GAME CHANGERS:

Bold Actions by Cities to Accelerate Progress Toward Carbon Neutrality

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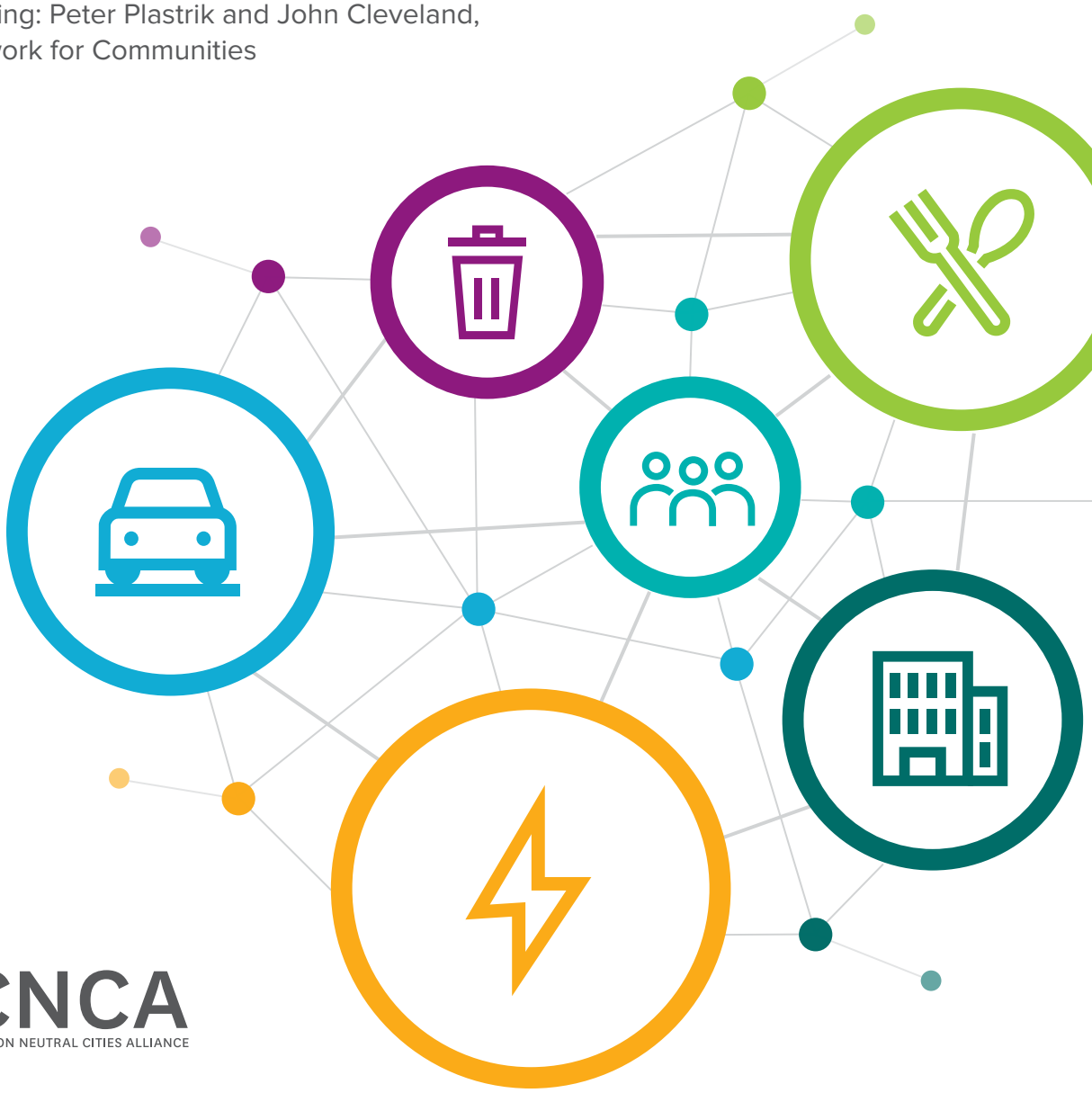

CNCA
CARBON NEUTRAL CITIES ALLIANCE

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About the Carbon Neutral Cities Alliance

The Carbon Neutral Cities Alliance (CNCA) is a collaboration of leading global cities working to cut greenhouse gas emissions by 80-100% by 2050 or sooner—the most aggressive GHG reduction targets undertaken anywhere by any city. It is possible for cities to achieve their interim carbon reduction targets through incremental improvements to existing systems, but achieving carbon neutrality will require radical, transformative changes to core city systems.

The Alliance aims to address what it will take for leading international cities to achieve these deep emissions reductions and how they can work together to meet their respective goals more efficiently and effectively.

These cities collaborate to share lessons in planning for and implementing deep carbon reductions and opportunities to accelerate best practices in deep decarbonization.

CNCA'S MISSION:

CNCA enables leading cities worldwide that are working aggressively toward a zero-carbon future to advance their own transformational efforts, collaborate with each other and key partners to overcome barriers, foster innovative approaches, and share lessons with other cities ready to pursue similar goals.

CNCA'S VISION:

The long-term vision of the Carbon Neutral Cities Alliance is that by 2050, or sooner, Alliance member cities will achieve carbon neutrality and that this will engender greater economic prosperity, social equity, enhanced quality of life, and climate resilience for the people and businesses in CNCA member cities. CNCA believes that by proving that carbon neutrality can be achieved by leading cities, it will generate replicable models and lessons for other cities and advance a movement toward carbon neutrality globally.

For more information about CNCA, go to CarbonNeutralCities.org.

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LETTER FROM THE MAYOR
OSLO

The summer of 2018 will go down in history as one of the hottest summer months ever recorded. According to NASA, May, June and July 2018 continued the warming trend of the past 40 years, where June this year tied with June 1998 as the third warmest in 138 years. New research depicts a grim future: climate change is happening faster than expected, and it's more extreme than the Intergovernmental Panel on Climate Change warned just three years ago.

When science is so evidently clear, two words come to mind. Urgency. And change. Urgency to act. And change path. Both require leadership. And I think what this report does is exactly that: it depicts leading cities tackling climate change aggressively, through new ways of thinking and implementation of measures at an impressive pace.

Albert Einstein once said: "A person who never made a mistake never tried anything new." With the effects of climate change happening in every corner of the world, one thing is for sure: business as usual is no longer an option. If we are to succeed in fighting dangerous climate change, we must dare to think and act differently. In Oslo, we have 12 years to reach our target of becoming a zero-emitting city. Climate action cannot be left for someone else, somewhere else, at another time. We have introduced a new sharp governance instrument to help achieve our target: a municipal climate budget where we count CO_2 the way we count money. It's a budget just like any ordinary budget, where a maximum emission level is set, and it identifies who is responsible, when measures are to be implemented, and at what cost. It's transparent. And it works! In 2016, emissions went down 8% compared to 2015. The use of private cars on the streets of Oslo is decreasing; more people than ever before use public transport, and in the first quarter of 2018 more than 60 percent of all new cars sold in Oslo were electric or plug-in hybrids — resulting in Oslo being named the EV Capital of the World.

This report brilliantly turns the spotlight on climate action from leading cities around the globe: Boulder, London, Melbourne, New York City, Rio de Janeiro, San Francisco, Stockholm, Vancouver, Washington, DC, and Oslo. Spanning from gold-standard approaches to waste management, to exemplary standard setting for buildings and clever design of low and zero-emission zones. What all of these cities have in common is the call to action and the willingness to share and learn. In a time where some leaders think that collaboration has gone out of fashion, CNCA cities forcefully demonstrate that working together is key to advance the climate agenda and for cities to prosper. Unilateralism is no recipe for innovation. Togetherness is.

With this report, I hope you find inspiration to act. I would encourage every mayor to join the growing movement of world-leading cities and take part in the amicable competition to deliver best practice in climate action. Happy reading.

RAYMOND JOHANSEN
Governing Mayor

City of Oslo

LETTER FROM THE MAYOR
VANCOUVER

Around the world, leading cities are stepping up and setting an inspiring pace on climate action. Like Vancouver, they are boldly leading the way by investing in renewable energy, building clean transportation infrastructure, and finding carbon-reducing efficiencies through greener building codes and waste reduction. In this report, the Carbon Neutral Cities Alliance (CNCA) identifies seven different areas of "game changing" policy and practice that will accelerate decarbonization in cities—from zero emissions buildings to creating a GHG emission budget. There are already major cities around the world leading the way and proving that these transformational policy changes work well at a community level.

Vancouver was the first major city in the Americas to commit to becoming 100% renewably powered. With 57 percent of our city's carbon emissions coming from buildings, the Zero Emissions Building Plan is a critical step to reaching our goal. Requiring 90 percent of new buildings to achieve zero emissions by 2025 will require transformative industry innovation and collaboration, and we have already seen this with 1.8 million square feet of zero emissions building projects. Vancouver's implementation of the Zero Emissions Building Plan will reduce GHG emissions from new buildings by over 60 percent and has catalyzed dozens of cities in Canada to adopt similar requirements.

Cities that are embracing these game changing opportunities are thriving and benefiting economically because they are clean, efficient cities where people want to live. In Vancouver, for example, our Zero Emissions Building Plan is not just reducing climate pollution and improving air quality and public health, it's also saving our residents an estimated $44 million in energy bills annually, and driving our green economy, with a 53 percent increase in green building jobs since 2010. Vancouver now has the strongest, most resilient, and greenest economy in Canada.

When cities collaborate on climate action, we are able to move farther and faster than we could by working alone. City networks like CNCA are invaluable to Vancouver as we strive to meet our ambitious targets. And this report is an important tool for helping us get there. With leadership and collaboration between cities, these essential actions are not only possible, they can provide tremendous benefits to our citizens.

GREGOR ROBERTSON
Mayor of Vancouver

CITY OF VANCOUVER | GREENEST CITY

CITIES ACHIEVING CARBON NEUTRALITY

CITIES ACHIEVING CARBON NEUTRALITY

Cities worldwide are stepping up to the challenge of reducing their greenhouse gas (GHG) emissions. Increasingly, cities are making big changes and pressing other levels of government and the private sector to do much more to combat climate change.

As part of this movement, a handful of cities came together several years ago to form the Carbon Neutral Cities Alliance (CNCA), now a global collaboration of 20 cities cutting emissions by 80% or more by 2050 or sooner. At CNCA, we help each other move further and faster to achieve GHG reduction, and we share what we learn and know with other cities. There are few emissions-reducing practices that our cities have not tried; in fact, these cities have pioneered many of them.

This year, we identified seven promising, next-generation practices to share with other cities. They are *Game Changers:* impactful actions that can accelerate and amplify decarbonization in cities. This is what CNCA cities are doing and what is happening on the ground at the leading edge of city decarbonization practice. They are changing the game. And they are the next essential steps that many cities should consider on the pathway to carbon neutrality.

Deep, long-term decarbonization depends on transforming our cities' key GHG-emitting systems and markets for transportation, energy supply, buildings, solid waste, and food, which have, until now, been wedded to the fossil fuel economy. Our goal is that carbon neutrality is a standard feature of these urban systems by no later than 2050.

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While transformation may seem daunting, the pathway to city decarbonization over the next few decades is clear. We need to phase out fossil fuel energy production and ramp up renewable energy supply. We must increase energy efficiency substantially, while expanding the use of public transportation, bicycling, and walking, and increasing the use of non-fossil-fueled vehicles. And we have to reduce the disposal of waste that generates GHG emissions.

Many cities are on this journey. They're measuring and analyzing the carbon production within their boundaries, setting decarbonization goals for their systems, and undertaking climate-action planning and implementation. As more cities initiate climate actions, a set of reliable, well-understood and cost-effective practices have emerged. These "no brainers" include installing LED

street lighting to reduce municipal energy consumption, partnering with commercial building owners and managers to increase energy efficiency, converting municipal fleets — cars, buses, service vehicles — to alternative fuels, and investing in more bicycle networks and pedestrian walkways to promote alternatives to driving.

But CNCA cities have come to understand — through cycles of research, planning, implementation, and learning — that it takes more than these practices to transform their systems and foster significant GHG reduction. We're designing and implementing new and bolder actions to expand and accelerate progress on the pathway to carbon neutrality. These actions build on previous climate actions, but they also seek to fundamentally change the policies, products and practices in key urban systems and markets. To do this, our cities are setting new standards and regulations, making substantial, targeted public investments, and partnering with communities and businesses. We're also taking a multiple-systems approach, finding new ways to leverage change in one system to affect another system.

Out of these processes have come the **7 Game Changers** described in this report.

To help cities determine the promise of these Game Changers for their own ambitions and particular contexts, and adapt them for use, we pooled the growing know-how of CNCA cities to identify potential Game Changers and selected those that are most relevant to other cities. We identified potential CNCA-city cases to use and discussed the implementation details with expert practitioners in those cities.

GAME CHANGERS AT A GLANCE

Game Changers at a Glance

ADOPT A ZERO-EMISSIONS STANDARD FOR NEW BUILDINGS	This standard requires that proposed buildings in a city be designed and equipped so that *all* energy use in the building, on an annual basis—for heating, cooling, lighting, appliances, vehicle charging, etc.—is as efficient as possible and comes from renewable energy sources. This performance requirement is just starting to be adopted for new buildings, but it can also be applied to additions and alterations to existing buildings. ***CNCA Example: Vancouver***
BUILD A UBIQUITOUS ELECTRIC-VEHICLE CHARGING INFRASTRUCTURE	This infrastructure provides drivers of electric vehicles within a city with convenient, quick, and safe access to fairly-priced charging stations. Along with access to bio-fuels and hydrogen fueling, it is an essential element in building the clean-energy mobility systems that are emerging in cities. ***CNCA Example: Oslo***
MANDATE THE RECOVERY OF ORGANIC MATERIAL	This mandate requires the capture of organic material—including separation, collection, and processing—from residences, businesses, and institutions so that it is kept out of landfills where it generates GHG emissions. The organic material is recovered for use as carbon-capturing compost for farms and landscapes or as biogas for vehicles and industry. ***CNCA Example: San Francisco***
ELECTRIFY BUILDINGS' HEATING AND COOLING SYSTEMS	This market-based effort by US cities involves partnering with manufacturers, distributors, utilities, and government agencies to decarbonize buildings' heating and cooling systems by increasing the purchase and installation of high-efficiency heat pumps that use electricity that is increasingly powered by renewable sources. European cities with district-scale heating and cooling systems are replacing fossil fuel sources with various clean or renewable energy sources. ***CNCA Examples: Boulder, New York City, Washington, DC***
DESIGNATE CAR-FREE AND LOW-EMISSIONS VEHICLE ZONES	This designation establishes parts of a city—a street or road, a district or even larger zone—in which the use of vehicles has been prohibited or subjected to a fee. Bans and pricing can apply to all vehicles or only to fossil fuel vehicles, usually with exemptions for emergency and public transit vehicles. ***CNCA Examples: Stockholm, London, Oslo***

EMPOWER LOCAL PRODUCERS AND BUYERS OF RENEWABLE ELECTRICITY	This set of policies and investments empower local residents, businesses, city government, and others to produce or purchase renewable energy supply directly, rather than relying on their utility. This is accomplished by investing public funds and encouraging private investment in production of renewable energy, adopting renewable energy standards, organizing buyer coalitions, and advocating for changes in regulatory policies. ***CNCA Examples: Washington, DC, Melbourne, Rio de Janeiro***
SET A CITY CLIMATE BUDGET TO DRIVE DECARBONIZATION	The climate budget is a tool to convert a city's climate goals into concrete, annual, measurable action. It establishes a maximum GHG emissions level for the budget year, based on the city's emissions goal. The budget details the city's proposed short-term, emissions-reduction actions to stay within the maximum amount, their projected impact, and cost. It is a distinct part of the city's overall budget and moves through the city's usual budgeting process, from proposal to adoption, implementation, and after-action assessment. ***CNCA Example: Oslo***

In the sections that follow, we use the experiences of CNCA cities as examples to describe each of the Game Changers—what it is and the impacts it has, essential precursors or building blocks, key implementation steps, lessons learned so far, and challenges cities face.

We note how other CNCA cities are advancing the Game Changer under different political and regulatory contexts.

And we present some global trends in markets and other levels of government that support adoption of the Game Changer. In the report's final section, we identify written resources for cities interested in learning more about implementing each Game Changer.

GAME CHANGERS IN DETAIL

ADOPT A ZERO-EMISSIONS STANDARD FOR NEW BUILDINGS

New construction has contributed, since 2010, to an increase in the building sector's global CO_2 emissions, and more buildings are on the way. The UN's 2017 "Global Status Report" estimates that the world will add 230 billion square meters (2.5 trillion square feet) of buildings by 2060. That's the equivalent of adding an entire New York City to the planet every 34 days for the next 40 years.

A zero-emissions or "net zero" building standard requires that proposed buildings in a city be designed and equipped so that *all* energy use in the building, on an annual basis—for heating, cooling, lighting, appliances, vehicle charging, etc.—is as efficient as possible and comes only from renewable energy sources. This performance requirement is just starting to be adopted for new buildings, but it can also be applied to additions and alterations to existing buildings.[1] The standard is achieved by reducing energy consumption through improved building design and energy efficiency of buildings' mechanical and electrical systems and by producing renewable energy onsite or purchasing it from offsite sources.

If a city controls its building code, it can phase in a zero-emissions standard. It establishes a progression of steps, or target years, after which all new buildings that enter the planning and permitting process must meet the new requirements, such as zero emissions. This is necessary due to the lead time required to design and permit new buildings and the need for the local building sector to adopt more energy-efficient design and operations for buildings. If the city does not have authority over building codes, it can build momentum in the right direction by incentivizing voluntary adoption of a green standard and applying the standard to new municipal facilities to demonstrate feasibility (see "Challenges" below).

Cities can use the zero-emissions standard to make sure new development will not perpetuate the existing building system's high levels of energy consumption and carbon emissions. At the same time, incentives and regulations can increase the energy efficiency of existing buildings.

The UN's "Global Status Report" estimates that the world will add 230 billion square meters (2.5 trillion square feet) of buildings by 2060.

ABOUT ZERO EMISSIONS

- A zero-emissions standard applies to the energy used or carbon emitted in ***operating*** a building, but not to the energy/carbon embodied in ***constructing*** a building.
- An "energy positive" or "energy plus" building produces more renewable energy than it needs to meet a zero-emissions standard.
- A "near zero" or "ultra-low energy" building uses some non-renewable operational energy and produces some carbon emissions, but much less than current buildings.

1 This standard will eventually need to be applied to existing buildings, if cities are to meet their deep decarbonization goals.

CNCA EXAMPLE: VANCOUVER

In 2016, Vancouver became one of the world's first cities to initiate a zero carbon-emissions standard. Vancouver did this to prevent future buildings from emitting GHGs, an essential part of the city's approach to achieving ambitious, long-term decarbonization.

The need for action was clear. Vancouver's city council had committed that 100% of all energy used in the city would come from renewable sources by 2050. Existing buildings were generating more than half of the city's GHG emissions. Population growth in this city of more than 630,000 residents was stimulating a sustained building boom. City staff estimated that, by 2050, 40% of all floor space in the city would be in buildings constructed after 2020. Most of these buildings would be for residential use and would connect to the city's electricity system, which is nearly 100% renewable, thanks to hydropower. But if the historical pattern of energy use continued, most buildings would also burn natural gas for space heating and hot water.

There was little reason to think the development and construction sector would shift to renewable sources or produce much higher levels of energy efficiency on its own.

To steer the building market toward the 100% renewable energy goal, the city adopted a plan and a new regulatory structure to put into place a new standard: by 2030, *all* new buildings would not emit any GHGs.

The city modeled its standard off the Passive House standard, which originated in Germany and is widely applied globally. Implementation of the standard by the building sector is supported by training programs, energy-modeling software, third-party verification processes, global networks of designers, builders, equipment manufacturers, and researchers who exchange information.

Because GHG emissions from buildings vary, the city decided to set GHG limits on each of four types of new buildings: one and two-family houses, multi-unit low-rises, high rises, and commercial buildings. These limits, which reduce emissions by an average of 50% in the first step target, are already in effect for low-rise multi-family buildings and will take effect in 2020 for the other building types. The limits will be stepped down and improved in 4-5-year phases, so that, by 2030, all new buildings will be zero emissions.

Vancouver's strategy went beyond issuing a new mandate to the building sector. It also supported the development of the building industry's capacity to produce zero-emissions buildings and required city government building projects to demonstrate zero-emissions approaches. "This is a plan to fundamentally shift building practice in Vancouver in just under 10 years," the city's 2016 "Zero Emissions Building Plan" states.

Vancouver designed its approach to ensure that these buildings will provide comfortable and healthy indoor environments. The city also sought to maximize local business activity and job creation to supply materials and labor for the buildings. It expects the approach will strengthen the long-term climate resilience of buildings and protect the affordability of housing in the city. Implementing a zero-emissions standard also reduces a building's energy costs and lessens the impact of future energy cost increases, while avoiding the potential future cost of energy-efficiency retrofit measures that might be required in buildings.

Vancouver's implementation of the zero-emissions building plan will prevent an enormous amount of GHG emissions that would have occurred during the decades-long life spans of new buildings that are expected to be constructed.

Key Implementation Steps

The implementation steps taken in Vancouver reflect steps that other cities are starting to take, with some variation due to differences in cities' building stock and development projections, availability of renewable energy, city authority over building codes, building industry norms, and other factors.

Vancouver cites two precursors or building blocks on which the design and implementation of the city's zero-emissions plan depended.

- **Ambitious Goals.** The city's ambitious GHG-reduction goals heralded the need for big changes in building and other sectors. The 2015 adoption of a 100% renewable energy goal for the city signaled the city government's long-term intention, with substantial implications for the building sector and other systems in the city.

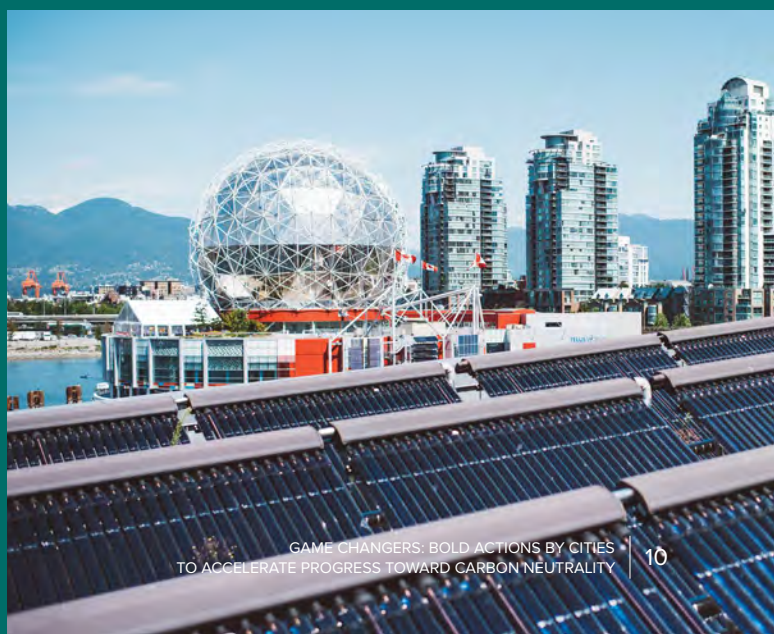
  Existing Green Building Standards. Vancouver already had a number of green buildings, as the city had been requiring and encouraging greener buildings for several years. It had prescribed better insulation in new homes, high-performing windows, more efficient furnaces, and other measures. Since 2004 it had required civic buildings to attain the Leadership in Energy and Environmental Design LEED Gold efficiency standard, and in 2010 it required the same of rezoning developments when expanding or modifying existing buildings. It also used the development of a new athletes' village downtown for the 2010 Winter Olympics to showcase ultra-high-efficiency building techniques (the neighborhood achieved LEED Platinum status). As a result of these and other actions, there were quite a few examples of green buildings in the city and even some that already met Passive House standards.

  This meant that some local developers had experience with meeting green standards and there were buildings in the city that provided evidence that it was feasible to achieve tougher-than-usual standards.

In this context, the city took/is taking major actions to implement the zero-emissions plan (although not necessarily in the following sequence).

1 **Engage with the development and building sectors and collaborate with potential early adopters in the industry.** From the beginning, Vancouver recognized that the transformation it wanted to achieve in buildings depended on the local industry's willingness to change. City staff started to meet with and listen to developers, architects, and builders, identifying those who were interested in developing greener buildings and partnering with the city to develop and apply new methods. The city worked with the sector to develop a building code structure that the industry thought could work and won public endorsement from many in the sector.

2 **Forecast potential building development in the city for the next few decades and focus code innovation on the primary building types.** Cities need to understand the types of buildings that are likely to be constructed and decide how to apply the zero-emissions standard to each type. Vancouver determined that it has four broad categories of buildings (other cities will use different typologies). It forecasted that residential buildings (houses, condominiums, and apartments) would generate more than 80% of the construction in the city for decades. The city's analysis identified the challenges that each building type would have in reaching the zero-emissions standard.



Right: Solar panels on the roof of the Creekside Community Centre provide hot water to the building, while a nearby district energy utility captures waste heat from municipal sewage lines and distributes it throughout the neighborhood. Creekside was the first community center in Canada that achieved a LEED Platinum standard for sustainable design.

3 **Select a zero-emissions standard to use.** Vancouver decided to model its zero-emissions standard on the Passive House standard, rather than the standard of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) used by many North American cities and upon which LEED is based. (Countries will differ on energy use standards and limits.) The city's research indicated that adopting the widely used ASHRAE standard, which focuses on energy consumption and costs, would not result in the GHG emissions reductions the city was seeking. Passive House, in contrast, ensured the design and building of a highly efficient building envelope and ventilation system, with almost no need for space heating. It also limited emissions for heating water and electricity use. The Vancouver code also adopted maximum allowed GHG emissions based on building energy performance modeling for each building type in the period before 2030. After that date, no emissions will be permitted.

4 **Develop a code with a clear structure and roadmap of changes and timelines.** Vancouver's new code treated each of the four building types in the city somewhat differently. All buildings had to achieve zero emissions by 2030, but each had a roadmap customized to the challenges that builders would face in getting to zero. For instance, it required new detached houses to achieve lower emissions than the existing code by 2020 and zero emissions starting in 2025. New high-rise buildings faced lower emission targets starting in 2020, and by 2025 rezoning projects that expanded or repurposed the building had to be zero emissions. These and other roadmaps were designed to give the building sector incentives and time to innovate and adopt high-energy efficiency practices.

The city also led by example. It required that new city-owned buildings met the Passive House standard in most cases and worked with public and nonprofit affordable housing entities to use the Passive House and other green building standards.

5 **Make the case for zero-emissions by highlighting benefits and addressing affordability concerns.** Although the zero-emissions code was driven by city goals for GHG emissions and renewable energy, it had other benefits that mattered to the public and elected officials in Vancouver: healthier, more comfortable, more climate-resilient buildings to live in, with lower energy costs. Of particular interest was the development of a green building sector with more business activity and job creation.

At the same time, though, the city had to address concerns that the new standard would drive up the cost of new buildings and, therefore, prices and rents. The city's research indicated that the additional cost of zero-emission compliance would be 2-4%, depending on a number of factors. But the city's analysis also found that an incremental increase in cost didn't necessarily affect the price of housing and offices; those depended on what the market would bear. Even if the costs were passed along to buyers, they added little to a monthly mortgage payment and would be offset by lower energy bills. The city concluded that a zero-emissions standard would have little impact on the price of market-rate housing and rentals, and that developers of affordable housing projects could meet the standard too, especially since buildings' energy costs would be reduced.

6 **Design and invest in support of the industry.** As Vancouver implemented the zero-emissions plan, it used city money to help establish, in partnership with the Vancouver Regional Construction Association, the Zero Emissions Building Exchange (ZEBx). This center of excellence serves the building industry by compiling and sharing knowledge, identifying and facilitating the removal of barriers, supporting multicultural home builders whose first language is not English, facilitating industry dialogue with the city, and showcasing zero-emissions buildings to the public. The center is an independent entity controlled by industry stakeholders.

7 **Tailor the city's building compliance processes to the zero-emissions standard.** Vancouver spelled out a process for demonstrating compliance, submitting digital documentation that showed how the building design would meet specific performance targets (e.g., ventilation rates, window-to-wall ratios, etc.). Now, as the new code kicks into effect, builders must demonstrate compliance by testing building systems and measuring energy use once the building is occupied. The city will perform initial quality control checks and provide the industry with training sessions and videos about compliance expectations.

Lessons Learned for Implementing Zero-Emissions Building Codes

Perhaps the most important lesson from Vancouver is that adopting a zero-emissions approach for new buildings involves much more than issuing a new requirement. It is, most essentially, about helping the building sector develop and adopt the new practices, expertise, products, and services needed to achieve the code standard. In this context, it is helpful to develop strong relationships with the private sector.

- **Establish sector-based mechanisms for exchange of information and learning to meet a zero-emissions standard.** Developers and builders trust each other for information and expertise more than they trust government, scientists, academics, and other outsiders. The most effective way to promote this standard in the sector is peer-to-peer exchange about what is being tried and learned—what works and what doesn't—to meet a zero-emissions standard. Vancouver's Zero Emissions Building Exchange is designed to provide a safe space for players in the sector to share and learn. Sharing of lessons learned and case studies is a condition of city incentives for new buildings that voluntarily pursue a near zero-emissions approach, such as Passive House, before it is required of them.
- **Work with industry to identify and address any regulatory barriers to applying zero-emissions code.** Vancouver officials realized that some existing regulations for buildings might conflict with the zero-emissions code and get in the way of achieving the standard. They invited industry players to identify potential regulatory problems that the city could correct. Among the issues that surfaced: the increased exterior wall thickness, which was needed to meet the new standard, actually reduced the amount of square footage in the building, which is the basis for prices. Consequently, the city council approved exemptions that allowed builders to build with increased insulation without losing floor space that can be occupied and sold. Turning to industry in this way, and addressing the conflicts, helped build the perception that the city really did want to help the sector succeed, not just regulate it.
- **Build informed political support that is willing to prioritize GHG reduction, not just greening of buildings.** Vancouver's city officials prioritized GHG emissions reduction for their building code revisions, so the code focuses on requiring actions, such as improving the building envelope, that will accomplish this goal in Vancouver's context. The prioritization meant that many other actions that make buildings greener were not mandated. The city pushed the development market to change, but not everything at once. This allowed elected officials to stay focused on an overriding purpose—GHG reduction—and develop expertise in what was being required, so they could address industry concerns without being unduly influenced by unfounded claims.

Other CNCA Cities Advancing Zero-Emissions Buildings

- **Boulder:** The city updated building and energy codes for new commercial and residential buildings and additions and alterations in 2017, setting a goal of net-zero construction by 2031.
- **Melbourne:** The city has been considering adoption of carbon-neutral building standards for all new buildings by 2030, but full implementation of a net-zero approach will need state- and federal-government support, which the city will seek.
- **New York City:** The city is studying the feasibility of having all new city-owned buildings constructed to Passive House standards by 2030.
- **Oslo:** The city is moving to have all new buildings meet a Passive House standard and has been actively engaged in the Future-Built program, which develops pilots that demonstrate that low/zero-carbon buildings can be achieved. The city council has also adopted a policy for fossil fuel-free construction sites for new schools, sports facilities, nursing homes, and other public facilities: diesel-driven machinery and equipment must convert to biofuels or other zero-emissions alternatives.[2]
- **Rio de Janeiro:** The city used the run-up to the 2016 Olympic Games in Rio to develop LEED-certified sports facilities and to

2 For info on Oslo's fossil fuel-free construction sites, see Espen D. Nicolaysen, "New Procurement Strategy: City of Oslo," March 2018, http://www.procuraplus.org/fileadmin/user_upload/Activities_files/Events/Oslo_2018/Procura__Seminar_Oslo_2018_-_Oslo_procurement_strategy.pdf. A reported 27 of 38 buildings currently under construction for the city are being built without the use of fossil fuels.

refocus its procurement processes on green building development. In 2018, the city planning department proposed offering property tax breaks for commercial and residential buildings that score well on greening criteria, including solar water heating, efficient lighting, natural lighting, solar-powered lighting, natural ventilation, and shading systems. With the incentive in place, it is projected that, by 2023, 15% of new buildings will qualify.

- **Sydney:** The city is collaborating with industry and state government to develop a pathway for strengthening the City's planning controls over time to deliver net-zero building standards.
- **Toronto:** The city added to its Green Building Standard a new "Zero Emissions Building Framework" in 2018, with stepped-up performance targets to approach zero emissions for all new buildings by 2030. Toronto estimated the change would reduce GHG emissions by 30 million tons by 2050.
- **Washington, DC:** The city's "Clean Energy DC" plan calls for phasing in adoption of net-zero building codes between 2020 and 2026, starting with construction of new single-family and small multi-family buildings in 2020, and for all new construction in 2026. As part of the shift, the city has considered providing a set of incentives—property tax abatement, accelerated permitting, increases in the permissible floor space-to-land area ratio—to promote new high-performance buildings and capture the attention of developers.[3]

3 District of Columbia, Department of Energy and Environment, "Clean Energy DC: The District of Columbia Climate and Energy Plan," Draft, October 2016, https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Clean_Energy_DC_2016_final_print_single_pages_102616_print.pdf, 55-57.

Challenges for Cities Implementing Zero-Emissions Building Codes

Vancouver's case contains several factors that are not necessarily present for other cities. The city has control over its building code; this authority is in the city charter. It has an electricity supply that is nearly 100% renewable. And the city is undergoing a development boom. In other cities, different factors may present challenges to implementing zero-emissions building standards. While these challenges are real, they do not necessarily have to stop progress.

- **My city doesn't have control over its building codes.** Cities may not control their own building and energy codes or may be prohibited from using codes that are stricter than state, provincial, or national governments. If so, they may promote and incentivize voluntary adoption of a zero-emissions standard by developers, much as the LEED standard was promoted before becoming widely adopted in building codes. Many cities are advocating for the adoption of zero-emissions codes by the controlling government authority.

  For example, Toronto, which did not have the power to use building and energy codes, embedded standards similar to those of Vancouver into its land-use regulations. Its Green Building Standard created a set of sustainable design requirements for new private and public developments.

- **My city's electricity supply has low renewable-energy content.** Cities with "dirty" electricity may still benefit from adopting zero-emissions standards, because the greatly increased energy efficiency of buildings will reduce GHG emissions, even if not to zero. They can set the "zero date" later than 2030 to allow more time for electricity supply to increase its renewability. These cities can also allow new developments to produce onsite renewable energy (or to invest in local offsite renewable production on other buildings) rather than rely on the grid's electricity.

  In designing a slower path to zero emissions, cities may establish more steps in the code—dates at which lower emissions are required—than Vancouver did. Cities can also customize roadmaps to zero for different building types.

- **My city is concerned about the potential impact of a zero-emissions approach on the affordability of housing.** Affordability is a significant challenge facing many cities. As mentioned earlier, Vancouver's research found that its plan's impact on construction costs would be relatively small in its housing market, especially since an incremental increase would be spread out over the term of a mortgage and offset by savings on energy costs. In other cities, the cost impact might be less, depending on the cost of skilled

labor, and the energy savings might be greater since Vancouver's energy is relatively expensive.

Regardless, there will be some additional up-front costs, and while occupants of high-efficiency buildings use less energy and therefore pay less in monthly energy costs, there is sure to be resistance to the higher up-front costs. To address this, cities may be able to make energy costs part of the definition of housing affordability, which will allow the energy savings from zero-emissions policies to be reflected as an improvement in affordability. They may also be able to design their program so that the cost of energy is tied to the monthly cost for an apartment or house, rather than the cost per unit of energy.

GLOBAL TRENDS ADVANCING ZERO-EMISSIONS BUILDING CODES

ARCHITECTURE 2030: The US nonprofit published "ZERO Code," energy efficiency requirements for new building construction, the first national and international zero code for commercial, institutional, and mid- to high-rise residential buildings. The code, which can be adopted by government jurisdictions, is supported by a free, open-source Zero Tool that can be used to estimate building energy use and the potential for renewable energy use.

CALIFORNIA: The state government adopted a net-zero energy goal for new buildings in 2007 and will begin, in 2020, to require that rooftop solar panels be installed on new single-family homes and low-rise multi-family buildings to offset the home's expected annual electricity use and achieve "zero-net electricity" status. The just-passed 2019 state energy code will also allow electrification of small low-rise residential buildings. A zero-emissions building code for the state, covering all energy used during building operations, is under consideration.

SOUTH AFRICAN CITIES: Johannesburg, Cape Town, eThekwini (formerly Durban), and Tshwane (formerly Pretoria) committed to work together to make zero-carbon the standard practice for new buildings, as part of the C40 Cities South Africa Buildings Programme.[4]

US STATE GOVERNMENTS: A dozen states have added Passive House certification as a factor for qualifying affordable housing projects for tax credits and financial incentives.[5]

4 C40 Cities, "Four South African Cities Strive to Make All New Buildings Zero Carbon," https://www.c40cities.org/press_releases/south-african-cities-make-all-new-buildings-zero-carbon.

5 Courtney Humphries, "How Affordable Housing is Driving Passive House Design," *Architect*, September 14, 2016, http://www.architectmagazine.com/practice/how-affordable-housing-is-driving-passive-house-design_o.

BUILD A UBIQUITOUS ELECTRIC-VEHICLE CHARGING INFRASTRUCTURE

The electric vehicle market is still at an early stage of development and quite small. Electric vehicle (EV) charging and battery technologies are changing rapidly and are not standardized, nor is government regulation of the charging infrastructure. The capital that will be needed to build out the infrastructure is sizable, while the business models for charging infrastructure are not yet well developed, and the uncertainties around potential return on private investment remain large.

Cities can develop plans and investment strategies to guide and support the extent, location, cost, and operation of the EV infrastructure and the pace of its development.

A charging infrastructure for EVs provides EV drivers in the city with convenient, quick, and safe access to fairly-priced cleaner fuel. This development, along with access to bio-fuels and hydrogen, is an essential element in building the clean-energy mobility systems that are emerging in cities and replacing fossil fuel vehicles and infrastructure.

The development of electric vehicle charging in cities typically involves investing in *public* charging infrastructure, partnering with electricity utilities, and incentivizing development of and/or requiring installation of *private* charging infrastructure. Local government planning and investment play a critical catalytic role because of the uncertainties that private investment faces.

Oslo officials say that in addition to providing an adequate EV charging infrastructure, there are two other success factors for “making EVs the right choice”: EVs must be cheap to buy and cheap to use.

ABOUT EV CHARGER SPEEDS

EV charging power varies and is broadly broken down into three categories based on speed: “Level 1”, or slow chargers, used primarily in residences; “Level 2”, or normal chargers, used in homes, workplaces, and for public charging; “Fast Chargers” used in public spaces. Many EVs are limited in the maximum charging power they can accept, and plug-in hybrids cannot use fast chargers.

ELECTRIC VEHICLE MARKET POLICIES IN NORWAY

Oslo officials say that in addition to providing an adequate EV charging infrastructure, there are two other success factors for “making EVs the right choice” in Norway:

- **EVs must be cheap to buy.** EV buyers in Norway pay no national taxes or fees on the purchase, while fossil fuel vehicle buyers pay high taxes. As a result, many EVs cost about the same as their fossil fuel counterparts.
- **EVs must be cheap to use.** EV drivers in Oslo have free access to toll roads and tunnels, free parking, free transport on ferries, and can use bus and taxi lanes. EV charging at public chargers is free. National toll roads are also free to EV users.

CNCA EXAMPLE: OSLO

In Oslo, rapidly building out a charging infrastructure for electric vehicles is critical for reducing GHG emissions in urban transportation, especially since Oslo's electricity supply, from hydropower, is almost 100% renewable. With 1,300 public EV chargers already available in a city of 670,000 residents, Oslo is adding 1,800 more by 2020 to keep pace with soaring electric vehicle sales that have given the city a world-leading EV presence.

About 60% of GHG emissions in Oslo come from vehicles, which makes the shift to renewably-powered EVs a high priority given the city's ambitious goals for reducing overall emissions by 95% by 2030 (from the city's 1990 level).

The city estimates that the 60,000 EVs currently operating in the metropolitan area reduce CO_2 emissions by at least 102,000 tons annually. Its 2018 budget projects substantial emissions reductions by 2020 that will result from installing charging stations for passenger and commercial vehicles (including car-sharing operations and low- to zero-emissions taxis) and achieving a fossil fuel-free public transit system.

In 2016, nearly 30% of all new vehicles registered in the Oslo region were electric. In 2017, battery EV and PHEV-purchase rate reached 50%, and in the first part of 2018 it went even higher. As a result, more than 20% of all cars in Oslo now run on electricity, which is double the market share of the next closest city anywhere in the world.

This significant shift is due, in large part, to a package of national and city policies that make the cost of buying and operating electric vehicles comparable to, or even cheaper than, the cost of fossil fuel vehicles. But providing easy, convenient access to charging infrastructure is also a crucial success factor. It eliminates potential buyers' anxiety about running out of fuel, provides access to emergency charging, and enables longer trips.

The city's expanding EV charging infrastructure is the backbone of its approach to developing a green mobility system based on renewable energy. The shift to EVs brings another benefit that Oslo and other cities have experienced: reducing gas-powered vehicle traffic results in reduced air pollution in the city. "A cleaner vehicle fleet will make Oslo's air better to breathe," states the city's 2018 budget.

Most charging stations in Oslo are curbside, but the city is also building parking garages for EVs only. The Vulkan Garage, for example, has 102 chargers, the largest number of any parking garage in the world.[6] The city is working with private charging companies to install faster chargers, especially in transportation corridors in and out of the city and in residential areas, since about 61% of Oslo's EV owners live in apartments and townhouses. It is developing a charging center for taxis, freight, and service vehicles, with flexible charging, pre-booking by smart phone app, and free residential parking at night. It is offering incentives for roadside convenience stores and gas stations to install fast chargers along roads.

The city-owned chargers are free to use, until at least September 2019 when the city will decide whether to continue the policy, but most are normal or slow chargers. Most of the faster chargers in the city are jointly owned by the city and private charging companies, which co-invest in their deployment. Pricing for these chargers is set by agreement between the city and its partners, with discounts for priority groups such as electric taxis and city service vehicles.

Oslo is also cleaning up the public transportation system, adding 70 electric buses to its fleet by the summer of 2019, with lower lifetime "cost of ownership" than traditional diesel-powered buses due to lower fuel and maintenance costs.[7] The city is supporting a conversion to zero-emissions taxis and providing curbside charging for car-sharing companies. At the same time, Oslo is investing in more bicycling lanes, pedestrian walkways, on-demand public autonomous vehicles, park-and-ride options close to metro and train stations, and a green freight-distribution system.

6 Steve Hanley, "Oslo EV Parking Garage is World's Largest, Uses 6,000 KwH of Electricity a Week," *Clean Technica,* December 3, 2017, https://cleantechnica.com/2017/12/03/oslo-ev-parking-garage-worlds-largest-uses-6000-kwh-electricity-week/.

7 Steve Hanley, "Oslo to Add 70 Electric Buses by Summer of 2019," *Clean Technica,* April 18, 2018, https://cleantechnica.com/2018/04/18/oslo-to-add-70-electric-buses-by-summer-of-2019/.

Key Implementation Steps

When Oslo determined that its clean-mobility future needed an EV-charging infrastructure, it developed a roadmap for infrastructure that addressed the following dimensions and was aligned with the development of the city's broader green mobility system. The steps Oslo took for developing EV infrastructure include:

1 Analyze the future EV infrastructure needs of the city and design the infrastructure accordingly. An analysis should project the growth of EV usage in the city and assess the needs of future EV users based on their likely driving patterns. From this analysis, a scenario for the location and mix of charging infrastructure can be developed and becomes the basis for implementation. Although publicly accessible charging is an important component of the infrastructure, charging at home and at the workplace are likely to be equally, if not more, important and should be a part of the overall infrastructure design.

Oslo asked residents for suggestions about where to place chargers and located many charging stations based on the feedback the city received. Other factors determining where Oslo places chargers include: being closer to electricity sources (which reduces costs and disruption); avoiding parking and traffic issues; and locating chargers in places that are not intrusive to residents. Within a specific location, such as a parking lot, they should be situated to allow for access by the maximum number of vehicles.

Oslo feels there is no ideal ratio of vehicles-per-charger because of the evolving complexities of the infrastructure, including the mix of different types of chargers, the location of EV owners, the city's goals in catalyzing the infrastructure development, and the pricing structure of the charging system. The European Union's "Clean Vehicles Directive" calls for a ratio of 1 charger per 10 electric vehicles, but Oslo views this as a suggestion, not a rule, since the city's priority is to make it possible for people to charge overnight at home. A 2017 analysis of EV charging infrastructure development in 14 high-uptake metropolitan markets worldwide found an average of 7 EVs per each charging point, but specific markets ranged from 5 to 30 EVs, and fast chargers ranged from 5-40% of all public chargers.[8] Oslo uses pilots and partnerships with private charging operators, car manufacturers, and research institutions to decide which charging technologies to commit to. It will only support open charging systems that all vehicles can use.

2 Establish necessary rules for use of chargers and best practices for signage and other use factors. When it comes to public chargers, many cities establish rules about the use of chargers and related parking spaces. For instance, Oslo fines non-electric vehicles that are in EV spots. Amsterdam restricts use of public parking spaces with chargers to EVs only. In Boulder, violators are fined $50 USD for occupying an EV charging space with a non-electric vehicle. Boulder also allows for the use of traffic control signage to place limits on the time an EV can occupy an EV charging space. In addition, cities have found that effective signage indicating where an EV charger is and what the usage rules are will increase usage and reduce drivers' confusion.

3 Jump-start infrastructure development with initial public investments. Because the electric vehicle market is still relatively small, charging infrastructure is unlikely to attract private investment early on. Oslo began to build its EV-charging infrastructure in 2008, investing in installing 400 public on-street chargers in the downtown area as a pilot. For a while, the city had more chargers than EVs, but that has changed. The pilot proved to be popular with the growing number of EV users, so the city decided to expand the infrastructure. Jump-starting a market's development with public investment is a time-honored way of creating the conditions for private investment.

4 Develop partnerships with utilities and private businesses as long-term investors when building out a city's EV-charging infrastructure. Oslo has been building partnerships with utilities, private charging companies, automobile makers, and other businesses to attract private investment for EV-charging infrastructure. The city now splits the cost of new chargers 50-50 with its business partners, but also gets half of the net profits.

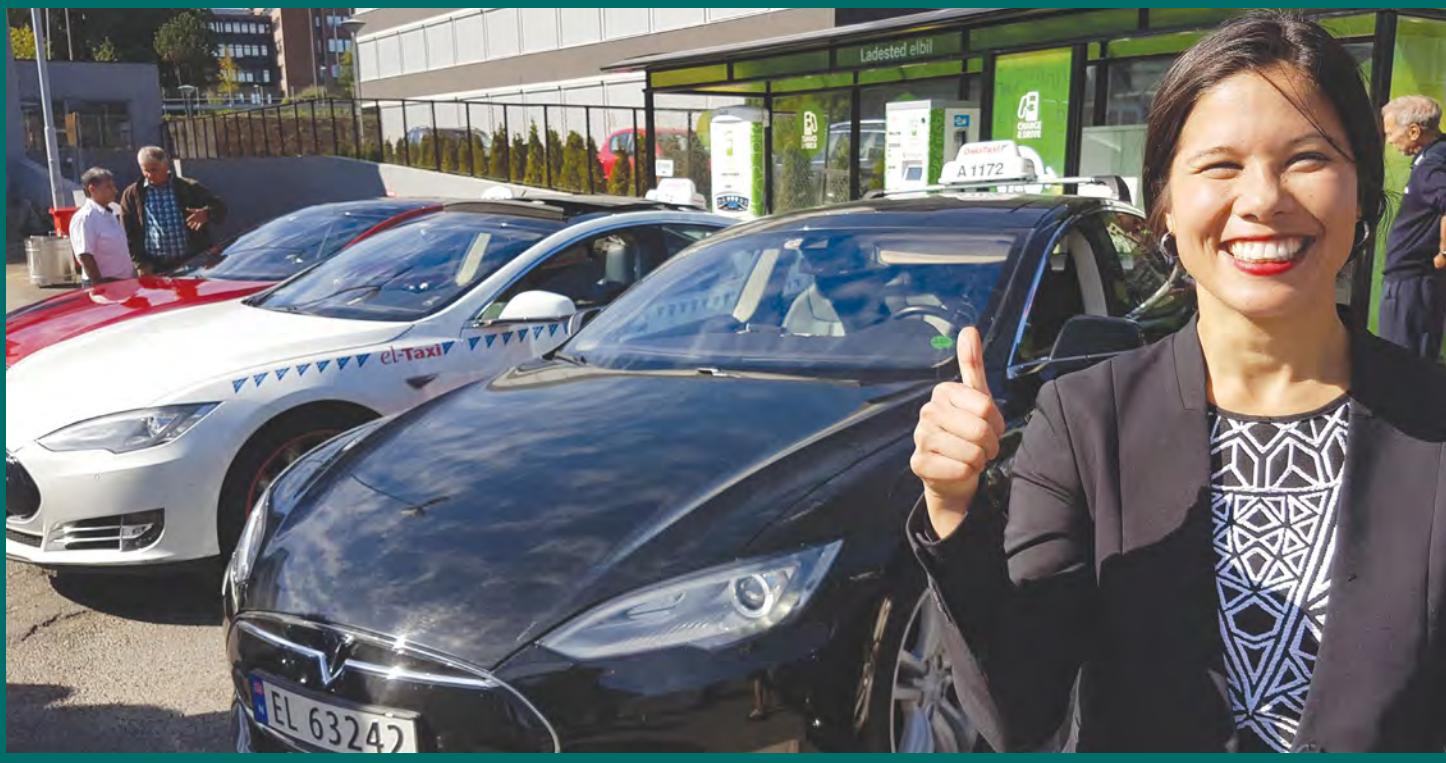
8 Dale Hall, Nic Lutsey, "Emerging Best Practices for Electric Vehicle Charging Infrastructure," International Council on Clean Transportation, October 2017, https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf.

The location of chargers, types of chargers installed, and prices charged to users are determined by the city in negotiation with its partners.

5 Monitor and adapt to trends in the EV market and with EV technologies, use of city infrastructure, and shifts in national or state/provincial government policies. In a rapidly evolving market like electric vehicles and EV-charging infrastructure, experimentation and change are constants. Studies predict that EV range will increase, prices will decrease, and more used EVs will be available for purchase—all factors that will expand the use of EVs. The costs of purchasing and installing charging technology have been going down in Oslo. Some charging station operators are generating more revenue by adding commercial sales of other products at the charging sites, much like gas stations do.

In France, Norway, and the Netherlands, policies are shifting against diesel-fueled vehicles, while some automakers have announced they will phase out production of fossil fuel cars. These and other developments may all have a bearing on the design, cost, and feasibility of city EV-charging infrastructure.

Below: Oslo's Vice Mayor for Environment and Transport Lan Marie Nguyen Berg gives a thumbs up outside an EV charging station.



Other CNCA Cities Advancing EV-Charging Infrastructure

- **Adelaide:** The city installed 40 EV chargers at on- and off-street locations, which can be used by all EV models in Australia. In 2017, the city partnered with Mitsubishi Motors, Tesla, and SA Power Networks, the State of South Australia's electricity distributor, to create an EV Charging Hub in the central business district, with 8 different types of chargers and 2 hours of free parking for EVs. The city is piloting ways to increase utilization of EV chargers in parking lots and to allow EV drivers to pay for charging without having to pre-register with charging-station providers. The city also offers financial rebates, of $3,700 USD, for property owners and tenants who install charging points.
- **London:** Transport for London and the Office for Low Emission Vehicles are investing approximately $24 million USD to unlock potential sites and upgrade electricity grids to support the development of a network of charging stations across the city. In addition the Mayor of London has recently launched a new Electric Vehicle Infrastructure Taskforce, bringing together industry, businesses and the public sector to work together to deliver electric vehicle charging infrastructure in the capital.
- **New York City:** The city is developing a comprehensive citywide charging network to spur the adoption of electric vehicles. It committed to creating the largest city-owned electric vehicle fleet in the US, which will be a key component of cutting fleet emissions 80% by 2035. By April 2018, the city had 500 Level 2

Lessons Learned for Implementing EV-Charging Infrastructure

- **Embed "EV readiness" in future parking infrastructure.** Oslo adopted a building code that requires all new buildings to be 100% EV-ready, with at least half of their common parking spaces set up with chargers and the rest ready to have chargers, if and when needed.
- **Be open to various business models for EV charging.** As Oslo works with partners to develop the charging infrastructure, it is also willing to consider support for different business models for the charging service. This is essential because there are no prevailing or best practice models at this time, and different models fit well in different contexts. A 2017 analysis[9] by the International Council on Clean Transportation identified several models:
  - Selling the electricity with a sufficient markup to recover the cost of the charging infrastructure. But the markup may lead EV owners to prefer charging at home.
  - Installing chargers at stores in order to increase retail sales to drivers who are charging. But this limits where chargers can be located and may have implications for parking.
  - Investing in charging infrastructure because its availability is key to increasing EV sales. A group of automobile manufacturers—BMW, Daimler, Ford, Volkswagen—is installing thousands of fast chargers along highways in Europe.[10] Tesla has more than 9,000 proprietary fast chargers in Europe.[11]
- **Plan for equity, not just efficiency.** In cities that recognize that public investment and regulation of mobility systems have systematically neglected disadvantaged parts of the city, especially areas with low-income and underserved populations, planning for EV-infrastructure can be informed by guidelines to ensure past discrimination is addressed and does not recur. For instance, Portland has prioritized the location of public EV chargers in low-income areas that are underserved by transit. Oslo prioritizes the placement of chargers in low-income areas and near tall buildings where residents do not have access to parking.

9 Hall & Lutsey, "Emerging Best Practices for Electric Vehicle Charging Infrastructure" https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf.

10 Paul Hockenos, "Power to the EV: Norway spearheads Europe's electric vehicle surge," Yale Environment 360, in *The Guardian*, February 7, 2017, https://www.theguardian.com/environment/2017/feb/07/power-to-the-ev-norway-spearheads-europes-electric-vehicle-surge.

11 David McHugh, "Race is on to set up Europe's EV charging network," *The Detroit News,* May 15, 2018, https://www.detroitnews.com/story/business/autos/2018/05/15/carmakers-team-europe-electric-vehicle-charging-network/34958583/.

Challenges for Cities Building EV-Charging Infrastructure

- **My city's electricity does not have high renewable energy content.** Oslo does not have this concern, but many cities do. But having a "dirty" electricity system does not mean that a city cannot benefit from expanding electric vehicle usage. Because electric engines are about three times more efficient than combustion engines, even if all the electricity used by EVs were generated from fossil fuel, the EVs would still contribute to reduction in CO_2 emissions. At the same time, EVs emit no tailpipe pollutants, so the city would also experience a reduction in air pollution. As a city's electricity grid becomes cleaner, the GHG reduction, due to the adoption of electric vehicles, would increase.
- **My city wants private investment, not just public funds, to build its EV-charging infrastructure.** Although Oslo and other cities have jump-started the development of the EV-charging infrastructure with public investments, many cities envision that a regulated private market will evolve for EV charging. According to Oslo's budget, the city is studying ways to evolve the infrastructure in the city to give "a larger role to private-sector participants, including a system that in the longer term could be run on a commercial fee-paying basis."[12]

  At the outset, the EV charging market is too small to attract private investment, so public investment and subsidized charging have been the norm. But free charging undercuts the business case for private investment, so it has to be reduced and possibly phased out at some point. Because of continuing challenges in the business case for private investment, Oslo now splits the cost of new investment 50-50 with private businesses, but also gets half of the net profit. Cities may have to be the "first movers" in developing EV infrastructure, but they can start building partnerships early on, anticipating that as the market grows more private investment can be attracted.

  Portland and San Francisco used grants from the CNCA Innovation Fund to collaborate with a coalition of vehicle manufacturers, EV charging service and equipment providers, utilities, and the Climate Neutral Business Network to develop a methodology to quantify the carbon-emissions reduction impact of EV-charging infrastructure. This globally applicable tool will provide the basis for EV infrastructure to qualify for carbon-reduction credits, a development that is expected to help generate increased private investment in EV-charging infrastructure.[13]

chargers for its growing e-fleet, 37 of them solar powered, and had committed $10 million USD to add 100 fast charging stations for fleet use. The city is developing five fast-charging hubs, with one hub per borough and up to ten fast chargers per location. The goal is to have of 50 locations where New Yorkers can access a fast charger by 2020. In collaboration with the local electricity utility, over 100 Level 2 chargers will be in operation at on-street parking spots as well. An "EV readiness" provision in a 2013 city law requires that 20% of new parking garage spaces have the conduit necessary to install EV chargers, an investment that helps mitigate the eventual cost of upgrading the infrastructure.

- **Portland:** The city's EV infrastructure development set several priorities for the placement of EV chargers. It focuses on areas that lack access to frequent public transit service and bicycle routes, contain low-income populations, or have higher proportions of multi-family housing and houses without garages. And it prioritizes large businesses with employees commuting long distances, residential buildings with high vehicle usage, and destinations that people tend to travel longer distances to access (for instance, recreation sites and event venues).
- **San Francisco:** In 2017, the city adopted a requirement that new residential, commercial, and municipal buildings must provide for sufficient electrical panel capacity to charge vehicles in 100% of parking spaces. New construction must also install circuits for EV chargers in 10% of parking spaces and be designed to easily set

12 City of Oslo, "Climate Budget 2018: Preliminaries/Climate Budget 2018/Technical report," 29. Download at Climate Budget 2018 – Sustainable Procurement Platform.

13 Verra, "New Methodology for EV Charging Systems Open for Public Comment," 2018, http://verra.org/new-methodology-for-ev-charging-systems-open-for-public-comment/.

up chargers in all parking spaces when needed.

- **Seattle:** The city electricity utility, City Light, is installing 20 publicly available fast-charging stations in city right-of-way areas on non-residential streets, following city guidelines to support shared-vehicle use and travel needs not well served by public transit. The utility also offers residential customers access to in-home charging at a manageable monthly cost. The city is developing a charging station network map to identify the optimal distribution of charging infrastructure and guide public and private investment. In developing the map, Seattle is working with partners in the region to ensure the network takes into account vehicle flows into and out of the city.

▶ **My city is concerned with how substantial EV demand will affect local electric utilities.** As the EV market has grown, many analysts note, it will increase demand for power from electricity utilities and may also provide electricity storage capacity that utilities can tap. Norway estimates, according to Oslo officials, that if *all* cars in the nation were electric, total demand for electricity would be 6% greater, with an increase of about 4% at peak times of the day (e.g., in the evening after work when owners plug in their EVs). But the growing number of fast chargers, which use very high amounts of power for short periods of time, could place additional stress on the grid.

In anticipation of these trends, Oslo is looking to a combination of "smart grid" and battery storage solutions. The city is collaborating with researchers and the city-owned electricity grid to plan for demand and supply effects that may occur. For any city, it is critical to develop a plan with electric utility and power regulators to manage these potential EV charging impacts.

GLOBAL TRENDS ADVANCING EV-CHARGING INFRASTRUCTURE

AMSTERDAM: The city offered residents up to $1,173 USD to pay for installing charging stations at homes, public parking spaces, or workplaces.

EUROPE: The charging infrastructure in Europe has more than 100,000 charging spots. The European Union requires new houses to have a charging station starting in 2019.

PARIS: The Autolib car-sharing service, with more than 500,000 subscribers, has 4,000 electric cars and nearly 5,700 charging stations around the city.

STATE OF CALIFORNIA: The state's three largest utilities are investing $200 million USD in 12,500 charging stations at and near workplaces, multi-family residences, and public spaces.

STATE OF COLORADO: The state government plans to use $10 million USD from its settlement in the Volkswagen "Dieselgate" case to invest in electric charging stations around the state.

SWEDEN: The country pioneered an "electric road" in 2018 that charges an electric vehicle as it drives along, drawing power from an electric rail embedded in the roadway. This technological advance could reduce the need for larger batteries in EVs.[14]

TAIYUAN, CHINA: The city replaced all of its 8,292 taxis with EVs in just 8 months. The taxis rely on more than 2,000 units of fast charging outlets, and the city plans to install 18 charging towers capable of providing power to 7,200 taxis simultaneously.[15]

THE NETHERLANDS: The Netherlands has used planning and regulation to ensure that every public charging station can be operated and paid for using a single radio-frequency identification device, thus addressing the lack of standardization among EV-charging stations.

UNITED STATES: The country has an estimated 42,000 Level 2 and fast chargers and, according to one estimate, will need 15 times that many chargers by 2030.[16]

14 Lefteris Karagiannopoulos, "Electrified roads: Swedish project could slash cost of electric vehicles," Reuters, May 14, 2018, http://news.trust.org/item/20180514170612-yazvi/?utm_source=EHN&utm_campaign=8021f0e644-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_8573f35474-8021f0e644-99402185.

15 The Climate Reality Project, "Making Transportation Cleaner: Three Cities with Drive," March 23, 2017, https://www.climaterealityproject.org/blog/making-transportation-cleaner-three-cities-drive.

16 Alana Miller, Teague Morris, and David Masur, "Plugging In: Readying America's Cities for the Arrival of Electric Vehicles," Frontier Group, MassPIRG, and Environment Massachusetts, Winter 2018, 12.

MANDATE THE RECOVERY OF ORGANIC MATERIAL

As much as 5% of global GHG emissions emanate from the solid waste sector, most of it from rotting organics. But waste emissions are even more problematic than that, because methane, although a short-lived climate pollutant, is much more potent than CO_2 in trapping heat in the atmosphere.

Capturing organic material, instead of disposing it in landfills, reduces the emission of GHGs, and especially methane. Recovering organic materials also helps replace products that are made from fossil fuels. Composting uses microorganisms to break down organics into the essential component of soil called humus, which can replace fertilizers made from fossil fuels. Cities also use anaerobic digestion facilities to turn food scraps and sewage into biogas, providing clean fuel for buses and other heavy vehicles and replacing fossil fuels. When cities use or sell their compost and biogas, they offset some of the cost of the organics recovery system. This is the beginning of a "circular economy" model.

Composting reduces GHG emissions in yet another way. Compost added to the soil increases plant biomass that can draw CO_2 out of the atmosphere and enhance the soil's capacity to sequester/hold the carbon. This is especially the case in no-till situations, such as in orchards, vineyards, and grazing lands, where the soil is not disturbed in ways that would release the CO_2.

Turning a large fraction of discarded organic material into a de- or re-carbonizing asset involves the mandatory separation, collection, and processing of food scraps, plant clippings, soiled paper and other compostable materials from residences, businesses, and institutions (hospitals, schools, etc.).

URBAN ORGANIC RECOVERY PROCESSES

The urban organics discard stream includes:

- Food scraps, spoiled food, and spoiled leftovers
- Soiled paper products (takeout boxes, plates, napkins, greasy pizza boxes)
- Plant trimmings (leaves and grass clippings, short branches, weeds, plants, and flowers)
- Wood (unpainted, unstained, untreated)
- Natural feathers and hair
- Compostable bags, cups, plates, and utensils

What is also organic, but best handled separately from the above stream, is sewage and animal manure.

Composting uses microorganisms to break down organics into humus. It can take 6-9 months for materials to decompose completely and become compost that helps plants take root and prevents soil erosion.

Anaerobic digestion facilities use microbes to break down organic materials into biogas and digestate. Digestors can be a wetter type (e.g., for a food scraps slurry) or a drier type (e.g., more plant trimmings), depending on feedstock and design.

CNCA EXAMPLE: SAN FRANCISCO

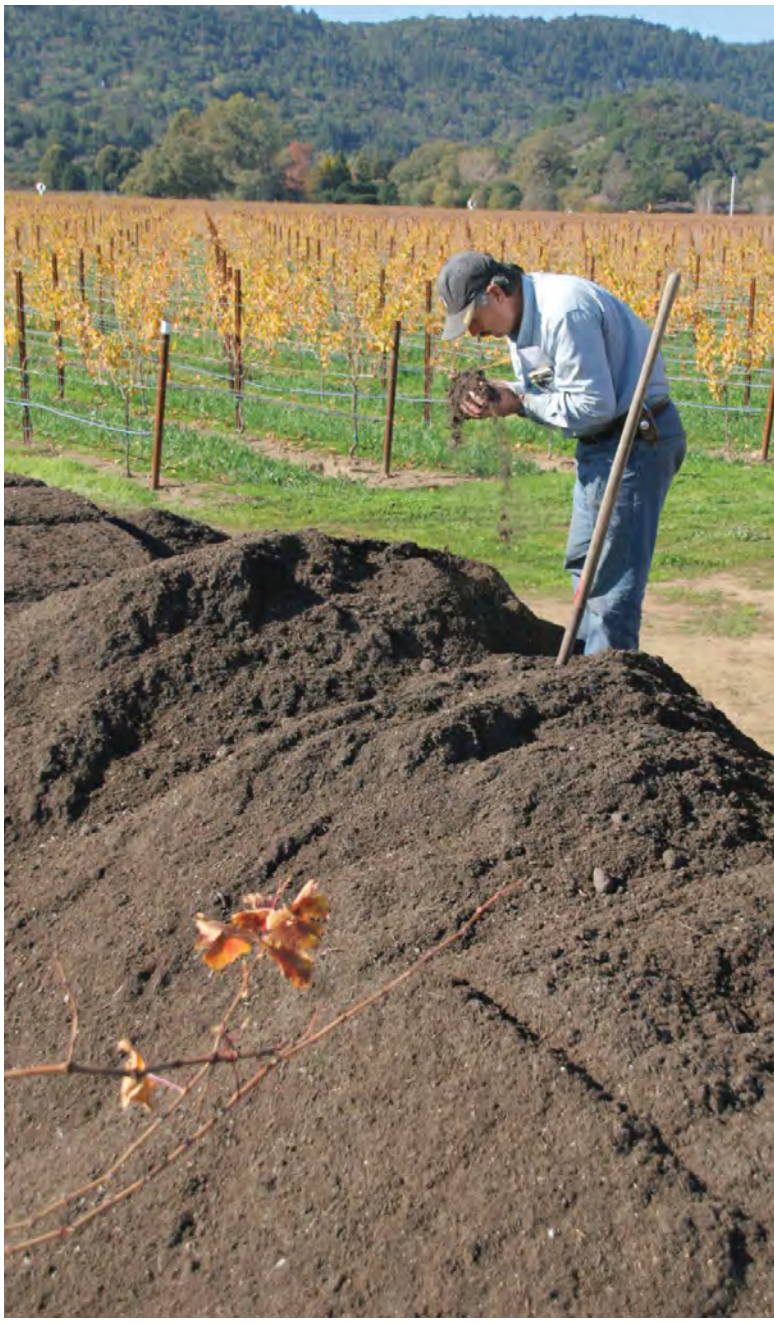
When San Francisco required everyone in the city to keep their compostables separate, the city started reducing the biggest source of GHG emissions in its waste stream while producing about 1 billion pounds of compost that now fertilize vineyards, orchards, and farms in the region and draw CO_2 out of the atmosphere.

For a US city of nearly 900,000 residents, and a world leader in advancing a goal of zero waste, targeting food scraps and other discarded organic materials has involved combining a separation mandate with convenient programming, an extensive and continuing outreach and educational campaign, financial incentives, and city enforcement. The city and its service provider, Recology, provide green bins for storing compostables, and offers smaller kitchen composting pails, signage, multilingual trainings, and consultations for businesses and building managers. Property owners and managers must provide color-coded bins, signage, and education for tenants, employees, contractors, and customers to ensure separation of discards.

Today, nearly 100% of residential and commercial properties in San Francisco are equipped for organics and recycling collection service.

Farmers in the San Francisco area who spread compost on pastured grasslands are eligible for carbon credits from the State of California. Experiments by dairy farmers in the region showed that a one-time application of compost — a ½-inch dusting — resulted in roughly 1 metric ton of carbon captured per hectare, per year. The application also stimulated biological processes in the soil that captured another ton of carbon over the years without adding more compost.[17] In addition, composting helps plants take root, prevents soil erosion, and increases water infiltration and storage in soil, which strengthen the land's resilience to flooding and drought.

Below: Farmers appreciate compost and return food and wine to San Francisco.



17 Brian Barth, "Farmers are Capitalizing on Carbon Sequestration: How Much is Your Carbon-Rich Soil Worth?" *Modern Farmer,* April 6, 2016, https://modernfarmer.com/2016/04/carbon-sequestration/.

Key Implementation Steps

San Francisco's composting mandate didn't emerge suddenly or on its own. It was added to a well-established citywide recycling system and a long-standing zero waste goal to not dispose of any waste in landfills or through incineration. Over the years, city officials say, recycling has become a cultural norm for San Francisco households and businesses, enabled by city policies and investments. Over the years, the city has tested and refined ways to make recycling convenient and to incentivize and publicize the desired behaviors. This baseline of behaviors and expectations helped keep, to a minimum, any political opposition to an organics mandate. San Francisco also has a citywide refuse system, operated primarily by Recology, an employee-owned business, which can cost-effectively produce large volumes of high-quality materials for markets.

Given this context, the city took a number of key steps to implement its composting mandate (though not necessarily in the following order).

1 **Establish the mandate firmly.** San Francisco adopted a mandatory recycling and composting ordinance in 2009. It was not a call for volunteers or a pilot initiative or government program for a small segment of the population. It was a full-fledged city commitment to composting by everyone, which signaled its purpose and priority.

2 **Design and build an organic discard collection and processing infrastructure.** The city must make numerous design decisions unique to organic materials, including:

- **Which organic materials will be accepted?** Different cities target different parts of the organics stream, depending on what they want to generate and can process. San Francisco accepts all organics, emphasizing food scraps, while Adelaide/South Australia's organics stream is mostly from industry and timber, for example.
- **How and where should organics be separated?** San Francisco provides bins of different size and color for collection of compostables, recyclables, and trash. Oslo provides green bags for organics that go into the household trash and are later separated out by optical scanners in city facilities.
- **How often will the city pick up the organics?** San Francisco collects residential organics once a week, apartments and commercial facilities more frequently if needed, and up to daily for large restaurants. San Francisco determined that collection schedules for food scraps should be at least as frequent as for trash, to prevent it from becoming too smelly on site, which could deter compliance.
- **Will organics be converted into compost, biogas, or something else?** San Francisco strives for an "uncontaminated" compostables stream to turn into high-quality compost that organic farms can use. Other cities may divert food scraps to a digester (or mix them with sewage, which decreases compost quality). Composting requires more land for sites than digesters, but also needs much less capital expenditure for equipment.
- **Where will compost sites, which require lots of land, be located?** Locating composting sites near agricultural customers reduces transport costs and time. Existing composting enterprises may be accustomed to processing farm waste like rotting vegetables, but not the processed foods and food-soiled paper products from cities.

3 **Incentivize user participation.** San Francisco provided free composting collection initially to help with compliance. When it started to charge for the service, it charged less for composting than for waste collection.

4 **Educate and enable users.** San Francisco undertook large-scale and long-term communications efforts to get residents and businesses to understand why it is important for the city and that recovering organic materials is the law. But the city also needs

people to understand how to comply and that handling organic discards is easy to do properly and conveniently. At the same time, the city must make sure everyone has the collection infrastructure—bins, compostable bags, etc.—and reliable services to encourage organics recovery.

5 **Enforce the mandate.** The mandate to separate organics provides a tool that the city can use to ensure compliance. In San Francisco, failure to separate organics properly can result in a fine for residents or businesses, starting at about $100 USD for the first offense. In addition, the city can place a lien on the property of those not subscribing or paying for adequate refuse service, taking possession until the owner meets their obligation. Although composting is mandatory for everyone, the city decided not to enforce the mandate initially in multi-tenant buildings because of the difficulties of identifying non-compliant entities in those facilities.

6 **Develop circular markets.** Oslo and Portland use organic discards to generate biogas for city-owned buses and other heavy-duty vehicles. This is a way of providing an "instant customer" for the recovered product. Compost, on the other hand, is sold on the open market to farmers and must compete with other products and meet customer requirements. San Francisco establishes specific plans for, and partners with whom to establish, these circular markets.

Right: San Francisco children cleaning plates and composting food scraps.

Other CNCA Cities Advancing Organic Material Recovery

- **Adelaide/State of South Australia:** The state government generated $53 million USD in market value in 2016–17 by recovering more than 1 million tons of organic materials, mostly from industry, gardening, and timber. The state's overall waste strategy avoided the release of 1.25 million tons of GHGs by achieving an 83% rate of material diverted from landfill.[18]
- **Boulder:** The city has required, since 2016, that all businesses separate recyclables and compostables from the trash and provide properly placed containers and signage to facilitate the collection of recyclables and compostables. All property owners must provide tenants with recycling and composting services. Special events held in the city must also provide recycling and composting collection.
- **Copenhagen:** The city requires that every household, private enterprise, and school sort out and separate organic material for collecting, recycling, and composting into biogas.
- **New York City:** The city's organics program, started as a pilot in 2013, now serves more than 3.3 million city residents. It is mostly used to create compost, but also produces energy to heat buildings in the city. For city residents who do not have access to curbside collection of organic materials or whose buildings do not participate in the program, the city also has 98 residential food scrap drop-off sites at farmers'

18 Green Industries SA, Government of South Australia, "South Australia's Recycling Activity in 2016-17," http://www.greenindustries.sa.gov.au/SArecycling.

Lessons Learned for Implementing Organic Material Recovery

San Francisco's experience with recovering organic materials suggests several lessons:

- **Make it convenient and easy to separate organic materials and have it collected.** Initially, San Francisco encouraged backyard composting by residents and onsite composting by commercial establishments, but this didn't generate enough participation to reach significant scale. For some, it wasn't convenient and easy enough to do (e.g., lack of space in their facilities). Others simply were not interested in being involved in the full recycling process (sorting materials, composting them, using the fertilizer) on their own. Providing a collection service, backed by a mandate, simplified what people had to do and was key to increasing participation and the volume of organic material that was collected.
- **A mandate is necessary, but not enough.** When residents and commercial establishments know what is expected and have the tools to do what is expected (bins, collection service, etc.), most of them will obey the law. Some won't comply very well, but San Francisco provides education and, with larger users such as apartment buildings, technical assistance to ensure more effective compliance. The city also uses behavior-change campaigns to expand the number of people and businesses participating.
- **Play the long game.** Developing high levels of user compliance can take years and experimentation to figure out what works best to facilitate the desired behavior of residents and businesses. San Francisco cites a decades-long strategy that culminated in a high recovery rate.

  Oslo decided in 2012 to mandate food scraps sorting by households and set a target of 50% food scrap recovery by 2018. At the start, the recovery rate was 33% and by 2016 it had reached almost 44%, an increase attributed mostly to the introduction of color-coded bags for food scraps that can be placed in the household's trash and sorted out at city facilities.

  Building large-volume circular markets also takes years. The recovered products — compost, biogas, etc. — must be produced with consistent quality and introduced into local and other markets. Potential customers may need to be persuaded to try out and adopt the recycled products, especially if they're unfamiliar with alternatives to long-used products.

  The timelines and experimentation involved suggest the importance of strong relationships between cities and refuse service providers based on their competence, innovativeness, and sustainability, not just their cost to the city.

Challenges for Cities Implementing Organic Material Recovery

The challenges for organic material recovery are similar to the ones that recyclers of metals, glass and plastic have confronted in past decades. They have to get large numbers of people to keep their material properly separated for collection, and they must find buyers for the recovered materials.

- **My city needs to increase compliance in mandatory recovery.** Cities can use tried-and-true methods to boost compliance. They can invest in communicating with and educating residents and businesses, informing them about the requirements and how to comply. They can help people understand how to sort their organic materials properly so that the aggregated stream will be as uncontaminated as possible. They can test various sorting and collection approaches with different types of users to see which ones gain traction. They can use public institutions—schools, hospitals, city government—and corporations to model the behavior, and they can publicize the efforts.
- **My city wants to develop markets for recovered organic materials.** Producing substantial volumes of recovered products, delivering them to customers, and generating income that helps to cover the cost of the city's recovery system involve business development and management tasks that many cities are not prepared to perform. They either must have their agencies learn how to do this or partner with entities—businesses and nonprofits—that know how. San Francisco's primary refuse service operator, Recology, is a business with substantial experience in recovery operations and markets. The city sets Recology's rates for organic material collection and composting at a level that provides the company with a reasonable profit for the activity.
- **My city doesn't control the waste haulers.** This can be a significant obstacle in building large-scale recovery of organic materials, if the price to deliver organics to composting facilities and agricultural users is uncompetitive with the price to dispose of the material in landfills or the price of other fertilizers. In these situations, the city could financially subsidize organics recovery to offset the price differences or increase prices on landfill disposal. It can also seek to develop a permitting system to specifically regulate the hauling, processing, and/or disposal of organic materials.

markets, libraries, commuter hubs, and other high-traffic sites. Since July 2016, the city has required separation of organic material by all food service establishments in hotels with more than 150 rooms, food vendors in large arenas and stadiums, food manufacturers, and food wholesalers. The following year, the requirement was extended to more food-service enterprises and now covers about half of all commercial food discards in the city.

- **Oslo:** The city has required households to collect food scraps in green bags since 2012. The bags are sorted from the waste stream in two plants by optical sorting equipment and robotic arms. The city's Romerike biogas plant can process 50,000 tons of solid and liquid organics annually, producing biogas and three types of fertilizer: liquid biofertilizer, bioconcentrate, and solid organic material. The gas is used in the city's buses and the fertilizer is sold to farmers in the region.
- **Portland:** The city is constructing a $12 million USD renewable biogas facility to turn waste methane from sewage into renewable gas. This will cut carbon emissions by 21,000 tons a year, the equivalent of replacing the diesel fuel used by more than 150 city refuse trucks. The renewable biogas will produce about $10 million USD in annual revenue from sales of surplus gas.
- **Stockholm:** The city intends to turn about 70% of food scraps into biogas and

fertilizer by 2021. It collects the material in separate bins and is building a food-scrap separation plant that uses near-infrared technology to detect food scrap bags in the household waste stream. Digestion of food scraps will take place in neighboring cities to produce fertilizer for nearby agriculture. Stockholm already turns sewage from treatment plants into biomethane fuel for vehicles, including 330 city buses, and has 20 public filling stations for biomethane.

- **Toronto:** The city collects organic materials from about 460,000 private homes, as well as apartment and condominium buildings, schools, and city-owned buildings, and produces compost for use in gardens and parks. It is testing the use of green bins to collect organic materials in 20 parks across the city.
- **Vancouver:** The city banned all food scraps from disposal as garbage in 2015. At the time, food scraps were 40% of all material headed to the landfill. Now, raw and cooked food scraps, plate scrapings, leftovers, expired food, meat, bones, and dairy products must be recovered.

GLOBAL TRENDS ADVANCING ORGANIC MATERIAL RECOVERY

EUROPE: The percentage of municipal solid waste that is recovered increased to 45% in 2015 from 31% in 2004, with one-third of the boost due to increased composting and digestion of organic materials.[19]

UNITED NATIONS SUSTAINABLE DEVELOPMENT GOAL 12: This SDG goal advocates for sustainable consumption and production and includes the target of reducing global food waste by 50% by 2030. A city's ability to recover food waste is not a substitute for reducing food waste before collection. Cities are also joining efforts to reduce the amount of food waste that is produced.

US CITIES: A growing number of city governments have committed to a zero waste goal, including Austin, Dallas, Los Angeles, Minneapolis, New York City, Phoenix, and Seattle.

19 European Environment Agency, "Recycling of municipal waste," November 30, 2017, https://www.eea.europa.eu/airs/2017/resource-efficiency-and-low-carbon-economy/recycling-of-municipal-waste.

ELECTRIFY BUILDINGS' HEATING AND COOLING SYSTEMS

In many cities, a large percentage of GHG emissions come from the use of fossil fuels to provide heating, cooling, and hot water in buildings. In the European Union, half of all energy consumption is used for heating and cooling in buildings and industry, and 84% of this energy is from fossil fuels. In US cities, the emissions from burning fossil fuels onsite for these uses range from 15% to 40% of cities' total emissions.

Approaches to decarbonizing heating and cooling systems in buildings depend on whether the city provides an extensive district-scale heating and cooling system, as many European cities do, or uses a market in which individual buildings purchase and operate their own systems, which is the prevailing practice in Asia and North America.

Stockholm and Copenhagen have focused on replacing fossil fuel sources in their district systems with waste-to-energy, thermal biomass, biogas, solar thermal, and other clean or renewable sources. Stockholm, for instance, where 80% of the buildings are connected to district heating systems, is using waste and biomass incineration combined with district-scale waste heat pumps to reduce carbon emissions from heating. Meanwhile, Copenhagen's district heating system is expected to be carbon neutral by 2025, thanks to both the replacement of coal fuel with biomass in combined heat and power plants and the elimination of plastic from waste incinerated for heat.

In the US, cities are partnering with manufacturers, distributors, utilities, and government agencies to decarbonize buildings' heating systems by increasing the purchase and installation of high-efficiency, electric heat pump technologies. These technologies use electricity that is increasingly powered by renewable sources to replace existing fossil fuel-based systems, such as oil- or gas-fired boilers and furnaces. The cities are using a market-based approach to decarbonize thermal systems building-by-building, converting them to electricity that, in the future, can become carbon-free. These cities' efforts include the following: 1) energy efficiency measures to reduce load requirements, which will make the replacement more cost effective; 2) distributed renewable energy, such as rooftop solar PV systems, that can help power heat pump technology; and 3) decarbonized electricity grids.

ABOUT HEAT PUMPS

The most prevalent replacement technologies in the US are high-efficiency electric heat pumps: Air Source Heat Pumps (ASHPs), Heat Pump Water Heaters (HPWHs) and Ground Source Heat Pumps (GSHPs). The implementation of these technologies is referred to as "building electrification".

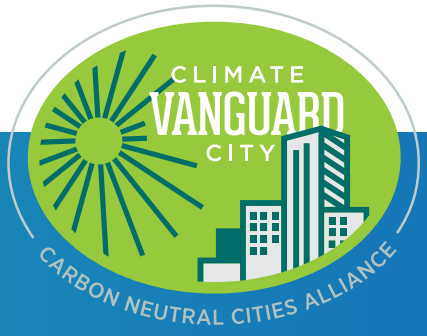
In single-family and small multi-family residential buildings, the systems being replaced are typically boilers and furnaces fired by natural gas or fuel oil for heating and window air conditioners for cooling. In larger commercial buildings, the process can also include conversion of gas-fired chillers or combined heat and power systems to large scale heat pumps in the form of variable refrigerant flow (VRF) or GSHPs (also known as geothermal) systems.

High-efficiency heat pumps offer a compelling alternative to fossil fuel-based building systems in many cities across North America. These technologies have had significant market penetration in some parts of the world, notably in Asia, but currently make up a very small portion of the market throughout most of the US. These technologies are well-suited for retrofits of heating systems in small residential homes today, which tend to be simple buildings, while larger multi-family and commercial buildings may require more significant engineering.

Recent developments have made two of these technologies also suitable for providing space heating and hot water to homes in colder climates.

While the full potential of GHG reductions from heat pumps require a clean grid, in many regions these systems can reduce GHG emissions even under the current electric grid, because of their high levels of efficiency.

CNCA EXAMPLES: BOULDER, NEW YORK CITY, WASHINGTON, DC



Boulder, New York City, and Washington, DC are partnering with manufacturers and utilities to increase the use of high-efficiency electric technologies to heat space and hot water in residential buildings. They are replacing the use of fossil fuel that is burned onsite in buildings, which is one of the largest sources of GHG emissions in many cities. The cities are working with industry to generate local customer demand for electric heat pumps, targeting high-potential market segments and launching marketing campaigns.

These US cities are some of the founders of the Building Electrification Initiative that, over the coming years, will help dozens of North American cities decarbonize their buildings' thermal systems. The initiative is a market-based approach led by cities that do not operate extensive district-scale heating systems. In addition to partnering with industry, the cities are conducting outreach and marketing to building owners, helping to build networks of contractors specializing in heat pump installation, and advising manufacturers on technology needs that would improve existing heat pumps for their markets. And they are advocating for state-level incentives for switching from natural gas and fuel oil to electric heating and other necessary changes to state-level utility regulations.

Boulder's building electrification initiative was motivated by its commitment to an 80% reduction in emissions by 2050. Its 40,000 single-family homes are predominantly built with natural gas as the primary space and water heating fuel. This city, of 110,000 residents, started by developing detailed data sets to target households that would be good candidates for conversion to ASHPs and HPWHs. It developed a system capable of producing an hourly energy model for every single-family residence in the city, and it used that to create a customized Roadmap to Renewable Living for each household that provides options for home electrification, including energy efficiency, electric vehicle acquisition, onsite solar, and heat electrification. In April of 2018, the city launched an outreach campaign in collaboration with Mitsubishi Electric, one of the globe's largest manufacturers of heat pumps, with the goal of doubling ASHP adoption in the first year.

More than 40% of New York City's GHG emissions come from onsite combustion of fossil fuels in buildings for heating and hot water production. By 2050, an estimated 50-60% of buildings in the city, which has 8.5 million residents, will need to electrify heating by converting to ASHPs and 90% or more will need to electrify hot water production. Through detailed market segmentation, the city identified 176,000 1- to 4-family buildings that are the best candidates for heating electrification based on a combination of technical, market, and socio-demographic characteristics. The city is partnering with its electric and gas utility, Consolidated Edison, Mitsubishi Electric, and the New York State Energy Research and Development Authority (NYSERDA) to complete market research to identify the best value propositions for key customer segments. The partners are targeting opportunities for outreach and training for heating, ventilation and air conditioning (HVAC) contractors. And they are advocating for potential new city, state, and utility incentive programs that will target these households for conversion to thermal electrification technologies.

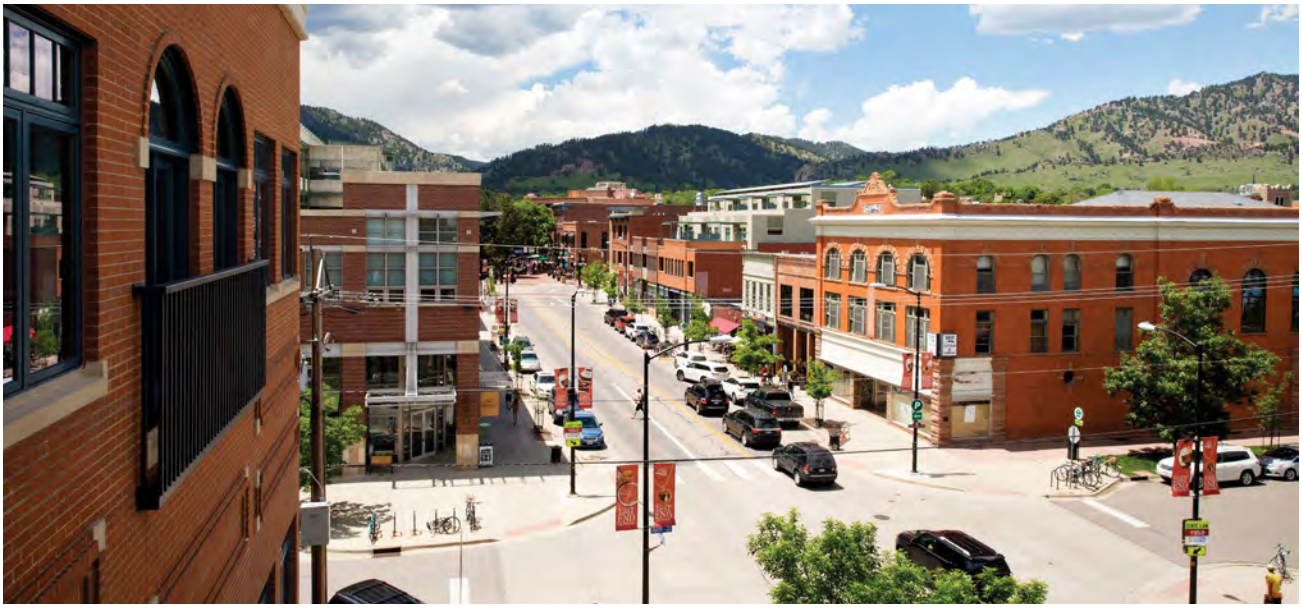
New York City will also pilot heat pump installations in larger multi-family and commercial buildings under the NYC Retrofit Accelerator program, which will work to phase in deep energy retrofits over the next 10-15 years that will reduce energy use by 40-60%. Lastly, the NYC Mayor's Office is compiling a list of technology needs that would improve existing heat pumps for the NYC market, researching alternative refrigerants and their disposal practices, and has begun working directly with manufacturers to identity opportunities to develop these new systems.

In Washington, DC, a city of 700,000, approximately 25% of city emissions come from the natural gas, oil, and diesel fuel used for heating and cooling in buildings. The city has

completed a market segmentation analysis of its 92,000 1- to 4- family buildings, which account for half of all the buildings in the city. Ten percent of these buildings were determined to be good candidates for ASHP adoption, since they are using baseboard electric heating and window air conditioning units. The city, in collaboration with the DC Sustainable Energy Utility, which helps residents and businesses reduce energy consumption and costs, and industry stakeholders, is developing more effective incentives and distributor partnerships to speed adoption of ASHPs. In addition, Washington, DC is conducting a study that examines the technical potential of ground source heat pumps, and identifies regulatory and permitting challenges.

Below: Boulder's building electrification initiative was motivated by its commitment to an 80% reduction in emissions by 2050.

Right: Washington, DC has 44.8 MW of installed solar PV, as of the end of 2017.



Key Implementation Steps

To develop a market-based approach to decarbonizing building heating, cooling, and hot water systems, these cities are taking steps to build partnerships, analyze market dynamics, and then design interventions. Many of these activities can happen concurrently, but they start with aligning the cities' efforts with those of industry.

1 **Build industry partnerships.** A market-based approach depends ultimately on private market players driving market changes by providing high-quality products and services to customers and a compelling value proposition for the new technology. This requires the development of collaborative relationships with industry players who will benefit from increased market demand. Primary among these partners are heat pump manufacturers and their distributors and contractors who sell, install, and service equipment. The purpose of these partnerships is to align private market development activities with city goals and strategies for heating system technology conversions.

2 **Understand the local regulatory environment and cost structure.** Boulder, New York City and Washington, DC found that starting with a detailed understanding of the market environment that enables heating electrification was essential before developing their strategy. This analysis can create a nuanced understanding of:

- The economics of gas- and fuel oil-fired heating systems and how they compare to the economics of electric alternatives. This is primarily driven by the local cost of natural gas and electricity and the local climate.
- The degree to which there are state- and city-level policies and incentives in place that support or restrict fuel switching for building heating.
- Each city's ability to impose building requirements and launch new programs for emissions reductions.

3 **Understand and prioritize market segments.** Depending on the availability of data, a detailed market segmentation can include analysis of the city building stock by types of buildings, location, square footage, energy use intensity (EUI) per square foot, age of buildings, and type of heating source. This segmentation can be combined with additional market and socio-economic data, such as homeownership, age range, and neighborhood sales rates, which, when combined, can help predict customer likelihood for technology adoption. This market segmentation will enable the city to prioritize target buildings for electrification conversion and establish quantitative targets by which to measure progress. Boulder, New York City, and Washington, DC developed sophisticated household analysis and targeting systems to help prioritize individual households. The analysis was based on a wide range of factors, including building type, size of basement, heating fuel, age of current system, and homeowner demographics. New York assessed building characteristics, economic factors, and market factors for all 800,000 of the city's 1-4 family buildings to identify the subset of these buildings that would be good candidates for heat pump installations.

4 **Develop customer value propositions.** Successful outreach requires marketing materials that make a convincing case for conversion. Customer benefits can include improved health, reduced costs, improved cooling, dehumidification, increased zonal control, ease of installation and environmental stewardship.

In Boulder, the value proposition, for homeowners, included the cost and environmental advantages of combined implementation of onsite solar, energy efficiency improvements, electric vehicle ownership and heat electrification. The city launched a pilot marketing program, called "Comfort 365," to emphasize that heat pumps provide heating and cooling year-round, are affordable, and produce environmental benefits. It targeted environmentally conscious customer segments for the campaign, while Mitsubishi Electric launched a complementary campaign for its products that amplified the city's message.

5 **Understand and organize local equipment distributors and installers.** Having a local supply chain that understands heat electrification technologies is critical to success. Unfortunately, existing local supply chains are typically fragmented, disorganized, and not well structured to support the conversion of fossil fuel heating systems to electricity. (For example, the contractors that install and service gas furnaces are typically not the same contractors that install and service heat pumps. If a household needs to replace its heating system, it will almost inevitably be replaced with another gas furnace, unless the household is prepared for a "conversion decision" in advance.)

Pursuing a market-based strategy therefore involves understanding and organizing a network of manufacturers, distributors, and service organizations that promote and simplify the process of electrification conversion, for homeowners. New York City, which has too few heat pump suppliers, is completing research to identify potential contractors willing to change their current business model and begin installing heat pumps. The cities involved in the Building Electrification Initiative have developed partnership relationships with heat pump manufacturers and distributors that provide support and in-kind services for their marketing efforts.

6 **Change policies and incentives.** The regulatory regime and incentive schemes for building electrification and thermal decarbonization, more broadly, are poorly developed. In the United States, there are few state-level targets for decarbonizing thermal systems, few financial incentives for conversion (and in many cases outright restrictions on incentives for fuel switching), and very few, if any, proven business models that incentivize utilities to support thermal fuel switching. In addition, most building energy requirements are focused on energy use intensity per square foot of a building, but not the carbon content of the energy. Cities pursuing market-based strategies can become proactive in helping change this regulatory landscape.

7 **Create an outreach infrastructure/organization.** A building heat electrification strategy is highly labor intensive and requires large amounts of "retail" transactions at the household level. Boulder, New York City and Washington, DC realized that they need a well-resourced organization that is staffed up to develop a creative outreach and marketing strategy and execute it. This has proven to be a challenge, since cities are not typically structured for this kind of direct service delivery. Over time, it will require developing new organizational models for scaling up building electrification in order to decarbonize building heating, cooling, and hot water systems.

Below: New York City's renewable solar energy has increased solar sixfold to over 148 megawatts.

Photo credit: New York City Department of Citywide Administrative Services

Other CNCA Cities Advancing Building Electrification

- **Oslo:** The city council decided in 2008 to phase out oil-fired heating in all municipal buildings by 2012. In total, 180 municipal buildings have converted to renewable energy, and emissions have been reduced from approximately 7,200 tons of CO_2 in 2009 to 600 tons in 2015. Since 2008, approximately 1,500 oil-fired boilers have been replaced by renewable energy through grants or loans from the municipal Climate and Energy Fund.
- **Seattle:** The city has an oil conversion program to transition oil-heated homes to heat pumps, with Mitsubishi Electric offering rebates of up to $2,000 USD for Seattle residents purchasing its heat pumps to replace oil-fired heating systems. By "switching from dirty, expensive heating oil, to an energy-efficient heat pump using clean electricity, you reduce your heating and cooling costs, improve comfort and health, all while helping the environment by cutting use of fossil fuels," a promotional website states.

Lessons Learned for Electrifying Buildings' Heating and Cooling Systems

- **Industry partnerships are developed by defining and quantifying shared interests.** Industry players will partner with cities if they are convinced that it will help them increase their market share. This is best done by quantifying the market potential, segmenting and prioritizing the market in a detailed way, and aligning city strategies with industry best practices.

  As a result of market research, Boulder is targeting environmentally conscious customers in areas where energy retrofits will be cost-effective, which could include a combination of heat pumps, solar power, and electric vehicles. The city is aiming to double the current rate of heat pump installations through its current campaign. New York City is focusing on the nearly 20% of its 1-4 family buildings (roughly 176,000 buildings) that are considered good targets based on building size, heating fuel type, home ownership, and other factors.

- **Cities can play an important role in advancing state/provincial or national government policies to support building electrification and thermal decarbonization.** The on-the-ground knowledge that cities develop while implementing market-driven strategies can provide data that helps inform public policies. In many US states, energy efficiency incentives are based on concrete information about the cost effectiveness of specific measures. As cities gain increased experience with building electrification, the data from their initiatives can give other policymakers confidence that incentives will have the desired decarbonization paybacks. This requires aggregation of data from pilot projects and city willingness to engage directly with other policymakers.

  New York City is working with Con Edison and National Grid on pilot projects for building electrification and other sources of renewable heating, such as ground source heat pumps under New York State's Renewing the Energy Vision framework. This will help the utilities identify new business models that can inform the Public Service Commission's future utility regulations.

- **Market-based approaches can be paired with other approaches.** Cities do not have to pursue market-based approaches to the exclusion of all other strategies. Policies that prohibit fossil fuel heating in new buildings (e.g., zero emissions building codes) can be pursued simultaneously with attempts to

convert existing buildings to electricity-based heat. In fact, practical knowledge, derived from market-based approaches, can help build the political will to support regulatory requirements in new buildings.

Boulder, New York City and Washington, DC are working to update their energy codes for new buildings and substantial renovations, moving toward performance-based codes and outcome-based codes that will require certain levels of energy performance. The use of ASHPs for heating is likely to be a significant opportunity for developers to meet the increasingly stringent energy performance requirements under these codes. In addition, both Washington DC and New York City have begun to explore opportunities for requiring energy performance in existing buildings and have proposals under development.

- **Cities should expect push-back from fossil fuel interests.** A number of stakeholders, including utilities and other fossil fuel distributors, have a vested interest in maintaining the status quo. As an example, the 2016 climate action plan for the Province of Ontario originally required all new homes and small buildings after 2030 to be heated by electricity or geothermal heat, a rule that would have expanded to all buildings by 2050. However, under pressure from the natural gas industry, these aggressive targets were dialed back and, instead, the plan now only requires small buildings built after 2030 to have "net zero carbon emissions" and eliminates the 2050 requirement for all buildings.

  Ideally, cities can work with local gas utilities and fuel providers to identify potential business models that enable them to stay in business, such as entering the heat-pump market and investing in geothermal heating systems. However, major questions remain about how quickly these business models could scale up and how successful they are likely to be, as well as what to do with potential stranded assets, such as gas pipelines.

  Cities should also build strong coalitions of support for electrification from private and non-profit sectors and from consumers. This is the best way to countermessage, reinforced by success in increasing local installation of heat pumps and delivering benefits to customers.

  New York City is partnering with Con Edison and the New York State Energy Research and Development Authority on cost-shared market research of customers and contractors in the New York City metro area, which is a starting point for developing coordinated programs and strategies to begin scaling up the installations of ASHPs.

Challenges for Cities Implementing Building Electrification

There are several challenges that cities wanting to use a market approach to building electrification will need to address.

- **In my city, heat pumps are not economically competitive with natural gas, fuel oil, and/or electric resistance heaters.** Heating and hot water heat pumps are currently price competitive against some fossil fuel sources, but not all. A recent ACEEE research report concluded that residential ASHPs and HWHPs are competitive with fuel oil, propane and electric resistance heat in most parts of the US, but are not yet cost competitive with natural gas-fueled technologies.[20] Becoming competitive with natural gas will likely require additional technology advances and incentives. In addition, heat electrification technologies for commercial/industrial users require a very context-specific cost analysis because of the increased complexity and diversity of the technologies.

  This challenge can be addressed by focusing in the short run on the households where there is a clear price advantage to electrification and partnering with manufacturers and HVAC system designers to continue to improve cost effectiveness. In addition, city-specific pilots on commercial/industrial heating and cooling electrification can help estimate how long it takes to pay back the capital investment on different kinds of technologies, which will improve predictability needed for private investment in these technologies. (Typically, a payback time has to be less than 5 years for business owners to want to invest the capital.) Over time, cost effectiveness will need to be improved by lower production costs, improved efficiency, lower installation costs, and pricing changes such as carbon pricing on fossil fuels.

- **My city's cold climate presents challenges for heat pump effectiveness.** ASHPs and HWHPs are effective in most climates, but in colder regions they are not yet efficient enough to provide economical heating on the coldest days of the year. Until the technology improves, this could require the maintenance of a parallel fossil fuel backup system, or at minimum operating the systems as basic electric resistance heaters for short periods of time. This challenge will need to be addressed by continued performance improvements in heat pump technologies by manufacturers.
- **My city needs a stronger overall policy framework for building electrification.** As noted above, policy regimes at the state and city levels to incentivize the transition to electrified heat are currently weak and need upgrading. In particular, restrictions in many US states, on providing incentives for fuel switching from fossil fuels to electricity, are major barriers in scaling up building electrification. This challenge can be addressed by cities advocating for comprehensive thermal decarbonization policy regimes at the state level. Many states in the US, including Massachusetts, Rhode Island, and New York, have conducted state-level analyses of policy options to advance thermal decarbonization.
- **My city must address the potential impacts of heat electrification on grid performance.** Wholesale conversion of urban heating systems to electric technologies will create new challenges for electricity grid operators that have not yet been worked out. While the pairing of building electrification with energy efficiency measures can mitigate potential electric increases or even reduce annual electric loads, electrification of heating and hot water systems will likely create major seasonal and time-of-day load shifts that could create strains on existing electricity generation, transmission, and distribution systems if utilities do not adequately plan

20 Steve Nadel, "Energy Savings, Consumer Economics, and Greenhouse Gas Emissions Reductions from Replacing Oil and Propane Furnaces, Boilers, and Water Heaters with Air-Source Heat Pumps," ACEEE, July 2018.

for them. Cities can address this challenge by scaling the market more slowly, focusing on areas of excess grid capacity, and proactively working with their utility partners to anticipate and address grid reliability issues. Cities with smart meters can also look at possibilities to work with their utilities on incentivizing electricity use for, e.g., washing machines, during off-peak hours.

- **My city doesn't have relationships with manufacturers and distributors.** In the US, the Building Electrification Initiative has built a set of partnerships with heat pump manufacturers that can be leveraged by member cities in their local markets. The manufacturers can support cities by upgrading their distribution networks, training local contractors, and developing effective sales and marketing materials.

GLOBAL TRENDS ADVANCING BUILDING ELECTRIFICATION

AMSTERDAM, ROTTERDAM AND UTRECHT: These cities and 28 other Dutch cities have signed a "Green Deal" for "gas-less neighborhoods," which will lead to the first residential districts being disconnected from the gas grid over the next two years. This is part of the national government's plan to remove gas as source of heating and cooking for all residential buildings in order to reduce CO_2 emissions from the built environment by 80% in 2050. Under this plan, no new houses will be connected to the existing gas grid, and an average of 170,000 homes will be disconnected each year. Gas heating systems will be replaced with a combination of heat pumps and district heating systems.

BURLINGTON, VERMONT (USA): In the city, 85% of the 17,000 housing units use natural gas for heating and an additional 1,200 homes are heated by fuel oil and propane. The city's priority targets for ASHP conversion are homes heated by fuel oil. The city is partnering with its municipal utility, Burlington Electric Department, to develop a cost-sharing program to combine with existing building energy efficiency incentives to target these homes for ASHP conversion. The experience from this pilot test will be used to design a broader effort to expand into the natural gas market at a future date.

NORWAY: The national government will prohibit the use of oil and paraffin to heat buildings beginning in 2020, in an effort to reduce domestic emissions of greenhouse gases. The ban will cover new and old buildings and applies to private homes and businesses as well as publicly owned facilities. Recommended alternatives to oil-based products include heat pumps, electricity from the country's hydroelectric grid and even special stoves burning wood chips.

DESIGNATE CAR-FREE AND LOW-EMISSIONS VEHICLE ZONES

Fossil fuel vehicles are the primary source of urban transportation emissions. In Europe, transportation produces nearly 26% of all GHG emissions and in the US more than 28%. In many cities, transportation's share of GHG emissions is much higher than that.

Reducing automobile use is a key strategy for cutting GHG emissions within a city. Car-free or low-emissions vehicle zones are parts of a city — a street or road, a district or even larger zone — in which the use of vehicles has been prohibited or subjected to a fee. Bans and pricing may be applied to all vehicles or only to fossil fuel vehicles, usually with exemptions for emergency and public transit vehicles. Bans may be permanent or temporary. Charges may vary by time of day and road. When vehicles cross into or out of the zone, cameras take pictures of license plates and bills are sent to the owners.

Car-free and low-emissions zones are "travel demand management" approaches that use different tools — e.g. a ban and a price — to change driving behaviors. In addition to reducing GHG emissions, they produce other significant benefits. They reduce air pollution, which typically disproportionately impacts a city's poorer residents, and city traffic. They increase street safety, reduce noise, and enable the repurposing of streets and public parking spaces. They can generate substantial revenue for the city, which may be invested in the transportation system and other purposes. They also improve residents' perceptions of the quality of the urban environment. As cities add more and more people, these benefits are becoming more attractive, especially cleaner air.

Congestion fees have resulted in documented GHG reductions in cities. For instance, Stockholm's charge has produced a 10-15% reduction in GHG emissions in its downtown area and a 2-3% reduction in the metropolitan area, which is a large impact for a single climate action. Studies found that the fee had an immediate effect and has, over the years, reduced traffic by more than 20% compared to 2005 levels. Drivers adapted to the charge in many ways. Some switched to public transit, some reduced trip frequency and planned routes to avoid charges.[21] With reduced congestion, travel time on roads improved, and this was obvious to the public. Studies did not find any negative effects on the retail sector inside the congestion-charge cordon. In London, officials estimate that plans to substantially expand the city's zone for congestion fees will reduce NOx emissions from road transport by 28% across the city.[22]

Car-free or low-emissions vehicle zones are parts of a city — a street or road, a district or even larger zone — in which the use of vehicles has been prohibited or subjected to a fee.

21 For an extensive study of Stockholm's congestion fee, see Jonas Eliasson, "The Stockholm Congestion Charges: Overview," 2014, Centre for Transportation Studies-Stockholm.

22 Anna Hirtsenstein, "London Mayor to Expand Ultra-Low Emissions Zone to Whole City," *Bloomberg*, June 8, 2018, https://www.bloomberg.com/news/articles/2018-06-08/london-mayor-to-expand-ultra-low-emissions-zone-to-whole-city.

CNCA EXAMPLES: STOCKHOLM, LONDON, OSLO

Stockholm, London, and Oslo are reducing vehicle use in larger and larger areas of their cities. They're applying congestion charges and outright bans to cut GHG emissions and air pollution, generate funding for transportation infrastructure, reduce traffic, and improve pedestrian safety and quality of city life in other ways.

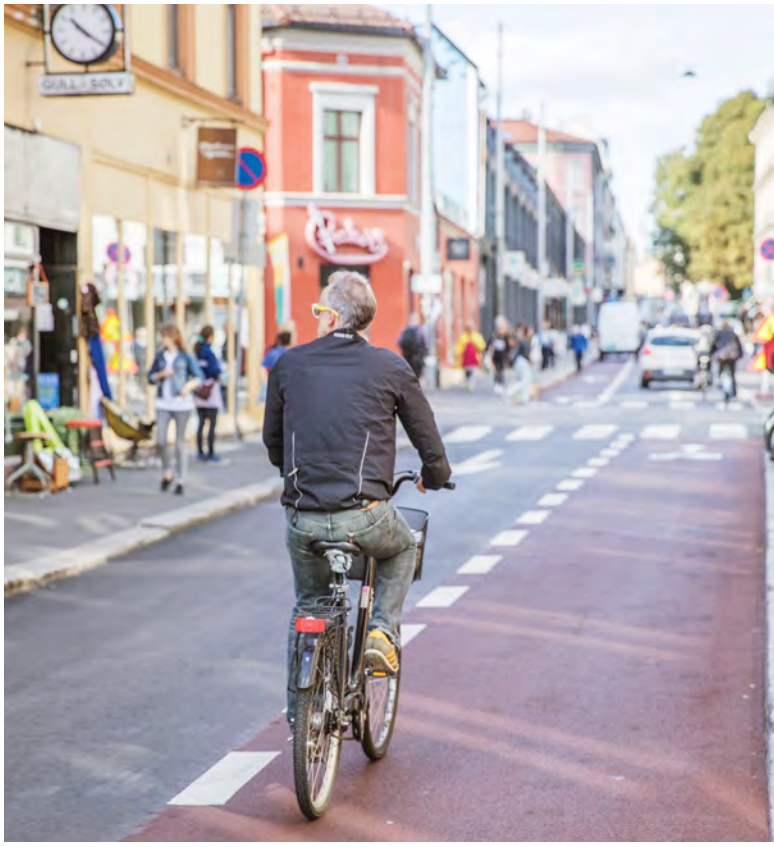
Each of the three CNCA cities highlighted here is expanding its car-restricting zones after finding that they have rapid and lasting impact and are increasingly popular with residents because of quality-of-life improvements in the city. London first levied a congestion charge in 2003, while Stockholm's began in 2007, and Oslo's charge goes back to the 1990s. Four years after Stockholm instituted a charge, a majority of the public supported the charges. That support was led by more than 80% of people who had no car, but also favored by more than 50% of car owners who often paid the charge.[23]

Stockholm's congestion fee — now up to $4 USD — applies to vehicles as they enter or leave the inner city during rush hour. The fee covers an area about a fifth of the city's land mass, or 13.8 square miles/36 square kilometers, and includes a third of its population, about 335,000 residents, and some 23,000 workplaces employing 318,000 people. In order to reduce air pollution, the city is considering establishing a low-emissions zone, allowed under a 2018 national law, that would only let electric, hydrogen, and low-emissions vehicles enter. An even stricter zone — small areas and certain streets for electric and hydrogen cars only — is also under discussion.

London's Ultra Low Emissions Zone (ULEZ) will be in place in 2019 in central London, an area containing a significant part of its financial district and commercial and entertainment centers. It will cost almost $17 USD a day to enter, starting in 2019, for petrol and diesel cars and vans and motorbikes that do not meet designated standards for emissions. In 2021, London, a city of 8.7 million people, will expand the zone by 18-fold and it is estimated that 100,000 cars and 38,000 vans and trucks could be affected daily by these stricter emissions standards. By 2020, tough emissions standards will also apply throughout the city to buses, coaches, and trucks.

Oslo will add a car-free central district in 2019. In the 1.3-square kilometer/.5 square mile car-free zone, parking spaces on public streets will be reused for pedestrians, bicyclists, and outdoor activities, with some space designated for persons with disabilities in need of parking and freight and service delivery vehicles.

Below: To get a larger share of the population to ride their bikes for daily trips, Oslo is building 100,000 new bike lanes between 2015 and 2025.



23 Jonas Eliasson, "The Stockholm Congestion Charges: Overview," 2014, Centre for Transportation Studies-Stockholm, 18.

Key Implementation Steps

1 Design the geographic zone and the restrictions, exemptions, and prices. There are many design decisions, but the most important one is which part of the city to turn into a car-free or congestion-price zone. Cities typically start with the most congested central-city areas, commercial centers, key roadways, heavily visited sites.

Although a ban and a fee both reduce driving and emissions, they have different overall effects. Imposing a congestion fee reduces, but does not eliminate, driving, while it also generates revenue for government. Designating a car-free zone has a more radical effect on vehicle use in an area and allows repurposing of space, but does not directly generate revenue. Experience to date suggests that cities start with one or the other approach, not both at the same time, but eventually may use both approaches.

Other design decisions depend on which approach is being used. The amount of a congestion fee has to be set, as does when it will be levied. London's expanded ULEZ will operate 24 hours a day, 7 days a week, while Stockholm's congestion charge is limited to rush hours. Which vehicles must pay or are banned also has to be established. Cities can use pricing as an additional incentive for promoting the purchase of non-fossil-vehicles by exempting these cars from the congestion price. Stockholm's congestion price started with this exemption, but it was dropped after five years.

Cities with car-free zones have to figure out how to accommodate necessary deliveries to stores and residences. Oslo is establishing dedicated loading and unloading spaces for commercial vehicles to reduce the number of these vehicles driving around the central city.

2 Build public support through consultation and experimentation. In all three CNCA cities, government officials conducted extensive outreach with the public and stakeholders. It involved hearings, polling, design charrettes, and more. In London, Transport for London and the Mayor ran a 3-month consultation process with the public. They reported 56 percent support for expanding the ULEZ and, responding to specific feedback, decided to give vehicles for persons with disabilities and charities a longer period of time to adjust to the regulations.

In Stockholm, congestion pricing was piloted with the commitment of local elected officials that after a 7-month trial period there would be a vote on whether to make it permanent. During the trial period, public support grew substantially because, analysts reported, the evident benefit (i.e. less road congestion) outweighed concerns that the measure would not work, drivers adapted fairly easily, and paying the charge didn't affect people as negatively as they had feared.

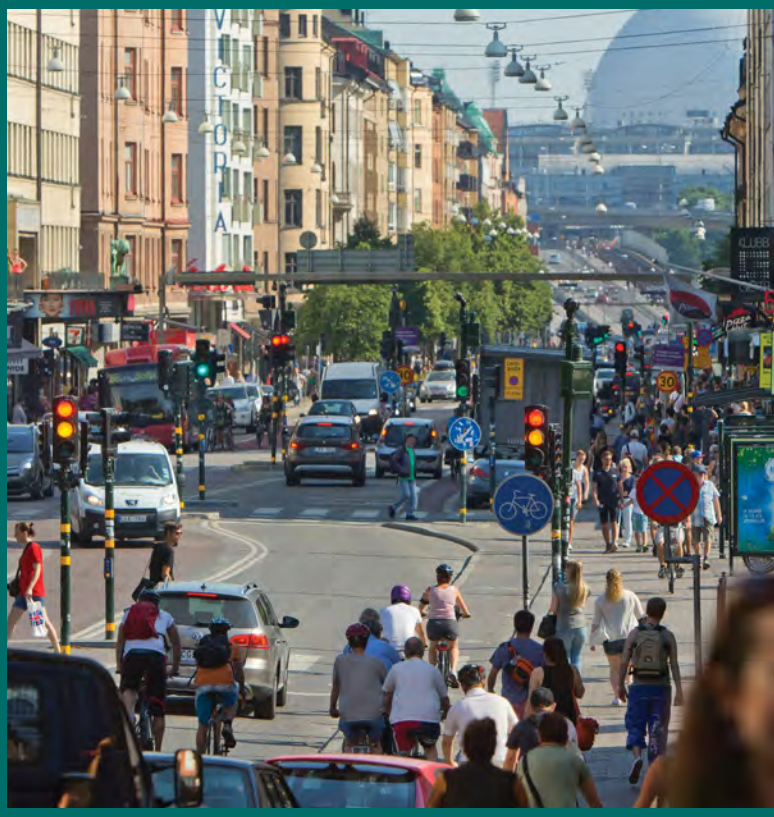
Oslo announced its car-free zone more than two years ahead of its implementation to provide time for revisions and adjustment. The city is implementing the car-free zone step by step, removing on-street parking within the zone in 2017.

3 Designate the use of congestion-charge revenue for investments that benefit the city. In Oslo, 90% of the income from congestion charges is directly channeled to funding investments in the public transportation system. Public transportation and roads are also the beneficiaries in Stockholm. This makes sense to the public — i.e. what transportation system users pay is then used to cover system costs — and helps win support for the fees. It also keeps the public from wondering what is happening with the money or from disapproving of how it is being used.

4 Invest in mobility alternatives using public transit, bicycles, and walking. Cities that use fees and bans closely link the approach to actions that increase alternatives to driving: availability and quality of public transportation service, extension and safety of bicycle networks, and improvement of the pedestrian

experience. This is especially important when it comes to car-free zones, since people need to have convenient, attractive, and affordable alternatives.

5 Consider what related policies may be needed. Some cities have also been reducing the number of public and private parking spaces they have as a way to discourage driving. In 2017, Oslo eliminated 300 parking spots in its planned car-free zone and intends to eliminate 400 more in 2018. Some cities have reduced parking space requirements for new development. Others require buildings to set aside space for parking bicycles, as a way of promoting that travel mode. Many cities have adopted transit-oriented development policies that promote increased residential and commercial densities around public transit stations, which can facilitate car-free lifestyles.



Right: Götgatan (Stockholm) is a street that has an important function both for businesses and for transport, especially for active modes.

Below: Strandvägen (Stockholm) connects areas of high recreational value with the CBD area.

Other CNCA Cities Advancing Car-Free and Low-Emissions Zones

- **Copenhagen:** The city closed one of its busiest streets, Norrebrogade, a principal shopping area, to all road traffic and is considering similar restrictions on another major commercial street, the Amagerbrogade.
- **Melbourne:** The city council began public discussion in 2018 of a proposal to: 1) establish car-free "superblocks" in the central business district, which requires closing off vehicle access to streets within designated block areas, 2) remove parking spaces, and 3) reduce pedestrian wait times at traffic lights. In car-free zones, streets could be repurposed for wider footpaths for pedestrians, outdoor dining, seating and spaces for civic activities, tree planting, and rainwater management.
- **New York City:** The city banned cars from Central Park, one of the world's best known and most visited urban green spaces, in June 2018, closing a 6-mile loop through the 843-acre park and ending more than a century of use by automobiles. The city banned cars from Prospect Park earlier this year as well, demonstrating a commitment to fostering safe and active modes of transportation in the city's vibrant green spaces.
- **Portland:** The city council directed the city's transportation bureau to work with the State of Oregon and regional partners and cities to research and evaluate best practices for congestion pricing, including area-based tolls, parking demand management, and pricing for electric

Lessons Learned for Implementing Car-Free and Low-Emissions Zones

- **Be transparent about the use of revenue from congestion charges.** All three cities have learned that when it comes to congestion fees, it's critical that the public trusts the government officials making decisions, especially when it comes to how the money generated will be used. Many of the design decisions for a congestion fee depend on technical information and analysis and will be left to the experts. But how much money will be obtained and how it will be used are inherently hot button issues for much of the public. The charge can be sold as a measure to protect the environment and public health, while reducing traffic, and cities have found public support for dedicating the funds to pay for transportation system improvements. Within this framing, though, there remains the usual political jockeying around what portion of the funds will go for public transit versus roads. Cities determined to reduce driving and promote car-free living may lean toward having the bulk of funds go to public transit even if that's not the traditional split in transportation funding.
- **Making other mobility modes more attractive builds acceptance for reduced driving.** Promoting and investing in public transit, bicycling, and walking are not just necessities if a city wants more and more of its residents to drive less or not at all. It also presents the public with a positive vision for what a city can be like: greener, quieter and with less expensive mobility. Oslo constantly promotes these themes in its communications with the public. That's a more acceptable message than an anti-driving, regulation-oriented message that can be perceived as "a war on cars."

Challenges for Cities Implementing Car-Free and Low-Emissions Zones

- **My city does not have the authority to charge a congestion fee or permanently ban vehicles.** Most cities need permission from a higher-level government or regional agency before they can institute these actions. They typically lobby and negotiate with that entity, noting where its interests and those of the city are aligned: increased funding for transportation and reductions in air pollution and GHG emissions. To gain headway, they can propose a smaller-scale pilot, an experiment, as a way of reducing the perceived political risks of making the changes. But, ultimately, they need to strike a deal. If such an agreement is not possible initially, cities can take other steps to reduce driving and test them for public support. They can, for instance, convert some of the city fleet to electric vehicles and keep its remaining fossil fuel vehicles out of designated areas. They can institute temporary car bans, such as a Sunday prohibition on driving on certain popular streets, or a temporary or even permanent "play street" designation in which the street surface is turned over to neighborhood residents for activities. And they can expand and improve non-driving mobility alternatives to help lure people out of their cars.
- **My city faces significant community concerns and political opposition to a congestion fee or car-free zone.** Proposed fees and bans are almost certain to generate concern and opposition, and cities have found they need to manage the decision-making process carefully. Some have had to modify initial plans to address resistance, cutting back on the size or routes of the affected area. In Oslo, downtown merchants feared that reduced downtown parking would cut severely into their business. In London and Stockholm, there was substantial political opposition to congestion fees when they were first introduced. But after a while, the policies have been considered successful and gained public support. Cities have shown there are several ways to build support:
  - Start with zones that are small, but big enough to show that charges or bans can be effectively implemented and produce desirable benefits. The initial effort may also be considered temporary, with an evaluation to follow before it's made permanent.

and shared mobility vehicles. "These strategies should be evaluated for their ability to reduce Portland congestion, help improve multi-modal options and overall transportation outcomes for low-income and marginalized communities, and help achieve climate goals," according to the council resolution.[24]

- **Seattle:** In April 2018, the city began developing a plan to establish tolls on vehicles using some city roadways, a policy that will likely need the approval of local voters. Revenue from tolls could be used to increase public transit service in the city and support development of more electric vehicle infrastructure.

24 Download Portland city council resolution at http://efiles.portlandoregon.gov/Record/11443602/

- Communicate the benefits of cleaner air and better health, reduced traffic, increased pedestrian safety, repurposed space, improved livability, and more money for transportation improvements, instead of emphasizing the "resource efficiency" of the restriction or charge.
- Argue that it's only reasonable for drivers, who use the roads and streets and whose cars pollute the air, to pay for the effects of driving.
- Ensure that access to non-vehicle travel modes — i.e. the alternatives to driving — is convenient and that public transit quality is good. Investing in these alternatives shows the public a "carrot", not just the "stick", of fees and bans.
- Point to other cities that have adopted these approaches and the data that are available about what happened. For instance, there are numerous examples of cities closing streets or shopping areas to vehicles without a subsequent downturn in business. Similarly, the emissions-reduction effects of congestion charges have been well documented by third-party analysts.

GLOBAL TRENDS ADVANCING CAR-FREE AND LOW-EMISSIONS ZONES

BARCELONA, MADRID, AND PARIS, among other cities, have taken steps to create car-free zones. Paris prohibits cars made before 1997 from driving in the city center on weekdays and plans to limit selected streets to electric vehicles starting in 2020. Barcelona is applying the "superblock" concept to a half-dozen neighborhoods by limiting car circulation on streets within a designated area, enhancing bicycle and bus networks and pedestrian space, and repurposing streets, parking areas, and intersections. Madrid plans to ban cars from 500 acres of its city center, with 24 city streets redesigned for pedestrians instead of cars.

HAMBURG became the first German city to ban some diesel cars, starting with two main roadways that will affect an estimated 214,000 cars.

EMPOWER LOCAL PRODUCERS AND BUYERS OF RENEWABLE ELECTRICITY

Getting to 100 percent renewable electricity, or as close to it as possible, is going to be necessary if cities are to meet their deep decarbonization targets. Yet cities typically have very little direct control over their energy supply. Most cities do not own their own utilities and thus have been dependent on decisions made by their state or investor-owned utilities and the entities that regulate how much renewable energy is in their power mix. Even cities with municipal utilities face challenges in getting to significantly larger percentages of renewable energy, as this often requires substantial changes to their business and revenue models.

Increasingly, however, cities are drawing on a diverse menu of approaches to empower local residents, businesses, city government, and others, to produce or purchase renewable electricity supply. They are using a variety of policies and actions to invest directly and support private investment in renewable-energy production, adopt renewable energy standards, and organize buyer coalitions. At the same time, they're advocating for changes in energy-supply regulations of higher-level governments to increase access to and production of renewable energy.

These changes increase local use of renewable energy and signal to the community and to policy makers the crucial importance of increasing the renewable content of energy supply. And they help generate local buy-in for the transition to renewable electricity. In some cases, the empowerment policies take advantage of opportunities in the growing renewable energy sector. In others, they work around constraints in energy-supply markets and regulations heavily invested in fossil fuel energy.

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CNCA EXAMPLES: WASHINGTON, DC, MELBOURNE, RIO DE JANEIRO

Washington, DC requires that electricity suppliers obtain at least 50% of their supply from renewable energy by 2032 and at least 5% from local solar production. The city has set a goal of 100% renewable energy for city facilities. The city purchases wind and solar energy for municipal facilities, which saves an estimated $25 million USD over the 20-year terms of the contracts. The wind power purchase agreement (PPA), the largest of its kind by an American city, provides 30% of the municipality's electricity, while the solar PPAs helped install solar panels on 50 government sites citywide.

Currently, there is a legislative proposal to increase the city's renewable energy requirement for electricity supply to 100% by 2050.

In 2018, Washington, DC became the first US city to establish a Green Bank, a quasi-public institution capitalized with limited public funds to attract private investments that accelerate the deployment of clean energy projects. Green Banks have been used successfully by states and countries to finance projects that create green jobs, expand solar power, and lower energy costs, while reducing overall GHG emissions.

Several DC-based universities have used PPAs to obtain renewable energy, one of them for 52 megawatts of solar power, which is the largest non-utility solar purchase in the eastern US.

In Melbourne, a city of 4.9 million, the Melbourne Renewable Energy Project (MREP) — a group of local governments, cultural institutions, universities, and corporations — collectively purchased renewable energy from a newly built facility, an 80-megawatt wind farm. The group's long-term power purchasing agreement — the first in Australia — enabled a private clean-energy company to finance and construct the project outside the city. The MREP also produced a guide for others in Australia interested in buying offsite renewable energy through large-scale contracts.[25]

Rio de Janeiro, with a population of about 6.5 million, advocated successfully for national legislation to enable and incentivize consumers to install micro- and mini-generation systems for producing electricity. Rio has also developed an initiative to install 30 megawatts of onsite solar power generation on municipal buildings or a 100-acre/40-hectare in-city solar farm. The city is connected to the national electricity grid, which is driven almost entirely by renewable hydropower, but recent droughts have called attention to the value of tapping into solar power too.

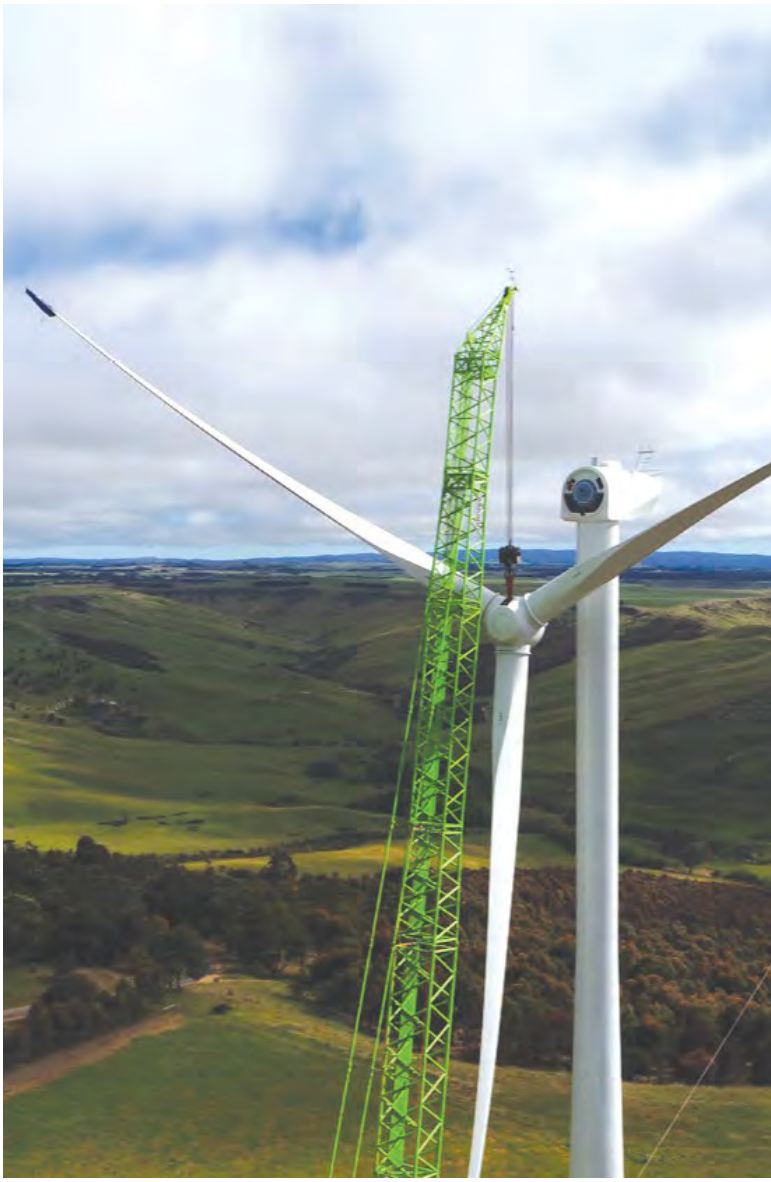
In another empowerment approach, Boulder has been fighting for several years in the State of Colorado regulatory system to gain control of key assets of the electricity utility (a private company with monopoly status), so the city can accelerate the conversion to renewable energy and meet its ambitious decarbonization goals. Voters in the city have twice approved spending for the cause, at a total of more than $20 million USD.

Although the amount of renewable energy that is purchased or produced in any one city project is usually small, there is potential for much larger aggregation, especially when state/provincial or national governments have aligned their policies with city production and purchasing

25 City of Melbourne, "Renewable Energy Procurement," http://www.melbourne.vic.gov.au/business/sustainable-business/mrep/Pages/renewable-energy-procurement-guide.aspx.

empowerment. In San Francisco, for instance, more than 100,000 residents and businesses are enrolled in the city's not-for-profit CleanPowerSF program operated by the San Francisco Public Utility Commission, which gives them access to more renewable energy than they can obtain from the electricity utility serving the city and at competitive prices. This purchasing is made possible by the State of California's Community Choice Aggregation Program, which allows cities to pool their citizens' purchasing power to buy or generate their own electricity.[26]

26 City of San Francisco, "Cleaner, Greener Electricity Coming to SF Businesses This Summer," http://sfwater.org/Index.aspx?page=17&recordid=474.



Right: A crane lifts a turbine rotor assembly into place at the Crowlands Wind Farm, two hours from Melbourne.

Below: Concrete is poured for the base of a wind turbine at the Crowlands Wind Farm.

Key Implementation Steps

City implementation of any of the renewable energy empowerment approaches tends to be highly dependent on contextual factors. State/provincial and national governments have different energy supply regulatory regimes. Electricity providers are often under different ownership: some are publicly owned, some are private investor owned. The availability of renewable energy producers also differs from region to region, as do prices for renewable and fossil fuel energy. These variations shape what a city's options are and what implementation might involve.

For cities, here is a basic set of implementation steps:

1 **Understand the electricity supply landscape within which the city operates.** Cities should understand trends in their energy markets, the types of utilities and their commitment to increasing renewable energy, the form of government regulation and existing government energy policies, the prices of different sources of energy, and more. This can be complicated terrain in which cities have little previous experience. In the US, for instance, there are investor-owned and city-owned utilities and utility cooperatives. There are various state and federal government regulatory bodies, and some states have deregulated control over electricity generation, transmission, and distribution. Without a map of this landscape, cities cannot effectively develop strategies for empowering renewable energy production and purchasing.

2 **Identify which potential approaches the city might use to boost renewable electricity.** Cities should enlist expertise—consultants, academics, utility managers, renewables producers—to figure out which empowerment approaches might work in its energy landscape. When Boston researched what its options were for renewables purchasing and generation, advisors identified nine possible actions, from collaborating with other cities, corporations, and other large energy users for a bulk purchase of renewable energy, to installing solar panels on city-owned sites.

3 **Engage with electricity providers and government regulators to gauge their willingness to be supportive.** Consumer and corporate interest in using renewable energy is growing and the cost of producing renewable electricity is becoming increasingly competitive with fossil fuel production processes. These trends make it less likely that regulators and utilities will flat out reject a city's ideas about empowering local production and purchasing; they may be more willing to try some experiments or fashion compromises. But a city's persuasive power is much greater when it engages with utilities and regulators as part of a larger alliance of cities, corporations, and other energy customers.

4 **Select promising approaches to start implementing.** Which approach a city might start with depends, of course, on its context, and what degree of cooperation it has from utilities and regulators. But another factor that has been important in some cities is to prioritize approaches that enable low-income households and neighborhoods to produce and purchase renewable electricity.

One example is city support for “community energy projects” that design and fund solar energy production at neighborhood scale. Portland’s city council has prioritized development of community-based renewable energy production to provide 10% of the city’s renewable energy by 2050, and it invests in the capacity of community organizations to lead the effort. In Minneapolis, “solar garden” projects in underserved neighborhoods take advantage of state policies to assemble investment from local residents and businesses, who will be long-term subscribers to the garden, and other financial sources. The energy the gardens produce is sold to the electric utility, which deducts the amount from garden subscribers’ electricity bills.

Below: Aquário Marinho do Rio (AquaRio) is the largest solar power project in the state of Rio de Janeiro. More than 2,000 photovoltaic solar panels occupy a surface area of 6,000 square metres—equivalent to a football pitch—and produce about 77,000 kWh of clean electricity each month. This represents 20 to 30% of the electricity consumed monthly and also prevents the release of 320 tonnes of carbon dioxide into the atmosphere each year.

Other CNCA Cities Advancing Renewable Electricity Empowerment

- **Adelaide:** The city allocated nearly $1.5 million USD for installation of solar photovoltaic systems on municipal buildings in 2017–2019. Through its Sustainability Incentive Scheme, Adelaide has provided financial incentives for installation of solar PV and energy storage systems in nearly 300 residences, businesses, apartment blocks, and community organizations.
- **Berlin:** The city is working to eliminate coal-based power and heat generation by 2030. The city is studying how to use decentralized renewable-energy production and energy storage in residential buildings and neighborhoods to add renewable energy to the electricity grid and link with electric-vehicle charging infrastructure.
- **Boston:** The city announced in June 2018 that it is seeking to pool the renewable energy demand of multiple cities into large potential purchases that would drive down prices charged by suppliers. The city is collecting renewable energy demand data from interested cities and intends to issue a Request for Information from renewable energy suppliers later in 2018.
- **Boulder:** The city offers residents and businesses that have installed solar electric or solar thermal (hot water) systems on their property a rebate of up to 15% of sales and use taxes on materials and permits for the systems.
- **Copenhagen:** The city has taken advantage of a Danish law that gives local citizens the right to purchase up to 20% of the shares in wind turbine projects

Lessons Learned for Implementing Renewable Electricity Empowerment

- **Set ambitious, near-term city goals for renewable electricity to inspire the community and innovation.** When a city publicly commits to ambitious renewable electricity goals—even though it may not know how to accomplish them—it is likely to inspire more electricity customers to demand more renewable energy, and it triggers the implementation process described above. This can unleash an especially powerful dynamic if the city sets some near-term goals (e.g., for 2025 and 2030), because it must take credible actions toward the goal within a few years.
- **Leverage the city's buying power and that of potential partners.** A city can organize a substantial amount of demand for renewable electricity. Municipal facilities and operations add up to a relatively large customer. City residents, if bundled together, form a huge volume of demand. And businesses in the city, especially larger corporations, are also relatively large customers of the electricity system. Organizing these sources of demand into a unified voice that utilities and regulators cannot ignore is not a simple task, and it is not something cities have experience doing. But cities find that there are far more potential partners than there were just a few years ago.

  A growing number of corporations have committed to achieving 100% renewable electricity. More nonprofit advocacy organizations have experience in organizing community demand for renewable electricity. More and more consumers expect to have access to renewable electricity and are even willing to pay more for it if necessary. Cities can convene, support, and co-lead local efforts to build demand-side pressure for changes in regulations, public policies, and utility investments to produce more renewable electricity.

  Further enhancing the potential for cities to organize demand-side pressure is the broad trend of electrifying transportation and buildings in cities, which is beneficial to the electricity sector. The pace and extent of expanded electrification depend, in part, on decisions made by cities, as evidenced by several of the Game Changers in this report: zero-emissions building codes, electric vehicle charging infrastructure, electrification of buildings' thermal systems, and low-emissions vehicle zones. But implementing these and other actions makes more sense when the electricity system is rapidly decarbonizing.

A MENU OF POLICIES AND TOOLS FOR RENEWABLE ELECTRICITY EMPOWERMENT

The menu of policies and tools from which cities can select has been growing. And different approaches are needed in the different energy-supply contexts in which cities find themselves, usually due to regulatory policies of higher-level governments.

The European Union has been advancing a Clean Energy for All Europeans package of legislation that includes a renewable energy supply target of 32% by 2030 from wind, solar, hydro, tidal, geothermal, and biomass sources. The policies, including financial incentives for renewable energy producers, will accelerate a shift in the architecture of the European electricity system toward more flexible production of energy.[27]

A 2017 report by Meister Consultants Group, "Pathways to 100: An Energy Supply Transformation Primer for US Cities," identified three categories of approaches:

- Cities enable energy consumers, including residents and businesses, to procure renewable energy or generate their own renewable energy onsite or offsite
- Cities procure renewable energy to meet the electric demand of municipal operations
- Cities directly or indirectly influence the energy supply of the electric utility that serves the city

Among the empowering actions that cities can take:

- Offer financial incentives (e.g., tax breaks, low-interest loans) for onsite production of renewable energy
- Adopt mandates for onsite renewable energy for new construction or for connection to a district heating system
- Support group purchasing programs for renewable energy, which reduces costs through bulk purchasing
- Streamline permitting processes for siting of renewable energy production
- Lease public facilities and land for community-scale renewable energy projects
- Direct city-owned electric utilities to compensate local producers of renewable energy for the value of the energy
- Establish renewable energy purchasing requirements for city buildings
- Install renewable energy systems on municipal facilities
- Work with independent renewable energy producers to directly purchase electricity through power purchase agreements
- Establish a local renewable portfolio standard that sets minimum renewable percentages for electricity supply by certain dates
- Renegotiate their long-term contracts with utilities that outline requirements for the utility to use the city's public rights of way
- Municipalize the local electric grid by purchasing it from the utility

27 European Commission, "European Commission guidance for the design of renewables support schemes," 2013, 14, https://ec.europa.eu/energy/sites/ener/files/com_2013_public_intervention_swd04_en.pdf.

in a local area. Thousands of residents have invested in renewable electricity production this way.

- **Minneapolis:** The city pledged in 2018 to achieve 100% renewable electricity for municipal facilities and operations by 2022 and citywide by 2030.
- **New York City:** The city has installed 10 megawatts of solar-energy capacity on municipal buildings and intends to have 100 megawatts installed by 2025.
- **Sydney:** The city set its target for 50 percent of electricity to come from renewable sources by 2030. Today, the carbon intensive grid is only 11 percent renewable. The city has worked with key stakeholders to design and implement a range of programs to accelerate the uptake of more renewable energy locally with a range of incentives delivered through a new $4 million USD budget. It has also supported large-scale local solar projects through environmental grants and waivers of all fees associated with development applications for solar installations. A large urban development precinct in the area, Barangaroo, will be carbon positive by maximizing solar onsite and a renewable energy purchasing agreement. Sydney is also installing about 2 megawatts of solar-power capacity into its buildings and procuring at least 50 percent renewable electricity by 2021.
- **Toronto:** The city enables the installation of solar photovoltaic systems on residential and commercial buildings as part of its Green Standard and Renewable Energy By-law and has city programs that provide low-interest financing for local renewable production.

Challenges for Cities Implementing Renewable Electricity Empowerment

Most cities have little experience working with energy-supply issues. When they decide to increase their residents' access to renewable electricity, they will face unfamiliar challenges.

- **Cities need technical capacity to intervene in utility regulatory and decision-making processes.** Few cities have experience and expertise in intervening in the government regulatory processes that shape energy-supply markets. But Minneapolis and other cities have found that intervening is a way to make the city's case for an expansion of renewable electricity and to get the attention of government policymakers and utilities. Portland has joined with other stakeholders to discuss, with one of the investor-owned utilities serving the city, ways to enable large customers to use the utility to purchase renewable electricity that is generated by other producers. Intervention-minded cities hire staff and consultants, partner with nonprofit advocacy organizations with relevant expertise, collaborate with other cities, and work with academics to build the capacity needed for these efforts.
- **Money to incentivize small-scale renewables production may be scarce.** A city's capacity to provide financial incentives for private investment in renewable energy production can be weakened by fiscal stresses. Even small incentives can be useful in signaling the city's commitment, but they probably won't have the power to mobilize many people to invest in production. Washington, DC's Green Bank is a potential way to use a concentrated amount of public capital to leverage much larger amounts of private capital.

GLOBAL TRENDS ADVANCING RENEWABLE ELECTRICITY EMPOWERMENT

SOUTH AUSTRALIA: The state government announced a deal in 2018 with Tesla to install as many as 50,000 solar-powered systems on homes, including panels and storage batteries, at no cost to residents.

STATE OF CALIFORNIA: In the state, about 135,000 homes already generate their own solar power. State government is requiring solar panels on *all* new houses by 2020, a mandate that is expected to add as many as 100,000 new solar homes annually.

SET A CITY CLIMATE BUDGET TO DRIVE DECARBONIZATION

A climate budget is a tool to convert a city's climate goals into concrete, annual, measurable action. It establishes a maximum GHG emissions level for the budget year, based on the city's emissions goal. The budget details the city's proposed short-term emissions-reduction actions to stay within the maximum amount, their projected impact, and cost. It is a distinct part of the city's overall budget and moves through the city's usual budgeting process, from proposal to adoption, implementation, and after-action assessment.

The climate budget is a tool for governance transformation. It requires city administrators and elected officials to be concrete, specific, and public about what *short-term* actions they want to take to achieve *long-term* GHG-reduction goals, and to submit their proposals to open political debate and public discussion. It sets up the potential for tough decisions if the city is not progressing well toward its targets. It also makes monitoring and reporting on progress in reducing GHG emissions a part of the city's regular budget review process.

By spelling out which department and agency is responsible for which climate action and by providing the necessary funding, a climate budget allows citizens and the city council to hold government officials accountable for the GHG emissions reductions they produce. By using a multiple-year time frame, it provides departments with some flexibility in achieving targets, but requires explanations about why an action was delayed or ineffective.

The climate budget, with its specificity and cost estimates, helps to stimulate a public discussion and political debate about what are the most effective and financially efficient ways to proceed and at what pace the city should move. While this dynamic can generate disagreement, the budget's transparency and subsequent discussions also produce a better-informed public and can solidify support for climate actions. It shows the community what it will take to achieve ambitious GHG emissions reductions and how much progress is being made toward targets. And it can describe the various co-benefits that may also be produced for the city — reduced air pollution and traffic congestion, for instance — by the proposed climate actions.

Adoption of a climate budget by the city's elected officials also allows the public to hold its political leaders accountable for making clear progress on climate goals at an acceptable cost to the city.

The climate budget is a tool for governance transformation. It requires city administrators and elected officials to be concrete, specific, and public about what short-term actions they want to take to achieve long-term GHG-reduction goals.

CNCA EXAMPLE: OSLO

In 2017, Oslo became the first major city in the world to adopt an annual "climate budget," revealing in a single, public document how and at what cost it would reach its aggressive GHG reduction target for 2020, on the way to achieving near-zero emissions by 2030. Oslo's 2020 target of 766,000 tons emitted in the city is 36% below the city's 1990 level. Its 2030 target is an extremely ambitious 60,000 tons, a 95% reduction.

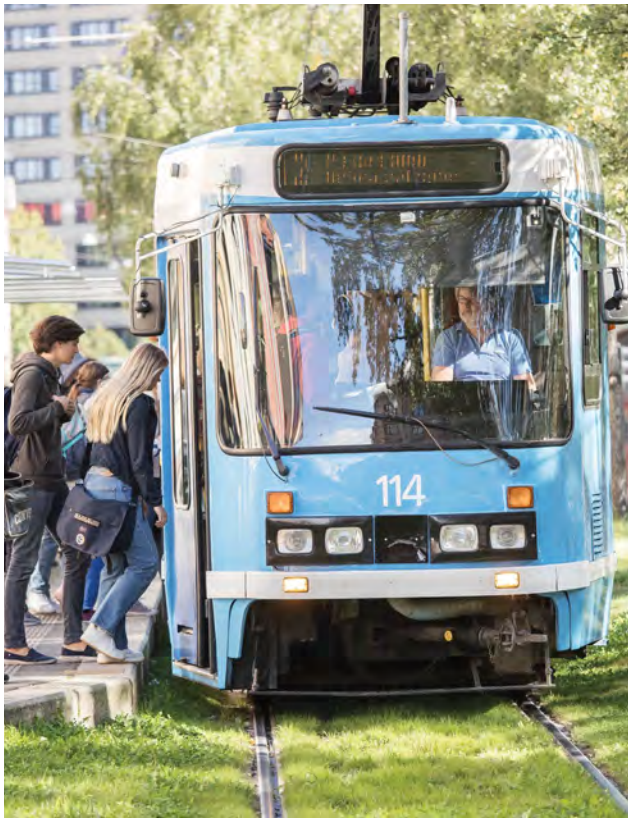
The unique budget for the Norwegian capital of 670,000 people is designed to stimulate public awareness and discussion and support climate-action planning, evaluation, and adjustment. It details the major GHG-reducing actions the city will take during the budget year, the estimated GHG-reducing impacts each action is projected to have, how much more will be spent that year on each action, and which government entity is responsible for implementation.

The budget also describes how climate actions contribute to making Oslo a better city to live in. The material makes it easier for city residents to follow the progress that is being made to decarbonize the city and to understand what it will take to achieve deep reductions in the long term.

The 2018 climate budget adopted by the city council was Oslo's second. It provided a four-year cost estimate for climate actions between 2018-2021, divided into operating and investment budgets. Proposed climate-action spending in 2018 was about $21.1 million USD above the previous year for 19 measures designed to cut emissions in 2020 by 460,000 tons. The budget acknowledged that 100,000 tons of the projected reduction were attributed to actions whose effects were not yet fully quantified. It explained that the city had lowered its 2020 GHG emissions reduction target because the national government had delayed investment in a carbon capture-and-storage (CCS) system for the city's waste incineration plant. Full scale CCS implementation from 2020 was an explicit prerequisite for achieving the city's GHG-reduction goal.

Oslo's climate budget pushes city government to show how it will deliver, year-by-year, on the general commitments and strategies found in city's longer-term climate-action plans. This makes it hard for city administrators and elected officials to rely on wishful thinking (about new technologies) and minor efforts, or to ignore the need to act in the short term after making a long-term commitment. Given ambitious goals, the budget must address the fact that waiting to act won't work and that major actions will be needed.

Below: Transport accounts for two thirds of Oslo's emissions. For the city to reach its ambitious targets, more people will need to use public transport.



Key Implementation Steps

Oslo officials have been quite aggressive for years in setting goals and measurable targets for long-term reduction of GHG emissions within the city's boundaries and in planning and implementing bold climate actions. Without reduction targets with fixed dates, the development of a climate budget is not possible. In the city, there's been general public and political support for this approach. The public has approved of taking climate actions, as measured by regular polling of citizens. The city council contains representatives of eight political parties, and all but one voted in support of the 2018 climate budget.

The general steps for developing and implementing a city climate budget are similar to typical city government budgeting processes.

1 **Establish structural authority over the climate budget process.** In Oslo, all city departments are responsible for developing and implementing their climate actions, but the city's Department of Finance oversees the climate budget-making process. This is a way to ensure that the city government prioritizes financial efficiency in achieving emissions reductions. Within the city's usual budget oversight process, administrators report climate-budget progress and expenditures to the finance department on a quarterly basis.

2 **Design a climate budget template for departments to use.** Oslo developed a climate budget template to ensure clear information about essential components. It specifies climate actions the city will take and which department is responsible for each action, details what the action will cost over a specified time period (Oslo uses a 4-year time frame), and what each action's measurable GHG emissions reduction is expected to be. Oslo's climate budget includes actions with direct impact on the city's emissions that are implemented or funded by the national government and therefore not in the city's control.

3 **Address the challenge of time lag in GHG emissions data.** Oslo depends on emissions statistics from Statistics Norway for municipalities, but these are only calculated every two years. While the city has advocated for an annual updating of GHG emissions, it also produced a "climate barometer" that allows it to track some local indicators of GHG emissions more frequently, as often as quarterly, and assess how well climate actions are working.

4 **Provide technical details about the assumptions and calculations of actions' emissions-reduction impact.** Disclosing the assumptions informs public discussion and political debate over what the city should be doing. This is a crucial step; without it, it is difficult for others to assess the potential effectiveness of city plans and to hold departments accountable for performance. It is important to disclose the uncertainties that may be involved in the calculations.

5 **Assemble the budget into a single document with clear and non-technical explanations and make it public.** Oslo's 2018 climate budget is a 75-page document with a great deal of explanation and definition and context setting. About half of the document is a separate technical report that provides the assumptions behind the climate actions and budgeting.

6 **Monitor public opinion regularly.** Even before developing the climate budget, Oslo regularly surveyed its citizens and businesses to gauge their receptivity to specific climate actions and the city's overall effort. Since the production of a climate budget is supposed to help inform the public, it's essential to find out how well this is working.

Another CNCA City Advancing Climate Budgeting

In 2017, Sydney released a carbon budget for its own operations. Now, for the first time, the city accounts for emissions across the organization in the same way it does for its finances.

Known as the "Asset Environmental Budget," it translates operational carbon emissions targets into a detailed plan. Emissions targets have been allocated to relevant areas of the organization's assets and operations.

The Asset Environmental Budget is incorporated into a resource plan to promote transparency in monitoring of performance, timely decision-making at a strategic level that allows the organization to stay on track, and visibility of successful reduction measures.

Lessons Learned for Implementing a Climate Budget

Although Oslo has been using a climate budget for a few years now, it continues to refine the methodology and the document, as part of the learning process for climate-action planning and community engagement. For example, the first climate budgets have not included a great deal of data about the additional benefits that various climate actions may produce, such as cleaner air and reduced traffic congestion. The city is looking at including this sort of information in future climate budgets.

- **Emphasize all benefits of climate actions.** Oslo's climate budget document opens by stressing that the city's climate actions "will also make Oslo an even better and more modern city to live in," by reducing traffic and air pollution and growing the green economy, for instance. The city emphasizes that many climate actions are things it would be doing anyway to improve city life. Throughout the year, the city publicizes and tells stories about the positive changes that are occurring, e.g., how the reductions in traffic congestion make travel quicker and safer and how the reductions in air pollution relieve those who suffer from asthma. At the same time, the city packages the measures as part of the city's image as a change-oriented community. This way of presenting climate action can reinforce residents' support for GHG reduction and also help to persuade residents who have not made up their minds.
- **Don't let the technical challenges get in the way.** For cities that are committed to a goal-and-target-setting model for GHG emissions reduction, with targets tied to fixed dates, the technical challenge of estimating the impact of specific actions and of measuring progress annually will seem daunting. In Oslo's experience, the solution is not to try to be perfect from the outset. The climate budget, like any new performance-management tool, is a work-in-progress that needs to be revised periodically. Oslo has acknowledged the technical challenges as part of the budget, disclosed the assumptions and uncertainties in the budget detail, and developed tools that allow it to, at least initially, manage some of the technical problems.

Challenges for Cities Implementing a Climate Budget

- **In my city, presenting a separate budget for climate actions may make the actions more vulnerable to political opposition and budget cutting.** This is certainly possible, especially in cities that don't have substantial public support for taking climate action and/or in which there is significant political opposition to taking climate action. Bundling a city's climate actions and information into a single climate budget, with its costs and uncertainties, can become an easy target. But if a city government is committed to the transparency and informed discussion of a climate budget, it can emphasize the ways that climate actions produce other benefits that improve city life and should be pursued anyway. It's important to locate climate action within a larger narrative about the city's future.

  At the same time, producing a climate budget can be a mechanism, Oslo has found, for effectively engaging with citizens who don't have strong opinions about climate action. It can help to shape their understandings and views, rather than leaving them at the mercy of political noise. Oslo officials have focused on this audience in their public communications and community engagement efforts.

- **My city's elected officials and administrators may not be willing to tie themselves to the specific performance outcomes for GHG emissions reductions that are in a climate budget.** In Oslo, administrators were nervous initially about making explicit plans for specified amounts of GHG reduction, especially given some of the uncertainties involved in whether actions will work and how long they will take to work. City operations are only directly responsible for about 4% of Oslo's GHG emissions, so actions depend heavily on getting residents and businesses to act. But the climate budget template gives administrators some flexibility—a four-year time frame for producing results—and allows them to state what the uncertainties or barriers are that might impede progress. It allows them to identify actions for which they cannot yet project results. The same "safety net" is available to elected officials. As Oslo officials are working on their third annual climate budget, they are now coming to consider the budget exercise to be a natural, integral part of the overall city budget process.

- **My city only uses a one-year budget. In many cities, an annual budget is the prevailing practice, but many climate actions need multiple years to impact GHG emissions.** And some actions depend on decisions by other levels of government, which may be delayed—as Oslo experienced—or derailed. A one-year climate budget wouldn't present enough information for the public and elected officials to assess how the city will progress toward a GHG emissions target that is a number of years away. By using a four-year budget, Oslo is able to show how it plans to achieve its 2020 target while detailing how certain actions will achieve impacts over more than a one-year period. The spending in the out-years is projected, but not locked in; each year, that year's budget has to be adopted by the city.

CONCLUSION

THE ROAD FORWARD

In leading cities, because of the work described in this report, our communities are stronger, safer and more secure. We're eliminating dirty emissions and putting people — not fossil fuels — at the center of our economies. And that's changing the game for every city.

As a result, life is more livable, our city systems are more efficient and productive, and our people are happier and healthier.

The ingredients for this transformation are here in these "game changers." Zero-emissions new buildings. Electric vehicle infrastructure. Recovered organic materials. Decarbonized heating and cooling systems. Reduced traffic and car-free zones. Empowered local renewable electricity producers and buyers. City climate budgeting.

Changing the game in cities is how we're going to get the future we want. And yes, these actions may seem daunting for some cities, given the technical, political, and financial obstacles they face. But they are far from impossible, which we hope is evident from the details and lessons learned provided by the cities in this report.

This is the path forward for cities wanting to decarbonize radically and rapidly. We can get there, but only if more cities step up, other levels of government help them, funders provide support, and the public asks for it. That's not only how we change the game, that's how we win it.

We're eliminating dirty emissions and putting people — not fossil fuels — at the center of our economies. And that's changing the game for every city.

RESOURCES FOR GAME CHANGERS

ADOPT A ZERO-EMISSIONS STANDARD FOR NEW BUILDINGS

- "Zero Emissions Building Plan." City of Vancouver, July 12, 2016. This plan provides a thorough and clear example of the background research and "case statement" a city made for adopting a zero-emissions building plan.
- "ZERO Code." The Architecture 2030 website offers complete background and details on a building emissions code that cities can adopt.
- New Buildings Institute website: https://newbuildings.org/hubs/zero-net-energy/. NBI is a 20-year-old US nonprofit organization that works with the building industry to promote practices, technologies, and policies that improve energy efficiency in buildings.
- "Zero Emissions Building Framework." City of Toronto, March 2017. This document provides a clear, detailed explanation of the city's zero emissions framework, with analytic and modeling information and background about the city's GHG emissions from buildings.

BUILD A UBIQUITOUS ELECTRIC-VEHICLE CHARGING INFRASTRUCTURE

- "EV Charging Points in Oslo — 400 Public Charging Stations in 4 Years, 2008-2011: A City's Strategy to Support the Use of Electric Vehicles and Become the World's Electric Vehicle Capital." Oslo, 2012. This document details many of the practical lessons learned during Oslo's first four years of developing its EV-charging infrastructure.
- "Plugging In: Readying America's Cities for the Arrival of Electric Vehicles." Alana Miller, Teague Morris, and David Masur, Frontier Group, MassPIRG, and Environment Massachusetts, Winter 2018. This report contains a comprehensive, well-researched landscape review of city efforts to develop electric vehicle charging infrastructure, especially in the US and Europe. It is highly informative and offers valuable guidance for cities.
- "Emerging Best Practices for Electric Vehicle Charging Infrastructure." Dale Hall, Nic Lutsey, International Council on Clean Transportation, October 2017. This study provides data-filled analysis of public EV-charging infrastructure worldwide and issues in the further development of the infrastructure.

MANDATE THE RECOVERY OF ORGANIC MATERIAL

- "Food Scraps and Yard Waste." This New York City Department of Sanitation website covers organic-waste requirements and services.
- "Managing and Transforming Waste Streams: A Tool for Communities." This is a useful US Environmental Protection Agency online framework and policy-development tool for cities.
- "San Francisco Mandatory Recycling and Composting Ordinance." This Wikipedia entry provides history and other details about San Francisco's pioneering efforts.
- "Cities in the Circular Economy: An Initial Exploration." Ellen MacArthur Foundation, 2017. This overview provides a framework for understanding the opportunities for cities to turn waste and other resources into recycled goods for markets.

ELECTRIFY BUILDINGS' HEATING AND COOLING SYSTEMS

- "Thermal Decarbonization: First Stage Findings in Developing Renewable Heating and Cooling Alternatives for Residential and Municipal Buildings." Carbon Neutral Cities Alliance, 2016. This report summarizes the results of the first phase of a renewable heating and cooling project for residential and municipal buildings conducted by the cities of Boulder and San Francisco. Additional CNCA reports on thermal decarbonization are available on their web site at: https://carbonneutralcities.org/initiatives/innovation-fund/

- "An EU Strategy on Heating and Cooling." European Commission, 2016. The Commission document offers an overview of the EU strategy for reducing emissions from building heating and cooling.
- "The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings." Rocky Mountain Institute, 2018. The Institute provides an essential economic analysis.
- "City of Boulder—Roadmap to Renewable Living." The City of Boulder website provides information that helps residents electrify heating and cooling, increase building efficiency, and install onsite solar and adopt electric vehicles—a combination of decarbonizing actions consumers can take.
- "Commonwealth Accelerated Renewable Thermal Strategy." Massachusetts Department of Energy Resources, 2016. This US state's strategy is a good example of state-level policy options to support building thermal decarbonization.

DESIGNATE CAR-FREE AND LOW-EMISSIONS VEHICLE ZONES

- "The Stockholm Congestion Charges: Overview." Jonas Eliasson, Centre for Transportation Studies-Stockholm, 2014. This is a detailed study of the lessons learned during the first 6 years of Stockholm's congestion charge.
- "Mayors of 12 Pioneering Cities Commit to Create Green and Healthy Streets." C40 Cities, October 2017. This details the mayors' pledge to accelerate their cities' transition away from vehicles powered by fossil fuels.

EMPOWER PRODUCERS AND BUYERS OF RENEWABLE ELECTRICITY

- "Pathways to 100: An Energy Supply Transformation Primer for US Cities." Meister Consultants Group. This report provides a clear, thorough analysis of the energy-supply landscape of US cities and dozens of pathways that cities are using to transform their energy supply.

SET A CITY CLIMATE BUDGET TO DRIVE DECARBONIZATION

- "Climate Budget 2018: Preliminaries/Climate Budget 2018/Technical Report." City of Oslo, download at Climate Budget 2018—Sustainable Procurement Platform. The climate budget, chapter 2 of the city budget, contains a great deal of explanatory detail about the budget's purpose and technical development.
- "Oslo Climate Budget." Europa, 2017. This brief document provides a best practice summary of the Oslo Climate Budget.

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CNCA

"In CNCA cities, life is getting better, cleaner, healthier and more efficient as we embrace a clean energy future, work to eliminate dirty emissions and put people — not fossil fuels — at the center of our economies. We are kicking carbon to the curb and prioritizing the physical and economic health of our people and communities. This is why cities must be — and will be — at the fore of climate action going forward."

JOHANNA PARTIN

Director of the Carbon Neutral Cities Alliance (Time Magazine)

http://time.com/4573414/climate-change-americas-cities/