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DISCLAIMER

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ABSTRACT

An increasing number of state and local jurisdictions are implementing building performance reporting laws, which generate large quantities of useful data on the characteristics and resource consumption of the building stock. However, to realize the potential of these policies, the data must not only be disclosed, but put to work to drive energy savings. Under a three-year pilot, Washington DC (DC), New York City (NYC) and their partners are pioneering the use of data from building performance reporting in energy efficiency programs. To minimize the administrative burden of managing, combining, and sharing these data sets, the cities are utilizing the U.S. Department of Energy's (DOE) open-source Standard Energy Efficiency Data (SEED) Platform.

The Putting Data to Work project team is working with efficiency program administrators to develop and implement new and innovative ways in which the data collected through benchmarking, energy audits, and related policies can be used to improve energy policies and planning, unlock data directly for market use, scale-up the market for energy efficiency services, drive competition, better target utility incentive programs, and inform measurement and verification.

This paper details achievements and key findings in DC and NYC to date, including the importance of high compliance, data quality, and data cleansing in using the information collected; methods that the cities are using to apply data to drive maximum energy efficiency; and the importance of inter- and intra-agency collaboration in program success. The paper also outlines the path forward and details expected outcomes and scalability of project activities.

Background

The purpose of benchmarking is to compare the performance of a building to its own historical energy and water consumption, and to compare it to the performance of similar buildings in its peer group. Benchmarking policies require the owners of certain types of buildings, most often commercial and multifamily spaces, to report on the buildings' characteristics and energy and water performance to the governing jurisdiction. These policies include size thresholds, whereby only buildings exceeding a certain square footage are subject to compliance, and the compliance cycle may be annual, at the time of sales transaction, or some other frequency. This is often paired with a transparency component, whereby portions of the building's benchmarking data are released publicly.

Some jurisdictions have adopted additional requirements on top of benchmarking and transparency that require periodic energy audits, retro-commissioning, and/or additional energy assessments or actions. Beyond tracking the energy performance of a building, these policies

require the building owners to take action, either by contracting an auditor to review the systems and operation of the building against a certain standard, or by requiring upgrades to systems that do not meet certain criteria.

To date, 16 U.S. cities and counties have adopted building energy benchmarking and transparency policies, with varying compliance thresholds and requirements. These policies combined cover over 58,800 buildings and more than 6.5 billion ft^2 of space. Additionally, seven of these cities require audits and/or actions related to energy assessments on top of energy benchmarking (IMT 2016). As these programs mature, city staff and efficiency program administrators are left with tens of thousands of data points each year. This information is only valuable if it is managed in a streamlined and centralized process, and put to intelligent use to inform actionable efficiency offerings within these cities and counties.

The cities of New York, NY and Washington, DC have pioneering ordinances in building energy data collection; staff in these cities have several years of experience developing processes to collect and manage data, providing instruction to building owners subject to compliance, and thinking through actionable use for the information being collected. In both cities, buildings represent at least three-quarters of all greenhouse gas (GHG) emissions, and thus are the largest single opportunity for meeting sustainability and carbon-reduction goals within the cities. Both cities have benchmarking laws requiring that all private commercial and multifamily buildings over 50,000 ft^2 annually benchmark energy and water use in ENERGY STAR® Portfolio Manager® and report those results to the city governments for public disclosure, and both cities have data collected back to calendar year 2012 or earlier. In Washington DC, the benchmarking law covers around 2,000 buildings, accounting for 1.6 percent of the building stock and 50 percent of the floor area in the city. New York City has a suite of benchmarking, audit and retro-commissioning, lighting upgrade, sub-metering and green code ordinances enacted through the Greener, Greater Buildings Plan (GGBP), beginning in 2009 (City of New York 2009). To varying degrees, these policies affect New York's largest commercial and multifamily buildings, generating robust data to cover over 23,000 buildings in the City.

In the past, much attention has rightly focused on the potential of benchmarking policies to drive market transformation with speed and scale by enabling market actors to compare building performance when buying or selling properties. While DC and NYC are beginning to see this effect, the existence of the data disclosed publicly on government websites has a limited impact on its own; this data is more powerful when put into the platforms that market actors use when making decisions. Moreover, direct market application is not the only way that market transformation happens - it also is driven by government policies and energy efficiency programs whose effectiveness can be greatly enhanced by the use of benchmarking and audit data.

Under a three-year pilot project partially funded by a grant from the U.S. Department of Energy (DOE) and coined "Putting Data to Work," partners in DC and NYC are working to provide critical answers about the value of benchmarking data and building data-related ordinances overall through deployment of data-driven energy efficiency programs within their cities. Lessons learned and best practices will be captured throughout both cities' piloting of data-driven efficiency programs, ultimately resulting in a publicly available toolkit of resources designed to enable additional cities to calibrate benchmarking and related policy requirements, and optimize the deployment of efficiency programs in their jurisdictions.

With the Institute for Market Transformation (IMT) leading coordination efforts, project partners in New York include:

- New York City Energy Efficiency Corporation (NYCEEC),
- New York City Mayor's Office of Sustainability (NYMoS), and
- New York State Energy Research and Development Authority (NYSERDA),

while project partners in Washington, DC include:

- District of Columbia Department of Energy and Environment (DOEE), and
- District of Columbia Sustainable Energy Utility (DCSEU), operated by the Vermont Energy Investment Corporation (VEIC)

This paper describes the efforts of DC and NYC to use the data collected through their ordinance programs to inform energy efficiency offerings within their jurisdiction, and includes information on how each city has used SEED in its processes. As detailed further in the sections below, the following key findings have emerged during the first year of the project:

- High rates of compliance, data quality, and a method for "cleaning" data are paramount to using data to inform energy efficiency policy-making and program design
- Beyond transparency, building performance data must be applied in order to drive maximum energy efficiency
- Inter- and intra-agency integration and collaboration are crucial to program success

SEED Platform and SEED Platform Collaborative

For cities that have benchmarking and transparency policies, data collection and management represent one of the most critical components of a successful program. Many cities have developed their own internal solutions for data management through tools such as Microsoft Access® and Excel®, or custom proprietary systems. However, these options are costly, time-consuming and have the potential for introducing human error. In fact, many cities are utilizing a half to full time staff member on data management alone.

To address the need for a common low-cost tool, the DOE developed the Standard Energy Efficiency Data (SEED) Platform™. The SEED Platform is an open source software application that enables streamlining of complex building data and allows users to share selected data with partners or make it publicly available. A paper from the proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings provides more technical details about the design and capabilities of the SEED Platform (Alschuler et al. 2014).

One of the most important aspects of implementing a benchmarking program is ensuring that the data reported are high quality and accurately reflect the actual state of the buildings that are reporting. Data collected under benchmarking and audit ordinances are typically self-reported by building owners and managers, which may involve manual entry or transcription, often resulting in gaps or erroneous values in the data reported to the local jurisdiction. To mitigate these problems, the SEED Platform has been designed as a data management system that can ensure data quality and help benchmarking program staff cleanse and improve the data reported by building owners. There are several aspects to the data quality features of the SEED Platform, including algorithms to automatically identify missing or erroneous values in data sets imported to the system, the ability for users to filter and tag data for values that match certain criteria, and the ability to plot data to compare groups of buildings. Using these built-in tools, program administrators can more easily identify non-compliant buildings and ensure the highest quality data for subsequent application of the benchmarking information.

While there is significant interest in adopting the SEED Platform, many organizations need assistance getting existing datasets and software connected, updating internal business processes, and extracting the most value out of the data. To help these organizations succeed, DOE launched the SEED Platform Collaborative in early 2016, which is a partnership with state and local governments and efficiency program administrators, leading non-profits and private sector companies that are committed to radically reshaping the data landscape in the buildings sector. In exchange for testing new features and sharing their experiences with the community, DOE provides partners with limited-time free hosting of the SEED Platform and one-on-one technical assistance, as well as ongoing access to the SEED Platform Collaborative community and opportunities to provide input on future development. The first cohort of partners include: Atlanta, Berkeley, Cambridge, the California Energy Commission, DC, Houston, Kansas City, Montgomery County, NYC, Orlando, Philadelphia, and Salt Lake City.

Use of SEED in NYC and DC

DOEE has been actively participating in the development of SEED since its initial conception, and as part of the SEED Platform Collaborative is using SEED to assist with data management, data quality review, and to share data with partners and the general public. SEED provides a reliable and secure way to ensure that various departments and partner organizations have access to the most complete and accurate data sets available in real time. For public buildings, the DC Department of General Services (DGS) has also gone beyond annual benchmarking, tracking and disclosing online next-day 15-minute interval data for all DGS facilities via the BuildSmartDC website. DGS and DOEE have partnered with researchers from Carnegie Mellon University at the Consortium for Building Energy Innovation to integrate management and analysis of interval data into SEED, and to develop widgets and tools that help decision-makers use this detailed data to identify opportunities to save energy and money. Further, VEIC, DGS, and DOEE are developing direct application program interface (API) connections between SEED and their internal software tools. Similar to DOEE, the NYMoS and NY Department of Buildings (DOB) have been providing perspective and input into the development of SEED. As an inaugural partner in the SEED Platform Collaborative, NYC is exploring the use of SEED for compliance determination in the benchmarking enforcement program, and is investigating ways that SEED can tie into existing systems and processes to expand the use case for the City.

Washington, DC

The District of Columbia's comprehensive sustainability agenda calls for a 50 percent reduction in GHG emissions by 2032 and an 80 percent reduction in GHG emissions by 2050. Similar to other large cities with extensive public transit infrastructure and limited industry, 75 percent of GHG emissions attributed to the District come from buildings. To address this, the District enacted the Clean and Affordable Energy Act of 2008, which established mandatory benchmarking for large buildings and established a third-party demand side management (DSM) program administrator, the DCSEU. Since implementation in 2013, the District has collected benchmarking data on over 275 District Government buildings and over 1,500 private buildings, covering a total of over 370 million ft^2. Data include calendar years 2013 and 2014 for most properties, going back to 2010 for government and larger private buildings (DC DOEE 2016).

Addressing Compliance and Data Quality

For the benchmarking data to be used to drive policy, and have market-transformative effects, it is essential that policymakers, stakeholders, and the public have confidence in the reliability of the data. DOEE is responsible for administering the District's benchmarking requirements, which include assembling the covered building list, providing comprehensive technical support, collecting the reported data, enforcing data completeness and quality, and publicly disclosing the data online.

Improving the quality of the reported data has been a major focus of DOEE and its partners. DOEE and DCSEU have operated a Benchmarking Help Center since the initial implementation of the benchmarking law in 2013. The Help Center fields between 1,000 and 2,000 requests a year, providing detailed support on reporters' use of Portfolio Manager and with enforcement issues by phone and email. At first, DOEE only verified that a report was received, to ease initial compliance. Beginning in 2015, DOEE now verifies that reports are complete, meaning that they contain energy use intensities (EUIs), ENERGY STAR Scores where appropriate, water consumption data, and other key indicators. These basic data points are often missing from reporters' submissions due to an array of commonplace user errors. Nonetheless, extensive technical support, sometimes covering a period of several weeks, is often needed to resolve these problems. Buildings with incomplete data are listed as non-compliant, and are fined. Through extensive technical support and enforcement, DOEE has brought the overall compliance rate for recent years from 50 percent to 90 percent. And while only 75 percent of initial reports were complete in 2015, technical assistance and enforcement raised this number up to 97 percent by the close of the reporting cycle.

Accurate benchmarking of complex multi-tenant properties, particularly multifamily properties, depends on the ability of building owners to access whole-building aggregated utility data. In both NYC and DC, building owners must include this data when benchmarking, and utilities are mandated to provide it to them; in NYC by a rate case, and in DC by the Sustainable DC Act of 2014. DC's law further mandates that the data be directly uploaded to Portfolio Manager, eliminating manual data entry errors and providing many building owners, for the first time, with automated monthly access to the total energy consumption of their property. Direct upload of electricity data has been available since December 2014, and has increased the number of buildings reporting whole building data. However, DOEE has found that over 20 percent of multifamily property owners who claim they are using whole building data are likely not reporting it correctly; beginning in 2016 DOEE enforces this as well.

While the presence of a complete report is important, it is equally important, and more challenging, to ensure that the reports are accurate. In 2015, DOEE funded research by New York University's (NYU) Center for Urban Science and Progress (CUSP) and IMT to use statistical modeling and qualitative interviews to identify apparently complete reports that nonetheless have data quality concerns. A full discussion of this methodology is discussed in detail in another 2016 Summer Study paper (Kontokosta et al. 2016). In brief, the two-step methodology first checks indicators on whether reporters are correctly gathering and/or reporting data for the whole building, then develops a predicted EUI based on the reported space use values and compares that to the actual reported energy data, flagging buildings with a large deviation for follow-up and possible inspection or other enforcement actions.

Putting the Data to Work

In order for the value of building performance data to be fully realized, it must be applied to inform energy efficiency programs and policies. In addition to publicly releasing the benchmarking data online, DOEE is putting the benchmarking data to work to drive policy making, planning, and program design. Most notably, DOEE shares all benchmarking data with the DCSEU, so it can better shape and target its energy efficiency incentives for maximum performance impact. DOEE and DCSEU were sharing the benchmarking data prior to receiving the DOE grant described herein, but the grant enables more extensive and integrated work. DCSEU is able to use the benchmarking data is several ways, primarily in relation to targeting of programs and incentives, as discussed below.

First, the data indicates trends and reactions of the market as a whole. The benchmarking data allows DOEE and DCSEU to understand changes in building size, square footage, and EUI over time, which buildings have data centers or other highly energy-intensive uses, and differential changes in energy efficiency and energy utilization by fuel type. One of the earliest findings of the DCSEU was that many more large commercial customers than expected in DC did not use natural gas service, relative to other northeast markets; this, in turn, allowed more efficient targeting of gas incentives and improvements in gas program design.

Second, the data provides a mid-level picture of trends within market types and sectors, by combining with other data sets such as CoStar, and segmenting based on metering configuration, building occupancy, ownership length or turnover, zip code, and neighborhood. This segmenting is particularly useful for targeting areas of concern, and for avoiding principal/agent barriers.

Finally, the data allows for more intensive and custom work with an owner or manager's portfolio of buildings or single building. The DCSEU can use the data to look at portfolio-level trends, improvements over time, comparisons to direct peer competitors, and identification of the best opportunities within a portfolio or between portfolios. Moreover, DCSEU has found that building owners and managers who have benchmarked their properties start their conversations with the DCSEU at a much higher level of information and engagement than those who have not.

Integrating the Programs and Findings

To scale-up the impacts of using benchmarking data, integration and collaboration are key, both within governments and among governments, the private sector, and NGOs. The benchmarking data is being put to work in DC through numerous other, aligned avenues that involve collaboration and integration in using the data. The District uses the data to enhance targeting and outreach for several other programs in similar ways as described above for the DCSEU. The District's Commercial Property-Assessed Clean Energy (DC PACE) program, which is administered by Urban Ingenuity, coordinates closely with DCSEU and uses the benchmarking data to target its own loan programs at buildings that stand to benefit from deeper energy efficiency incentives than can be financed purely through DCSEU incentives. The PowerDown DC Competition, a multifamily building utility reduction competition operated by Stephen Winter Associates and funded by DOEE, also uses the benchmarking data to identify potential participants and compare savings.

The benchmarking data is also central to tracking citywide progress in reducing energy. The District Government and the Downtown DC Business Improvement District (BID) were early joint partners in DOE's Better Buildings Challenge (BBC). The District and the Downtown

DC BID jointly committed to reducing energy use by 20 percent by 2020 among both DC Government buildings and the over 60 million ft^2 of aggregate commercial building stock within the BID. In order to track progress for the BBC, the BID does not directly collect the energy use for all the buildings within its borders, but rather uses the benchmarking data reported to DOEE. In reviewing the submitted public and private data, DOE provides an additional third-party check on data quality and progress over time for both DGS and DOEE.

In addition to program and agency activity, DOEE is actively seeking to use the benchmarking data to create data-driven policies to drive GHG and energy reductions. In 2014, the Mayor convened the Building Energy Performance Standard (BEPS) Task Force to examine what next-generation policies could be built on the benchmarking data (District of Columbia 2014). The report published a number of proposed strategies for building on the benchmarking data, including improved transparency of the data and a possible minimum energy performance standard for existing buildings, wherein buildings would be asked to achieve a given standard of performance or make improvements towards that goal. The task force report found that if all buildings that had reported benchmarking data performed at or above the national median, adjusted for use and weather, the energy use of the building stock over 50,000 ft^2 would drop by 12 percent. This and other policies are now being explored through the District's Comprehensive Energy Plan (CEP), which will provide a roadmap for energy policy to help the District achieve its GHG reduction goals. The modeling and analysis for the CEP directly integrates DC's benchmarking data on a sectoral basis. To our knowledge, this is the first time that such granular, geographically-specific data has been used to inform such a plan.

While all of these efforts are exciting and innovative, it should also be noted that there are limitations to what DOEE and its partners can do with the benchmarking data alone. The annualized, self-reported nature of the data makes it difficult for the DCSEU to use the benchmarking data to do any kind of demand response or behavioral programs, or to support evaluation, measurement, and verification (EM&V). By design, Portfolio Manager collects and measures how much energy a building uses, but it does not track or adjust for individual building systems. Without the detailed audit data of the sort being collected in NYC, DOEE and DCSEU are more limited in their ability to design policies or programs targeting specific technologies or the lowest-cost, highest-impact retrofit opportunities.

New York City

As in the District of Columbia, addressing the energy used in buildings is crucial to reaching New York City's goal of reducing GHG emissions by 80 percent by 2050. The City passed the suite of legislation that makes up the Greener, Greater Buildings Plan of 2009 in order to better understand how the City's largest buildings use energy, and what can be done to reduce their consumption (City of New York 2009). Since the City's benchmarking and auditing ordinances passed in 2009, the Department of Buildings (DOB) has collected and disclosed energy and water data on over 20,000 buildings representing over 2.1 billion ft^2, and received energy audit and retro-commissioning reports (Energy Efficiency Reports, or EERs) on one fifth of the city's large buildings.

Addressing Compliance and Data Quality

While DOB is responsible for the collection and disclosure of benchmarking data, the City's Department of Finance (DOF) administers the issuance of fines for non-submittal. Failure

to submit a report each year by May 1st results in a $500 fine, with subsequent deadlines and additional $500 fines for failure to submit by August 1st, November 1st, or February 1st with a maximum fine of $2,000 in a given year. In past years, these fines are only levied in the case of non-submission, but the City is beginning enforcement based on data completeness and accuracy in 2016. To address systemic issues, the NYMoS, in partnership with DOB, holds annual roundtables with the highest-volume submitters to discuss issues of data collection from energy utilities and the Department of Environmental Protection (DEP), common problems found in submittals, and other concerns in the market. In addition, the City re-launched its Benchmarking Help Center in January of 2016, following the successful initial employment in 2012-2014, which will be used to target both those properties that consistently do not submit reports and those that omit crucial pieces of information. In 2012, the City received just over 10,000 benchmarking submissions, and analysis for the first comprehensive benchmarking report removed over 2,600 submissions through the data cleaning method. In 2014, the City received over 13,000 submissions and the analysis for the respective report only removed around 1,600 submissions. The City will better understand the effects of the re-launched Help Center after it receives the next round of submissions.

In 2013, the City collected the first set of Local Law 87 (LL87) EERs, comprising energy audit and retro-commissioning reports, and has since collected the subsequent reports for 2014 and 2015. LL87 requires that building owners hire an energy auditor to conduct an ASHRAE Level-II energy audit and perform retro-commissioning, or a "tune-up" of existing building systems to restore performance so that they operate as designed, submitting both reports to the DOB through spreadsheet-based reporting forms. The energy audit component requires that submissions include an inventory of the base-building system, a list of the recommended energy conservation measures (ECMs) including energy and cost savings, and a breakdown of the buildings' energy end use. LL87 does not require that buildings undertake any of the ECMs recommended in the audit. Only the low-cost retro-commissioning measures and tune-ups, defined in the law, are required.

In the first two years of collection, the City has received over 1,800 EERs. These have provided invaluable information about the building stock, but many did not comply with the law's standards. For the past two years, DOB has undertaken an effort to ensure the quality of submissions by enforcement auditing submitted EERs, which end with one of three results: (1) the EER is returned to the submitting agent and a new report must be developed, (2) DOB brings the submitting agent in to review the report, or (3) the EER is accepted and the building owner has complied with the law.

Putting the Data to Work

In addition to taking steps to improve the quality and accuracy of the City's benchmarking and audit data, the City initiated programs to assist building decision-makers who were not using the information provided to them to take specific energy conservation actions. In September 2014, current NYC Mayor de Blasio released the City's 10-year comprehensive plan to reduce energy consumed in buildings, *One City: Built to Last*, which committed to designing programs and policies that would encourage privately-owned buildings to use their energy audits and benchmarking information to take steps to reduce their energy consumption and increase the value of their buildings, in addition to many other initiatives to reduce buildings-based GHG emissions (City of New York 2014).

The NYC Retrofit Accelerator is one of the key programs that launched under the *One City* plan. This program provides privately-owned building decision-makers with free technical assistance and guidance for undertaking energy and water efficiency upgrades. The Retrofit Accelerator utilizes the data collected from local ordinances in two primary ways: first, to identify buildings with the highest opportunities with regard to energy consumption and system types, and second, to assist building decision-makers with using the information in those reports to increase the value and sustainability of their buildings.

The collection of both the benchmarking and energy audit data is crucial to the implementation of the data-driven outreach strategy utilized by the Retrofit Accelerator. The analysis used to derive strategy ranked properties by four main indicators: high savings potential, high need, high project opportunity, and "low-hanging fruit." The high savings potential indicator acted as a filter for all the other indicators, and was generated by creating data flags primarily from benchmarking data and DEP boiler data to indicate high energy usage compared to peers. These data flags were then rolled up, allowing the program to rank buildings that have the highest savings potential based on the number and type of flags that were triggered. All buildings with associated benchmarking reports were ranked according to this methodology. The systems inventories and ECM recommendation information collected through LL87 EERs were then layered on to help identify specific project opportunities. Buildings that had systems with ECM recommendations that would take longer lead times to implement and result in high energy savings, such as boiler replacements, were flagged as "high opportunity projects." These two indicators were then combined to identify the highest priority buildings for outreach. In addition to identifying high priority buildings, this analysis will allow the Retrofit Accelerator to assist portfolio managers identify specific opportunities for their portfolios.

In addition to assisting those buildings that have undertaken their energy audits, this process has allowed the City to identify buildings that have not yet come up on their LL87 compliance year, but have a high savings potential and would therefore benefit from a high quality energy audit to identify strategies for reducing energy consumption. Therefore, the Retrofit Accelerator has committed to helping these buildings understand how to obtain good audits, which will ultimately increase the overall quality of data that the City can collect. This strategy is currently in the first phases of implementation, and its success will be documented through the "Putting Data to Work" project.

Integrating the Programs and Findings

In addition to the launch of the Retrofit Accelerator, the City has taken a number of steps to enable the public and policymakers to better utilize and visualize the trove of benchmarking data, while also taking steps to use energy audit and retro-commissioning data to implement programs and inform policy decisions. While the quality and accuracy of a significant portion of the benchmarking data can still be improved, the sheer volume of submissions and remaining verified data has meant that the City and its research partners are able to use the data to come to important conclusions about how the City's large buildings use energy, and further display that information to the public. In addition, the systems-level information submitted within the EERs has enabled a large-scale study of ways in which the City's buildings can reach its 80x50 goals. In partnership with NYU CUSP, the NYMoS launched an energy and water benchmarking map that lets users compare their energy and water consumption to neighbors and peers. Before the release of this map, the City disclosed all benchmarking data in a spreadsheet format that was not easily used, and did not foster much interest outside of the building energy community.

NYC's benchmarking data has also been used by external organizations to develop tools that allow building representatives and other interested parties to better understand opportunities available in the city. Urban Green Council (UGC) released its map, Metered-NY, which allows users to view changes over time and to compare multiple buildings. NYCEEC has also developed a tool, called EfficienSEE^{TM}, that calculates an "Energy Savings Potential" for multifamily buildings based on a combination of benchmarking data, pre- and post-retrofit data from NYSERDA, and other sources. As part of this grant, the tool is being adapted to include the most current data available, and to include commercial buildings.

The Mayor also convened a Buildings Technical Working Group (TWG) in February of 2015, to come up with long-term strategies for reducing energy use in buildings that are based on the data the City has collected in conjunction with expert insight. Members of the TWG include real estate industry members, architects, engineers, labor unions, academics, affordable housing experts, and environmental advocates, who discussed strategies, barriers, and implementation mechanisms to help the City reach its goals. This advisory group was paired with a study that represented the most comprehensive analysis of energy use in New York City to date by using the data reported under LL87 and LL84. The results of the TWG and technical study were published in a report in April 2016 (City of New York 2016). The report describes expected trends in construction, population, and GHG emissions, and builds on reported data with industry expertise to investigate the technical GHG reduction potential of over 100 ECMs if implemented across the City's building stock. If all ECMs were implemented in every applicable building, they would reduce current building-based emissions by 33 percent and lead to $2.7 billion in energy cost savings. Paired with recommendations for policies aimed at easing the implementation of retrofits and higher performance construction, this report charts a potential pathway for the City to reach its 80x50 goals.

The need to address the City's heating distribution systems is an important example of how this analysis will impact future interventions. The City found that across all large buildings, space heating and domestic hot water account for over half of the GHG emissions from buildings, and this proportion is magnified to 74 percent in large multifamily buildings. Building on this information, the City further investigated the systems that heat the City's buildings and found that more than 70 percent use some form of steam distribution systems, which are notoriously difficult to control and often improperly maintained. This information was paired with an analysis of the costs and GHG reduction potential of measures to repair or upgrade these systems to help identify the measures that had the greatest citywide reduction potential per square foot and per dollar. The City found that requiring all buildings over 25,000 ft^2 to repair and improve their heating distribution systems has the potential to reduce building-based GHG emissions by four percent, which is one of the most impactful actions that the City can take.

Findings, Next Steps, Key Takeaways

The Putting Data to Work project was developed on the assumptions that the publication of building performance data on government websites does little to drive transformative change in the energy efficiency market on its own, and that the value of the building performance information being collected by many cities nationwide is not yet being fully realized. Similarities in the nature of the information being collected across cities mean that those jurisdictions with newer benchmarking and building performance disclosure policies can benefit from best practices and lessons learned developed through the work of cities like DC and NYC, who have years of experience collecting and using this information.

At the time of publication of this paper, the project team will be one year into our effort to discover ways in which this data has real value-add to the energy efficiency marketplace, and how it can be used to help cities reach energy and sustainability performance goals - using efforts in the cities of DC and NYC as "learning labs" to capture their successes as lessons for other cities nationwide. Our project cities serve as examples of varying data availability: in DC, the District collects only benchmarking data, while in NYC the City collects benchmarking, audit, and supplemental data through several local laws under the GGBP. These cities also have different relationships with their incentive programs: in DC, the DCSEU is operated under direct contract to DOEE, while in NYC, the City serves as a resource to aid building decision-makers in seeking out incentives, but does not provide or control incentives. Lessons learned from these cities can inform the context in other jurisdictions with differing levels of information and resources. To that end, the early stages of this project have seen three driving themes emerge as important topics for consideration:

High compliance, high quality, and a method for "cleaning" submitted data are important prerequisites for using this information in energy efficiency policy-making and program design. Users of the data, both on the government side and the market side must have confidence that the information is accurate in order to rely on it to make decisions, and most importantly, to ensure that those decisions are driving increases in energy efficiency.

Building performance data must be applied, rather than simply published, in order to drive maximum energy efficiency. This information can be used to identify and track trends for the market as a whole and for market sectors, and to engage more fully with individual building owners. It can also inform work done in other parts of a local government, like the department of buildings, the department of finance, or local sustainability programs and partnerships. For DSM programs, benchmarking data alone provides a real value-add to raw utility data, by pairing consumption data to specific buildings and decision-makers, providing key information about the use factors that are driving energy use, and scoring the buildings for their actual efficiency. As evidenced by the work being done in New York, the addition of energy audit information on top of benchmarking data adds a layer of depth that allows for informed prioritization of projects by savings potential based on the type of information collected and shared with the City and efficiency program administrators.

Integration and collaboration are key to successful use of building performance data to increase energy efficiency. This applies both within local governments, where work is being done within agencies to partner on better program design and targeting, and among local governments where work is being done to collaborate and shape programs that collect similar information, publish and use it in similar ways, and learn from the successes and challenges of peer jurisdictions. This is evidenced through the work of federally-led programs, like the SEED Platform Collaborative, through NGO-led groups like the City Energy Project, and through networks of cities like C40 and the Urban Sustainability Directors Network (USDN).

Over the remainder of the project period and beyond, the cities of DC and NYC will continue working to improve the sustainability performance of their cities, using building energy efficiency as a tool to achieve their ambitious goals. Among other things, this will involve working with the SEED Platform Collaborative by using the program and providing feedback on the city-level use case for SEED, piloting energy efficiency programs that enable data-driven decision-making, continuing the conversation with other jurisdictions by sharing lessons learned and best practices, and contributing to the outcomes of this project. Most notably, the project will result in a publicly-available toolkit of resources for local jurisdictions to assist in the

deployment of data-driven energy efficiency programs based on the programs piloted in DC and NYC, which is slated to be available in full in the summer of 2018.

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