Turning Local Data into Global Action: Analyzing Building Energy Data across Global Cities

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ABSTRACT

There is growing international recognition that cities are at the front line of ambitious action on climate change. Building energy consumption accounts for nearly 50% of emissions in large global cities on average, rising to 80% in cities like New York and London. To make their building stock fit for a low-carbon future, cities need reliable data on how buildings within their jurisdiction perform, as well as insights into what comparable cities have been able to achieve with similar buildings. Cities have been collecting substantial amounts of building performance data through mandatory and voluntary initiatives, and are eager to understand opportunities for further energy and emissions savings based on other cities' measured successes. This study explored building energy data comparability opportunities through interviews with 15 world leading cities and numerous building energy data and policy experts. It found definite interest and desirability for comparable data and a series of other key city needs in the area of building energy efficiency and data. As world leading cities set ever more ambitious climate goals, additional policy tools and levers are needed. Better and more comparable data, as well as enhanced support on methodologies, policies and policy evaluation will help cities target their interventions to meet their climate goals as effectively as possible. Cities are leading the way with new policy activity and are willing to collaborate towards increased ambition. This paper reviews the findings of the study and discusses likely next steps toward collaboration.

Introduction

The twenty-first session of the Conference of the Parties (COP21) created the momentum needed to prevent catastrophic climate change. The governments of 196 countries agreed an ambitious goal in the Paris Agreement: to restrain average global temperature rises to "well below" 2 degrees above the pre-industrial average, with an aspiration of a 1.5 degree limit. The global ambition set at COP21 can only be achieved if it is swiftly and visibly transformed into local implementation, particularly in the critical period between now and 2020 when the Agreement will come into force, by which time global emissions need to have peaked. Research by C40 Cities Climate Leadership Group[1] shows that urban policy decisions before 2020 could determine up to a third of the remaining global carbon budget that is not already "locked-in" by

[1] Created and led by cities, the C40 Cities Climate Leadership Group (C40), now in its 10th year, connects more than 80 of the world's greatest cities, representing 550+ million people, and one quarter of the global economy. C40 convenes networks which connect city officials around the world who are tackling similar challenges and opportunities for climate action. Each of the 16 networks is focused on a specific topic of highest priority to C40 cities and with the potential for the greatest climate impact. C40 networks help cities replicate, improve and accelerate climate action. The networks on Municipal Building Efficiency and Private Building Efficiency together have seen participation of nearly half of all C40 member cities.

past decisions (C40 and SEI 2015). Recent analyses also suggest that much lower carbon budgets may be available than previously estimated, placing even greater urgency on climate action (Rogelj et al. 2016).

Cities are already leading the charge on global climate action, having taken almost 10,000 climate actions since COP15 (C40 and Arup 2015). However, staying within 1.5 degree warming relies on reducing energy demand at much greater speed and scale, particularly from buildings. Building energy consumption is a major source of urban greenhouse gas emissions constituting nearly 50% of emissions in C40 cities on average, and rising to 75% and 80% in cities like New York and London (C40 and Arup 2011). Globally, the greatest savings opportunities for city governments are in building energy use. The abatement potential from this sector has been estimated at 2.4Gt CO2e in 2030 and 4.5 GtCO2e in 2050, with significant savings arising from deep building energy efficiency standards for new urban buildings, building energy retrofits for existing urban buildings and aggressive energy performance standards for urban building lighting and appliances (Erickson and Tempest 2014).

Achieving significant emissions reductions from buildings in line with a 1.5 degree scenario will require scaled ambition from cities, as well as more targeted support to enable cities to achieve high-speed transformation of their building stock. The transition to a low carbon future will additionally require increased coordination between national and city governments, including cross-agency collaborations, and investment in local capacity building and enhanced analytical capabilities (IEA 2016).

To transform their building stock and identify the greatest opportunities to reduce energy demand from buildings, cities need to identify the actual energy consumption and emissions of their building stock, set realistic but ambitious reduction targets and identify the most effective means for meeting these targets. This is the triple challenge. C40's experience is that cities can tackle such challenges better when they work together. As the recent Climate Action in Megacities 3.0 research shows, one third of all climate action in cities is taken as a result of city network exchanges and peer learning (C40 and Arup 2015). And when cities work with other cities in a specific C40 network, they mostly focus on buildings sector actions.

Already, cities within the C40 Private Building Efficiency (PBE) network are drawing on examples of global best practice to develop local policies. They collaborated to create *Urban Efficiency: a Global Survey of Building Energy Efficiency Policies in Cities* (C40 and TMG 2015), which they are currently expanding. However, both qualitative and quantitative evidence is required to inform policies and set targets. For this reason, ten cities in C40 (Houston, London, Los Angeles, Melbourne, New York, Philadelphia, San Francisco, Singapore, Sydney, Tokyo – the Data Insight workstream) have joined forces to collaborate on comparing data from their cities to identify international top performance in different buildings segments in order to inform and motivate improved local performance. The initial hypotheses developed by the ten cities were to assess whether cities could agree comparable city metrics and methods for data collection and whether combining data into an integrated dataset would be an effective way to enable policy measures associated with the best performing buildings to be identified and replicated.

This paper presents the findings from a scoping study funded by ClimateWorks Foundation. It tested these hypotheses and reviewed additional city needs in the area of building energy efficiency and data. The scoping study was based on the results of a literature review, surveying, analysis of key documents, and semi-structured interviews with 15 cities. These included the ten initial cities which expressed interest in collaborating on building energy data,

and five other cities with different regional perspectives and development paths (Cape Town, Mexico City, Paris, Shenzhen, Wuhan). All city interviewees are members of C40's buildings networks, holding senior positions within Green Building, Energy Efficiency and Sustainability government teams in their respective cities. The study additionally included more than 15 interviews and informal discussions with relevant stakeholders and international experts. These were identified through desk-research and snowball sampling, with diverse participation from building energy data platforms and initiatives, academic research, policy research and advisory, standardization efforts, financial organizations, national governments and private sector energy management. The paper is structured as follows: Methodology; Findings (Building Energy Data Landscape: Nations, Cities and Other Stakeholders; Data Collection in C40 Cities; Opportunities for Enhanced Collaboration; Next Steps); and Conclusions and Recommendations.

Methodology

Literature Review and Preliminary Survey

A detailed literature review was conducted to identify relevant work taking place in the field and key stakeholders. This was directed by conversations with cities from the PBE network and other experts who were consulted in the initial research stages. It focused on:

- Comparisons of building energy performance data across multiple countries, cities or jurisdictions, including standardization and fair comparison issues;
- Data collection policies/initiatives and relevant stakeholder groups;
- Policy impact evaluation efforts.

Additionally, city reports on local policies and initiatives, and, where available, analysis of the data generated through these initiatives, were reviewed. This allowed for the development of a survey for cities to gather more specific information regarding the drivers of data collection and the types, quantity, and issues related to the datasets that city interviewees were collecting or had access to.

Following completion of the preliminary survey by the ten Data Insight cities, a preliminary findings report was compiled, including summary tables of city data availability, potential challenges and solutions to comparability, as well as a list of areas where further information was required. That information allowed for the development of an interview structure to be used with cities and the rest of the interviewees.

Semi-structured Interviews

Interview questions were sent in advance of the interview and covered three main themes: the possibility and challenges of data pooling; interest in data pooling (where applicable); and the potential impacts. Interviews with organizations that collected building energy data focused on their approach to data collection and analysis, and potential collaboration areas.

Findings

Building Energy Data Landscape: Nations, Cities and Other Stakeholders

Nations. City policy is closely linked to national level initiatives and efforts. To date, many countries in Europe, North America, Asia, and Oceania have begun to implement building energy performance rating programs or similar initiatives that generate significant building energy data. Europe has mandated energy certification, while in other regions popular voluntary energy rating tools have become incorporated into mandatory policies requiring the collection and disclosure of energy consumption information. The U.S. Environmental Protection Agency's (U.S. EPA) Energy Star Portfolio Manager tool is the basis for mandatory energy rating policies, being based on periodic national surveys (e.g. Commercial Buildings Energy Consumption Survey and Residential Energy Consumption Survey). In Australia, the National Australian Built Environment Rating System (NABERS) was originally developed for New South Wales and has now become the foundation for mandatory energy rating of offices across the country, with the most data collected in the two largest cities, Sydney and Melbourne. Related policies have also been evolving in Asia. A brief history of building energy performance rating and disclosure policies is shown below in Figure 1.

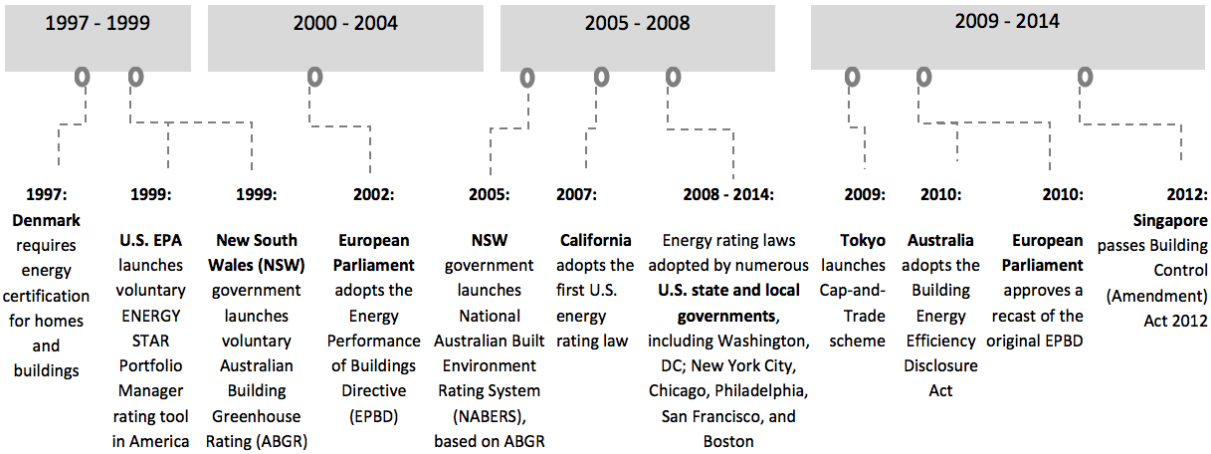

Figure 1. Building energy performance benchmarking and disclosure policies over time. *Source:* Adapted from Burt, Burr and Hinge 2015

At the international level, the International Energy Agency (IEA) has been conducting significant work on building energy data, summarizing datasets available around the world and data typologies along with challenges to data pooling and comparison (IEA 2013) and providing historic metrics data (2000-2012) for national building energy use (IEA 2015a). More recently, a new IEA Annex, Annex 70 on Building Energy Epidemiology[2] has been approved for development. This Annex will focus on the analyses of real building energy use at scale to inform realistic low carbon transition pathways and solutions. It will engage with government, industry and technology manufacturers to identify user requirements for data, establish best

[2] See Hamilton, I.G.M Summergield, A. J., Lowe, R., Ruyssevelt, P., Elwell, C.A., and Oreszczyn, T. 2013. Energy epidemiology: a new approach to end-use energy demand research. Building Research & Information, 41, 482-497. Doi:10.1080/09613218.2013.798142

practices in data collection and analysis, developing metrics and performing international comparisons of building stocks and their energy use (IEA 2015b).

Cities. The number of cities enacting reporting and benchmarking laws has been growing in both C40 and non-C40 members. Within C40, the number of cities taking action on commercial building and facility benchmarking rose from 12, in 2011, to 30, in 2015 (C40 and Arup 2015).[3] Cities are not just increasing the number of actions taken on building rating and reporting but also the scale of the action, moving quickly from the pilot or significant scale to the citywide scale (C40 and Arup 2015). This trend is significant as cities look to better understand their building stock and more effectively target their policies. For instance, the data gathered through the New York's benchmarking law (Local Law 84) enabled the city to set the first data-driven energy targets in the U.S. and informed its Retrofit Accelerator and Carbon Challenge Programs.

Tokyo implemented a Cap-and-Trade program in 2009 which requires the 1300 highest emitting buildings to annually report carbon emissions and progress toward reductions. Tokyo has also developed a mandatory emissions report and disclosure program for small and medium facilities. In Singapore, legislation was passed in 2012 that requires all building owners to annually report energy consumption data, starting with commercial buildings in 2013 and expanding to tertiary institutions and healthcare facilities in 2015.

Outside of C40, and in the U.S. in particular, there has also been a major increase in mandatory benchmarking and transparency policies in the past three years, some of it advanced more quickly through efforts by the Institute for Market Transformation (IMT) and the Natural Resources Defense Council (NRDC). These new policies are stimulating a lot of interest and new sources of data. Additionally, several U.S. national initiatives have been launched to support localized energy data and analysis (e.g. Cities-LEAP Project).

Other stakeholders. A number of key organizations are also actively working on building energy data and have started partnering with cities on specific projects (e.g. building stock analysis; open data advocacy work). These include global networks or organizations led by corporate occupiers, property investors and developers, owners and managers, each with their own platform solution (e.g. Urban Land Institute Greenprint; Global Real Estate Sustainability Benchmark; Global Building Information Gateway). Other relevant working groups include policy research and advocacy groups (e.g. City Energy Project; Institute for Market Transformation), academic research groups (e.g. University College London Energy Institute; Lawrence Berkeley National Lab; New York University Center for Urban Science and Progress) and standardization efforts (e.g. U.S. Standard Energy Efficiency Data (SEED) and Building Energy Data Exchange Specification (BEDES); Carbon Disclosure Project; World Resources Institute) or financial organizations (e.g. Investor Confidence Project). There is also an overwhelming amount of private sector activity underway tapping into building energy data. This activity is igniting significant innovation in terms of analytical capacity and user interfaces for building energy data.

[3] The report Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities (C40 and TMG 2015) provides more information about the other types of policies led or implemented by C40 cities.

Data Collection in C40 Cities

As revealed through the preliminary survey completed by cities and the follow up interviews, the type and quantity of data collected by cities depend on the underlying policy/initiative. Table 1 provides a summary of datasets assembled in C40 cities where the level of data gathered thus far may be suitable for data pooling. Most cities' mandatory policies are limited to annual reporting of total energy consumption and energy by fuels, including basic building characteristics such as floor area, building type (generally following established local conventions about floor area calculations and definitions of building "types" and "uses") and in some cases occupancy information. All cities report gross floor area with a few exceptions (e.g. Sydney; Mexico City).

Table 1. Details of datasets assembled in C40 cities

City	Data Source	Driver	Building Type(s) Included	Year
Houston	City Gov't Buildings	V	G	2008 - 2014
London	Business Energy Challenge	V	O, H, R, Rest	2010 - 2013
Los Angeles	Better Buildings LA	V	O, H, R, HC, F, Resi, G	2010 - 2014
Melbourne	Not applicable (various sources)	V&M	O, H, R, E, F, G	
New York	City Gov't Buildings	M	O, E, HC, G	2010 - 2014
New York	Private Non-Residential	M	O, H, R, Rest, E, HC	2011 - 2014
New York	Private Multi Family Residential	M	Resi	2012 - 2014
Philadelphia	Benchmarking Initiative	M	O, H, R, Rest, E, HC, G	2012 - 2013
San Francisco	Commercial Buildings Ordinance	M	O, H, R, Rest, E, HC	2010 - 2014
San Francisco	City Gov't Buildings	M	G	2010 - 2014
Singapore	Benchmarking program	M	O, H, G	2013 - 2014
Sydney	Audit Report Core/Base Building	V	Resi	2010 - 2011
Sydney	Large Hotels	V	H	2009
Sydney	Better Buildings Partnership	V	O	2005 - 2014
Tokyo	Tokyo Cap & Trade	M	O, H, R, Rest, E, HC, F, G	2009 - 2013
Tokyo	Top-Level Certified	M	O, H, R, E, HC, F, G	2010 - 2013
Tokyo	Small & Medium Facilities	M	O, H, R, Rest, E, HC, F, G	2009 - 2013
Mexico City	Voluntary Certification Program	V	O, E, F	2011 - 2014
Paris	Schools Retrofit Program	V	E, G	2008 - 2014

Key: *V* = Voluntary reporting; *M* = Mandatory reporting; O = Offices; R = Retail; Rest = Restaurants; E = Education; HC = Healthcare; F = Factories; Resi = Residential; G = City Government. *Source*: Adapted from C40 (2015).

All U.S. city building energy data activities (both mandatory and voluntary) rely on the Portfolio Manager tool for building data input which also enables cities to download city-wide datasets as needed. The only other common energy platform used by more than one C40 city is the NABERS (National Australian Building Environmental Rating System) Energy Rating system. Cities in these two regions have normalized energy intensity, with the rating system generating a normalized energy "score" (e.g. 1 to 100 for Energy Star; 1 to 6 for NABERS Energy). Other interviewees (e.g. Tokyo, Singapore) expressed interest in developing an energy efficiency index to account for differences in occupancy density and other variations in how buildings are used to gain insights beyond energy intensity data.

All datasets include actual energy consumption data. In a few cases, energy data are reported on a monthly basis (e.g. Tokyo, Sydney, Houston, Los Angeles, Cape Town, Paris), which could enable weather-dependent end-use analyses.

Data collection most often takes place through building owners. In some of the cases (e.g. London, Tokyo), a proportion of the participants are not necessarily 'buildings' but instead a 'location' or 'facility'. For instance, about half of the total participating locations in the Mayor's Business Energy Challenge are whole buildings, for which the program collects energy data for both a prescribed baseline year, and for the challenge year, to calculate the level of improvement. In Australia, the large majority of buildings report either base building energy consumption data or tenant energy data. This can lead to better information being conveyed to the decision-makers who can make the required changes to reduce energy use, but makes comparing whole building performance difficult. The Sydney Better Buildings Partnership has recognized the need to understand whole building energy consumption for meaningful tracking of progress toward climate goals, and have been collecting both base building and tenant energy data for more than half of the buildings that report into their program.

While there is a desire to move toward regular automated upload of periodic energy consumption data, that has not been particularly successful in all except a few cities (e.g. Singapore). In some cases, energy consumption data is regularly collected and reported electronically, but matching that energy consumption history to building characteristics can be challenging. For example, the City of Paris official stated that they have excellent energy use data, but finding accurate floor area for all of the buildings to calculate energy intensity is a significant challenge.

Most cities and organizations have an organic, "home-grown" approach to their analysis where their own experts have developed a system that works for the scheme that they are implementing. Many cities expressed interest in improving the quality of their data, given their concerns about data accuracy, particularly with self-reported data that does not go through any independent review or validation. The most robust data quality is when there is a level of independent verification, such as with Tokyo's Cap-and-Trade program, and Sydney's Better Buildings Partnership. More sharing about these different methodologies could avoid duplicated efforts, as well as improve existing practices.

A smaller number of cities also have mandatory energy audit requirements (e.g. San Francisco, Sydney, New York) and, in these cases, much broader types of information are collected. A wider variety of data is also usually collected through voluntary reporting schemes (e.g. London, Sydney, Houston, Los Angeles). However, according to one of the experts advising a voluntary initiative, the perceived additional reporting burden has had a negative impact on the level of participation.

Powers for the collection and disclosure of building energy performance data vary widely by cities. Most cities have powers to collect business information about buildings (e.g. floor area, number of employees), but that power typically does not include collecting energy consumption data. Many cities noted that there are privacy concerns about revealing detailed energy consumption data. In some cases, the privacy concerns are more an issue of the energy provider wanting to protect confidentiality of all customer data. In many cities, issues around energy data confidentiality are under review, as there is growing interest in data transparency to support improved performance, whilst respecting consumer privacy. These issues are also being addressed by some of the other interviewees. For example, the City Energy Project is actively

involved in a number of regulatory proceedings tied to data privacy, and supporting cities on driving data access policy changes.

All of the interviewed cities expressed interest in improving their datasets and being able to compare data for different cities and countries. While many cities expressed more interest in longitudinal comparison, others noted strong interest in absolute energy intensity information. What emerged with unexpected emphasis from the research was deep city interest in the methodologies and policies which sit behind the data, as much as the data itself. City motivations for better and more comparable data varied, with some of the key motivations including:

- understanding how their buildings compare with best performers in other leading cities in similar climates ("like for like" buildings) and their potential for improvement;
- understanding which policies have been most effective at cutting emissions in other cities over time and which of them could be applied to their city;
- having the evidence base to make the case for more action at the political level and with different stakeholder groups;
- understanding the rate of progress against their ambitious climate targets.

Several cities also expressed a desire to share data collection, analysis and verification tools. However, a few cities were wary of new data "tools". They have seen significant efforts and potential software solutions that ended up adding burden without commensurate additional value.

Opportunities for Enhanced Collaboration on Building Energy Data

The amount of data available through some of the most advanced cities has grown to a level where there is a significant opportunity for broader analysis about top performing buildings in different parts of the world. This is true for the ten initial cities within the C40 workstream driving the scoping study. However the five cities chosen to broaden the scope of the work (Cape Town, Mexico City, Paris, Shenzhen, Wuhan) generally did not have as comprehensive or long term datasets.

Although nearly all interviewed cities expressed interest in being able to compare data for different cities and countries, no organization has done this for public use, except for ULI Greenprint. A major commercial real estate sustainability executive noted that while they are interested in international comparisons of energy performance, there has not yet been any business requirement for them to develop a tool or normalization process on their own. Data pooling and comparison is a long-term effort, with challenges stemming from different factors such as variances in energy use reporting conventions, floor area measurement, occupancy levels and operating hours, presence of special equipment (e.g. data centers), and climate impact. Beyond the U.S. and Australia, there are no widely accepted normalization approaches, although cities and others acknowledge the importance of developing climate and occupancy adjustments for better comparability of data. While many cities reported that just comparing building energy intensity without any normalization would not provide meaningful comparison information towards making useful policy decisions, they agreed this would be an important starting point for understanding data availability and other challenges.

A common data exchange or sharing protocol is necessary to facilitate data comparison, along with collective agreement on meaningful metrics that should be used. These efforts can

build off and adapt from substantial work begun by the U.S. Department of Energy, ULI Greenprint, International Energy Agency and others. However, any work on comparable building energy data must be grounded in city needs. Developing standard data metrics and methods that allow for comparison should be done in phases, with the recognition that cities in different regions currently use different conventions. Initially the different conventions could be compared and mapped to one another with defined "translations", outlining how they differed.

Cities need more policy levers ("more arrows for the quiver'') to get them to their stated climate targets. Better data and information on measured results from other jurisdictions can add to the suite of policy options. Cities saw a lot of value in learning from one another and international experts; they do not wish to start from scratch where others have already thought through the solutions for their challenges.

Next Steps

The detailed findings of this scoping study are being shared through the C40 buildings networks and cities are discussing options for taking this work forward. In fact, a number of cities have already started a pilot comparison of their office building stock data. This pilot aims to inform and improve city comparability through assembling representative samples of building energy data and to complement existing published inter-city comparisons.

ULI GreenPrint reports include the most known international inter-city building performance comparison to date. Each annual report includes a map summarizing the city-average Energy Use Intensity (EUI) for participants. Members are self-selected and the representativeness of the sample varies among cities and from year to year. For instance, Figure 2 shows that participation happened to be low in Sydney, compared to London or DC, and given the limited sample, the EUIs are not comparable. Data derived from mandatory energy disclosure is more likely to enable a more representative comparison, while also raising many new questions in the process.

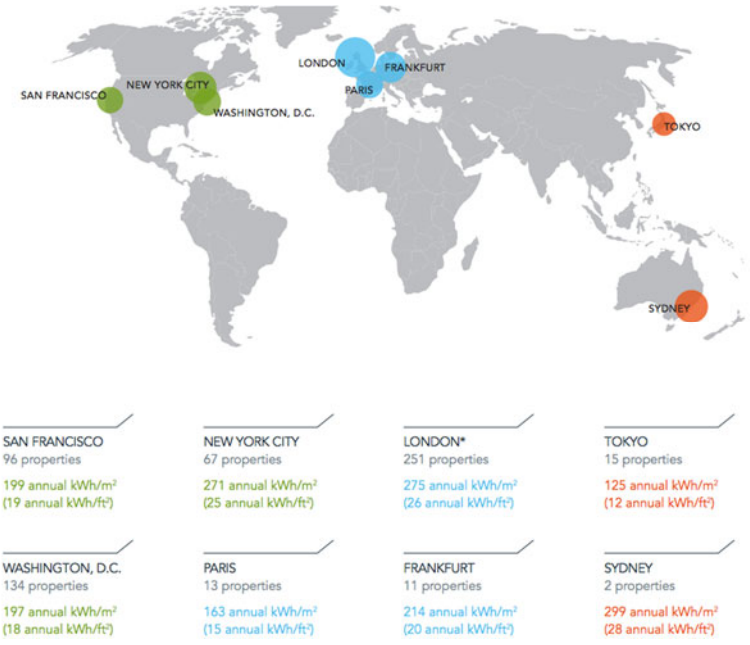

Figure 2. Energy use intensity in air conditioned offices across eight cities. *Source*: ULI Greenprint (2013)

The pilot comparison being conducted through C40 is led by the City of San Francisco and includes many of the cities that took part in the scoping study, starting with datasets that have already been publicly disclosed and then expanding to include datasets made available by cities. Additional cities expressed interest in this project and it is likely that the number of cities collaborating on building energy data through C40 networks will grow. Based on the findings of the study, additional support will be provided to cities in the following areas:

- Data standards for city data collection, analysis and dissemination methodologies;
- Peer comparisons of sectoral building performance;
- Policy development and impact evaluation.

Conclusions and Recommendations

The initial hypotheses were to assess whether cities could agree on comparable city metrics and methods for data collection and whether this data could be combined into an integrated dataset to enable policy measures associated with the best performing buildings to be identified and replicated. The study found significant interest in comparable building energy data, with some global cities collecting data that is similar enough to enable initial data pooling. With relatively simple inputs of building energy use, floor area, and changes in these over time, cities can compare their changes in building energy use and intensity and identify market segments with the most potential for reduction. The ten cities in the Data Insight workstream specifically identified data comparison as the reason to come together as a working group in 2014. The ten cities are currently collaborating on a simple, unadjusted pilot office comparison, looking at both absolute energy intensity information and, where available, relative improvement over time. This effort will act as a proof of concept for peer comparisons and could continue with several other types of common private and municipal government buildings (e.g. hotels, schools).

In the longer term, analyses could include more granular data to discern inter-city trends in key variables and explain differences in energy consumption distributions across cities (e.g. weather and climate data, occupancy and operational information, space usage, energy boundaries). These analyses will likely rely on vertical and horizontal collaboration and should build on the substantial work begun by the U.S. Department of Energy, ULI Greenprint, International Energy Agency and others. While the private sector has had little incentive for developing normalization methodologies for international comparisons, there is growing interest in international building energy data metrics and analyses at large scale within the academic communities around the world, which can act as great partners to cities and are likely to have access to complementary datasets.

There is also strong interest in the use of building energy data for policy evaluation. Cities want to understand the impacts of their policies, and whether these are having the intended effects. This could lead to protocols for the quantitative evalution of building efficiency policies, based on longitudinal changes in building stock energy performance, linked to timing of policy interventions. The principle that “you can’t manage what you can’t measure” is fundamental to C40’s theory of change and if cities want to learn from each other’s approaches, they need a common measurement framework. Standard frameworks for reporting and evaluating data have

been developed for greenhouse gas emissions[4] and are equally important in specific sectors, such as building energy efficiency.

To enable more robust analysis at the local and national level there should be ongong support to cities to improve the quality of their data. Indeed, all cities, independent of region or development status, required more support on data collection, analysis, verification and dissemination. C40 has already built the necessary infrastructure to support the sharing of leading practices through its networks and will continue to do so, engaging with experts in the field and relevant efforts to provide access to cities to the latest thinking in this area. Additionally, cities may need to make the case for additional investment in long-term data analysis and modeling resources. As C40 experience shows, successful examples of what has been achieved in other cities can enable cities to make the case for additional support in this area.

Cities are interested in collecting, analyzing and comparing building energy performance data to identify long-term energy efficiency targets, construct their low-carbon pathway, and more effectively target policy interventions to drive emissions reductions. More support in this area will enable friendly competition and raise ambition, empowering not just C40 cities but also cities outside the organization, as the actions of global megacities are often emulated by cities throughout the world. At the international level, more robust urban data can overcome the lack of knowledge regarding national and global trends against climate targets (IEA 2016), informing the transition to a 1.5 degree world.

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