CNCA
CARBON NEUTRAL CITIES ALLIANCE

ENERGY SYSTEM TRANSFORMATION PLAYBOOK

A Step-by-Step Guide for Municipal Governments

August 2016

Developed for the Carbon Neutral Cities Alliance by Integral Group

FUNDED BY

CNCA
CARBON NEUTRAL CITIES ALLIANCE

DEVELOPED BY

INTEGRAL GROUP

IN COLLABORATION WITH

CITY OF BOULDER

Minneapolis
City of Lakes

City of Seattle

CONTENT

INTRODUCTION

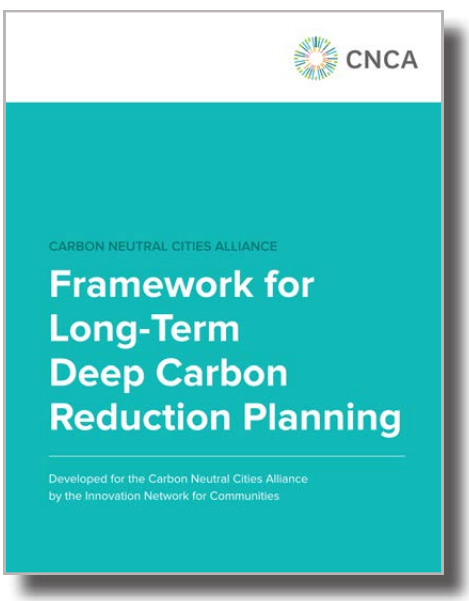
This Playbook provides a step-by-step process for municipal governments to follow in order to move toward a zero-emission energy future. Urban centers as they are currently conceived and built are major contributors to climate change. The high concentrations of people, buildings, and transportation networks are creating a growing demand for fossil-fuel based energy. This intersection of people and infrastructure also creates a high level of vulnerability to the impacts of climate change, as warming temperatures, extreme weather events, and flooding can all threaten the reliability and security of the energy system we depend on. Addressing these growing risks while reducing our impact on the climate will require unprecedented efforts to change the way our energy system is structured.

Fortunately, what makes the world's urban centers key drivers of energy use and emissions can also make them powerful agents of change. Cities represent centers of social and technological innovation that are capable of fostering transformative change towards a zero-emission energy system where it matters most. Municipal governments can play a key role in harnessing the energy and vitality of urban centers to create inspiring new visions of what a decarbonized world can look like, while ensuring that important co-benefits of this transformation are distributed equitably across their populations. In these and other ways, cities and other urban centers across the world are well-positioned to lead the transformation of our energy systems toward a more sustainable, resilient, and equitable state.

CNCA
CARBON NEUTRAL CITIES ALLIANCE

BUILDING ON THE CNCA FRAMEWORK

To assist in this transformation, 20 leading cities have come together in an effort to reduce GHG emissions as the Carbon Neutral Cities Alliance (CNCA). Formed in 2014, the primary aim of CNCA is to develop and share lessons learned on the means of achieving deep and aggressive GHG reductions of 80% or more by the year 2050. Beyond its broader goals of advancing and advocating for transformative change in the world's urban energy systems, CNCA has also committed to developing Carbon Neutral Planning Standards – "approaches, analysis, and tools to support carbon neutrality; standardizing measurement and verification methodologies for tracking progress" (p. ii).



To this end, 2015's CNCA Framework was designed to provide municipalities with a "detailed synthesis of the processes, strategies, practices, tools, and institutional structures used by leading-edge cities worldwide to plan long-term, deep reductions in carbon emissions" (p. v). Based on the experiences of the founding CNCA cities, it serves as a primary tool and template to help cities to develop their own approach to achieving deep GHG reductions. This Playbook builds on the framework by offering a comprehensive tool to assist municipal governments initiate their own energy system transformation. While the Framework provides a basic understanding of the key issues and challenges associated with pursuing deep GHG reductions, this guide provides a more specific process that outlines how municipal governments can strategically achieve them.

A PLAYBOOK FOR MUNICIPAL GOVERNMENTS

While actions will be required across sectors and at all levels of government, the Playbook has been designed primarily to assist municipal governments in exploring citywide or neighborhood-specific strategies for decarbonization. Its overarching aim is to provide municipal governments with a clear, step-by-step process that helps them to understand their energy system and its characteristics, identify and prioritize strategies and actions for achieving deep GHG reductions, and implement their own Energy System Transformation Strategy. Its development emerged from a collaborative process between three municipal governments in the United States: Boulder, CO; Minneapolis, MN; and Seattle, WA. Individual tools included in this Playbook were initailly selected and refined using a review of existing tools and framework, then applied through energy and emissions modeling to a specific neighborhood in each of the three cities. This produced individual Energy System Transformation Strategies for each neighborhood, which were then used to refine and strengthen the tools presented in the Playbook to ensure their clarity and usefulness to a range of other municipal governments. Individual actions included in the Playbook were compiled based on an inventory of key strategies that are being used by CNCA members and other leading cities to achieve deep GHG reductions.

Image adapted from original by Lloyd Lee, City of Vancouver

TRANSFORMING URBAN ENERGY SYSTEMS

Energy system transformation is a process that goes beyond the development of GHG reduction strategies in that the ultimate objective is to completely eliminate GHG emissions from the different components of a city's energy system (see Box 1 on the next page). It is a process that can and should be carried out with the goal of creating resilient, equitable, and decentralized energy systems that can power cities long into the future. In doing so, the transformation of the energy system will yield benefits beyond GHG emissions reductions. A modernized grid can improve the stability and dependability of energy supply, lowering utility operating costs and the price of energy for end users. Investments in local renewable energy systems and building energy efficiency upgrades can help to support local businesses and create local jobs. Shifting toward non-automotive modes of transportation will improve the health and well-being of urban communities, while investments in public transportation infrastructure will provide access to mobility to lower-income populations.

TRANSFORMING URBAN ENERGY SYSTEMS (CONT'D)

While the Playbook is focused on effecting change at the municipal scale, achieving the benefits of energy system transformation will require coordinated action and cooperation by several key actors. The necessary changes to the way we generate, distribute, and use energy will require the collective support and effort of many communities and institutions. Several municipal governments have begun to lead this important shift, but have quickly recognized that it can only be realized through the development of strong and lasting partnerships with other actors, including regional, state, and federal authorities, utilities, industry, local businesses, and residents. Municipal governments themselves must work to address or align different interests in order to change or upgrade infrastructure, revise regulatory frameworks, and encourage new market structures and business models that enable new technology and shift consumer purchasing and energy use behaviors. While each city's context and characteristics mean the specific shape of these changes differ from one place to another, their fundamental properties remain the same (see Figure 1 on the next page).

BOX 1
Overview of the three key functions of the energy system.

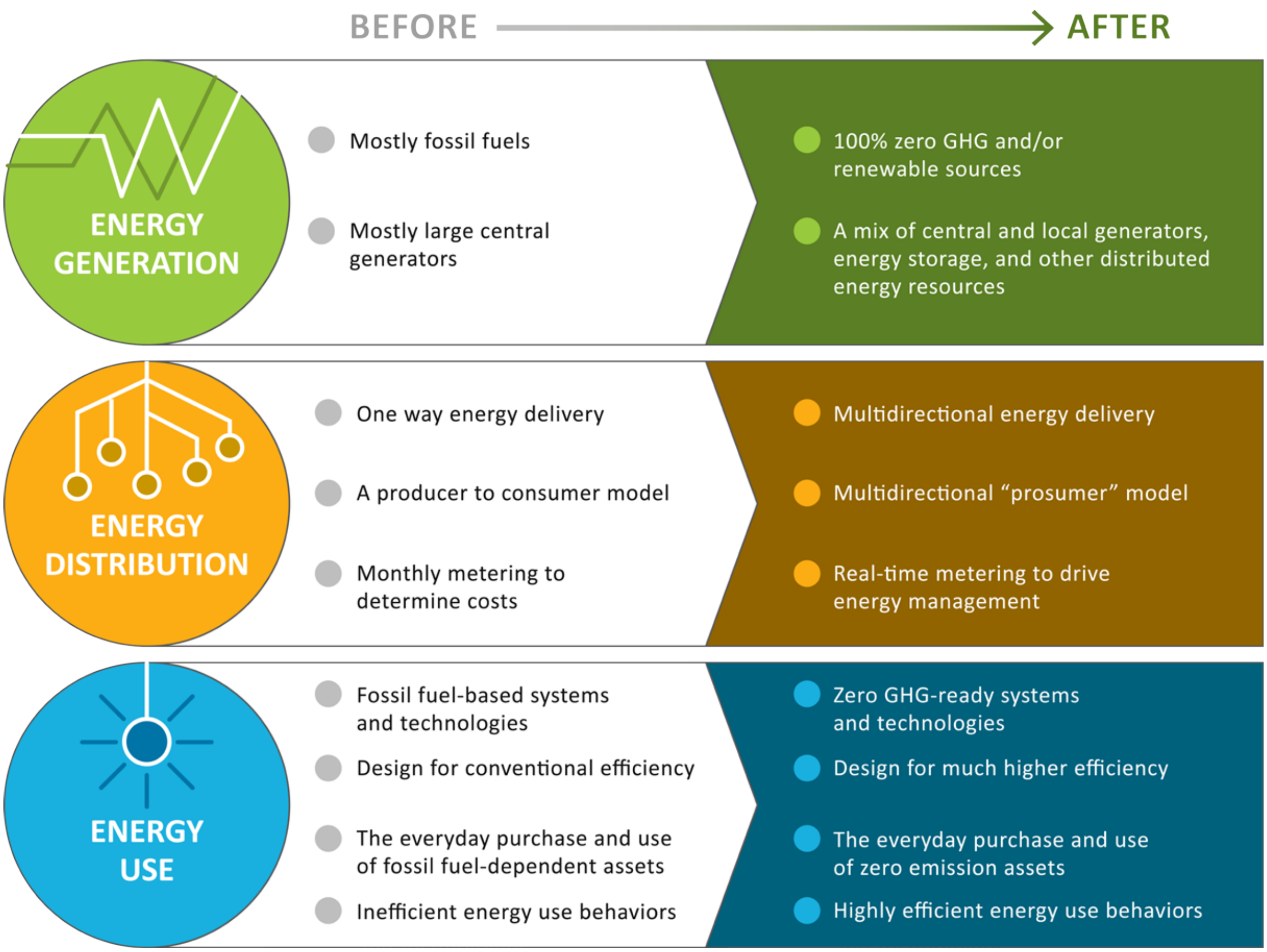
WHAT DO WE MEAN BY ENERGY SYSTEM?
Energy systems are comprised of three interrelated aspects of generation, distribution, and use.

ENERGY GENERATION refers to the power plants and other energy generators that transform primary energy sources, such as coal, natural gas, wind, or sun, into useable energy.

ENERGY DISTRIBUTION refers to the network of pipes, powerlines, and vehicles that deliver useable energy from where it is generated to where it is used. For electricity, this includes transmission and distribution.

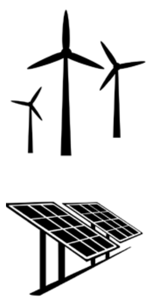
ENERGY USE refers to both the total amount of energy consumed by our systems and technologies, as well as the demand for energy at a given moment in time. Energy use is shaped by the way we interact with and use these systems and technologies, including our expectations of consistent supply, convenience, and cost.

Figure 1 | The key dimensions of the energy system transformation.

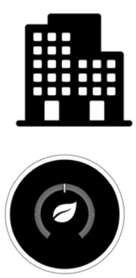


URBAN ENERGY SYSTEMS

To effect a transformation in the energy system, it is first important to understand what an energy system actually is. In this Playbook, “energy system” refers to the interdependent network of infrastructure, technologies, actors, regulations, market structures and consumers that **generate**, **distribute**, and **use** energy (see Box 1 on p. 7). This system can be broken down into three primary urban systems: energy supply, buildings, and transportation.[1] Substantial efforts will be required in each of these three urban systems to improve their energy efficiency and eliminate their dependency on fossil fuels.



ENERGY SUPPLY SYSTEMS consist of the infrastructure, technologies, regulations, and institutions that guide the generation and distribution of electricity and thermal energy. The GHG emissions intensity of a given energy system depends on two factors: the source of fuels used to generate the energy, and the efficiency of the systems delivering them (e.g. power lines for electricity transmission and distribution). Decarbonizing this system will require a shift away from fossil fuels, supported by a modernized electricity transmission and distribution system to increase distributed energy generation.



BUILDING SYSTEMS consist of all new and existing buildings in an urban environment. The design and operation of these building systems determine the type of energy they can use, and thus their impact on energy use and GHG emissions. Building systems are important because their design affects the ability of the overall energy supply system to shift towards zero-emission energy sources. As a result, an energy system transformation will require building systems to be designed, constructed, and/or retrofitted to be compatible with renewable energy systems, and most likely dependent primarily on electricity.

TRANSPORTATION SYSTEMS consist of the network of infrastructure, technologies and institutions that move people and goods throughout and around a city. This system both shapes, and is shaped by, the transportation choices that individuals and organizations make. Under an energy system transformation, transportation systems will have to shift toward higher levels of walking and cycling, and transit, vehicle sharing, and goods movement driven by electricity and potentially other zero-emission fuels for all trips, requiring vehicles.

(1) Adapted from CNCA’s Framework for Long-Term Deep Carbon Reduction Planning, 2015.

TRANSFORMING NEIGHBORHOOD ENERGY SYSTEMS

Municipal governments tend to be deeply involved in all three urban systems, whether through the design and enforcement of building codes, the maintenance of roadways, or the purchase or distribution of energy. While several decisions about energy supply, building, and transportation systems can be made at a municipal scale, the effects of these decisions are felt most acutely in the neighborhoods, communities, or districts where people live and work. Neighborhoods are also where physical infrastructure, buildings, and transportation networks meet, forming a nexus of energy use (and its associated emissions) as people move throughout their day.

As a result, neighborhoods are often the ideal scale to begin implementing the integrated forms of planning necessary for energy system transformation. Actions taken in a single neighborhood can also act as a testbed for innovative policies that can eventually catalyze actions across a municipality or region. The tools provided in this Playbook have therefore been designed for application to individual neighborhoods, in addition to citywide energy systems.

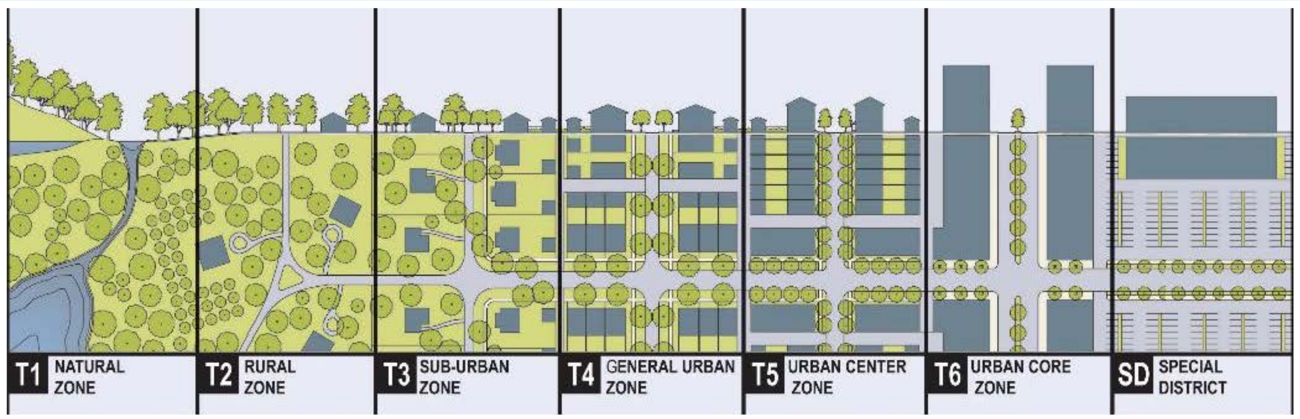
To help guide the application of these tools at the neighborhood scale, the Playbook draws on the Urban-to-Rural Transect Model, a framework that helps characterize a city's different zoning categories based on varying physical and social dimensions. Six Transect Zones are used to characterize the continuum of urban development from low to high concentrations, using a series of identifiable patterns of development in the United States (see Box 2 on the next page). The characteristics used to delineate these six zones include features such as:

- **Block size:** the size of a typical neighborhood block;
- **Lot coverage:** a ratio of total building area to total lot area;
- **Building typology:** the classification of different building forms into subgroups, based on their respective design elements and functional properties;
- **Building frontage and setback:** the relationship between the front of a building and the street, as well as the distance between the sides of the building and the lot boundary; and
- **Walkability:** a measure of how conducive an area is to walking as a primary mode share, including physical access and infrastructure, places to go, and proximity to home.

The Playbook employs the Transect Model as a geographic lens to help municipal governments understand the shape and nature of different neighborhoods, and choose the most appropriate strategies and actions. This process is outlined in further detail in **STEP 5 | Selecting Strategies and Actions**. However, the Transect Model can be useful to municipalities interested in effecting an energy system transformation at any stage of the Playbook.

BOX 2

Visual representation of the urban transect model with transect descriptions. Project Teams can use the Transect Model to characterize the neighborhood(s) being analyzed.



Source: Duany Plater-Zyberk & Company via Center for Applied Transect Studies

T1 – NATURAL ZONE: Land that is unaltered by human settlement, either because it is artificially protected or unsuitable for development due to site conditions (i.E. Topography, hydrology, or vegetation).

T2 – RURAL ZONE: All areas that are sparsely settled, including agricultural land, grassland and woodland. Building typologies reflect these types of land uses – farmhouses and agricultural buildings, cabins, and villas.

T3 – SUB-URBAN ZONE: Low-density residential areas, typically adjacent to higher density zones with some mixed-use. Often consists of single-family detached homes on large blocks, relatively deep setbacks, and an irregular road layout.

T4 – GENERAL URBAN ZONE: Mixed-use but primarily residential areas with a wide variety of housing options on medium-sized blocks – single-family detached, row houses, and side yards.

T5 – URBAN CENTER ZONE: Higher density mixed-used areas with retail, offices, row houses, and apartments. The street network is tight, with wide sidewalks, consistent tree planting, and shallow building setbacks.

T6 – URBAN CORE ZONE: Areas with the greatest density, building height, and range of uses and services. Large blocks with extensive tree planting, buildings set close to wide sidewalks, and several civic buildings is common. Generally found only in large towns or cities.

SPECIAL DISTRICT: An area that exists outside of the transect framework, as building elements do not align in form or function with the six Transect Zones, e.g. industrial zones, business parks.

USING THIS PLAYBOOK

Whether action is being taken at neighborhood scale or citywide, this Playbook will help municipal governments gather important information, identify relevant strategies and actions for decarbonization, and ultimately create an implementable Energy System Transformation Strategy. The outputs of each step should be compiled into a cohesive work plan that clearly outlines what steps the municipality will take to decarbonize their energy system (Figure 2 on p. 14).

The following section (GETTING STARTED) orients municipal governments to the basic requirements of the process, including suggestions on the formation of a Project Team, the kind of data necessary for the completion of each step, and the importance of identifying and forming partnerships with key actors.

The next page provides a summary of each step to give users a sense of the full process of implementing the Playbook.

1

UNDERSTANDING YOUR ENERGY SYSTEM

A list of key questions to helps Project Teams obtain a basic understanding of the key players, characteristics, and dynamics of their energy system.

2

CHARACTERIZING YOUR SPHERE OF INFLUENCE

A pair of tools provide Project Teams with a means of characterizing their relative degree of interest, influence, and control over each of the three urban systems comprising a city's energy system: energy supply, buildings, and transportation. The exercise allows Project Teams to identify the broad transformation pathway they can take

3

QUANTIFYING YOUR ENERGY AND EMISSIONS BASELINE

Project Teams use data on energy use in each of the three urban systems to determine their relative contributions to the overall GHG emissions of the municipality or neighborhood under exploration. Teams can then use this information to develop future projections and prioritize their decarbonization efforts.

4

IDENTIFYING BARRIERS & OPPORTUNITIES

A series of questions help Project Teams derive further insight into any potential barriers or opportunities they may face in implementing action in any of the three urban systems.

5

SELECTING STRATEGIES & ACTIONS

Project Teams use the information gathered in previous steps to identify the specific strategies and actions they can take to initiate an energy system transformation. Based on their sphere of interest (and where applicable, the development profile of the neighborhood under exploration), Project Teams select the strategies and actions most relevant to their context and interests.

6

IDENTIFYING CO-BENEFITS

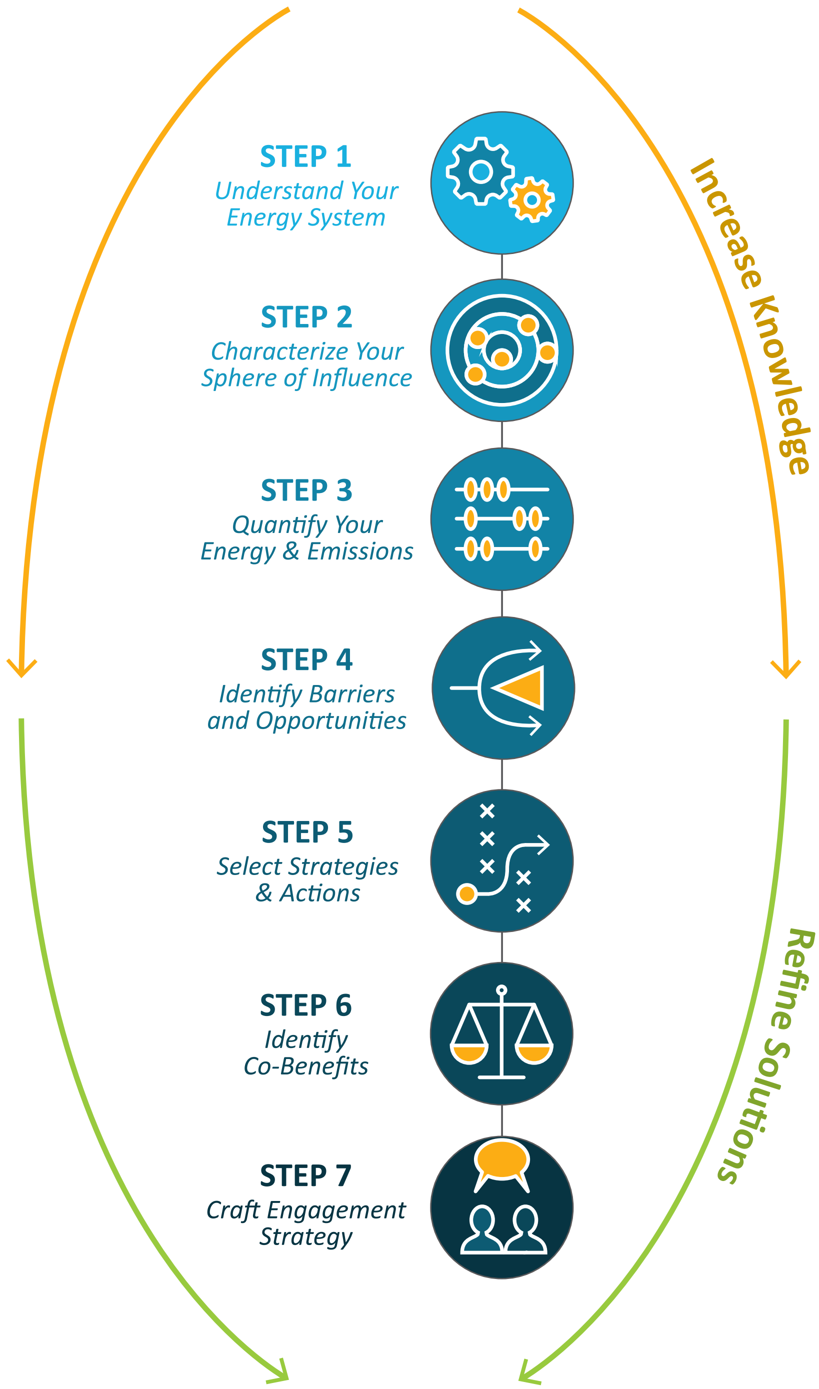
With strategies and actions identified, Project Teams identify potential synergies or conflicts between each action and existing municipal policies or priorities. Project Teams identify important co-benefits to ensure the wise use of resources and harmonization with existing municipal government action.

7

CREATING AN ENGAGEMENT STRATEGY

Stakeholder mapping helps Project Teams identify important stakeholders and develop the appropriate means of engaging them.

Figure 2 | The Playbook takes Project Teams through seven steps to develop an Energy System Transformation Strategy.



GETTING STARTED

ASSEMBLING A PROJECT TEAM

As noted above, the process of eliciting a full energy system transformation will require the effort and contributions of many actors, organizations, and communities across a city. However, the full engagement and collaboration of all stakeholder groups is not necessarily useful at every step of the way. Municipal governments interested in leading this effort should identify the steps they can take to help build their own knowledge and capacity for energy system transformation to provide a solid foundation for processes of deeper stakeholder engagement to be held during appropriate phases of the project.

The process of crafting an Energy System Transformation Strategy should therefore begin with the identification of core team members and key strategic partners that will be most useful at each step. To ensure a coordinated and effective process, a specific group or 'Project Team' should be assembled to act as a central coordinating body. Contingent upon staff time and other available resources, this responsibility may rest in the hands of a single staff member, an interdepartmental body of various municipal government staff, or a steering committee of local community and industry members, experts, and thought leaders. Potential members of such a committee could include:

- Representatives of relevant government departments (e.g. planning, sustainability, legal, infrastructure);
- Representatives of local business associations, property managers, or large land owners;
- Local academic or other research and development institutions;
- Staff members of regional or State levels of government; and
- Representatives of local community groups or neighborhood associations.

SCOPING THE PROJECT

The process of creating an Energy System Transformation Strategy will also require the dedication of resources towards the collection and aggregation of key pieces of information. Before initiating the project, it is important for municipal governments to identify the kinds of resources and capacities that are available. This should include an inventory of both internal municipal government staff capacities, as well as any opportunities for collaboration with local partners that could supplement existing resources. Data needed to complete the steps outlined in the Playbook include:

- Projected re/development rates for the city and/or neighborhood, including a range of potential scenarios;
- Baseline energy and emissions profiles at the city and/or neighborhood scales;
- Broad system characteristics, including the legal, political, environmental, socio-economic, and other conditions and capacities held by the municipal government; and
- Neighborhood characteristics, including development mix and projected growth patterns;
- Existing or future plans and policies that could either help or hinder decarbonization efforts.

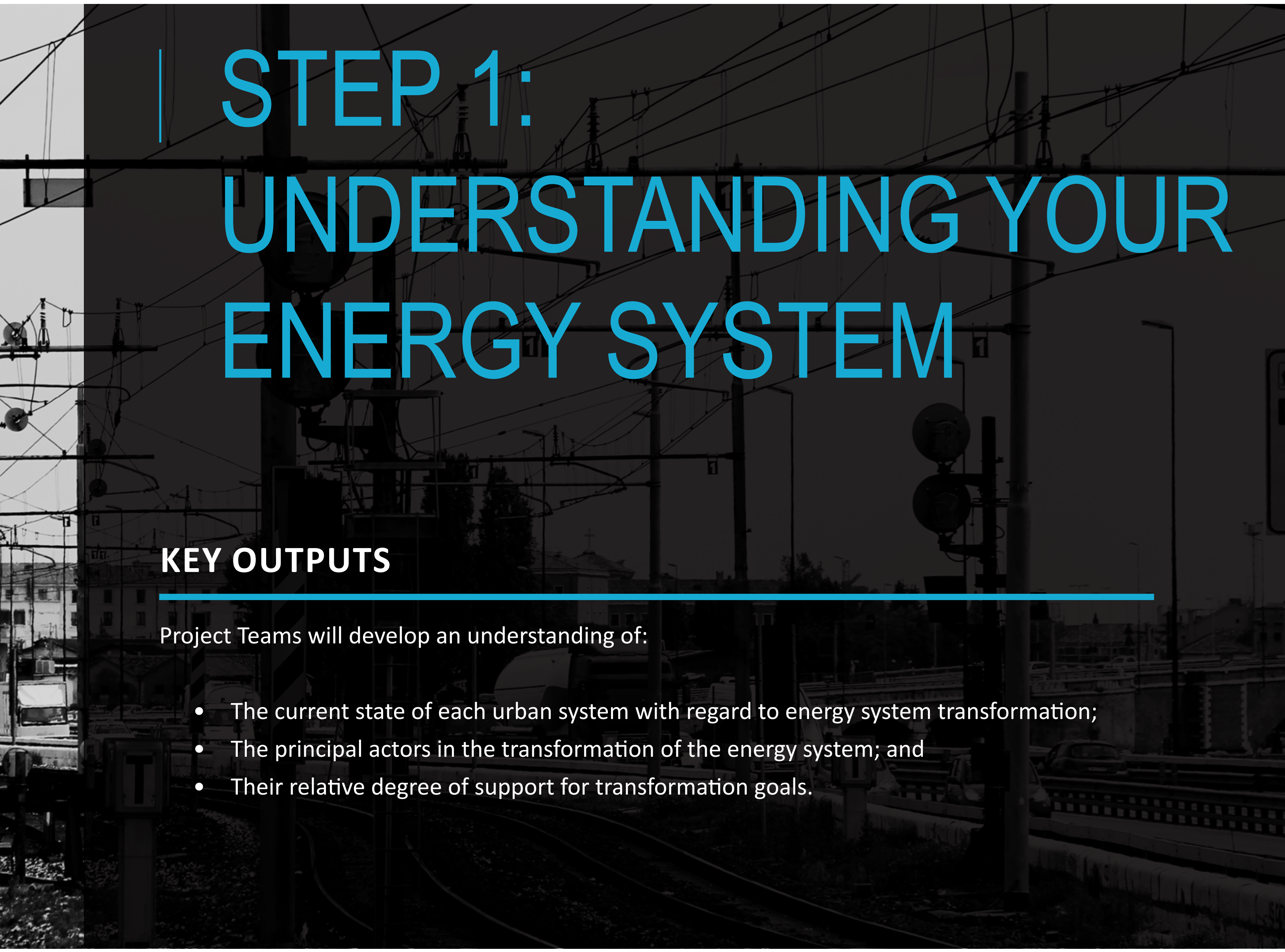
Collaborations with other internal municipal government departments is crucial to identifying and obtaining the kinds of data needed to complete the Transformation Strategy. These collaborations should be initiated early on and consistently maintained throughout the project. Possible sources of support or capacity include partnerships with local academic institutions, which can take the form of research collaborations, graduate student placements, or summer internship programs. Local not-for-profit or business organizations may also offer useful resources, support, or data.

COLLABORATING WITH STAKEHOLDERS

Harnessing the support and enthusiasm of key resident groups, businesses, industry partners, and other levels of government is crucial to achieving zero-emission cities. Committing to a collaborative process with these many stakeholders is therefore an important component of energy system transformation. This may involve a process of collectively defining the nature and desired outcomes of an energy system transformation for the city and its residents and businesses. As early as possible, municipal governments should identify key stakeholders, explore potential partnerships, and prepare to engage communities and industries in the process of energy system transformation.

To help guide the identification of relevant stakeholders, a Stakeholder Mapping exercise has been outlined in STEP 7 | Crafting an Engagement Strategy. Project Teams may wish to conduct this exercise earlier on in the process as a way of exploring who to include in a potential steering committee, and who should be included in later stages of project development. Further information on ways of engaging and communicating with stakeholders and the public can also be found in the 2015 CNCA Framework (pp. 112-119).

OPPORTUNITIES FOR ENGAGEMENT: While the support of city residents is key to the success of an Energy System Transformation Strategy, the full participation of every stakeholder at every step of the Playbook may not be necessary. To assist municipal governments take advantage of key opportunities to engage with stakeholders, methods and tools of engagement are outlined in each section of the Playbook. The "Speech Bubble" icon in each section marks suggestions on potential steps and/or actors that should be considered for engagement. However, it should be noted that these will change for each city based on its particular context and structure. As such, it is important for municipal governments to explore and identify what stakeholders to involve in the process, and how to engage them in the way best suited to the particular issue under exploration and group being engaged with.



STEP 1: UNDERSTANDING YOUR ENERGY SYSTEM

KEY OUTPUTS

Project Teams will develop an understanding of:

- The current state of each urban system with regard to energy system transformation;
- The principal actors in the transformation of the energy system; and
- Their relative degree of support for transformation goals.

STEP ONE | UNDERSTANDING YOUR ENERGY SYSTEM

To begin the process of transforming a city's or neighborhood's energy system requires developing an understanding of the overall state of the current energy system and, particularly, the actors that shape it. As discussed in the Introduction, several key actors will play important roles in the transformation process. Some actors will exert a particular, strong influence over the energy system as a result of their regulatory authority, organizational experience and capacities, decision-making powers, and/or contribution to the current state of the energy system.

Municipal governments should take care to understand the roles these key actors play in energy system transformation, including the way any current plans and policies align or conflict with transformation goals. This will help ensure resources are used effectively and help identify any areas in which support for decarbonization must be improved. Understanding the mandates, values, and concerns of each group will also help municipal governments design effective policies and programs.

The following set of questions is intended to help Project Teams characterize the current state of the energy system and the actors that shape it:

- What issues, priorities, and sensitivities do residents and businesses have that could be affected by or addressed through energy system transformation?
- What plans, policies, or targets does each actor hold with respect to an energy system transformation?
- How might actors' plans and priorities hinder action or create resistance to energy system transformation?
- What other plans and priorities might align with energy system transformation and stimulate actors to support change?
- How do actors' past and current actions align with any statements they have made in support of energy system transformation?
- How active are the state government and electrical utility in decarbonizing the electricity supply and modernizing the grid?
- How active are the state government and utilities in building energy efficiency and decarbonization?
- What is the current state of transportation with respect to a reduction of vehicle dependency and the transition of vehicles to zero-emission technologies?

To help guide this inquiry, Box 3 (on the next page) outlines the ideal roles and responsibilities that each key actor group will play in energy system transformation.

BOX 3

Key energy system actors and their roles and responsibilities in energy system transformation.

MUNICIPAL GOVERNMENTS

- Provide leadership and guidance for residents, businesses, other levels of government, and utilities
- Use building codes and zoning to decarbonize new and existing buildings, enable distributed energy generation, and interact with a modernized electricity system
- Encourage building retrofits to eliminate dependence on fossil fuels, improve energy efficiency, enable distributed energy generation, and interact with a modernized electricity system
- Prepare buildings, parking lots, and electricity distribution systems for a fully electrified passenger vehicle sector;
- Plan and design communities to foster increased transit, cycling, walking, and vehicle sharing
- Plan, design, and regulate communities to enable distributed energy generation and energy sharing
- Build capacity and partnerships with local industries

STATE GOVERNMENTS

- Regulate utilities to eliminate GHG emissions from the energy supply, modernize the electricity system, and enable distributed renewable energy generation
- Design energy rate requirements to incentivize lower rates of energy consumption
- Use building codes to decarbonize new buildings, enable distributed energy generation, and improve interactions with a modernized energy supply system
- Use regulations, incentives, and infrastructure investments to facilitate a transition to zero-emission passenger and freight vehicles
- Invest in transportation infrastructure to foster increased transit, cycling, walking, and vehicle sharing
- Establish equipment and product standards that eliminate fossil fuel dependency

ELECTRIC UTILITIES

- Decarbonize centralized electricity generation
- Increase and enable distributed renewable energy generation and other distributed energy resources (including energy storage) that will facilitate more efficient and less GHG-intensive management of the grid
- Modernize the electricity system to enable distributed renewable energy generation and improve resilience
- Partner with other institutions to implement deep decarbonization and energy efficiency retrofit programs

GAS UTILITIES

- Begin a transition away from natural gas where zero-emission energy can provide the same service
- Begin a transformation toward an energy services model (e.g. ownership and management of heat pumps and geo-exchange system) and zero-emission thermal energy generation and distribution (e.g. district energy systems)
- Work with electric utilities and municipal governments to implement decarbonization and energy efficiency retrofit programs

INDUSTRY (E.G. MANUFACTURERS, DEVELOPERS, INDUSTRY GROUPS)

- Increase local capabilities to design, construct, retrofit, and operate zero-emission buildings
- Increase local capacity to achieve the scale of building retrofits necessary to achieve the energy system transformation
- Orient supply chains towards delivering the equipment and technologies necessary for zero-emission buildings

END USERS (E.G. RESIDENTS, BUSINESSES, INSTITUTIONS)

- Purchase assets that can be powered by zero-emission energy
- Replace existing assets (e.g. cars, lights, boilers) with highly efficient, zero-emission technologies
- Reduce energy consumption by adjusting behaviors in the home and at work
- Advocate for key energy system actors to play their roles in the energy system transformation

THE CHANGING ROLE OF GAS UTILITIES

Of all the actors listed in Box 3 (p. 22), an energy system transformation will undoubtedly have the most significant implications for gas utilities. Today, natural gas is often framed as a bridge fuel that will help move the electricity supply from high to low GHG intensity sources of energy (i.e. from coal to renewables). However, it is increasingly clear that natural gas must be quickly phased out of the energy supply to avoid unacceptable levels of global warming. The methane released during natural gas extraction traps over 80 times as much heat as carbon dioxide over a 20-year period, which will lead to much more rapid climate warming.[2] M ethane leakage rates from natural gas extraction also reduce or eliminate natural gas's GHG reduction benefit over coal, potentially making natural gas as large a contributor to climate change as coal itself.

Furthermore, natural gas generators and building systems last for decades, prolonging or displacing the integration of renewable energy generators and zero-emission building systems. As a result, the installation of any form of natural gas infrastructure compels either its continued use for several years to come, or an expensive retrofit before the end of its useful life. For these reasons, natural gas has a very limited role to play in a transformed energy system. While in the near future it may be required for certain industrial processes, heavy vehicle transportation, and backup electricity generation, natural gas utilities will be compelled to shift towards a different business model to ensure their continued success, in a transfromed energy system.

However, natural gas utilities as businesses and institutions could have a unique and important role to play in energy system transformation. These utilities have existing relationships with a broad customer base, access to capital, and deep experience and knowledge about how to finance, develop, and manage energy assets of various scales. Using these assets utilities could lead fuel switching programs and move from energy sales to energy services. This may involve but is not limited to: developing and managing zero-emission district energy systems; ownership, management, and leasing of heat pumps and geo-exchange systems; and, delivering building retrofit programs alongside electric utilities and municipal governments. By embracing an energy services model natural gas utilities can capitalize on the significant economic opportunities that energy system transformation will bring. There is potential over the long-term that these opportunities, while not without risk or investment of significant capital, could be more profitable than traditional commodity energy sales.

(2) p.87, IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

THE ROLE OF ENERGY END USERS

A second key aspect of a transformed energy system is the collective group of everyday assets and technologies used by residents, businesses, and other members of a community. To decarbonize the energy system, any assets that depend on fossil fuels must be replaced by those that can be powered by zero-emission energy, many before the end of their useful life. This includes everything from the technologies we use to heat and cool our homes and businesses to the forms of transportation we use to move around. Achieving this asset change will require a combination of regulations, incentives, and education programs that raise awareness of the GHG emissions associated with everyday habits, offer and encourage low-emission choices, and transform the product market. Fostering the scale of asset change needed to completely decarbonize the energy system will likely be one of the biggest challenges municipal (and state) governments face, and should be considered in the development of both the Energy System Transformation Strategy and the engagement that accompanies it.

ASKING KEY QUESTIONS: Identifying the roles, responsibilities, and overall direction of each key actor in the energy system requires a detailed understanding of each one. Working with representatives of each of the key actor groups listed in Box 3 can both help to clarify the answers to each question and begin to establish relationships with key partners in the energy system transformation. Background research into each actor may also be necessary to fully answer each question, which can be undertaken by a Project Team member or using an internship program with a local academic institution. Local communities and residents should be included wherever possible, including low-income communities that may have the most to gain from lower energy system cost or experience the most difficulty shifting to different fuels and technologies.

STEP 2: CHARACTERIZING YOUR SPHERE OF INFLUENCE

KEY OUTPUTS

The results of the Sphere of Influence exercise will:

- Provide Project Teams with a full understanding of the level of control a municipal government has over each component of the urban systems comprising their energy system;
- Help to identify where responsibility lies at other levels of government, which can in turn facilitate the identification of relevant stakeholders; and
- Focus Project Teams on the types of actions they can and will need to take to transform different components of the three urban systems comprising a city's energy system.

STEP TWO | CHARACTERIZING YOUR SPHERE OF INFLUENCE

With an overall understanding of the energy system and its key actors, municipal governments can now turn to the identification of specific strategies and actions necessary for deep GHG emission reductions. What approach a municipal government selects to initiate an energy system transformation depends largely on the extent of their influence or control over the system component in question. Municipal powers over different assets, functions, or decision-making structures vary according to their jurisdiction and circumstances. While one municipal government may have full control over their building code, others may be required to conform to state regulations over building form and energy efficiency.

Sphere of Influence mapping can help municipal governments understand the level of control or influence they have over each of the key energy system components. The extent of a municipal government's influence can be determined by placing it into one of the three broad categories, as shown in Figure 3 on the next page.

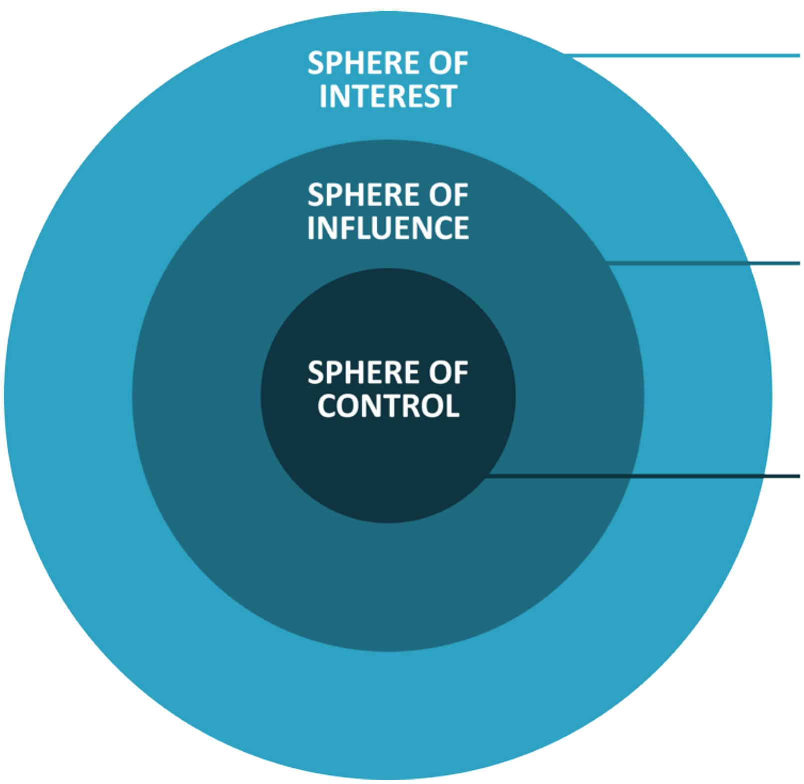
Once a municipal government's level of control is established, Project Teams can begin to assess the appropriate means through which the different phases of the energy system transformation can be instigated.

> *"The responsibilities of local governments give them large influence over energy use in their communities through land use and zoning, building requirements, property taxes and transfers, transportation investment decisions, economic and workforce development, and, in many cases, the provision of services such as water and electricity... No leading-edge city has anything close to full control over the system-transforming strategies it might want to pursue; most must rely on other levels of government for decisions about many of the strategies."*
>
> - Carbon Neutral Cities Alliance Framework for Long-Term Deep Carbon Reduction Planning, 2015

ASSESSING YOUR SPHERE OF INFLUENCE

To determine a municipal government's sphere of influence, Project Teams should begin by asking a number of key questions to help determine both the willingness and ability of the municipality to decarbonize the various components of each urban system. Questions to guide this inquiry are presented in Table 1 on the next page. Each question can be answered using a sphere of influence "map", as presented in Figure 4 (p. 30), or in a table format as presented in Table 2 (p. 30). It should be noted that not all dimensions of the energy system will fall neatly into one category or another, but may lie on a continuum depending on different legal, regulatory, and

Figure 3 | The Sphere of Influence heuristic can be used by Project Teams to determine the municipal government's ability to affect change in different aspects of their energy system.



INTEREST

Where a municipal government has neither control nor direct influence over components of the urban system, but is interested in and possibly affected by the outcome of decisions made by other actors.

INFLUENCE

Where a municipal government has no decision-making authority, but has access to resources and forums that can be used to influence decision-making by market actors or other levels of government.

CONTROL

Where a municipal government has near-complete or full decision-making authority over components of the urban system or issue in question.

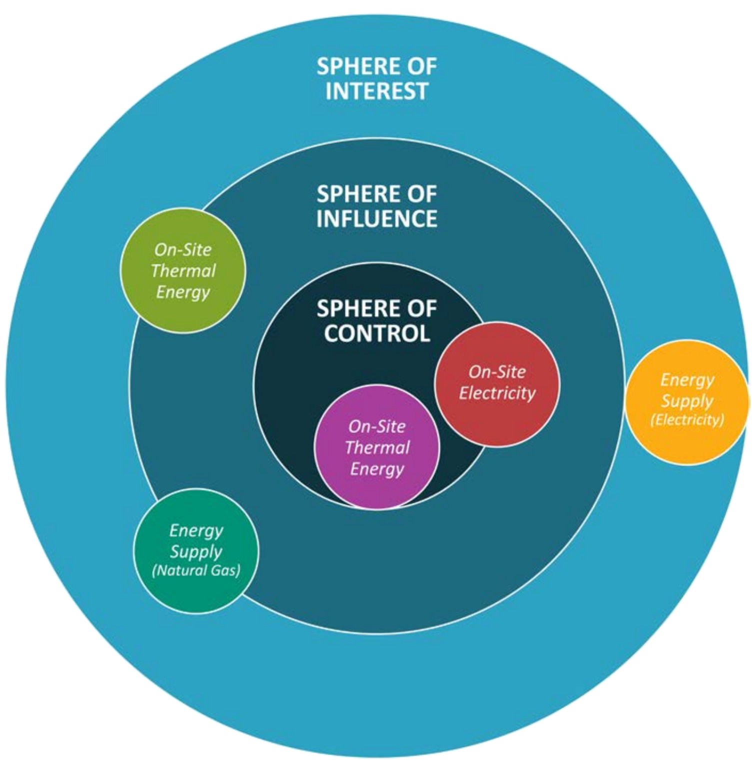
Table 1 | Key questions to help guide Project Teams in determining the municipal government's level of control and ability to influence different aspects of their energy system.

CATEGORY	QUESTIONS
LEGAL OR REGULATORY CAPACITY	Are there any existing laws, legal frameworks or regulations that may enhance or restrict the implementation of any decarbonization strategies?
	Does the municipality control its own building code?
	Does the municipality have the authority to influence energy use in buildings via zoning and development?
	Does the municipal government control or influence local or regional transit networks?
	What kind of relationship does the municipality have with local regional utilities or transit authorities?
WILLINGNESS TO DRIVE CHANGE	Is the local administration willing to push for measures above and beyond basic requirements (e.g. up-zoning sustainability requirements)?
POLITCAL ATTITUDE	How supportive are state, regional, or federal governments of decarbonization goals?
	What policies or regulations might hinder or support decarbonization at these scales?
RESIDENT SUPPORT FOR DECARBONIZATION	Is there a critical mass of local residents capable of consistently influencing the state, regional or municipal governments to take action on decarbonization?

Table 2 | Project Teams can use a table to capture the level of control the municipal government has over aspects of their energy system.

URBAN SYSTEM	SYSTEM COMPONENT	LEVEL OF CONTROL	NOTES
ENERGY SUPPLY	Grid-supplied energy (imported) • Electricity • Thermal	*Some control* *Some influence*	
	Neighborhood-scale energy (local) • Electricity • Thermal	*Some influence* *etc.*	
	On-site energy (local)		
	Grid Modernization		
BUILDINGS	New Buildings		
	Existing Buildings		
TRANSPORTATION	Mode Share		
	Zero-Emission Vehicles and Fuels		

Figure 4 | Project Teams can use a diagram to map the level of control the municipal government has over aspects of their energy system.



WORKING WITH YOUR SPHERE OF INFLUENCE

The Energy System Transformation Phase Matrix (Figure 5 on pp. 33-34) can help Project Teams identify the types of activities the municipal government should focus on given the level of interest, influence, or control they have over each urban system component. The priority activities for each cell are based on the key changes to energy generation, distribution, and use necessary for an energy system transformation, as organized into three phases.

01 First, municipal governments can initiate the energy system transformation by starting to procure zero-emission energy, create policies, incentives, and support systems to foster zero-emission buildings, and invest in low-carbon transportation infrastructure.

02 Second, municipal governments can strategically decarbonize urban systems by ratcheting up zero-emission energy requirements and expanding associated infrastructure.

03 In the final stages of the transition, municipal governments can take any remaining steps necessary to eliminate GHG emissions from the city's energy system.

Figure 5 also indicates that while progress through these three phases can be achieved by any municipality, the relative control of a municipal government over the different urban systems will influence how it can progress through each phase. Where municipal governments have **weak influence or little to no control**, decarbonization will depend considerably on the actions of other actors or levels of government. In this situation, municipalities can use four principal strategies to help facilitate a movement through the different phases of decarbonization:[3]

- **PROVIDE INSPIRATION, INFORMATION, AND INCENTIVES** – While control may be limited, several actions can still be taken, including municipal leadership and demonstration projects, incentive provision, research and analysis, capacity building, and others.
- **ALIGN STAKEHOLDER INTERESTS** – Engage in networking and coalition-building activities with other levels of government and local stakeholders to align interests and garner support for a proposed vision or actions.

(3) CNCA Framework, 2015

- **ADVOCATE FOR POLICY CHANGES** – Intervene in regulatory matters and lobby other levels of government to add or amend legislation that supports an energy system transformation.

- **ACQUIRE MORE DIRECT CONTROL** – Try to extend control or influence by purchasing or acquiring new assets, increasing regulatory authority (e.g. building codes), or developing new or joining existing decision-making structures (e.g. boards, working groups, or committees) at regional or state levels of government. Many of these strategies may also require the development of additional expertise (e.g. new skills or knowledge) in areas that were previously not a part of the municipal government's mandate.

Where municipal governments have **moderate to high influence** over assets or decisions, they can exercise power where they have it, such as through the use of rezoning or other development powers. However, they may also seek to extend their control and decision-making authority as a way of more directly influencing their progress through the phases of energy system transformation.

Finally, where municipal governments already have **full or substantial control** over relevant systems or assets, they can employ more direct action using policy and regulation to move through the phases of the energy system transformation. As they depend relatively little on the actions and policies from higher tiers of government, they are often able to push decarbonization the furthest in a relatively short period of time.

COLLABORATIVELY MAPPING YOUR INFLUENCE: Sphere of Influence mapping is an exercise that can benefit from broader participation across municipal government departments, including both members of council as well as staff representatives of legal, operational, financial, and other relevant areas. A workshop approach can be especially helpful by making use of either a table that can be collectively filled in (Table 2 on p. 30) or an influence map (Figure 4 on p. 30) to help visualize the different levels of control the municipal government has over each urban system or system component.

Figure 5 | Project Teams can use the Energy System Transformation Phase Matrix on the next page to determine what actions the municipal government should take based on their level of control over different aspects of their energy system.

ENERGY SYSTEM TRANSFORMATION PHASES

WORKING WITHOUT CONTROL:

Act where possible + Acquire more control where feasible + Lobby for Implementation of Phases 1-3

LEVEL OF CONTROL	INTEREST	INFLUENCE
Energy Supply — *Grid-Supplied Energy (Imported)*	• Increase purchases of zero-emission energy where possible • Conduct outreach campaigns	• Explore/develop MOU with electrical utility to increase zero-emission energy supply
Neighborhood-Scale Energy (Local)	• Provide programs and incentives • Conduct outreach campaigns • Encourage organizations to procure zero-emission energy • Decarbonize city-owned generators • Increase internal capacity • Purchase zero-emission energy where available	• Use existing powers (e.g. right-of-way) to leverage low-emission district energy systems (DES) • Use zoning powers to compel low-emission DES studies for large developments
On-Site Energy (Local)	• Provide programs and incentives • Conduct outreach campaigns • Offer bulk buy programs • Increase internal capacity • Install on-site generation at city facilities	• Update policies and regulations to support and/or encourage on-site energy generation
Grid Modernization	• Develop internal capacity to understand grid modernization and its relationship to achieving climate and energy objectives	• Work with utilities to install advanced metering infrastructure • Work with utilities to increase the strategic deployment of distributed energy resources (DER)
Buildings — *New Buildings*	• Offer incentives • Coordinate bulk buy programs • Support building sector training • Pilot technologies • Study thermal and industrial decarbonization options	• Integrate GHG emissions performance into 'up-zoning' and programs • Add zero-emission requirements for municipal-funded buildings
Existing Buildings	• Provide decarbonization and efficiency programs and incentives • Support building sector training • Pilot technologies • Study thermal and industrial decarbonization options • Implement municipal energy management program • Increase internal capacity	• Explore/develop MOU with utilities to decarbonize buildings
Transportation — *Mode Share*	• Apply transit-oriented development planning • Promote transit, cycling, walking, and teleworking • Support pilot projects and reduce regulatory barriers for new technologies	• Increase attractiveness of non-auto modes • Invest in bicycle sharing • Redevelop neighborhoods into "complete" streets • Redesign goods movement
Zero-Emission Vehicles and Fuels	• Coordinate bulk buy programs • Convert fleets to low- and zero-emission vehicles • Encourage adoption of low- and zero-emission vehicles (ZEVs)	• Develop partnerships for ZEV car share • Develop partnerships for electric vehicle infrastructure • Support shift from trucks to rail • Lobby state government to mandate ZEV sales

PHASE 1: Initiate Energy System Transformation	PHASE 2: Strategically Decarbonize	PHASE 3: Zero-Emission Energy System
CONTROL		
• Procure zero-emission energy directly (e.g. power purchase agreements, community choice aggregation) or indirectly (e.g. renewable energy credits)	• Increase zero-emission energy supply • Phase out indirect purchases (e.g. renewable energy credits)	***City runs on 100% zero-emission energy***
• Develop or require development of low- and zero-emission DES • Require certain new buildings to connect to DES	• Transition from low-emission to zero-emission DES • Prioritize connection of existing loads to DES	***High intensity loads are served by zero-emission district energy as needed***
• Evaluate potential for zero-emission on-site thermal systems • Develop a renewable energy proliferation strategy • Lobby for authority to allow peer-to-peer energy transactions	• Establish peer-to-peer energy transactions as a key part of the city's energy market • Implement an on-site renewable energy strategy	***Grid-supplied and neighborhood-scale zero-emission energy supplemented by desired level of on-site generation***
• Require buildings to install advanced meters • Study grid's ability to host DER (with utility) • Lobby state and electric utility to incorporate DER into planning	• Develop a location-based profile of energy and emissions • Implement and support pilot projects • Work with state to allow and develop a peer-to-peer energy market	***Highly efficient grid capable of supporting desired level of zero-emission DER***
• Develop a roadmap to zero-emission building (ZEB) codes • Map trajectory to ZEB performance • Phase in zero-emission energy ready requirements • Develop Incentive programs with utilities for ZEBs	• Implement ZEB codes	***All new buildings required to be zero emissions***
• Offer incentives for decarbonization • Enact a building energy reporting and benchmarking policy • Integrate GHG emissions into retrofit requirements • Develop incentive programs with utilities for ZEBs • Offer decarbonization incentives	• Retrofit all existing buildings to eliminate fossil fuel dependency	***All existing buildings retrofitted to operate on zero-emission energy***
• Develop non-auto transportation infrastructure • Implement road use charges for fossil fuel vehicles	• Expand non-auto transportation infrastructure to increase coverage and demand	***Multimodal transportation network offers people multiple zero-emission options***
• Install electric vehicle (EV) charging infrastructure in high priority locations • Require EV charging infrastructure capabilities in buildings and parking lots • Incentivize ZEV ownership	• Require vehicle charging stations in buildings and parking lots • Adjust ZEV incentives based on costs and market adoption • Disincentivize fossil fuel vehicle ownership	***All vehicles run on zero-emission fuels***


520

STEP 3: QUANTIFYING YOUR ENERGY AND EMISSIONS BASELINE

KEY OUTPUTS

Establishing an energy and emissions baseline and developing a model can assist Project Teams:

- Identify and prioritize key urban systems and their components in terms of their relative contribution to a city's or neighborhood's emissions;
- Explore how broad trends or specific actions may impact future energy use and emissions;
- Identify areas where additional data or analysis may be necessary or useful; and
- Evaluate the potential energy and emissions impacts of policies and programs.

STEP THREE | QUANTIFYING YOUR ENERGY AND EMISSIONS BASELINE

While the Sphere of Influence exercise provides a list of the key actions a municipal government can take to decarbonize its energy system, it cannot provide a sense of their relative importance. For example, where a city already draws on a zero- or near-zero-emission source of electricity (e.g. hydroelectricity), actions associated with the transformation of the electricity supply will have a lower priority than actions to improve building energy performance, shift thermal energy to zero-emission sources (e.g. electrification), and advocate for vehicle emissions standards.

Municipal governments therefore need a baseline understanding of where energy is being used the most in the city, as well as where the majority of GHG emissions are coming from, in order to prioritize actions based on their relative contribution to a city or neighborhood's GHG emissions. An energy and emissions baseline can also indicate areas or sectors for which data is lacking, or where additional analyses may be necessary to select and design appropriate transformation strategies and actions.

The primary focus of this section is to guide Project Teams in establishing an energy and emissions baseline to identify the urban systems (e.g. buildings) and their key components (e.g. building thermal systems) that contribute to a city or neighborhood's total GHG emissions. An energy and emissions baseline uses similar information as a municipal GHG inventory, but includes additional layers of data within a model structure to improve its utility in developing an Energy System Transformation Strategy.

COLLECTING DATA

Before collecting data, Project Teams must establish the scope and boundary of the baseline. The geographic boundary of the city or neighborhood should first be defined to avoid any double counting with other neighborhoods or jurisdictions (e.g. ports or airports). This can be especially difficult at the neighborhood scale, as neighborhood-specific data is less readily available and the Project Team must determine how to assign responsibility for energy and emissions to different neighborhoods.

Second, the scope of emissions must be clarified. GHG emissions can be broken down into three scopes. Municipal governments typically include direct emissions from sources located within the geographic boundary (Scope 1) and indirect emissions that occur as a result of grid-supplied electricity, heat, steam, and/or cooling within the geographic boundary (Scope 2). Some municipal governments are starting to include indirect emissions that occur outside the geographic boundary due to activities taking place within the geographic boundary (Scope 3).[4]

Once the emissions scope and geographic boundary of the exercise are established, Project Teams can collect data on energy consumption and GHG emissions for the three urban systems. For the energy supply system, the key data are current and projected emissions factors (GHGs emitted per unit of energy) for each energy source (projected factors are only required for forecasts). Project Teams can procure these from utilities, GHG protocols,[5] or regional energy market system operators.[6]

BOX 4 | Key sources of data to complete an energy and emissions baseline and develop projections.

- Citywide and corporate GHG inventories
- Utility databases and customer service agents
- City's building energy benchmarking database
- Property and/or tax databases
- Transportation surveys
- Energy Information Administration's energy consumption surveys (e.g. CBECS, RECS, MECS)
- State energy and environmental databases

For the building and transportation systems, Project Teams must collect three categories of energy consumption (e.g. MW, kBtu) and GHG emissions (e.g. tCO_2e) data:

- **FUEL TYPE:** This includes all types of fuel used in the city (e.g. electricity, natural gas, fuel oil, gasoline). Organizing data by fuel type helps to identify which fuels need to be reduced or eliminated, and where strategies may need to focus on switching to zero-emission fuels.
- **URBAN SYSTEM COMPONENT:** This includes the types of buildings (e.g. single family, offices) and transportation modes and vehicles (e.g. passenger vehicle, transit, freight). Organizing by urban system components helps to identify the types of buildings or transportation modes that should be targeted for action.
- **ENERGY END-USE:** This includes the activities within each urban system component that require energy use and result in emissions (e.g. lighting, industrial processing, commuting). This finer level of detail can be more difficult to acquire, but will help Project Teams determine what actions may be necessary to eliminate emissions from different system components (e.g. eliminating natural gas dependency in single-family HVAC systems).

While some of this data may be readily available (see Box 4), others may require calculations using activity data to derive relevant emissions factors.[7] Data that define or describe building and transportation system components (e.g. square footage of office buildings) provides useful information and context and may be necessary for effectively designing some strategies and actions.

---

(4) The CNCA Framework for Long-Term Deep Carbon Reduction Planning (2015) provides additional information on both types of boundaries (p.38) and links to useful resources (pp.41-42).

(5) E.g. the Global Protocol for Community-Scale GHG Inventories (GPC), http://www.ghgprotocol.org/city-accounting.

(6) See the Federal Energy Regulatory Commission website, http://www.ferc.gov/market-oversight/mkt-electric/overview.asp.

(7) Activity data is a quantitative measure of a level of activity that results in GHG emissions during a given period of time (e.g. volume of natural gas used, miles/kilometers driven).

ORGANIZING THE BASELINE

Project Teams can organize an energy and emissions baseline in several ways. A table format can help to organize baseline data and allow Project Teams to make calculations and develop figures (Table 3 on the next page). More graphic formats typically lack similar detail, but can provide an overall snapshot of all energy and emissions in a city or neighborhood (Figure 6 on p. 41). Project Teams can further organize the baseline according to the different types of data noted above: for example, energy consumption data for office buildings can be broken down into different building end-uses (e.g. lighting, HVAC), or by end-use by fuel type (e.g. electricity used for lighting, electricity and natural gas used for HVAC). Nesting the data in this way provides clearer information about what activities are driving GHG emissions, and consequently improves the design and cost-effectiveness of policies and programs.

While this level of detail can provide useful insight, collecting and analyzing this data may require additional time and resources. As a result, Project Teams should focus on identifying, collecting, and analyzing the data and information they already have, then take steps to gather more where useful. STEP 5 | Selecting Strategies and Actions may also yield new insights into the forms and sources of additional data and information Project Teams may find useful.

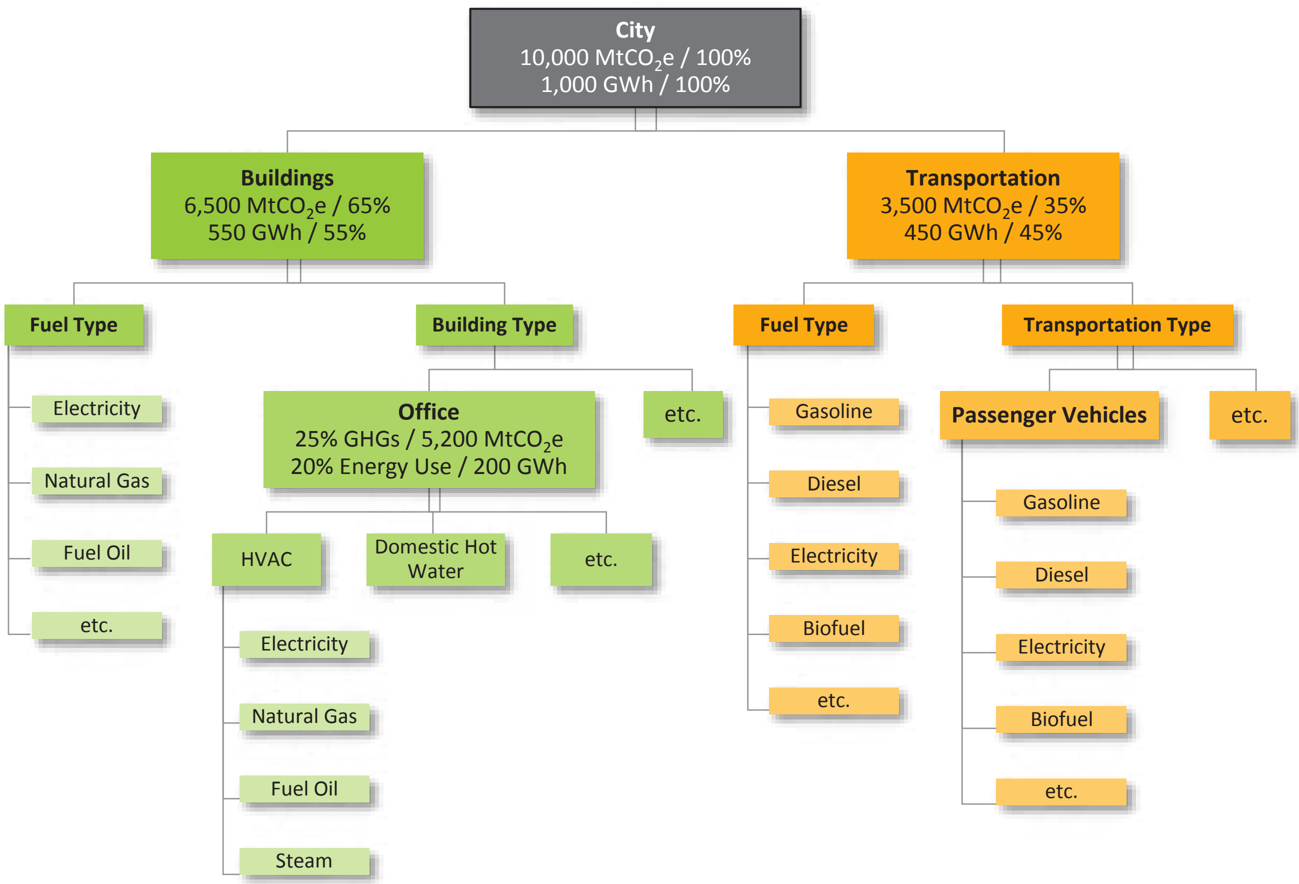
Table 3 | Project Teams can use a table to capture energy and emissions baseline data.

Energy and Emissions from Buildings					Comments	
Fuel Type	Energy Consumption (e.g. MW, Kbtu)	Percent of Citywide Energy Consumption	GHG Emissions (e.g. tCO_2e)	Percent Of Citywide GHG Emissions	Importance as a Target for Action	Additional Data or Analysis Required or Useful
Electricity	#	%	#	%		
Natural Gas	#	%	#	%		
Fuel Oil	#	%	#	%		
District Steam	#	%	#	%		
Etc.	#	%	#	%		
Total Energy	#	%	#	%		

Energy and Emissions by Building Type – Fuel Type			Comments	
Building Types	Total Energy Consumption and GHG Emissions	Energy and GHGs by Fuel Type	Importance as a Target for Action	Additional Data or Analysis Required or Useful
Office	Energy Consumption: # Percent of Building Energy Consumption: %	Electricity: # / %		
Square Footage: #	GHG Emissions: #	Natural Gas: # / %		
	Percent of Building GHG Emissions: %	Fuel Oil: # / %		
Etc.		Etc. : # / %		
Multifamily	…	…		
Retail	…	…		
Etc.	…	…		

Energy and Emissions by Building Type – Energy End Use			Comments	
Building Types	Total Energy Consumption and GHG Emissions	Energy and GHGs by Energy End Use	Importance as a Target for Action	Additional Data or Analysis Required or Useful
Office	Energy Consumption: #	HVAC: # / %		
	Percent of Building Energy Consumption: %	Domestic Hot Water: # / %		
	GHG Emissions: #	Lighting: # / %		
	Percent of Building GHG Emissions: %	etc. : # / %		
Multifamily	…	…		
Retail	…	…		
Etc.	…	…		

Figure 6 | Project Teams can use a tree diagram to summarize all energy consumption and/or GHG emissions from a city's or neighborhood's energy system.



PROJECTING INTO THE FUTURE

Once established, the baseline can be used to project future energy and emissions. Projections provide an understanding of how energy and emissions may change over time, and can be instrumental in evaluating the effectiveness of different strategies and actions in each of the three urban systems. Projections require the Project Team to develop a model that represents current energy supply, buildings, and transportation, as well as the key factors driving change in each urban system component. Energy and emissions models range in complexity, from simple projections based on current trends, to simulations of consumer purchase decisions, the impact of raw processing costs on fuel availability, and the way changes in prices drive changes in energy consumption. The model's purpose is not to determine exactly what future energy and emissions will be, but rather to increase the availability of information that can be used to prioritize actions, design policies and programs, and develop an Energy System Transformation Strategy. As such, projection models should be developed to suit the needs and abilities of each municipal government.

To project into the future, models first require a primary business-as-usual (BAU) scenario that accounts for expected changes to the energy system. For example, growing populations will lead to the construction of new buildings and increased demands on transportation, increasing both energy use and emissions. Identifying how these kinds of trends affect total energy use and emissions can provide insight into priority areas for action. For example, a growing city may prioritize eliminating fossil fuel dependency through its building code to ensure new buildings are designed to operate in a zero emission future, rather than constructing buildings that will require fuel switching retrofits (and the costs associated with them) in the near future.

As in the energy and emissions baseline, the projection model requires emissions factor data to represent the energy supply system, as well as activity data to represent buildings and transportation. Key data include but are not limited to:

- **ENERGY SUPPLY:** Projected change in the GHG intensity of the electricity system, local solar installations, and new district energy supply;
- **BUILDINGS:** Rates of new construction, building stock turnover, and the energy use intensity[8] of new and existing buildings for each building type; and
- **TRANSPORTATION:** Changes in the market share of passenger vehicle drivetrains (e.g. gasoline, electric), shifts in mode share, new transit options, improving vehicle fuel efficiency, and changes in transportation demand.

With the BAU scenario, Project Teams can then simulate the impact of different strategies and actions, either on their own or relative to one another. For example, a model can be used to determine the number of buildings that must be retrofitted per year to eliminate natural gas from the building stock, as well as the proportion of emissions this action will eliminate compared to shifting to a renewable source of electricity.

BUILDING A MODEL: The data and assumptions required to develop an energy and emissions baseline and projection model are often held by multiple municipal departments and utilities. To gather this data, the Project Team must reach out to these partners to determine what data is available and what can be shared. Contacting these actors early on will help to ensure the baseline and model are designed to work based on available data, and preferably data that is updated regularly.

Where a projection model is being used to identify and prioritize actions, the Project Team should engage with experts (both internal and external) on how best to simulate actions and build different parts of the model to ensure it is a suitably accurate representation of the city's energy system. Once developed, the projection model can be used as a stakeholder engagement tool to demonstrate the relative impact of different actions and

(8) Energy use intensity (EUI) is a metric used to designate the energy performance of a building. It is calculated as energy use per square foot per year (e.g. kBtu/ft²/year), where lower numbers indicate less energy used per square foot.

STEP 4: IDENTIFYING BARRIERS AND OPPORTUNITIES

KEY OUTPUTS

Answering the questions posed in this step will help Project Teams to:

- Understand the major characteristics and conditions that may impact the success of different decarbonization strategies or actions; and
- Understand the potential barriers or opportunities to achieving an energy system transformation

STEP FOUR | IDENTIFYING BARRIERS AND OPPORTUNITIES

Following the development of an energy and emissions baseline, Project Teams may find that they lack key contextual information on each system to identify how to select and prioritize strategies and actions. To ameliorate this, Project Teams can pose a series of questions about the characteristics and conditions of a city's energy system. This will add context to the energy and emissions baseline (and projection) and help the Project Team identify potential barriers and opportunities in transforming the energy system.

The PESTLE tool (Figure 7 on p. 49) offers a useful framework for identifying the different kinds of factors Project Teams should consider when evaluating strategies and their feasibility in a broad range of environments or spheres. Answering key questions about the Political, Economic, Socio-Cultural, Technological, Legal, and Environmental nature of a city or neighborhood will allow municipal governments to tease out the different factors and forces that can affect the outcome of various strategies and actions. While several of the questions posed in the framework apply to the city scale, others can be used to reveal trends, opportunities, challenges, and limitations in specific neighborhoods.

IDENTIFYING BARRIERS: As in STEP 2 | Characterizing your Sphere of Influence, a workshop-style approach may be useful in identifying the relevant barriers and opportunities in each of the six categories. Breakout groups can be used to explore different categories or spheres in further depth by putting relevant stakeholders or experts together to brainstorm means of taking advantage of opportunities or overcoming barriers.

Stakeholders that may be helpful to involve at this stage include representatives from municipal offices or departments, private consultants, community and business leaders, and academics.

Table 4 (on the next page) provides questions for each aspect of PESTLE that Project Teams can use to drive their investigation. Where valuable, Project Teams can build on these question with additional areas of inquiry. For example, Project Teams may wish to add a more explicit category to the table that explores the *internal institutional and/or operational capacity* of the municipal government itself to carry out certain strategies or actions. Project Teams may also find it useful to enter answers to each question into a table to assist in organizing responses and identifying opportunities for further action, and where efforts to overcome some barrier or constraint will be required.

Figure 7 | The PESTLE framework provides a broad overview of different system characteristics and guides Project Teams toward an understanding of the broad trends and specific barriers or opportunities that can arise in the energy system.

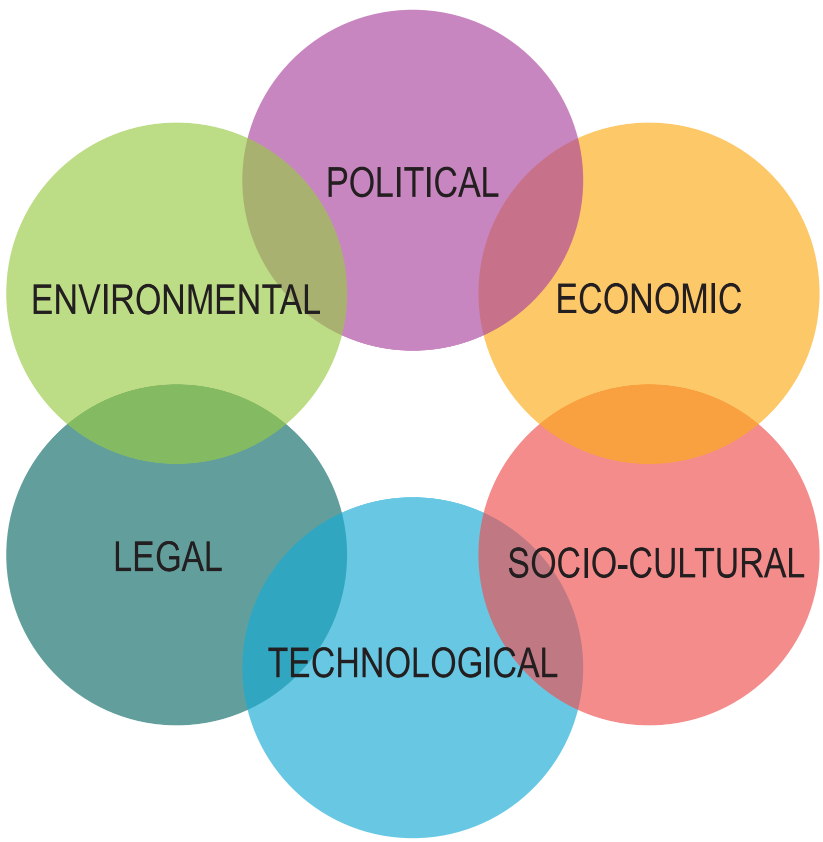


Table 4 | PESTLE questions designed to help Project Teams obtain a broad understanding of their energy system while contributing answers to key questions needed to move forward in developing an Energy System Transformation Strategy.

SPHERE	BROAD QUESTIONS	BARRIERS OR OPPORTUNITIES
Political	• *Support for decarbonization:* Are local residents, businesses, and/or institutions supportive of decarbonization? • *Strength of community leadership:* Are community leaders well-organized and able to mobilize residents to support decarbonization?	
Economic	• *Economic growth:* What local economic trends may help or hinder energy system transformation efforts? (e.g. high/low economic growth and development, unemployment) • *Key economies:* Are there local industries or sectors that should be specifically addressed? • *Rates of development:* Will high rates of growth or development result in higher emissions and/or require more stringent measures for new construction? • *Energy affordability:* Do existing prices and/or rate structures of energy limit or enhance the potential of certain decarbonization solutions?	
Socio-Cultural	• *Closing the gap*: Are there significant housing affordability and/or energy poverty issues that can be addressed using energy system transformation strategies? • *Inequality*: Are there significant gaps or variations in income distribution or other inequalities (e.g. housing affordability) that should be considered in the formation of strategies? • *Demographics:* Are there specific demographic attributes that should be considered in the selection of energy system transformation strategies (e.g. age of population, ethnic and racial diversity, education)?	
Technological	• *Technological availability*: Are the necessary technologies for decarbonization available, affordable, and reliable (e.g. low temperature heat pumps)? • *Technological capacity:* Does capacity around the marketing, installation, and maintenance of necessary technologies exist at local, regional or state levels? • *Culture of innovation:* Are there any local industries that can provide technical expertise, resources, capacity, or support for energy system transformation (e.g. clean tech, research organizations)? • *Retrofit capacity:* Is the municipal government or are other local organizations or businesses experienced with large-scale building retrofit programs?	
Legal	• *Legal or regulatory factors*: Are there any laws, legal frameworks or regulations that may inhibit the implementation of energy system transformation strategies and actions?	
Environmental	• *Future climate*: How might projected changes in climate affect the feasibility or impact of certain strategies (e.g. heating/cooling demand, solar potential, grid reliability)? • *Energy/water nexus:* Will projected changes result in greater water scarcity and a higher energy demand for water provision? • *Resilience and Adaptation*: Are there projected changes in climate that will require changes to building design?	

STEP 5: SELECTING STRATEGIES AND ACTIONS

KEY OUTPUTS

Upon completing this step, municipal governments will have a comprehensive set of strategies and actions that can be implemented to initiate an energy system transformation. These are the primary building blocks to develop a full Energy System Transformation Strategy, however, these must be further refined and prioritized using Steps 6 and 7.

STEP FIVE | SELECTING STRATEGIES AND ACTIONS

Steps 1 through 4 above collectively provide Project Teams with a means of gathering the key pieces of information required for an energy system transformation. At this stage, Project Teams can use information to identify the strategies and actions a municipal government can take to transform its energy system and achieve deep GHG reductions in the three urban systems of energy supply, buildings, and transportation.

STRATEGY

A strategy is the approach to decarbonization that a municipal government takes for a specific system. Strategies are different across systems due to differing system conditions, visions for the redesigned system, and degrees of city control.

ACTION

An action is the specific service, appropriation, tax, subsidy, regulation, or other mechanism that a municipal government uses to implement a strategy. A single strategy may have many actions associated with it.

The Appendix includes a list of over 40 strategies and over 100 actions cities can take to decarbonize and transform their energy system. The lists include key actions leading governments are taking around the world, and differ in their ease of implementation. While many actions can be implemented by any municipality, others require a higher level of influence or control. These lists are certainly not comprehensive, but provide a solid foundation on which to build and represent many years of design and implementation work. Municipal governments and other actors will develop other approaches and Project Teams are encouraged to identify other ways to move forward with their energy system transformation where the strategies and actions provided seem insufficient. Municipal governments will need to determine how to design and implement actions to succeed in their given context, as well as how to engage key actions in both processes.

CITYWIDE STRATEGIES AND ACTIONS

To determine what actions can actually be taken by a specific municipality, Project Teams can use the insights derived through Figure 5 (pp. 33-34) in the Sphere of Influence exercise (Step 2). The results of the Sphere of Influence provided an understanding of the general path a municipal government can take given their degree of control over the three urban systems. Building on this information, Project Teams can now use Figure 8 on the next page to identify what actions the municipal government can take given their sphere of influence.

Using the results from STEP 3 | Quantifying your Energy and Emissions Baseline can help Project Teams identify priority action areas in each of the three urban systems. The results of the PESTLE exercise will also assist municipal governments identify how best to decide upon, design, and implement specific strategies and actions, as opportunities and barriers can be highlighted and explored in further depth.

Figure 8 | Actions municipal governments can likely take based on their level of control as determined in Figure 5 (pp. 33-34). Once Project Teams have determined the municipal government's level of control over each energy system component, they can begin to select specific strategies and actions (e.g. E.2.1, T.7.3) provided in the Appendix. Project Teams must use their discretion as not all strategies and actions will be appropriate for every municipality. Phase 3 is achieved once a the energy system has been decarbonized so is not included in the following figure.

	Energy System Transformation Phases	Working without Control		Phase 1	Phase 2
	Level of Control	INTEREST	INFLUENCE	CONTROL	
ENERGY SUPPLY	Grid-Supplied Energy (*Imported*)	E.2.1, E.10.2	E.1.1	E.1.2, E.9.3, E.12.1, E.13.1, E.13.2	E.12.2, E.12.3
ENERGY SUPPLY	Neighborhood-Scale Energy (*Local*)	E.2.1, E.6.1, E.9.2, E.11.1, E.11.2	E.5.1	E.8.1, E.9.1	E.12.4
ENERGY SUPPLY	On-Site Energy (*Local*)	E.2.1, E.3.1, E.6.1, E.9.4, E.10.1, E.11.1, E.11.2	E.1.3, E.4.1	E.7.1, E.14.1	E.14.2, E.18.3
ENERGY SUPPLY	Grid Modernization		E.15.2	E.15.1, E.16.1, E.17.1, E.17.2, E.18.1, E.18.2	E.16.2, E.17.3, E.18.3
BUILDINGS	New Buildings	B.3.1, B.4.1, B.6.2, B.7.2, B.8.2, B.9.1, B.9.2, B.11.1, B.11.2	B.6.1	B.8.1, B.12.4, B.13.2, B.13.3, B.14.4	B.13.1
BUILDINGS	Existing Buildings	B.1.1, B.1.2, B.1.5, B.1.6, B.2.2, B.3.1, B.4.1, B.5.1, B.6.2, B.7.1, B.7.2, B.8.2, B.9.1, B.9.2, B.10.1, B.10.2, B.10.3, B.10.4, B.10.5, B.11.1, B.11.2	B.1.3, B.1.4, B.2.1, B.2.3, B.14.6	B.8.1, B.12.1, B 12.2, B.12.3, B.12.4, B.14.3, B.14.4	B.14.1, B.14.2, B.14.5
TRANSPORT	Mode Share	T.1.1, T.1.2, T.1.3, T.1.4, T.1.5, T.2.1, T.2.2, T.2.3, T.5.2, T.8.3	T.5.3, T.7.4, T.8.1, T.8.2, T.8.5, T.8.6	T.6.1, T.7.1, T.7.2	T.7.3, T.8.4
TRANSPORT	Zero-Emission Vehicles and Fuels	T.3.1, T.6.2, T.6.3, T.9.1	T.7.6	T.4.1, T.4.2, T.4.3, T.4.4, T.5.1, T.7.5, T.9.2, T.10.1, T.10.5, T.10.6, T.11.1	T.10.2, T.10.3, T.10.4

NEIGHBORHOOD-SCALE ACTIONS

Where interested in exploring how to transform the energy system of a specific neighborhood, Project Teams can take an additional step to determine the most useful strategies. As discussed in the section TRANSFORMING URBAN ENERGY SYSTEMS, different neighborhoods present different characteristics and development patterns, which in turn lend themselves to different approaches to energy system transformation. As such, some approaches will be more relevant or applicable to one transect than another.

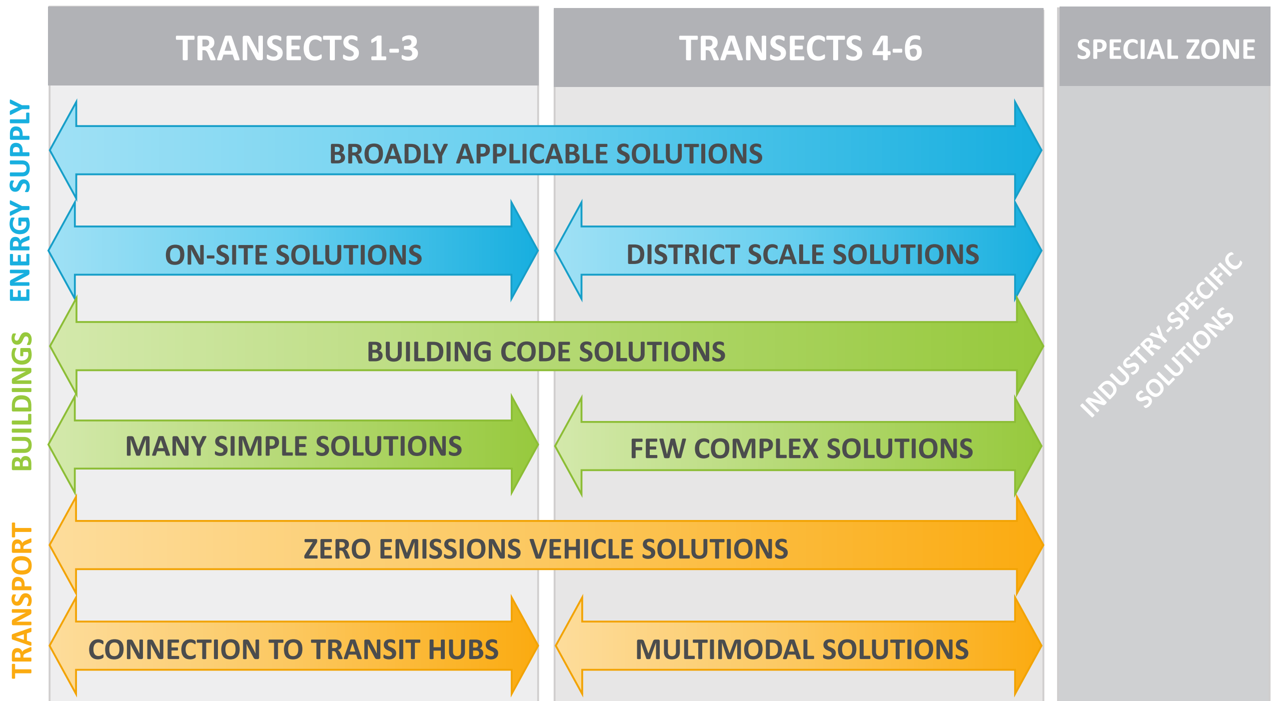
Broadly speaking, transects can be divided into two categories: lower density transects (T1-T3) and higher density transects (T4-T6) (Figure 9 on the next page). This division can help narrow down which strategies and actions may be appropriate. For example, while some energy supply strategies are applicable across all transects, on-site solutions such as solar generation tend to have a larger impact in terms of reducing total GHG emissions in lower density transects (T1-T3).

In contrast, district-scale solutions have both a higher impact and are more feasible in high-density transects (T4-T6). Similarly, certain building strategies may be uniformly applicable to all transects, such as changes to the building code that affect building types found across transects 2-6. Other strategies may be more or less applicable based on transect: typically, simple one-off solutions (such as residential incentive programs) are more applicable to transects 1-3, while more complex strategies are needed in higher density areas due to the higher number of actors, interests, and constraints.

Transportation strategies in higher density transects will differ from those in lower-density areas as both the need and opportunity for multimodal solutions increase with density. However, the support of electric vehicle (EV) infrastructure is important to provide across all transects.

Special zones, including industrial areas or business parks, may be suitable for a range of strategies, but in many cases will require more tailored approaches given their unique physical characteristics, and regulatory circumstances, and energy needs. For example, industrial buildings are rarely governed by the same building codes as residential or commercial buildings, and therefore may require the development of MOUs or other forms of agreement. Other opportunities for energy generation may also exist, which can be supported by special incentives and/or partnerships with utilities, organizations, and others.

Figure 9 | General heuristic for thinking about energy system transformation by transect.

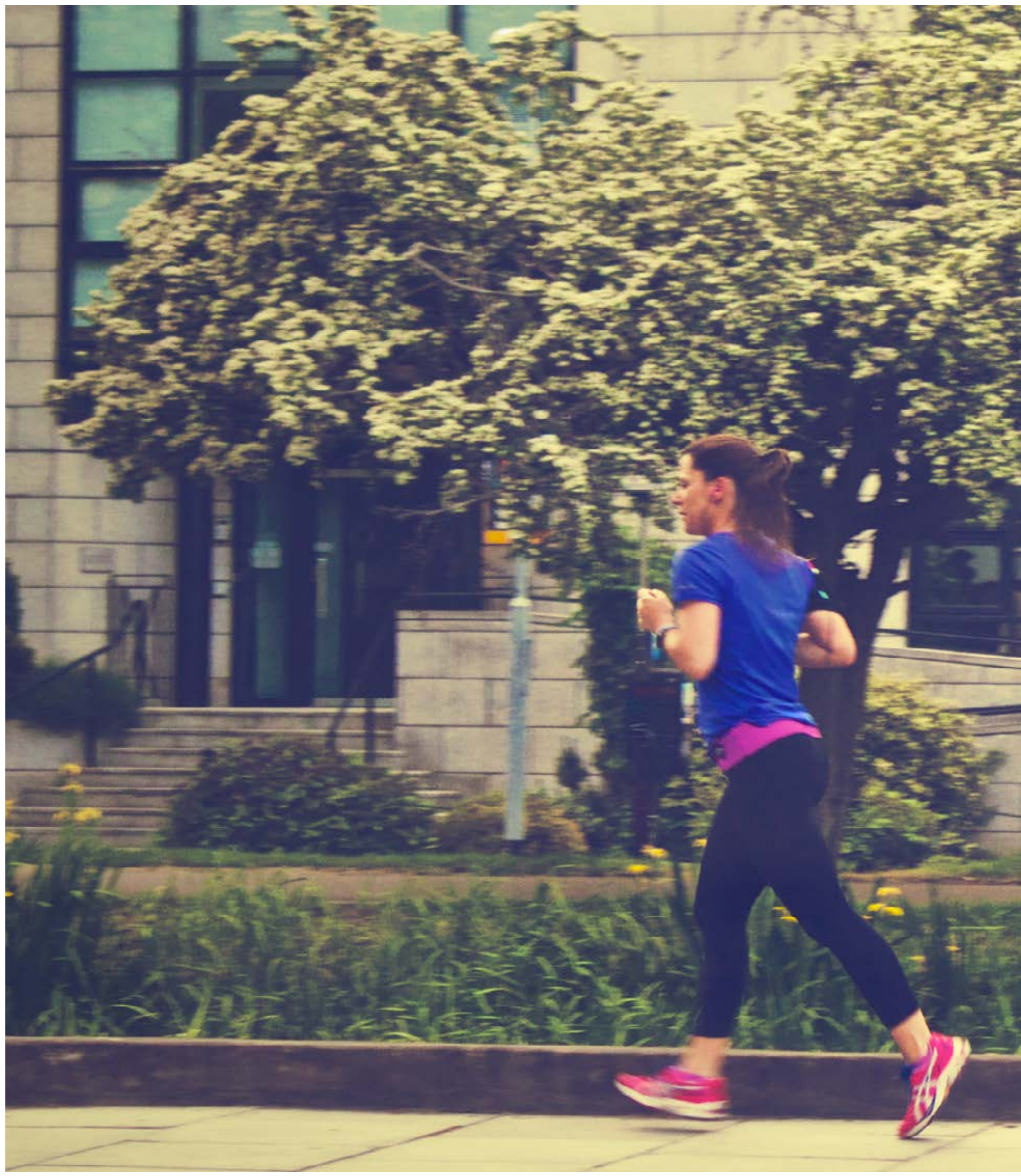


Determining suitable strategies for transforming a given neighborhood therefore first requires identifying of the broad development profile of the neighborhood. Project Teams should begin by conducting a brief analysis to determine the following neighborhood characteristics:

- Overall land use density and variation;
- Proportion of building and/or land use types (e.g. residential, commercial, industrial, institutional);
- Ownership mix and models, including any large public or private land owners;
- Likelihood of future development or redevelopment;
- Low- or zero-emission district energy potential; and
- Neighborhood characteristics that influence transpartation choices and the current mode share breakdown.

This scan can be assisted by or done in conjunction with STEP 3 | Quantifying your Energy and Emissions Baseline and STEP 4 | Identifying Barriers and Opportunities, as the exercises in those can help Project Teams identify neighborhood characteristics. Using the results of these steps, Project Teams should be able to identify the transect category most applicable to the neighborhood under investigation. Once the transect category is known, specific strategies can be tailored to suit the neighborhood of interest as indicated in columns 3 and 4 of the tables in the Appendix.

SELECTING STRATEGIES AND ACTIONS: The final selection of strategies and actions, whether at the city or neighborhood scale, can certainly involve more direct engagement with other stakeholders. Including stakeholders will help Project Teams select the most appropriate approach to implementation and earn the support of those that will be most affected by or required to take action because of an action. Planning and other municipal staff should be included at this stage, as well as any citizen boards or standing committees of stakeholders that may be affected by the changes in a given neighborhood.



STEP 6: IDENTIFYING CO-BENEFITS

KEY OUTPUTS

By exploring the various co-benefits of each strategy and action outlined in STEP 5 | Selecting Strategies and Actions, Project Teams will be able to identify:

- Priority actions with substantial co-benefits that should be implemented immediately or in the short term;
- Actions that require further exploration or adjustment to ensure their harmony with other municipal government and/or city stakeholder priorities; and
- Key co-benefits that will emerge from the overall Energy System Transformation Strategy that can be used in framing communications and engagement (see STEP 7 | Crafting an Engagement Strategy).

STEP SIX | IDENTIFYING CO-BENEFITS

As noted in the Introduction, decarbonization has several benefits that extend beyond GHG emissions reductions. As a next step in the development of the Energy System Transformation Strategy, Project Teams should explore each of the strategies and actions above in further depth to identify potential co-benefits and ensure their integration into the strategy. This will help to ensure actions are harmonized or aligned with existing municipal government and other stakeholder priorities. Identifying co-benefits also allows Project Teams to prioritize specific actions over others (above and beyond the initial prioritization outlined in STEP 3 | Quantifying your Energy and Emissions Baseline).

One way Project Teams can identify co-benefits is by exploring synergies between energy system transformation strategies and actions and other city policies and programs. This process can create opportunities to share resources and expertise between municipal government departments, reduce administrative burdens, build support for energy system transformation, and streamline implementation. There may also be instances where select actions present a potential conflict with other municipal efforts. These should be explored in further depth to resolve or avoid any potential clashes with existing or future municipal government actions. Similarly, community stakeholders and other groups may either benefit from or feel threatened by certain actions. Forming partnerships with these groups can help Project Teams more fully address these opportunities or challenges, creating stronger buy-in and support for the implementation of Energy System Transformation Strategies.

Project Teams should also inventory actions as a basis for subsequent public engagement and communications strategies (STEP 7 | Crafting an Engagement Strategy) and to help garner support across a broader range of demographics and interest groups. Communication efforts should take care to highlight the multiple benefits of the actions that have been selected, as well as the process through which they have been selected. For example, energy system transformation actions can help stimulate the local economy by keeping dollars spent on energy closer to home (Figure 10 on the next page). Other benefits of energy system transformation actions include the ability to:

- Improve the city's ability to attract new business;
- Stimulate local business and create new job opportunities;
- Enhance cost savings for consumers, households and businesses;
- Improve public health and quality of life;
- Improve environmental quality and enhance environmental protection;
- Garnere cost savings that improve the competitiveness and efficiency of municipal government operations
- Improve opportunities for affordability and equity; and,
- Increase energy security and resilience to fluctuations in energy prices and extreme weather events.

Table 5 (on the next page) presents some sample metrics for six broad categories of co-benefits, while the matrix presented in Table 6 (pp. 65-66) provides a format municipal governments can use to identify the co-benefits their portfolio of actions will generate.

Figure 10 | The impact of shifting away from fossil fuels and transitioning to more local energy spending, as demonstrated for Boulder, CO.

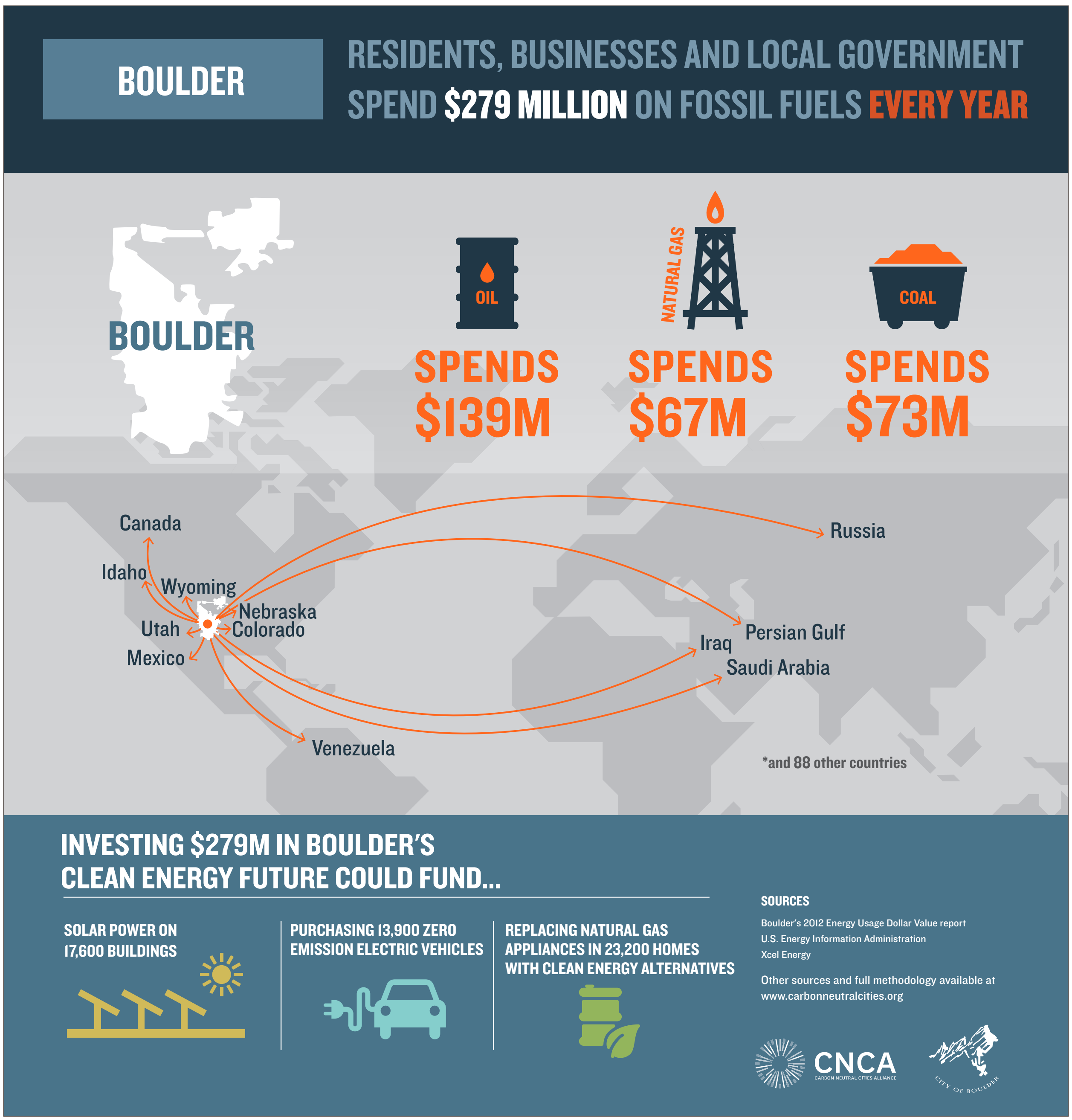


TABLE 5 | Potential co-benefits from energy system transformation and metrics for their evaluation.

CO-BENEFIT	EXAMPLE METRICS
Healthy Communities e.g. neighborhood livability, individual/community well-being, fitness	• Walkability scores • Mode share rates for walking or cycling • Resident perceptions of well-being and safety
Local Economies e.g. local business development, tourism, neighborhood improvement	• Jobs created or retained in energy-related sectors • Level of business retention and expansion • Number of new locally-owned businesses
Energy Security e.g. improved system performance during times of stress	• Percent of energy demand met by domestic production • Total of renewable energy resources • Stability of energy prices
Environmental Quality e.g. air quality, habitat, biodiversity	• Number of air quality advisories • Land use percentage of park or green space • Local species counts
Affordability and Equity e.g. energy savings, housing affordability, local energy control	• Rates of energy poverty • Percent change in utility rates • Total uptake of retrofit and other incentives • Availability and uptake of training programs
Resilience e.g. reduced vulnerability to extreme heat or cold events	• Rates of peak energy demand • Number and duration of power outages

IDENTIFYING BARRIERS: As in STEP 2 | Characterizing Your Sphere of Influence, identifying important co-benefits will require tapping into the existing expertise and knowledge of other municipal government staff. To this end, the co-benefits of different strategies and actions should be explored either in conversation with individual representatives of other municipal departments, or in a workshop format that allows for the emergence of overlapping co-benefits and challenges. Where appropriate, Project Teams may also wish to engage external stakeholders.

Where there are potential co-benefits or conflicts with other municipal efforts or priorities, additional workshops or breakout sessions with individual staff or municipal departments may be required to delve more deeply into specific actions. The aim of these sessions should be the identification of methods to ensure consistency and harmony between

TABLE 6 | Example matrix Project Teams can use to capture and assess potential co-benefits associated with different strategies and actions, which can help determine synergies with existing city priorities, identify resource sharing opportunities, and shape engagement strategies.

STRATEGY	CO-BENEFITS			
	HEALTHY COMMUNITIES	LOCAL ECONOMY	ENERGY SECURITY	ENVIRONMENTAL QUALITY
RELEVANT ACTIONS				
ENERGY SUPPLY				
E.4.1. Provide financial incentives for on-site and off-site renewable generation (e.g. property tax breaks)				
Action 2				
Action 3				
…				
BUILDINGS				
B.1.1. Conduct building energy performance challenges				
Action 2				
Action 3				
…				
TRANSPORTATION				
T.2.3. Implement smart-transit systems to provide up-to-the-minute transit/parking/travel information to residents				
Action 2				
Action 3				
…				

			CHALLENGES & SOLUTIONS
AFFORDABILITY & EQUITY	RESILIENCE	OTHER	


PLEASSSSE
THANKS
FOR
LETTING
ME REST!

STEP 7: CRAFTING AN ENGAGEMENT STRATEGY

KEY OUTPUTS

Upon completing this step, Project Teams will have:

- A map of energy system stakeholders characterized by their potential interest in and influence over transformation strategies targeting different urban systems;
- A Stakeholder Engagement Strategy to guide engagement and collaboration to craft the Energy System Transformation Strategy; and,
- The beginning of new partnerships and other collaborations that will be invaluable in strategy and action selection, design, and implementation.

STEP SEVEN | CRAFTING AND ENGAGEMENT STRATEGY

Each step in the Playbook notes opportunities and methods to include and engage with different stakeholders. However, the development of a final Energy System Transformation Strategy will require a continuous and in-depth process of stakeholder engagement and partnership.

A stakeholder engagement process is necessary to build a constituency around energy system transformation and to ensure that key stakeholders, including residents and businesses, feel a sense of ownership of the final product. Meaningful engagement and partnership with key stakeholders can both secure broad support for the strategies and actions that are proposed, and strengthen the strategies and actions themselves.

> *Effective deep decarbonization plans are not possible without the active support of key stakeholders. Stakeholder points-of-view can strengthen or weaken the political will to take bold actions. And because municipalities directly control only a small portion of the assets that drive deep emissions reductions, many of the actions and investments that will be needed must come from stakeholders. This is why it is essential to connect the challenge of climate change to stakeholders' interests and concerns and to communicate in terms that make sense to them.*
>
> **- Carbon Neutral Cities Alliance Framework for Long-Term Deep Carbon Reduction Planning, 2015**

STAKEHOLDER MAPPING

Project Teams can use Stakeholder Mapping to identify the key players and stakeholders relevant to the Energy System Transformation Strategy according to their connection to, interest in, and control over project outcomes. Once stakeholders are identified, Project Teams can determine how to involve and engage with each one.

To create a Stakeholder Map, Project Teams must first create a list of all stakeholder groups that could be affected by, interested in, or have influence over each urban system (energy supply, buildings, and transportation). This list should include actors at federal, state, municipal, utility, and neighborhood scales. Stakeholders can then be organized into a ‘map’ that indicates their relative interest in and influence over the relevant urban system (Figure 11 on the next page). Stakeholders can be placed on a separate map for each urban system, or combined into a single map that shows all key stakeholders in one place.

Once Project Teams have formed a complete list, they can further explore each stakeholder for the ways in which the stakeholder’s mandate, role and interest in decarbonization, either align or conflict with energy system transformation efforts. Where potential partners or supportive institutions are identified, Project Teams may also wish to identify barriers or limitations to their participation, and possible means of overcoming these limitations (Table 7 on the next page).

Finally, Project Teams can develop a communications and engagement strategy based on the level of interest and influence of each stakeholder. Figure 12 (p. 72) shows four principal engagement approaches based on the four quadrants of the Stakeholder Map. These four approaches should be developed in further detail to suit specific stakeholders. An engagement strategy can also outline the partnerships and methods the municipal government will use to extend its existing control over each of the three urban systems.

Figure 11 | Stakeholder Map that classifies stakeholders based on their level of influence (y-axis) and level of interest (x-axis) in a given aspect of the energy system transformation. Project Teams can use this tool multiple times to evaluate different parts of their energy system and/or potential strategies and actions.

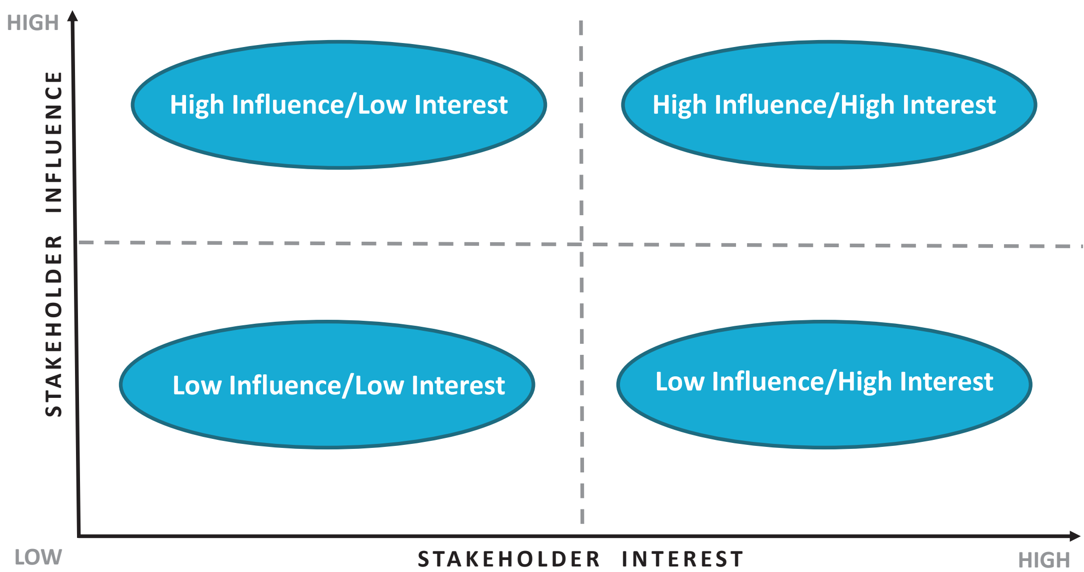
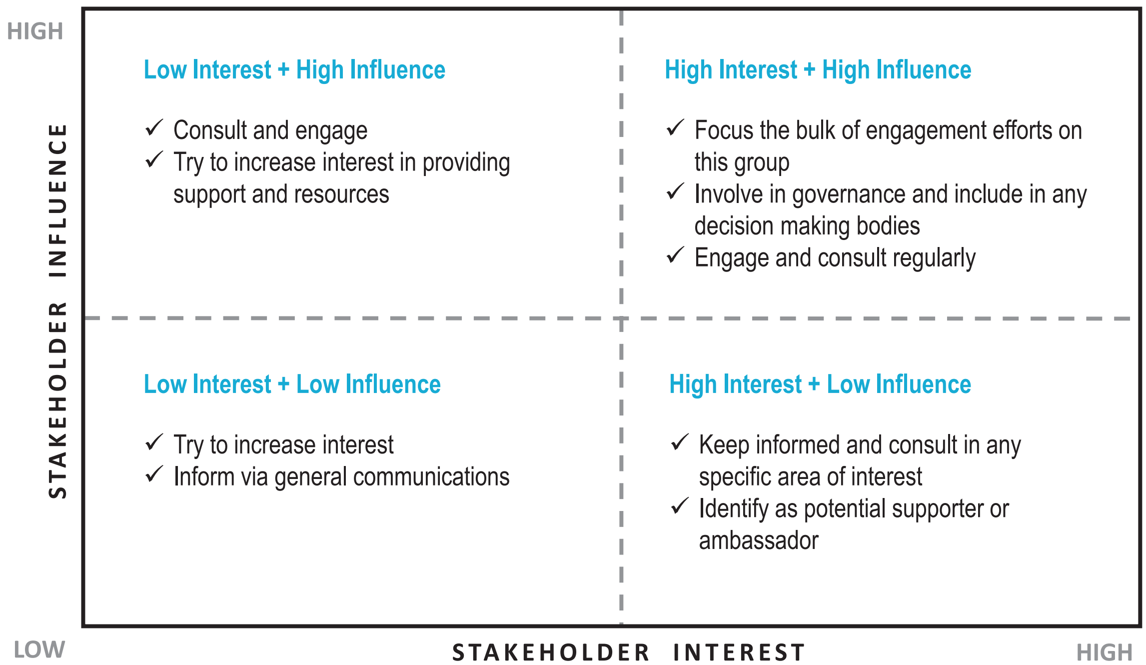


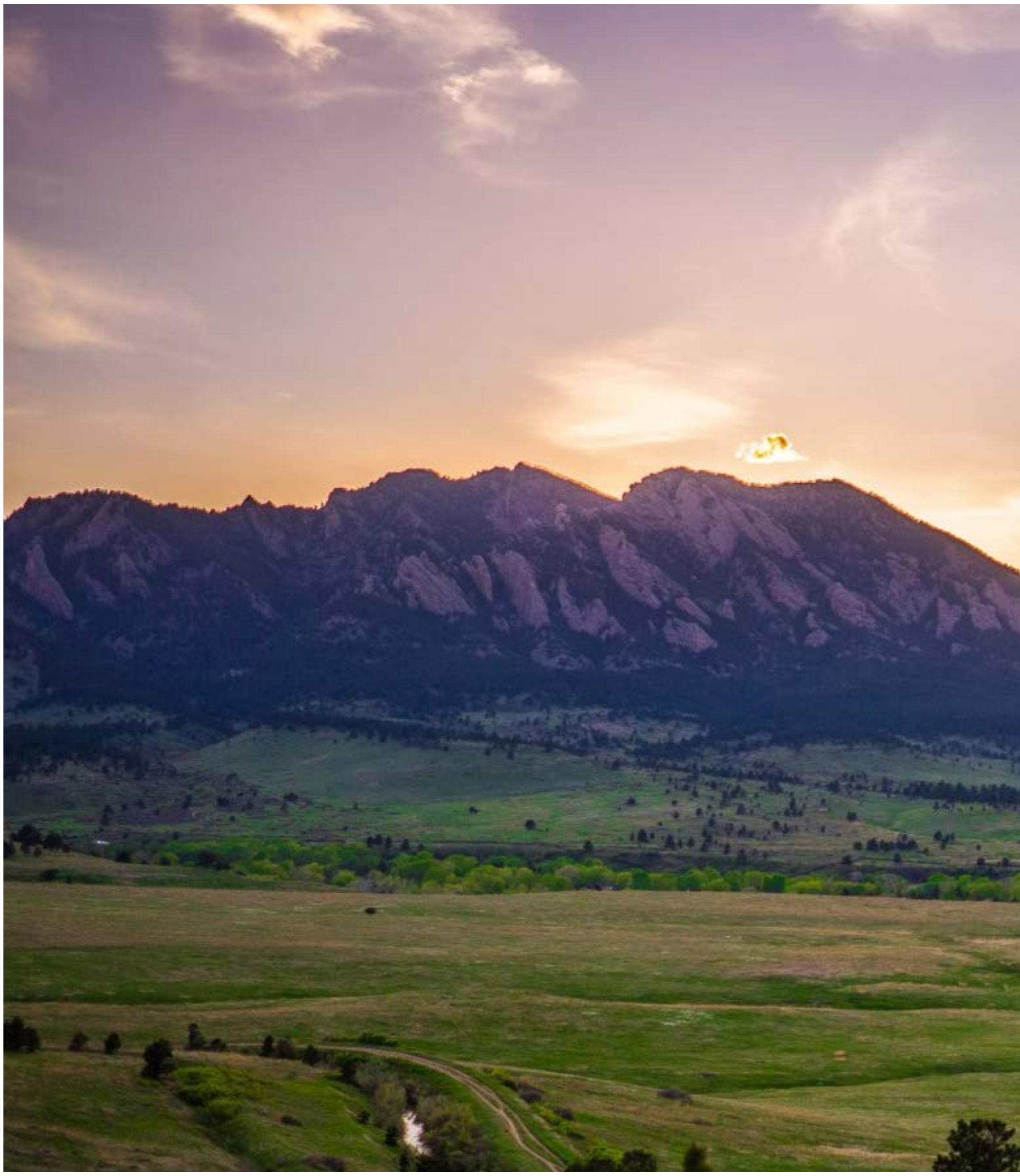
Table 7 | Example table Project Teams can use to capture key information about stakeholders.

TRANSPORTATION					
STAKEHOLDER	MANDATE	SCALE	ROLE/INTEREST	LIMITATIONS ON PARTICIPATION	WAYS TO ADDRESS LIMITATIONS
e.g. Regional Transit Authority	To oversee and coordinate the provision of mass transit operations	Regional	• Improvements in service provision • Operational efficiencies and cost savings • Low-carbon goals	• Poor relationship with business community • Lack of coordination with local transit plans	• Use of trained facilitator • Strengthen communication and linkages with municipal government staff
e.g. State Transit Agency					

Figure 12 | Overview of stakeholder engagement strategies Project Teams can use based on a stakeholder's level of interest and influence over a given aspect of the energy system. This tool can be used multiple times for different aspects of the energy system transformation and different engagement priorities.



COLLABORATIVE STAKEHOLDER MAPPING: While it is an exercise intended to identify necessary efforts for stakeholder engagement, Stakeholder Mapping itself can be performed in a workshop setting to assist in creating a comprehensive list of relevant stakeholders. The exercise can be facilitated by first using post-it notes on a white board or wall to visually demonstrate the position of each stakeholder on the map (Figure 11 on the previous page). Linkages between stakeholders can be indicated using strong, moderate, or weak lines to connect them. The results of the mapping exercise can then be transferred into a table or matrix for further analysis (see Table 7 on the previous page).



CONCLUSION

This Playbook provides a tool municipalities can use to effect a broad transformation of their city or neighborhood's energy system. It offers municipal governments the process and guidance needed to gather data and information, select and design appropriate strategies and actions, and engage with key stakeholders. Project Teams must adapt and implement each step in the way that best suits the needs, resources, and circumstances of both the municipal government leading the transformation, and the city or neighborhood under investigation.

As momentum towards an energy system transformation grows across the world, leading municipal governments must share resources and lessons learned to assist others in decarbonizing their energy systems. This growing pool of knowledge and expertise will make effecting change easier for all parties as new partnerships and innovative methods emerge, experiences and lessons grow in breadth and depth, and actions taken by one municipal government make taking action easier for another. The tools and methods provided in this Playbook are intended to contribute to this momentum by assisting municipal governments to understand, scope, and ultimately achieve an energy system transformation.

APPENDIX: STRATEGY AND ACTION TABLES

Energy System Transformation Strategies and Actions

ENERGY SUPPLY			
STRATEGIES	**ACTIONS**	**TRANSECTS**	
		T1-T3	**T4-T6**
E.1. Enable consumers to purchase and/or produce renewable energy	**E.1.1.** Provide a clean power purchasing option (e.g. allow consumers to participate in wholesale market, Community Choice Aggregation)	√	√
	E.1.2. Assist large enterprises in implementing clean energy purchasing through PPAs and other arrangements		√
	E.1.3. Ease permitting/land use regulation for on-site renewables (e.g. rooftop solar)	√	√
E.2. Increase public awareness of decarbonization, renewable energy, energy efficiency	**E.2.1.** Implement a media, outreach, and communications strategy focused on increasing public awareness of efforts and specific programs and increasing adoption of programs	√	√
E.3. Coordinate discount purchase opportunities for residents and businesses	**E.3.1.** Coordinate and manage discount purchase opportunities (e.g. bulk buy programs) to increase consumer access to strategically important technologies (e.g. solar panels, air source heat pumps)	√	√
E.4. Reduce cost of renewables	**E.4.1.** Provide financial incentives for on-site and off-site renewable generation (e.g. property tax breaks)	√	√
	E.4.2. Provide feed-in tariffs and/or net metering incentives for excess distributed renewable generation	√	√
E.5. Ease regulatory compliance	**E.5.1.** Reduce regulatory barriers to zero-emission neighborhood-scale energy systems (e.g. microgrids, district energy, tri-generation)	√	√√
E.6. Increase availability of financial resources	**E.6.1.** Develop and manage financial resources specifically for decarbonization, increasing renewable energy, and decreasing energy use (e.g. green bank, PACE financing)	√	√
E.7. Implement a renewable electricity proliferation strategy	**E.7.1.** Invest in a municipal government-run program to increase renewable energy generation by strategically targeting buildings, neighborhoods, businesses, and homeowners based on generation opportunities (e.g. rooftop suitability, electricity distribution capacity)	√	√
E.8. Develop a District Energy Strategy	**E.8.1.** Assess thermal energy demand and local low- and zero-emission supply opportunities and use the results to develop a neighborhood-scale energy strategy that can inform other municipal government policies and regulations and support specific infrastructure projects (e.g. energy system installations)		√
E.9. Invest in renewable supply	**E.9.1.** Invest in neighborhood-scale energy generation (e.g. district energy, tri-generation districts), including through public-private partnerships	√	√√
	E.9.2. Invest in converting municipal government-owned fossil-fuel power generating facilities to zero-emission generators	√	√
	E.9.3. Invest in large-scale renewable generation facilities to supply community energy demand (e.g. power purchasing agreements)	√√	√
	E.9.4. Invest in "community solar" projects	√√	√
E.10. Purchase and produce renewable energy	**E.10.1.** Install distributed renewable energy generation on municipal government facilities	√	√
	E.10.2. Purchase clean energy directly (e.g. through power purchase agreements)	√	√
E.11. Task an organization or department with managing energy performance programs	**E.11.1.** Establish or commission a municipal government department or office separate from the municipal government to manage and implement renewable energy and energy performance programs	√	√
	E.11.2. Provide a centralized online clean energy and energy efficiency commerce system that provides information on programs, access to financing and permits, and connection to support staff	√	√

ENERGY SUPPLY (continued)			
STRATEGIES	**ACTIONS**	**TRANSECTS**	
		T1-T3	**T4-T6**
E.12. Mandate decarbonization of central supply	**E.12.1.** Increase renewable portfolio standards (RPS) for utilities (at state/province, regional, national scale)	√	√
	E.12.2. Force the retirement or conversion of fossil-fuel plants (perhaps with financial support)	√	√
	E.12.3. Implement an emissions “cap and trade” market (at state/province, regional, national scale)	√	√
	E.12.4. Require the phasing out/conversion of buildings’ fossil-fuel heating systems (and provide technical and financial assistance for owners/managers) toward waste heat, biomass or geothermal energy systems	√	√
E.13. Mandate increased energy efficiency and conservation	**E.13.1.** Increase efficiency and emissions performance requirements for fossil-fuel plants	√	√
	E.13.2. Implement mandates to reduce energy consumption in buildings	√	√
E.14. Mandate renewable energy generation in buildings	**E.14.1.** Require new buildings and major renovations to be capable of supporting a minimum amount of on-site renewable energy generation (e.g. roof design, electrical system capabilities)	√	√
	E.14.2. Require new buildings and major renovations to generate a minimum amount of renewable energy on-site, with exceptions (e.g. shading on rooftops)	√	√
E.15. Install advanced metering infrastructure in buildings	**E.15.1** Require all new buildings and major renovations to install advanced metering infrastructure (aka “smart meters”)	√	√
	E.15.2 Retrofit existing buildings to install advanced metering infrastructure	√	√
E.16. Analyze energy supply system needs and capabilities	**E.16.1.** Conduct a hosting capacity study to determine the electricity system’s ability to host additional distributed energy generation (e.g. solar panels) (with electric utility)	√	√
	E.16.2. Develop a location-based profile of energy consumption, energy demand, and GHG emissions	√	√
E.17. Plan for electricity system modernization	**E.17.1.** Define a vision of the future grid and characterize the stages of grid modernization (with state/provincial government agencies and electric utility)	√	√
	E.17.2. Revise integrated resource planning to account for distributed generation and other distributed energy resources (DER) (state/provincial government)	√	√
	E.17.3. Identify and implement pilot projects to support learning and planning related to grid modernization and decarbonization (with state/provincial government agencies and electric utility)	√	√
E.18. Adjust the regulatory environment to support modernization and distributed energy resources	**E.18.1.** Identify and address any legislative and regulatory barriers hindering electricity system modernization (with state/provincial government)	√	√
	E.18.2. Adopt or develop a framework to value DER as an energy source (state/provincial government)	√	√
	E.18.3. Enact legislation that allows residents and businesses to participate in a peer-to-peer local energy trading market (with state/provincial government)	√	√

For neighborhood-scale planning, checkmarks indicate how appropriate an action is for transects 1-3 (lower density) and 4-6 (higher density).

√ = action is appropriate for those transects

√√ = designates that an action may be more effective for one set of transects than the other

BUILDINGS			
STRATEGIES	**ACTIONS**	**TRANSECTS**	
		T1-T3	**T4-T6**
B.1. Encourage improved energy efficiency performance of existing buildings	**B.1.1.** Conduct building energy performance challenges	√	√
	B.1.2. Promote building energy rating systems (commercial and residential)	√	√
	B.1.3. Promote voluntary energy use benchmarking programs		√
	B.1.4. Promote voluntary “stretch” building energy conservation codes and green-building principles by providing information and technical assistance	√	√
	B.1.5. Promote “cool roofs”, air tightness testing, and other low-cost energy conservation approaches	√	√
	B.1.6. Support best practice information sharing among building owners	√	√√
B.2. Promote energy conservation behaviors by building occupants/tenants	**B.2.1.** Work with utilities to improve customer access to energy-use data	√	√
	B.2.2. Conduct public education programs and campaigns that promote energy-saving measures	√	√
	B.2.3. Promote green leasing for commercial buildings that enable a fair proportion of costs/benefits to be allocated to both tenants and landlords		√
	B.2.4. Provide energy management resources to support organizations in managing energy and emissions (e.g. shared energy managers)	√	√
B.3. Coordinate discount purchase opportunities for residents and businesses	**B.3.1.** Coordinate and manage discount purchase opportunities (e.g. bulk buy programs) to increase consumer access to strategically important technologies (e.g. solar panels, electric vehicles, ASHPs)	√	√
B.4. Provide financial incentives	**B.4.1.** Offer financial incentives to increase adoption of specific, strategically important technologies (e.g. to enable decarbonization)	√	√
B.5. Increase access to financing	**B.5.1.** Improve access to specialized financing to pay for efficiency improvements (e.g. green bank, PACE financing, carbon tax with distribution fund)	√	√
B.6. Support/provide rewards for performance	**B.6.1.** Provide regulatory and zoning relief (e.g. increased FAR, accelerated permitting) for projects meeting certifiable high standards (e.g. LEED)	√	√
	B.6.2. Promote supportive market mechanisms such as building appraisal and mortgage underwriting that capture the value of investments in energy efficiency	√	√
B.7. Subsidize capacity improvements for building management	**B.7.1.** Support efforts to train building operators in energy efficiency best practices		√
	B.7.2. Invest in the sustainable buildings sector to improve the capacity of local or regional industry members to market, install, and maintain the technologies necessary for decarbonization	√	√
B.8. Expand capacity of efficient heating and cooling	**B.8.1.** Develop and expand energy sharing networks for low- to zero-emission thermal energy systems		√
	B.8.2. Pilot new building technologies on municipal government buildings	√	√
B.9. Investigate options to decarbonize more challenging building systems	**B.9.1.** Conduct a study to evaluate options to decarbonize thermal energy systems in buildings (both air and water)	√	√
	B.9.2. Identify where industrial processes depend on fossil fuels and investigate options for decarbonization or deep GHG reductions	√	√

BUILDINGS (continued)			
STRATEGIES	**ACTIONS**	**TRANSECTS**	
		T1-T3	**T4-T6**
B.10. Invest in decarbonizing government-owned and -financed buildings	**B.10.1.** Implement Municipal Strategic Energy Management programs to decrease energy consumption and GHG emissions in municipal government buildings	√	√
	B.10.2. Conduct deep retrofitting combined with installation of on-site renewable energy supply	√	√
	B.10.3. Improve building operations and preventative maintenance	√	√
	B.10.4. Improve energy efficiency of public/government-owned housing	√	√
	B.10.5. Require all rehabilitation projects financed by the municipal government to include “green” capital needs assessment	√	√
B.11. Task an organization or department with managing energy performance programs	**B.11.1.** Establish a municipal government department or office separate from the municipal government to manage and implement renewable energy- and energy performance-focused programs	√	√
	B.11.2. Provide a centralized online commerce system that provides information on programs, access to financing and permits, and connection to support staff	√	√
B.12. Mandate reporting	**B.12.1.** Adopt Building Energy and Reporting Disclosure ordinances		√
	B.12.2. Require energy audits and disclosure		√
	B.12.3. Require sub-metering		√
	B.12.4. Require building rating system	√	√
B.13. Mandate no- to low-carbon standards for new construction	**B.13.1.** Adopt/phase-in zero-emission ready building and energy conservation codes (i.e. no inherent dependence on GHG emissions)	√	√
	B.13.2. Relax certain energy performance requirements for buildings utilizing low-emission district energy systems		√
	B.13.3. Implement a program or office to increase code compliance	√	√
B.14. Mandate performance improvement of existing buildings	**B.14.1.** Require targeted buildings to improve performance or take specific steps to improve performance if below a minimum standard (based on benchmarked data)		√
	B.14.2. Require “deep” retrofitting of buildings at designated intervention points (such as time of sale/purchase, permitting, financing, major renovation of building or space, rebuilding, and tenant turnover)	√	√
	B.14.3. Require upgrades to commercial/industrial buildings’ lighting systems		√
	B.14.4. Require higher standards for energy efficiency of appliances	√	√
	B.14.5. Require energy performance check-ins and/or improvement actions (e.g. audit, recommissioning) at designated time intervals (e.g. every 5 years)	√	√√
	B.14.6. Require certification of building operators		√

For neighborhood-scale planning, checkmarks indicate how appropriate an action is for transects 1-3 (lower density) and 4-6 (higher density).

√ = action is appropriate for those transects

√√ = designates that an action may be more effective for one set of transects than the other

TRANSPORTATION			
STRATEGIES	ACTIONS	TRANSECTS	
		T1-T3	T4-T6
T.1. Promote non-vehicular modes of transportation	**T.1.1.** Promote the recreational and health benefits of bicycling and walking	√	√
	T.1.2. Promote household financial benefits for reduced car reliance	√	√
	T.1.3. Promote teleworking as an alternative to commuting	√	√
	T.1.4. Promote carpooling and use of High Occupancy Vehicle lanes	√	√
	T.1.5. Partner with employers to encourage employee commuting using public transit, biking, or walking	√	√
T.2. Promote new mobility technologies and business models	**T.2.1.** Support pilots and address regulatory barriers for on-demand busing, shared use mobility, driverless vehicles, etc.	√	√
	T.2.2. Support on-demand parking software		√
	T.2.3. Implement smart-transit systems to provide up-to-the-minute transit/parking/travel information to residents		√
	T.2.4. Encourage private investment in street cars/highways/shared use systems	√	√
T.3. Coordinate discount purchase opportunities for residents and businesses	**T.3.1.** Allocate municipal government staff time to coordinate and manage discount purchase opportunities (e.g. bulk buy programs) for strategically important technologies (e.g. electric vehicles)	√	√
T.4. Increase the cost of fossil-fuel vehicles and reduce the cost of carbon-free vehicles	**T.4.1.** Establish congestion/climate taxes on fossil-fuel vehicles in designated areas	√	√√
	T.4.2. Establish taxes/fees on fossil fuel vehicles at purchase and/or registration	√	√
	T.4.3. Set taxes on gasoline/petroleum purchase (can be done on VMT basis)	√	√
	T.4.4. Provide zero-emission vehicle purchase incentives (e.g. rebates/tax credits)	√	√
T.5. Increase the cost of driving in certain places	**T.5.1.** Establish regional road pricing (e.g. toll roads, dynamic pricing)	√	√
	T.5.2. Promote automobile insurance options that reward drivers for driving less	√	√
	T.5.3. Tax off-street parking		√
T.6. Invest in decarbonizing public transit and municipal government fleets	**T.6.1.** Convert public transit to no- to low-carbon energy (electric, hybrid, natural gas, hydrogen)	√	√
	T.6.2. Convert government fleets to no- to low-carbon energy	√	√
	T.6.3. Encourage taxi fleets to transition to no- to low-carbon energy	√	√
T.7. Invest in increasing non-vehicle share of mobility	**T.7.1.** Invest in public transit capacity (modernization, expansion), choices (e.g. streetcars, light rail lines), reliability, speed, accessibility, convenience, way-finding, and reduced waiting times	√	√√
	T.7.2. Convert bus lines into high-capacity transit lines	√	√
	T.7.3. Expand rapid transit for job centers	√	√√
	T.7.4. Invest in bicycle sharing programs and public bicycle parking (coupled with requirements for buildings to provide bicycle space)		√
	T.7.5. Invest in infrastructure for low- to no-carbon mobility: electric vehicle charging, hydrogen, fuel cell infrastructure (including incentives for real estate owners to install charging stations)	√	√
	T.7.6. Support shift of freight transportation from road to rail and ship	√	√

TRANSPORTATION (continued)			
STRATEGIES	ACTIONS	TRANSECTS	
		T1-T3	T4-T6
T.8. Invest in redesigned urban form/density to promote less use of vehicles	**T.8.1.** Develop bicycle/walking infrastructure (citywide network)	√	√
	T.8.2. Develop "complete"/green streets, walkable neighborhoods, and complete/green public spaces	√	√√
	T.8.3. Use transit-oriented development (TOD) planning and investments to increase neighborhood density and use of public transit		√
	T.8.4. Develop an integrated, multi-modal mobility system at regional scale	√	√
	T.8.5. Redesign parking system regulations and infrastructure (e.g. eliminate/reduce parking spaces in high density/traffic areas)		√
	T.8.6. Redesign goods movement in city	√	√
T.9. Mandate vehicle fuel efficiency	**T.9.1.** Establish reduced idling ordinances	√	√
	T.9.2. Increase fuel efficiency targets for vehicle producers	√	√
T.10. Mandate electric vehicle readiness	**T.10.1.** Require single family buildings to equip parking spots with infrastructure required to connect an electric vehicle charging station	√√	√
	T.10.2. Require new buildings to install electric vehicle charging stations in a minimum percentage of parking spots		√
	T.10.3. Require new buildings to equip a minimum percentage of parking spots with the infrastructure necessary for future electric vehicle charging stations		√
	T.10.4. Require building electrical rooms and systems to be capable of providing electricity to all parking spots for vehicle charging in the future		√
	T.10.5. Require parking lots and garages to install electric vehicle charging stations in a minimum percentage of parking spots		√
	T.10.6. Require parking lots and garages to equip a minimum percentage of parking spots with the infrastructure necessary for future electric vehicle charging stations		√
T.11. Mandate a transition to zero-emission vehicles	**T.11.1** Require automakers to sell an increasing proportion of zero-emission passenger vehicles until all passenger vehicles are zero-emission (state/provincial government)	√	√

For neighborhood-scale planning, checkmarks indicate how appropriate an action is for transects 1-3 (lower density) and 4-6 (higher density).

√ = action is appropriate for those transects

√√ = designates that an action may be more effective for one set of transects than the other

CNCA

CARBON NEUTRAL CITIES ALLIANCE