







NEW YORK usa

DRIVERS OF ACTION

New York City contains just over 1 million buildings (Metcalfe, 2013), which collectively account for 67% of the city's emissions (NYC Sustainability, 2017). Many of these buildings will still exist come 2050. As such, it is imperative that the city's existing building stock be retrofitted in order to meet its ambitious emissions reduction targets. Meeting the new building targets will require climate action from all actors, public and private, and the municipality is setting an example and leading the way, with initiatives that affect their 4,000+ buildings and facilities.

These municipal properties are managed by more than 25 city agencies and span a wide range of building types, including schools, hospitals, firehouses, wastewater treatment plants, libraries and other facilities. Within the city, the Department of Citywide Administrative Services' (DCAS) Division of Energy Management is tasked with serving as a hub for energy management. DCAS is responsible for achieving the city government's GHG emissions reduction targets, including a 40% reduction for city-owned buildings by 2025, a 50% reduction by 2030, and a city-wide reduction of 80% by 2050. To date, DCAS has mostly implemented "lowhanging fruit" energy conservation measures, such as lighting- and heating-system upgrades, but the department recognises that delivering the objectives set out by Mayor De Blasio and the City of New York necessitates further bold and ambitious climate action. Deep energy retrofits could deliver these goals.

To achieve the targets set out in its 1.5°C compliant climate action plan (NYC Sustainability, 2017) and the Climate Mobilization Act, New York has highlighted the need to rapidly educate agencies and contractors on the meaning and necessity of deep energy retrofits.

The outcomes of this pilot programme will support DCAS and other city agencies in their efforts to make the case for a holistic approach to deep energy retrofits. In addition, the city is in the process of developing guidelines for deep energy retrofits. Peer-review by the C40 network will ensure that the findings of the pilot study inform the guideline development.

SCALED-UP BENEFITS: 700 SCHOOLS

The City of New York owns approximately 1,400 schools. These were built between 1911 and 2001 and range from 75,000sqf (6,968 sqm) to 400,000sqf (37,161 sqm). A scenario has been run where it is conservatively assumed that 50% of all schools (700 schools) will undergo deep energy retrofits in order to provide an indication of the benefits that can be attained if the actions of New York City are scaled up across a larger portfolio of buildings.

GHG 318,690 tCO₂ AVOIDED PER YEAR 9.56 MtCO₂ SAVED OVER THE PROJECT LIFETIME

MAINTENANCE COST SAVINGS \$52.2MILLION

ENERGY

COST SAVINGS

\$99MILLION

1

NET PRESENT

\$659.2MILLION

PAYBACK TIME

29 YEARS

2~3

PRODUCTIVITY

\$262.5

MILLION

 $\backslash A$

PER YEAR | PER YEAR



For this pilot, New York focused on 23 public schools with particularly high emissions. Energy audits are currently being conducted and the city is considering the following retrofit elements: glazing, insulation, heating, ventilation and air-conditioning (HVAC), lighting, controls, solar photovoltaic (PV) and building management systems.

PILOT PROJECT BENEFITS: 23 SCHOOLS



DELIVER ON TARGETS SET OUT IN THE CITY'S CLIMATE MOBILIZATION ACT AND THE 1.5°C-COMPLIANT CLIMATE ACTION PLAN

ENCOURAGE A HOLISTIC APPROACH TO BUILDING RETROFITS

FACILITATE COLLABORATION BETWEEN CITY DEPARTMENTS

CHALLENGES AND NEXT STEPS

DCAS's pilot of the tool. The Department has successfully drawn on the knowledge and skills of other agencies to inform its data inputs. Moreover, DCAS has used the benefits programme as an opportunity to engage external stakeholders and multiple agencies on the outcomes and benefits that the tool provides. The tool created valuable information that could be shared with other departments and created a robust basis for identifying multiple benefits across areas of responsibility. A key success for the city would be the quantification of occupant health- related outcomes. DCAS intends to build on its successful collaborations with agency partners to further consider the health and well-being outcomes of proposed future projects.

Over 1.1 million students attend the schools that are within the purview of New York City's Department of Education (NYC Department of Education, 2019). The findings of this study will enable DCAS to make a stronger case for more ambitious action across this building stock to significantly reduce GHG emissions as well as improve the indoor work environment for students, teachers and other staff. Energy auditors are currently making recommendations and deep energy retrofit projects are expected to begin as soon as 2021.

ITALY

DRIVERS OF ACTION

The stationary sector (buildings, industry and energy) is a key climate concern in Milan, since, just as in Copenhagen, it represents the majority of the city's emissions, at over 60%. Similar to many other cities, Milan is characterised by an old building stock that is energy inefficient due to the quality of materials and techniques used during construction (Legambiente, 2018). Much of the building stock in Milan was built between the 1960s and the 1990s, with an energy need of 150-220 kWh/m2 per year. There is also a significant number of historical buildings, which presents challenges when it comes to retrofitting. At the same time, energy costs are increasing across Italy and potential energy-bill savings are a key driver of energy retrofit interventions (OIPE, 2019; Sharing Cities, 2019).

Milan is a part of the European Sharing Cities programme that aims to establish a common approach to realising smart cities (Sharing Cities, undated). As part of this programme, Milan is in the process of completing the retrofit of five multi-family residential buildings located in different parts of the city and covering approximately 24,000m².

Retrofit actions in public buildings are 90% funded by the municipality, while Sharing Cities EU funds cover the remaining 10%. Retrofits of private buildings are paid by residents (partly with a tax payback system) and supported by a grant from Sharing Cities.

² The currency conversion is calculated

TAKING ACTION

The tool has been used to estimate the multiple benefits of the retrofit actions that have been implemented. The investment is estimated at EUR 2.5 million and aims at saving 50% of energy, according to Sharing Cities targets. The planned energy retrofits vary from building to building but include improvements to the building envelope, glazing, HVAC, lighting, energy controls and PV

The vision is that the tool will aid in a scale-up of national retrofit measures by demonstrating the benefits to other cities in the Milan metropolitan region, as well as across Italy as a whole. Such a given that 60% of the building stock in Italy was built before the first law for limiting building energyuse came into force in 1976. For Milan itself, the analysis will inform a bid for a EUR 24 million grant (USD 33.3 million)² that would enable further building retrofits and replace 3,500 gasolinepowered heating systems. These heating systems account for 30% of particulate-matter air polluting in Milan, so such retrofit action would significantly reduce the health impacts associated with poor air quality.

PILOT PROJECT BENEFITS: 5 RESIDENTIAL BUILDINGS

ပါပ GHG of Nor 23% 2.5% OLDS IN ENERGY **ASTHMA** REDUCTION IN \$790K N IN POVERTY REDUCTION **ENERGY** (EUR 590K) С 0) MOULD AND COSTS **15 YEARS EMISSIONS** DAMPNESS REDUCTION

a PPP exchange rate (2017).

SCALED-UP BENEFITS: 300 RESIDENTIAL BUILDINGS

Milan is exploring the possibility of retrofitting a further 300 private residential blocks that share similar characteristics to the pilot-project buildings as part of an extension of the Sharing Cities programme. The Milan results have been extrapolated based on this assumption. The inputs and results (e.g. floor areas, energy performance, etc.) have been averaged out across the 300

26,668 tCO₂ GHG 800.026 tCO SAVED OVER THE

250 FEWER PEOPLE IN ENERGY POVERTY

NUV NET PRESENT VALUE CREATION \$47.5MILLION 1.6K-3.4K (EUR 35.6MILLION) FULL TIME EQUIVALENT



PAYBACK TIME **15 YEARS** ပါပ **45 FEWER ASTHMA** CASES FROM DECREASED MOULD AND

1

DAMPNESS

buildings. In this particular case, the residential buildings selected do not specifically involve risks. The relatively few social benefits to be gained from this example reflect this - but clearly if the interventions were socially targeted, then greater social gains would be expected.

CCESS ADDITIONAL FUNDING FOR RETROFITS THROUGH THE EU-WIDE SHARING CITIES PROGRAMME

ICREASE THE EFFICIENCY OLD BUILDING STOCK

ADDRESS RISING ENERGY COSTS

CHALLENGES AND **NEXT STEPS**

With 49% of the occupied dwellings being multiowned or condominium buildings, large-scale retrofits in Milan will necessarily involve many private building-owners, which can be a major obstacle to deep energy retrofits. Co-design is a fundamental part of the Sharing Cities programme and the retrofit measures that were implemented in each private residential building were developed in collaboration with residents. The benefits will be shared with residents to show the wider gains they have achieved from their investment.

Milan is entering the scale-up phase of the Sharing Cities programme. This phase will last for two years and the city intends to use the benefits tool to demonstrate the value that deep energy retrofits bring about. The outcomes of the analysis will also be shared with a wider audience when Milan hosts a Sharing Cities 'scale-up' event in 2020, helping to shift practice and policy across Europe.

COPENHAGEN DENMARK

DRIVERS OF ACTION

The stationary sector (buildings, industry and energy) represents 60% of GHG emissions in Copenhagen. To reduce emissions, the city needs to transition to greener energy and reduce demand. The CPH 2025 Climate Plan (City of Copenhagen, 2012) was adopted by the City Council in 2012. It reflects the decision to make the city carbon neutral by 2025. The city has made considerable progress on reducing carbon emissions to date, however, the CPH 2025 Climate Plan calls for further action.

The country has a legal commitment to achieve 100% renewable power and heat by 2030, but the pressure on the energy grid is increasing as the city grows. Copenhagen depends on a district heating system that covers 97% of buildings (C40 Cities, 2011). Reducing energy consumption in municipal buildings will decrease GHG emissions+but also help address the pressure on the district heating system during peak demand periods (BhsxŽneŽBnodmg`fdm, 2012). This bnt k help to avoid or postpone the need to invest in new heating capacity for the

Municipal buildings represent 6% of Copenhagen's building stock and the city is leading the way on city retrofits by renovating its portfolio (CPH 2025, 2012). Is has set a target to reduce energy consumption in municipal buildings by 40% from 2010 251 2025. In 2010, operating city buildings and services represented 4% of Copenhagen emissions, with buildings accounting for half of that share.

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FULL TIME

EQUIVALENT

lated using a PPP exchange rate (2017

CREATION

1

VALUE

\$19.5MILLION

(DKK \$141.3MILLION)

7 YEARS

EXPLORE THE SOCIAL BENEFITS OF BUILDING RETROFITS

REDUCE PRESSURE ON THE CITY'S DISTRICT HEATING SYSTEM

ACCESS ADDITIONAL FUNDING FOR BUILDING RETROFITS BY PROVING THE SOCIAL BENEFIT

TAKING ACTION

The City of Copenhagen is investigating the investments needed to meet its emission target. The administration has already built a strong financial case for energy retrofits, but wants to explore the social benefits of mitigating carbon emissions.

For the pilot study, the municipality focused on the deep energy retrofit of five schools než Bnodmg`fdm&zŽ/Žohsx,qtmŽtbqnnkr-ŽThe investment is estimated at DKK 28.5 million (USD3.9 million)-2 The planned energy retrofit includes improvements to the building envelope, glazing, HVAC and lighting.

PILOT PROJECT BENEFITS: 5 SCHOOLS

19%

REDUCTION IN ENERGY

COST

PRODUCTIVITY VALUE \$840K (DKK \$6.1MILLION) PER YEAR

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SCALED-UP BENEFITS: 40 SCHOOLS

The Copenhagen municipality owns approximately 80 schools (excluding universities and further education facilities). To provide an indication of the benefits that can be attained if the actions of the pilot cities are scaled up across a larger portfolio of buildings a scenario has been run in which it is conservatively assumed that 50% of all

GHG 1,272 tCO₂ AVOIDED PER YEAR 63,630 tCO₂ SAVED OVER THE PROJECT LIFETIME

VUU JOB CREATION FULL TIME EQUIVALENT



NET PRESENT VALUE **\$156.2MILLION** (DKK 1.1BILLION) PAYBACK TIME **7 YEARS**

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PRODUCTIVITY VALUE \$6.7MILLION (DKK 49.1MILLION) PER YEAR

EMISSIONS

GHG

18%

schools (40 schools) will undergo deep energy retrofits. As the 5 schools in the pilot project are broadly representative of the school building stock, the inputs and results (e.g. floor areas, energy performance, etc.) have been averaged out across the 40 schools.

CHALLENGES AND NEXT STEPS

To control inflation, the Danish national government has instituted capital restrictions on public funding across all municipalities. The benefits analysis creates an opportunity for Copenhagen to demonstrate the wider value of building energy programmes. This can aid the municipality in unlocking further investments beyond the capital expenditure limit by showing the multiple social gains and the economic payback.

Copenhagen has utilised extensive energy consumption mapping and management as part of the city action plan, gathering a large set of data. Using the benefits tool allowed city officials to utilise existing sources to make additional connections, in order to highlight the link between indoor climate and improved productivity. This will lay the foundation for future focus areas and the development of the energy monitoring platform to contain indoor climate parameters.

Copenhagen aims to undertake large-scale retrofits of almost all the schools in the city. As a first step after this pilot process, the city will use the benefits tool to assess the case of two other schools that have been retrofitted. The purpose is to continue to illustrate the benefits from deep retrofit examples and make a stronger case for capital investment while restrictions are in place.



C40 Cities and ROCKWOOL have created a partnership to help cities make a stronger case for deep energy retrofit. Climate actions such as building retrofits reduce greenhouse gas (GHG) emissions and provide at the same time a unique opportunity to improve health and wellbeing, create jobs and increase household savings. Cities has undertaken cutting-edge research to demonstrate the multiple benefits of energy retrofits of buildings, and designed an easy-to-use toolkit that cities and other building owners can use to understand the full impact of this climate action.

To learn more about the benefits research work, visit https://www.c40.org/benefits



B U R O H A P P O L D E N G I N E E R I N G









