore, their energy efficiency varies significantly, intensifying the mammoth task of overcoming multiple challenges in relation to domestic energy efficiency. Retrofitting (i.e. improving existing infrastructures), in new and innovative ways, is therefore vital if any headway is to be made (London.gov.uk, 2017). London's ultimate goal is to become a zero-carbon city by 2050, and capital funding funding has been allotted in 2017 (at a total sum of £450,000) for the the Energy Leap Project.

This aims to match fund at least ten zero energy retrofit projects with the long-term goal (if successful) to roll out the Energy Leap approach on a large scale (GLA, Energy Leap Project pilots, 2018). With the potential to radically change the way energy efficiency and the eradication of fuel poverty are approached, it is pioneer projects like this which showcase London's hands-on involvement in the accomplishment of reaching emissions targets above and beyond those outlined by the nation and in keeping with the overall message of the 2015 Paris Agreement.

In practice: 2 approaches

Through the Energy Leap project, the GLA offers registered providers of social housing the opportunity to become partners to deliver the first zero energy home retrofit projects in London. This commitment is expected to make London the first capital city in the world to replicate the Dutch Energiesprong retrofitting approach. Highly influential upon London, again indicative of the city's plasticity when it comes to incorporating new and effective policy, this transformational approach to delivering 'whole house' retrofits without subsidy has proven highly effective in the Netherlands. Through use of state-of-the-art methods of construction to bring homes to net zero energy levels within a week, the approach is funded fully by guaranteed energy savings over the course of 30 years (London.gov.uk, 2017). Current initiatives in place in London include the retrofit programmes RE:NEW and RE:FIT, both of which involve using new technology on old buildings to make them more energy efficient (GLA, Energy in buildings, 2018).

2.1.2. RE:NEW

Carbon emissions in London's domestic homes account for around 40 % of the capital's total carbon footprint (GLA, Energy in buildings, 2018). In the UK the target to reduce greenhouse gas emissions by 80% by 2050 was legislated under the 2008 Climate Change Act. Carbon modelling by the Committee on Climate Change (CCC) has demonstrated that if targets are to be met under a medium abatement scenario, then a total saving of 98 MtCO2 will need to be achieved from the residential energy use sector between the years 2010 and 2030. By offering free support to organisations such as London boroughs, housing associations, and universities, RE:NEW is estimated to have saved around 46,000 tonnes of CO2 a year after its inception.

Approach

Support is uniquely tailored to each organisation and comprises a review of retrofit potential and formulation of retrofit projects as well as procurement of funding (GLA, Energy in buildings, 2018). Through the Green Homes Programme, the GLA offers a variety of services to homeowners:

loft and cavity insulation (free for those on benefits); internal and external solid wall insulation; heating upgrades; heater efficiency measures; double glazing and communal heating systems (GLA, Energy in buildings, 2018). The Green Homes "concierge service" provides bespoke energy audits and manages the installation of energy efficiency improvements, micro-renewables and water conservation measures for the able-to-pay sector.

In practice, a trained energy advisor visited residents and gave them a full energy audit, alongside simple energy and water efficiency measures and behaviour change advice. They intended to encourage the installation of small energy saving measures (such as radiator panels, in-home energy displays and low flow shower heads). A number of easy measures were provided for free (e.g. radiator panels, low energy light bulbs, standby-switches, radiator panels, "save a flush" cistern water savers, tap aerators, garden hose guns, letter box draught proofer and aerating shower-heads, real time monitors). In the long run, the RE:NEW programme also intends to convert these home energy visits into referrals and installations of further significant energy saving measures.

The RE:NEW scheme also works to identify skills gaps in the sustainable energy industry and to develop training (in collaboration with the relevant industry bodies) to improve the skills required to install and service energy saving and micro-renewable products and systems (Mayor of London, 2006).

In addition, the programme implements awareness raising campaigns to encourage homeowners to reduce their energy consumption. They tend to focus on encouraging two types of household energy conservation behaviour:

1. **Curtailment behaviours** are those that are habitual and repeated e.g. taking shorter showers to use less hot water, switching lights off, turning down the thermostat.

2. **Efficiency behaviours** can be described as one-off or occasional behaviours and include the installation of energy saving measures such as wall or loft insulation but can also related to purchasing an energy efficient

appliance.

The programme, therefore, has been designed to ensure the best return on investment and ensures all opportunities to increase energy savings are explored. By offering a service making energy efficiency that is accessible and simple, RE:NEW acknowledges the need for an approachable government whose interests parallel those of organisations. In that sense, London's approach is to combine sustainable development goals (e.g. reducing poverty) with climate change mitigation policies (e.g. improving energy efficiency) in order to improve the sustainability of its policies over the long run. The programme has been implemented alongside London's general policy for homes, which promotes the use of energy-efficient lightbulbs.

Impact

The programme was delivered by local authorities across the city's 32 administrative boroughs with the support of local contractors. During this programme 50,683 homes underwent RE:NEW home energy visits. The environmental impact of the programme was estimated in terms of carbon emissions abates and on average, for each household in the study, a visit led to an average carbon abatement of 146 kg C02 per household/per year, which equates to an annual average reduction in household carbon emissions of approx. 3% (based on the average of 4970kgco2/year):

The majority of this was achieved through the installation of small energy saving measures. The most effective measures, in term of abating carbon, were letter box draught proofers, low-flow showerheads and real time energy use monitors. These were installed in 10%, 55% and 67% of homes in the sample respectively. However, the impact of the visits on the installation of significant measures was negligible, as was the impact on behaviour change. Only 1 in 10 referrals led to the installation of further measures:

- Those who live in rented property have limited control over structural changes such as installing insulation

- In addition, they may be dis-incentivised from investing financially in such measures because they do not own their homes.

- Many of the properties were flats which means that structural changes may require negotiation with neighbours.

Therefore, visits did not overcome the barriers required to generate behaviour change or the barriers to the installation of more significant energy saving measures. The following changes in programme design and implementation could help overcome these hurdles:

- Increasing the length of visits: visits lasted approximately 40 minutes to 1 hour. This was not long enough to install all the devices, nor long enough to explain how the home energy monitor worked, or to speak in more detail about the specific benefits of each measure provided.

- Setting targets based on carbon targets: energy experts were paid per property visited, but these had negative effects on time spent and quality of visit. In future visits should set targets based on carbon targets, rather than number of visits delivered.

- Increasing monitoring and follow-up: follow up monitoring should be undertaken at reasonable intervals after the visit, to observe and record the extent to which measures remain in place. This could be useful in determining a more accurate estimation of the carbon impact of the easy measures.

- Providing home energy advisors with additional training: The RE:NEW programme should consider a more effective, focussed programme of training home energy advisors. This would help ensure accuracy of in home assessments and opportunities for installation. It may be beneficial for councillors to employ contractors directly, to ensure the quality of training is adequate. It should also be specific training in the giving of behaviour changing advice i.e. how to tailor information, induce commitment and frame the recommendations

- Targeting high energy consumers: visits should be targeted to high energy consumers that are consuming a lot of energy. These consumers are likely to be from more wealthy neighbourhoods for

whom cost is not as much as an issue. They are also likely to be homeowners who have more control over their properties to make structural changes.

- Working with social landlords: A scheme should also be developed to work with social landlords directly to deliver structural changes and reduce energy consumption and to help address energy poverty in other areas

- Be more proactive: move away from the previous strategy of door knocking, towards much more strategic engagement with the major landlords in on-going RE:NEW work.

2.1.3. RE:FIT

Approach

Similarly, RE:FIT is programme developed by the GLA for London's workplaces, working with a wide range of bodies from central government departments and educational establishments to cultural and heritage organisations to implement retrofit projects. It aims at making London's non-domestic public buildings more easily able to reduce energy bills and carbon emissions (GLA, Energy in buildings, 2018). Its approach to improving energy efficiency is fairly similar to that of the RE:NEW programme, focusing on increasing access to energy efficient technologies, promoting both small and larger energy saving measures, through the provision of tailored support.

RE:FIT's highly skilled and experienced Programme Delivery Unit (PDU) provide free-of-charge support to public sector organizations, to help them get energy efficiency retrofit projects and programmes up and running. These organizations include London boroughs, NHS bodies, central government departments, schools and other educational establishments and cultural and heritage organizations. The PDU provide a range of best practice information, including case studies, access to previous RE:FIT participants to share knowledge, benchmarking and cost information on project costs, savings and carbon reduction.

The RE:FIT framework is competitively tendered and OJEU (Official Journal of the European Union) advertised, comprising of

"Retrofitting our buildings is critical for hitting our carbon reduction targets, but it's a struggle to systematically deliver improvements. RE:FIT has been a brilliant solution for us. It's enabled my team to overcome our barriers to delivery and get savings moving and we're looking forward to our next RE:FIT phase." **Kenneth Kinsellla, Director of Capital Development.**

energy service companies (ESCo) selected for their excellent track record in providing energy reduction and generation measures (GLA, Energy in buildings, 2018): Ameresco Limited, Bouygues E&S FM UK Ltd, Breathe Energy, British Gas Trading Limited, Engie Services Limited, Cynergin Projects Limited, EDF Energy Customers plc, Herbert T. Forrest Ltd, ISS Facility Services Ltd, Kier Services, Larkfleet Limited, E.on Control Solutions Ltd, Zephyro ,Robertson Construction Group Limited, SSE Contracting Limited ,Vital Energi Utilities Ltd

The RE:FIT framework is an energy performance contracting framework. This means that when they enter into a contract with a public sector organisation, the ESCo guarantees the energy savings from the works that it is undertaken over a given period. As a result, organisations are assured of a secure financial saving. The framework helps public sector organisations to procure an ESCo quickly, efficiently and economically.

Typical Measures	
Lighting and controls	Photovoltaic panels
Heat recovery	Solar thermal
Variable speed drives on pumps/fans	Cavity wall and loft insulation
PC control and voltage optimisation	Insulation to pipework
Water efficiency measures	Draught proofing
Building management systems	Secondary glazing
Energy management software	Radiator reflector panels
Automated meter reading	District heating
Automatic monitoring and targeting	Combined heat and power

Figure 1: Typical Measures to Increase Energy Efficiency in London's Homes

Impact

The RE:FIT scheme has been successful in improving energy efficiency, as

demonstrated by the three case studies below.

1. University buildings: London School of Economics

With the aim to reduce carbon emissions by 54% by 2020 against 2005 levels, the London School of Economics (LSE) has worked with the RE:FIT programme to improve its energy efficiency. London estimates that while £2 million were invested, £320,00 were saved (after 6.5 years' payback). Energy measures installed include:

- Lighting replacements and lighting control measures, Solar PV
- Optimisation and control strategy improvements for BMS
- Boiler replacement with efficient economiser to gain stable temperatures within room

LSE has taken advantage of RE:FIT guaranteed energy savings and CO2 reduction and has reduced their carbon footprint in this 1st year, by 1783 tonnes of CO2 per year - that's equivalent to the annual carbon emission of about 475 of averaged-sized homes.

2. London Newham University Hospital Science

An initial phase included replacement and upgrade of air handling units, with heat recovery and improved control in the main hospital itself, while a second phase included the replacement and upgrade of air handling units in the main hospital and the pathology laboratory.

Newham University Hospital has taken advantage of the guaranteed energy savings and CO2 reduction and over four years of the RE:FIT operational phase has reduced their carbon footprint by 2130 tonnes of CO2 - that's equivalent to the annual carbon emissions of almost 570 average-sized homes.

3. London Fire Brigade

Ten fire stations were successfully retrofitted with energy conservation measures during the pilot stages and as a result the LFB applied RE:FIT to a further 48 fire stations in

three-phase process. During the first phase, LFB £50,000 a year were saved due to the reduction in energy use. Installation works on phase three will continue to 2018 part of a three-year rolling programme. These are some of the energy saving measures installed across fire stations:

- Photovoltaic panels
- Lighting upgrades
- Building management system upgrades
- Loft insulation and draught proofing.

The London Fire Brigade has taken advantage of the guaranteed energy savings and CO2 reduction and now has reduced their carbon footprint by 1,000 tonnes of CO2 per year - that's equivalent to the annual carbon emissions of just over 265 average-sized home

2.2.Policy regarding new buildings

London is a growing city which is increasingly attractive to work and live for opportunists with a passion for anything from media to finance. New buildings are in demand and must be designed and built in a way that cuts energy use and carbon emissions (GLA, Energy in buildings, 2018). By following the Mayors simplistic yet succinct 'energy hierarchy' developers are made overtly aware of the wider environmental considerations to be taken into account when planning a new building. This policy encompasses three main points (GLA, Energy in buildings, 2018):

- Be **lean**: use less energy by improving energy efficiency
- Be **clean**: supply energy efficiently, for example by using district heat networks.
- Be **green**: make use of renewable energy technologies (solar photovoltaic panels or heat pumps).

Local planning authorities and developers collaborate to ensure any new projects adhere strictly to this hierarchy, as well as meeting the targets outlined in Policy 5.2 of the London Plan (GLA, Energy in buildings, 2018). Policy 5.2 requires all major development proposals to submit a detailed energy strategy demonstrating that climate change mitigation measures are integral to

the scheme's design and evolution. The details of this report which developers are legally obliged to include (such as calculations of energy demands and CO2 emissions) makes the consideration of energy reduction targets inescapable. Such a high level of transparency means there is no way of brushing large annual emissions under the carpet. Due to the support, training and education offered by the GLA, developers are able to confidently design highly efficient buildings in a way which is both better financially and environmentally (GLA, Policy 5.2 Minimising Carbon Dioxide emissions, 2018).

The 2016 London Plan, from which policy 5.2 is derived, officially encompasses a London-wide zero carbon standard for major residential development; this includes a minimum 35% on-site carbon reduction target beyond UK Building Regulations (GLA, Policy 5.2 Minimising Carbon Dioxide emissions, 2018). Importantly, any shortfall must be made up as a cash-in-lieu payment to the relevant planning authorities' offset fund. This money is then directly pumped into the reduction of city-wide carbon emissions to ensure the construction work compensates for a failure to meet targets (GLA, Policy 5.2 Minimising Carbon Dioxide emissions, 2018). By demanding cash compensation developer's vested interest in energy efficiency become even greater, with the ultimate aim being profitability.

Photo credit: pxhere

3

Best Practices in the Transport Sector

Key Messages

- London's GHG emissions reduction policy employs a combination of policy instruments, ranging from carbon pricing to increasing access to public transportation. It places an important emphasis on human health.
- London has developed two approaches to reducing GHG emissions in the transport sector: changing modes of transport and operating transport more efficiently.
- Carbon pricing in London aims at incentivizing demand for low-carbon vehicles and fuels, and to drive innovation in further developing these technologies. London has also converted part of its public transportation into hybrid vehicles.
- London has also implemented a number of retrofitting projects for public transportation, in order to make it more energy efficient. Promoting eco-driving and increasing access to public transportation were two other strands of London's policy.

In London, the building sector collectively accounts for around 78% of CO2 emissions. As 80 % of extant building stocks are likely to remain in place post 2050, it is imperative that an immediate effort is made to improve the energy performance of current buildings (2.1.) (as well as future constructs) in order to cut down both on costs and carbon (GLA, Energy in buildings, 2018). On the other hand, if the city is to move towards a greener future, London also needs to strengthen its regulatory regime for the construction of new buildings (2.2.). This challenge is being faced head on by the Greater London Authority, with an armoury of different approaches to reducing emissions and improving the livelihoods of London's tenants being employed.

3.1.Changing modes of transport

London authorities have attempted to cut CO2 emissions through the implementation of carbon pricing policies, upgrades in quality and availability of public transport and taxis, improvement in the ease of cycling and walking to provide attractive alternatives to car travel (Mayor of London, 2006), and changing modes of freight transport.

3.1.1. Carbon pricing for transport

A key element of this strategy is carbon pricing for transport: this is essential to incentivise demand for low-carbon vehicles and fuels, and to drive innovation in further developing these technologies.

The Congestion Charge was launched in February 2003 £11.50 daily- paid by those driving a vehicle within the specified zone between 07:00 and 18:00, Monday-Friday (Mayor of London, 2017). This charge is an effective way to reduce emissions because it not only encourages the development and use of low-carbon vehicles, but it results in reduced congestion due to a reduced overall number of vehicles, reducing the level of emissions from traffic, and the revenue gained can be reinvested in further policies to reduce pollution. This charge has been proven to be very effective: it has resulted in a 20% reduction in four-wheeled traffic within the charging zone during charging hours, cutting 40-50m litres of vehicle fuel

consumption inside the zone and a total 100,000 tonnes of CO2 emissions annually across London (C40, 2011). This has led to a 16% reduction in road transport CO2 emissions from the original charging zone (C40, 2011). The main response by car drivers is to switch to public transport, but there has also been an 83% increase in pedal cycle trips (C40, 2011).

The congestion charge severity was increased in October 2017 with the launch of the toxicity charge which requires vehicles that do not meet the Euro 4/IV emissions standard to pay an additional £10 on top of any applicable Congestion Charge (Mayor of London, 2017), resulting in drivers of older, more polluting vehicles in central London paying a total of £21.50 during peak congestion (Mayor of London, 2018). From April 2019, the Ultra Low Emission Zone (ULEZ) will supersede the T-Charge and create stricter emissions standards for diesel vehicles, 24/7: under this proposal, the highest polluting vehicles will be charged £25 a day, while zero-emission vehicles will travel free (Mayor of London, 2018). Vehicles need to emit less than 75g/km of CO2 and meet Euro 5 engine standards to be exempt: these are pure electric and plug-in hybrid vehicles (Mayor of London, 2015).

3.1.2. Retrofitting & Hybrid Vehicles

Buses

London authorities have improved some of their bus fleet through retrofitting their buses, which often means replacing a bus's exhaust system, and have converted some of their bus fleet to biofuel buses and diesel-electric hybrid vehicles. As of March 2014, 120 biofuel buses were introduced, powered on a biofuel blend derived from cooking oil from the catering industry: this saved an estimated 1,000 tCO2 in 2013-14, as a 20% biodiesel blend result in 15% fewer carbon emissions over their lifespan than ordinary diesel-powered vehicles (TfL, 2018). In this context:

- The authorities' short to medium term strategy involves the introduction of hybrid buses: plug-in hybrids that require induction (wireless) charging and pure electric buses (Coyle, 2013). Wireless charging entails buses being fitted with

special technology enabling on-board batteries to receive a charge boost on plates fitted at bus stands at either end of the route: this inductive charging technology ensures that buses can top up their batteries without needing to be physically plugged in (TfL, 2018).

- The authorities' long term strategy involves the introduction of hydrogen fuel cell buses (Coyle, 2013). Hydrogen fuel is an ideal way to power public and private transport in London because it's only emission is water vapour which means that no CO2 or other air pollutants are released into the air (Mayor of London, 2018).

- A policy of low emission bus zones has also been proposed, which will see the the exclusive use of buses with top-of-the-range engines and exhaust systems that meet or exceed the highest Euro VI emissions standards. These zones will be prioritised in the worst air quality hotspots outside central London and in areas where buses would otherwise contribute significantly to road transport emissions to ensure that areas with particularly high emissions are targeted by emissions reductions policies.

Taxis

Taxis have been converted into more eco-friendly modes of transport by London authorities in an effort to reduce carbon emissions. Previous taxis were heavy diesel vehicles which are a significant contributor to poor air quality (Mayor of London, 2017). From 2017, authorities started scrapping the oldest taxis (Mayor of London, 2017), and from January 2018, no more new diesel taxis were licenced in London, and all newly registered taxis had to be zero emission capable. Authorities provided grants for the first 9000 electric taxis to encourage taxi drivers to change their vehicles (Mayor of London, 2017).

Freight

Freight modes of transport can also be changed to lower emission alternatives. Transport for London have investigated the use of river transport for construction materials where possible to reduce road transport (Transport for London, 2013), and

there is potential for the movement of different types of freight to be moved on to London's waterways and the rail network (Mayor of London, 2018).

3.1.3. Access

To encourage people to use these public transport facilities, London authorities have sought to make them more widely available and accessible:

- The London Underground has increased capacity and night availability.

- Bus routes have been improved, with more convenient routes to key amenities, such as shopping centres and hospitals, and certain routes have been selected to have reduced journey times as buses are given priority on the roads to get ahead of traffic (TfL, 2018).

- To encourage people to invest in electric vehicles, London authorities have installed an increased number of rapid charging points that will power vehicles in nearly 30 minutes (Mayor of London, 2018).

Cycling

Authorities have attempted to encourage people to adopt cycling and walking as alternative non-polluting modes of transport.

- Cycle Hire was expanded to southwest London, with an additional 2,000 bicycles and 5,000 docking points (Mayor of London, 2015).

- Work is underway to deliver quieter but still direct routes for cyclists who would prefer not to ride on busy roads, and designs have been made for segregated cycle superhighways. This will encourage people to ride bicycles because the routes are safer and easier to navigate (Mayor of London, 2015).

- Authorities have focused on developing and improving online journey planning and navigation tools that will make walking and cycling trips the easiest journeys to plan (Mayor of London, 2018). This policy has been complemented by the 'Legible London' policy which centred around improving way-finding: legible London walking way-finding maps have been put

up around London to provide people walking with the confidence to navigate street environments., and minimise the fear of getting lost (Mayor of London, 2018). London authorities have made an effort to create attractive places to improve the experience of walking (Mayor of London, 2018).

Walking

Authorities have encouraged people to use public transport and walk through facilitating public transport interchange by improving dispersal from stations. Measures to achieve slow traffic speeds and reduce the effect of traffic have been adopted by authorities: these include widening the pavement and narrowing the carriageway, traffic filtering, 'pocket parks' (small parks) and play streets (Mayor of London, 2018).

- A 'timed streets' policy has even been adopted in some areas whereupon streets are closed to all vehicles or cars during busiest hours (Mayor of London, 2018), and some zones have been made completely vehicle-free in a process of 'filtered permeability', whereby physical restrictions are used to prevent motorised vehicles from using certain streets (Mayor of London, 2018).

- To further improve the experience of walking, 'Operation Clearway' has been implemented to ensure that action is taken against businesses that persistently clutter pavements with A-boards, unlicensed retail stands or unlicensed al-fresco dining areas (Mayor of London, 2018).

- To make crossing the road safer for pedestrians, Pedestrian Countdown at traffic signals has been made available at 1200 traffic light sites around London (Mayor of London, 2018), which provides a visual depiction of the seconds people have left to cross the road. A pedestrian 'SCOOT' technique has also been put in place at 7 locations where occasional high volumes of pedestrians would benefit from a longer green pedestrian signal period: detectors are used to count the number of people waiting to cross in order to provide more green pedestrian signal time when it is busier (Mayor of London, 2018). Timing reviews have been made at signal junctions and crossings: in 2017 Transport for

London reduced the wait times for people walking at 200 crossing locations close to schools, hospitals and transport hubs (Mayor of London, 2018).

- Authorities are also actively encouraging people to walk through promoting the benefits of walking and attempting to instigate a culture and attitude change. This has involved working with specific communities. A particular community initiative named 'Walk Elephant' was centred around involving the community in improving walking routes across the Elephant and Castle area. A series of local walks involving residents, where they identified potential improvements to help people walking, such as new crossings, better landscaping or clearer signage. This community engagement encourages people to adopt walking as oppose to more polluting transport because their concerns associated with walking are addressed.

3.2.Operating transport more efficiently

London authorities have attempted to cut CO2 emissions through ensuring transport is operated more efficiently. This has involved encouraging eco-driving amongst public and private transport drivers, altering how the London Underground is operated, and reducing the number of freight trips made.

3.2.1. Eco-driving

Eco-driving has been promoted amongst all car, freight, taxi and public transport drivers. This is because simply driving more sensibly can reduce fuel use by 5-10%. Eco-driving policies include smoother acceleration/ braking and proper vehicle maintenance.

3.2.2. London Underground

The efficiency of the London Underground has been improved by Transport for London. The potential for **natural ventilation** and **daylighting** has been investigated, reducing emissions through preventing the need for

artificial ventilation and lighting; daylighting is achieved through the use of light tubes for transport of light to below ground locations (Transport for London, 2013).

The implementation of **humped alignment** has been investigated in stations: this involves the raising of a station so that trains entering the station roll up the 'hump' and require less energy for braking; they also use less energy to accelerate when leaving the station as they roll off the hump (Transport for London, 2013).

Design of the tube has been made to be more **energy efficient**: LED lighting has been implemented, daylight sensors have been provided for external lighting and for internal areas, which directly benefit from daylighting, and time switches and passive infra-red (PIR) sensors have been implemented for toilets and staff circulation areas (Transport for London, 2013).

Regenerative braking is an important way of increasing tube efficiency: this involves a process where the kinetic energy from braking is converted into another form of energy which can be reused in other parts of the tube system.

Thermal zoning and controls have been implemented to improve the heat efficiency of the London Underground, including individual temperature control for different areas of the stations, which ensures that heat is distributed throughout the station in a way that prevented wastage in areas where it is not needed.

Efficient **fans and pumps** have been deployed to reduce energy wastage associated with the mechanical ventilation system, including variable speed drives.

Efficient **lifts and escalators** have also been deployed in tube stations. Improving the efficiency of escalators entails the adjustment of the speed of the escalator to to slow down when not in use, or stop during off-peak periods, and a drive controller capable of variable speed, variable voltage and variable frequency control of the drive motor. Improving the efficiency of lifts involves the implementation of energy efficient lighting such as LED lighting, the activation of a 'standby mode' for when the lifts have been

inactive for a specified time, and a regenerative drive unit to allow the recovery of energy, for example as the lift brakes (Transport for London, 2013).

To make the supply of energy more efficient, **tunnel waste heat recovery** has been investigated: this involves utilising waste heat from the Underground tunnels other networks in London (Transport for London, 2013).

3.2.3. Freight

Increased efficiency of freight transport has been promoted through **reduction in the number of delivery trips** (Mayor of London, 2015). This involves companies being encouraged to transport products less often in larger quantities as oppose to transporting products more regularly in smaller quantities.

Summary

Overall, London authorities have focused on changing modes of transport and operating modes of transport more efficiently in order to reduce transport emissions. This is a successful two-pronged strategy because it encourages people to use more public transport and increases the efficiency and thus reduces emissions from this public transport.

Photo credit: Flickr

4

Shaping Hong Kong's Sustainable Future: Opportunities from London's experience

Key Messages

- Hong Kong's governance style differs from London's in at least three aspects: public transportation is privately operated, institutional capacity is lacking, and housing is largely government-operated.
- In addition, car ownership rates are low, and Hong Kong is significantly more vulnerable to climate change impacts that London. Air pollution also presents challenges to human health.
- This has important implications when assessing whether London's policies could be applied in Hong Kong.

Hong Kong and London are both global command centres for international finance. However, it is important to note that governance in London significantly differs from that in Hong Kong, where the bureaucracy "still assume a centralized governmental role" (Chu and Schroeder, 2010; Cheung and Scott, 2007). This has important implications on the type of policy instruments that can be used in Hong Kong, as demonstrated by Mah and Hills (2016), who argue that effective local climate governance is impeded by a lack of leadership originated in the "one country, two systems" model, a lack of institutional capacity due to departmental fragmentation, and a lack of enabling capacity for engagement.

In particular, Mah and Hills (2016) highlight the incompatibility between traditional policy instruments and new forms of governance, which require the use of a portfolio of policy instruments, opportunities for feedback from the public, and regional collaboration, both of which appear to be lacking in Hong Kong. As a result, Hong Kong's current approach is therefore limited to conventional command and control measures (e.g. emissions standards) and to voluntary measures to mitigate climate risk. However, according to Tracy, Trumbull and Loh (2017), if reducing GHG emissions is necessary, "the length of time that it takes for existing GHG concentrations to be reabsorbed by the Earth's natural systems means the world is already going to experience some level of change". This justifies the need for adaptation strategies aiming at increasing the resilience of natural, human and economic systems. This seems even more necessary when acknowledging Hong Kong faces a significantly higher level of vulnerability to climate change than London, for instance. We argue that such an approach could start with greater policy integration within specific sectors, which is why focusing on the building and the transport sector seems adequate.

Against that background, the rest of the section will be dedicated to an assessment of London's policies and how they could be implemented in Hong Kong, if at all. In particular, we can argue that London's strategy towards reducing GHG emissions in both the building and the transport sector revolve around three pillars :

1. Retrofitting building and transport infrastructure to **improve energy efficiency**, in particular under the RE:FIT and the RE:NEW programmes in the building sector, and through a portfolio of measures in the transport sector ;

2. **Shifting towards more sustainable modes of transport**, which involves reducing car dependence, developing public transportation, including freight transport, and combining health and climate adaptation through the promotion of walking and cycling ;

3. Strengthening the **regulatory framework**, in particular around the construction of new buildings and the use of "greener" modes of transport.

4.1. Retrofitting the building and transport infrastructure to improve energy efficiency

Hong Kong has taken steps to increase energy efficiency in the building sector, which account for around 89% of Hong Kong's energy consumption (Francesh-Huidobro, 2012), for instance by encouraging property owners and building managers to audit, curb and report on the GHG emissions in their buildings, and through the launch of the HKEERSB in 1998 to promote voluntary application of a set of BCs (minimum energy performance standard of different buildings). In London, this has been achieved through the Energy Leap Project, which has implemented the RE:NEW project in the housing sector, and the RE:FIT project for workplaces and public buildings.

Overall, we suggest that the RE:NEW project has a great potential for impact in Hong Kong, as "governmental intervention into the housing markets in Hong Kong is very prominent, with half of the population living in public housing" (Yung and Lee, 2014). It means that in contrast with London, Hong Kong wouldn't have to negotiate the RE:NEW project and retrofitting works with social landlords, because it already has direct control on social housing. We suggest that Hong Kong could strengthen this impact through increasing access to public housing, in order to subject a greater number of

households to guidelines regarding carbon emissions. This would further enhance the "sustainable development" approach of the project and lead the way for new modes of governance. Furthermore, Yung and Lee (2014) found that "about 53% of households in Hong Kong are home-owners, while around 43% are tenants", which means Hong Kong could further increase its impact by promoting home-ownership, as it is an essential condition for people to invest in larger energy improvements works (Chim and Wong, 2015).

Moreover, Hong Kong identifies both the residential sector and the commercial sector (including university campuses, public services etc.) are major causes of emissions; therefore, the RE:FIT scheme also appears to be sound in order to help abate carbon emissions. It would be particularly beneficial to university campuses and public schools, as various sources highlight a lack of climate change education within Hong Kong's population [include sources]. This may indeed raise awareness around that issue. However, it should be noted that London's RE:FIT scheme would be much harder to implement in Hong Kong, as it requires the use of a portfolio of policy instruments and good coordination between departments, which appears to be lacking in Hong Kong. However, because of the high benefits of this approach, Hong Kong may consider implementing an adapted RE:FIT scheme, which would be smaller in scale but would lead the way towards greater policy integration.[1]

4.2. Shifting towards more sustainable modes of transport

In Hong Kong, land transport is the second largest contributor of GHG emissions after power generation, making up to 18% of total emissions (Francesh-Huidobro, 2012; Yuhong, 2011). Hong Kong's government has taken steps towards reducing the sector's environmental footprint, for instance through the promotion of cleaner vehicles by decreasing the First Regulation Tax for private and commercial cars that use

[1] For further information on Hong Kong's buildings efficiency, see Li, Ng and Skitmore (2017) and Tan et al. (2018)

environmentally-friendly petrol, and through the promotion of biodiesel fuel, whose import is duty-free (Francesh-Huidobro, 2012).

4.2.1. Reducing car dependence

Most of London's transport policy is oriented towards the promotion of eco-driving amongst public and private transport drivers, including through the development of London's underground and bus freight to facilitate the use of public transportation, and through carbon pricing for vehicles with high carbon footprint. However, it is important to note that if private car use is a major cause of GHG emissions in London, Hong Kong has one of the lowest rates of private car use in the developed world (Cullinane and Cullinane (2003). In fact, Cullinane and Cullinane (2003) argue that Hong Kong has never become car dependent, and has a history of good, cheap public transport (Cullinane, 2002), which has been demonstrated to be negatively related to car ownership. For this reason, London's measures aiming at reducing private car use may not be appropriate to Hong Kong's context, where car use is mostly associated with company ownership. If carbon pricing measures were to be implemented in Hong Kong, they should therefore target this specific population of cars.

Even though car ownership rates are low in Hong Kong, Newman and Kenworthy (2000) noted that Hong Kong is still a car-saturated city, with one of the highest car densities in the world, and public transport accounting for around 90% of motorized journeys (Cullinane and Cullinane, 2003). It means that policies aiming at increasing the use of public transportation in Hong Kong, for instance, through increasing the capacity of Hong Kong's subway, or by providing more convenient routes to key amenities may not have as much impact in Hong Kong as in London, because the transport network is much more developed in Hong Kong. In particular, whereas the Tube is London's most used public transport mode, buses are the single major form of transport in Hong Kong, accounting for 36% of journeys (Hong Kong Transport Department, 2001), while the MTR accounts for around 20% of public transport journeys (Cullinane and Cullinane, 2003).

It also means that retrofitting public transport infrastructures, through the introduction of hybrid vehicles or more energy-efficient infrastructures (e.g. natural ventilation, daylighting, humped alignment…) may have a greater impact in Hong Kong than in London. In particular, as Hong Kong already has a policy promoting the use of biofuel, we suggest it should consider promoting the use of electric vehicles for public transportation, or of plug-in hybrid vehicles, while providing rapid charging points for electric vehicles. However, it should be mentioned that whereas London's Tube and bus freight are publicly operated, therefore allowing the GLA to exercise control over public transportation in London, Hong Kong's MTR, bus and taxi freight operate under a privatized model, which means it can't directly control how it operates. We explore in section 4.3.2. how this obstacle could be overcome.

In addition, it should also be noted that due to Hong Kong's higher vulnerability to climate change, risks of climate change impact to the region's physical infrastructure should be considered when planning the development of Hong Kong's public transportation. According to Tracy, Trumbull and Loh (2007), both roads and railways are likely to suffer damage from increased temperatures, causing road surfaces to deteriorate, rut or subside, and railways to suffer from shrinkages to foundations, buckled rails and distortion, and from storms and flooding, which can cut above-ground railway lines and flood underground train systems. Therefore, we suggest Hong Kong should carry an appropriate assessment of the state of its public transportation while "greening" its infrastructure, as some of the works implemented in London's underground such as humped alignment or regenerative braking constitute large investments.

4.2.2. Developing river and rail transport for freight

Industry and transport, combined with energy supply, constituted the largest growth in GHG emissions between 1970 and 2004 (Huisingh et al., 2014). The environmental externalities associated with distribution operations, i.e. logistics services, have still been largely overlooked (Nieuwenhuis et al., 2012) even though a major contributor to

the carbon footprint of a supply chain is the total energy consumed in manufacturing logistics.

According to To (2015), Hong Kong is one of the world's logistics hub, with one of the best deep-water ports in the world, which ranks as the world's third busiest container port. The Pearl River Delta region, and in particular manufacturers in Guangdong province produce a significant amount of goods for the world market. The logistics sector is one of the key economic pillars of Hong Kong, and produces around 36 million tonnes of CO2-eq per year, a significant portion of which is emitted from air freight.

Interestingly, London's strategy in the transport sector considers the carbon impact of freight transport, and promotes the use of alternatives vehicles for freight, such as river transport or an expanded use of the rail network, and a decrease in the number of delivery trips. These measures could have a great impact in Hong Kong, and echo with previous studies on Hong Kong's logistics sector's carbon footprint, which suggest that cargo movements between Hong Kong and Shanghai should be switched to other modes such as sea transport or land transport on trucks. According to To (2015), "it was found that the decrease of GHG emissions was 113 kilotonnes of CO2-eq per 100 kilotonnes of cargo changing from air to sea transport. In particular, we would encourage Hong Kong to switch towards sea transport instead of rail or truck transport, as the adaptive potential of the sea transport infrastructure could be better suited in meeting climate change impacts. It should be noted that it would require Hong Kong to consider the changing patterns of sedimentations around harbours, which would increase its ports' operating costs if left unaddressed.

In addition, we suggest a partnership with the neighbouring Guangdong province, where a large number of products come from, could be initiated.

4.2.3. Combining health and climate adaptation: promoting walking and cycling

In order to further promote the use of "greener" modes of transport, the GLA has also implemented a set of measures aiming

at facilitating the use of walking and cycling as mode of transport. In particular, they suggest expanding the cycling hire and widening the pavement, while implementing a range of measures aiming at improving the experience of walking and cycling, such as the construction of "pocket parks", of quieter routes for cyclists, the introduction of an online journey planning and navigation tool, of a "timed street" policy and pedestrian countdown.

Overall, the literature indicates these measures to be sound in the context of Hong Kong. According to Cerin, Lee, Barnett et al. (2013), "the availability of both non-commercial and commercial destinations may promote within-neighbourhood walking for transport, while recreational facilities and public transit points may facilitate overall walking for transport", and Cerin, Chan, Macfarlane et al. (2011) argue that the presence of parks and environmental aesthetics as well as street connectivity predicts longer walking distances. However, Lu, Xia and Ye (2016) argue that further developments in these aspects of walking and cycling may not have as much impact in Hong Kong as in London, because it already features high levels of land use mix and street connectivity, with "better developed public transport systems […] and much lower violent crime rate".

Furthermore, while the GLA promotes the health benefits of walking and cycling, for instance through the "Walk Elephant" initiative, it is doubtful Hong Kong could use the same argument to promote walking and cycling given its high levels of air pollution, which is known to have an adverse impact on human health (Lu, He and Leung, 2011). According to Fan, Lam and Yu (2012), "the number of days with Air Pollution Index (API) reaching "very high" or "severe" levels is on an increasing trend. Official statistics show that motor vehicles account for 82% […] for the local pollution loading". In particular, it should be noted that sulfur dioxide (SO2), respirable suspended particulates (RSP), nitrogen dioxide (NO2) and carbon monoxide (CO) are Hong Kong's major pollutants, and are specific to diesel vehicles (Lu, He and Leung, 2011; Fam, Lam and Yu, 2012). Air pollution is then "aggravated by the confined space between high rise buildings in Hong Kong" (Fan, Lam and Yu, 2012).

Therefore, if Hong Kong wished to promote walking and cycling, it should first investigate how it can reduce air pollution, as various sources highlight 63% of Hong Kong's pollution comes from local sources. This finding strengthens the case for a shift towards hybrid and electric vehicles, as diesel vehicles are a major cause of air pollution in Hong Kong. However, it should be noted that China Light and Power and Hong Kong Electric Holdings, the two major electricity companies, are another major cause of air pollution. Increasing the production of electricity from coal-fired power stations wouldn't, therefore, be sustainable. Hong Kong should then investigate more sustainable sources of electricity; in that respect, we suggest Hong Kong could explore opportunities for increased production of hydroelectricity, drawing from the example of other countries facing water-related risks such as the Netherlands. According to Tracy, Trumbull and Loh (2007), Hong Kong's supply of fuel and electricity could be significantly impacted by climate change, and the hydro-electric dams that produce more than 20% of the region's power are under threat. Therefore, Hong Kong should investigate how other countries under the same threat have built more resilient infrastructures.

4.3. Strengthening the regulatory framework

4.3.1. Regulations around new buildings

High-density metropolises face severe challenges to substantial carbon reductions in buildings to facilitate the transformation towards sustainability. The difficulties are even more severe in Hong Kong given the high-rise norm of buildings. To achieve very low or zero carbon emission buildings requires not only technological advances but socio-economic, regulatory and political measures. However, there's no Zero Carbon Building Policy in Hong Kong; according to Francesh-Huidobro (2021), regulations of height guidelines are weak in Hong Kong, which allows the construction of "tall buildings that create a wall effect that traps pollutants and increase island heat".

London planning authorities have worked with a range of policy instruments in order to ensure new projects adhere with their "Be lean, be clean, be green" hierarchy, including a legal obligation to submit a detailed energy strategy for all new major development proposals, the provision of training education for more efficient building design, and cash-in-lieu payments should any shortfall occur, which fund other GHG emissions reduction measures. As demonstrated above, improving the regulatory framework is one of the greatest challenges Hong Kong has to face regarding the reduction of carbon emissions, as vested interests impede effective climate action [add source]. However, London's experience in using a portfolio of instruments, some of which don't require setting taxes to promote the construction of energy efficient buildings, may still be useful to the strengthening of Hong Kong's regulatory framework.

4.3.2. Franchising green modes of transport

In section 4.2.1., we introduced the difficulty for Hong Kong to effectively implement retrofitting projects in the transport sector, mainly because public transportation in Hong Kong is operated through a privatised model. Though London's public transports are mostly publicly operated, Hong Kong could still get inspired by its policy regarding taxis, which are privately operated in London. London's policy includes grants for electric taxis and suggests that no more new diesel taxis will be licensed. In Hong Kong, these two measures could be expanded to all public transportation.

In addition, London intends to create low emission bus zones, which could be another way to promote greener modes of transport, without resorting to taxes.

Recommendations

Based on the information gathered in section four, recommendations for Hong Kong can be summarised as follows:

1. The RE:NEW project has a great potential for impact. Hong Kong should increase access to public housing in order to be able to implement guidelines regarding carbon emissions in a greater number of households.

2. Implement an adapted RE:FIT scheme, smaller in scale than London's, in order to pave the way towards greater policy integration.

3. Consider targeting company cars with carbon pricing measures.

4. Promote the use of electric vehicles or plug-in hybrid vehicles for public transportation.

5. Provide rapid charging points for electric vehicles.

6. Carry out an appropriate assessment of the state of public transportation, in light of the likely damage increases in temperature and rainfall will cause to road surfaces and railways.

7. Switch towards sea transport instead of rail or truck transport in order to be more adaptable to climate change impacts.

8. Consider addressing the changing patterns of sedimentation around harbours.

9. Initiate a partnership with neighbouring Guangdong province.

10. Reduce air pollution by shifting towards hybrid and electric vehicles in order to promote walking and cycling.

11. Use the example of the Netherlands to explore building resilient infrastructures to increase hydroelectricity production.

12. Provide grants for electric public transportation and do not allow new diesel public transportation to be licensed.

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