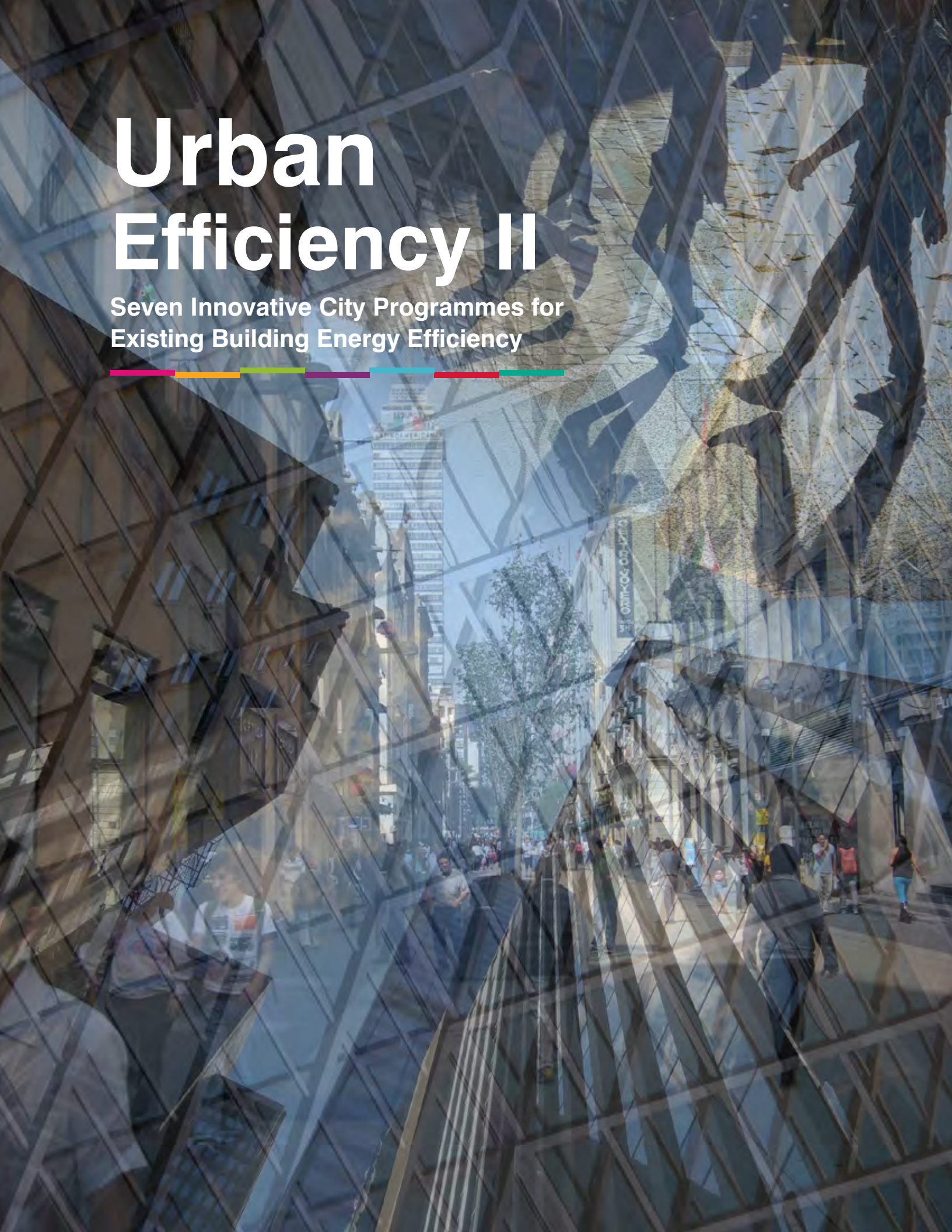
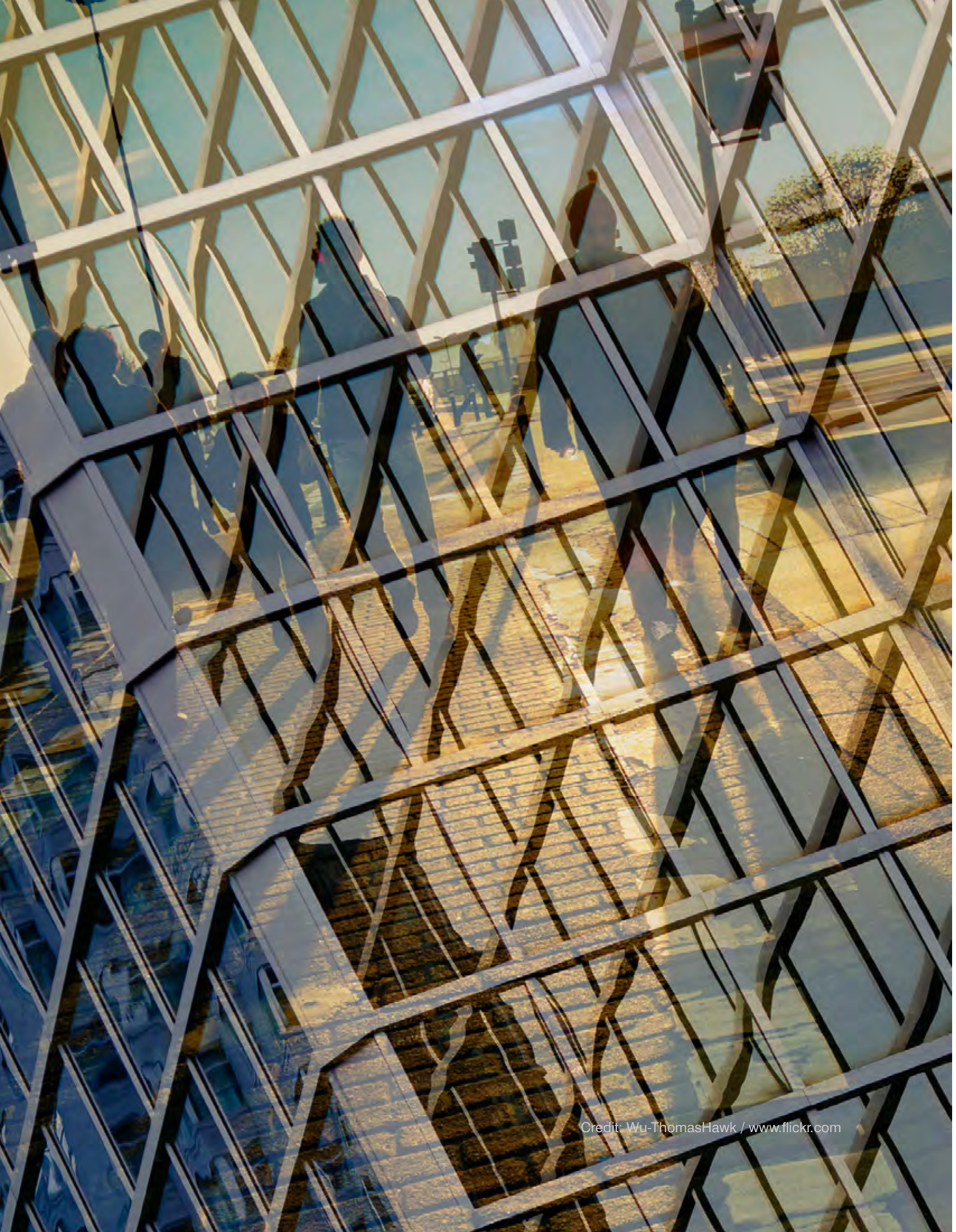


Urban Efficiency II

Seven Innovative City Programmes for Existing Building Energy Efficiency



Credit: Wu-ThomasHawk / www.flickr.com

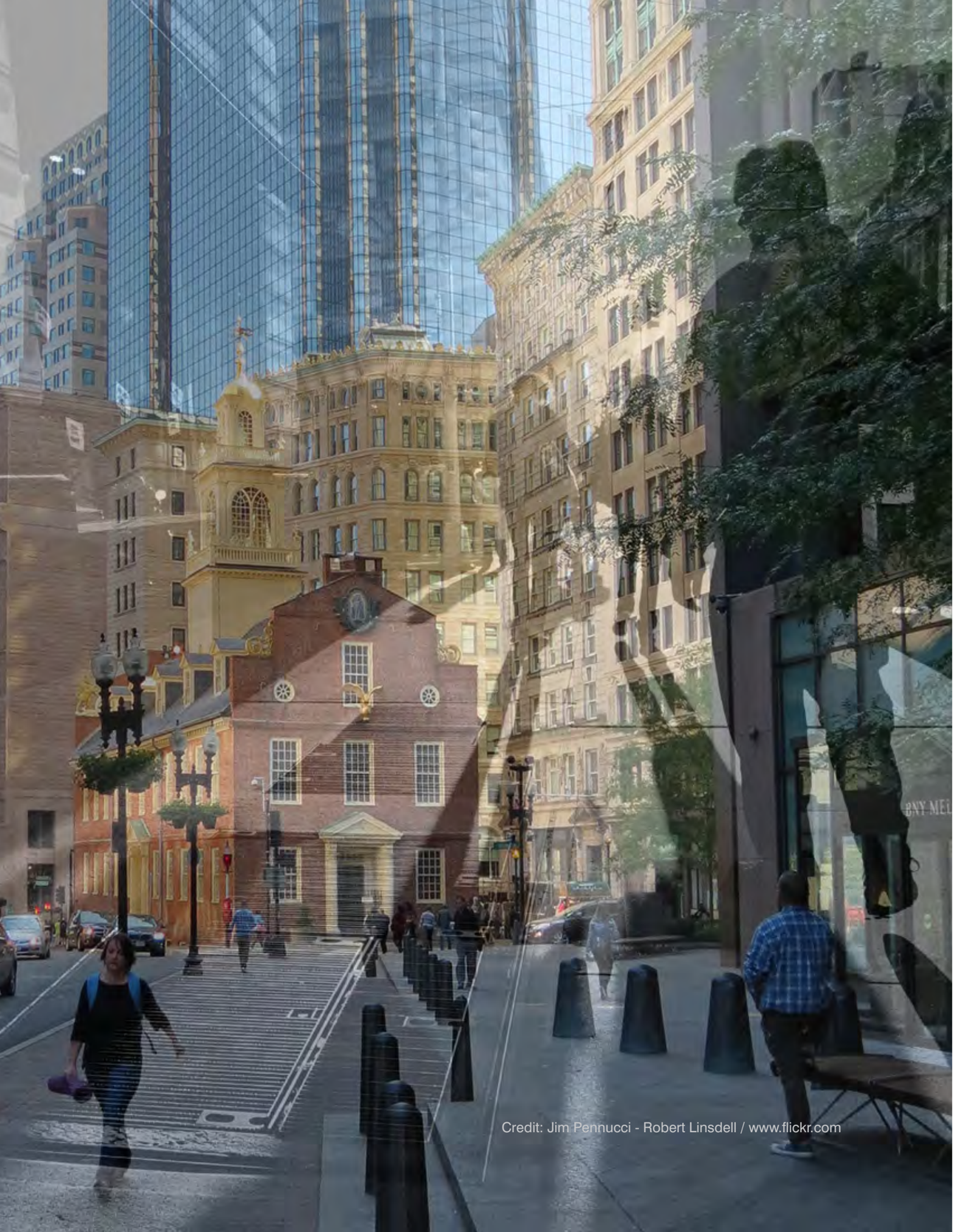
Urban Efficiency II

Seven Innovative City Programmes for Existing Building Energy Efficiency

C40 CITIES
CLIMATE LEADERSHIP GROUP

CSR DESIGN

TOKYO METROPOLITAN GOVERNMENT



Credit: Jim Pennucci - Robert Linsdell / www.flickr.com

Contents

Credit: Toshihiro Oimatsu - side78 / www.flickr.com

Forewords

Yuko Nishida
Tokyo Metropolitan Government

The Paris Agreement has come into effect and cities are now expected to play a greater role than ever. City officials in charge of climate change are now faced with the need to accelerate and scale up climate actions. In that regard, city networks like C40 Cities are crucial for identifying effective solutions in the urban context and expanding best practices. Tokyo Metropolitan Government (TMG) has participated in the Private Building Efficiency (PBE) network of C40 since 2013 by learning from other cities through workshops, webinars, sharing documents and conducting joint projects. Even though cities are defined by vastly unique local contexts, we face many common challenges. Inter-city communications through the C40 network thus provide many rich clues for solutions. In addition, the high motivation and enthusiasm we commonly share makes it an exciting task to tackle such challenges. Tokyo therefore sees great value in being a part of a network of such active collaboration, and we are honoured to be a lead city together with Sydney.

Tokyo hosted the PBE workshop in 2014, prompting publication of the first *Urban Efficiency* report. This was to share the important results of the workshop with other cities unable to attend, and also to other cities outside the C40 network. Documenting the results of innovative city-level action in the area of building energy efficiency and retrofitting is extremely important. It complements direct oral communication and also helps non-English speakers, including TMG staff, to more fully absorb lessons from other cities.

Thanks to the efforts of all those that cooperated in disseminating the first *Urban Efficiency* report in 2014 we have received much favourable feedback since its publication, including citations by various reports. This positive feedback has proved a great source of satisfaction and is a major factor behind our decision to release a second version.

In contrast to the ten case studies in the first report, which included many mandatory initiatives, *Urban Efficiency II* has surveyed mostly voluntary programmes (or those with a voluntary component). The effectiveness of these seven city programmes has been bolstered through a combination of creative

design efforts, stakeholder engagement and mixes of various policy instruments. For policy makers, I am confident that these detailed case studies will prove a treasure trove of practical tools and insights.

Urban Efficiency II is based on research conducted by TMG. In publishing our results, we would like to thank the efforts of CSR Design Green Investment Advisory (especially Tomoko Takagi) for much dedicated work. We also express much appreciation to Greg Trencher from Clark University as the lead author of the report, and for providing important insights from the perspective of the cases studies as a whole. This has deepened our understanding of city efforts in the area of building energy efficiency.

Finally, we extend special thanks to the contributors from each surveyed city sparing the time out of busy schedules to cooperate for interviews, provide additional information and correct the drafts.

It is my sincere hope that this report too will be an important reference not only for other C40 and PBE network members, but also for colleagues in other cities around the world.

Frankie Downy
C40 Cities Climate Leadership Group, London

At the C40 Summit in Mexico City, C40's Deadline 2020 research revealed the scale of action needed to ensure our cities follow a pathway consistent with the Paris Agreement, and limit global temperature increase to 1.5 degrees. If this is to happen, the next four years are critical and require a huge increase in the rate of climate action in cities.

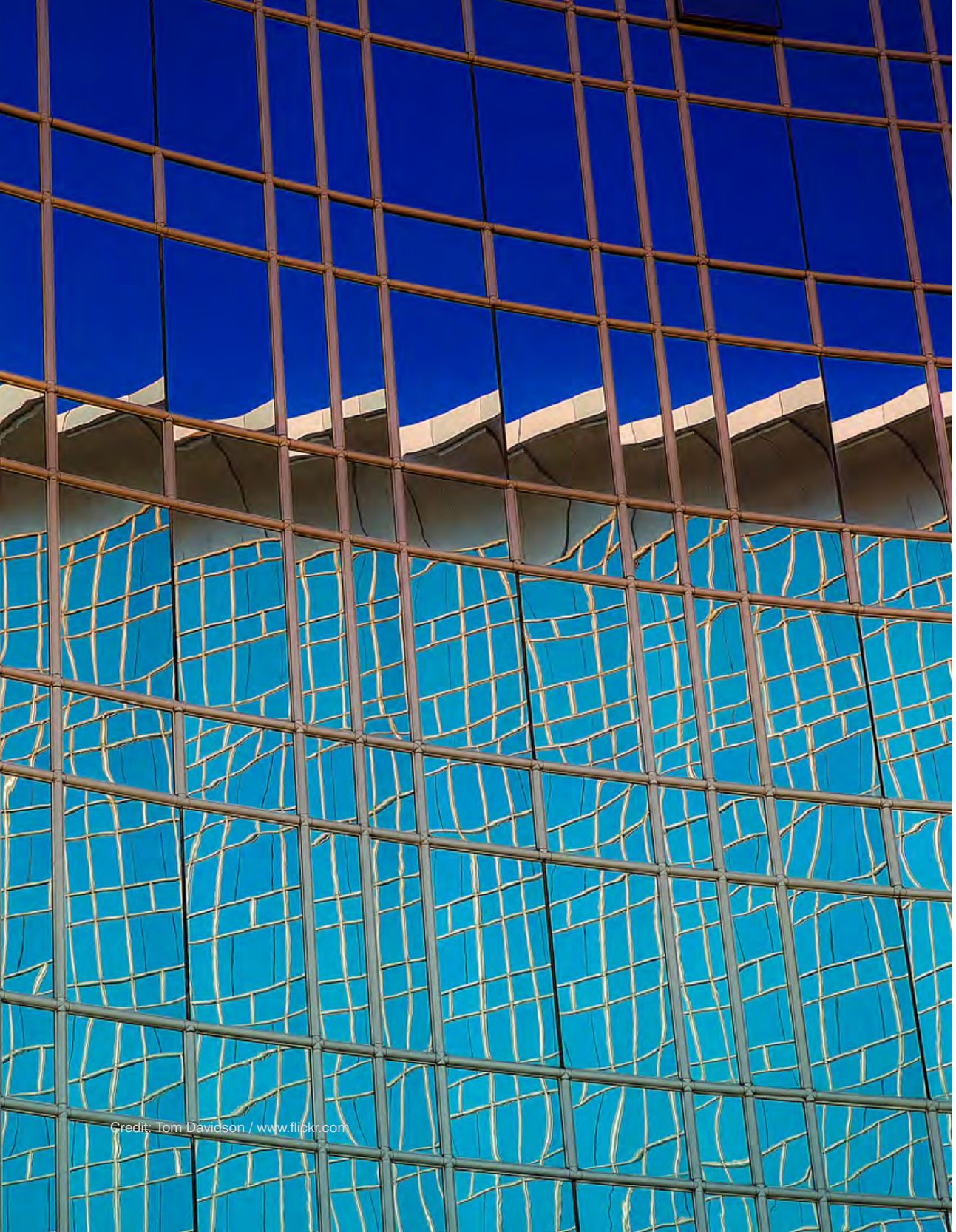
The member cities of the C40 represent 11% of the global population and a quarter of global GDP. They are the biggest cities in the world, and have a big responsibility to reduce emissions. But they are also the leading cities, innovative and ambitious in their plans and actions to tackle climate change.

Deadline 2020 highlights that it is the Buildings Sector where the highest proportion of actions must be taken. And within the Buildings Sector, retrofit and financial support or incentives for commercial and residential buildings together are projected to deliver 70% of emission savings. The C40 Private Building Efficiency (PBE) Network, co-led by Tokyo and Sydney, supports cities to replicate, improve and accelerate climate action across the commercial and residential sectors.

This report, the second in a series, was produced using examples from the PBE Network. Like the first report, it serves as a reference and evidence base for city officials when developing or improving building energy policies. The first report was incredibly useful for cities who used it to incorporate best practices from around the world, including financial incentives, sectoral benchmarking, and building optimisation programmes into their energy plans and roadmaps. Other cities used it as an evidence base to push for the introduction of new, ambitious building energy policies or expand already successful schemes. We hope this report will prove just as valuable.

To limit warming to 1.5 degrees all cities, not just C40 cities, are going to need to take action. Therefore C40 and Tokyo Metropolitan Government (TMG) are pleased to be able to share the valuable lessons and analysis in this report with policy makers around the world.

C40 would like to thank all those involved in producing the report - the generosity of TMG and in particular the dedication of Yuko Nishida; Greg Trencher from Clark University for his lead role in writing the report; and the efforts of CSR Design Green Investment Advisory, in particular Tomoko Takagi. And finally, to the city staff who contributed their time to help create this valuable resource.


Credit: Tom Davidson / www.flickr.com

Contributions and acknowledgements

Tokyo Metropolitan Government
Yuko Nishida (Research design, project direction)

C40 Cities Climate Leadership Group
Frankie Downy (Research design, project direction)

CSR Design Green Investment Advisory, Co., Ltd.
Dr. Tomoko Takagi (Co-lead author, research design, project direction)
Ryuichi Horie (Project direction)
Benjamin Tweed (Case research)
Kanayo Hara (Case research)
Randa Ziadeh (Case research)
Dr. Hyun Young Ryu (Case research)
Ying Xiangru (Case research)

Clark University
Ass. Prof. Gregory Trencher (Lead author, research design, project direction)
Kyle Pilkington (Language editing)

City programme officials interviewed and providing information

- **Boston:** Milton Bevington (Senior City Advisor, City Energy Project, Boston)
- **Chicago:** Jamie Ponce (C40 City Advisor, Chicago), Amy Jewel (Senior City Advisor, City Energy Project, Chicago)
- **London:** Louise Clancy (Principal Policy and Programme Officer, Greater London Authority), Dr Katherine Eames (Business Energy Challenge Delivery Team, Greater London Authority)
- **Mexico City:** Ruben Lazos (Director General of Environmental Regulation, Mexico City Secretary of the Environment), Graciela de Paz (Director of Energy and Environmental Economy, Mexico City), Rafael Ramos (C40 City Advisor, Mexico City)
- **Seoul:** Kim Kum-ho (Assistant Director, Environmental Policy Division, Seoul Metropolitan Government)
- **Shenzhen:** Yu Han (Sino-US Project Department Board Office Strategic Development Department, Department Manager, Shenzhen Institute of Building Research), Tingyu He (C40 City Advisor, Shenzhen)
- **Tokyo:** Kazuhiko Ueda (Director for Carbon Reporting Program, Bureau of Environment, Tokyo Metropolitan Government), Tomoaki Arai (Deputy Director for Carbon Reporting Program, Bureau of Environment, Tokyo Metropolitan Government)

Design and layout: Edward Cooper

Suggested citation

Trencher, G., Takagi, T., Nishida, Y., Downy, F. 2017. *Urban Efficiency II. Seven Innovative City Programmes for Existing Building Energy Efficiency.* Tokyo Metropolitan Government Bureau of Environment, C40 Cities Climate Leadership Group, CSR Design Green Investment Advisory, Co., Ltd. London.

Chapter 1:

Objectives and methods

Credit: Tom Davidson - helguera3 - Varock and Roll / www.flickr.com

1.1 Objectives

The importance of cities in tackling climate change and contributing to meeting the goals of the Paris Agreement has received much attention lately. C40 Cities Climate Leadership Group (henceforth C40) and ARUP have recently published important studies on this topic such as *Deadline 2020: How cities will get the job done* (Hurst, Clement-Jones et al. 2016). This report argues that for the world to meet the goals of the Paris Agreement, every city needs to diverge considerably from its current business as usual pathway. The next 4 years are critical; emissions can only rise a further 5% from current levels (as opposed to a 35% increase in a business as usual scenario). UN Habitat III, or the United Nations Conference on Housing and Sustainable Urban Development, also took place recently in Ecuador. In response, prestigious scientific journals such as Nature and Science shone the spotlight on the vital role of cities in advancing global sustainability. In particular, the significance of networks such as C40 for building collective learning and diffusing good practices was highlighted (Acuto, 2016; Wigginton et al. 2016).

Across the globe cities are making undeniable strides in implementing ambitious climate policies, often breaking new ground ahead of state or national counterparts. In C40 cities, building energy consumption constitutes nearly 50% of greenhouse gas (GHG) emissions, rising to 75% and 80% in New York and London respectively. With building-related GHG emissions and energy consumption often outweighing other societal sectors such as transport or industry, advancing the necessary deep energy savings across the building stock demands an unprecedented level of innovation and ambition from policy makers.

This report builds on research started in the predecessor *Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities* (Takagi et al. 2014). The central objective of this updated and expanded study is to continue advancing understanding into the characteristics and outcomes of innovative city programmes[1] emerging across C40 cities to advance operational energy efficiency and retrofitting in existing, private sector buildings. Specifically, our focus is on seven cities in the C40 Private Building Efficiency (PBE)[2] network.

Our primary intended audience is city-level policy makers and decision makers across the world, both within and outside the C40 network. As such, our hope is that this resource will help enhance policy efforts in other cities, both in designing new programmes and making adjustments to programmes already under implementation. In addition, through studies such as Trencher et al. (2016) we actively seek to share the experiences of the C40 and PBE network with a global academic audience in fields such as climate policy, urban sustainability transitions and building energy efficiency.

This report's specific objectives are to identify:

- Varying approaches, attributes and innovative features of programmes
- Programme functions and processes by which they were designed
- Opportunities, challenges and limitations encountered during the design and implementation of programmes, and useful countermeasures
- Environmental, social and market impacts (either actual or potential)

1.2 Structure of report

Overall, this report may be broken down into the following two sections:

Chapter 2: Key findings and overall analysis
This collates the key findings from our seven case studies. It follows roughly the same focus and structure used in the individual case studies (outlined below).

Chapter 3: Detailed case studies
We conducted a total of seven individual case studies. This collection showcases innovative city programmes from Boston, Chicago, London, Mexico City, Shenzhen, Seoul and Tokyo (see Table 1). Each case provides an in-depth look at multiple dimensions of policy design and implementation. They adhere to the same analytical structure and examine areas such as:

- The background and context of building energy efficiency polices in that city
- Key and innovative attributes and mechanisms driving the programme
- Incentives driving building sector participation
- Processes by which the programme was designed and implemented
- Key impacts
- Drivers, challenges and useful countermeasures

[1] This depicts the interconnected package of policy instruments, laws, regulations and support mechanisms that make up a unified city initiative to promote operational energy efficiency and retrofitting in existing buildings.

[2] This city-only working group of C40 is currently comprised of approximately 30 members across Asia, Oceania, Africa, Europe, and North and Latin America. It facilitates sharing of good practices on tackling climate change in privately owned buildings.

1.3 Methods

Overview of scope and sample

As shown in Table 1, our sample consists of one city programme from seven C40 cities. Efforts were taken to ensure diverse geographical and cultural representation and also to include new cities that were not featured in the first Urban Efficiency report. Due to the limited sample size, we acknowledge that these city programmes do not necessarily represent global trends across the entire PBE or C40 network. For an exhaustive analysis of worldwide trends in building energy efficiency and climate governance in C40 cities we refer readers to the joint C40 and consulting firm ARUP publications (Watts et al. 2015; Schultz et al. 2015) or the World Resources Institute Report by Becqué et al. (2016). That said, many of the lessons generated by our seven cases are not regionally specific. They will undoubtedly provide insight for policy makers all across the globe, enabling others to learn from and replicate that city's success.

Table 1: **Overview of sampled programmes**

City	Programme	Target	Year implemented
Boston	*Renew Boston Trust Commercial*	• Commercial • Industrial • Residential (MF*)	2018***
Chicago	*Retrofit Chicago Energy Challenge*	• Commercial	2012
London	*Business Energy Challenge*	• Commercial	2014
Mexico City	*Sustainable Buildings Certification Program*	• Commercial • Industrial • Residential (MF*)	2009
Seoul	*Building Retrofit Program Loan Scheme*	• Commercial • Residential (MF* & SF**)	2012
Shenzhen	*International Low Carbon City*	• Commercial • Industrial • Residential (MF* & SF**) • Public	2012
Tokyo	*Carbon Reduction Reporting Program*	• Commercial • Industrial • Public	2010

* MF = multi-family ** SF = single-family *** Not yet launched

Official representatives from each participating city were given the liberty to nominate which programme should be included in our study. Specifically, officials were invited to choose one innovative and flagship programme that seeks to advance operational energy efficiency and retrofitting in existing private buildings. In particular, we emphasised that the chosen programme should have high instructive value for other cities around the world, both within and outside the C40. As such, it should be understood that all of the seven cities have multiple programmes targeting energy efficiency and retrofitting in the building sector. Generally, these other programmes are not examined in our case studies.

All cities surveyed are active members of C40, and specifically, are members of the PBE network (see footnote 2). This is one of seventeen "networks" (i.e. working groups) within the larger C40. Networks are organised under six areas covering climate mitigation, adaptation and sustainability topics of highest priority to C40 cities. These help cities spur policy innovation and replicate, improve and accelerate climate action. The particular focus of the PBE network is on promoting joint-learning and collaboration across cities through sharing knowledge and resources, stakeholder engagement, data management and policy development in privately owned buildings. Therefore, our analysis of programmes within this network generates rich insights into pioneering or innovative approaches and potential impacts from different types of programmes under implementation by frontrunner cities.

Our specific focus is on existing, private sector buildings. Our use of the term "private" buildings includes commercial, industrial and residential (both multi-family and single dwelling) buildings. However, one of our case studies (Shenzhen) also includes components that deal with new construction and public buildings.

Data collection

Data collection for cases was conducted via four methods, each elaborated below:

1. Written questionnaires
2. Semi-structured telephone interviews
3. Document analysis
4. Email contact and case study verification

Written questionnaire

These were administered electronically and in English. They were sent to official city representatives who possess intimate knowledge about the design and implementation of each programme. These questionnaires enabled the gathering of basic qualitative and quantitative information regarding the following points:

- Background information on unique city conditions hindering the advancement of energy efficiency or sustainability in the building stock.
- Programme objectives and mechanisms by which they seek to advance operational energy efficiency and retrofitting
- Scope of programme and attributes of targeted buildings
- Innovative features
- Incentive and support mechanisms
- Links to other city programmes or policies
- Inputs during programme design such as timeframes, staffing, budgets and methods of stakeholder engagement
- Inputs during programme implementation such as timeframes, staffing, budgets and methods of stakeholder engagement
- Modifications made after initial design in reaction to particular circumstances
- Various impacts observed (environmental, social and market)
- Key drivers of success during design and implementation phases
- Challenges encountered and countermeasures taken during both design and implementation phases

Semi-structured telephone interviews

Written questionnaires were then followed up with semi-structured telephone interviews. At least one was administered for each city, and in some cases, several. These took place via telephone conference over the period December 2015 to August 2016. Initial interviews lasted approximately 90-minutes and typically consisted of one, two or more official programme representatives[3] from each city. For non-English speaking countries, English translators were sometimes utilised. Interviews were facilitated by researchers from Clark University and attended by officials from C40 PBE, Tokyo Metropolitan Government Bureau of the Environment and the research team in Tokyo (CSR Design Green Investment Advisory, Co. Ltd.). Interviews allowed programme representatives to elaborate in more detail on questionnaire responses and provide anecdotal evidence concerning the points of interest described above. Conversations were recorded, then later transcribed into minutes and analysed manually.

[3] In some cities, interviewed programme representatives were not direct employees of cities, but private or non-profit sector experts placed to aid with design and implementation.

In three cases however (Tokyo, Boston, Seoul), interviews were administered in person due to the physical proximity of government offices to the researchers involved. Additionally, some cities chose to conduct a second telephone interview in lieu of completing a questionnaire.

Document analysis

Data gathering was supplemented by the collection and analysis of key documents. These included those accessed via official programme websites such as programme reports, press releases and policy documents. Also, access was often granted by cities to key internal documents such as data reporting spreadsheets, programme participation agreements and case studies of individual building retrofit projects. Documentation was also examined from third party sources. Such documents include government or non-profit sector evaluations or analysis reports, press articles and academic journal papers.

Email contact and case study verification

Cities were contacted several times via email to request additional information throughout the data collection and case study drafting process. Sometimes these requests involved simple questions. At other times, these involved more comprehensive lists of questions that were translated into the language of that country to facilitate ease of answering.

As a final verification procedure, all case studies have been checked for accuracy several times through the assistance of cooperating programme representatives. This process was also used to obtain additional information relating to certain observations or interpretations.

List of references

Acuto, M. 2016. Give cities a seat at the top table. *Nature* 537 (7622): 611-613.

Becqué, R., Mackres, E., Layke J, Aden, N., Liu, S., Managan, K., Nesler, C., Mazur-Stommen, S., Petrichenko, K., Graham, P. 2016. *Accelerating Building Efficiency: Eight Actions for Urban Leaders*. Washington DC: World Resources Institute.

Hurst, T., Clement-Jones, A. et al. 2016. *Deadline 2020: How cities will get the job done*. London: C40 Cities and ARUP.

Schultz, S., Bailey, T., Ast, E., Russell, B., Morris, E., Kirk, P., Frost, L., Gibbons, A., Ozmumcu, A., Acuto, M., Rapoport, E., Ram, J., Hill, L. 2015. *Powering Climate Action: Cities as Global Changemakers*. London: C40 Cities and ARUP.

Takagi, T., Horie, R., Trencher, G., Sprigings, Z., Lawrence, S., Ast, E., Nishida, Y., Nakanishi, K., Okano, K., Graham, P. 2014. *Urban Efficiency: A global survey of building energy efficiency policies in cities.* Tokyo: Tokyo Metropolitan Government Bureau of Environment.

Trencher, G., Castán Broto, V., Takagi, T., Sprigings, Z., Nishida, Y., Yarime, M. 2016. Innovative policy practices to advance building energy efficiency and retrofitting: Approaches, impacts and challenges in ten C40 cities. *Environmental Science and Policy* 66: 353-365.

Watts, M., Schultz, S., Bailey, T., Ast, E., Russell, B., Morris, E., Vines, K., Lawrence, S., Kirk, P., Frost, L., Smith, T., Hurst, T., Clement-Jones, A., O'Brien, H., Schlichtkrull, N., Ozmumcu, A., Schamroth-Green, L., Acuto, M., Rapoport, E., Hill, L. 2015. *Climate Action in Megacities 3.0.* London: C40 Cities and ARUP.

Wigginton, N.S., Fahrenkamp-Uppenbrink, J., Wible, B., Malakoff, D. 2016. Cities are the Future. *Science* 352 (6288):904-905.

Credit: See-ming Lee / www.flickr.com

Chapter 2:

Key findings and overall analysis

Credit: Mario Sánchez Prada - Mauricio Lima - Shutter Runner / www.flickr.com

2.1 Overview of chapter

This chapter extracts the key findings that have emerged across the seven case studies making up the bulk of this report. In particular, the following sections examine areas such as:

- Key programme characteristics including general approach, start years and scope of targeted buildings
- Basic policy functions employed
- Incentives for promoting voluntary participation
- Environmental, social and market impacts achieved
- Innovative success measures and design features
- Common barriers and successful countermeasures

2.2 Key characteristics of programmes

As shown in Table 1, the sample in our second Urban Efficiency report is characterised by a preponderance of voluntary or hybrid approaches (i.e. involving both voluntary and mandatory components). Voluntary approaches are demonstrating remarkable adaptability in regards to coverage (definable both in terms of number of buildings covered and gross floor area (GFA). They are employed by both programmes targeting small groups of buildings or enterprises (i.e. around 50-100) and those targeting several thousand. For example, programmes in Tokyo and Seoul illustrate that it is possible to engage several thousand private sector buildings with voluntary approaches. In Tokyo's Carbon Reduction Reporting Program, the majority of enterprises and buildings reporting do so voluntarily. In other programmes however like in Chicago and London, the approach is more to work with a smaller cohort of influential leaders in the building industry. Although certainly significant in terms of GFA, smaller cohorts in these programmes allow for greater intimacy and relationship building. This is achieved through one-to-one communication between city officials and building owners or managers and facilitation of peer learning amongst buildings.

This said, it should of course be emphasised that each city surveyed holds multiple programmes for advancing operational energy efficiency and retrofitting in existing buildings and that some of these are mandatory. As already mentioned, our analysis is limited to a single, flagship initiative nominated by programme officials. Yet the proliferation of voluntary or hybrid approaches in our sample suggests clearly that policy innovation and effective building governance can still occur in the absence of regulatory frameworks. Voluntary schemes can also be a precursor to mandatory programmes. As argued by Trencher et al. (2016), this is by encouraging engagement and communication between city governments and building owners or tenants around energy and carbon emissions, and by nurturing relations and trust in a non-regulatory ambience. Voluntary programmes also facilitate a gradual transition to mandatory approaches by allowing policy makers to collect data to understand the performance and challenges in key areas of the building stock. This data can then inform subsequent development of additional policies or guide fine-tuning of existing programmes.

Table 1: **Approach and nature of programmes**[1]

City	Coverage		Programme type
Tokyo	Higher	34,499 buildings	Voluntary and mandatory
Shenzhen		53 km^2 total development area (on completion)	Voluntary and mandatory
Seoul		4,200 projects (in BPR finance scheme)	Voluntary
London		1,674 buildings (9.99 million m^2)	Voluntary
Chicago		62 buildings (3.99 million m^2)	Voluntary
Mexico City		65 buildings (2.2 million m^2)	Voluntary
Boston	Lower	No data (under planning)	Voluntary

Implementation year

The first year of implementation for each programme is summarised in Table 2. Boston's Renew Boston Trust – Commercial, being still in the advanced design stages, is not yet implemented. Its first batch of projects are scheduled for 2018. For the other six programmes, four were implemented in 2012 or thereafter. Outcomes for these programmes are therefore still emerging. Two programmes however, in Mexico City and Tokyo, are approaching years of maturity. The effectiveness of both programmes has therefore become relatively clear at this point, allowing several conclusions to be drawn.

Table 2: **First year of implementation**[2]

City	2009	2010	2011	2012	2013	2014	2015	2016
Boston[3]								
Chicago				◉	◉	◉	◉	◉
London						◉	◉	◉
Mexico City	◉	◉	◉	◉	◉	◉	◉	◉
Seoul				◉	◉	◉	◉	◉
Shenzhen				◉	◉	◉	◉	◉
Tokyo		◉	◉	◉	◉	◉	◉	◉

[1] Based on most recent data. Most programmes are expanding coverage.
[2] Refers to the first year that the programme came into effect and not the year when an ordinance or law was passed.
[3] Being still in the advanced stages of programme planning, the first batch of energy efficiency projects are set for implementation during 2018.

Target and scope

Table 3 summarises the attributes of the private sector buildings and stakeholders that each programme principally targets. Beginning from the left, as can be expected, all programmes are targeting commercial buildings. Although represented largely by office buildings, some programmes are actively targeting hotels, retail, health, medical, leisure, cultural, educational and worship facilities. Overall, relatively fewer programmes are targeting industrial facilities. However these are actively targeted by programmes in Boston, Mexico City, Shenzhen and Tokyo. We found that half of surveyed programmes are also targeting residential buildings. Of these, all target multi-family (MF) residences whilst only two also target single-family (SF).

Moving on to building sizes, all programmes have a relatively "open door" policy and lack minimum thresholds for gross floor area (GFA). Presumably, this comes from their voluntary or hybrid nature and ambitions to engage a large and diverse representation of private sector buildings in that city. Bearing in mind that there is no objective measure of a large or small building since this varies significantly depending on the size of the city, overall, we found that programmes tend to concentrate recruitment and engagement efforts on larger to medium buildings. This said, many small buildings were also seen to be participating. These range, for example, from small office buildings and chains of convenience stores in Tokyo to single-family or detached dwellings in Seoul and Shenzhen.

Finally, it is interesting to note that the majority of programmes are explicitly targeting tenants as well as building owners. This contrasts to mandatory approaches such as benchmarking and auditing or retrocommissioning regulations, which tend to primarily target building owners.

Table 3: **Characteristics of principally targeted buildings and stakeholders**

City	Sector			Size			Stakeholder	
	Commercial	Industrial	Residential	Large	Medium	Small	Owner	Tenant
Boston	◉	◉	◉ MF*	◉	◉		◉	
Chicago	◉			◉	◉		◉	
London	◉			◉	◉		◉	◉
Mexico City	◉	◉	◉ MF*	◉	◉	◉	◉	◉
Seoul	◉		◉ MF/SF**	◉	◉	◉	◉	◉
Shenzhen	◉	◉	◉ MF/SF**	◉	◉	◉	◉	◉
Tokyo	◉	◉		◉	◉	◉	◉	◉

* MF = multifamily ** SF = single-family, detached dwelling

Governance instruments to advance energy efficiency and retrofitting

The surveyed programmes provided much insight into the array of basic governance instruments used by city officials as they work to advance operational energy efficiency and retrofitting in the existing, private sector building stock. As shown in Table 4, what we have termed a single city "programme" is in fact a package or mix of various governance instruments.

By integrating multiple governance measures into single programmes, and also by cross-linking multiple programmes, city policymakers are able to mandate or encourage multiple forms of action or engagement from building owners and tenants. For example, as shown in the case of Tokyo, instead of just measuring and submitting energy consumption and GHG emissions data, reporting facilities and enterprises are also encouraged to display performance ratings based on benchmarks. In addition, the Carbon Reduction Reporting Program also provides various forms of capacity raising to improve access to finance and acquire industry relevant best practices for energy reduction measures.

In this way, with each city programme consisting of various instruments, the multiple components complement each other by carrying out interrelated yet subtly unique functions. The net impact of this is a situation where the totality of the mix of governance measures can prove "greater than the sum of the parts" (Van der Heijden, 2016).

Table 4: **Governance instruments used in each programme**

	Periodical data reporting	Performance disclosure & certification	Energy reduction challenge	Financial capacity building	Knowledge capacity building	Masterplan and target setting
Boston	◉			◉	◉	
Chicago	◉		◉	◉	◉	
London	◉		◉		◉	
Mexico City		◉		◉		
Seoul				◉	◉	
Shenzhen	◉			◉		◉
Tokyo	◉	◉		◉	◉	

The following sections provide an overview of the various governance instruments observed, and also extract key messages from Table 4. Our analysis is by no means intended as exhaustive. We acknowledge that each city programme may be carrying out additional functions than those indicated. Accordingly, our goal is merely to provide a more concrete idea of the multiple, varying and common or unique approaches that policy makers are developing and combining as they pursue programme goals.

Periodical data reporting

The periodical submission (both voluntary and mandatory) of quantitative data such as energy consumption, GHG emissions and GFA—sometimes in addition to qualitative information such as energy reduction measures taken—is the central governance instrument underpinning four of the seven programmes surveyed. Integration of this instrument into programmes is driven by expectations that "what gets measured gets improved" (Hsu, 2014). Two main types of data reporting mechanisms were observed; the EPA ENERGY STAR Portfolio Manager in Chicago (widely used in U.S. benchmarking programmes) and custom-made Excel spreadsheets in London and Tokyo. Although in most cases data submission is annual, the Retrofit Chicago Energy Challenge requires bi-annual reporting. This allows more frequent monitoring of progress and also gives some indication of seasonal differences in energy consumption.

For city governments, mandating or encouraging submission of quantitative and qualitative energy related data allows programme representatives to monitor the progress of individual buildings, recognise outstanding achievement and share best practices with other buildings. In Chicago, use of Portfolio Manager allows buildings to benchmark performance relative to peers. However data submission also fulfils other purposes. Firstly, it allows policy makers to understand the performance of targeted buildings and assess programme impacts. Secondly, as illustrated in the Tokyo and London cases, it allows policy makers to create building-specific benchmarks, and then share this information back to building owners. Both city programmes carry this out through carbon report cards. Benchmark information in Tokyo is highly tailored to its diverse users, consisting of more than 30 industry specific categories. Finally, collection of data on building stock energy performance allows policy makers to use this as evidence to inform future policies or fine-tune existing ones.

Performance disclosure and rating

Initiatives to publicly disclose building performance and actively communicate this to potential tenants, buyers and the general public were observed in Mexico City, London and Tokyo. In Tokyo, firstly, carbon emissions data and ongoing energy reduction measures are disclosed online. This enables both quantitative and qualitative comparisons of carbon emissions intensity (and thereby energy intensity) and energy reduction measures across same type buildings. Annually submitted carbon emissions data is also exploited to create performance ratings through the carbon report card initiative. This is novel in that it directly targets potential tenants and building owners to offer a detailed and ranked breakdown of the carbon intensity of a building relative to its business peers. This is in addition to providing qualitative information such as implemented energy efficiency improvement measures. Mexico City's certification programme takes a more holistic classification approach. It allows buildings to demonstrate differing forms of activities or innovation in an array of sustainability categories. Aside from energy efficiency, these encompass water, mobility (use of shuttle buses and connectivity to public transport etc.), renewable energy, waste, societal and environmental responsibility and green roofs. The Mexico City certification scheme is also unique in that it is entirely run by a local government, and additionally, allows tenanted sections of individual buildings to obtain certification.

Financial capacity building

Financing related governance measures were also widely observed, present in six of the seven programmes. The significance of barriers related to accessing finance is well documented elsewhere (Van der Heijden, 2016; Becqué, 2016). Banks and lending institutions are sometimes reluctant to fund retrofitting projects out of concern that investments may not be reflected in future evaluations of properties, and because of the uncertainty related to the ability of projects to generate reliable cash flows. Even in cases when financing or capital can be accessed, "split-incentive"[4] issues between tenants and owners will very often hamper efforts from either party to invest in energy efficiency upgrades. In addition, unique, local conditions can also impact the ability of building owners and tenants to invest in retrofitting or obtain finance. As an example, Tokyo's case illustrated that seismic (i.e. earthquake) resistance tends to gain priority on the building market, dampening owner enthusiasm to invest in energy efficiency. Boston's case emphasised that the structure of investment cycles is a major impediment to the acquisition of project financing. This is because "mid-cycle investments" in longer 20 to 30-year commercial real estate investment cycles are rare—and sometimes even prohibited—in leasing language.

Various forms of financial capacity raising were observed to tackle these barriers. Some programmes such as Shenzhen or Tokyo seek to alleviate retrofitting associated financial burdens by allocating direct subsidies or offering tax credits. Other programmes such as Seoul or Mexico City act as intermediaries by processing applications and then recommending applicants to private or international lending institutions. Applicants are then provided loans at attractively discounted interest rates. Boston adopts a novel approach in its adoption of an "energy aligned" or "green" lease approach (see Janda, 2016; Feierman, 2015). Firstly, it aims to help building owners overcome split-incentive issues by reforming leasing language. This allows owners to pass through the costs of energy reduction retrofitting measures to tenants as "utility payments".

[4] Refers to a situation where on one hand a building owner lacks an economic rationale to invest in an energy efficiency upgrade as the benefits (i.e. lower energy expenditures) would be principally reaped by the tenant. On the other hand, the tenant also lacks an economic incentive to invest in energy efficiency upgrade since this benefits of the upgrade would be largely received by the owner (i.e. an increased property value).

Secondly, it integrates performance guarantees into projects, assuring the ability of a project to generate cash flow for loan repayments, even in the case of an underperforming retrofit. This consequently improves the bankability of projects, and protects lending institutions from default. A third innovative feature is the creation of a special purpose, nonprofit and self-funding entity for administering the payback process to project contractors and lender investors.

Knowledge capacity building

The second type of capacity building consists of disseminating knowledge related to operational energy efficiency and effective retrofitting measures. These were widely observed across programmes. Such measures have been called "educative" (Dowling, 2014) since policy makers use this approach to fill knowledge gaps in the market and educate key stakeholders. As emphasised by the Intergovernmental Panel on Climate Change (IPCC, 2007), a lack of knowledge about the opportunities for reducing energy consumption, technological options, effective financing approaches and best practices can hamper interest in retrofitting. City programmes can therefore play an important role in closing the information gap by collecting and disseminating differing forms of knowledge. This can come not just from technical experts in the city, but also other buildings and programme partners such as private consultants or non-profit organisations.

As a prominent example, knowledge enhancing measures were particularly central to the Retrofit Chicago Energy Challenge. In addition to providing one-to-one consultations with technical experts in the city and hosting networking events and engineer roundtables, Energy Road Maps were a noteworthy approach. Implemented through grant funding and cooperation of private sector partners, the provision of road maps assisted Challenge participants with compiling energy use data, creating energy baselines, benchmarking performance, quantifying actual and planned energy reduction measures to-date, and finally, creating business cases and then identifying sequential actions and investments to meet the 20% reduction commitment. Information diffusion and educative measures were also significant in Tokyo's Carbon Reporting Program. Programme officials hold an annual training seminar to some 300 industry stakeholders. This seminar shares annual carbon emission trends for more than 30 business types, various improvement strategies for each, and best practices from frontrunner buildings. Tokyo's programme employs other important knowledge enhancing mechanisms. Programme officials conduct on-site visits to reporting facilities to verify data and identify opportunities for further improvement. In parallel, experiences accumulated through the program are collated into industry specific manuals for 27 business types (e.g. fitness centres, convenience stores, supermarkets etc.) to showcase effective capital and non-capital intensive energy reduction measures.

Energy reduction challenges

The central idea of the energy reduction challenge is to mobilise a cohort of frontrunner or motivated buildings and incentivise efforts to monitor and

Credit: John Wlwanski / www.flickr.com

subsequently reduce energy consumption over a specific, and typically concentrated time span. As demonstrated by London and Chicago, two key variables can distinguish different adoptions of this governance measure: 1) the presence of a competitive element and 2) the length of the challenge period. In London's Business Energy Challenge, this unfolded over 12-months. Individual businesses (typically comprising of several premises across London) compete with each other to reduce CO_2 emissions from baselines. Businesses are thereby incentivised by the prospect of "winning" and qualifying for specific award categories given at ceremonies and receiving official recognition from the Mayor. Since the Business Energy Challenge unfolds over 12-months, this encourages intensified efforts and rapid improvements over energy consumption baselines. In Chicago's case, however, the approach was more long-term (five-years), and also lacked a competitive approach. Instead, the Retrofit Chicago Energy Challenge seeks to create a sense of solidarity and cooperation. This is by setting a common target for participants (a 20% energy reduction over five-years), and by asking that participants serve as mentors to other buildings.

Masterplan and target setting

The importance of setting aspirational and ambitious building sector targets for energy efficiency is highlighted by Becqué (2016). Such an approach was observed in Shenzhen's highly ambitious International Low Carbon City Initiative in Pingdi. This is unique among the sampled programmes in many respects. Firstly, all development in the low-carbon eco-city is guided by a comprehensive masterplan, prepared by an international team of Dutch and Chinese scholars and urban planning experts. As well as outlining zoning and citywide infrastructure considerations, this document provides the vision and set of principles that are guiding efforts to transform the built and natural environment. Secondly, this vision concerns both the physical environment and the economy. As such, building usage (i.e. the type of industry housed in the building and its strategic importance to the low-carbon city) is a highly important consideration in the selection of retrofitting, new construction and low-carbon business projects.

Target setting is integral to Shenzhen's approach. As shown in the case study, a large array of indicators and explicit objectives are fixed for the year 2025. These cover environmental, economic and societal dimensions. Two overarching targets include carbon emissions intensity relative to GDP (set to 0.32 t-CO_2 per RMB 10,000) and carbon emissions per capita (set to 5 t-CO_2 per capita per year). Specific building targets are also fixed. 100% of new construction is expected to meet the national green building standard and 50% for existing buildings by 2025. Data collection and monitoring is a crucial element of the target setting and governance of the low-carbon eco-city. A goal has also been fixed that energy consumption monitoring must extend to 100% of the building stock.

Inputs during design and implementation phase

We were able to collect some information—albeit limited—to illustrate the scale of time, human and financial resources made available during the design and implementation of each programme. Tables 5 and 6 summarise these findings.

Design phase

Table 5 indicates that programmes overall have been relatively quick to set up, with the bulk of planning mainly occurring over 1-2 years. For some large-scale programmes such as the Shenzhen Low-Carbon International City, this is particularly impressive. On the whole, programme planning has taken place in spite of highly limited human resources. Another notable trend is the formal and continuous input of various external parties to programme design. As prominent examples, the Retrofit Chicago Energy Challenge was collaboratively designed by both city officials and members of energy utilities, engineering firms and various non-government and non-profits, in addition to C40 staff. Similarly, the conception and masterplan for the Shenzhen Low-Carbon International City is the fruit of intense collaboration between government officials, university researchers and engineers, both locally and from the Netherlands.

Table 5: **Inputs to design phase**

	Time (years)	Human resources
Boston	3-4	1 FTE (external advisor)
Chicago	1	Multiple (internal/external)
London	1	1 FTE (internal)
Mexico City	1-2	2 FTE (internal)
Seoul	1-2	No data
Shenzhen	2	Multiple (internal/external)
Tokyo	1-2	Multiple (internal)

Implementation phase

Information showing the scale of inputs to the implementation of programmes is compiled into Table 6. Where data is available, it shows that human resources, described in full-time equivalent (FTE) for programme implementation, range from two to six internal officials. Although specific, quantitative data is lacking, it is worth noting the diversity in funding arrangements for programmes. The Renew Boston Trust – Commercial will be entirely self-funding since it will establish a non-profit entity to run the programme. This will collect revenue to cover running costs via overheads from supported projects, whilst project funding will come directly from private institutional lenders. Implementation of Retrofit Chicago Energy Challenge (and its impressive coverage of 62 buildings spanning more than 43 million ft^2) relies entirely on grant funding and part-time pro bono support from within the city and the programme's partner network.

Table 6: **Inputs to implementation phase**

	Human resources	Financial resources
Boston	Multiple (internal/external)	Self-funding, Private lenders
Chicago	Pro bono part-time support from multiple partners (internal/external)	No devoted budget Funding from grants
London	1 FTE (internal) plus consultant support (1FTE) for 3-months year.	GBP 70,000
Mexico City	2 FTE (internal)	No devoted budget
Seoul	4 FTE (internal)	KWR 22.5 billion for loan support scheme (2012-15)
Shenzhen	No data	No data
Tokyo	6 FTE (internal), including for related programs	No devoted budget JP¥ 1.237 billion budget in 2015 for incentive programmes for small to medium entities

2.3 Incentives

Given that all programmes are either completely or partially voluntary in nature and that success depends on successful engagement of the targeted building sector, cities developed an interesting array of incentives to entice participation. Some of the most noteworthy are showcased in Table 7.

Table 7: **Examples of incentives for enticing participation**

Type of incentive	Notable case examples
Financial or economic	• **Mexico City:** Payroll and property tax reductions increasing with higher levels of certification. Participating buildings also gain access to a special retrofitting loan support scheme. • **Seoul:** Attractive loan conditions such as low-interest rates, grace-periods for commercial customers and long payback periods. In addition, insulated windows and entrances provided through suppliers at discount rates. • **Shenzhen:** Allocation of subsidies per m^2 of retrofitted floor space. Provision of loan support for retrofitting and nurturing new business ventures. • **Tokyo:** Buildings participating in programme gain eligibility for retrofitting subsidies, tax credits and loan support schemes.
Marketing tools	• **Tokyo:** Provision of low-carbon industry benchmarks, broken into more than 30 business categories and carbon report cards. When combined with carbon report cards, these provide owners with new information and tools to market the property and potentially pursue green premiums.
Knowledge and capacity building	• **Chicago:** Organisation of networking events and engineer roundtables, peer-to-peer learning through sharing best practices, and consultations with technical experts. • **Tokyo:** Organisation of industry seminars for showcasing building sector emissions trends and best practice reduction measures.
Awards and public recognition	• **London:** Recognition by Mayor of London through awards ceremony. • **Chicago:** Recognition of participants on official website and newspaper advertisements. • **Tokyo:** Official programme participation plaques for display in building lobbies. High performing buildings awarded a certification and featured on official website.

2.4 Outcomes and impacts

A wide array of results and impacts were observed from surveyed programmes. Although environmental impacts such as reductions in energy consumption and CO_2 emissions were noted in several cities, strong evidence emerged to suggest that other types of impacts—namely of a social or market nature—were just as important. In light of this broad array of impacts, our findings suggest there are significant opportunities for policy makers to look beyond the narrow scope of solely environmental outcomes when designing or evaluating programmes.

Environmental impacts

Noteworthy impacts of an environmental nature were widely observed across programmes. These are summarised into Table 8. As can been seen, reductions in CO_2 emissions and energy or electricity consumption are highly significant. Additionally, important decreases in water consumption were achieved in Mexico City as a result of the Sustainable Buildings Certification Programme. Needless to say, such outcomes are important for water scarce Mexico City. However, as a general trend, programmes tend to place most emphasis on reductions of energy and GHG emissions. A host of reasons (e.g. differing baseline years, units of measurement, total GFA of affected buildings etc.) and unique programme objectives prevent direct comparison of results across cities. Also, it should be pointed out that despite such impressive outcomes, most programmes did not fix any explicit numerical targets for GHG emissions or energy consumption reductions.

Programmes in Shenzhen and Mexico City both incorporated new construction with retrofitting. A notable impact in both these cities was an increase in green building surfaces such as green roofs/walls and surrounding spaces. Particularly in Shenzhen, building and urban greenery will play a vital role in mitigating urban heat island intensity in the International Low Carbon City to less than 1°C, and also promote air purification. Shenzhen's case study also highlighted another important environmental outcome of retrofitting projects—the ability to beautify and restore deteriorated buildings and neighbourhoods. In the case of the traditional Hakka house restoration project, not only did this increase energy efficiency, comfort and fire safety, renovation of traditional buildings also generated new opportunities for commerce and culture (e.g. tea houses and exhibition spaces).

We also observed that city programmes to advance operational energy efficiency and retrofitting can drive uptake of renewable energy installations. This was particularly evident in Mexico City, where commercial and multi-family buildings are incentivised to obtain higher certification levels by installing rooftop solar photovoltaic installations and solar hot water systems. Boston's Renew Boston Trust – Commercial also demonstrated a potential to help realise climate resiliency projects such as district energy plants and microgrids across the city.

Table 8: **Various observed environmental impacts**

Type of impact	Notable case examples
Reductions in GHG emissions, energy and water consumption	• **Chicago:** As of July 2016, participating buildings achieved 11.7% reduction in energy use (weather normalised source energy) from baselines, representing annual savings of 90 million kWh of electricity and 70,000 tonnes of GHG emissions. • **Mexico City:** By 2015, 40 certified buildings achieved total savings of 66,120 t-CO_2 and 20.1 million kWh of electricity from 2009 base year. Potable water savings of 205,690 m^3 were also made. • **London:** In 2014, savings of 80,000 t-CO_2 were made relative to 2010/11 baseline year. In 2015, savings of 188,000 t-CO_2 were realised relative to the same baseline. • **Tokyo:** From 2009 to 2014, for 21,097 facilities submitting reports for six successive years, total CO_2 emissions declined by 12.3%.
Increase of green surfaces (green roofs, wall vegetation, gardens etc.) to mitigate heat island	• **Mexico City:** Increased uptake of green roofs across certified buildings • **Shenzhen:** Innovative wall vegetation installations achieved in key projects such as Low Carbon Exhibition Center.
Onsite production of renewable energy	• **Mexico City:** Increased uptake of solar hot water systems and PV installations. • **Boston:** Renewable energy and climate resiliency projects ($50 million district energy plant, efficiency upgrades and multi-user microgrid) under planning.
Environmental beautification and restoration of deteriorated buildings	• **Shenzhen:** In traditional Hakka housing restoration project, original forms and spatial layout were preserved whilst enhancing comfort, energy efficiency, fire safety and business opportunities (tea houses etc.).

Social impacts

Outcomes of a social nature were vast and widely observed across programmes. Notable examples are collated into Table 9. In addition to building owners and tenants receiving enhanced knowledge and financial capacity to improve building environmental performance, many programmes reported success in triggering greater building industry attention on climate, energy and sustainability issues. For those buildings participating directly in programmes, periodical monitoring and reporting of energy consumption is a major driver of this. Yet awareness around climate and energy efficiency issues can also be stimulated in the building community at large. This occurs from the leadership and public communication of successful energy reduction strategies shown by frontrunner buildings.

Table 9: **Various observed social impacts**

Type of impact	Notable case examples
Greater building industry attention on climate, energy consumption and sustainability issues	• **Chicago:** Consistent growth in Challenge participants, reaching 62 buildings and 43 million ft^2 in 2016. Cohort features iconic skyscrapers, historical landmarks, multi-family housing, charities and famous attractions such as Navy Pier and John G. Shedd Aquarium. • **Tokyo:** Voluntary carbon report submissions grown from 1,217 enterprises in 2010 (representing 10,965 individual facilities) to 1,871 in 2015 (representing 11,476 individual facilities). These outnumber mandatory submissions six-fold. Industry organisations now actively recruit new enterprises for the programme.
Enhanced capacity to improve building environmental performance from exposure to knowledge and financial capacity building	• **Seoul:** Over 4,000 residential and commercial building energy efficiency improvements successfully financed and completed over 2012-2015. • **Chicago:** Participant capacity to plan, finance and carry out effective retrofits enhanced through peer-to-peer learning, road maps, technical consultations and subsidised audits.
Greater transparency of building energy efficiency for potential tenants, buyers or lenders	• **Boston:** Plans to integrate performance guarantees to assure cash flow from retrofitting projects, increasing creditworthiness. • **Mexico City:** 45 buildings certified, 20 in process of certification. Commercial buildings can opt for inclusion on list of green buildings in Mexico City for prospective international tenants. • **Tokyo:** Carbon report card initiative implemented to show performance of building relative to industry specific benchmarks. Report cards can serve as green building ratings to be marketed to potential tenants. • **Mexico City and Tokyo:** Certifications and carbon report cards allow estimation of building running costs.
Behavioural changes in building usage	• **Tokyo:** Behavioural changes to reduce energy consumption continued, even after power supplies were restored after Fukushima disaster. Widely observed measures include extinguishing lights and air-conditioning in vacant rooms or after normal business hours, and also, optimising heating and cooling temperatures.
Overcoming split-incentive issues	• **Mexico City:** Individual tenanted sections of commercial buildings can obtain certification for tenant occupied space. For existing multi-family properties, certifications can be obtained for tenanted sections, common areas or whole building. Property tax reductions incentivise owner investment in tenant areas. • **Boston:** Green leases pass on amortisation costs of energy efficiency projects to tenants, allowing both owners and tenants to benefit from lower energy expenses and building upgrades.

Another important social impact is the capacity to supply missing market information and increase transparency around building energy efficiency to potential tenants, buyers or lenders. Programmes developed many unique strategies to this end. Mexico City pursued a building certification approach. Tokyo adopted a similar approach. Officials are presently experimenting with carbon report cards to render visible the performance of an individual building relative to industry benchmarks for peer buildings. In both Mexico City and Tokyo, such information allows potential tenants to estimate running costs. Boston's programme also seeks to supply missing market information, but of another kind. It uses performance guarantees to reduce uncertainty on returns and increase credit worthiness towards investor lenders by guaranteeing the ability of energy efficiency upgrades to generate cash flow. Financial and technical performance of multiple projects will be collected and supplied to financial institutions to facilitate traditional credit worthiness assessment.

Finally, noteworthy approaches were observed to tackle split-incentive issues. Chicago's programme organised workshops to assist participating buildings in forming green leases to share costs and benefits associated with energy efficiency upgrades between tenants and owners. Green lease strategies also underpinned Boston's programme. This seeks to rework lease agreements to tap into tenant utility payments to owners, reduced after energy efficiency projects, to repay costs to investor lenders. Mexico City's certification programme had a highly unique approach to enticing tenant engagement. It incentivises tenanted sections of buildings to invest in upgrade measures to obtain certification by also offering payroll and property tax reductions for tenants.

Market impacts

Outcomes of an economic nature were also widely reported across the surveyed programmes. Notable examples are summarised into Table 10. Retrofitting impacts featured highly among these. Programme influences on retrofitting activity were measured in different ways. In Seoul, officials in the Building Retrofitting Programme loan scheme are able to track retrofitting activity through financed project completion reports. Energy challenge programmes working with smaller cohorts of frontrunner buildings are more easily able to gauge programme influences on retrofitting activity due to intimate and frequent communications with participants. Tokyo uses an annual survey approach to measure changes in year to year retrofitting activity. In addition to retrofitting outcomes, programmes have also brought about other economic benefits such as reduced electricity expenditures. Tokyo's programme appears to have contributed to a 18.2% decrease in power consumption in participating buildings. Although affected in early years by electricity shortages following the Fukushima disaster, buildings have continued to conserve energy even following the restoration of power supplies. Mexico City's certification programme reported significant green premiums up to 20% for certified office buildings. Finally, both Mexico City and Seoul are contributing to green job creation. The former has created nearly 70 new jobs by training and hiring technicians to oversee building auditing and certification. By extending financing support to ESCO's, Seoul's programme is also contributing to the growth of this industry.

Table 10: **Various observed market impacts**

Type of impact	Notable case examples
Stimulation of retrofitting and installation of low-carbon technologies or onsite renewable energy	• **Seoul:** For commercial buildings, increased installation of energy efficient lighting systems, HVAC systems and insulation. For residential buildings, increased installation of insulated windows, wall insulation, heating systems and LED lighting. • **Chicago:** Commitments to energy challenge driving several buildings to invest in retrofitting of key building components such as HVAC systems. • **Shenzhen:** 100,000 m^2 of buildings retrofitted so far (mostly old factories, warehouses and residential Hakka houses).
Reduction in energy expenditures	• **Chicago:** Current financial savings from 11.7% energy use reduction in Challenge building cohort estimated at $6.4 million per year. • **Tokyo:** From FY2010 to FY2014, average electricity consumption reduction of 18.2% (from 1994 Mj/m^2 to 1646 Mj/m^2) achieved across reporting facilities, representing annual savings in 2018 of ¥838 per m2.
Growth of ESCOs, service providers and green jobs	• **Mexico City:** 68 new jobs created through training and hiring technicians to oversee auditing and certification of buildings. • **Seoul:** Expansion of ESCO business activities by providing financing.
Increased demand for green buildings, manifestation of green premiums	• **Mexico City:** Green premiums of around 20% for rental yields observed for certified office buildings.

2.5 Innovative success factors

Case studies revealed an array of strategies to increase the effectiveness and appeal of city programmes. Notable examples are compiled into Table 11. We found that these factors were often related to programme design features, as generic policy instruments (e.g. carbon reporting or building certification schemes) are appropriated from elsewhere and then tailored to local conditions and contexts. This fine-tuning and modification of generic policy instruments is an important driver of policy innovation and trailblazing in the C40 PBE network (Trencher, 2016). Newly added design features become a powerful driver of programme outcomes, also creating attractive incentives to entice building industry participation.

We also highlight how collaboration with external experts was underlined as a major success factor by programmes. For example, production of the master plan for the International Low Carbon City in Shenzhen involved extensive collaboration between city officials and Dutch and local urban planning experts (see De Jong, Wang et al. 2013; De Jong, Yu et al. 2013). There was also strong evidence of collaboration in other city programmes during both design and implementation. Chicago's programme is co-implemented by a team of experts from organisations such as C40, National Resources Defence Council and Environmental Defence Fund. Tokyo's programme collaborates tightly with industry organisations to recruit new participants, compile and then diffuse knowledge on best energy saving practices through manuals and seminars.

Table 11: **Noteworthy drivers and strengths**

City	Feature	Effect
Boston	Design of explicit economic incentives for both owners and tenants through modification of leasing language.	Owners can conduct asset improving retrofits without needing to raise capital. Tenants can benefit from reduced energy expenditures once project is paid off.
Chicago	Clear, ambitious and quantitative reduction goal (20% over 5-years).	Provides participants with a common and clear objective and timeframe to pursue from beginning. Encourages ambitious energy reduction measures and mid- to long-term planning and investment strategies.
London	Multiple award categories	Drives programme recruitment by providing diverse opportunities for businesses to receive recognition for improving energy efficiency and reducing carbon emissions.
Mexico City	Attractive financial incentives such as payroll and property tax reductions. Both owners and tenants eligible for certification.	Building owners and tenants not pursuing certification under conventional schemes like LEED etc. are incentivised to seek certification.
Seoul	Non-reliance on subsidies. Project funding is channelled from City Climate Fund to private lending institution, and then to loan recipient.	Minimises burden to City and tax payers. Creates a sustainable business model where the loan support scheme can target an increasing number of buildings and continue indefinitely as funds are repaid.
Shenzhen	Phased roll out and gradual improvement strategy, with comprehensive, quantitative targets and rigorous monitoring.	Success factors identified in pilot zone can be exported to larger, future developments. Development targets and associated monitoring of progress facilitate planning of projects in line with city goals, also offering chance to engage the public.
Tokyo	Collaboration with corporate/ industry groups to encourage participation, and produce/ disseminate information on energy efficiency measures and opportunities.	Voluntary reporting segment of programme has grown, with building numbers now outnumbering mandatory segment six-fold.
	Integration of reporting data into numerous formats such as low-carbon industry benchmarks, carbon report cards and industry specific energy conservation manuals.	Educational value and usefulness of data is enhanced, serving as a powerful incentive to drive voluntary reporting.

2.6 Key challenges and countermeasures

The case studies provide rich information on the various challenges and hampering factors encountered by officials and programme representatives during design and implementation. The most notable of these are compiled into Table 12. Overall, many of the particular challenges encountered appear to be localised, contextual and highly related to the type of programme approach taken. Others, however, were common across several programmes. The case studies also shed light on an array of innovative coping strategies taken in response to various obstacles or limitations of programmes. It is hoped other cities might learn from these experiences.

Table 12: **Notable challenges and countermeasures**

Type of challenge	Notable countermeasures
Turnover of building ownership or management challenges continuation	• **Chicago:** Monitor building market. In event of sale, re-engage new owners and managers by informing of previous owner's commitment.
Inclusion of diverse representation of building stock	• **Chicago and London:** Shift away from minimum GFA thresholds defining participation eligibility to allow inclusion of smaller, more diverse building types.
Split-incentives between tenants and owners	• **Boston:** Modify leasing language to incorporate costs of retrofitting into tenant utility payments, which are then offset by increased energy efficiency. Create opportunity for tenants to benefit from reduced energy expenditures once project costs recovered. • **Mexico City:** For commercial buildings, allow certification of tenanted building sections or common areas. In multi-family apartment complexes, also allow certification of common areas.
Limited human resources and budgets	• **Boston:** Design programme as a self-funding and self-operating public-private partnership, eliminating need for direct city budget or implementation. • **Chicago:** Secure pro bono support for programme implementation from partner network of non-profits and private sector consulting firms. Also, focus on communicating business cases for retrofits to overcome incapacity to allocate subsidy type incentives. • **London:** Secure engagement of university partner for data analysis.
Low participation of existing smaller businesses due to cost hurdles	• **Mexico City:** Allow gradual certification over several years, reducing yearly upfront costs for any necessary retrofitting.
Preference of citizens for subsidies rather than loan support	• **Seoul:** Increase economic attractiveness of loan scheme through designing highly attractive loan conditions (interest, payback and grace periods). Also, reduce upfront purchase costs of key building installations (insulated windows and entrances) through memorandums of understanding (MOUs) with equipment suppliers.
Low market demand for energy efficient commercial buildings	• **Tokyo:** Create carbon report card scheme to provide easy to understand visual representation of building energy efficiency relative to same-type buildings. Owners can use these to attract tenants. In parallel, use financial subsidy schemes and integrate estimates of improved report card performance into retrofitting plans.
Difficulties in mainstreaming low-carbon business models	• **Shenzhen:** Minimise financial burdens through retrofitting subsidies and low-interest start up loans. In parallel, promote spirit of innovation and entrepreneurship across city.

List of references

Becqué R, Mackres E, Layke J, Aden N, Liu S, Managan K, Nesler C, Mazur-Stommen S, Petrichenko K, Graham P. 2016. *Accelerating Building Efficiency: Eight Actions for Urban Leaders*. World Resources Institute, Washington DC.

De Jong, M., Yu, C., Chen, X., Wang, D., Weijnen, M. 2013. Developing robust organizational frameworks for Sino-foreign eco-cities: comparing Sino-Dutch Shenzhen Low Carbon City with other initiatives. *Journal of Cleaner Production* 57: 209-220

De Jong, M., Wang, D., Yu, C. 2013. Exploring the Relevance of the Eco-City Concept in China: The Case of Shenzhen Sino-Dutch Low Carbon City. *Journal of Urban Technology* 20 (1): 95-113.

Dowling R, Mguirk P, Bulkeley H. 2014. Retrofitting cities: Local governance in Sydney, Australia. *Cities* 38: 18-24.

Feierman A. 2015. *What's in a Green Lease? Measuring the Potential Impact of Green Leases in the U.S. Office Sector.* Institute for Market Transformation, Washington.

Hsu D. 2014. Improving energy benchmarking with self-reported data. *Building Research and Information* 42(5): 641-656.

IPCC. 2007. *Climate Change 2007: Mitigation of Climate Change*. Contribution of Working Group III (Chapter 6 Buildings). London and New York: Cambridge Press.

Janda KB, Bright S, Patrick J, Wilkinson S, Dixon TJ. 2016. The evolution of green leases: towards inter-organizational environmental governance. *Building Research and Information* 44(5-6): 660-674.

Trencher G, Castán Broto V, Takagi T, Sprigings Z, Nishida Y, Yarime M. 2016. Innovative policy practices to advance building energy efficiency and retrofitting: Approaches, impacts and challenges in ten C40 cities. *Environmental Science and Policy* 66: 353-365.

Van der Heijden J. 2016. The new governance for low-carbon buildings: mapping, exploring, interrogating. *Building Research and Information* 44 (5-6): 575-584.

Chapter 3:

Case studies

Credit: Peter Tandlund / www.flickr.com

Credit: MarthaMccolough - Kindra Clineff MOTT / www.flickr.com

Case 1: Boston

Renew Boston Trust - Commercial

Abstract

Renew Boston Trust - Commercial (RBT-C) exploits structured finance principles through a nonprofit and public-private partnership to channel private investor funds into energy efficiency and renewable energy projects in commercial-sector buildings. Now in its advanced design stages, the programme will integrate performance guarantees into projects. This will allow it to navigate commercial lease hurdles to ensure that both benefits and costs are properly shared, enabling all parties to benefit from reduced energy expenditures. A major feature of RBT-C are strategies to overcome split-incentive issues and uncertainty regarding financial and technical performance to foster deep energy retrofits and climate resiliency investments.

Credit: Thomas Hawk / www.flickr.com

1. Programme context

Citywide reduction target(s)

As laid out in the 2014 Climate Action Plan (Greenovate Boston), the City of Boston is aiming to reduce its GHG emissions 25% by 2020, and 80% by 2050, compared to 2005 levels. Although highly complementary, the activities of RBT-C are not explicitly linked to these goals. The City of Boston is also targeting a 12.5% CO_2 emission reduction from large buildings and institutions specifically.

Built environment context and programme background

The structure of investment cycles in the commercial real estate sector in Boston and across the U.S. is a major impediment to the acquisition of project financing for building retrofit projects. Commercial real estate in Boston and the national market typically operate s on a 20-30 year refinancing cycle. During initial construction, and again when a building is refinanced, there will typically be a large investment in energy efficiency technology and building rehabilitation. However, this leaves a large period of time (referred to as the “mid-cycle”) where it is often difficult—or even expressly forbidden in an owner’s lease language—to make investments in retrofitting. This is because an owner’s collateral, in this case the building itself, is pledged under the initial mortgage. This is the only financing mechanism available for real estate in the U.S., and is called “mortgage finance”. Mortgage finance puts building owners in a difficult position. Even with access to capital, leases will prevent the acquisition of owner finance for retrofitting projects during this mid-cycle period. If in the case where an owner is able to secure financing from a third party, this party will be in a subordinate position to the mortgage holder on a building. That is, without permission from the mortgage holder, this third party is not entitled to repayment. This is the first set of problems that Retrofit Boston Trust Commercial (RBT-C) seeks to address.

RBT-C also seeks to tackle other factors hampering the growth of investment levels in energy efficiency projects in the commercial real estate market. Research informing the RBT-C initiative tells that there is presently around $642 million worth of unexploited energy efficiency investment opportunity in Boston’s commercial building stock. One major factor behind this unseized potential is that retrofitting projects in large commercial and multi-family buildings currently suffer from a lack of “bankability”. This term means that energy efficiency retrofitting projects—if considered an “investment” — will typically fail to provide the degree of certainty (which affects credit worthiness) and cash flow reliability (for loan repayments and returns for investors). A major reason for this uncertainty is that potential performance of energy efficiency upgrades is often based on engineering estimates provided by a contractor. To reduce liability, contractors are typically not willing to provide a guarantee on the operational performance of newly installed building technologies and materials. Technical and financial uncertainty put potential loan investors in an undesirable position. They are not protected against default should the retrofitting project fail to perform and

provide a cash flow for repayment. Government subsidies for energy efficiency projects are widely available across the U.S. and mitigate to some extent these circumstances. Yet since in most cases subsidies provide only limited portions of necessary investment amounts for energy efficiency upgrades, private sector financing is still required for the remaining “gap”. These restrictive conditions and low bankability therefore reduce the attractiveness of retrofitting projects in commercial real estate properties for both large, mainstream investors and lending institutions.

Additionally, a lack of information is also preventing retrofitting projects from achieving their market potential. First, when creating credit ratings and assess default rates, large lenders and investing institutions require robust empirical data drawn from an extensive and historical accumulation of technical and financial performance of similar projects implemented across industry. In the case of commercial building retrofitting projects, such information currently lacks. Making matters worse, loan investors are typically more interested in new construction, where returns are higher and more certain. Since investors typically look to use real estate as a short-term investment strategy (two-three years), energy efficiency retrofitting projects requiring longer paybacks are deprioritised. Combined with the earlier described conventions of lease language and investment-cycles in the real estate industry, this array of factors is currently behind the underinvestment in energy efficiency projects for mid-cycle commercial real estate assets.

To appeal to institutional or mainstream loan investors, mid-cycle energy efficiency retrofits must become an approved and investable asset class. This means meeting the standards of large investment entities and gaining access to investors of all types and sizes. To achieve this, however, requires gathering the necessary information to perform traditional financial analysis and secure access to financing in a building’s mid-cycle. Uncertainty on returns also must be eliminated through performance guarantees on technology upgrades to buildings. It is these exact functions that RBT-C has been designed to carry out.

Credit: Kyle Klein Photography / www.flickr.com

2. Programme overview

Overall goals and start year

RBT-C has been in development since early 2014. Now in the latter stages of planning and having received political support in Boston, its implementation is scheduled for 2018. Targeting large commercial buildings, RBT-C is one of four components making up the umbrella initiative Renew Boston Trust. The focus of this case study is the commercial buildings (RBT-C) component. The other three market segments targeted by the wider Renew Boston Trust are municipal (RBT-M), nonprofit institutions (RBT-I) and multi-family properties (Deep Green Loan Pool). Emergence of Renew Boston Trust has been facilitated by the City Energy Project. This is a ten-city joint initiative between the Natural Resources Defence Council and the Institute for Market Transformation. The goal of this project is to create “on-ramps” to building energy efficiency in cities through new policies and institutions.

The immediate overall goal of RBT-C is to increase mid-cycle investment levels in commercial building energy efficiency, climate resiliency and renewable energy projects. This is to allow them to fulfil their market potential and become an investible asset class capable of attracting funds from private investment institutions. This will be achieved by explicitly tackling the various factors outlined earlier in the background.

In particular, RBT-C is designed to foster “deep retrofitting” projects. As defined by the Rocky Mountain Institute (2012), these are construction and upgrade measures targeting multiple systems across the whole building. They achieve a much larger energy cost savings compared to “shallow” projects, which focus on upgrading isolated building components, such as lighting or water pump replacement. In RBT-C, a key indicator for measuring the depth of retrofitting in commercial properties is the investment amount relative to Gross Floor Area (GFA). RBT-C is currently aiming to foster investment levels of around $4.00 to $7.00 per ft^2. To put this in context, municipal buildings in Boston are currently investing only around $0.19 per ft^2 per year. As an interconnected goal, the programme will also finance climate resilience projects. These include building upgrade measures to strengthen preparedness for potential extreme weather events or electricity grid failures.

To reach these goals, the programme will form a public-private partnership. This will involve the establishment of a new, special purpose entity (SPE) organised as a nonprofit. This SPE will facilitate turnkey project design, implementation, and financing from private investors to realise energy efficiency improvements in commercial buildings. It will require energy savings guarantees from contractors. These guarantees will be used as a form of credit enhancement to improve project bankability. The SPE will outsource many of its functions to contractors. It will then collect repayments as utility charges from building owners and transfer these to the investors.

Programme target and scope

Since RBT-C seeks to foster large-scale and deep-retrofitting projects requiring high levels of investment, it will target the owners of existing and large commercial buildings or upper-market multi-family properties such as condominiums. Ideal candidates for the programme will be those real estate assets at mid-cycle, situated several years from both the initial construction and rehabilitation phases. Initially the programme will target assets within the City of Boston. It does however hold ambitions to expand to the surrounding region. At this stage a minimum GFA requirement has not been fixed.

As programme funding will need to be strategically allocated, participants will need to meet certain criteria. Many buildings in the U.S. have been caught by a dramatic change in efficiency standards in 2006 from the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). Buildings constructed in the years preceding these changes were built to less stringent standards and are now approaching their mid-cycle. These buildings are not well positioned to compete with newer more efficient buildings adhering to ASHRAE standards, and in principle, will be looking for options to finance improvements to reduce their operating costs.

Under RBT-C, the City of Boston will mainly take a convening role, bringing together the institutions required to form the public-private partnership. Additionally, the City will also play a part in the creation of investment performance standards and processes to make these projects more attractive to potential investors. This may also involve providing incentives in the form of partial project financing. However the necessity or feasibility of this is still mostly unclear.

Programme structure and function

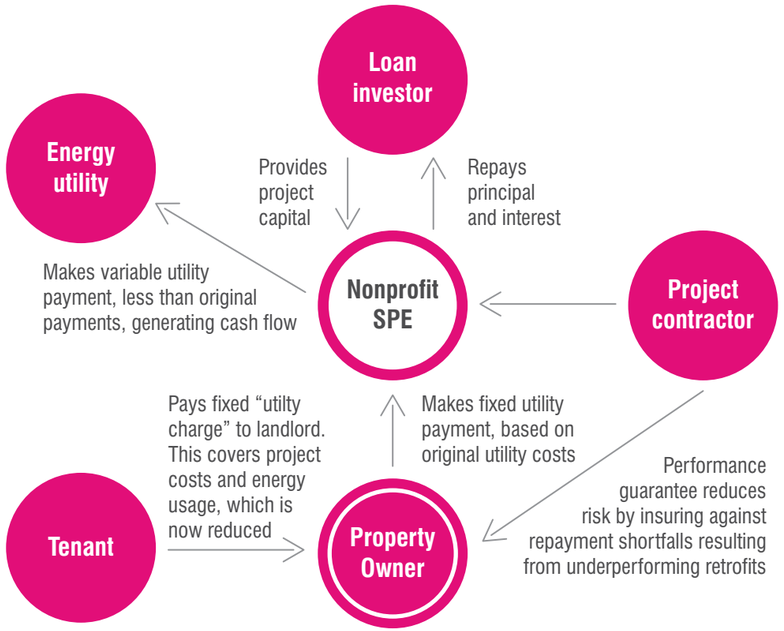
RBT-C will be organised by the City Energy Project through the Boston Department of Environment, Energy and Open Space. The implementing entity (i.e. the SPE) will operate as a public-private partnership and take the form of a nonprofit organisation. The public dimension of the partnership will be Boston’s Economic Development and Industrial Corporation (EDIC). Precise membership of the private entity is yet to be determined. It will however consist of multiple large loan investors with interests in commercial real estate finance, equipment leasing, project development and social or environmental impact investments.

The structure and function of the RBT-C is shown in Figure 1. The SPE and property owners will enter into a managed utilities service partnership. This resembles the function of a conventional Energy Services Company (ESCO). Through this agreement the property owners will consent to repay a fixed amount to the SPE, who will then pass repayments to the loan investor. This means that the SPE will pay energy utilities monthly as required, and then recuperate savings on energy expenditures (generated by the retrofit) to offer repayment of debt incurred from retrofitting. This process and other details are elaborated below.

To provide loan investors with enough credit enhancement (i.e. assurance that a debt will be repaid) a performance guarantee from the contractor must be secured. These guarantees will be provided through a performance contract. This will hold the contractor accountable for two aspects. First, the maximum price of project implementation, and second, a specified amount of savings resulting from improved operational building performance. Although these guaranteed “savings” refer to energy savings such as BTU/year and not literally “currency savings”, depending on energy prices, projects would generate a cash positive revenue. This performance contract will in effect remove both technical and financial uncertainties from a deep retrofitting project. Negotiating these guarantees will be the responsibility of EDIC. Once the performance of the implemented energy efficiency technologies is guaranteed, the loan investor will have sufficient protection against default. This is because, regardless of the operational performance of the energy efficiency upgrade, a building owner is legally obliged to make fixed utility repayments to the SPE. However, under the performance contract, the contractor has an obligation with the building owner to

make up any cash shortfall from energy savings the owner might experience as a result of an underperforming retrofit. When they occur, shortfalls are payable in cash to the owner, effectively covering the repayment amount to the loan investor.

Figure 1: **Relationships between the different stakeholders involved with RBT-C.**



However, before a loan investor will agree to finance a project, the SPE must obtain and provide a waiver from the mortgage holder on the building. This waiver is critical, as the SPE must have legal authority to collect repayments from the property owner. The mortgage holder is the primary debt holder on the building (i.e. the bank or investor) and is, generally speaking, given priority for collection of debt repayment. However, for mid-cycle energy efficiency projects, this means any project financier would place themselves in a subordinate position to the mortgage holder. Thus the SPE, on behalf of the loan investor, will secure a waiver that grants permission to collect repayments. It is anticipated that this negotiation will prove relatively easy, since the repayment amounts to cover an energy efficiency upgrade would only represent a small percentage of the total mortgage for the building itself. Additionally, retrofitting projects would enhance the market value of the mortgage holder's asset. Negotiations for obtaining this waiver will occur just prior to closing on project financing, after the scope of a project has been determined and all guarantees are in place. This waiver, along with the performance guarantee is thought of as a form of credit enhancement to make the project bankable. Once a project is deemed bankable, a traditional credit underwriting can be performed to examine if the project creates enough savings to cover servicing any debt incurred. If this is found to be the case, the project will be financed and the energy savings effectively used to make repayment.

Once an energy efficiency project was implemented, the property owner would begin making fixed, regular payments to the SPE. This amount is calculated to cover 1) projected energy expenditures (now reduced compared to before the upgrade), 2) principal loan balance and accrued interest of project implementation costs and 3) a small fee to fund the SPE's operations. The advantage of this approach is that overhead costs of the SPE would be collected as small transaction costs from a large number of projects. This leads to reduced transactions costs for each project. Payments to the energy utility will be made by the SPE on behalf of the building owner at a variable rate (determined by the performance of the efficiency measures and the cost of energy at the time). The difference between the fixed, regular payment to the SPE from the owner and variable but reduced payments to the utility will create the cash flow to repay the providers of capital to a project.

In the case of a tenant-occupied building, these payments to the SPE would be obtained from tenants. Many commercial leases in the U.S. contain language allowing landlords to pass through capital costs in events where tenants would receive the benefits as lowered operating expenditures. In cases where this is not possible, RBT-C would address this by drafting an outsourcing contract between the landlord and the SPE for all utility service charges, including energy utilities. "Utility charges" would be defined in the contract to include both variable utility payments for electricity, gas and so on in addition to the amortisation of capital costs incurred to lower energy expenses through a retrofit project. This arrangement allows the landlord to pass through capital costs to tenants as operating costs. This would thus overcome any split-incentive issues—even in a situation where the original lease places a limit on the passing through of capital upgrade costs.

Both tenants and building owners benefit from this situation. For tenants, since energy costs decline once the project is amortised, no additional costs are incurred as they make fixed utilities payments to the owner (which must also cover the principal, interest and service charges to the SPE). Furthermore, once the energy efficiency project is completely paid off, the portion of the "utility charges" that is attributable to the financing of the project is dropped from the monthly invoice sent to each tenant by the building owner. Since the building's energy use is permanently lower, the tenant would then benefit from permanently reduced energy expenses. Conversely, building owners also profit from this financing arrangement. This is primarily by capturing funds, that would have otherwise flowed to local energy utilities, to upgrade the building and generate additional capital. Completed energy efficiency upgrades would

likely increase the building's value and strengthen its competitiveness in the rental or selling market.

Accepted projects will operate within a given performance period and be subject to energy efficiency audits. This will be determined by the payback period of installed energy efficiency measures. For example, if a building implements upgrade measures with a 20-year payback, the performance period would also extend for 20-years. During this time, a so-called measurement and verification audit is normally performed annually. These audits will analyse the performance of installed technologies and building components relative to the guaranteed energy savings. This will be used to hold contractors accountable for any shortfalls arising in the event of a building underperformance. With all the necessary guarantees in place, projects organised through RBT-C will be able to reasonably assure loan investors that returns will be made.

As can be seen through the above structure and set of processes, RBT-C will overcome the multiple and interconnected market and institutional barriers to securing financing for mid-cycle energy efficiency retrofits. Using the SPE to directly interact with loan investors and contractors will allow property owners to develop projects and acquire funding more easily. Conversely, the performance guarantee negotiated by the SPE will make a project more bankable and mitigate the risk to investors of lending to mid-cycle building upgrades.

Data collection and utilisation

At this stage the programme has no plans for mandating data collection and reporting (such as aggregate building level energy consumption) for submission to the City of Boston. Incidentally, this will be unnecessary since Boston's Building Energy Reporting and Disclosure Ordinance (i.e. benchmark scheme) will cover most buildings interested in financing retrofit projects through RBT-C. The ordinance was created in 2013 and requires reporting from buildings larger than 50,000 ft^2. This said, as mentioned, monitoring of the actual performance of installed technologies will be conducted through yearly energy audits.

Unique and innovative features

RBT-C's principle innovation lies in using the SPE to deploy an energy services agreement with energy performance contracts; that is, energy management services that include savings guarantees. This is crucial, since as explained, a lack of certainty regarding technical and financial performance has historically prevented financing for energy efficiency upgrades in commercial buildings. Certain types of energy services agreements such as power purchase agreements are widely used to secure financing for single, large and "meter-able" projects like PV solar arrays or combined heat and power plants. These normally include a performance guarantee. RBT-C will use the SPE to extend the energy services agreement model to energy efficiency, which is harder to meter. It will also facilitate the realisation of large numbers of smaller projects

Credit: Thomas Stromberg / www.flickr.com

that would not normally be feasible, given the high fixed costs of structured project finance. This approach will create a larger number of bankable projects. More projects will in turn drive a reduction in the minimum project size needed to qualify for financing.

Targeting levels of investment instead of environmental indicators such as GHG, kWh or energy use intensity (EUI) reductions is another innovative feature. Many programmes focus on end results as a key metric. In contrast, RBT-C envisions increased investment levels in mid-cycle energy efficiency to serve as the key indicator and driver of energy and GHG reductions across commercial buildings. This has the advantage of being easily measured and explained to funders. Furthermore, where performance guarantees are involved, investments that drive projects can be directly linked to reductions in energy and GHG emissions as climate change mitigation.

Lastly, exploiting funds from private sector investors outside Boston and the state of Massachusetts to fund local energy efficiency projects is highly novel. City programmes to advance energy efficiency in existing buildings often rely on incentives from local energy utilities or corporate finance operations of real

estate owners. In contrast, in addition to exploiting locally available subsidies, RBT-C will primarily draw on funds from any interested loan investors—both local and out of state. There is hence potential for RBT-C to channel a larger volume of investment funds into the Boston building stock than could be done with local funds alone.

Incentive and support mechanisms

The principle incentive for building owners engaging with RBT-C is the possibility of securing financing for energy efficiency improvements without traditional corporate finance – that is, RBT-C represents an additional source of capital for the owner, which because of its nature, is not available for any other use. Furthermore, upgrades use savings from reduced energy expenditures to pay for themselves, cash flow to repay project debt that is secured by a damages clause in the performance contract promising to make up the difference whenever there is a shortfall. Further incentives will flow from potential to improve the value and market competitiveness of a property by raising energy efficiency, as well as lowering operating costs. This increase in property value also incentivises the mortgage holder on a property to provide the SPE with the waiver necessary to collect repayment. Leveraging of utility incentives will also be critical to the success of the programme. They serve as additional sources of funding that will allow projects to attain deeper levels of retrofitting activity.

Links to other programmes

As mentioned earlier, RBT-C is strongly related to other complementary RBT programmes, covering both public and private sectors, each of which has unique financing requirements and appeal to different types of investors.

Early Boston efforts to provide resources for homeowners and small businesses to reduce energy costs by installing insulation and other energy saving measures shared many goals with the multi-sector Renew Boston Trust. It therefore proved logical to appropriate the name for the sake of ensuring continuity and name recognition.

3. Design and implementation

Design phase

Timeline

Planning of the RBT-C began in early 2014. The programme is still in the advanced stages of design and tailoring. Implementation of initial projects are envisioned for 2018. These will include a $50 million district energy plant, efficiency upgrades and a multi-user microgrid.

Inputs

Three years of funding was required to organise Renew Boston Trust and was provided through the City Energy Project by Bloomberg Philanthropies, the Kresge Foundation and the Doris Duke Charitable Foundation. When sealing a Memorandum of Understanding with the City Energy Project, the City of Boston opted for a focus on investigating and implementing financial solutions for spurring energy efficiency in the built environment. The advisor chosen for this role then carried out the design and background research for the Renew Boston Trust. This individual had accumulated experience working with multiple C40 cities such as Houston and Melbourne from 2006 to 2010 as a program director with the Clinton Climate Initiative. The implementing partners of City Energy Project, Natural Resources Defence Council and Institute for Market Transformation, together provide administrative support to RBT-C.

Key collaborations

Although development was carried out by a single advisor to the City of Boston, implementation of RBT-C will be carried out though multiple persons and public-private partnerships. As mentioned, the nonprofit SPE will be the main implementing agent. It will unite EDIC, the core public partner, with numerous private lenders and investment institutions. During implementation, the SPE will also exploit external grants from funders to employ staff to assist with legal requirements, project management and to build programme capacity with city government. Once established, the SPE will operate independently from loan investors and contractors, but receive technical support from partner organisations.

EDIC will be responsible for processing project applications and proposals, as well as maintaining relationships with lending institutions. EDIC is an existing quasi-public entity that functions as a board of the City of Boston, and is appointed by the Mayor. This board operates in tandem with the Boston Planning and Development Agency and is mandated to promote and finance infrastructure projects in the city. These organisations will be critical to the operations of the SPE. Having existed for many years, they will provide a framework for which to evaluate project proposals, and will already have support from the city.

Precise membership of the private entity is yet to be determined. It will however consist of multiple large loan investors with interests in commercial real estate finance, equipment leasing, project development and social or environmental impact investments. These loan investors will provide project financing, and EDIC will act as facilitator and disperse funds for projects.

4. Outcomes and impacts

Environmental

Although explicit targets have not been fixed, the fostering of deep retrofitting projects in large, commercial and multi-family buildings will enable significant reductions in energy and water consumption and GHG emissions in key Boston landmark buildings. The particular focus on deep-retrofitting will also ensure that differing components of buildings are brought into a synergistic and energy efficient alignment. This can achieve greater environmental savings than isolated shallow retrofitting projects of single building components. In addition, since several projects will be implemented to boost climate resiliency, those buildings will be significantly strengthened against events such as flooding and power shortages.

Social

Using the SPE to implement energy service agreements will increase building owner access to mid-cycle financing without the need for strategic capital. As mentioned earlier, lack of mid-cycle financing opportunities is a key barrier hindering retrofitting in the U.S. at present. Also important, RBT-C can eliminate any split-incentive issues that exist. As explained earlier, this will be achieved by outsourcing the owner's utility payments to the SPE, and redefining "utility charges" in the contract to include costs incurred in upgrading a building to lower energy expenditures. This approach will allow a building owner to pass on costs of energy efficiency projects to tenants, who would then see these amortisation charges offset by lower energy expenses. As an additional social outcome, performance contracts will incentivise project contractors to perform due diligence regarding the use of efficiency technologies. This is to avoid the situation where underperforming upgrades would force them to cover financial shortfalls for the building owner. This would ensure monitoring of completed retrofit projects to ensure that full environmental benefits (i.e. reduced energy and water consumption) were captured.

Market

The greatest potential market impact will be the creation of a new asset class of investment-grade efficiency returns that has never existed before. This will open the door to institutional investors interested in sustainable environmental investments. Performance guarantees and accumulation of data from multiple projects will allow traditional credit underwriting to be performed. The SPE facilitated public and private collaboration will allow the design of bankable projects. These would overcome much uncertainty involved in predicting financial performance of building energy efficiency upgrades. Consequently, future projects implemented through RBT-C could possibly attract substantial private risk capital to finance mid-cycle building upgrades that tap energy efficiency savings. As well as improving the market value of commercial buildings, these would lead to a dramatic expansion of the current retrofitting market, which is currently far below its potential. Additionally, this increase in retrofitting activity will create green construction jobs and spur diffusion of green building technologies.

5. Lessons learned for replication

Strengths and drivers

Clear and attractive benefits for both owners and tenants

The success of RBT-C will be propelled by a set of explicit and attractive benefits for both building owners and tenants. As explained earlier, building owners will be incentivised by the prospect of upgrading their asset without the need to raise additional capital. This is because energy efficiency projects are designed to be self-funding, and capital charges are passed on to tenants as operating expenses (i.e. as "energy utilities"). As for tenants, they will be incentivised by the prospect of benefiting from permanently reduced energy expenditures. This would occur once the energy efficiency upgrade was paid off and the portion of the "utility charges" associated with the project's financing was erased from monthly invoices from the owner. Also, during the upgrade project financing cycle, monthly energy related payments to the building owner would not effectively rise relative to the situation before project implementation. This is because energy expenditures would be immediately reduced after implementation, and project payments generated by capturing funds that would otherwise flown to energy utilities. In summary, this set of clear benefits for both sides will serve as a powerful strategy to overcome any potential split-incentive issues between owners and tenants when planning energy efficiency upgrades to mid-cycle buildings.

Exploitation of private sector funds

Instead of relying on funding from government sources or utilities, RBT-C takes advantage of generally underutilised private risk capital to finance mid-cycle building projects for energy efficiency, renewable energy and climate resiliency. Performance guarantees from contractors (capping maximum project costs and assuring minimum levels of energy efficiency performance) will significantly boost the interest of institutional loan investors. This is because the performance guarantees offered by contractors would effectively protect against project default. This will remove both technical and financial uncertainty from funding projects, enhancing the credit worthiness and bankability of projects. Based on

the global amount of private capital available that is seeking yield with safety, RBT-C is therefore well positioned to grow and support an increasing number of projects.

Speed in establishment and potential scalability

RBT-C works within the bounds of existing legislation. Since it does not require the formation of enabling legislation, it has the potential to be replicated and up-scaled in most regions of the world in a relatively quick and efficient manner.

Challenges, limitations and countermeasures

Obtaining support from the city

Lacking a history of public-private partnerships (PPPs) in Boston, it has proved challenging to muster support for the SPE and PPP model from other officials and departments in the city. Several factors however have aided in winning support. First, RBT-C represents an important opportunity for the city to pursue ongoing economic development investments and improve large parcels of city-owned land. Second, the nonprofit SPE is designed to be self-sufficient by operating with funds and grants from external sources and small transaction fees collected from projects. This eliminates the need for any specific budget from the city. Finally, the programme represents an important strategy for the city in its Climate Action Plan.

Long-term approaches required to achieve market transformation goals

It is expected that the goal of transforming the Boston and national retrofitting market in Boston by turning deep energy retrofitting projects into an approved asset class will be a slow and challenging process. This is apparent when considering that currently, the U.S. commercial retrofitting projects market is estimated to be attaining only 10% of its full potential. In addition, the nature of the deep-retrofitting projects targeted by RBT-C therefore is long-term, with many projects planned to reap paybacks over a decade or more. As such, long-term commitments and strategies are required from all parties participating in RBT-C and its SPE.

Obtaining a waiver for multi-family properties

Challenges are anticipated in targeting the multi-family sector. These properties are often owned by a group of investors rather than an individual. Convening this group and making the argument for the repayment waiver could prove difficult for logistical reasons. Additionally, multi-family properties developed under affordable housing schemes can also have federal restrictions against taking on additional debt. These essentially prevent “opening up” of contracts for mid-cycle investment. For this reason, it is expected that RBT-C will see more success in addressing the market-rate and luxury segment (i.e. condominiums) than the so-called affordable end of the multi-family housing market.

List of references

Bevington, M., Seely C. 2012. Making Energy Efficiency Bankable: Lessons Learned From a Global Market Transformation Effort. ACEEE Summer Study on Energy Efficiency in Buildings 6-25:6-38.

Bevington, M. 2014. Renew Boston Trust Overview. https://vimeo.com/100718630, Accessed 23 July, 2016.

Bevington, M. 2015. Renew Boston Trust: Managed Utilities Service Partnership for Commercial Property. Unpublished (available on request).

City Energy Project 2013. Frequently Asked Questions. http://www.cityenergyproject.org/faq Accessed 23 January 2016.

City of Boston. 2014. Greenovate Boston 2014 Climate Action Plan Update. http://www.cityofboston.gov/climate/bostonsplan/ Accessed 23 January 2016.

Rocky Mountain Institute (RMI). 2012. Guide to Making the Case for Deep Energy Retrofits. http://www.rmi.org/Content/Files/RMI_Retrofit_Guide_BuildingTheCase_1.1.pdf Accessed 23 January 2016.

Credit: Guiseppe Milo - Double Zanzo / www.flickr.com

Case 2: Chicago

Retrofit Chicago Energy Challenge

Abstract

The Retrofit Chicago Energy Challenge (“the Challenge”) encourages, supports and celebrates voluntary energy efficiency leadership among large commercial, institutional, and private buildings throughout the City of Chicago. In partnership with diverse public, nonprofit and private stakeholders, the Challenge motivates and guides voluntary action towards reducing energy consumption by 20% over five years. The Challenge provides direct support and peer networking to help participants achieve their energy goals. Additionally, it facilitates best practise sharing and showcasing of ambitious energy leadership and impact.

Credit: Roman Boed / www.flickr.com

1. Programme context

Citywide reduction target(s)

As mapped out in the Chicago Climate Action Plan (CCAP) created in 2008, the City of Chicago aims to reduce CO_2 emissions by 25% by 2020 and 80% by 2050, compared to 1990 levels.

Built environment context and programme background

In the 19th century Chicago gave birth to the modern skyscraper. In the 20th century, the city built a spectacular skyline that is a living monument to innovative architecture and design. Now, in the 21st century, Chicago is working to make that skyline one of the most energy efficient in the world. Residents and businesses in Chicago spend more than $3 billion each year on energy consumption, and building energy use accounts for 71% of citywide GHG emissions. Much of the building stock's energy expenditures are spent on Chicago's 3,246 heating degree days (C)[1] during cold months. This amount of required heating is the primary metric through which the U.S. Department of Energy defines the City of Chicago as having a "cold climate".

To advance Chicago's long-term climate and environmental goals through practical, near-term action, Chicago Mayor Rahm Emanuel led public and private stakeholders in creating the Sustainable Chicago Action Agenda (City of Chicago, 2012). This plan identified energy efficiency and the promotion of renewable energy as key components of citywide sustainability efforts. The Retrofit Chicago Energy Challenge (henceforth "the Challenge") emerged from this context. It represents an important piece of the City of Chicago's participation in the Better Buildings Challenge launched by President Obama and the U.S. Department of Energy in 2011. This national initiative mobilises local governments, businesses and partner institutions across the U.S. to bring cities to take measures to improve the energy efficiency of commercial, industrial, residential and public buildings by 20% over 10 years. Chicago's participation in the Better Buildings Challenge comprises of three related programmes (commercial, municipal, residential). The focus of this case study is on the segment of Retrofit Chicago targeting commercial, non-profit, institutional and other private sector buildings.

[1] The degree-day measurement is the difference in temperature between the average outdoor temperature over a 24-hour period and a given base temperature for a building space, typically 25°C. It represents the magnitude of heating requirements in a location. Examples of other cities are 2,420 in Seattle, 2,509 in New York City, and 2,967 in Philadelphia (source: http://www.c40.org/cities).

2. Programme overview

Overall goals and start year

Since its launch in 2012, the Challenge has sought to motivate large buildings to commit to the pursuit of a common energy reduction target. Participating buildings make a public commitment to improve energy efficiency by 20% within five years of joining the programme. Their participation involves sharing progress and serving as ambassadors to other buildings seeking to save energy and operating costs. The Challenge assists participating buildings in overcoming barriers to improving energy efficiency and delivering successful energy retrofit projects. It provides direct support to managers and owners, facilitates best practice sharing among buildings, and in parallel, seeks to foster voluntary energy efficiency leadership across the building industry.

Programme target and scope

The Challenge targets the owners, managers, operations teams and other stakeholders in existing, large commercial, institutional, multifamily residential and cultural facilities. There is presently no explicit size to qualify for joining the Challenge. Participants range in size from 30,000 to more than 4 million ft^2. The average Gross Floor Area (GFA) is approximately 700,000 ft^2.To date, 62 buildings are enrolled in the programme, spanning more than 43 million ft^2 of space. Initial participants were clustered in Chicago's central business district. Yet subsequent expansion has broadened participating building types and the geographical scope of the programme. Currently, 72% of participating buildings serve primarily as commercial offices. The remaining participants are comprised of hotels, universities, multifamily residences and cultural institutions. Specifically, these include iconic skyscrapers, historical landmarks, affordable and market-rate housing, worship facilities, mission driven organisations such as the Salvation Army headquarters and beloved Chicago attractions such as Navy Pier and the John G. Shedd Aquarium.

Programme structure and function

The Challenge is a collaboration between the City of Chicago and a host of public, nonprofit and private organisations. These include the C40 Cities Climate Leadership Group, Natural Resources Defense Council, City Energy Project, Institute for Market Transformation, Environmental Defense Fund, Alliance to Retrofit Chicago Higher Education, Rocky Mountain Institute and Midwest Energy Efficiency Alliance. Initial recruiting for the Challenge drew upon pre-existing relationships among city officials, public interest groups, building owners, management, design firms, utilities and energy service providers.

To join the Challenge, a senior representative of building ownership or management sends a letter to the Mayor's Office stating a commitment to the following goals:

Credit: City of Chicago. Copyright © 2016

- Reduce energy usage in one or more buildings by at least 20% within five years
- Begin energy efficiency work within six months
- Track progress using the U.S. Environmental Protection Agency (EPA) ENERGY STAR Portfolio Manager (henceforth Portfolio Manager) and share best practices with the public
- Serve as ambassadors to other buildings interested in increasing energy efficiency

The commitment that participants make to reduce energy usage by 20% within five years is critical. Challenge partners selected the 20% energy reduction target—which applies to all energy use across the entire building, including electricity, natural gas, and district energy—to be specific, ambitious and impactful, yet achievable. The 20% reduction applies to a 12-month baseline period of up two calendar years prior to the commitment date. For example, if a build joins the programme in July of 2016, it can select January through December of 2014, 2015 or 2016 as its baseline. In this case, the target of reducing whole-building energy use by 20% must be reached by no later than the period running January to December in 2021. The stipulation that energy efficiency work begins within six

months of joining the programme can include energy audits or implementation of retrofit measures. Due to the urgency of reducing energy reduction opportunities, overall, participants have not struggled to meet this requirement. The qualitative commitments, such as best practice sharing to serve as ambassadors to other buildings across Chicago, are also very important, as capacity building is crucial to the programme.

To achieve a 20% improvement in energy efficiency within five years, Challenge participants are led to pursue the following five steps, seeking advice and support from programme partners along the way as necessary:

- Benchmark the building
- Conduct an energy assessment or review previously conducted assessments to identify savings opportunities
- Develop a business case for a building retrofit that considers utility incentives
- Plan and implement retrofit work
- Measure and track energy savings each six months via Portfolio Manager

To help progress towards greater energy efficiency and successful retrofitting, participants receive access to several crucial capacity building resources from the combined public, private and nonprofit resources of the various partners involved in implementing the programme. Support measures include access to consultations and expertise from city technical advisors and programme partners, also extending to invitations to participate in events for networking, knowledge sharing or celebrating outstanding practices and achievements.

As an example of building-specific technical support, Challenge participants in 2013 had the opportunity to consult with technicians and form an Energy Road Map. Also seeking to deepen relationships with key building and partner stakeholders, these roadmaps were made possible by a public-private collaboration and grant funding. They aimed to assist Challenge participants with various key tasks such as compiling energy use data, creating energy baselines, benchmarking performance against other same-type buildings through Portfolio Manager, quantifying actual and planned energy reduction measures to-date, identifying any gaps remaining to achieve the 20% goal, and finally, prioritising sequential actions and investments to meet (and exceed) the 20% reduction commitment. This latter estimate took into account expected capital costs, available utility funding incentives, projected return-on-investment and payback periods. A total of 19 participants took advantage of these road maps in 2013. Together, roadmaps identified $5 million in annual energy savings, with average building-level savings of $250,000 per year. Internal rates of return on efficiency investments ranged from 8% to 10%.

Additional programme activities include a workshop facilitated by the Natural Resources Defense Council on energy aligned leases. This helped familiarise building managers with leasing arrangements that allow landlords and tenants to overcome “split incentive” barriers by sharing the costs and benefits of energy efficiency upgrades. Furthermore, on a quarterly basis, the Challenge hosts engineer roundtables to showcase building operation practices that lead to large efficiency gains. Jointly organised by Retrofit Chicago, the Environmental Defense Fund and ComEd (Chicago’s publicly-traded electricity utility), these roundtables include tours of individual buildings, programme updates, briefings on utility incentive opportunities, peer-to-peer lesson sharing and networking.

Data collection and progress tracking

The principle data collection tool employed is Portfolio Manager. Weather-normalised source energy use—expressed as kBtu (thousand British thermal units)—is the chief metric used to measure participant progress toward the 20% reduction target. As highlighted above, reporting occurs twice per year. For certain building types such as offices, hotels and multifamily residential housing, Portfolio Manager also calculates adjusted energy use intensity (EUI). This metric controls not only for weather, but also for changes in building operations and space uses. Where possible, Portfolio Manager considers both adjusted and weather-normalised source EUI.

Participating buildings share read-only access to their Portfolio Manager accounts. This allows the Mayor’s Office and Challenge partners to assess ongoing energy performance. At the beginning of each calendar year, participants are asked to review and update their Portfolio Manager profiles to ensure up-to-date, accurate data. All data is self-reported and provided at the whole-building level. Although building-level progress tracking precludes assessment of the impacts of some specific retrofit projects or other interventions, many participants track these investments internally to measure return on investment or to fulfil utility incentive requirements. The Challenge regularly shares aggregate programme progress and impacts. This said, it does not share individually identifiable building energy data to the public or other participants without permission.

Innovative programme features

The specific goal of reducing energy usage by 20% within five years in each participating building is central to the Challenge’s success and credibility. It provides a clear, quantitative target for guiding voluntary efforts to improve the energy performance of individual buildings. It also motivates participants to continue taking action due to the commitment they have made publicly. At the same time, this individual building commitment fosters a shared sense of ambition, solidarity and responsibility among all participants as the Challenge tracks and shares collective energy savings.

Also innovative is the Challenge’s cross-sector collaborative implementation model. This unites public and private entities, including city officials, NGOs, private consultants and utilities. Operating in this way makes it possible to tap into the diverse and complementary resources of the partner network. These partners are made available to participating building owners and managers to provide varying forms of assistance. These include one-on-one technical expertise, access to utility incentive schemes, outreach to tenants, innovative

leasing structures to facilitate cost and benefit sharing of retrofits, sharing best practices and support with tracking progress.

Incentives and support mechanisms

Apart from receiving guidance on how to leverage utility incentives to accelerate and increase financial returns on energy efficiency investments, there is no direct financial assistance provided from the city for participation in the Challenge or financing retrofits. Rather, the primary incentive for participation stems from the above-described capacity building components of the programme.

As an additional strategy, mayoral recognition is used to publically promote the Challenge and encourage buildings to participate. Various platforms for showcasing participants include individual building profiles on the official website[2] and regular mayoral press releases to recognise new participants and progress. In addition, full page advertisements are run in both major Chicago daily newspapers. These commemorate both the launch of the programme and subsequent expansions as new participants join. Also, Chicago's Mayor Emanuel is publicly and visibly committed to the Challenge. He has personally participated in programme announcements, updates and building tours every year since the programme's launch. This top-level support from the city lends gravity and prestige to the programme, while also serving to underscore the importance of energy efficiency to the City of Chicago. In addition to these outlets, since 2014, participants are invited to take part in an annual award ceremony to recognize outstanding building achievements and overall Challenge progress. Over three years, this event has grown to include scores of participating building and partner representatives, senior city officials, real estate executives and environmental leaders. Awards are broken down into the following categories:

- **Mayor's Leadership Circle Award:** For participants who have reduced whole building energy use by 20% or more below their baseline, thereby reaching the main programme goal.
- **Most Valuable Engineer Award:** In recognition of an engineer who has gone above-and-beyond in identifying and achieving energy savings through efficient building operations at his or her facility.
- **Most Valuable Property Manager:** In recognition of a property manager or management team member who exemplifies how and why energy efficiency is critical to excellent property management.
- **Innovative Energy Efficiency Project or Partnership Award:** In recognition of a project, programme or partnership that has demonstrated innovative, impactful and replicable energy savings.

As a further incentive measure, participating buildings planning energy efficiency retrofits can receive expedited permitting assistance for energy related building

[2] www.RetrofitChicago.net

Credit: Tripp / www.flickr.com

upgrades. This is enabled by a cross-departmental collaboration between the Mayor's Office and the Chicago Department of Buildings.

Links to other policies and programmes

Initial experiences and data from Challenge participants informed the design of Chicago's Building Energy Use Benchmarking Ordinance, adopted in 2013. This ordinance mandates all buildings with more than 50,000 ft^2 of GFA to report annual energy usage data to the City of Chicago through Portfolio Manager. Results are then publically disclosed by the city. By virtue of their size and space uses, almost all buildings participating in the Challenge are also required to comply with the benchmarking ordinance. Early experiences in progress tracking for the Challenge illuminated common building challenges encountered by building owners and managers when collecting and reporting data. These included obtaining whole-building electricity and natural gas use data, and also using the Portfolio Manager reporting platform. Implementation of the Challenge thus provided valuable experience for city officials charged with administering the benchmarking ordinance, and vice-versa. Furthermore, partnerships formed with utilities, public interest groups, energy service providers, real estate

portfolios and other stakeholders in the Challenge also proved invaluable to ordinance development, outreach and provision of recommended actions to increase energy performance.

The mandatory benchmarking ordinance and voluntary Challenge thus both form an important and mutually re-enforcing relationship. The benchmarking scheme only mandates data reporting and no actual improvement in energy efficiency. On the other hand, the Challenge plays a vital role by providing covered buildings with a concrete opportunity to receive support and recognition for actually improving energy performance year to year.

3. Design and implementation

Design phase

Timeline

The Challenge was conceived during 2011 to early 2012 by senior city officials and environmental partners following Mayor Emanuel's election and mayoral transition.

Inputs

The Challenge was shaped through conversations between many key stakeholders including the Mayor's Office, local and regional electric and gas utilities, the Natural Resources Defense Council, C40 Cities Climate Leadership Group, the Joyce Foundation, private sector design and engineering services firms, and other mission-aligned non-profit organisations and foundations. Existing local and national voluntary energy efficiency initiatives at that time—as well as efforts to improve energy performance of Chicago's municipal buildings—provided a frame of reference and inspiration for the programme.

Implementation phase

Timeline

The programme launched in June of 2012 with a public announcement by Mayor Emanuel and U.S. Energy Secretary Steven Chu. The 14 founding participants represented 14 million ft^2 of commercial office and hotel space. The Challenge has since seen three major expansions, attracting 18 additional building participants in both 2013 and 2014 and 12 additional participants in 2016. This has brought total participation to 62 buildings and 43 million ft^2. However Mayor Emanuel has since announced the city's intention to continue expanding the number of participants in the programme to around 80 by mid-2017.

Inputs

As highlighted, the City of Chicago is not the exclusive co-ordinator of the Challenge. Instead, it operates as a collaboration that unites multiple partners and stakeholders from various sectors in the building and environmental community. From 2012 to 2016, coordination of the Challenge was carried out by the City of Chicago's Chief Sustainability Officer, the Chicago City Director of the C40 Cities Climate Leadership Group and a team of approximately ten part-time staff from the various core partners. As mentioned, these include Natural Resources Defense Council, City Energy Project, Institute for Market Transformation, Environmental Defense Fund, Alliance to Retrofit Chicago Higher Education, Rocky Mountain Institute and Midwest Energy Efficiency Alliance. In addition to this core partner network, the Challenge also draws on sponsorship and technical support from The Joyce Foundation, World Business Chicago, BOMA/Chicago, Sieben Energy Associates, AECOM and Seventhwave. As other contributions, a private engineering firm PositivEnergy Practice was behind the delivery of the 2013 Energy Road Maps. Also, programme participants have received several million dollars in energy utility incentive funding (through ComEd and Peoples Gas) to support efficiency improvements.

There is no public budget line item for the Challenge. Most costs are covered by pro-bono partner engagement and modest grant funding. Private partners—including local utilities and private companies—provide specific financial support for the annual awards.

To ensure reliable progress tracking, Challenge partners regularly review self-reported building energy use data, using a set of simple screening measures to flag potential data errors or inconsistencies. When periodic questions arise about specific building data, Challenge partners and buildings meet to review the data and address any issues. Although this process does not include third-party energy audits, this has proven to be an effective means of tracking progress and ensuring quantitative data quality.

Adjustments

Upon its launch, the Challenge targeted buildings with 200,000 ft^2 or more of GFA. These large buildings comprised mostly of offices. Based on partner and participant input, this threshold was later loosened in response to suggestions that additional buildings with large energy savings potential might be interested in participating alongside larger peers. Lowering the minimum size threshold thus allowed the programme to achieve a greater diversity in participants by including properties such as hotels, universities, multifamily housing, places of worship and cultural institutions.

4. Outcomes and impacts

Environmental impacts

In July of 2016, Mayor Emanuel's office published a press release (City of Chicago, 2016) announcing the third expansion of the Challenge, together with key results. To date, participating buildings have achieved a total energy use reduction of 11.7% (weather normalised source energy) from baselines. This marks a significant improvement over the previously announced cumulative reduction of 7% in 2015. The latest results represent an annual savings of 90 million kilowatt-hours of electricity and 70,000 metric tonnes of avoided GHG emissions.

Social impacts

The Challenge has succeeded in fostering industry-wide awareness and a greater appreciation of the need to reduce energy use in commercial and private buildings. Many participating buildings are large downtown landmarks that are highly visible and influential components of the Chicago skyline. Since many of these landmark assets are looked to as leaders in the private sector real estate industry due to their size and history, their commitment to the pursuit of greater energy efficiency has important ripple effects on the rest of the citywide building stock. Typically, energy performance improvement at many buildings is frequently hidden from public view and competitor buildings. The Challenge, however, makes participants' accomplishments visible through recognition, best practice and case study sharing and networking events. In sharing the experiences and outcomes of the retrofitting journeys of frontrunners to other participants as well as the public, the Challenge is able to encourage other buildings to follow their lead. This is achieved by demonstrating empirically how investing in energy efficiency leads to important financial gains in the mid-term.

In addition, at the individual building level, the ability of management teams or owners to improve the energy performance of a building is enhanced through the capacity building measures of the Challenge. As well as providing knowledge from the experiences and best-practices of other Challenge participants, these include one-on-one technical consultations with city officials or Challenge partners. For example, the already described Energy Road Maps have been cited by many buildings as a critical enabler of energy reduction progress. Also significant, participation in the Challenge serves as an important opportunity for building owners and management teams to reach out to tenants for cooperation in reducing energy consumption, financing retrofitting, and sharing benefits. The Challenge offers extensive support in this area, thus contributing significantly to the improvement of tenant and owner/management relations around energy matters.

Market impacts

Meeting the 20% energy consumption reduction goal for the Challenge requires investment in retrofitting or other operational interventions such as

Credit: Marianao Mantel / www.flickr.com

retrocommissioning. This is explicitly outlined in the Challenge pledge, which requires that participants "start energy efficiency work within 6 months". Case studies on individual buildings show that, in addition to retrocommissioning to ensure that existing building systems run at high-efficiency, many buildings are carrying out retrofitting. Common installations include lighting (including occupancy sensors), boilers, chillers, fans, elevators and building automation systems for equipment scheduling and temperature setbacks. Also, the Challenge has assisted participants to leverage several millions of dollars in incentive funding from local energy utilities ComEd and Peoples Gas to support energy efficiency upgrades.

As well as increasing employment opportunities related to green construction, the above mentioned energy reductions are generating important savings in energy expenditures for participant buildings. Current financial savings from the above reported energy consumption reduction of 11.7% are estimated at around $6.4 million per year. Instead of flowing to energy utilities as monthly invoice payments, these savings (from both retrofitting and retrocommissioning) have been captured to finance retrofitting projects that also improve the market value and competitiveness of the building.

5. Lessons learned for replication

Strengths and drivers

Clear and meaningful, quantitative, mid-term goal

The goal of achieving a 20% reduction over five years drives the programme in two ways. First, it provides participants with a clear objective and time frame to pursue right from the beginning. Second, it encourages formation of mid- to long-term planning and meaningful investment strategies to meet the target, which would not be possible over a shorter time period.

Progress through capacity building

Sharing of best practices, both formally and informally, is a key driver of the programme. There is often a large knowledge gap associated when striving to make a building more energy efficient. Low awareness of the available low-risk and low-cost strategies for reducing energy consumption can prevent building owners and managers from pursuing improved performance. As experiences regarding successful measures or common pitfalls in improving energy efficiency have accumulated in the Challenge since 2012, this knowledge has become a common stock for all participants to draw upon. As mentioned, it is freely shared with other participants via means such as engineering roundtables, case studies, networking events and programme awards. This collective body of knowledge thus reduces uncertainty surrounding retrofitting whilst raising chances of success for late adopter buildings who can learn from the successes of frontrunner peers.

Commitment to controlled, continuous expansion

Since its initial implementation in 2012, the Challenge has adopted a snowballing strategy of recruiting new participants to expand the participant pool. As mentioned, it has quintupled in size—from an initial cohort of 14 large, office buildings—to a diverse community of 62 properties including hotels, universities, multifamily residences, a house of worship and cultural institutions. This cohort of buildings is one of the largest in the U.S. for a voluntary programme of this kind. This rapid expansion of the initial pool of participants has been achieved through word-of-mouth, ongoing outreach and public recognition of building accomplishments. Top-level and visible support for the programme from Chicago's Mayor is another key driving force. With each expansion of the participant base, a unique new set of building profiles, capacities to improve energy efficiency and expertise are integrated into the Challenge, expanding the shared pool of knowledge.

Challenges, limitations and countermeasures

Turnover in the real estate industry

A significant challenge encountered stems from instances where buildings are bought and sold during the Challenge participation period. Since the Challenge works directly with upper level building management and owners, a transition of ownership or management when buildings changes hands can result in continuity issues. Furthermore, a shift in ownership may also result in staffing changes in the building concerned. This can disrupt relationships and momentum towards investments and strategies for implementing energy efficiency improvements since energy efficiency or participation in the Challenge may not be prioritised by new owners or managers. So far, the programme has been able to overcome such obstacles by directly engaging with new ownership or management to inform them of the previous commitments and of any progress made so far. This however involves constant market monitoring and building re-engagement from Challenge coordinators and partners.

Representing Chicago's building stock

Although initial participation consisted mainly of Class A office spaces in the central business district, programme coordinators and partners have learned that it is a fallacy that energy efficiency opportunities apply only to a city's most visible and well-funded buildings. For this reason, recruitment efforts have since expanded to integrate a richer diversity of building types, sizes and sectors. This is to demonstrate that all nature of buildings can benefit from improved energy performance. This is evidenced by the most recent addition of 12 participants, which includes a church and a large, mission-driven organisation. However, achieving inclusivity is difficult, as differing types of buildings are characterised by differing levels of financial, organisational and technical limitations.

Limited resources

Although the Challenge does its best to leverage utility incentives that make retrofitting measures more affordable, cost nevertheless remains a significant barrier to many potential retrofitting opportunities. To date, the key approach to dealing with this problem has been to help participants understand the business case for taking energy efficiency action. The aforementioned Energy Road Maps, which highlight projected upfront costs, payback periods and returns on investment, are an excellent example of this. Additionally, the Challenge currently lacks a full-time team of coordinating and engineering staff and a dedicated budget. As such, it must rely heavily on pro-bono technical, financial and manpower support and donations from its various partners, as well as external grant funding. It follows therefore that additional resources (such as full-time, dedicated staff and funding) would allow for expanded technical support to guide building efforts and to recruit additional participants. This would also permit enhanced relationship and capacity building for participating buildings and also facilitate more engaged public communication through social, Internet and press media.

List of references

City of Chicago. Retrofit Chicago Energy Challenge. Official website. http://www.retrofitchicago.net Accessed 10 December 2016.

City of Chicago. 2012. Sustainable Chicago Action Agenda. Office of the Mayor. http://www.cityofchicago.org/content/dam/city/progs/env/SustainableChicago2015.pdf Accessed 25 January 2016.

City of Chicago. 2016. Mayor Emanuel Announces Third Expansion of the Retrofit Chicago Energy Challenge (press release). Office of the Mayor. http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2016/july/Retrofit-Chicago-Energy-Challenge.html Accessed 25 July 2016.

Natural Resources Defense Council. 2015. Retrofit Chicago Commercial Buildings Initiative Recognizes Energy Efficiency Leaders Across the City (press release). http://www.nrdc.org/media/2015/151021a.asp Accessed 25 January 2016.

Retrofit Chicago Commercial Buildings Initiative. 2014. Best Practices Report. http://www.retrofitchicago.net/our-media/entry/initiatives-best-practices-report-now-available Accessed 25 January 2016.

U.S. Department of Energy (DOE). 2010. Guide to Determining Climate Regions by County. http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf Accessed 25 January 2016.

Credit: Christopher Smith - Welshwitch36 / www.flickr.com

Case 3: London

London's Business Energy Challenge (BEC)

Abstract

This voluntary programme taps into the competitive disposition of private sector enterprises to drive reductions in energy use and CO_2 emissions in key London businesses. By rewarding outstanding achievements through Mayoral recognition and a diverse array of awards, London's Business Energy Challenge (BEC) aims to foster low-carbon business practices and building usage across a large range of industry types. Overall results from the programme are analysed to draw out key carbon intensity and energy consumption performance trends for each industry sector. Data will be used by the Greater London Authority to increase understanding of the energy intensity and carbon emissions of the local building stock. Feedback is also provided to businesses in the form of individual report cards on the carbon intensity performance of their buildings compared to peers.


Credit: DavideD'amico / www.flickr.com

1. Programme context

Citywide reduction target(s)

As described in the Mayor's Climate Change Mitigation and Energy Strategy of 2011, London set a citywide CO_2 emissions reduction target of 60% by 2025, relative to 1990 levels. London's Business Energy Challenge (BEC) aims to contribute to the delivery of this commitment.

Built environment context and programme background

The advancement of energy efficiency measures across London's building stock is hindered by a high diversity of individual building ages, structural characteristics and energy performance. This diversity makes it difficult to create standardised solutions citywide. This problem is worsened by a high building density that can complicate efforts to intervene on an individual building to carry out energy efficiency upgrades. In addition to these environmental difficulties, split-incentive dilemmas between tenants and building owners is commonly cited as another significant obstacle to increasing investment in energy efficiency measures. On the other hand, challenges to reducing energy consumption are somewhat lessened by London's mild climate and correspondingly lower heating demands relative to colder counterpart cities across Europe and North America.

Policies to ensure building owners undertake energy efficiency upgrades during scheduled refurbishments (i.e. maintenance measures to prolong building life and preserve or improve appearance and function) are also noticeably lacking in the U.K. The one major exception is large-scale refurbishments requiring building permits. These are subject to national and local building regulations and planning policy. There is also a lack of Mayoral and municipal powers to gather the necessary energy use data from private sector buildings to enable the monitoring of energy performance. Although there are national energy performance benchmarks for individual building types, the absence of local information on building energy use has hampered the development of energy efficiency standards specifically for London buildings. BEC attempts to address these challenges, by both generating London specific data on commercial building energy use and promoting efforts to reduce energy use and CO_2 emissions.

2. Programme overview

Overall goals and start year

BEC was first implemented in 2014 by the Mayor of London and is delivered by the Greater London Authority (GLA). It aims to foster commitment and a sense of competitiveness around energy efficiency and reducing carbon intensity among commercial properties in London. BEC was prompted by realisations that many businesses are making great efforts to reduce energy usage even in the absence of regulations. It provides mayoral recognition and public award ceremonies to those businesses that demonstrate outstanding improvements in carbon intensity over the course of a year in their London locations, as well as encourage other businesses to follow. The first award ceremony for the programme took place in November 2014, incorporating energy use data for 2010 and 2014.

The programme has not fixed any specific carbon intensity reduction goal for the coveted gold award for individual participants. The logic behind this was that any attempt to set a specific emission reductions target may have discouraged high performer businesses from achieving their true potential.

Programme target and scope

BEC targets businesses with either single or multiple locations in London. If a business has locations nationwide, only those in London will be considered. During its second year of running in 2015, BEC included entries from over 100 businesses. These represented 1,674 locations and a total floor area of 9,988,950 m^2. The majority of participants are owners, managers, or tenants of commercial retail and office spaces. However, large food stores, restaurants, hotels, banks and entertainment venues are also represented.

Energy efficiency progress is assessed by measuring the percentage change in carbon intensity (kg CO_2/m^2) over 365 calendar days against a standard baseline year of 2010/2011. Businesses have the option of reporting data based on either the respective calendar year or financial year (April 1st to March 31st). The choice of reporting timeline must be the same for both the baseline year and the reporting year. In the case where a business with multiple London properties chooses to participate, they must include those premises where gross internal floor area (GIFA) exceeds 500 m^2 (as measured according to Royal Institute of Chartered Surveyors standards). They are however also encouraged to include those premises falling below this threshold.

Two key reasons lie behind the decision to measure progress in energy efficiency through changes in carbon intensity (kg CO_2/m^2) rather than absolute emissions or energy use. First, by focusing on CO_2 emissions relative to gross internal area, the programme seeks to enable a fairer comparison between businesses and buildings of varying type, usage and size. This is by encouraging and recognising improved energy efficiency even in the case where a business might have expanded its operations and overall energy usage. Second, this metric was necessitated due to the absence of any energy efficiency benchmarks relative to building-specific industry averages across London. Without such information, it was deemed that it would be difficult to create fair and meaningful award categories if relying on overall emissions or energy use to appraise good performance.

Programme structure and function

The process of participating in BEC can be considered in five phases: 1) recruitment of businesses and verification of eligibility, 2) measuring and reporting of energy use and gross internal area data, 3) analysis and verification of reported data, 4) recognition of outstanding performance at an award ceremony and 5) provision of carbon-intensity report cards.

Recruitment of businesses takes place between June and July each year. Pre-existing databases within GLA are scanned to identify suitable businesses. During this process, much care is taken in selecting a cohort that will be representative of the diversity of building types and usages across London's building stock. Since business recruitment and engagement requires a large time commitment, a portion of this work is contracted to a specialised consulting firm. Once a business is selected, a letter is sent from the Mayor's Office directly to the company executives asking for their participation. Requiring a top-level commitment helps ensure prioritization of the programme within a business's operations. If a business expresses interest in participating, then begins the process of gathering the necessary energy consumption data and building profile information from all locations across London. Since gathering such information can prove time consuming and sometimes challenging, programme staff are available to respond to questions and assist participants with filing their application. This is primarily done via email and telephone calls.

If a business is determined eligible, they receive an Excel spreadsheet designed by BEC to facilitate the data reporting process and provide programme staff with information to assess the annual carbon intensity performance of a business. Spreadsheets are due to BEC via email by a September 30th deadline. To help ensure data reliability, spreadsheets must also be accompanied by a document stating that self-reported data has properly adhered to the terms and conditions of the programme. This must be signed by a senior member of staff in the participating business.

At this point, programme staff with assistance from a contracted consulting firm begin verifying submitted data. Common discrepancies include incorrect entries for GIFA, energy use amount or energy generation source. In the event that suspected data errors are identified, concerned businesses are contacted by programme officials.

All buildings must submit data for participation in a general award category referred to as the "main award." In addition, there are other categories or "special awards"

Credit: Davide D'Amico / www.flickr.com

that may or may not require submission of additional information. Details regarding submissions required for special awards are described in Table 1.
For the main award, businesses are ranked relative to one another based on the quantity of carbon intensity reduction from the baseline year:

- **Gold** – Awarded to the 10% of businesses attaining the greatest percent reduction in carbon intensity
- **Silver** – Awarded to the following 15% of businesses
- **Bronze** – Awarded to the following 20% of businesses
- **Recognition of participation** – Awarded to remaining businesses

The BEC award ceremony takes place each year in late November. Businesses earning the Gold award or any special award category (see Table 1) are able to receive recognition and accept trophies directly from the Mayor of London (or the Deputy Mayor for Environment and Energy if unavailable). In addition to the special awards, BEC invites businesses to share information on their energy efficiency projects in the form of case studies. These are prepared on a voluntary basis only and distributed at the awards ceremony to promote shared learning and acquisition of best practices for reducing energy consumption.

Table 1: **List of special award categories**

Award category	Description	Additional materials or data required
Sector leader	Sector specific performance using the same metrics as the main award. Considers finance and insurance, manufacturing, retail, accommodation and/or food service and entertainment locations.	No
Novel climber	Considers first year participants only. Uses same metrics as main awards.	No
Climber of the year	For businesses that participated in 2013/2014. Calculates % reduction in carbon intensity relative to 2013/2014 instead of 2010/2011.	May be required
Large portfolio climber	Considers businesses that have over 30 locations in London. Based on same metrics as the main award.	No
Climber of the decade	Uses 2005/2006 baseline to show cumulative energy performance in the decade leading to the present.	Yes
Courageous climber	Considers businesses that allow the GLA to publish their data in the public domain. Requires written permission from company director.	Yes
Team climb	Recognises collaborations between energy managers and landlords/tenants/managing agents/facility managers that have contributed to energy efficiency since 2010/2011.	Yes
Climbing crew	Considers carbon intensity reductions per staff member.	Yes
Small and micro business	Considers businesses with fewer than 50 employees.	Yes

As a final means of assisting London businesses on their paths towards greater energy efficiency and reduced carbon emissions, participants are now provided with individual carbon report cards. These give a snapshot of how the individual carbon intensity performance of an individual business compares with peers in the same category of business type.

Data collection and utilisation

BEC relies on self-reported data from businesses and does not mandate any third-party verification. However, the programme officers examine the data and further evidence is requested from many businesses to ensure the data is correct. As mentioned, quantitative and qualitative data is compiled into a purpose-designed Excel spreadsheet. BEC experiences have shown that businesses can spend a large amount of time and resources gathering information for the various fields in this spreadsheet. Since resources are limited in participating businesses, the more time spent on reporting and submission of information, the less time is available for actually implementing energy and carbon saving projects. In designing the spreadsheet, programme officers have therefore had to balance needs to minimise the effort required for reporting, whilst at the same time, still allowing the gathering of a meaningful breadth and depth of information. The below sections outline the required reporting metrics along with the appropriate data sources and measurement methods.

Basic building information is collected in areas such as:

- Type of energy control and metering
- Gross internal floor area (GIFA), typically excluding outdoor areas
- Number of employees
- Length of time occupied
- Property use
- Measures to reduce energy consumption (optional)

Businesses enter information for main sources of energy:

- Grid electricity used (kWh)
- Mains gas used (kWh)

These sources of energy can be measured using the following data sources:

- Bills or actual meter readings
- Calculation based on delivery of measured volumes over a period of 335-365 days
- Bills that include at least two actual readings 335-365 days apart
- Automatic meter readings
- Manual meter readings that are quality controlled

Additionally, energy use from other sources can also be included:

- Photovoltaics (MWh)
- Wind power (MWh)
- Other zero carbon electricity generation (MWh)
- Gas oil (litres)
- Fuel oil (tonnes)
- Diesel (litres)
- Coal (tonnes)
- Wood pellets (tonnes)
- Solar thermal (MWh)

Once data on GIFA and all energy sources has been added, the spreadsheet automatically calculates carbon intensity by applying national emissions intensity factors. The ensuing carbon intensity results are also displayed automatically in a graph. This feature of the spreadsheet was included so that businesses gain an immediate overview of performance as a benefit from entering their data. As part of participation, businesses agree to allow their data to be sent anonymously to third parties to inform research and policies regarding building energy efficiency and carbon reduction in London. The main output from this data collection is a benchmarking report prepared by the Bartlett School of Environment, Energy and Resources at University College London (2015). This report serves as the first effort to create specific energy efficiency benchmarks for commercial properties in London. To date, this analysis has successfully begun the process of comparing energy use across different building types, as well as comparing energy use of BEC participants to current national efficiency benchmarks.

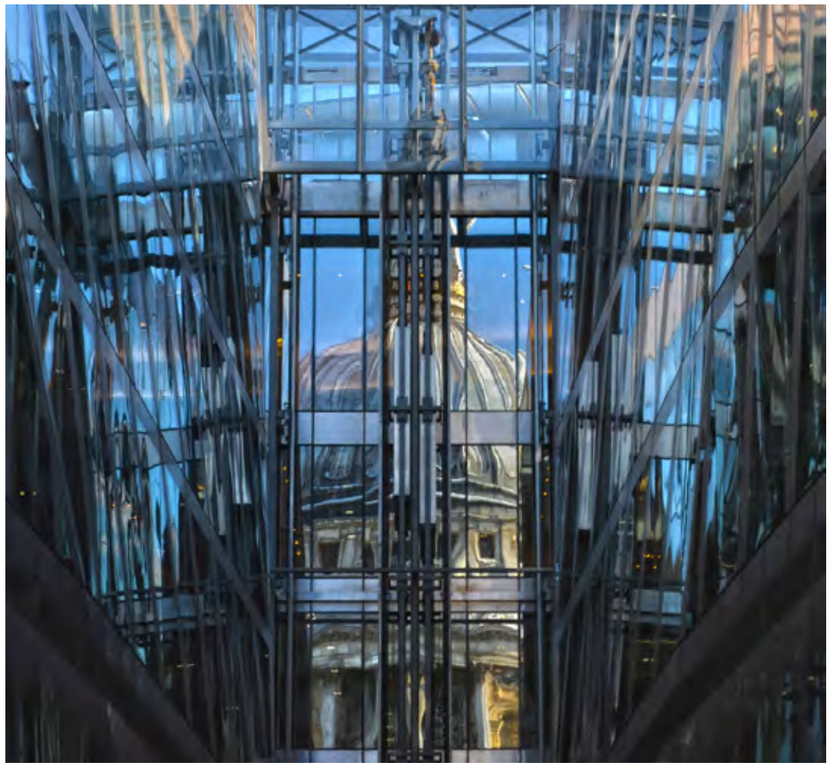
Innovative features

BEC has demonstrated much innovation in the design of award categories. Although the common yardstick for all categories is CO_2 emissions relative to floor area, a wide variety of special awards is able to recognise a multitude of different achievements. For example, the sector leader rewards outstanding performance relative to other peer buildings of the same type, the novel climber recognises and encourages newcomers to participate and the climber of the decade encourages long-term commitment to energy efficiency. This diversity of awards is also able to appeal to contrasting motivations, strengths and temporal areas of interest in differing businesses. Additionally, by measuring carbon intensity reductions rather than absolute emissions or energy use, the programme is able to encourage business sector efforts to reduce energy consumption while still expanding operations.

In addition, BEC's explicit focus on annual CO_2 emission intensity rather than energy use intensity (as is common in benchmarking programmes in the USA) is noteworthy. Consequently, the challenge has the potential to foster a sense of solidarity in the business community around the need to reduce CO_2 emissions—not just for the sake of reducing running expenses, but also to contribute to wider efforts to mitigate climate change.

Incentive and support mechanisms

An important incentive for participating businesses is the prospect of receiving public recognition from GLA officials and the Mayor of London for outstanding improvements in carbon intensity. Also important is the possibility of using participation or awards gained from BEC as a publicity improvement tool for demonstrating commitment to sustainability, climate change and energy efficiency. For example, businesses winning awards are listed on the official Mayor of London website. Businesses are also able to feature their involvement with BEC in corporate sustainability or CSR reports. Some also communicate to the public about mayoral recognition received by making their own press



Credit: Jean Marc / www.flickr.com

releases or displaying awards on business premises. A further incentive for participation concerns the analysis of aggregate results. For example, the benchmarking report produced by University College London offers businesses the opportunity to compare their performance to peers and other commercial building types. This information can be used by frontrunner businesses to make further improvements, allowing them to be first-movers on energy efficiency.

Links to other city policies or programmes

The programme is not directly associated with any other policies or programs. However, data collection and reporting requirements were designed to resemble closely those already present in the mandatory national Carbon Reduction Commitment programme, as well as the voluntary Display Energy Certificates programme.

3. Design and implementation

Design phase

Inputs

Programme design was led by GLA in 2014. This involved one full-time equivalent (FTE) over one year. With assistance and support from C40 (which provided a secondment), GLA convened a group of stakeholders including private sector businesses to discuss what was required to foster energy efficiency improvements in the commercial building stock. From this emerged the shared view that recognising the achievements of high performers would be an important step forward in advancing energy efficiency in the commercial building sector. There was no budget devoted to the design phase of the programme.

Timeline

Design of BEC began in early 2014 and concluded with recruitment of first year participants.

Implementation phase

Inputs

Implementation is headed by one FTE from GLA. This is supplemented by consultancy support of one FTE for around three months during the most active phases of data submission each year. BEC is provided an annual budget of GBP 70,000. Half of this amount is spent conducting outreach to potential participants and auditing reported data. Smaller portions are used for staff time, award ceremony and communications costs and the production of case studies. The programme benchmarking report (UCL, 2015) is compiled at no charge by University College London.

Timeline

Business recruitment and engagement typically begins in June or July. Data must be reported by September 30, with the awards ceremony taking place in late November. The programme has completed two implementation cycles, for reporting years in 2014 and 2015.

Key collaborations

In light of limited human and financial resources, several key collaborations have been forged with the academic and private sector. As mentioned, University College London has played a major role by creating the benchmarking report on an entirely voluntary basis. This report analyses aggregate results from the

base and challenge year and identifies possible energy benchmarks for differing building types. Private sector consultants have also played a key role in business engagement and data analysis tasks.

Compromising/adjustments

One notable change occurring since the initial implementation of BEC involves data reporting methods. In the first year of implementation, an online tool was used for data collection and business eligibility verification. Yet this system proved too complicated and cumbersome. This prompted programme staff to create a more streamlined process of data submission. Development of the aforementioned Excel spreadsheet allows businesses to input the required data directly, bypassing the previous online platform. In addition, a key modification envisaged for the future is the creation of an energy use report card for participants. It is likely that these will incorporate the newly available information from the benchmarking report to indicate a business's performance relative to average carbon intensity for that building type. In addition to these modifications, at the end of the 2014 programme year, BEC officials collected input from participants via a voluntary survey. This helps identify any changes that may be desirable or required.

4. Outcomes and impacts

Environmental

BEC achieved a marked decrease in CO_2 emissions for its two challenge years. In 2014, total emission reductions achieved by all participating businesses amounted to 80,000 t-CO_2 relative to the 2010/11 baseline year. This figure increased during the 2015 challenge year, which saw a total reduction of 188,000 t-CO_2 relative to the same baseline. This represents a CO_2 reduction of just over 10% in the second year.

Social

The social impacts of BEC are highly significant. By participating in the programme, businesses are led to see the impact of their operations on citywide carbon emissions. Some businesses are expressing that before participating in the challenge, their energy use was mostly unknown. Programme participation, however, has created the previously non-existing incentive for businesses to measure energy consumption and carbon emissions. Data collected through the programme also has high importance for policy makers. As mentioned earlier, the absence of information about the London building stock and average energy use for certain building types is a major hampering factor for efforts to spur greater engagement to energy efficiency in the commercial sector. The programme is filling this information gap for policy makers. Annual results will lay the first and important foundations for future industry benchmarks specifically designed to indicate low or high energy performance in commercial buildings in London.

Market

Market impacts are yet to be formally examined by BEC officials. However limited anecdotal evidence compiled into case studies on top performing buildings indicates that some businesses are undertaking measures to reduce carbon emissions. These include contracts with external consultants to improve building energy management and retrocommission existing building equipment and implementation of upgrades to lighting, boilers, chillers and so on. Such evidence comes from direct communications with businesses as well as from optional provision of information about measures to reduce energy consumption. However linking such outcomes to BEC is problematic since retrofitting activities in many cases take place before and after programme participation. On another note, since BEC targets commercial and tenanted properties, there is high interest for programme officials in examining any green premiums that may be associated with improved energy efficiency ensuing programme participation.

5. Lessons learned for replication

Strengths and drivers

Array of awards encourages wide participation

Multiple award categories serve to provide opportunities for a wide variety of businesses to demonstrate a commitment to, and receive recognition for, improving energy efficiency and reducing carbon emissions. This is particularly important for businesses with operating profiles or other circumstances that make them uncompetitive for the main award (gold, silver and bronze level businesses). By including the more specialised and targeted awards (see **Table 1**), BEC becomes more inclusive and more impactful by appealing to the contrasting strengths and interests of diverse participants and building profiles.

Diversity of business types increases data value

As highlighted, a defining feature of BEC is the diversity of building types and businesses represented. These range from office buildings and shopping facilities to entertainment venues, storage facilities and cultural facilities. From a data collection point of view this is important. A diverse representation of building types has given an important first glimpse into average energy efficiency and CO_2 emission performance of certain commercial building types in London. As mentioned, this has laid the first steps to creating an array of industry-specific benchmarks for other same-type businesses to follow and measure performance against.

Mandatory high-level commitment in participants

Participation in the programme requires formal acknowledgement from company directors or other high-level management such as the CEO. In addition, senior management is required to sign off on data submitted to the programme. This strategy is a clear strength. On one hand, it encourages top-level support for various efforts within that organisation to decrease energy consumption. On the other hand, it allows for top-down delegation of energy conservation responsibilities, also creating the opportunity to introduce changes in energy use practices uniformly across all London locations.

Mayoral support

The Mayor of London serves as official endorsement of the programme, also attending the awards ceremony to personally congratulate businesses. The prospect of meeting and earning direct recognition from the Mayor is a rare opportunity for many businesses. This thereby serves as an important factor in enticing private sector support and participation in the programme.

Regional recognition

Many participants are national or international businesses. Many of these recognise and highlight the participation of their London locations within the larger company, and look to them as examples. This will encourage businesses to make efforts elsewhere and help drive the conversation about energy efficiency on a larger scale.

Challenges, limitations and countermeasures

Balancing data depth with business time restrictions

Requesting voluntary submission of data for the programme involves a fine balancing act. On one hand, a certain level of detailed data on building energy use is essential if policy makers are to build an in-depth understanding of energy efficiency and carbon emissions in the various commercial building types in London. On the other hand however, participating businesses are often unable to devote large staff resources to data collection and reporting, and additionally, energy use issues can often prove technical for non-experts. To address this, BEC has had to make adjustments to ensure a streamlined and burden free reporting process. As mentioned, a key step in overcoming this involved the transition from a complex web-based reporting platform to a simpler Excel reporting sheet (*see Data collection and utilisation*).

Designing meaningful awards

Providing meaningful categories of recognition for high performers has proved highly challenging in designing the programme. There is a very large number of energy efficiency measures that may be impactful in the commercial sector.

Credit: Angelbattle bros / www.flickr.com

Yet providing too many award opportunities risks diluting the importance and prestige of the achievement. Again, this is a balancing act that has demanded constant adjustment. Designing the portfolio of award categories is particularly difficult when considering the diversity of circumstances and building profiles among the participating commercial properties in London. The number and type of awards must be reassessed at the beginning of each new programme year, with removal of awards, or design of new awards always being possible.

List of references

Greater London Authority (GLA). 2011. *Delivering London's Energy Future: The Mayor's Draft Climate Change Mitigation and Energy Strategy*. https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Energy-future-oct11.pdf Accessed 11 March 2016.

Greater London Authority (GLA). 2016. *Business Energy Challenge – 2015 Winners*. https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Energy-future-oct11.pdf Accessed 23 March 2016.

University College London (UCL). 2015. *Mayor of London Business Energy Challenge 2014 Data Analysis*. Bartlett School of Environment, Energy, and Resources. https://www.london.gov.uk/sites/default/files/bec_building_energy_benchmarks_2014.pdf Accessed 23 November 2016.

Credit: Nathan O'Nions / www.flickr.com

Credit: Ronald Woan - Júbilo Haku - Haceme un 14 / www.flickr.com

Case 4: Mexico City

Sustainable Buildings Certification Programme

Abstract

Mexico City's Sustainable Buildings Certification Programme (SBCP) offers the owners or tenants of commercial, residential and industrial buildings an opportunity to reduce and demonstrate the environmental impact of their properties across a broad range of categories. By requiring multiple actions covering energy, water, waste, transport and social and environmental responsibility, SBCP promotes a holistic view of sustainability in the building industry. Participation from owners and tenants is incentivised through tax reductions, reduced energy and water bills, access to project financing, expedited permitting procedures, and finally, prospects of increased rental yields from green premiums.

Credit: Enrique Abe / Courtesy Mexico City Ministry of the Environment, 2017

1. Programme context

Citywide reduction target(s)

Mexico City aims to reduce GHG emissions 50% by 2050 compared to 2000 levels.

Built environment context and programme background

Though Mexico City is fortunate to have a mild climate across the year, energy use in commercial and industrial buildings accounts for around 30% of citywide carbon emissions. Driven by a rapidly growing population across Mexico, the capital Mexico City is currently experiencing a rapid increase in construction, especially the residential sector. However, as more and more buildings are added to the capital each year, historical construction codes did not take into account energy efficiency. This has recently been tackled when Mexico City's Environmental Ministry recently unveiled in June 2016 updated building codes for both retrofitting and new construction. Targeting commercial, industrial and residential buildings, these lay out Complementary Technical Standards to provide guidance for energy efficiency performance of insulation, solar-powered water heaters, lighting, window glazing and building envelopes. They also address mechanical systems such as elevators, elevators and water pumps and water efficiency such as water saving faucets and showers.

This said, the existing building stock is today dominated by buildings with poor energy efficiency. Policymaker efforts to promote retrofitting of this existing building sector must contend with a host of challenges. In addition to high capital costs, long-term visions and investment strategies are generally lacking in the market place due to priorities in generating fast and high revenue at the lowest possible cost. There is also a lack of attractive local government incentives and financing options for private sector owners considering upgrading properties. Furthermore, there is a general lack of transparency in the market place regarding the energy efficiency of individual buildings. Although international building certifications such as LEED are present across Mexico, there is generally little financial incentive to encourage building owners to make the necessary investments for obtaining certification.

The Sustainable Buildings Certification Programme (SBCP), which grew out of Mexico City's First Climate Action Programme, is a first and major step towards tackling this set of challenges in the building sector.

2. Programme overview

Overall goals and start year

SBCP began operation in 2009. It aims to foster sustainable construction and building usage by awarding certifications that reflect various levels of sustainability performance. It targets both new and existing buildings in the commercial, industrial and residential (mostly multi-family) sector. Evaluation of building sustainability performance is holistic, taking into account a wide variety of categories and improvement actions. In addition to energy, it also assesses and awards varying levels of performance for water, mobility, solid waste, social and environmental responsibility and green roofs. Voluntary certifications issued through the programme are a first step towards the long-term goal of developing more stringent voluntary and mandatory building codes that integrate environmental performance and energy efficiency.

Programme target and scope

Both building owners and tenants may obtain certification through the programme. For commercial or industrial buildings, certifications can therefore be awarded to entire buildings or the portion of tenant occupied space. In the case of a multi-family building, in principle, certification and retrofitting actions apply to the entire property—both common and private areas. Since in reality this proves difficult due to financial restraints or lack of tenant cooperation, most multi-family certifications are confined to common areas such as entrances, outdoor spaces and corridors etc.

To date, 65 buildings or tenanted portions have been certified. These total 2.2 million m^2 of Gross Floor Area (GFA). Commercial properties account for 45 of these, with the remaining 20 being residential. A further 20 properties (predominantly multi-family residential) are in the process of obtaining certification. Of the 85 total buildings that are either certified or in the process, new construction makes up approximately 25%, with the remaining 75% consisting of existing buildings. The programme currently holds ambitions of expanding coverage to government buildings.

Programme structure and function

For existing buildings, enrolling in the programme firstly requires performing an audit. SBCP participants are responsible for costs associated with this step. Audits are carried out by third party organisations referred to as “implementing agents”. These have received training from Mexico City´s Ministry of the Environment. This ensures that techniques for measuring building sustainability are standardised. Since certification auditing addresses multiple sustainability areas in addition to energy efficiency, it can sometimes involve a team, with each member possessing differing expertise.

Table 1: **Stages of the certification process**

Step	Description
1. Registration	Building owner or tenant chooses an implementing agent to register their property with the Ministry of the Environment.
2. Audit	Implementing agent inspects buildings plans or conducts a physical assessment (audit) of existing building components. Documentation is reviewed to identify compliance with national and local energy efficiency standards. For existing buildings, energy and water invoices for the previous year are reviewed to establish baselines and for new buildings, energy and water consumption estimated.
3. Diagnostic report and implementation plan	If required, implementing agent creates an implementation plan to conduct any measures needed to solve any non-compliance issues or increase performance in the various sustainability categories.
4. Execute implementation plan	If required, building owner or tenant executes implementation plan under supervision of the implementing agent.
5. Evaluation assessment	Upon successful completion of implementation plan, the agent submits a certification request to the Ministry of the Environment.
6. Certification awarded	The Ministry of the Environment issues the Sustainable Building Certificate according to three levels for residential (compliance, efficiency and excellence) and two for commercial (compliance or excellence).
7. Follow up audit	Both new and existing buildings are subject to a follow-up audit every two years after certification to measure actual environmental performance and ensure continued compliance.

Credit: Enrique Abe / Courtesy: Mexico City Ministry of the Environment, 2016

An overview of the certification process is as follows, with further details provided in Table 1. First, a building owner or tenant selects an implementing agent from a list of certified organisations. The implementing agent then files a building registration report with the Mexico City´s Ministry of the Environment. The agent or agents then conduct an audit of the building, evaluating performance from six sustainability areas (each is elaborated further below): (1) energy, (2) water (3) mobility, (4) solid waste, (5) social and environmental responsibility and (6) green roofs. After initial evaluation, a diagnostic report is then lodged. Agents will identify for building owners or tenants opportunities to invest in building upgrades to gain a higher certification level. If adopted, building improvements are then carried out. Once a building has obtained its final evaluation from auditors, an appropriate level of certification is determined and awarded by the Ministry of the Environment. Follow up audits are then carried out each two years after the certification is issued to ensure continued compliance with environmental laws and verify actual energy and water savings achieved.

Commercial buildings may qualify for two levels of certification: compliance or excellence. In general, compliance requires meeting various federal and local laws regarding areas such as energy efficiency standards for lighting and electromechanical systems, water and solid waste management. In addition, buildings are required to demonstrate performance in additional areas such as mobility and social and environmental responsibility. In addition to these basic prerequisites, if a building meets more stringent international standards (if taking the case of energy) such as LEED, Energy Star or FIDE (Mexican), it may qualify for an excellence level. In contrast, residential buildings (predominantly consisting of multi-family) may obtain three levels of certification: compliance, efficiency and excellence. These varying levels are determined using a points system. Points are accumulated by satisfying a higher number of requirements or actions across the six performance categories.

- Compliance 21 – 50 points
- Efficiency 51 – 80 points
- Excellence 81 – 100 points

The following paragraphs provide a more detailed overview of some key areas covered in each of the six sustainability categories, for both commercial and residential buildings. For reference, the total quantity of points that can be collected by residential buildings is included.

Energy (up to 25 total points)

Up to 25 points are awarded based on a building's compliance with National Energy Efficiency Standards (Norma Oficial Mexicana - NOM). Buildings that meet the standards set forth in both NOM-14 "Energy efficiency in lighting systems" and NOM-8 "Energy efficiency in non-residential buildings" will be awarded the full 25 points. Two additional points may be obtained by installing photovoltaic cells, and a further seven for installation of solar water heating systems. Awarding of these additional points is based on the generation capacity of installed systems relative to the quantity of energy or grid electricity consumption that is substituted.

Water (up to 25 total points)

This category awards points for installation of rainwater collection systems, grey water treatment, water saving equipment in toilets and showers and treatment of plumbing leaks.

Mobility (up to 14 total points)

Properties may obtain points for implementing actions to foster use of public transport, car sharing, private shuttles and bicycles, in addition to increasing accessibility for disabled people etc. In practice, this means providing shared transportation for employees and residents (i.e. privately contracted bus shuttles), bicycle parking facilities and measures to encourage carpooling. Also, entry bays allowing employees to board or alight from private vehicles or taxies (so as to avoid creating traffic jams) are also considered.

Solid waste (up to 17 total points)

Points are awarded for performing waste separation and recovery of recyclables, having adequate infrastructure for temporary storage of solid waste and for having whole property waste management planning.

Social and environmental responsibility (up to 25 total points)

Points are also given for effective management of noise pollution (such as installing double planed glass), encouraging social action (such as making or maintaining green areas and public gardens around the property), bioclimatic design (i.e. exploiting natural sunlight, warmth and vegetation for cooling/heating), periodical building maintenance practices, access to safe and convenient offsite parking structures and providing reasonable comfort to workers.

Green roofs (up to 8 total points)

A building may obtain points if converting a percentage of roof area into green space. A roof with 40% coverage will be given three points, 85% coverage six points and 100% coverage eight points. This percentage is calculated based only on those areas which can be feasibly turned into green space. This green roof option falls under the category of social and environmental responsibility.

The evaluation process can take anywhere from six months to two years, depending on the building size and number of building improvement measures implemented. Commercial building tenant participants are only responsible for meeting programme criteria within their rented space, with common areas excluded. However, tenants and building owners are encouraged to work together to obtain certification for the entire building. For existing buildings, environmental performance such as energy and water consumption is measured onsite by auditing key building components and inspecting utility invoices. For new properties, engineers and architects meet with programme representatives before construction begins. This allows construction plans to be created in alignment with the sustainability criteria developed for the programme.

When awarded, buildings have the option of publically displaying the certification on the property, as well as highlighting the achievement in advertisements and other promotional materials. The Ministry of the Environment requires no application fee for the certification process. City officials may also publicly disclose a building's certification after permission from the property owner. Importantly, in the event where a building requires significant investments to bring it up to a certifiable standard, owners or tenants have the option of spacing the certification process and compliance period over several years. This allows a building to address one criteria at a time and receive feedback throughout the process of certification.

Data collection and utilisation:

Data collection is limited to that used to determine a building's level of performance in each of the performance categories, and the accompanying audits conducted every two years thereafter. For existing buildings, baselines for energy efficiency and water consumption performance are created by auditing equipment and utility invoices. In the case of a new building, energy and water savings are projected based on comparisons with a traditional construction of the same characteristics. Actual performance is then measured in follow up audits. These are also required for existing buildings to demonstrate continued compliance with environmental regulations.

Innovative features

Engagement of owners and tenants

SBCP's innovation lies in its flexibility. As explained, it allows certification for both building owners (i.e. the whole building) and for tenants (i.e. leased portions of buildings). For commercial buildings, removing the need to obtain certification for a whole building allows tenants in poorly performing properties to improve the sustainability of their section, and then receive public recognition and financial benefits for this. On the other hand, for multi-family buildings, the programme encourages owners to purse building-wide certification, inclusive of private living areas. Although this has only been achieved once for existing buildings, several new construction projects currently in the process of certification have invested in energy and water saving measures in tenant living quarters.

Holistic certification criteria

Creation of a custom-made sustainability certification scheme for buildings is an uncommon approach for a city government. Admittedly, other green building certification programmes such as LEED also score buildings on a holistic series of sustainability criteria. Yet the comprehensiveness of areas assessed by SBCP is nevertheless remarkable. As indicated above, performance categories and indicators range extend from building design and materials (i.e. building energy, water systems and green roofs) to building usage (i.e. waste) and sustainability measures impacting employees (i.e. sustainable transport options etc.) and improve the local community.

Incentive and support mechanisms

Reductions of property taxes and payroll taxes serve as an important factor incentivising building owners and commercial or industrial tenants to seek certification. Importantly, tax reductions are designed to incentivise higher levels of ambition. As shown in Table 2, they offer increasing discounts for higher levels of savings in energy and water consumption from baselines. To obtain the corresponding tax discount amount, buildings are only required to achieve the corresponding level of savings in either water or energy consumption, relative to baselines.

Table 2: **Corresponding tax reductions for energy or water savings**

Discount amount	Savings level
Property tax reduction	
10%	30 to 39%
15%	40 to 49%
20%	50 to 100%
Payroll tax reduction	
20%	30 to 44%
30%	45 to 59%
40%	60 to 100%

Building owners are also financially incentivised to participate by the prospect of receiving a green premium on rental prices. As a further coaxing measure, participants are entered into a list made available to international or domestic corporations looking for office space or industrial facilities in Mexico City (this list is not disclosed publicly and is available upon request). Often, these companies are searching for space in green buildings to align with their sustainability policies. Certification in the programme thereby allows participants to access these potential new tenants, some of whom are willing to pay a premium for green building rental.

Other benefits too ensure program participation. Certified participants may gain assistance in applying to financial schemes with attractive interest rates to cover the costs of building upgrades from local and international development institutions. This is a particularly important driver amongst capital-intensive and extensive retrofitting and upgrade projects for larger buildings. Although this funding programme is open to non-SBCP buildings, certified buildings enjoy expedited processing of applications when applying. Finally, both new construction and existing participants can benefit from expedited processing of construction permitting and environmental impact assessment phases during building planning.

Credit: Enrique Abe / Courtesy: Mexico City Ministry of the Environment, 2016

Links to other city policies or programmes

SBCP was designed as part of Mexico City's first Climate Action Programme. This was developed in 2008 and mostly concerned itself with short-term climate goals reaching through the year 2012. The programme exceeded its initial emissions reduction goals by 10%, resulted in a 7.7 million-tonne reduction in CO_2 equivalent (henceforth CO_2e) emissions for 2008-2012. After this initial success, in 2014 the Climate Action Programme was updated to produce Mexico City's second Climate Action Plan. This laid out goals for the 2014-2020 period. Although SBCP has continually operated independently of the Climate Action Programme, it can be thought of as promoting the voluntary climate leadership portion of city climate goals. The SBCP's sustainability criteria are also designed to align with current national construction and energy efficiency standards, as well as environmental impact assessment requirements for new construction. These standards are created by the Federal Ministry of Economy.

3. Design and implementation

Design phase

Inputs

Certification criteria and methods were created though collaboration between city officials and technical experts from universities, government and the building industry. These experts possessed experience in the various performance areas covered by the certification criteria. The city devoted two full-time staff members to the design of the programme. An additional ten other staff members also offered support in convening stakeholders and planning. The design of the programme was included in the programme budget of the Mexico City Environmental Ministry.

Timeline

Design of SBCP took place during the period 2008-2009.

Implementation phase

Inputs

Two full-time staff members are charged with implementation. Given that actual auditing of participating buildings is conducted by third party technicians, this small number of staff suffices for implementation. In addition to outreach, staff duties include training and certification of third-party certifying auditors. There is no dedicated budget for marketing or communications.

Early in the programme, staff needed to recruit participants. This was accomplished by screening building permit applications for new construction and retrofitting of commercial and residential properties and industrial facilities in Mexico City. As judged from the engineering plans, programme officials reached out to those projects demonstrating the highest potential for energy savings and sustainability improvements. Since the programme has no devoted budget for marketing, recruitment relies heavily on word of mouth, with technical experts involved in the certification process speaking directly to prospective new participants. City officials are invited to speak about SBCP at conferences, universities and key building industry bodies such as the Mexican Chamber of Construction Industry. As awareness of the programme and its incentives has spread, participants now mostly seek to enroll on their own, nullifying the need for recruiting.

Timeline

Implementation of the program began in 2009 and is scheduled to continue indefinitely.

Key collaborations

SBCP forms an important relationship with the companies of Mexico City that offer technical expertise relating to environmental sustainability in building construction and operations. As mentioned, programme implementation relies heavily on third-party technicians. These implementing agent audit buildings, appraise sustainability performance, identify improvement opportunities and supervise the overall certification process. The city provides training resources for these professionals to earn a credential as an official implementing agent, thus allowing them to perform energy audits for the programme. This credential then provides the auditors with a new opportunity to win contracts.

Programme changes and adaptations

Since its inception, SBCP has expanded the scope of sustainability criteria considered in the certification process. When the program was first launched in 2009, performance criteria was limited to energy and water use and solid waste disposal. These criteria were expanded in 2013 to include mobility, green roofs and social responsibility. Particularly those criteria associated with energy efficiency, were designed to drive continued improvements in certified buildings in accord with new technology developments. The addition of mobility and green roofs was added to encourage facilities with sustainable transport, reduce air pollution and to mitigate the urban heat island.

4. Outcomes and impacts

Environmental impacts

Compared to the base year 2009, for the 40 buildings certified as of 2015, the programme has achieved a total reduction of 20.1 million kWh of electricity and 66,120 tonnes of CO_2e.For existing buildings with baselines, these represent actual savings. For new buildings with no baseline, these figures represent estimate savings from a business as usual building design. As mentioned earlier, Mexico City's initial Climate Action Programme—from which SBCP was originally derived—achieved a 7.7 million tonne reduction in CO_2e for 2008-2012. A total of 834,529 tonnes of this came from energy efficiency improvements in the building stock and other sectors such as transport. Although this achievement cannot be singularly attributed to the SBCP, nevertheless, the programme carried out an important contribution to this amount. On top of energy savings impacts, the 40 certified buildings in 2015 have also achieved a savings of 205,690 m^3 of potable water. This is an important outcome in water scarce Mexico City.

Market impacts

Based on anecdotal evidence, officials report that owners of certified buildings can expect a green premium of around 20% for office rentals. These premiums, along with substantial property and payroll tax credit incentives, are generating important economic benefits for participants. These benefits work in concert to reduce financial risks for building owners when carrying out sustainability improvement measures. Certification also adds a degree of predictability to building operational costs. This is because quantifying efficiency performance allows for more accurate calculation of expenditures on energy and water. Additionally, through training and hiring technicians to oversee the auditing and certifying of participating buildings, SBCP has directly created 68 new jobs. As a further market impact, it is anticipated that certification would lead to increases in property values. Such impacts are not measured directly however.

Social impacts

Social outcomes of SBCP are significant. Firstly, since private sector building codes in Mexico City have not previously addressed energy efficiency and environmental performance, the programme fills a regulatory void. It brings owners, engineers and tenants in new construction projects or existing buildings to voluntarily integrate sustainability principles and environmental performance into building design and maintenance. Secondly, certifications (showing grades of either Compliance, Efficiency or Excellence) supply the market and public with a clear indication of the sustainability performance of a building or tenanted section. These are based on diverse, objective and quantitative information that was previously non-existent. This newly created information allows both potential building buyers and tenants to scrutinize and choose properties based on their environmental performance. Thirdly, SBCP has also contributed to increased awareness regarding building sustainability in both key stakeholders in the building industry as well as the general public. This is by the process of certification and ensuing certifications serving as an educational opportunity for both building users and management. Finally, by allowing tenanted sections to pursue certification, SBCP is fostering improved cooperation between building owners and tenants. These improved relations lead to sustainability performance gains for both building components and management, which can then create good publicity for the firm and building.

5. Lessons learned for replication

Strengths and drivers

Ability to foster retrofitting and improved building design

A major strength of SBCP's certification approach is its ability to foster physical improvements in building shells, equipment and systems that improve environmental sustainability and reduce fossil fuel consumption. For existing buildings, this occurs through retrofitting and upgrading building systems to more efficient technologies, or additionally, by installing additional components such as green roofs and solar PV systems. For new buildings, project developers consult the criteria of the certification during the design phase to bring the building into alignment with sustainability goals. A further driver of environmental impacts comes from various levels of certification. The prospect of receiving a higher certification level can incite building owners and engineers to invest further in raising sustainability performance. As already explained, higher certification levels generate higher property tax and payroll tax reductions.

Promotion of renewable energy and targeted technologies

Another programme strength lies in the role that certifications play in diffusing specific, sustainable building and renewable energy technologies. As explained, the energy efficiency component of the certification highlights the installation of photovoltaic electricity generation and hot water systems as a means of gaining extra points. This is serving to directly promote increased renewable energy capacity in Mexico City. Additional technologies promoted include high performance lighting, window glazing and water pumps, water saving devices in toilets, water taps and showers and electric power control sensors. For building shells, certification encourages use of natural ventilation and measures to mitigate urban heat island effects such as white or green roofs, and white interiors and exteriors.

Holistic approach to building sustainability

Giving buildings different options for accumulating points allows the programme to attract more participants, and thereby contributes to greater impacts. Furthermore, the extremely broad and comprehensive scope of sustainability categories covered incentivises buildings to give attention to wider sustainability concerns asides energy efficiency. This drives action to reduce environmental impacts from employee mobility, to adopt green roofing measures and to use more sustainable building materials and designs. Since the financial return on investing in such measures may not be evident, tax break incentives provided by SBCP play a crucial role in motivating building owners, designers and tenants to consider such areas.

Explicit and attractive incentives

SBCP is an incentive driven initiative where clear fiscal and financial incentives from Mexico City are driving programme uptake. These offset some of the risks and costs associated with retrofitting or investing in high performing sustainability building technologies. As mentioned, these include tax credits, green premiums associated with certified properties, special project financing opportunities, expedited permitting processes and optional placement on a list solicited by international corporations looking for space in Mexico City. Lastly, for buildings that may lack the capital necessary to pursue a certification, the process can be extended over a number of years to allow for gradual compliance. In contrast, other non-government green building certification schemes such as LEED are unable to provide the same level of government-backed fiscal incentives to spur market uptake.

Standardisation

Implementation of SBCP requires that third party auditors carry out vital roles such as auditing and allocating sustainability scores to buildings, recommending performance improvements and then conducting follow up monitoring. The programme ensures that auditors maintain similar standards and work ethics by mandating trained and certification through Mexico City´s Ministry of the Environment. Additionally, auditors will typically specialise in one certification category (e.g. energy). On one hand, this allows building owners, designers and tenants to draw upon the expertise and capacities of multiple companies and certifying certification agents. On the other hand, each agent undertakes the same training and certification from the city. This standardisation of the auditing processes ensues adherence to a common set of practices and principles by various technicians with contrasting expertise.

Challenges, limitations and countermeasures

Engagement of existing commercial buildings and small businesses

Whilst certification of new construction is progressing well, engaging existing commercial buildings—and especially small businesses—is proving a major hurdle. For small businesses, the principle hurdle to securing participation can be explained by the extra upfront costs required for auditing and retrofitting. For existing buildings, relative to a new building where construction plans can be designed to reflect technical requirements in performance categories, certification can prove lengthy and expensive. The principle countermeasure to overcome cost hurdles for existing buildings and smaller businesses is the aforementioned strategy of allowing gradual certification over several years. In this way, a building may for example earn points for energy in one year, waste the next, and then transport in the next and so on.

Difficulty engaging rental properties

There has so far been limited success in enticing owners of multi-family properties to invest in retrofitting the entire property, inclusive of common and tenant areas. There are several reasons for this. Firstly, performing audits and carrying out installation of energy efficient lighting, water efficient toilets and shower heads etc. in tenant living quarters is difficult for privacy, organisational and financial reasons. The main coping strategy to navigate this hurdle is to allow certification of uniquely common areas. However even for common areas, certification can prove costly and difficult. One reason for this is that environmental regulations for multi-family buildings are generally less stringent than those for commercial or industrial properties. As a result, bringing multi-family building systems up to required levels of performance can prove costly.

Lack of legal structure

Programme representatives have underlined that SBCP would find more traction in the building industry if backed by a more clearly defined legal structure. This would occur, for example, by incorporating the programme into the Mexico City Environmental Law and its regulation into the Self-Regulation and Environmental Audits chapters. Additionally, the development of additional supporting and regulatory measures for promoting energy efficiency and environmental considerations is required. The already mentioned unveiling of updated construction regulations in Mexico City that cover energy efficiency and environmental sustainability will likely address this problem and serve as a key driver of programme participation in the future. It is anticipated that many new, future buildings meeting the new building code will be able to fulfil many requirements for certification under SBCP.

List of references

City of Mexico. 2012. Programa de Certificación de Edificaciones Sustentables. Ministry of the Environment (in Spanish). http://martha.org.mx/una-politica-con-causa/wp-content/uploads/2013/09/15-Certificacion-Edificaciones-Sustentables.pdf Accessed 4 September, 2016.

C40 Cities Climate Leadership Group. 2012. Mexico City meets, exceeds Climate Action Program goals. http://www.c40.org/blog_posts/mexico-city-meets-exceeds-climate-action-program-goals Accessed 4 July, 2016.

United Nations Environmental Program. 2014. State of Play of Sustainable Building in Latin America 2014. http://www.unep.org/sbci/documents/State%20of%20Play%20Sustainable%20Buildings%20LA2014%20_ENG.pdf Accessed 15 July, 2016.

World Resources Institute. 2015. Accelerating Building Efficiency in Mexico City. http://www.wrirosscities.org/sites/default/files/MEXICO%20CITY%20BUILDING%20EFFICIENCY%20WORKSHOP%20SUMMARY%20(MARCH%2019%202015).pdf Accessed 4 April 2015.

World Resources Institute. 2016. Mexico City Prioritizes Building Efficiency with New Regulations. http://www.wrirosscities.org/news/mexico-city-prioritizes-building-efficiency-new-regulations

Credit: Enrique Abe / Courtesy: Mexico City Ministry of the Environment, 2016

Credit: Jordi Sanchez Teruel - Artjouer Street Art - Jhonny Silvercloud / www.flickr.com

Case 5: Seoul

Building Retrofit Program (BRP) Loan Support Scheme

Abstract

As part of its wider One Less Nuclear Power Plant policy, Seoul Metropolitan Government has formed an ambitious Building Retrofit Program (BRP) to spur retrofitting in government, commercial and residential buildings. This case focuses on the loan support scheme for this programme that targets building owners and tenants, and also, energy service companies and retrofitting contractors. This initiative promotes energy efficiency refurbishments by facilitating access to highly attractive, low interest rate loans with generous repayment and grace periods. In parallel, it lowers financial barriers to key building technologies such as high performance insulated windows and doors.

Credit: El_ave / www.flickr.com

1. Programme context

Citywide reduction target(s)

In 2012, Seoul Metropolitan Government (SMG) launched its ambitious vision for 2020 in its One Less Nuclear Power Plant policy. Phase One of this plan aimed to reduce energy demand by the equivalent of 2 million tonnes of oil equivalent (TOE) by 2014. This amount equates to the output of a typical nuclear power plant for the period. Energy reduction strategies were formulated for six key areas: new and renewable energy production, building retrofitting, environmentally friendly and high-efficiency transportation, green job creation, smart urban planning and fostering of energy conservation in the civic sector. The 2 million TOE goal was met within two years, in the first half of 2014, approximately six months ahead of schedule. From July 2014, Phase Two set the goal of achieving a 20% rate of self-sufficiency in electricity production by 2020 from 2012 levels whilst also achieving 4 million TOE of energy savings and production. This would lead to a 10 million tonne savings of GHGs.

In addition to the One Less Nuclear Power Plant policy, SMG has also set the target of reducing CO_2 emissions by 40% by 2030 relative to 2005 levels.

Built environment context and programme background

In South Korea, energy consumption continues to climb each year. Presently, 83% of national GHG emissions are related to energy production and consumption. Recently, in response to growing energy demand and instability of supply, the Government of South Korea has continued to expand nuclear power generation.

South Korea's share of domestically produced energy accounts for only 4%. The other 96% is dependent on imported energy resources such as oil, natural gas and uranium. Despite this reliance on imports, government subsidies and supportive policies for nuclear energy (especially electricity of which around 30% is generated from nuclear power plants) have resulted in electricity prices significantly cheaper than other industrialised nations.

Energy consumption is particularly high in the Seoul metropolitan area, home to some 10 million residents. In 2011, Seoul was consuming 7.5% of total national energy and 10.9% of national power consumption. Between 2009 and 2013, electricity consumption grew annually at 1.12% and was forecast to reach 50,330 GWh by 2020. In 2013 Seoul's use share of renewable electricity made up 4.2%, with the remainder coming from fossil fuels and nuclear. Furthermore, the building sector in Seoul is responsible for emitting annually 32.96 million t-CO_2. This makes up 69% of citywide GHG emissions. The building stock is dominated by commercial and residential buildings. Some of this is aged, as a total of 340,000 citywide residential buildings were built over 20 years ago. Having been constructed during an era where energy efficient design was not emphasised, some of these buildings have poor energy efficiency. The energy

Credit: D convertini / www.flickr.com

efficiency standard for new building design has been strengthened since 2001, however retrofitting the older stock is an important challenge.

Despite a large potential for raising energy efficiency, retrofitting buildings to reduce energy expenditures has lacked an economic rationale due to cheap consumer prices for electricity. A national loan programme has existed for several years to help with the financing of energy efficiency upgrades for industrial facilities at the national level. However this did not cover the retrofitting of older commercial and residential buildings, including small houses, which account for the majority of energy consumption in Seoul.

SMG's Building Retrofit Program (BRP) therefore sets out to advance energy efficiency in government, commercial and residential buildings to pursue progress towards the One Less Nuclear Power Plant target and the citywide CO_2 reduction goal of 40% by 2030, from 2005 levels.

2. Programme overview

Overall goals and start year

Starting in 2008, BRP aims to spur the retrofitting of government, commercial and residential buildings to reduce energy consumption as part of the wider One Less Nuclear Power Plant policy. In its early stages, BRP began with a focus on retrofitting projects for commercial and public buildings (including social welfare facilities and schools). Specific strategies for this includes developing a model to demonstrate energy efficient upgrades, provision of guidelines for inspection of building energy performance and deploying building energy management systems (BEMS), provision of retrofitting subsidies and installation of LED lighting. For particularly energy intensive commercial buildings, SMG analysed energy consumption patterns, disclosed this data and reduction measures to the public, and additionally, offered various incentives to entice retrofitting. As of 2015, retrofitting has been carried out on 59 social welfare facilities, 116 schools and several hundred commercial buildings. BRP aims to achieve the retrofitting of 90,000 buildings by 2018. This goal also represents 20% of total citywide buildings built over 20 years ago.

In parallel, BPR has been accompanied by other SMG efforts as part of the One Less Nuclear Power Plant policy. One key and connected programme involves diffusing the installation of several million LED lights across the city. This has targeted subway systems, high-rise apartment buildings, restaurants, fitness centres and so on. An Energy Service Company (ESCO) program was introduced to replace the lighting in underground parking lots of apartments and office buildings with LED lights. Lighting is installed free and costs later recuperated from electricity invoices. These various BPR initiatives for public and private buildings are also supported by improving energy policies in the field of urban planning and architecture at the municipal and national government level.

In 2012, the focus and strategy of BRP expanded measures to explicitly drive retrofitting in residential buildings by integrating a loan support scheme with cooperation of private lending institutions.

Target and scope

This case study focuses specifically on the BRP loan support scheme for private buildings, which as mentioned, forms a key component of the wider BRP project.

Anyone within the Seoul metropolitan area can apply for a BRP loan. Eligibility includes the owners and tenants of both residential (including multi-family buildings and single apartments, townhouses or detached housing) and commercial buildings. ESCO registered businesses and energy saving equipment suppliers and installers may also apply to the loan to expand business operations. Financing may be used, for example, to procure and replace high-

performance insulation and windows, LED lighting and lighting equipment, air-conditioning and heating systems and renewable energy production facilities.

There are two types of BRP loans: “Housing BRP” targeting the residential sector and “Building BRP” (non-residential) targeting commercial buildings. In 2016, Building BRP supports loans in the range of KRW 5 million to 20 billion ($US 1 = KRW 1,126.24 as of 17.9.2016) whilst the Housing BRP provides between KRW 2 million to 15 million to each applicant. Loans may cover up to 100% of project costs. An attractive low interest rate and long-term payback period has been set for the programme. In 2016, interest rates were set to 1.45% and payback periods up to eight years. As of 2015, total loans provide through the programme amounted to KRW 54.9 billion.

Programme structure and function

Figure 1 explains the process of the BRP loan support scheme and the involvement of three sets of actors: applicants, SMG officials and private financial institutions. The application process is essentially the same for all types of buildings and applicants.

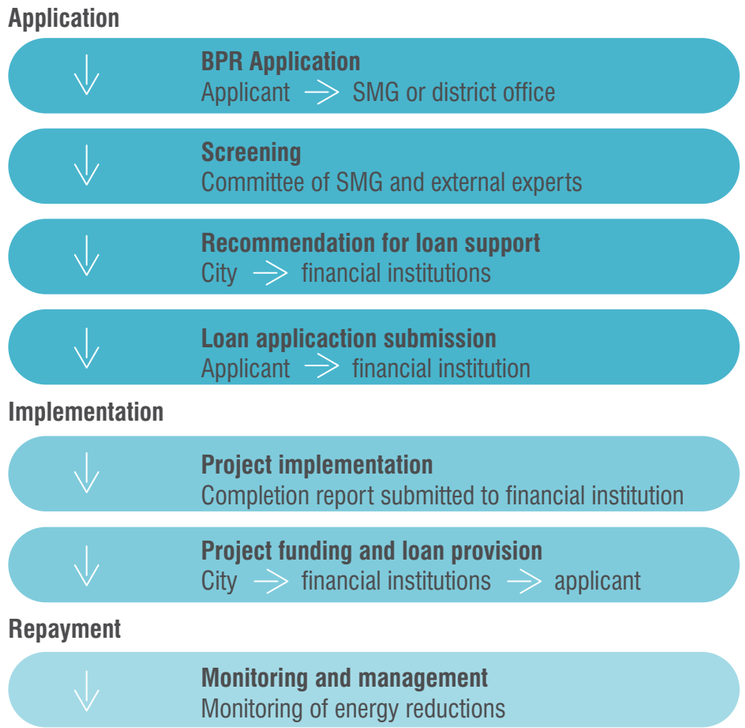
Application

Applicants first submit an application to SMG or a district city office. Applications must include an overview of the planned nature and scope of the energy reduction retrofitting or construction project. This plan must also outline the projected energy savings. Eligible projects for commercial buildings would include, for example, installation of exterior wall insulation and high-performance insulated windows, lighting and equipment, Building Energy Management Systems (BEMS), waste heat recovery systems and high-performance heating, ventilation and air-conditioning systems and renewable energy installations. For residential, projects would typically include upgrades or installation of insulated windows, doors and entrances, wall insulation, high-performance heating systems and LED lighting. Loan support only applies to retrofitting or construction projects under planning or still in the process of implementation. Completed projects are not eligible to apply.

SMG officials evaluate the application to assess the adequacy and economic feasibility of the proposed retrofit and to determine suitability for loan support. Screening is conducted by a committee comprising of two SMG officials, one representative from the Korean Energy Agency and three external experts from the field of building, machinery and electrical engineering. In this manner, SMG serves as a screening committee for banks, helping eliminate technical and financial uncertainty. This committee also act as a mediator between banks and the borrower, who in many cases, would not be able to secure finance if approaching a lender directly.

In the case of a successful screening, SMG then makes a recommendation to financial institutions and the applicant submits a loan application to a bank. The bank confirms the possibility of financing.

Figure 1: **Overview of BPR loan support process**



Implementation

SMG and the financial institution then review the report and provide loan support upon the approval of SMG. The SMG Climate Change Fund covers the project funds. These are transferred to applicants as a loan from the financial institution. Once funds are received and the retrofitting project implemented, a completion report is then submitted to the financial institution.

Repayment

Applicants repay the loan directly to the financial institution concerned. Applicants have the option of a long-term repayment plan up to eight years. In the case of non-residential buildings, applicants are also eligible for a three-year grace period where repayments are subject only to interest. As detailed below, the performance of retrofit projects is monitored and energy saving amounts recorded by SMG.

Data collection and utilisation

To monitor the energy saving impacts achieved by retrofitting, data is collected two different ways. First, the expected energy consumption reduction amounts are provided in the application process, as mentioned. Second, energy consumption amounts are monitored by collecting utility invoices which SMG collects itself. All types of energy consumption are monitored, and the reduction is usually calculated by comparing the fuel consumption amount per hour before and after the retrofit. This hourly rate is then multiplied by the number of hours operated per year.

Innovative and unique features

The BRP loan scheme is the first programme in Seoul to cover residential buildings of all types and size. Until now there have been a few national loan schemes that have supported projects for energy efficiency improvement; one being the ESCO programme by the Korean Energy Agency. However, this mostly targets industrial facilities.

Additionally, the loan support scheme is open to all groups of building stakeholders such as owners, tenants, ESCO operators and retrofitting contractors. This approach of opening the scheme to diverse stakeholders has several impacts. Firstly, there have so far been several cases of tenants participating in the scheme. These applications have usually involved the financing of projects which have a shorter period of return on investment and relatively high energy reduction effect such as replacements of indoor lighting to LED. Secondly, by working with ESCOs and contractors, SMG has forged several memorandums of understanding (MOU) with construction material suppliers such as LG Hausys and Eagon Window and Doors. These provide citizens with insulated windows and doors at reduced prices when bought as collective purchasing. Third, by providing low-interest loans to ESCOs, SMG is able to promote uptake of ESCO implemented projects. These are typically self-financing, nullifying the need for building owners to generate repayments on their own accord.

Incentive and support mechanisms

The primary incentive for tenants and owners of private buildings to participate in the loan scheme comes from the prospect of receiving finance under highly attractive conditions. As mentioned, interest is currently set to an extremely low rate of 1.45%, loans are repayable over eight years and also include a three-year principal free grace period for non-residential projects. Additional incentives come from the reduced prices for materials such as insulated windows and doors, which are achieved through MOUs between product distributers and SMG. For ESCOs and general contractors, an important incentive is provided where they may use the scheme to apply for loans on behalf of a building owner. This allows them to expand their businesses whilst at the same time playing a key role in marketing the scheme to potential clients.

Credit: Lieven Van Melckebeke/ www.flickr.com

Links to other city policies or programmes

Since 2012, buildings participating in BPR can receive additional benefits through the SMG eco-mileage system (C40, 2014). This is a reimbursement system, established to incentivise energy conservation in the residential, commercial and public sectors. As of October 2016, 1.87 million memberships have been issued. Based upon the quantity of energy consumption (electricity, natural gas, water and district heating) saved in schools, businesses and individual houses etc., citizens and organisations are able to earn points. These can be redeemed for goods such as LED lamps or services such as ESCOs (in the case of individuals) and financial support for building greening and installation of renewable energy facilities (in the case of institutions). For completed BRP projects, the accumulation of energy reductions can be checked and accumulated through the eco-mileage system and exchanged with these services, goods or monetary benefits.

3. Design and implementation

Timeline and inputs

SMG designed the wider BRP initiative by devising a comprehensive plan for rationalization of private building energy performance in 2008. Coinciding with this, SMG reorganised the Climate and Environment Headquarters, where the Energy Efficiency Team under the Environmental Policy Division is in charge of designing and planning BRP. Staff resources included one team leader and four staff members. Implementation of the early BPR initiative took place from 2008. The initial focus was limited to eight pilot retrofitting projects for government buildings and a few private sector, large office buildings which participated voluntarily. These were supported with KRW 500 million per building from the SMG Climate Change Fund, with a total budget allocated of KWR 3.3 billion. From the following year to 2015, a total of KRW 78.9 billion was spent.

BRP entered into a major stage of expansion in 2012 when the SMG launched the One Less Nuclear Power Plant plan. BRP created a new target of including small residential and multi-family buildings to widen retrofitting support from its initial focus on commercial buildings. To this goal, KWR 22.5 billion was set aside for funding the loan scheme in 2012. KRW 15 billion has been set aside for 2016. Also in 2016, a marketing and communication budget accounted for KWR 10 million to produce materials for BRP promotion.

Key collaborations

SMG has recruited six banks to serve as official partners and agencies for the loan support scheme. These are Woori Bank, Industrial Bank Capital, Hana Bank, Kookmin Bank, NH Bank and SME bank. Woori Bank is the only one providing a financial service for residential applicants.

In parallel, a large number of MOUs have been forged between the private sector and SMG. These include those created with the Korea Chamber of Commerce and Industry, the Korea Federation of Banks and the Korea Association of ESCOs. As already mentioned, MOUs have also been forged with various suppliers of material such as insulated windows and doors to offer reduced price materials to citizens.

SMG has also collaborated with Korea Green Building Council to offer education and training courses for building interior retrofitting contractors to obtain professional knowledge and skills and also to promote the residential arm of the loan scheme. Participants in these courses include interior design and construction companies, members of Korea Green Building Council and social housing welfare companies. On completion of the course, SMG will select the best performing “Green Interior Shops”. These are given a certification mark and posted on the SMG website for promotion.

Compromising or adjustments

Several adjustments have been made to the loan support scheme since initial implementation in 2012. Most notably, SMG has adopted the strategy of constantly reducing interest rates to entice further uptake of the scheme over successive periods. For the first year of BRP, annual interest rates were set to 3%. This was then lowered to 2.75% in 2011, 2.5% in 2012, 2% in 2013, 1.75% in 2015, and most recently, 1.45% in 2016. Also, in reaction to feedback that the application procedure (until recently, conducted in person at SMG or local ward offices) was complicated and inconvenient. A streamlined online procedure was introduced in 2016 with the aim of increasing accessibility to the scheme.

4. Outcomes and impacts

Environmental impacts

Some 4,200 projects implemented through the BRP loan support scheme have achieved a savings of 25,841 t-CO_2 for the period 2012 to 2015. Savings are larger for the BRP programme as a whole, owing to the participation of larger commercial and public buildings, and a far larger number of projects. In 2014, SMG collected data from 100 buildings retrofitted over 2012 to 2013. These results show an energy use reduction in TOE of 10% in residential housing and 6.5% in the non-residential building sector.

Market impacts

The BRP loan support scheme has clearly brought about an increase of retrofitting across the private existing building sector. Figure 2 shows the total number of buildings that have successfully completed retrofitting projects through the scheme each year. Residential buildings make up the bulk of participants, with a steady growth each year, culminating in a total of 4,034 successfully completed projects in 2015. Non-residential buildings are considerably fewer, with a total of 112 financed as of 2015.

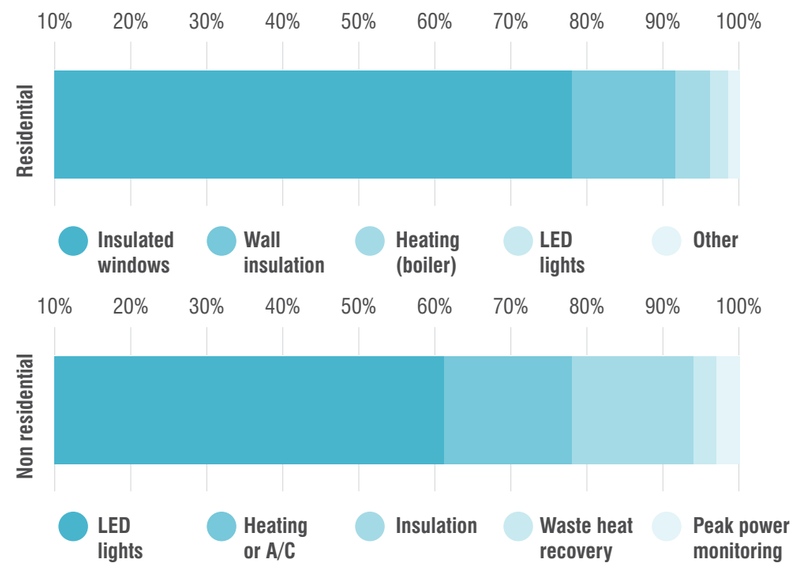
Figure 2: **Number of completed retrofits in BRP loan support scheme**

	2012	2013	2014	2015
Residential	148	904	1545	1437
Non residential	19	35	33	25

(The left axis shows annually completed residential building project numbers. The right axis shows annual non-residential building project numbers)

This retrofitting activity has spurred installation of an array of targeted low-carbon technologies. Figure 3 shows the types of equipment installed through the loan scheme from 2012 to 2015. As can be seen, for residential buildings, the majority of projects involve the installation of insulated windows (77%) and wall insulation (14%). For smaller households, these represent a relatively faster return on investment and an immediate improvement to thermal comfort. Upgrades to heating systems (5%) and LED lights (3%) were far less common. For non-residential buildings, results differ. Replacement of lighting to LED light is the most popular (61%) due to larger lighting areas and higher prospects of achieving a faster return on investment. Next most common are upgrades of heating systems (18%) and insulation (15%). Other technologies such as waste heat recovery (3%) and peak power monitoring (3%) measures were also installed, but to a far lesser extent.

Figure 3: **Types of retrofitted equipment through the BRP loan support scheme**



Lastly, by providing finance to ESCOs and building contractors, the scheme has also contributed to the expansion of these industries, serving to increase green job opportunities. At the same time, it has also boosted citizen access to affordable insulated windows and doors by lowering cost and finance barriers to these technologies.

Social impacts

The steady increase in the number of loan support scheme participants suggests that the initiative has succeeded in motivating approximately 4,000 residential applicants to invest in reducing home energy use and upgrading properties. It is also notable that several tenants have used the scheme to fund lighting upgrades to LED.

Another important outcome is that the Government of South Korea, through the Ministry of Land Infrastructure and Transportation, has adopted many elements of the BRP loan support scheme in its recently introduced Green Remodelling Interest Support Programme. This national initiative also supports the financing of commercial and residential building retrofitting projects and has made insulation upgrades mandatory for every project.

5. Lessons learned for replication

Strengths and drivers

Multiple and attractive financial incentives

A core strength of the BRP loan support scheme lies in its multiplicity of approaches to lowering the financial barriers to retrofitting commercial and residential buildings. Firstly, it offers extremely attractive interest rates, which have consistently declined since the scheme was first launched. Secondly, it has expanded the total possible loan amount, from 80% to 100% of eligible retrofitting costs. Thirdly, payback terms are generous. Loans may be paid back over a period of up to eight years, with three-year principal free grace periods also available for non-residential projects. Additionally, the scheme has also taken the approach of lowering the costs for procuring key building technologies offering high energy savings potential such as insulated windows and doors. As mentioned, this is by forming MOUs with several key manufacturers and installation companies to provide reduced prices for group purchasing.

Involvement of ESCOs and installation contractors

Since ESCOs and retrofitting contractors are able to apply for project funding, these stakeholders serve as powerful marketers and promoters of the scheme. This approach also allows residential and commercial clients to install important, energy efficient building technologies without having to raise collateral or direct cash repayments. This is because ESCO business models are able to generate repayments from the energy savings achieved from retrofitting projects. On the other hand, the BRP loan support scheme also provides the opportunity to ESCO and retrofitting contractors to recruit retrofitting projects in the goal of increasing their business activities.

Sustainable business model

The BPR loan support scheme does not rely on subsidies for its sustenance. It draws instead on funds from the SMG Climate Change Fund. These are administered to eligible projects though private sector lending institutions with legal power to ensure repayments are honoured. As such, the scheme is able to continue in the long-term, fixing ambitious targets to continuously secure large numbers of new applicants as money is returned to Climate Change Fund. Of note, the scheme has fixed itself the long-term goal of financing projects for approximately 12,500-13,000 new applicants each year from 2015 to 2020.

Challenges, limitations and countermeasures

Citizen preference for subsidy models

Increasing the scale of participation in the BRP loan support scheme in line with its lofty targets is proving difficult. Many citizens are reluctant to take on the economic burden of loans and prefer direct government subsidies. The principle approach to dealing with this has been to increase the attractiveness of loans by decreasing interest rates, increasing loan amounts and coverage, and simultaneously, by working with contractors through MOUs to lower costly retrofitting technologies such as insulated windows, doors and entrances.

Success in residential, challenges for commercial buildings

Whilst there has been much success in recruiting residential applicants (apartments and detached dwellings), progress has been slow for commercial buildings. The reasons for the growth in residential applicants appears to be linked to growing interest in reducing energy expenditures. This also appears to be driven by expectations of being able to improve property value, particularly through exterior surface renovations. Conversely, the low involvement of commercial type buildings appears to be hindered by split-incentive issues, whereby energy saving effects would benefit the tenant whilst the owner would cover the significant costs.

Cheap energy costs

Citizens and businesses in Seoul and the rest of South Korea currently enjoy some of the cheapest electricity prices in OECD nations. As such, it is difficult for policy makers to spur efforts to invest in retrofitting to save energy. This is because cheap power prices reduce the economic rationale for retrofitting by undermining returns on investment. Due to this situation, building energy performance in the real estate market also tends to be undervalued.

List of references

C40. 2014. *Case Study. Eco-mileage: a citizen's participation programme for protecting the environment.* http://www.c40.org/case_studies/eco-mileage-a-citizen-s-participation-programme-for-protecting-the-environment
Accessed 13 January, 2017.

Kim, M., Cho, H., In, S. 2010. *Program Evaluation Methods for Building Energy Saving of Seoul.* The Seoul Institute (in Korean).
http://www.dbpia.co.kr/Journal/ArticleDetail/NODE02038815
Accessed 11 April 2016.

Kim, M., Kim, M., Chang, Y. 2011. *Policy Suggestions for Invigorating the ESCO Industry in Seoul.* The Seoul Institute (in Korean).
http://www.dbpia.co.kr/Journal/ArticleDetail/NODE02038815
Accessed 11 April 2016.

Lee, T., Lee, T., Lee, Y. 2014. An experiment for urban energy autonomy in Seoul: The One 'Less' Nuclear Power Plant policy. *Energy Policy* 74: 311-318.

Seoul Metropolitan Government. 2012. Seoul Overall News: Seoul City to Support the Improvement of Building Energy Efficiency with 22.5 Billion Won.
http://english.seoul.go.kr/seoul-city-to-support-the-improvement-of-building-energy-efficiency-with-22-5-billion-won/ Accessed 11 April 2016

Seoul Metropolitan Government. 2013. *One Less Nuclear Power Plant.*
http://www.ieac.info/IMG/pdf/201305smg-one_less_nuclear_power_plant.pdf
Accessed 13 August 2016.

Seoul Metropolitan Government. 2015. *One Less Nuclear Power Plant Phase 2 - Seoul Sustainable Energy Action Plan.*
http://env.seoul.go.kr/files/2015/11/5656c402747ae7.44367433.pdf
Accessed 11 September 2016.

Credit: D convertini / www.flickr.com

Credit: Tomislav Domes - Forgemind Archi Media / www.flickr.com

Case 6: Shenzhen

International Low Carbon City (ILCC)

Abstract

Shenzhen is taking the lead in demonstrating innovation in sustainable urban transformation and future-orientated city planning through its ambitious International Low Carbon City (ILCC). This initiative aims to transform the previously manufacturing-based and carbon-intensive economy and built environment of Pingdi into a model of low-carbon, post-industrial urban revitalisation. ILCC maintains a focus on preserving and refurbishing existing buildings to the latest environmental standards whilst also pursuing new construction of cutting-edge, low-carbon buildings and urban infrastructure. As such, this initiative marks a significant shift from large-scale demolition and new construction centred modes of urban development. Also involving extensive collaborations with the Dutch government and other international partners, futuristic green buildings and economic transformation is pursued whilst taking the utmost care to preserve the natural environment and cultural identity of the area.


Credit: Brisan / www.flickr.com

1. Programme context

Citywide reduction target(s)

To meet China's new 13th five-year working programme to control GHG emissions, by the year 2020, the City of Shenzhen aims to reduce its CO_2 emissions by 10% relative to every RMB 10,000 of GDP (1 RMB = US $0.151 as of 20 August, 2016) compared to 2015 levels, and at least 45% compared to 2005 levels. As a specific goal for the built environment, also by 2020, the city aims to ensure that 100% of all new buildings comply with national green building standards.

Built environment context and programme background

Designated as China's first Special Economic Zone (SEZ)[1] in 1980, the southern city of Shenzhen, in Guangdong province, has since experienced skyrocketing economic growth. The adoption of flexible economic and social policies has transformed it from a small town with a total population of less than 30,000 to one of the most developed cities in the country. Its population now exceeds ten million. However some unofficial estimates put the population possibly as much as 15 million. These favourable policies attracted both Chinese and foreign investments and, in less than thirty years, the city has become home to the headquarters of China's most reputable high-tech companies. Shenzhen now enjoys a prosperous economic output, ranking fourth among 659 Chinese cities, behind Beijing, Shanghai and Guangzhou. Shenzhen's overall GDP grew by a yearly average of 17.9% from 2001 to 2014. As of 2014, per capita GDP was RMB 64,664. The city, once only 10.65 km^2 in area, has also experienced a huge expansion. Initially, the rapid development of the city was exclusively centred around the designated SEZ area of 327 km^2. However, non-SEZ areas were also included in the city masterplan to embrace forecast growth in population and industrial development. Currently, the total area of Shenzhen has now approached nearly 2,020 km^2.

Shenzhen has not only played a significant role in China's economic reform, but has also taken a leading role in environmental responsibility and tackling climate change. To this end, it has created several innovative policies. One pioneering measure was the country's first local law on GHG management, titled "Provisions of Shenzhen Special Economic Zone's GHG Emissions Management". These provisions set the legal foundation for carbon finance and trading, facilitating the launch of China's first emissions trading pilot scheme, operating since 2013. Buildings complying to green standards occupy an area of 16.36 million m^2, which

[1] Special Economic Zones (SEZ) in China are supported by the national government. Although they vary in function and scope, SEZs enjoy special preferential reform treatment such as trade policies, taxation, land use and others. They were launched as part of China's opening-up policy and market-orientated reforms. Some SEZs became experimentation zones for high-tech innovation whilst others aimed at attracting international investments and boosting the economy.

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

is the largest in the country. Shenzhen also boasts the lowest carbon emission per RMB 10,000 of GDP among major cities in China.

In 2010, Shenzhen was selected by the National Development and Reform Commission (NDRC) as one of the first eight cities to become a “low-carbon city pilot” (LCCP). Later expanding to encompass a total of 36 cities across China, LCCP’s are expected to lead the transition to a low-carbon economy by designing and implementing innovative policies to spur low carbon development, that can be applied nationally. Selected cities are encouraged to focus on lowering energy consumption in six main categories: industry, traffic, buildings, energy production, lifestyles and land use. As a flagship initiative from this context, Shenzhen launched a comprehensive and ambitious project called the “Shenzhen International Low Carbon City” (henceforth ILCC) in the Pingdi sub-district of the northeastern part of the Longgang district. Pingdi is located about 40 km from the main urban area in Shenzhen. It is situated near the provincial borders of Shenzhen, Dongguan and Huizhou, which are less than a two-hour drive away. It is also within easy reach of Guanzhou and Hong Kong’s downtown. Surrounded by mountains, and with three rivers flowing through its heart (Dingshan, Longgang and Huangsha), it also enjoys a lush, natural environment.

Pingdi was once a poor and highly underdeveloped district of some 170,000 residents that escaped the benefits of Shenzhen’s dramatic rise to prosperity. In contrast to central Shenzhen, Pingdi’s environment was characterised by scores of relatively low-value houses, energy intensive old factories and a scattered layout. In recent years, traditional heavy industries such as mining and quarrying and light manufacturing industries such as plastics, textiles, furniture and tobacco etc. created serious air and water pollution. In 2012, per capita GDP in Pingdi was one-fifth the average level of Shenzhen whilst carbon emissions per unit of GDP were 2.5 times higher, and energy consumption double. An abundance of land and natural resources and a waning, carbon-intensive economy therefore represented an ideal location for Shenzhen to reduce CO_2 emissions and energy consumption whilst demonstrating a new model of sustainable, urban renewal.

2. Programme overview

Overall goals and start year

Shenzhen’s ILCC was officially launched in 2012. It aims at catalysing the transformation of a previously economically insignificant and polluting urban district into a model of low-carbon development, high-output and high-technology industry, environmental sustainability and sustainable lifestyles.

ILCC project takes a new path in development. The project pursues urban transformation and low-carbon innovation through the integration of efforts to preserve existing buildings and heritage with construction of cutting-edge new buildings and infrastructure. This marks a radical departure from the “demolish and build from scratch” mentality that drove much of Chinese urban development over the recent decades. It also aims at creating new forms of mixed-use developments and creative forms of low-carbon businesses and services. Buildings will be designed to enable young entrepreneurs to reduce start-up costs by using spaces for both residential and commercial purposes. Additionally, ILCC promotes preservation of the rich, natural environment and traditional culture. Approximately 70% of the eco-city will be set aside for green spaces and natural environment zones. These will assure heat dissipation and natural ventilation, clean air quality and natural flood and waterlogging control.

Skyline of Shenzhen

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

Table 1: **Various key indicators and low-carbon targets**

Category	Indicator	Unit	Target value in 2025
Low-carbon output	Carbon emissions intensity relative to GDP	t-CO_2 per RMB 10,000	<0.32
	Carbon emissions per capita	t-CO_2 per capita per year	≤5
Low-carbon Industry	Proportion of emerging industries in GDP	%	≥80
	Proportion of R&D input relative to GDP	%	≥5
	Per capita annual GDP growth rate	%	≥7.5
Green buildings	Proportion of new buildings meeting national green building standard	%	50% 1-star 30% 2-star 20% 3-star
	Proportion of existing buildings meeting national green building standard	%	50% 1-star
	Coverage of energy consumption monitoring	%	100
	Utilisation of renewable energy in buildings	%	≥5
Low-carbon Transportation	Participation rate of green travel	%	≥80
	Proportion of electric vehicles in motor vehicles	%	≥81
Optimisation of energy structure	Cleanliness of electric power	t-CO_2 /MWh	0.694
Green spaces	Ratio of green space	%	Planning area ≥ 73.5% Built-up area ≥ 35%
Resource use and recycling	Recycle rate of industrial water	%	≥90
	Utilisation of non-traditional water resources	%	≥20
	Resource recovery rate of solid waste disposal	%	≥70
Environmental quality improvements	Good air quality days	days/year	≥350
	Heat island intensity	°c	≤1.0
Low-carbon management	Coverage of carbon emission monitoring system	%	100

Source: **Based on materials from City of Shenzhen**

As shown in Table 1, a comprehensive set of quantitative goals has been set to guide development in ILCC, and also to allow subsequent monitoring of progress. Firstly, by 2025 carbon emissions relative to each RMB 10,000 of GDP will be reduced to less than 0.32 tonnes of CO_2 (henceforth t-CO_2). Secondly, also by 2025, per capita CO_2 emissions will be reduced to 5 t-CO_2 (comparable to average E.U. national standards in the same year). Both of these goals are highly ambitious, and represent a vast improvement from current levels. For reference, unofficial estimates place current per capita emissions in Pingdi in the range of approximately 9 t-CO_2. Additionally, carbon intensity in Pingdi in 2011 was 2.21 t-CO_2 per RMB 10,000 of GDP, which is around double that of Shenzhen.

Programme target and scope

When completed, ILCC will cover an impressive total area of 53.4 km^2. The present population of the Pingdi area is approximately 170,000. This is expected to grow significantly, to around 420,000 in 2020 (including both residents and commuters working in the eco-city). As shown in Figure 1, development will be rolled out on three scales. Initial development will centre on a pilot zone of 1 km^2 around the Gaoqiao Dingshan River, to be fully established by 2020. In parallel, development is also taking place in an expanded zone of 5 km^2 around the Gaoqiao, Pingshan and Dingshan riverbanks, to be completed by 2025. Finally, the third development scale covers the entire Pingshan community. This is expected to materialise at some point after 2025, with significant progress made over the next decade. For the entire development, land for construction will cover only 17.5 km^2 and the remaining 35.9 km^2 dedicated to water, green spaces and forest areas.

Figure 1: **Layout of ILCC showing the pilot (red), extension (orange) and comprehensive (green) zones.**

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

The logic of realising the ILCC in phases and zones is three-fold. First, to draw lessons from the pilot zone in terms of effective technologies, economic development strategies and policy approaches. Second, to grant sufficient time for improving the performance of existing buildings and the local economy and enhancing the quality of the currently polluted environment. Third, the controlled and phased-out development model also aims to allow the City of Shenzhen to construct the required infrastructure (energy, water, transport, waste treatment etc.) at a pace matching that of development in the area.

Programme structure and function

ILCC is essentially a City of Shenzhen driven initiative, with extensive private sector involvement in both design and construction of individual projects. Essentially, the City of Shenzhen is responsible for setting the overall vision, goals and layout of ILCC through a masterplan, and then creating the regulatory and zoning framework to guide development. The city is also largely responsible for investing in the supporting infrastructure (metro, roads, water, energy etc.) and managing allocation of land to the private sector. The city of Shenzhen is also charged with measuring progress to the various goals. The private sector is largely responsible for investment and implementation of the majority of construction projects. The city however, is playing a significant role in attracting new enterprises and construction projects to Pingdi as well as creating incentives and subsidies to encourage existing industries to implement retrofitting (see *Incentives and support mechanisms*).

General layout

The spatial layout of ILCC follows a grouping method where mixed-use urban forms are clustered following the principle of “one axis and one belt; one core and three sub-centres”. As shown in Figure 2, the entire ILCC will be threaded and united by a single axis (shown in red) that marks an extension of the original city of Pingdi. This will be mainly achieved through an extension of the current Line 3 of the Shenzhen metro (creating seven new stations over 9.4 km), a major reconstruction of existing Pingdi Road, and the addition of trunk roads, highways and expressways. All vital elements of the city will centre around a single belt (shown in dark green) following the north-south flow of the Dingshan River. Within this area will be found public buildings and spaces like the convention centre, innovation park and landscape architecture etc. The core of the city will consist of three interconnected areas (shown as dark, red circles) that comprise of three key functions, each built around a separate metro or railway station. In the first, a Low Carbon Exhibition Centre will demonstrate green technologies and be used for holding conferences etc. The second will be a low-carbon service centre dedicated for commercial use (i.e. low-carbon businesses and finance, shopping and entertainment) and public services. The third will be a low-carbon living centre for leisure, recreation and culture. Three sub-centres (shown as circles along the main red axis) will serve as sub-centres in three zones that comprise a mixture of industries, services and residential areas.

Figure 2: **Spatial planning for ILCC**

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

Overview of key projects

Based upon the vision, goals and spatial planning outlined in the masterplan for ILCC, the City of Shenzhen has started implementing approximately ten major infrastructure and construction projects around the pilot zone and expansion area. The following sections shed more light on the chief components and characteristics of this initial progress.

• **Urban renewal and industrial transformation:** A chief feature of the pilot zone is the preservation of existing buildings whilst renovating and upgrading them to meet strict green building standards (see Table 1). Large demolitions are avoided. Industrial premises such as warehouses or factories are thus being transformed into modern, high-tech buildings that can provide additional and mixed-use spaces for leisure, R&D, offices, residential and commercial purposes (e.g. hotels, R&D and exhibition centres etc.). Another flagship retrofitting project aims at improving the environmental performance of traditional Hakka courtyard-style houses (see photo Refurbished traditional Hakka houses) whilst preserving their traditional spatial layout, form and appearance. Retrofit measures include repairing deteriorated surfaces and structures, upgrading lighting, ventilation and fire protection performance, whilst at the same time, introducing novel space uses such as tea houses and cultural exhibition centres.

• **New green buildings:** All new buildings will be designed to meet the latest green design methods, incorporating advanced building technologies to attain

Refurbished traditional Hakka houses

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

high environmental performance. Iconic demonstration green buildings will also be established. One key new building project involved construction of the ILCC Exhibition Centre in 2013. This serves as a site for demonstration and exchange of low-carbon technologies, holding of low-carbon international meetings and other services. The centre exceeds the national green building 3-star standards, with energy consumption around 50% less than a comparable, conventionally designed exhibition centre. It occupies a gross floor area (GFA) of 35,000 m^2 and a building area of 25,000 m^2. It boasts almost 100 unique, low-carbon features and technologies. These include vertical gardens, rainwater collection, membrane sewage treatment and water recycling, ecological building materials, advanced insulation and natural cooling features, solar photovoltaic electricity production and a smart micro-grid. Materials from the older structures on site were also recycled to make road aggregate, seats and flower pools.

• **Low carbon infrastructure:** Upgrades are currently being carried out to overhaul existing, or create new, low-carbon and ecologically responsible infrastructure for the city. These include treatment and recycling networks and plants for water, sewerage and storm water, energy distribution systems, solid waste treatment, transport and permeable pavements. Energy infrastructure upgrades include a high voltage electricity transmission corridor, renewable energy installations such as solar and wind and construction of a distributed energy centre. The latter will provide electricity and district hot water and cooling to commercial, public and residential premises from renewable sources and through a smart grid. Natural gas will be used as a base to support renewable energy sources including solar, wind and biogas from sewerage sludge and wastewater. The centre will also feature battery storage. A low-carbon comprehensive transportation system will be introduced in ILCC. This includes advanced networks of roads, highways, metro, tramway and bus lines and pedestrian pathways. It will encourage public transit and be designed to effectively connect key clusters and blocks in the city.

• **Industrial park for advanced low-carbon industries:** This will be built on an area of 3 km^2 with a total investment of around RMB 20 billion. The park will host a demonstration and R&D zone for both domestic and international enterprises in the low-carbon technology manufacturing and energy saving sector. Featured technologies will include solar, biomass, biogas, energy storage, waste, water and materials recycling, green building technologies, robotics and high-end equipment manufacturing, medicine, health and biotechnology. As well as being home to the abovementioned distributed energy centre, this park will also see construction of the world's largest and most advanced waste incinerator; the Shenzhen East Waste-to-Energy Plant. Scheduled to open in 2020, this will be a 267,000 m^2 facility capable of incinerating 5,000 tonnes of trash per day (around a third of Shenzhen's daily output). Recyclable materials will be recuperated first, and then heat captured to provide electricity to the city. It is estimated that the facility will save up to 750,000 t-CO_2 per year and constitute the largest carbon saving project in Pingdi. Designed by Danish architects who won an international design competition, the entire site will be built to green building standards and feature a solar array of 44,000 m^2, making up 65% of roof space. Pollution control standards for waste incineration exhaust emissions will be in the vicinity of two to eight times higher than those in the E.U.

• **R&D research clusters:** ILCC aims to become a knowledge city, hosting national and international research institutions and R&D facilities that contribute to low carbon technologies, innovation and other research areas related to future-orientated urban development. Some research institutes currently under planning or construction include the Aerospace Science and Technology South Centre, Shenzhen Institute of Building Research, China Academy of Functional Material (CAFM) and the Sino-U.S. Low-Carbon Building and Community Innovation Experiment Centre (a collaboration with the Lawrence Berkeley National Laboratory in the U.S.).

• **Natural environment enhancement:** In addition to preserving existing green and blue resources, a central feature of ILCC will be efforts to remediate previously polluted sites. One key project is the Dingshan River Water Quality Improvement Project. This features several measures to improve water quality and aquatic ecosystems such as construction of a sewage collection pipe network, water treatment plant with a capacity of 25,000 m^3 per day and flood control trenches. The project will also encompass environmental improvement and vegetation enhancing measures to improve the embankments and restore natural wetlands. This restoration project will extend 6.7 km and include the creation of an urban waterfront, public spaces and parklands.

Data collection and utilisation

Given the comprehensive set of low-carbon development goals laid out in Table 1, data collection and monitoring of progress will form a central part of the governance

and evaluation framework for ILCC. The monitoring system infrastructure itself is still under development. Yet it is envisioned that once completed, results for each of the indicators will be publically viewable online, and in real-time. Big data collection and analysis will thus play a large role in monitoring the various environmental, economic and societal impacts of the city. Energy and emissions related indicators will encompass the full life-cycle of construction and manufacturing. The entire set of indicators will also allow government officials to objectively gauge the merits of various project proposals and requests from industry to relocate to the eco-city. In addition, with ambitions to make real-time results from the monitoring platform highly visible around the city, this system will also serve as a powerful educational tool for industry and citizens alike.

Unique and innovative features

Urban renewal and industrial transformation

ILCC integrates preservation and reformation of existing buildings with advanced, new construction projects. The development model avoids large-scale demolition of old industrial establishments and housing (which requires relocation of residents). It instead works with citizens and building owners to upgrade buildings to attain new levels of environmental performance. In parallel, by reforming buildings and industrial facilities to achieve novel and re-imagined building uses (e.g. combined commercial, residential and cultural etc.), ILCC is also serving to restructure and revitalise the local economy. Previously polluting, old factories, warehouses and residences are being transformed to futuristic green buildings and spaces that generate a higher economic output relative to floor area and carbon emissions. The result is a dynamic and mixed-use urban landscape that puts citizens and lifestyles at the centre. Young entrepreneurs and start-ups will have the chance to use their spaces for both residential and commercial purposes. Transition to an energy-intensive industrial infrastructure to a new low-carbon technology and service orientated economy also serves to provide new employment and further reduce pollution and carbon emissions.

Building a whole new city while preserving the natural environment

The guiding vision and various projects comprising ILCC strive to balance progress in technological and built environment innovation with ecological health, and harmony of human and natural systems. As mentioned, a distinguishing feature of the eco-city will be the overwhelming presence of natural spaces. These will make up more than 70% of the total area, whilst construction is confined to the remaining 30% or 17.5 km^2. Furthermore, these green zones will comprise of existing natural forest, river and mountain areas on the one hand, with manmade or enhanced environments such as wetlands, urban forests, parklands and building vegetation (green walls and roofs) on the other hand. This preserved and enhanced natural environment will deliver multiple benefits such as climate control (i.e. reduced heat-island effect), air purification, beautification and recreation.

Incentive and support mechanisms

City planners in ILCC exploit various incentive mechanisms to encourage private sector developers and enterprises to pursue low-carbon construction and technological innovation. Since many existing households and factories have low environmental performance, the City of Shenzhen offers various incentives to incite owners to upgrade their facilities. Firstly, it provide subsidies of RMB 20-40/m^2 for refurbishment projects. Secondly, being a nationally supported low-carbon pilot city, larger refurbishment projects of industrial buildings can benefit from financial subsidies offered by NRDC. These help reduce expenses incurred in implementing retrofits to conserve energy and reduce CO_2 emissions, and equally, can also be given to selected new building projects. Third, new, small enterprises may apply to a low-interest loan programme from private, local and foreign banks (including German development banks and the World Bank) to aid with capital raising for initial business start-up. Fourth, since Pingdi has been integrated into the SEZ of Shenzhen, companies operating in the pilot city are able to enjoy special tax benefits.

ILCC also spurs green building and technical innovation by carefully screening business development and construction plans of private enterprises wishing to relocate or start up in the eco-city. This is done by using specific criteria created by researchers at the Harbin Institute of Technology that include GHG emissions, environmental impact, development potential and relevance of industry type to the overall goals of the city. This selective screening strategy has the advantage of assuring that existing or new enterprises settling down in Pingdi are committed to low-carbon innovation and environmental sustainability, and therefore, well-positioned to play an active role in the transition to a low-carbon, technology-driven economy. This selective admittance of industry also serves to drive uptake of 2-star rated building certifications. For existing buildings, typical costs of upgrading buildings to achieve this rating are around RMB 100/m^2. Obtainment of this certification fits well with the mission of new and relocating enterprises. In addition, such entities are also well-positioned to appreciate the business case of investing in building certification, since this ultimately leads to higher energy efficiency and reduced running costs.

Links to other city policies or programmes

ILCC is one of the centre-pins by which Shenzhen will achieve its transition to a low-carbon and technology driven economy. Due to the breadth and scale of the development currently unfolding, Pingdi will contribute significantly to the progress Shenzhen is currently making towards various targets for the year 2020. These include, for example, reducing CO_2 emissions relative to every unit of GDP, increasing overall GDP and the proportion spent on R&D or created from low-carbon industry, percentage of green spaces and buildings obtaining green certification, coverage of public transport and proportion of energy derived from renewables, to name a few.

View of Low Carbon Exhibition Centre (architectural rendering)

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

3. Design and implementation

Design phase

Timeline and inputs

Development of the idea of establishing a low-carbon pilot city in Shenzhen unfolded over around two years, from 2010 to 2012. As mentioned, in 2010 Shenzhen was officially nominated by NRDC to become one of the first national low-carbon pilot cities in China. This gave the City of Shenzhen the responsibility of trialling various policies and initiatives to reduce carbon emissions and achieve a new model of low-carbon, urban development that could be shared with other cities across China. This designation as a national low-carbon pilot city sparked a series of exchanges and collaborations between the City of Shenzhen, the Embassy of the Kingdom of the Netherlands, and Dutch research institutions such as Delft University of Technology and Harbin Institute of Technology Shenzhen Graduate School on areas like urban planning, infrastructure and sustainable city development etc. Also, research by local institutions on establishing a zone for industrial cooperation between the three provinces of Shenzhen, Dongguan and Huizhou was conducted. In parallel, 2010 also witnessed an international conference called the "International Conference on Next Generation Infrastructure Systems for Eco-cities". The event was attended by hundreds of experts from around the world, and culminated in the suggestion that an "ecological knowledge city" be established in Pingdi.

In 2011, further research was conducted on establishing this ecological knowledge city. As part of this, officials from Shenzhen and from the Netherlands shared several meetings and official visits, that eventually lead to the formal decision to establish a "Sino-Dutch Low Carbon City". This name later was changed to "International Low Carbon City". In 2012, cooperation between the two sides was raised to the national level between China and the European Union. In the "High-Level Conference on China-EU Urbanization Partnership"[2] attended by Prime Minister Li Kequiang and the Mayor of Shenzhen, ILCC was officially launched as one of eight pioneering eco-cities projects by China. These all involved collaborations with E.U. countries and Singapore.

In 2013, the official masterplan titled "Shenzhen International Low Carbon City Pilot Zone Planning Research (Detailed Blueprint)" was approved by the City of Shenzhen and Longggan District Government. This masterplan was a collaboration between various academic players in Harbin Institute of Technology, the Next Generation Infrastructures Foundation (affiliated with Delft University of Technology) and the Dynamic City Foundation, a Dutch-owned architecture institute in Beijing. This 150-page report was based upon research into the geographical, economic, environmental and infrastructure attributes of the target area. It included all the details on the land functions, spatial plan and project guidelines of the new eco-city, in addition to images showing the appearance of the futuristic, green and knowledge city. After adoption of this masterplan, input of foreign architectural firms was then integrated into the design of individual large construction and infrastructure projects through international design competitions.

Implementation phase

Timeline and inputs

Construction in ILCC began in late 2012. Ground breaking on the new exhibition centre, one of the centrepieces of the initial pilot zone, took place in early 2013. For detailed information on the timeline and implementation progress, refer back to sections 'Programme target and scope' and 'Programme structure and function'.

Key collaborations

To design and implement the ILCC project, the City of Shenzhen attached great importance to establishing partnerships to draw upon international expertise in eco-cities, urban planning, energy and other areas, and combine this with Chinese expertise. Collaboration across government, private sector firms, NGOs

[2] The Sino-Euro partnership on urbanisation was launched in Brussels in May 2012 offering a framework for cooperation between European and Chinese cities on sustainable urban development projects in China. Twelve agreements have already been signed and a yearly Sino-Euro forum was established for exchanges between leaders and stakeholders from both sides on advanced forms of sustainable urbanisation.

and development organisations—local, national and international— is thereby the motor by which ILCC is unfolding. Moving into construction and business development, countless alliances have been forged between public agencies in Shenzhen and domestic or foreign private enterprises, international organisations and research institutes. Some notable examples include:

- Joint establishment of Sino-U.S. Low-Carbon Building and Community Innovation Centre by Lawrence Berkeley National Laboratory in the U.S. and Shenzhen Institute of Building Research. This will be a base for R&D in low-carbon construction technologies, energy efficiency testing, human resource training and new business development. The RMB 480 million facility will attain 70,000 m2 of GFA and encompass testing facilitates, offices, incubator spaces and apartments.

- An annual international low-carbon forum is held in the exhibition centre in ILCC. This annual event gathers experts, scholars and companies to exchange information and exhibit the latest green technologies and sustainable building methods, thus becoming a driver for more innovation in the city. Shenzhen relies heavily on this forum, first launched in 2013 as a promotion platform for ILCC. It aims to attract international attention of businesses and research institutions and serve as a feedback platform for international views on the progress of the eco-city.

- Other collaborations with international organisations have included the United Nations Development Programme, World Bank, Asian Development Bank, Global Environment Facility, World Wildlife Fund, C40 Cities Climate Leadership Group and R20 Regions of Climate Action.
Compromising/adjustments

Compromising or adjustments

After completing the pilot zone and majority of the extension zone in 2025, Shenzhen plans to replicate lessons learned there on the remaining area. In addition, the various quantitative targets set for the eco-city have all been designed to be highly ambitious, and therefore, difficult to achieve. It is possible that some of these could be adjusted according to the outcomes of development progress over the next several years.

View of innovative green buildings surrounded by rich environment of Pingdi

4. Outcomes and impacts

Environmental impacts

As suggested by Table 1, the environmental accomplishments of ILCC will be vast. With various projects realised so far, the Pingdi area has witnessed substantial improvements to the built and natural environment. Carbon emissions intensity per unit of GDP have already dropped by 22% in Pingdi, from 2.21 t-CO_2 in 2011 to 1.72 t-CO_2 in 2014. This is largely the result of the industrial transformation, as many new low-carbon enterprises move into locations around the pilot zone. Vastly greater reductions are anticipated for the future, since Shenzhen officials are limiting to limit carbon intensity to 0.32 t-CO_2 per RMB 10,000 , or 5 t-CO_2 per capita, by 2025. Additionally, renewable energy will make up 30% of ILCC's energy supply, decreasing coal usage and boosting air quality. This will result in a low-carbon electricity mix of 0.694 t-CO_2/MWh. Expectations are also that a combination of low-carbon power, green spaces and vegetation in building roofs and walls will ensure that at least 350 days per year exceed the good air quality index, whilst at the same time, heat island intensity is mitigated to below 1°C. As mentioned already, water quality in river systems will also be significantly improved, as ecological sewerage and treatment networks, recycling up to 90% of industrial water discharge, and vegetation-based flood control measures, are implemented.

Environmental impacts are already prominent in the building stock, and poised to grow. So far, around 100,000 m^2 of buildings has been retrofitted, as ILCC aims to achieve a 1-star rating for 50% of existing buildings, and for new

buildings, 50% as 1-star, 30% as 2-star and 20% as 3-star. The aforementioned exhibition centre, for instance, has already attained a 3-star rating. Further environmental improvements will include the transport system. Improved walkways, comprehensive public transit (metro, buses and streetcars) and measures to encourage bicycle use—in addition to an 80% electric vehicle share of road transport by 2025—will reduce citizens travel-related carbon footprint whilst promoting exercise and healthy lifestyles.

Social impacts

Pingdi was once was a poor, crowded and polluted district with a low quality of life. Its population of some 170,000 low-income farm workers and built environment was marked by heavily polluting and low output factories, deteriorated traditional houses and chronic urban sprawl. This scene is now in the process of transforming into a highly livable, dense and mixed-use, futuristic and ecologically-centered city that will draw global attention. Population will grow to over 420,000 by 2020 and increase further in the years beyond. It is predicted that around 50,000 high-paying new job opportunities will be created by 2020 as a result of the economic and environmental reformation. Mixed-use urban forms, combining commercial, residential and industrial premises into tightly compact pockets, surrounded by dense green zones will promote sustainable lifestyles among the citizens, reducing transit times and need for travel. Live monitoring of emissions and educational efforts from public agencies will make citizens aware of their activities and how they are affecting the environment.

ILCC will thus become a role model for other Chinese cities struggling with pollution and problems of urbanisation, and other cities around the world. Pingdi will demonstrate that high levels of environmental quality can be attained with existing built environmental heritage. On the planning side, this is through a combination of visionary and long-term masterplans, ambitious targets, explicit guiding principles and progress indicators, and on the implementation side, a combination of retrofitting and new construction driven by public-private and international collaboration. This marks a radical new form of urban development for China, which until recently, has not typically pursued international collaboration or preservation of existing buildings and heritage.

Market impacts

Although ILCC concerns the physical transformation of the built and natural environment in Pingdi, it is equally an economic transformation project. It's chief accomplishment will be the transition from carbon-intensive and low output forms of industry (mostly traditional manufacturing with low economic output relative to floor area) to low-emission and high output types of new industries. As shown in Table 1, by 2025 it anticipated that new, low-carbon industries will make up in excess of 80% of local GDP. Initial indicators demonstrate that early progress is being made. Firstly, ILCC has attracted many new businesses and industries. In the last two years, 40 high-tech companies with a total output of RMB 9.6 billion have settled in the eco-city. Secondly, industrial output in Pingdi grew strongly between 2011 and 2014, from RMB 11.5 billion to RMB 23.4 billion. This translates to an annual growth rate of 27%. Third, indications show that in the same period between 2011 and 2014, rental yields of factories doubled from around RMB 7/m^2 to around RMB 14/m^2 whilst fixed asset investment doubled. Fourth, state asset investments in the eco-city also grew for this period, from RMB 1.91 billion in 2011 to RMB 4.25 billion in 2014. This equates to an annual growth rate of around 30%. Pingdi is therefore poised to become a leading-edge centre of international significance for sustainable urban development. This will bring global attention to exploit lessons from this transformation experience in other cities around the world, thus providing unique business opportunities for Chinese companies.

5. Lessons learned for replication

Strengths and drivers

Balance of national government support with city-led decision making power

Support from the national government (i.e. NRDC) and substantial state asset investments are significantly driving progress in ILCC. Following the decision to select Pingdi as one of eight national pioneering low-carbon eco-city projects, a city-level branch of NRDC was set up in Shenzhen to serve as the official body guiding ILCC, and also, establish networks with external parties. National governmental interest in ILCC not only contributed to the increase of state asset investment, it also instilled confidence in the business sector to get involved, equally facilitating governmental cooperation with the Dutch side. On the other hand, designation as a pilot city also emphasised a bottom-up approach. The City of Shenzhen was given authority from NRDC to adopt policies and approaches that best fit its local conditions. Thus, synergy attained from the commitment of the national government, together with rule-making and goal-setting power given to the City of Shenzhen, has played and will continue to play an important driving role in realising the establishment of ILCC.

Gradual improvement strategy, with rigorous monitoring

One factor also helping ILCC achieve its ambitious goals is the strategy of focusing efforts and investments in controlled phases and development zones, of which the results are carefully monitored. By focusing on fully establishing the pilot zone of 1 km^2 and much of the 5 km^2 extension area by 2025, results will be concentrated and highly visible. ILCC will consequently be well-positioned to extract lessons from these initial development sites and apply them to the remaining area. Use of the low-carbon index and its comprehensive set of indicators will allow objective, quantitative monitoring of environmental, economic and societal performance as the eco-city unfolds. As shown in Table 1, not only will these serve to measure progress, they are also serving as yardsticks of sustainability against which various project proposals can be evaluated. In addition, they also send an explicit vision and set of guiding principles for urban planners and new industries regarding the

types of environmental performance required by the individual components for the entire city.

International and local collaborations

Driven by public-private partnerships, both local and international, ILCC is constantly injected with expertise and emerging technologies from around China and the globe. This gives a chance for cutting-edge ideas from outside to find their way into the emerging eco-city. These drive innovation and progress in a fashion that might not have been possible with domestic policy and industry know-how alone. ILCC also emphasises the international identity of Pingdi and Shenzhen. Significant efforts are being made to increase use of English through language education, international schools and signage etc. This further facilitates the migration or engagement of foreign firms, urban designers and engineers. The financial resources of Shenzhen and the commitment of the national government to driving green development then allow these experts to contribute to achieving a level of innovation and socio-environmental impacts that would not have been possible in their home country.

Challenges, limitations and countermeasures

Promoting low carbon industries as a mainstream business model

The concept of an eco-city and low-carbon economy is still new to the local industry, still heavily influenced by its recent and traditional manufacturing based past. Despite support from the national and local government and appeal as a general idea, propagating the concept of a low-carbon economy to foster viable business models and achieve significant investment levels in a non-mature, still emerging market is proving highly challenging. This is especially so given that the mind-set of industry is slow to change, with many key players still unable to see the financial sense in establishing high-capital and high-risk ventures and building projects in an uncertain market. The main strategy used to overcome these barriers are subsidies for retrofitting and low-interest loans for smaller start-ups. However even these are sometimes not sufficient enough to entice retrofitting of older, industrial premises and reformation of business models, since many owners perceive little immediate benefit from doing so.

Technological innovation dependent on subsidies

The pursuit of advanced technological innovation is hugely dependent on governmental support and investments. Since many technologies are new, unproven or still emerging, the cost of production and installation is still high. As such, government officials face the challenge of having to not only promote diffusion of these technologies, but also support industry so that low-carbon technologies can be produced at lower costs. Achieving this will require time and continued, large, public and private investments in R&D. It will also necessitate a spirt of risk taking and innovation, which is still in the process of emerging.

Credit: Provided by Shenzhen Municipal Government. Copyright © 2016

Also essential is trust and intimate cooperation between Chinese and foreign firms. However concerns over protection of intellectual property appear to be challenging progress in this area. This highlights the need for institutional and private sector measures to protect the intellectual property fruits that arise from increased R&D spending and blue-sky innovation activities.

Restrictions imposed by natural environment setting

ILCC is located in a rich, natural environment. Half of the existing land comprises of vegetation, mountains and forests of which 40% is a natural reserve. However, full development of the entire eco-city in the coming years will require some encroachment upon these natural areas. This poses fundamental challenges to the overall goal of preserving natural spaces across the entire city, and creating additional greenery to attain a green land surface area of around 70% overall, and 35% in the central urban areas. To tackle this challenge, the City of Shenzhen has a set ecological protection lines around the city where development is restricted. Integration of dense, mixed-use urban development principles with careful, phased-out development and city-led planning are also serving to contain sprawl and preserve natural spaces.

List of references

Baeumler, A., Ijjasz-Vasquez, E., Mehndiratta, S. 2012. *Sustainable Low-Carbon City Development in China*. The World Bank. Washington.

Chen X. 2012. Bilateral Collaborations in Sino-foreign Eco-cities: Lessons for Sino-Dutch Collaboration in Shenzhen International Low-carbon Town. Master's thesis submitted to Delft University of Technology. http://repository.tudelft.nl/view/ir/uuid%3A09108de7-05ea-4e85-8212-b6506705da77/. Accessed 18th August 2016.

City of Shenzhen. *Introduction to the cities of the future award project of Shenzhen international low carbon city*. Documentation received from the City of Shenzhen.

City of Shenzhen. 2015. *Exhibition on Green Development of Shenzhen International Low Carbon City*. Documentation received from the City of Shenzhen.

City of Shenzhen. International Low Carbon City Shenzhen. http://en.ilcc.com.cn Accessed 20th September 2016.

De Jong, M., Wang, D., Yu, C. 2013. Exploring the Relevance of the Eco-City Concept inChina: The Case of Shenzhen Sino-Dutch Low Carbon City. *Journal of Urban Technology* 20 (1): 95-113.

De Jong, M., Yu, C., Chen, X., Wang, D., Weijnen, M. 2013. Developing robust organizational frameworks for Sino-foreign eco-cities: comparing Sino-Dutch Shenzhen Low Carbon City with other initiatives. *Journal of Cleaner Production* 57: 209-220

Dong, W., Hao, G. 2014. *A Study on Construction Path of Shenzhen International Low-Carbon City* http://zh.scientific.net/AMM.675-677.1750. Accessed 18th August 2016.

European Commission. *The EU-China Urbanisation Partnership*. https://ec.europa.eu/energy/sites/ener/files/documents/12_cities.pdf. Accessed 18th August 2016.

Huang, L., Xie, Y. *The Plan-led Urban Form: A Case Study of Shenzhen*. 48th ISOCARP Congress 2012. http://www.isocarp.net/Data/case_studies/2162.pdf Accessed: 18th August t 2016.

Li, H. 1996. *Development of the Shenzhen Special Economic Zone*. http://www.neaef.org/public/neaef/files/documents/publications_pdf/annual_meeting/6th-1996/6.1.Li_6an_1996.pdf Accessed 18th August 2016.

Lu, J. 2009. *Spatial Planning in Shenzhen to Build a Low Carbon City*. 45th ISOCARP Congress 2009. http://www.isocarp.net/Data/case_studies/1413.pdf Accessed 28th August 2016.

Next Generation Infrastructures Foundation. Harbin Institute of Technology Shenzhen Graduate School. 2011. *Developing a Special ECO-2-ZONE at the Intersection of Three Cities How Ping-Qing-Xin can become A World-Class Innovation Hub.* Original planning and vision documentation for Pingdi, received from the Delft University of Technology.

Ruben, C. 2014. *Shenzhen Low Carbon City: A transformation of Concept and Planning Process*. Master's thesis submitted to University of Amsterdam. http://www.newtowninstitute.org/pdf/MasterthesisRubenCales.pdf Accessed 17th July 2016.

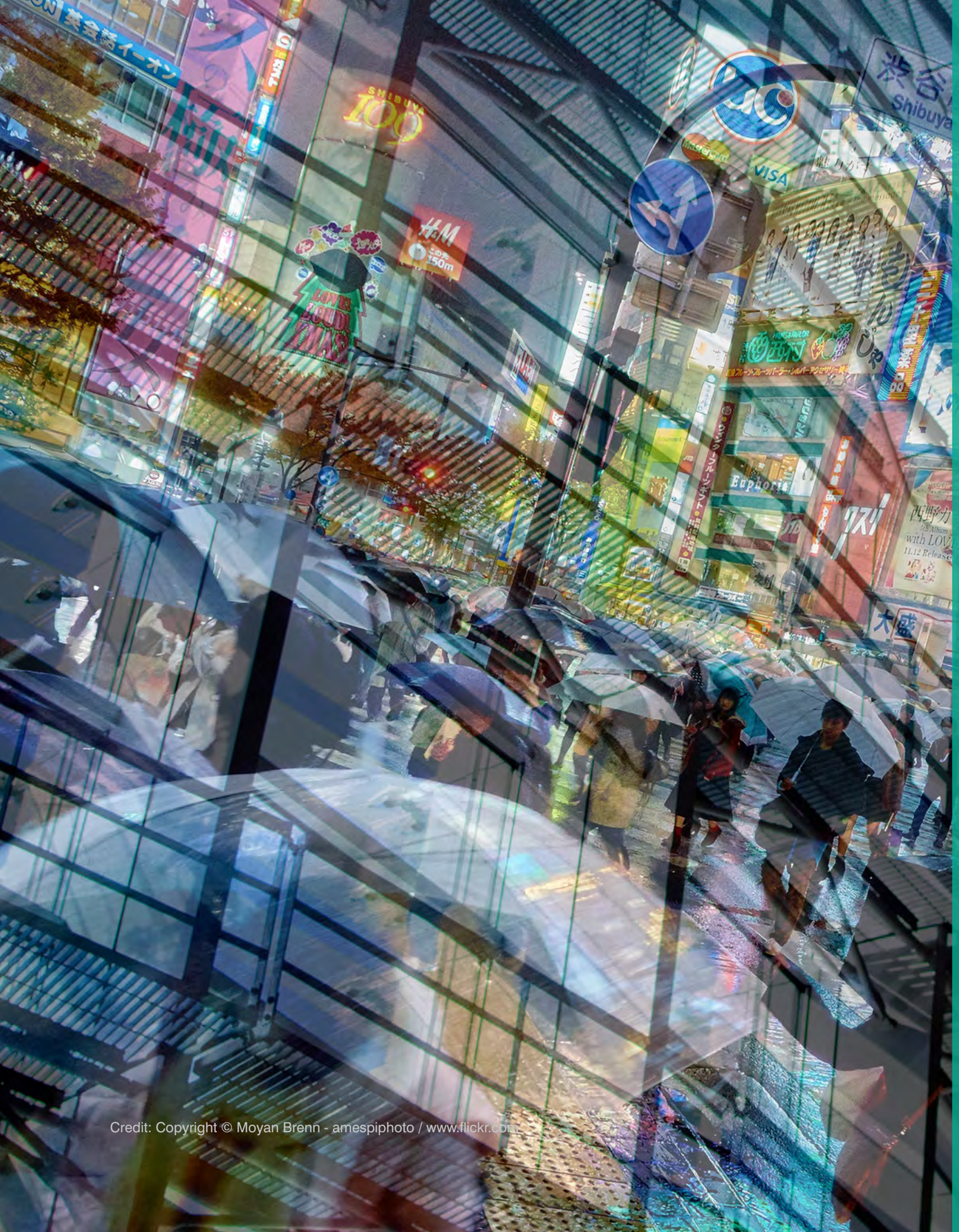
Shenzhen Center for Design (SCD). *Alternatives for Low Carbon City and Competition Requirement Specification of Architectural design contest*. http://www.szdesigncenter.org/wp-content/uploads/2015/04/Competition-Requirement-Specification-of-Architectural-design-contest-for-Land-lot-05-01-and-05-03.pdf. Accessed 24th August 2016.

Shenzhen International Low Carbon City Forum Organizing Committee. 2016. *Shenzhen International Low Carbon City*. http://www.ilccforum.com Accessed 18th June 2016.

Tao, L. 2010. *The Vision of Urban Spatial Planning Based on the Concept of Low-Carbon City*. 46th ISOCARP Congress 2010. http://www.isocarp.net/Data/case_studies/1663.pdf. Accessed 18th August 2016.

Wu, Z., Tang, J., Wang, D. 2016. Low Carbon Urban Transitioning in Shenzhen: A Multi-Level Environmental Governance Perspective. *Sustainability* 8(8): 720.

Yufei, W., Qijiao S., Jijiang, H., Ye, Q. 2015. Developing low-carbon cities through pilots. *Climate Policy* 15 (S1): S81-S103.



Credit: Copyright © Moyan Brenn - amespiphoto / www.flickr.com

Case 7: Tokyo

Carbon Reduction Reporting for Small and Medium Entities

Abstract

The Carbon Reduction Reporting for Small and Medium Entities (CRR) mandates the annual reporting of CO_2 emissions for existing small and medium-sized facilities (i.e. single building or group of buildings) in the Tokyo metropolitan. These facilities comprise some 60% of total CO_2 emissions in Tokyo's industrial and commercial sectors. In addition to the mandatory component, CRR has succeeded in attracting a large number of voluntary submissions from facilities keen to monitor annual emissions and compare to industry benchmarks.

Credit: Chao-Wei Juan / www.flickr.com

1. Programme context

Citywide reduction target(s)

With 2000 as the base year, Tokyo Metropolitan Government (TMG) has fixed mid-term reduction targets for both GHG emissions and energy consumption. For GHG emissions, reduction targets are 30% by 2030. For energy consumption, the Environmental Master Plan (revised in March 2016) calls for a 38% reduction by 2030.

Built environment context and programme background

Commercial and residential buildings in Tokyo accounted for more than 72% of metropolitan-wide energy-induced CO_2 emissions in 2013. In addition to many large buildings, approximately 660,000—or 10% of Japan's small to medium commercial and industrial facilities —are concentrated in Tokyo. The majority of buildings were constructed during the so-called "Bubble Economy" period of the late 1980's to the early 1990's. This period saw much emphasis on lavish building design and little consideration on construction and running costs. Today, although many buildings erected in this era are in need of retrofitting to increase energy efficiency, such investments are lacking. In addition, following the Great East Japan Earthquake of 2011 and earlier seismic disasters across the nation, industry naturally attaches greater importance to buildings meeting seismic resistance codes than those with high energy efficiency. This said, it is estimated that some 30% of all small and medium buildings fall short of the most recent seismic resistance standards. Such buildings suffer from low market competitiveness, reducing the attractiveness of financial arguments to invest in energy efficiency upgrades. Additionally, building leases in Tokyo typically run in two-year cycles. Since tenants prioritise short-term rental costs, higher rental premiums—necessary to recover retrofitting investments for energy efficient buildings with low long-term running costs—have little appeal in the market place.

The Great East Japan Earthquake and Fukushima nuclear power plant disaster in 2011 have also significantly hampered efforts to reduce GHG emissions. This double calamity prompted the stopping of the entire national fleet of nuclear power plants for the past few years and switching of electricity generation to mainly gas and coal. Consequently, the carbon intensity of metropolitan electricity has spiked from 0.382 kg-CO_2/kWh pre-disaster to 0.489 kg-CO_2/kWh. Tokyo metropolitan is now in a unique and unfortunate position. Although a 17% reduction of energy consumption in the commercial and industrial sector was achieved from 2005 to 2013, the CO_2 reduction benefits have been mostly offset by this roughly 30% increase of carbon intensity in the electricity supply. Although this situation poses fundamental mid-term limitations to efforts to decrease GHG emissions in buildings, industry and policy making efforts to reduce CO_2 emissions are continuing regardless.

[1] TMG officials use this term to refer to either a single building or an industrial/commercial property with several buildings on the premises.

2. Programme overview

Overall goals and start year

CRR was launched in 2010 with two core objectives. First, to bring the owners and tenants of small to medium, commercial or industrial facilities to monitor annual CO_2 emissions, and subsequently, take measures to reduce these. Secondly, to provide policy makers with data on the building stock, and provide this back to the owners and the market. These goals are pursued by mandating for facility owners the submission of an annual report outlining CO_2 emissions for the previous fiscal year and additional qualitative information such as implemented or planned emissions reduction measures. There is no common CO_2 emissions reduction target for the programme. Reporting entities are encouraged to fix individual emissions reductions targets. Reports are publically disclosed on the TMG website. CRR is a hybrid programme both a mandatory and voluntary component. Two types of reporting thereby occur: 1) facilities reporting as a regulatory obligation or 2) facilities reporting as a voluntarily measure to monitor CO_2 emissions and compare performance to peers.

Programme target and scope

CRR specifically targets the owners and tenants of approximately 660,000 small and medium-sized facilities (including commercial, industrial and public) located in the Tokyo metropolitan. Targeted enterprises may comprise of single or multiple facilities. The threshold for mandatory reporting is set to facilities with an annual energy consumption in crude oil equivalent (COE) between 30 kL to 1,500 kL. For scale, a facility with annual energy consumption of 1,500 kL COE roughly corresponds to a typical office building with around 30,000 m^2 of Gross Floor Area (GFA). For businesses owning or operating multiple facilities in Tokyo, reporting is mandatory if combined annual energy consumption for the whole property portfolio is greater than or equal to 3,000kL. In this way, CRR is able to target the small, individual properties of large chain businesses. In financial year (FY) 2015 (reporting data for 2014) the total number of enterprises facing mandatory reporting requirements was approximately 291, representing approximately 23,023 individual facilities. Yet the number of enterprises reporting voluntarily dwarf this. Approximately 1,871 enterprises representing 11,476 individual facilities submitted reports in FY 2015.

Covered commercial, industrial and governmental facilities include convenience stores, owner occupied and tenant offices, supermarkets, restaurants, educational facilities, hotels, factories, entertainment venues and so on. Excluded facility types include vehicle, rail, shipping, air and other transportation related services, as well as residential buildings. Both owners and tenants are targeted by the programme. In the case of a leased facility, the owner would report for the entire property whilst the tenants would report for the leased area. In this way, two reports may be submitted from a single facility. Also, in the event where an enterprise possesses multiple facilities, the head office or representing section

Credit: © Tokyo Convention & Visitors Bureau

will report based on aggregated data for all facilities rather than individual properties. Incidentally, any individual facility with annual energy consumption above 1,500 kL COE faces mandatory GHG emission reduction responsibilities under the Tokyo cap-and-trade scheme. Therefore, such a case would nullify the need for compliance with CRR.

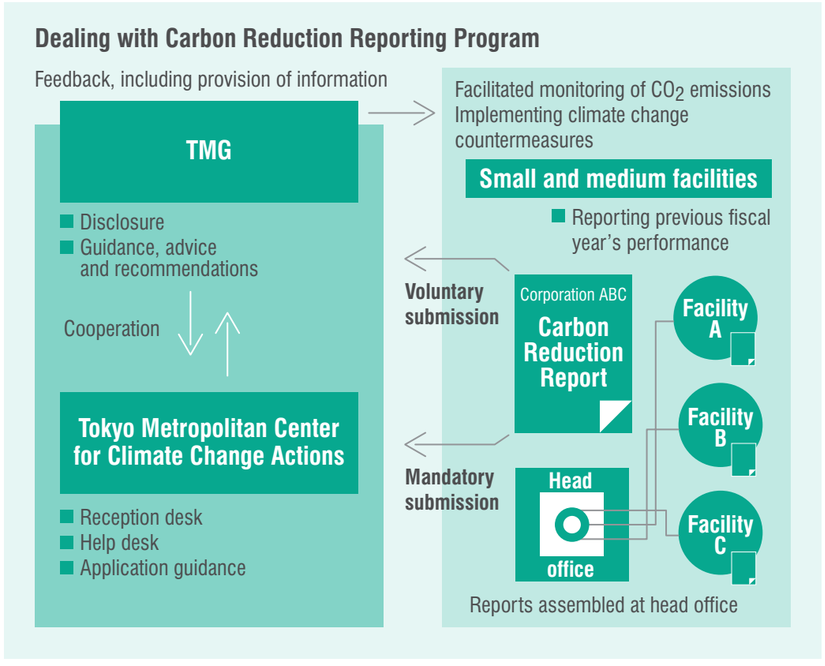
Programme structure and function

The mandatory and voluntary carbon reporting process can be characterised by the following major steps and components, also summarised in Figure 1.

Report compilation and submission

Reporting for CRR covers the previous fiscal year. TMG provides an easy report making tool in Excel sheet format to facilities free of charge. A step by step guidebook explains how energy consumption data is collected and calculated (see *Data collection and utilisation*). Full reports may be prepared and submitted either in paper or electronic form to the Tokyo Metropolitan Center for Climate Change Actions (Cool Net Tokyo). This public corporation, funded entirely by TMG, was established to implement energy saving programmes on behalf of TMG.

Figure 1: **Overview of the reporting process**



Source: After Tokyo Green Building Report 2015.

Reports provide TMG with an array of quantitative and qualitative data such as:

- Facility attributes (facility type, extent of ownership in the facility, GFA, reporting scope [i.e. whole building or tenanted area only])
- Annual consumption amounts of electricity, gas, other fuels and water (including sewerage discharge) and CO_2e amounts
- CO_2 emissions for each energy consumption amount
- CO_2 emissions intensity (total annual CO_2 emissions relative to GFA)
- Overall organisational approach to promoting energy conservation and any CO_2 or energy reduction targets
- Specific measures (planned and implemented) for promoting energy conservation and reducing CO_2 emissions

Report verification

Since CRR does not mandate specific CO_2 emission reductions, third party verification of data is not required. However to enhance the reporting scheme's credibility, TMG checks all submitted reports by comparing data with submissions for the previous year, and also contrasting results with those of similar type buildings. This contrasts with the cap-and-trade scheme, which requires third-party verification of data by agencies registered with TMG.

Public disclosure

Both mandatory and voluntary reports are publically disclosed on the official TMG website[2] in a searchable database format. Reports for individual enterprises can be located by anybody from the general public inputting a particular company name or address. Publically disclosed data includes total annual CO_2 emissions from energy use and water consumption, GFA, carbon intensity and qualitative information on energy consumption reduction measures. Raw energy consumption amounts are not publically disclosed.

Site inspections for mandatory facilities

The Tokyo Metropolitan Environmental Security Ordinance requires occasional site inspections for entities with mandatory reporting obligations. Each inspection lasts approximately two hours; the first hour for interviews and verification of energy bills, and the second for a site inspection of energy reduction measures reported, and identification of further opportunities to decrease energy use. Inspections are conducted by a specialist from Cool Net Tokyo and a TMG officer at the rate of approximately 90-100 each year. In this way, it requires approximately three years to visit all 300 mandatorily reporting enterprises. In general, site visits are positively recognised by relatively larger facility operators as an opportunity to deepen knowledge about unexploited onsite energy efficiency potential.

Feedback and guidance

As shown in Figure 1, CRR is characterised by a two-way exchange of information between reporting facilities and TMG. Data is collected through annual reports and then feedback provided through various forms. First, through a set of building-specific benchmarks, and second, through a carbon report card showing the "graded" carbon intensity relative to same type facilities (both elaborated in Data collection and utilisation). Industry specific handbooks outlining effective energy consumption reductions measures form a third feedback mechanism, and finally, annual training seminars are held each March, and attended by more than 300 industry stakeholders. These provide a general analysis of annual results for 30 business types and suggests various improvement strategies for each, also allowing frontrunner enterprises to share best practices with peers.

[2] http://www8.kankyo.metro.tokyo.jp/ondanka/ad135gcce/index.php

Credit: © Tokyo Convention & Visitors Bureau

Data collection and utilisation

The core metric by which facilities monitor and report annual CO_2 emissions is carbon intensity (kg-CO_2/m^2). This reflects CO_2 emissions resulting from consumption of electricity, gas, other fuel use and water (including both consumption and discharge) relative to GFA over the reporting year. This data is collected via the above-mentioned Excel reporting tool. Since this calculates automatically the carbon intensity for each facility, it eliminates the need for technical knowledge in facility staff charged with reporting. Based upon energy invoices, reporting persons simply input annual energy consumption amounts for individual fuel sources in units such as kWh, Nm^3, kg, L and so on. Each of these quantities are then converted automatically by Excel to caloric energy units (GJ/year) and then to CO_2 emissions. Lastly, the total CO_2 emissions are converted to COE (kL/year).

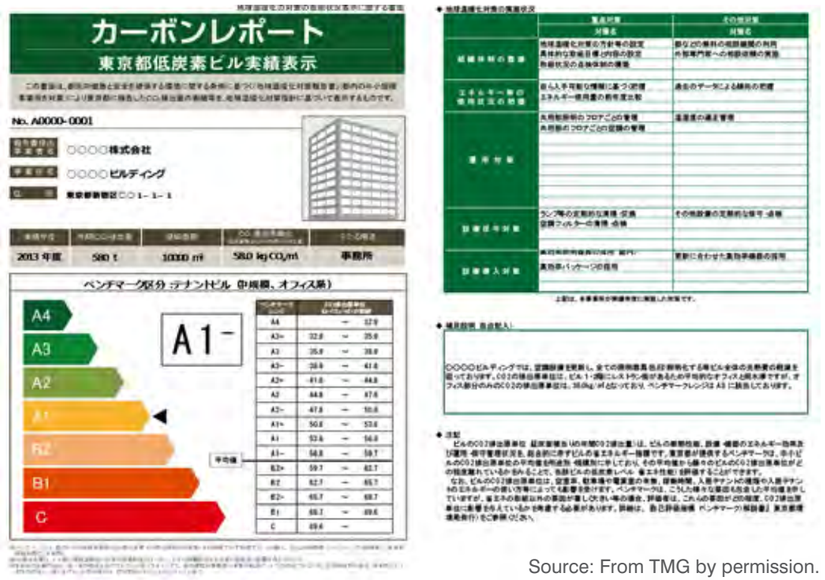
Integration of Low Carbon Benchmarks

This initiative was integrated into CRR in 2012 after it was realised that merely reporting annual energy consumption and CO_2 emissions would not necessarily suffice to motivate facility owners and tenants to take actions to reduce energy consumption. Benchmarks allow owners and tenants to determine if their facility is currently performing above or below the mean performance of other same-type buildings in a table of 30 building categories. These range from office buildings (including sub-categories for different sizes), supermarkets, convenience stores, restaurants, educational facilities, hospitals and entertainment venues to mention a few. Benchmarks are based on three to four years of data. The first set released in 2012 was updated in 2016. Updates will continue each three or so years. For reference, the most recent mean carbon intensity for owner-operated office buildings was 65.4 kg-CO_2/m^2 (average GFA 4,232 m^2) and 585.4 kg-CO_2/m^2 for convenience stores (average GFA 142 m^2).

Addition of Carbon Report Cards

In 2014, a Carbon Report Card initiative was added to CRR. This seeks to facilitate for prospective tenants the easy comparison of energy efficiency and CO_2 emissions intensity of multiple same-type buildings. The report card is individualised for each facility (see Figure 2 for the front and back image) and contains essentially two sets of information. The first is a quantitative comparison of that facility's CO_2 emissions performance relative to average industry benchmarks. This data is derived from the abovementioned Low Carbon Benchmarks and annual submissions of that facility. As seen on the left side of Figure 2, performance ranges for CO_2 emissions intensity extend from A down to C (with C broken down into a further 11 sub-levels). Mean performance (A1-) is set as the lowest sub-category in the A range. The second set of information is qualitative and appears on the rear of the card (right of Figure 2). This contains a summary of the ongoing or planned energy saving measures (both capital intensive and building usage related) for that facility.

Figure 2: **Carbon Report Card front (left) and back (right).**



Source: From TMG by permission.

Several expectations underpin this report card initiative. The first is that reporting facilities can more accurately determine individual performance relative to peer buildings than from benchmarking data alone, and then take measures to improve results and obtain a higher grade each year. In this way, report cards can facilitate a Plan-Do-Check-Act (PDCA) cycle, since annual improvements can be planned and measured each year. The second is that report cards could allow prospective tenants mindful of energy efficiency to easily compare performance across various buildings under rental consideration. They can also be used to estimate electricity running costs by converting carbon intensity to kWh/m^2 and then applying average utility electricity charges. Report cards can be displayed for the public in building spaces such as lobbies or shared directly with potential tenants by real estate agent representatives. The ultimate goal is that reports could serve as a building labelling scheme and drive a trend towards increased demand for low-carbon buildings.

Unique and innovative features

A unique defining feature of CRR is the explicit focus on CO_2 emissions. This contrasts to benchmarking schemes, which focus on energy consumption amounts. CRR's focus on CO_2 emissions serves several purposes. First, public disclosure of CO_2 emissions data and not energy consumption amounts has enabled the scheme to attract many firms which would have been otherwise wary of publically disclosing raw energy consumption data (which can indicate intensity of internal business operations, which many industrial facilities prefer to keep confidential). Second, the focus on CO_2 emissions is a natural consequence of the manner in which the programme is framed and marketed. Although translated in English as a "Carbon Reduction Reporting Programme", the Japanese name is "Global Warming Countermeasures Reporting Scheme". Adoption of this term was driven by TMG desires to move beyond energy efficiency measures (which were already addressed by previous Japanese laws) towards fostering measures to tackle climate change by reducing CO_2 emissions. As such, CRR serves to mobilise industry support not only for reducing energy consumption (which directly benefit business operating expenditures) but also the wider goal of tackling climate change. Third, CRR complements the mandatory cap-and-trade scheme, which is also focused on CO_2 emission reductions. Whilst the cap-and-trade focuses on large facilities with an annual energy consumption above 1,500 kL of COE, CRR focuses on the numerous smaller properties of large chain enterprises falling outside coverage of the cap-and-trade. Individually the CO_2 emissions of each small facility might be relatively low and insignificant. Yet when seen as an aggregate portfolio for an individual enterprise, these emissions are often vast and comparable with large, single facilities targeted by the cap-and-trade.

Incentives and support mechanisms

CRR provides a variety of carefully designed incentive measures to both encourage voluntary participation in the programme and spur implementation of retrofitting measures to reduce energy consumption and CO_2 emissions:

Programme Participation Certificate

A major incentive for voluntary participation—which makes up the bulk of reporting enterprises—is the prospect of improving PR to the public and shareholders. Public display of a Programme Participation Certificate (officially called "PR Sheet" in Japanese) can serve this end. This serves as official evidence of CRR participation and commitment to monitoring and reducing CO_2 emissions in the public interest. The certificate displays CO_2 emissions intensity for that year and previous years and GFA. It can be displayed alongside the above-described Carbon Report Card in a public space such as a building lobby or elevator.

Recognition of outstanding performance

Small and medium leased buildings that consistently report more than three years and beat average CO_2 intensity benchmarks may receive recognition as "Low Carbon Model Building". These are featured on the TMG website[3], which showcases information such as carbon intensity and performance relative to benchmarks, year-to-year emissions trajectories and notable emissions reductions taken. Any reporting tenant building is eligible to apply and must undergo an onsite verification by TMG officials.

Financial incentives

TMG has formulated an array of targeted subsidies and corporate tax credit schemes for small to medium entities. These incentivise and reduce the financial burden for facility owners implementing energy efficiency upgrades. Each has distinct objectives and eligibility requires participation and annual reporting in CRR. One subsidy package with a budget of ¥675 million aims to reduce CO_2 emissions in facilities by covering a portion of expenses accrued when shifting from in-house to an external and energy efficient cloud data storage. Another subsidy scheme under planning seeks to diffuse green lease practices. With a budget of ¥600 million, this will cover a portion of retrofitting costs for building owners on the condition that a green lease is concluded with a tenant. A third subsidy scheme aims to increase uptake of the Carbon Report Cards and render visible the impacts of retrofitting. With a budget of around ¥4 billion between FY2014-FY2015, qualifying facilities receive a maximum allocation of ¥20 million. This subsidises installation of LED lighting and motion/natural light sensors and high efficiency HVAC systems to obtain a higher grade (at least A2) on the Carbon Report Card. A final economic incentive offered by TMG involves a corporate tax credit scheme. This covers up to ¥20 million of purchase costs of specified low-carbon building equipment such as air conditioning, lighting, small boilers, and onsite renewable energy. On top of these, free energy audits are also provided to participants through Cool Net Tokyo. Beginning in 2008, each year approximately 300 facilities have undertake these audits, although some years have seen up to 700 facilitates participate.

[2] https://www.kankyo.metro.tokyo.jp/climate/other/lowcarbon/model_b.html

Credit: Yunphoto.net Copyright ©

Links to other city policies or programmes

CRR functions as one of three core TMG programmes working to foster green buildings. The other two include the Tokyo Cap-and-Trade Programme, mandating CO_2 reductions in some 1,300 large facilities, and the Green Building Programme. The latter mandates integration of energy efficiency and green design principles in new construction over 5,000 m^2. CRR does much to complement the cap-and-trade. First, it targets corporate chains comprised of numerous small to medium facilities scattered around Tokyo. Individually, each facility may fall under the minimum threshold marking mandatory participation in the cap-and-trade (1500kL COE per year). Yet if viewed as a portfolio, aggregate emissions can often exceed a single, large facility in the cap-and-trade. Second, sharing a common currency of CO_2 does much to assist reporting responsibilities for facilities moving from one programme to another. For example, since 2010, some 200 large facilities have reduced energy consumption to the point of being able to exit the cap-and-trade. CRR provides an important opportunity for such facilities to continue monitoring and reporting emissions. Third, large facilities in the cap-and-trade have the option of purchasing CO_2 emissions reduction credits from small and midsize facilities. One of the preconditions for small to medium facilities wishing to register and sell credits to larger cap-and-trade counterparts is annual reporting in the CRR.

3. Design and implementation

Design phase

Timeline

CRR was launched in 2010. Yet ambitions to create a carbon reporting scheme for small to medium-sized facilities date back to the planning stages (around 1998) of the Tokyo Carbon Reduction Reporting Program for existing large facilities. Running from 2002-2005, this reporting scheme mandated reporting of CO_2 emissions to TMG for large facilities consuming more than 1,500kL of COE per year. This scheme was superseded by the mandatory cap-and-trade, also launched in 2010. Prior to the CRR launch date, in excess of one year was required for policy planning and revision of the Tokyo Metropolitan Environmental Security Ordinance to enable integration of coverage of small and medium sized facilities.

Inputs

Policy planning for CRR took place in tandem with the cap-and-trade. Within TMG, the initial approach was to first target larger facilities and then to later widen the scope to encompass small to medium counterparts. The bulk of planning was undertaken by a limited number of staff charged with CO_2 emissions and energy matters in facilities not covered by the cap-and-trade.
As such, there was no such specific budget fixed for design of CRR.

Implementation phase

Timeline

Implementation of CRR was made possible when the Tokyo Metropolitan Environmental Security Ordinance was revised in 2008. The programme itself came into force in 2010. The Low Carbon Benchmarks component was added in 2012 and the Carbon Report Card initiative in 2014.

Inputs

As of December 2015, six full-time staff from TMG are involved with implementation of CRR and related programmes such as free audits and financial incentives. Cool Net Tokyo, also assisting with implementation, holds a further 32 full-time staff. In addition to specific implementation of CRR (including verification of reports, data analysis, on-site visits etc.), these staff conduct marketing to promote carbon reduction measures in small and medium-sized facilities, provision of free energy audits, energy efficiency seminars and training, and various financial subsidy programmes.

Key collaborations

TMG has forged several partnerships and cooperative relationships with key industry groups to facilitate recruitment of reporting enterprises and programme implementation. These all serve as important drivers of the programme. In particular, the Tokyo Corporation Association (representing the interests of 140,000 corporations in Tokyo) has played a crucial role in CRR promotion. It has featured the programme in printed communications for members and requested TMG officials to conduct presentations at key meetings to outline CRR objectives and other policy strategies and support mechanisms for global warming countermeasures. It has also directly encouraged voluntary reporting from its various local chapters in the Tokyo metropolitan by awarding those attaining high submission rates for CRR with its own specially prepared budgets. The Tokyo Building Owners and Managers Associations has also played a key role. They have helped identify and contact frontrunner small and medium-sized-buildings to register for potential designation as a Low Carbon Model Building. This assistance was vital since registration for this requires tenants to share detailed data beyond reporting requirements of CRR.

TMG officials have also strategically reached out to corporate real estate agencies for cooperation in raising tenant awareness about CRR. One approach consists of jointly-held information seminars about CRR for tenants. Conducted twice during 2015, these attracted 170 participants, thus prompting plans to hold more in the future. Lastly, real estate industry representative groups, building owners, and on-the-ground technicians and experts have co-operated in forming a Small and Medium Tenant Building Low Carbon Partnership. This aims to spur market diffusion of the Carbon Report Cards.

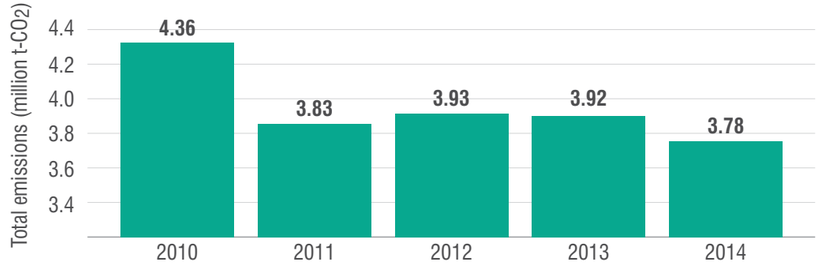
4. Outcomes and impacts

Environmental

As we show in Figure 3, the latest data from the 23,786 facilities submitting reports over five successive years since 2010 shows a declining trend for CO_2 emissions, with a 13.3% reduction achieved for the period 2010 to 2014 (shown as fiscal years). In reflection of this, CO_2 intensity in reporting facilities has also dropped—most saliently for office buildings. In owner-occupied offices, average CO_2 intensity dropped from 61 kg-CO_2/m^2 in 2010 to 49 kg-CO_2/m^2 in 2014 (a 20% reduction). Similarly, in tenant occupied office spaces, CO_2 intensity declined from 78 kg-CO_2/m^2 in 2010 to 63 kg-CO_2/m^2 in 2013 (19% reduction). Interestingly, emissions intensity improvements were not significant across all building types. They were notably lower in educational facilities such as schools and universities, together with hotels and entertainment venues. With approximately 93% of CO_2 emissions in reporting facilities attributable to electricity usage, these impressive reductions in overall emissions and sector-specific CO_2 intensity can be attributed to a significant decrease in electricity consumption. Of note, CO_2 emissions reductions observed over 2011-2013 can be largely attributed to rationing of electricity and extreme voluntary measures to reduce consumption in response to power shortages, caused by the closure of Fukushima. However the most significant achievement of CRR is that emissions have not rebounded even after power supplies to the Tokyo metropolitan were fully restored.

These CO_2 emission reductions hinge on using a fixed emissions factor of 0.382 kg-CO_2/kWh for electricity, also used in the cap-and-trade. If taking into account the roughly 40% increase in carbon intensity of electricity following the post-Fukushima shift from nuclear to gas and coal, these impacts are nullified. Mirroring the second compliance period of the cap-and-trade, CRR's new CO_2 intensity factor for 2015-2019 will be 0.489 kg-CO_2/kWh. The long-term impacts of CO_2 emissions in CRR reporting facilities therefore requires further monitoring over the coming years.

Figure 3: **Total emissions (million t-CO_2) for facilities reporting five fiscal years in a row.**



Social impacts

A major social outcome concerns the impressive number of facilities that have been led to monitor and report carbon emissions on a voluntary basis. As shown in Table 1 and Table 2, voluntary reporters have grown from 1,217 enterprises in 2010 (representing 10,965 individual facilities) to 1,871 in 2015 (representing 11,476 individual facilities). Since programme launch, voluntary submissions have consistently outnumbered mandatory submissions approximately six-fold (although they represent only 4% of CRR's total CO_2 emissions). Not overlooking attractive financial retrofitting subsidies from TMG that are linked to CRR, and the efforts of industry groups to recruit voluntary reporting facilities, rising voluntary submissions are driven by increasing industry appreciation for the many benefits of programme participation (*see Strengths and Drivers*).

Table 1: **Growth of mandatory and voluntary participating facilities***

	2010	2011	2012	2013	2014	2015
Mandatory	20,326	22,567	21,896	22,348	22,415	23,023
Voluntary	10,965	11,439	12,114	11,180	11,914	11,476
Total	31,291	34,006	34,010	33,528	34,329	34,499

*Data shows number of facilities (i.e. buildings) participating in CRR. Based on TMG data as of 12 February, 2016.

Table 2: **Growth of mandatory and voluntarily reporting enterprises***

	2010	2011	2012	2013	2014	2015
Mandatory	273	306	315	287	291	291
Voluntary	1,217	1,313	1,532	1,706	1,969	1,871
Total	1,490	1,619	1,847	1,993	2,260	2,162

*Data shows number of enterprises, which may consist of multiple facilities.
Based on TMG data as of 12 February, 2016.

Information obtained from annually submitted reports also provides important data on non-capital intensive energy saving measures likely fostered by participation in CRR. For tenant occupied sections of office buildings, approximately 95% report taking measures such as extinguishing lights in vacant rooms or hours outside normal operation, 80% report turning off air-conditioning in vacant rooms or hours outside normal operation, and 45% report adjusting heating and cooling temperatures to less-energy intensive settings. Such measures were widely reported across most types of buildings.

Additionally, there are also expectations that the Carbon Report Cards, if shared with potential tenants, will boost market transparency and easy comparison of building energy performance, and serve as a type of green building label.

Market impacts

When compiling annual reports, in addition to abovementioned types of behavioural responses, facilities are able to report any retrofitting activity by selecting from a menu of different low-carbon technologies. Although the following outcomes are likely driven by wider market shifts towards installation of energy efficient technologies, participation in CRR appears to be playing a key role in driving retrofitting.

Results show that in particular, convenience stores and hospitals have attained a high and increasing rate of installation. For convenience stores (7,303 individual stores reported in 2015), installation of high performance lighting bulbs is growing; from an adoption rate of 20% in 2011 to approximately 90% in 2014. Also in 2014, other measures such as installation of air curtains in frozen/refrigerated sections had attained over 60% adoption rate, and approximately 45% for high-efficiency food display lighting and window-vicinity lighting control systems. Direct comparison with introduction rates in 2011 for these last three measures is not possible since menu options were updated in 2014. Nevertheless, compared to 2011, data from 2014 shows overall a significant growth from previously low adoption rates of energy saving technologies. For hospitals and medical clinics, the most widely adopted forms of low-carbon technology were high performance bulbs, lighting fixtures and HVAC equipment, each attaining around a 60% uptake rate in 2014. Another important CO_2 saving measure was installation of water saving equipment. This grew from around 15% of facilities in 2011 to approximately 50% in 2014. Similar to the convenience stores above, although direct comparison between 2011 and 2014 is not possible due to an update of menu items, 2014 data does suggest an increasing trend towards installation of energy saving equipment.

The combination of both non-capital intensive behavioural changes and installation of energy saving technologies has resulted in a highly significant reduction in electricity expenditures. From FY2010 to FY2014, an average electricity consumption reduction of 18.2% (from 1994 Mj/m^2 to 1646 Mj/m^2) was achieved across reporting facilities. This translates to an annual savings in 2014 of ¥838/m^2.

The combination of both non-capital intensive behavioural changes and installation of energy saving technologies has resulted in a highly significant reduction in electricity expenses. In hospitals and medical clinics for example, average annual electricity consumption dropped by 15.8%, from 204.2 kWh/m^2 in 2010 to 171.9 kWh/m^2 in 2014. If assuming ¥24/kWh, this translates to around ¥774/m^2 or ¥2.6 million in savings for each facility. In addition to other facility types such as retail stores, bars, restaurants, entertainment venues and so on, savings levels were also high in tenanted sections of office buildings (approximately 962 individual reporting facilities in 2014). Average annual electricity consumption dropped by 18.2%, from 192.5 kWh/m^2 in 2010 to 157.5 kWh/m^2 in 2014. If assuming ¥24/kWh, this equates to an approximate annual savings of ¥838/m^2 or ¥1.08 million per building.

5. Lessons learned for replication

Strengths and drivers

Measures to increase educational value of data

CRR wields multiple strategies to increase the educational value of data collected through annual carbon reports and motivate enterprises to pursue improved energy efficiency. First, Low Carbon Benchmarks provide both building owners and current tenants with a snapshot of whether or not the particular facility is performing under or above industry averages for 30 building categories in Tokyo. Second, Carbon Report Cards aim to spur facility owners to improve annual benchmark performance and use report cards as green building labels to boost attractiveness to potential tenants. As a third educational strategy, TMG has collaborated with key industry stakeholders to produce a series of tailored energy efficiency handbooks aimed at facility supervisors and management in 27 specific business types. To mention a few, these include hospitals, convenience stores, fitness clubs and supermarkets. These provide an analysis of industry CO_2 emission trends (based on annually submitted reports) and a detailed breakdown of various operational and cost-effective retrofitting and energy reduction measures. These integrate both tacit knowledge gained from annual report submissions and intact knowledge gained from personal interactions between facility engineers and TMG officials.

Communication of clear benefits to encourage voluntary reporting
Messages used in marketing the programme and associated benefits and incentives to industry have proved highly successful in securing voluntary reporters, eliminating the need for expensive advertising campaigns. Marketing messages concentrate on three core merits. The first is that participation in CRR allows industry to play a key and direct role in contributing to climate change mitigation efforts in Tokyo. This is important for corporations seeking to improve public image and tenant relations around climate change. The second is that reductions in CO_2 emission intensity ultimately lead to reduced running expenses, and the third is that annual reporting is simple and hassle-free. This third point is assured by the earlier mentioned Excel tool (see *Data collection and utilisation*).

Measures to boost data reliability

Although third-party verification of data is not required for reporting facilities, TMG takes various measures to boost data reliability. This is important since accuracy of reported data is crucial for maintaining continued industry support, particularly in voluntary reporters. Staff at Cool Net Tokyo (where reports are submitted) briefly check the energy consumption and CO_2 emissions amounts for year-to-year consistency. In cases where sudden changes in energy consumption are observed, reporting organisations are contacted. On top of this, before public disclosure, the entire quantitative and qualitative data (i.e. measures to reduce energy consumption) in each report is verified. When errors are identified, reporting organisations are contacted and data problems rectified. TMG staff communicating with enterprises about incorrect data entries identified after submission are careful to maintain a highly supportive attitude and ensure smooth and productive communication through easy to understand explanations. This is seen as a crucial strategy in motivating enterprises reporting on a voluntary basis to take the trouble to verify and then resubmit flagged data.

Simplified reporting and conscientious guidance

Another two points may contribute to the increased number of the voluntary reporting. The first one is the easy to understand simple reporting system, as the covered entities include small shop owners. Free drafting excel sheet for the Carbon Reduction Reporting Programme is provided to reduce the difficulties for the voluntary submission. The simple inputs of annual electricity, gas, fuels and water consumption in the excel sheet can be easily converted to CO_2 emissions.

Challenges, limitations and countermeasures

Acquisition of tenant data

Similar to benchmarking programmes, building owners in CRR often face difficulties in acquiring tenant energy consumption data. Since these challenges were anticipated, two countermeasures were conceived. The first was the decision to publically disclose only CO_2 emissions intensity data and not raw energy consumption amounts. This helps overcome concerns of tenants not wishing to disclose energy consumption. The second measure was to allow building owners to estimate energy consumption in tenant spaces where difficulties in data gathering are experienced. This strategy has not posed any significant challenges to maintaining the accuracy of overall programme data—principally for two reasons. Firstly, the number of cases where owners are forced to estimate tenant data consumption are relatively rare. Secondly, and perhaps more importantly, the generation of CO_2 emissions data does not constitute the primary objective of CRR. Rather, the main programme goal lies in prompting a shift in industry awareness around energy consumption through the act of reporting itself. This occurs as various building stakeholders cooperate to collect data, monitor emissions and consider improvement measures.

Reporting and disclosure of energy consumption data

TMG officials have so far been unable to achieve a disclosure of raw energy consumption data due to industry resistance. There are principally two reasons why disclosing energy data is important. Firstly, energy consumption amounts are a direct indicator of energy use and can thus more easily show the results of retrofitting and operational measures to reduce energy consumption. Secondly, since the Fukushima nuclear disaster, the CO_2 intensity of the Tokyo power supply has risen by approximately 40% following a switch in fuel from nuclear to natural gas and coal. In this light, public disclosure of energy consumption

quantities would deliver a more positive and meaningful message to the public and programme participants than CO_2 emissions. Mutual disclosure of both energy and CO_2 emissions data therefore constitutes an important area for CRR to tackle over the next few years.

Market demand for low carbon buildings

Officials are experiencing difficulties in simulating market demand for low-carbon buildings through the various tools developed for CRR. As already explained, strategies taken to boost the educational value of CRR data and increase tenant recognition and demand for energy efficient buildings include Programme Participation Certificates, Low Carbon Benchmarks, and Carbon Report Cards. Yet results of a survey administered in 2015 to 1,149 small and medium sized organisations revealed extremely low awareness and utilisation of these initiatives. For example, only 14% of respondents had heard of the Programme Participation Certificate, and of these, only 30% reported currently displaying it. Industry awareness of the Low Carbon Benchmarks and Carbon Report Cards is similarly low, at just over 10% for each. Of these respondents, only 40% indicated using the benchmarks, and 25% for the Carbon Report Cards. The most common reason cited was uncertainty as to how these tools could be effectively used. Several countermeasures have been formulated in response. For example, the already mentioned retrofitting subsidy for incentivising improved energy efficiency based on report card performance (see *Financial incentives*) is expected to play an important role in increasing report card usage. The Small and Medium Tenant Building Low Carbon Partnership consisting of a collaboration with key industry stakeholders—also formed to spur wider market diffusion—is equally anticipated to mitigate this challenge.

Tenant engagement

Officials are encountering challenges in engaging corporate tenants with energy efficiency issues. Tenant demand in Japan for earthquake resistant buildings tends to overshadow that for energy efficiency. Also, frequent turnover of tenant leases reduces the ability of owners to raise rents to cover building upgrades. This problem surfaces particularly during free energy audits; many recommendations are not implemented due to split-incentives between owners and tenants. The absence of any industry group in Tokyo specifically representing tenant interests also hampers tenant outreach efforts. To overcome this, as mentioned TMG officials have recently collaborated with corporate real estate agencies to conduct tenant seminars on CRR participation, key results, and effective energy efficiency measures. In addition, TMG has started to promote green leases through, for example, earlier mentioned retrofitting subsidies that require sharing of costs and benefits through lease modifications.

List of references

Bureau of Environment. 2012. *Heisei 23 Nendo Chikyu Ondanka Taisaku Seminar: Chikyu Ondanka Taisaku Houkokusyo no Teisyutu Jyoukyou Oyobi Bunseki Kekka (2012 Climate Change Countermeasures Seminar for Business Operators with Small to Medium Sized Facilities)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/news/20120321/pdf/cool-net_H23houkokusyo_syuukei.pdf

Bureau of Environment. 2014. *Carbon Report no Riyouhouhou ni Kansury guideline (Carbon Report Usage Manual)* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/other/attachement/carbon_report_GL.pdf

Bureau of Environment. 2014. *Cyusyou Teitanso Modelu Bilu (Small to Medium scale Low Carbon Model Building)* (in Japanese). Tokyo Metropolitan Government. https://www.kankyo.metro.tokyo.jp/climate/other/lowcarbon/model_b.html

Bureau of Environment. 2014. *Carbon Report Seido no Gaiyou: Cyusyou Tenant Bilu Syouene Teitansoka Programme* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/other/attachement/carbon_report_gaiyou_20140707.pdf

Bureau of Environment. 2014. *Enlarged Carbon Report Format.* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/other/lowcarbon.html

Bureau of Environment. 2014. *Taisyo to Naru Jigyosyho (Covered Facilities)* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/large_scale/overview/target.html

Bureau of Environment. 2015. *Press Release: Cap and Trade Seido 4 Nendome no Sakugen Jisseki Houkoku.* (in Japanese). Tokyo Metropolitan Government. http://www.metro.tokyo.jp/INET/OSHIRASE/2015/02/20p2j700.htm

Bureau of Environment. 2015. *Tokyo Green Building Report 2015*. Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/tokyogreenbuilding2015/docs/report2015.pdf

Bureau of Environment. 2015. *Tokyo Kankyo Kihon Keikaku no Arikatani Tsuite: Cyukan no Matome, Gaiyo (The Next Tokyo Environmental Master Plan: Interim Report in Brief)* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/basic/attachement/matome_gaiyou.pdf

Bureau of Environment. 2015. *Tokyo-to KankyoShingikai: Tokyo Kankyo Kihon Keikaku no Arikata ni Tsuite (Cyukan no Matome)* (in Japanese).

Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/basic/attachement/matome.pdf http://www.kankyo.metro.tokyo.jp/basic/conference/council/public_comment.html

Bureau of Environment. 2016. *Chikyu Ondanka Taisaku Houkokusyo Sakusei Handobkku Honpen (Carbon Reduction Reporting Program Handbook)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/report/handbook/Handbook_Main2016.3ver.pdf

Bureau of Environment. 2016. *Cyusyo Kibo Jigyosyo no Onshitu Kouka Gas Haisyuturyou no Syukei Kekka, Sokuhou Chi (The Latest Aggregated CO_2 Emissions Data from the Small to Medium Sized Facilities)* (in Japanese). Tokyo Metropolitan Government. http://www.metro.tokyo.jp/INET/CHOUSA/2016/02/60q2p100.htm

Bureau of Environment. 2016. *Jikohyouka Shisu Kaisetusyo (Explanation of Benchmarks)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/benchmark/pdf/TokyoBenchMark-Manual_[2012data]new.pdf

Bureau of Environment. 2016. Published Data of Tokyo Carbon Reduction Reporting Program for Small and Medium-scale Facilities. Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/ad135gcce/index.php

Bureau of Environment. 2015. *Heisei 26 Nendo Cyusyo Kibo Jigyosyo no Syouene Suishin Anketo (Survey for Energy Saving Measures in Small to Medium Sized Entities)* (in Japanese). Tokyo Metropolitan Government. http://www.kankyo.metro.tokyo.jp/climate/businesses/attachement/surveyreport.pdf

Bureau of Environment. 2016. *Heisei 27 Nendo Chusyokibo Jigyosyo no Ondanka Taisaku Seminar (2015 Climate Change Countermeasures Seminar for Business Operators with Small to Medium Sized Facilities)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/news/20160303/index.html

Bureau of Environment. 2016. *Heisei 28 Nendo no Chikyu Ondanka Taisaku Houkokusyo no Sakusei Teisyutu ni Kansuru Goannai (Overview of Carbon Reduction Reporting for Small to Medium Entities)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/news/20160303/pdf/2016_sakuseiannai.pdf

Bureau of Environment. 2016. *To no Kikou Hendo Taisaku to Cyusyo Kibo Jigyosyo no Syo Ene Taisaku (Energy Saving Measures for Metropolitan Small to Medium Sized Entities)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/news/20160303/pdf/2016_shiensaku.pdf

Bureau of Environment. 2016. *Tei Tanso Benchmark (Low-carbon Benchmarks)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/benchmark/index.html

Bureau of Environment. 2016. *Tonai Chusyokibo Jigyosyo no Chikyu Ondanka Taisaku Houkokusyo Seido (Carbon Reduction Reporting Program for Small and Medium Facilities in Tokyo)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/pdf/2016_leaflet.pdf

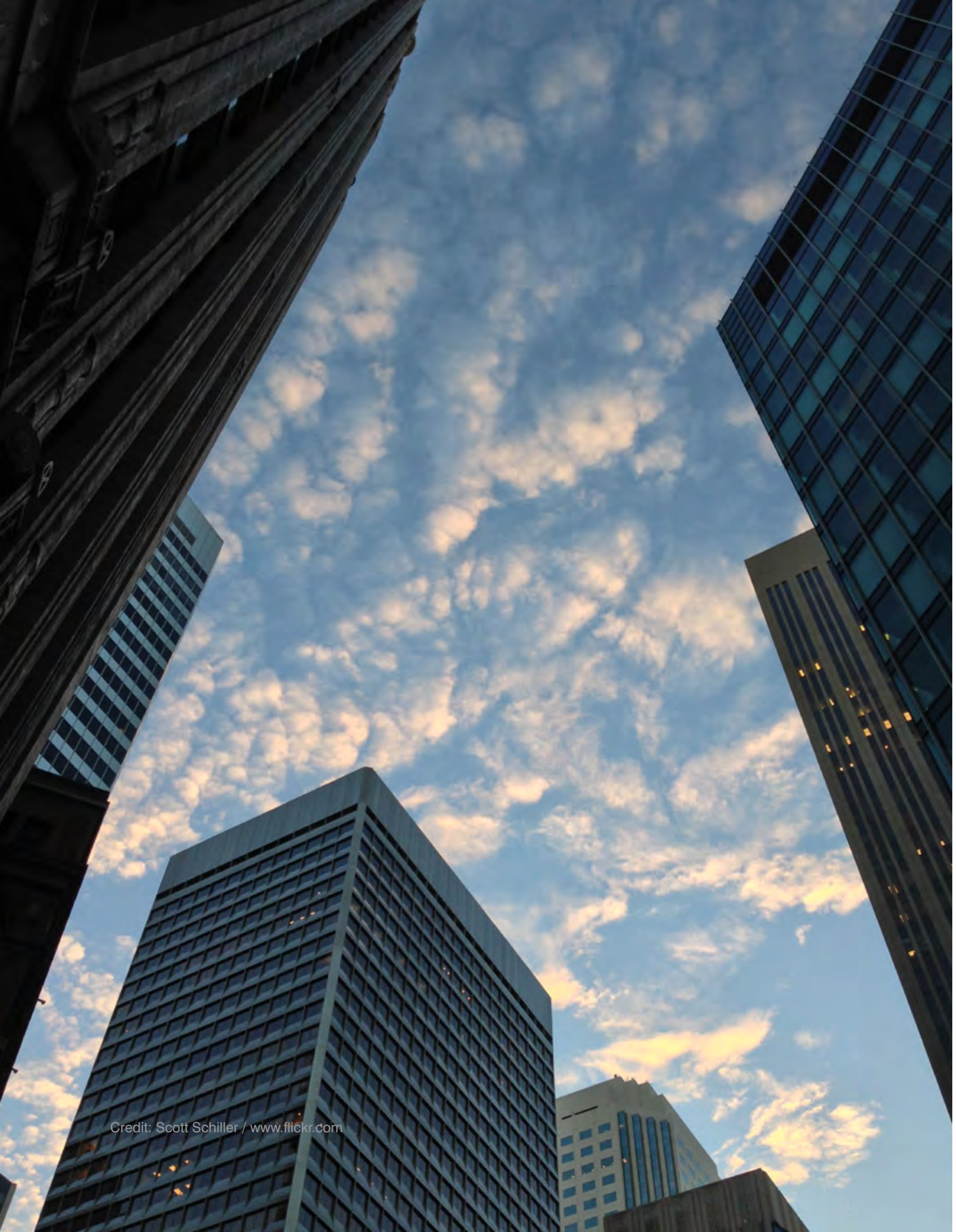
Bureau of Environment. 2016. *Teitanso Benchmark [2012 Jisseki-ban (2015-nenndo Jissekiikou no Haisyutukeisuu)] Kubunn Ichiran. (Latest Benchmark Classification List)* (in Japanese). Tokyo Metropolitan Government. http://www8.kankyo.metro.tokyo.jp/ondanka/benchmark/pdf/the_list_of_TokyoBenchMark[2012data]new.pdf

Tokyo Metropolitan Center for Climate Change Actions. 2014. *Gyoshubetsu Syou Enegy Taisaku Tekisuto (Energy Efficiency Handbooks by Business Type)* (in Japanese). http://www.tokyo-co2down.jp/seminar/type/text/

Tokyo Metropolitan Center for Climate Change Actions (Cool Net Tokyo). 2015. *Dai 3kai Bosyu (Saisyu) no Goannnai!: Syouene Setsubi Dounyu ni Saidai 2,000 Manen no Jyosei! (Third Call for Projects: JPY 20 Million Subsidies for Retrofits of Energy Saving Equipment)* (in Japanese). https://www.tokyo-co2down.jp/cmsup/pdf/leafletMieruka3.pdf

Conclusion

Credit: Micheal Muraz -Micheal Kappel / www.flickr.com



Credit: Scott Schiller / www.flickr.com

This second report in our *Urban Efficiency* series set out to generate a detailed understanding into differing approaches taken in C40 cities (specifically those in the PBE network) to advance operational energy efficiency and retrofitting in existing, private buildings. As well seeking to unpack important aspects of each programme's functioning, we also aimed to build knowledge on success factors that can be designed into programmes, and also, innovative measures for coping with various obstacles and limiting factors.

Our findings unearthed a wide array of approaches. These ranged from carbon reporting and disclosure (Tokyo), large scale urban transformation (Shenzhen), finance support (Boston and Seoul), leadership programmes and energy reduction challenges (Chicago and London) and building certification schemes (Mexico City). Although at first glance these may appear as unique approaches with little in common, we drew attention in our analysis to similar policy functions (see Table 2.3) that run across programmes. In our survey of seven programmes, a noteworthy feature was that the majority were voluntary (or contained a voluntary component). A further interesting feature was that some of these voluntary programmes were targeting several thousand buildings, whilst others focused on capacity enhancement and intimate relationship building with relatively smaller and select participant cohorts (see Figure 2.1).

Coinciding with work of other researchers (Van der Heijden, 2017), this serves as convincing evidence that cities are continuing to experiment with voluntary approaches in attempts to govern energy efficiency in the built environment. The degree of stakeholder involvement in programme design, and the careful array of incentives designed to encourage building sector involvement (see Section 2.3) was noteworthy. This all suggests that voluntary governance instruments are continuing to play a vital complementary role alongside mandatory approaches. It may also be a reflection of the difficulty of engaging with the privately owned building sector. Cities are therefore undertaking a diverse range of mandatory and voluntary approaches.

However programmes (and their various instruments) for building energy efficiency and retrofitting are by no means "cast in stone". They should be understood as packages of evolving governance tools, that are constantly refined in response to accumulated data, knowledge and experiences. From this perspective, we also highlight that voluntary programmes can serve as ideal vehicles for later transitions to mandatory programmes. This transition can occur by building relations and trust with key building industry players, and by producing fundamental datasets to allow policymakers to understand their building stock.

From another perspective, one area we were unable to explore—but nevertheless did draw attention to—is the role of "policy mixes" (Rosenow et al. 2016) and interactions that occur across the various programmes in a city to advance energy efficiency and retrofitting in buildings. We use this term firstly to illustrate that an individual programme is in fact a collection of various governance instruments (see Table 2.3). We also employ this concept to point out that cities possess multiple programmes targeting energy efficiency in buildings. One illustrative example is Chicago. The city's benchmarking ordinance plays a vital role in mandating that buildings larger than 50,000 ft^2 track and report annual energy and water consumption. As with all benchmarking schemes, buildings subject to this ordinance are under no obligation to actually improve energy efficiency performance each year or attain certain benchmarks. Retrofit Chicago Energy Challenge therefore plays an important complementary role by motivating and mentoring influential leaders in the building industry to improve operational energy performance and carry out retrofitting. Success in the Challenge thereby improves benchmarking performance for an individual building, which then drives success of the benchmarking ordinance as a whole. The question of *How to design one programme to achieve optimal compatibility and synergies with another?* is therefore a key challenge for policy makers to undertake. It is clear that a carefully designed policy mix for advancing energy efficiency and retrofitting in existing, private buildings will comprise of both "sticks and carrots" (i.e. mandatory and incentives or voluntary approaches). We saw this with Tokyo's Carbon Reduction Reporting Program (CRR), a hybrid mandatory and voluntary initiative. Efforts were made by policymakers to ensure synergistic links with other programmes such as the cap-and-trade system. A mechanism was established to allow sale of emissions credits gained from retrofitting projects implemented by CRR participants (small to medium buildings) to large buildings in the cap-and-trade. Care was also taken to provide incentives for buildings to implement energy saving measures by linking CCR to a free energy audit initiative. The sharing of strategies that enhance complementarities and synergies across various programmes and instruments in a city's policy mix is a key topic for future research and discussions.

Expectations are high for the surveyed programmes. Still related to the idea of policy mixes, many form integral components of wider city visions and targets for energy, climate change and sustainability. For example, the surveyed Building Retrofitting Program Loan Support Scheme in Seoul forms a vital component of the ambitious One Less Nuclear Power Plant (OLNPP) vision. First launched in 2011, OLNPP initially set out to reduce energy demand in Seoul by 2 million TOE (tonnes of oil equivalent) by 2014, which represents the equivalent annual output of a typical nuclear power plant. These energy reduction goals have since doubled in ambition, to 4 million TOE by 2020 from 2012 levels, for the second phase of OLNPP.

So how are the surveyed programmes doing? Our research uncovered some impressive evidence of outcomes and successes (Section 2.4). Far from being limited to environmental impacts such as reduced GHG emissions or energy consumption, we demonstrated that programmes were delivering significant outcomes of both a social and market nature. This too highlights the importance of broadening the appraisal of programme outcomes beyond traditional and narrow environmental indicators. Evidence also suggests that outcomes and successes are not incidental, but are rather designed into programmes. For instance, our report shed light on an array of innovative strategies used to boost success in programmes (see Section 2.5). Given the voluntary nature of programmes, the careful preparation of incentives to entice participation by the building sector was notable. To mention a few, in addition to financial incentives, these also included knowledge type incentives (e.g. provision of industry benchmarks, best practices for reducing energy consumption etc.) and the creation of opportunities for buildings to be publically recognised for their leadership and success in reducing energy consumption.

Finally, our report unearthed a range of obstacles and hampering factors that arise during both programme design and implementation stages. Here too, since "necessity is the mother of all invention", programmes demonstrated an array of innovative coping measures to overcome such challenges (see Section 2.6). To mention but a few, programmes showed much innovation in addressing split-incentive issues between tenants and owners. Boston has developed a finance mechanism to pass on the costs of energy efficiency retrofits to tenants, whilst assuring they receive the benefit of reduced energy expenditures once the project is paid off. The project also addresses lending institution reluctance to finance building energy efficiency upgrades by incorporating a performance guarantee into projects. In Mexico City, tenants are encouraged to invest in building energy efficiency by allowing certification of tenanted portions in the Sustainable Building Certification Program. Another commonly observed strategy was for cities to overcome resource limitations (e.g. personnel, financial etc.) by designing and implementing programmes in tandem with private and nonprofit sector partners. This was particularly observed, for example, in the Retrofit Chicago Energy Challenge. The integration of external expertise was also noticeable in Shenzhen's International Low Carbon City in Pingdi. Here, Dutch researchers worked closely with Shenzhen officials to design the vision and masterplan of the city (see De Jong, Yu et al. 2013; De Jong, Wang et al. 2013).

From perspectives such as these, *Urban Efficiency II* has provided a goldmine of information and insights into various approaches for governing energy and sustainability challenges in the existing building stock. In addition to this understanding we hope that our findings regarding strategies for increasing chances of success, and overcoming obstacles when encountered, will help other policymakers around the world design and implement programmes more effectively.

On behalf of C40 and the PBE Network, Tokyo Metropolitan Government hopes sincerely that this report serves as a tool for promoting information and experiences sharing, and that it also contributes to the development of additional resources and tools for this field.

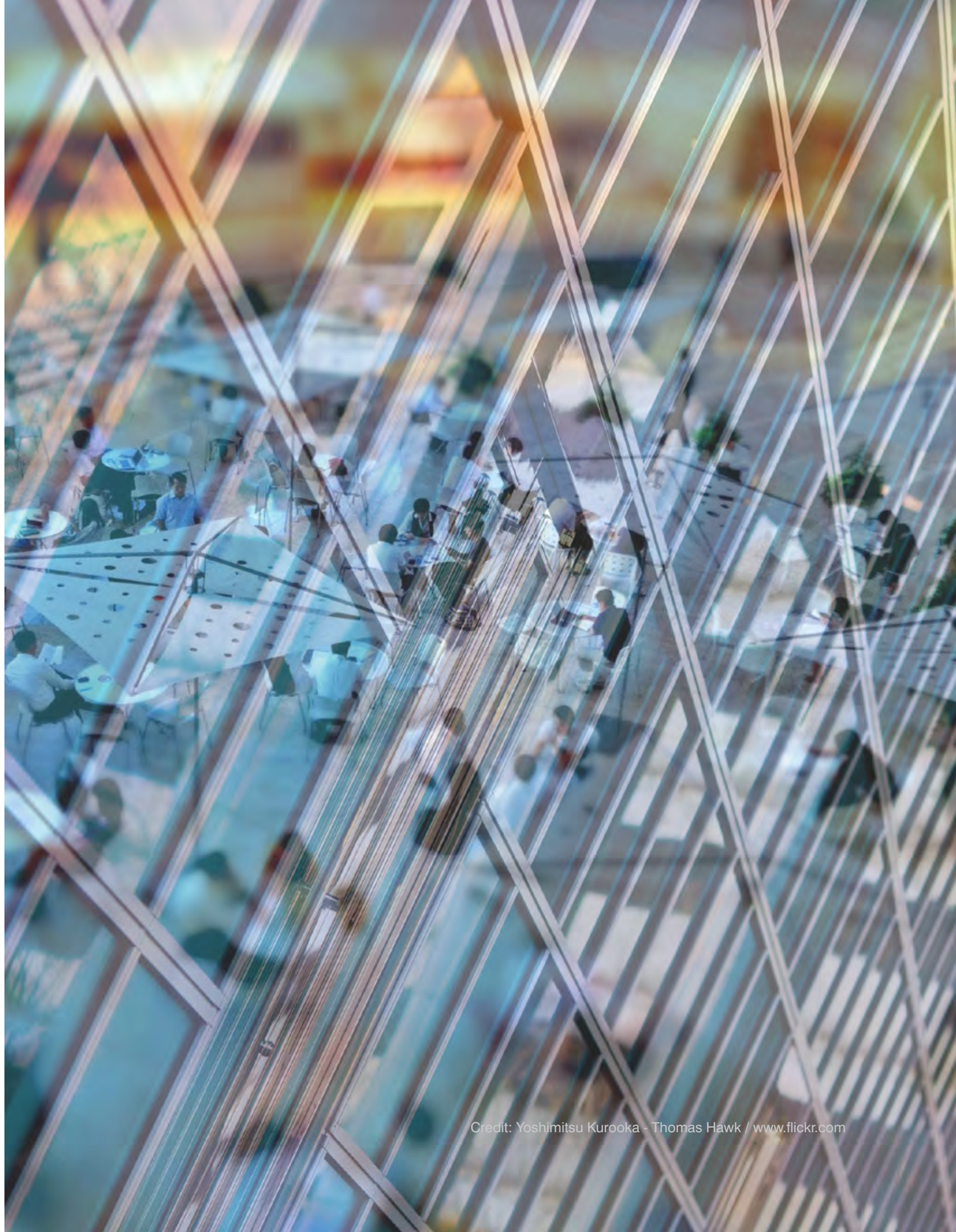
List of references

De Jong, M., Yu, C., Chen, X., Wang, D., Weijnen, M. 2013. Developing robust organizational frameworks for Sino-foreign eco-cities: comparing Sino-Dutch Shenzhen Low Carbon City with other initiatives. *Journal of Cleaner Production* 57: 209-220

De Jong, M., Wang, D., Yu, C. 2013. Exploring the Relevance of the Eco-City Concept in China: The Case of Shenzhen Sino-Dutch Low Carbon City. *Journal of Urban Technology* 20 (1): 95–113.

Rosenow, J., Fawcett, T., Eyre, N., Oikonomou, V. 2016. Energy efficiency and the policy mix. *Building Research and Information* 44 (5-6): 562-574.

Van der Heijden, J. 2017. *Voluntary programs for sustainable buildings and cities: opportunities and constraints in decarbonising the built environment*. Cambridge, Cambridge University Press.



Credit: Yoshimitsu Kurooka - Thomas Hawk / www.flickr.com

C40 Cities Climate Leadership Group
C40 North West Entrance, City-Gate House
39-45 Finsbury Square Level 7 London,
EC2A 1PX
United Kingdom.
Website: www.c40.org
Email: contact@c40.rg

Tokyo Metropolitan Government
2-8-1, Nishi-Shinjuku, Shinjuku-ku, Tokyo,
163-8001 Japan
Website: http://www.kankyo.metro.tokyo.jp
Email: S0000721@section.metro.tokyo.jp

CSR Design Green Investment Advisory, Co., Ltd.
Kudan Tamagawa Bldg. 5F 3-7-12,
Kudan-minami Chiyoda-ku, Tokyo,
102-0074 Japan
Website: http://www.csr-design-gia.com/
Email: gia@csr-design.com