CURB: Climate Action for Urban Sustainability

A scenario planning tool to support city-scale climate action

Silpa Kaza
Urban Specialist

April 23, 2018

WORLD BANK GROUP

C40 CITIES

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

AECOM

What is CURB?

- A scenario planning tool that helps cities prioritize more than 50 different low carbon actions and investments
- Analytically rigorous and transparent with regards to impact on costs, energy and greenhouse gas emissions
- User-friendly, GPC aligned, and globally relevant with wide range of interventions appropriate for developed and developing countries
- Able to be used with minimal training even in low capacity, data scarce environments (proxy data available if local data is missing)

What does CURB do?

Sector-specific analysis

Baselining and Benchmarking

Calculates project-specific energy and emissions by sector

Benchmarks performance to other cities globally

Action Prioritization and Planning

- Allows selection of energy and emission reduction targets
- Helps user identify and prioritize low carbon actions across six sectors
- Estimates energy and emission implications and financial performance of actions tailored to city's context
- Segments expected impact by city vs. national/regional authority
- Compares multiple low carbon scenarios

What information does a city need to run CURB?

Private sector buildings

- Residential units and commercial building area

Electricity generation

- Sources for grid-supplied power

Transportation

- Trip generation rates and passenger mode share
- Vehicle kilometers traveled

Municipal buildings & public lighting

- Building energy consumption by fuel type
- Number of types of street and traffic lights

Solid waste

- Solid waste generation, composition, collection and disposal methods

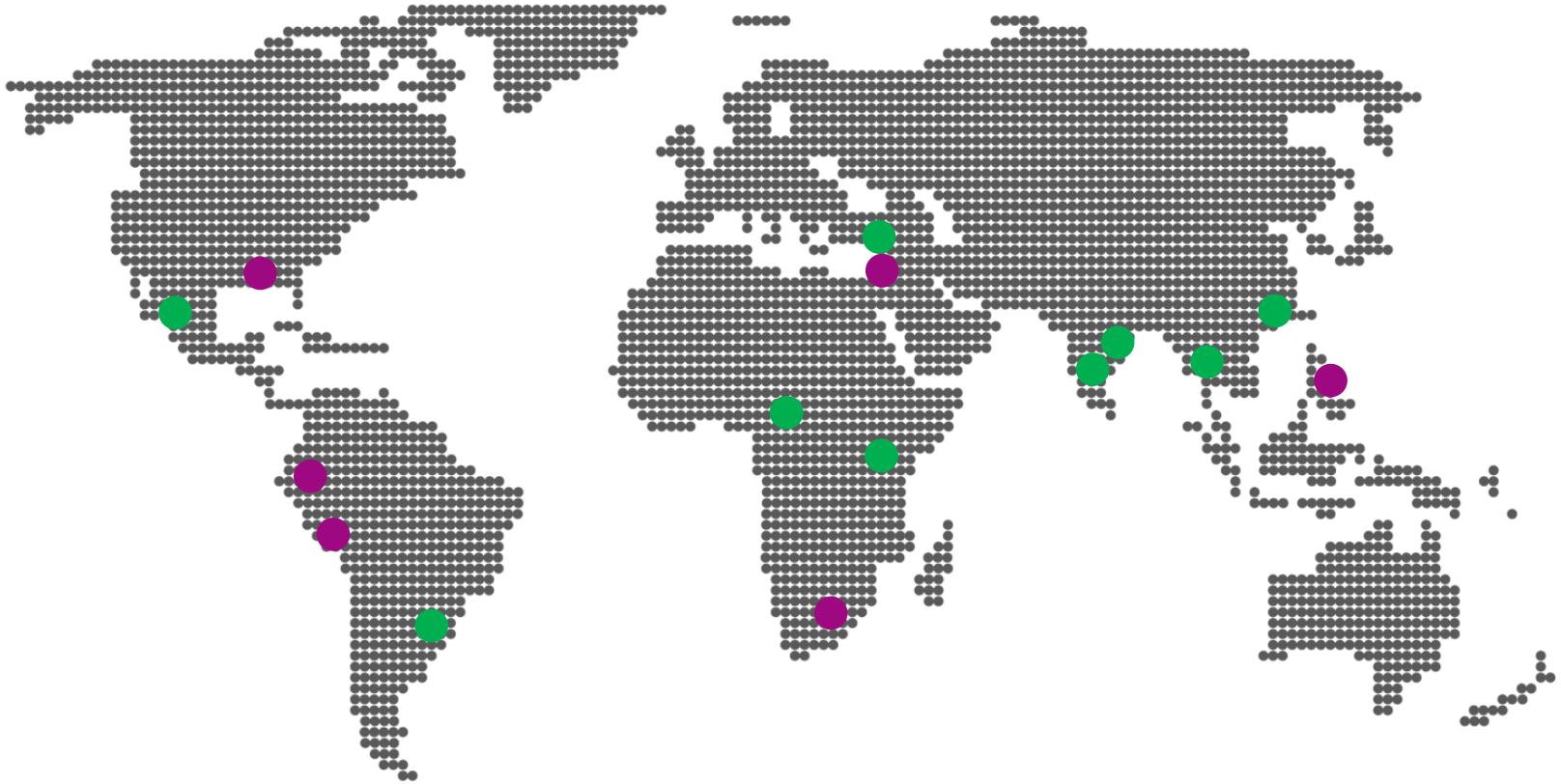
Waste and wastewater

- Wastewater generation and management types

Demographic and cost information

- Population & projected population
- Number of jobs & projected growth
- Cost of electricity and other fuels

Where and why is CURB being used?



Climate Action Planning | Target Setting

New project design | Capacity building | Investment allocation

United States: Climate Action for a Resilient New Orleans

Objective: Given that coastal cities are most at risk from climate change, City of New Orleans aims to reduce emissions contribution while adapting to changes in their climate

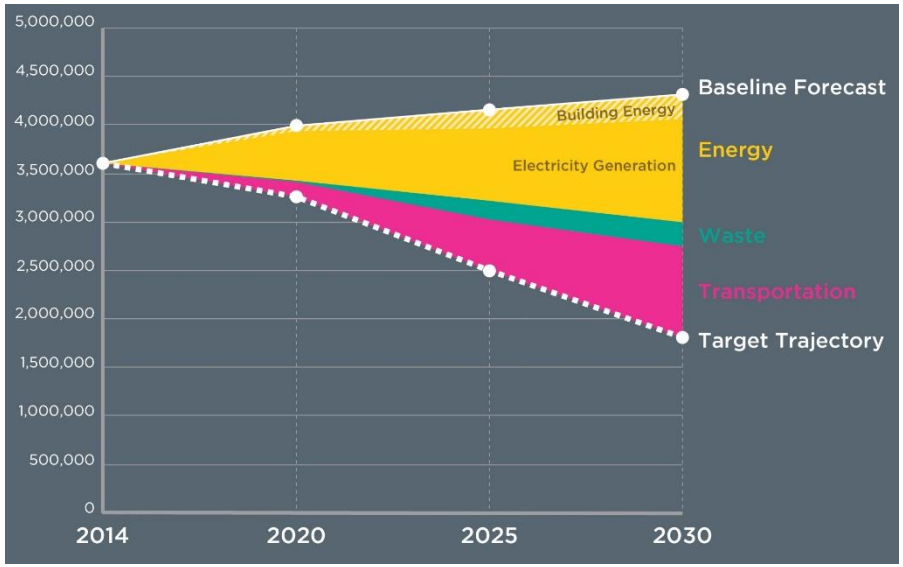
Inventory Results:

- 3,606,199 tonnes CO2 equivalent in 2014
- 50% Energy, 44% Transportation, 6% Solid Waste

CURB Use:

- Established target of 50% reduction by 2030
- Prioritized and selected low-carbon investments to develop climate action plan achieving target

Climate Action Plan Adds up to 50% Reduction by 2030



Energy: 100% low-carbon power by 2030

- Reduce reliance on carbon-intensive fuels
- Save energy and save
- Increase resilience of energy, water, and sewer infrastructure

Transportation: 50% non-automobile trips

- Reduce car dependence
- Encourage active transportation
- Increase fuel efficiency, clean fuel use, and shared-use mobility services

Solid Waste: Divert 50% of waste from landfills by 2030

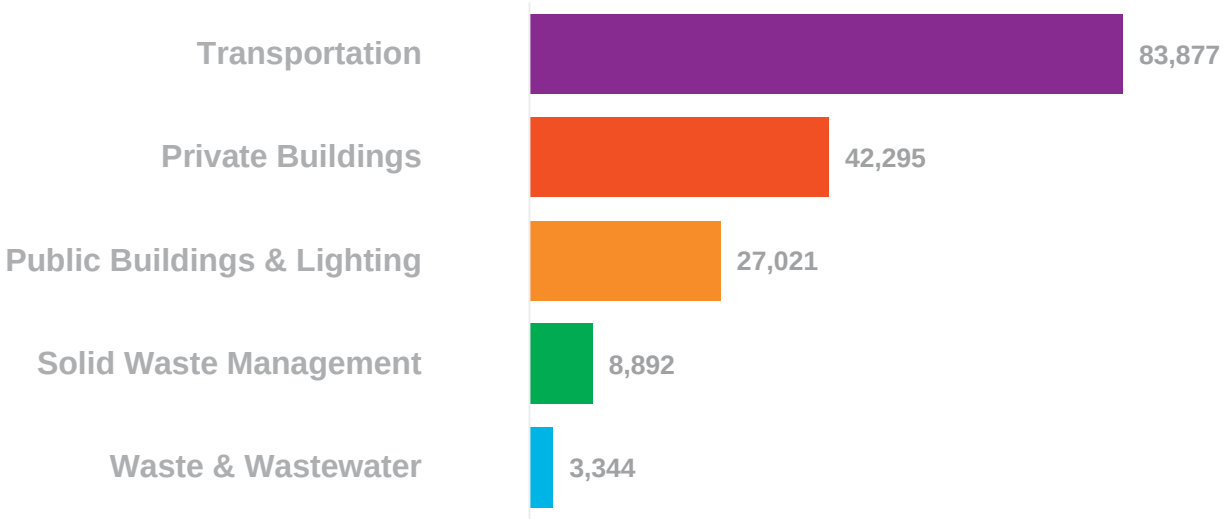
- Zero waste by 2050. Launch comprehensive recycling and waste reduction initiative
- Generate value from waste

Lebanon: Low Carbon Planning for Byblos

Objective: Identify feasible and scalable low carbon investments to help Lebanon achieve environmental sustainability while paving a path forward for cities throughout the country

Baseline Results: 2016 CO2 tonnes equivalent

Over 90% of Byblos' carbon emissions emerges from buildings and automobiles



Action Summary

Action	Action Description	Emissions Reduction (tonnes CO2e/year)	Net Present Value of Investment	Capital Expenditures
Passenger Mode Shift	• Change 50% of private automobile trips to bus trips • Change 50% of taxi trips to bus trips	33,205	$21,626,285	$36,649,633
Residential Photovoltaic Systems	• Install 2 kW PV panels on 30% of home roofs	10,012	($4,235,226)	$17,708,406
Vehicle Fuel Efficiency	• Improve bus efficiency by 50% from baseline, such as by purchasing a modern fleet or switching fuel to “clean” sources	7,919	Not Available	Not Available
Modernization of Dump Operations / Landfill Gas Capture*	• Convert managed dump operations and infrastructure to reflect a basic sanitary landfill (daily cover, lining, etc.) • Collect and flare methane gas, or use gas to generate electricity • Emissions estimate assumes diversion of all organic waste to landfill	7,015	Not Available	Not Available
Municipal Photovoltaic systems	• Install municipal solar power generation system of 2 MW • ~16 acres of land is required to achieve energy reduction stated • *Note: Byblos receives 300 days of sun a year!*	5,571	($1,546,089)	$7,656,250
Anaerobic Digestion of Organic Waste*	• Moving 50% of organic waste to anaerobic digestion (currently 100% managed dump)	4,710	($2,537,740)	$2,830,416
Composting of Organic Waste*	• Moving 50% of organic waste to composting from managed dump	4,000	$2,998,771	$708,555

Green indicates expected cost savings

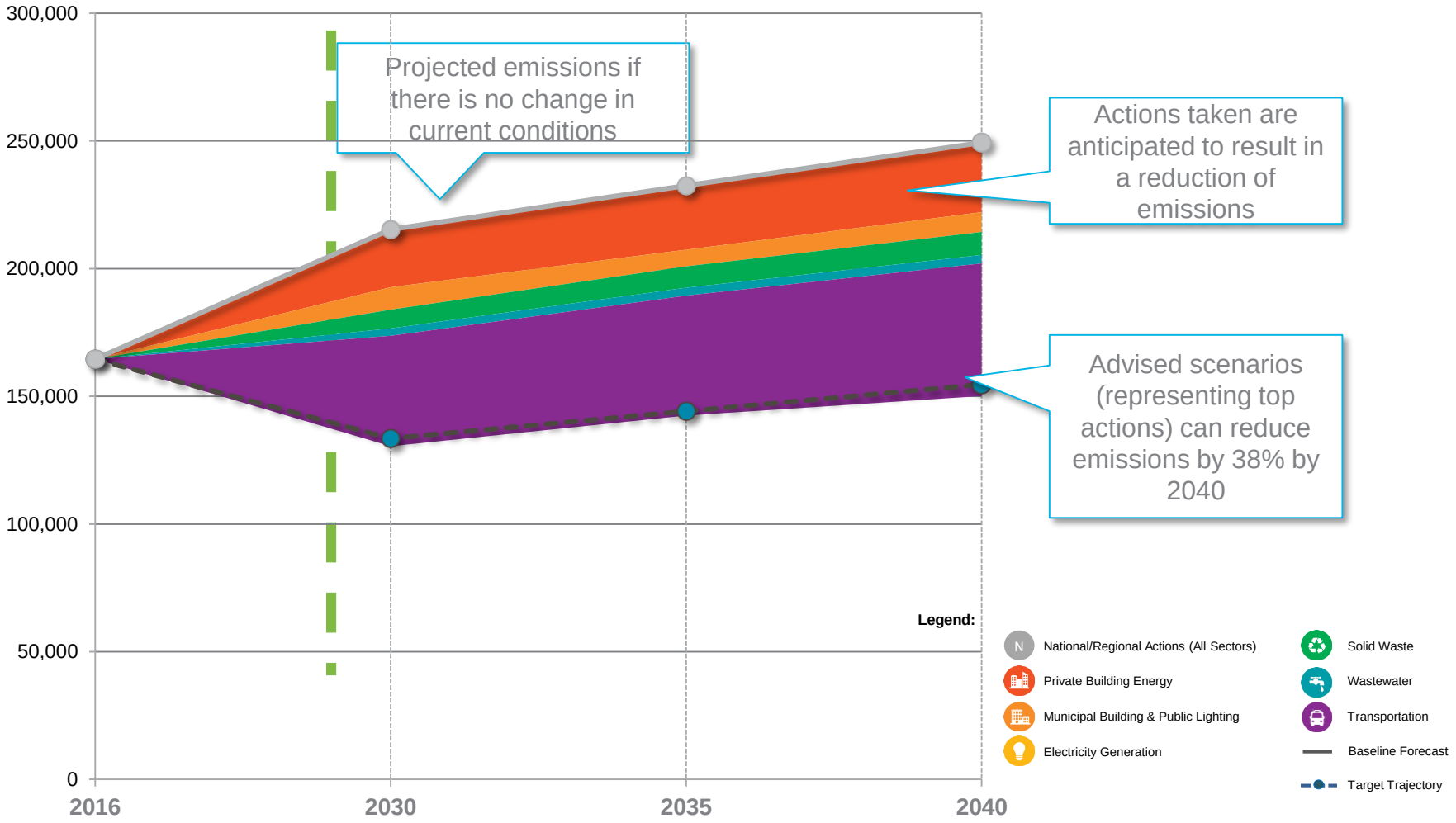
*A combination of organics management may be pursued, estimates provided assume that only one solution is chosen

Action Summary

Action	Action Description	Emissions Reduction (tonnes CO2e/year)	Net Present Value of Investment	Capital Expenditures
Lighting - Residential (Existing)	• Convert 50% of home lighting to LEDs	2,578	($6,089,974)	$205,454
Lighting – Commercial (Existing)	• Convert 50% of commercial lighting to LEDs	2,208	($1,648,991)	$3,148,974
Improved Recycling of Paper	• Increasing recycling rate of paper from 75% to 100%	1,960	$914,821	$176,377
Wastewater Treatment Type Switching	• Move 50% of waste treated by septic systems to newly installed wastewater treatment system	1,619	12,674,982	$46,411,056
Lighting - Residential (New)	• Use LEDs in 100% of new buildings	1,590	($4,416,343)	$211,794
Lighting – Municipal (Existing)	• Change 50% of Fluorescent lightbulbs to LED lightbulbs • Install occupancy controls	1,390	($1,226,637)	$2,299,390
Cooling – Residential (Existing)	• Convert 50% of cooling systems in homes to high-efficiency	1,353	$684,888	$2,343,708
Lighting – Commercial (New)	• Install LEDs in 50% of new commercial bulbs	1,362	($1,243,177)	$3,246,147
Streetlights	• Change 50% of high-pressure sodium bulbs to LED	1,262	($1,513,841)	$5,220,000
Wastewater Biogas-to-Energy Optimization	• Convert biogas from anaerobic lagoons to electricity	689	($1,685,477)	$3,193

Green indicates expected cost savings

Byblos Modeling Results: Actions Add up to 40% Reductions



CURB Tool

Climate Action for Urban Sustainability

WORLD BANK GROUP

C40 CITIES

COMPACT of MAYORS

CURB offers five modules to help cities prioritize investments for climate action planning using quantitative and qualitative analysis

Community context data necessary to run CURB

To use CURB you will need to enter city-specific data or select defaults from datasets provided within the model. Please enter the requested information in the blue highlighted cells on this page. It should be noted that the tool's results will be more accurate if city-specific data are provided. While the development team has made efforts to provide the best available regional or national proxy data, city-specific values could vary considerably from those provided.

1. Basic Data

A. City Characteristics

Data Item	Value	Units
City Name	Bangalore	N/A
Country	India	N/A
Area of City (exclude water, natural, and agricultural areas)	775	Square kilo
City Annual Precipitation	Moderate (750-1000mm)	mm/yea
City Climate	Tropical	N/A

CURB customizes outputs based on key local data from individual cities.

2. Community Greenhouse Gas Emissions Inventory Data

Select One:

- ○ Option 1: Enter the community's base year greenhouse gas emissions inventory (a GPC-compliant
- ◉ Option 2: Use a CURB-generated greenhouse gas emissions inventory

CURB can either operate on a city's existing GHG inventory data or simulate the development of one based on sectoral activity data.

3. Private Building Energy Data

A. Building Energy Data

Select Proxy Building Energy Dataset

Data Item	Region/Country/City	Data Available?	Proxy Data Region/Country/City Selected
Region	South Asia	Yes	South Asia
Country	India	Yes	India
Energy Model City	Bangalore	Yes	Bangalore

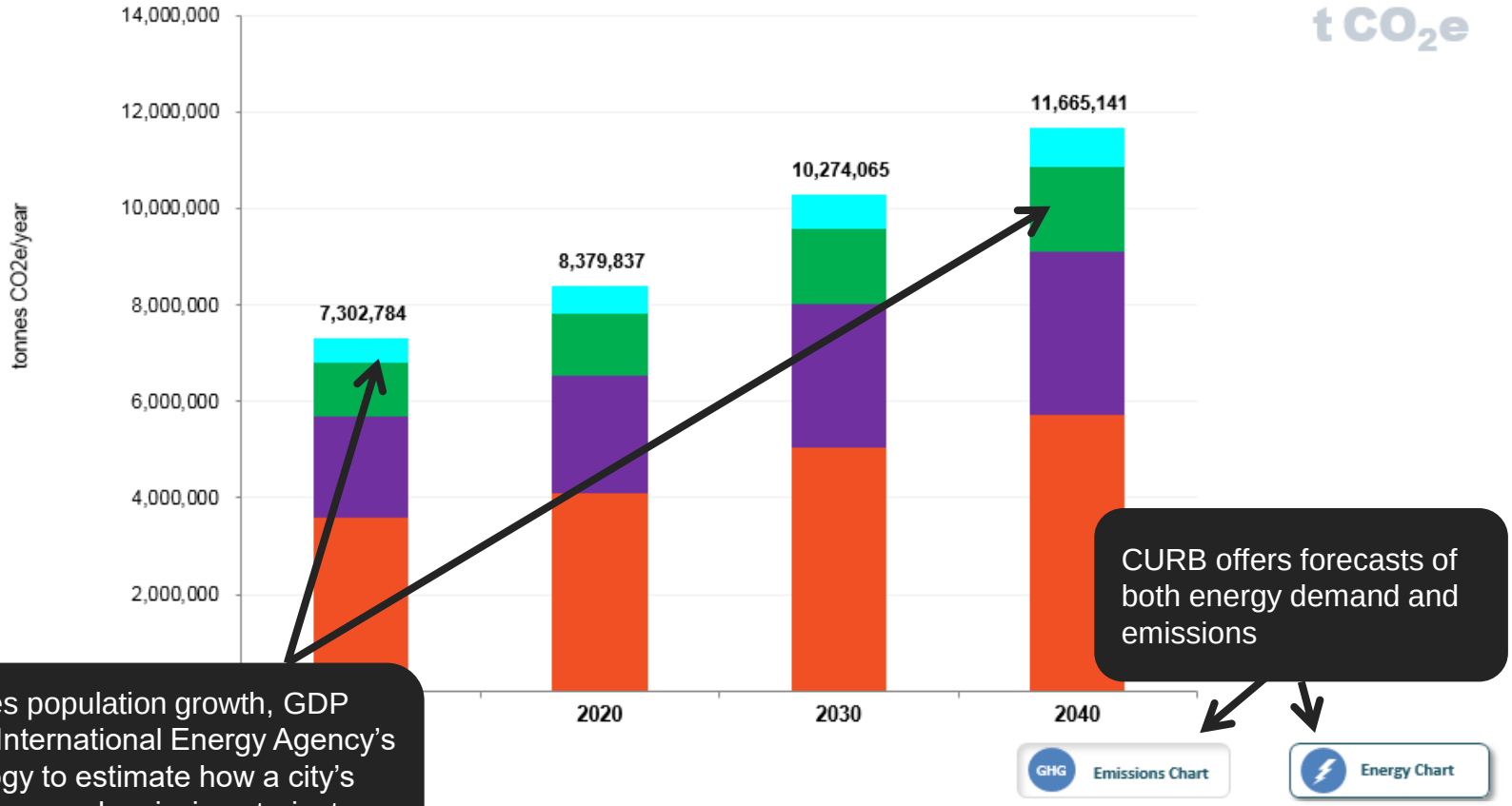
B. Private Sector Building Inventory Data

Select One:

- ◉ Option 1: Use tool-generated building inventory estimates
- ○ Option 2: Enter city-specific residential building inventory data and use tool-generated commercial b
- ○ Option 3: Enter city-specific commercial building inventory data and use tool-generated residential b
- ○ Option 4: Enter city-specific residential and commercial building inventory data

City can depend on proxy data for remaining inputs if local data is not available.

Community Emissions by Sector 2015 to 2040



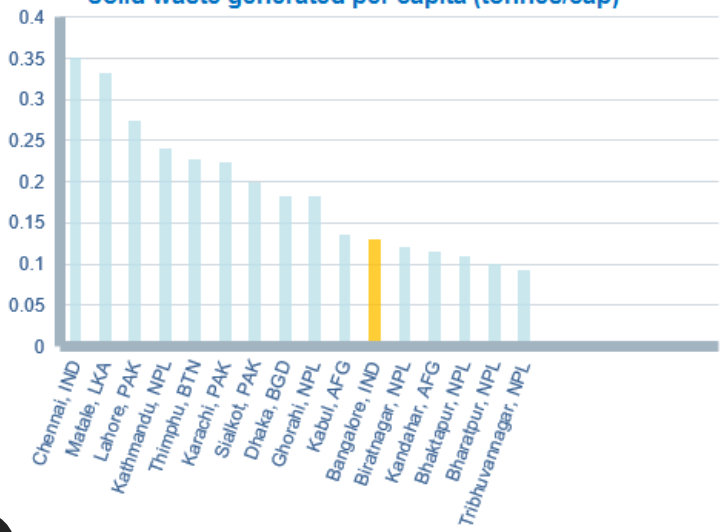
CURB uses population growth, GDP growth or International Energy Agency's methodology to estimate how a city's business-as-usual emissions trajectory will change over time

CURB offers forecasts of both energy demand and emissions

Benchmarking City Performance

How does your city compare to others in terms of emission-related performance indicators? Choose an action area and a key performance indicator (KPI) from the menu to compare your city to others in the chart below. The buttons below the chart allow to user to limit the comparison to other cities in the same region or climate, or to cities that have a similar human development index level. Choose the 'no filter' option if you wish to compare across the range of performance found in cities around the world.

Sector	Key Performance Indicators
Private Building Energy	Solid waste GHG emissions per capita
Municipal Buildings & Lighting	Solid waste generated per capita
Electricity Generation	Percentage of population with solid waste collection
Solid Waste	Percentage of solid waste recycled
Wastewater & Water	Percentage of solid waste biologically treated
Transportation	
All Sectors	



Based on current local data, CURB benchmarks a city against relevant peers over 20+ key performance indicators

Use the buttons below to compare to cities with similar characteristics. Once you have selected the comparison filter, push the desired indicator to update the chart.

Benchmark Comparison Filters:

Region | Development | Climate | No Filter

CURB helps cities assess the intervention areas over which it has authority to own and operate assets, set policies, and control budget. This ensures analyses are best targeted toward feasible interventions.

In what areas does your City have authority to take action?

Use the dropdowns below to indicate the level of control city officials have within each action area category.

Municipal Buildings and Public Lighting

Energy Efficiency in Municipal Buildings

Own/Operate Assets	Set/Enforce Policies and Regulation	Control Budget	Level of Authority:
Owns or operates asset/service	Sets AND enforces policies/ regulations	Controls budget for asset/function	*High*

Renewable Energy Systems on City Property

Own/Operate Assets	Set/Enforce Policies and Regulation	Control Budget	Level of Authority:
Partially owns or operates assets/service	Sets policies/ regulations, but does not enforce	Has influence over budget for asset/function	*High*

Public Street Lights

Own/Operate Assets	Set/Enforce Policies and Regulation	Control Budget	Level of Authority:
Owns or operates asset/service	Sets AND enforces policies/ regulations	Controls budget for asset/function	*High*

Traffic Lights

Own/Operate Assets	Set/Enforce Policies and Regulation	Control Budget	Level of Authority:
Partially owns or operates assets/service	Sets AND enforces policies/ regulations	Controls budget for asset/function	*High*

Other Public Outdoor Lighting (i.e., parks, parking lots)

Own/Operate Assets	Set/Enforce Policies and Regulation	Control Budget	Level of Authority:
Owns or operates asset/service	Sets AND enforces policies/ regulations	Controls budget for asset/function	*High*

Electricity Generation

Utility Electricity Generation

CURB helps users identify actions to focus on based on the city's assessment of its authority, the level of technical difficulty, and the cost and payback opportunities.

Which Actions Does the City Wish to Implement?

The following table summarizes the results of the 'City Powers' survey and provides information on difficulty of implementation, cost, and
this information and consider which actions the City would like to pursue. Navigate the the 4.B Action Development to define the impleme

Sector / Action Category / Action	Level of City Authority	Level of Technical Difficulty	Implementation Cost	Payback Duration	Emissions Reduction Potenti	
PRIVATE BUILDING ENERGY						
ENERGY EFFICIENCY & FUEL SWITCHING						
EXISTING RESIDENTIAL BUILDINGS						
Lighting - Residential	Moderate	Low	Low	Short	0.0%	Go to Action
Appliance and Electronics - Residential	Moderate	Low	Low	Short	0.0%	Go to Action
Space Heating - Residential	Moderate	High	Moderate	Moderate	0.0%	Go to Action
Cooling - Residential	Moderate	High	Moderate	Moderate	0.0%	Go to Action
Water Heating - Residential	Moderate	Moderate	Moderate	Moderate	0.0%	Go to Action
Water Fixtures - Residential	Moderate	Low	Low	Short	0.0%	Go to Action
Building Envelopes - Residential	Moderate	Moderate	Moderate	Moderate	0.0%	Go to Action
EXISTING INFORMAL RESIDENTIAL						
Lighting - Informal	Moderate	Low	Low	Short	0.0%	Go to Action
Space Heating - Informal	Moderate	Low	Low	Short	0.0%	Go to Action
Cooling - Informal	Moderate	Low	Low	Short	0.0%	Go to Action
Water Heating - Informal	Moderate	Moderate	Moderate	Moderate	0.0%	Go to Action
Cooking - Informal	Moderate	Moderate	Moderate	Moderate	0.0%	Go to Action
EXISTING COMMERCIAL BUILDINGS						
Lighting - Commercial	Moderate	Low	Low	Short	<1%	Go to Action
Appliances and Electronics - Commercial	Moderate	Low	Low	Short	<1%	Go to Action
Space Heating - Commercial	Moderate	High	Moderate	Moderate	<1%	Go to Action

Action Areas

Click on the action area you wish to develop actions within.

- Private Building Energy
- Solid Waste
- Municipal Buildings & Public Lighting
- Wastewater & Water
- Electricity Generation
- Transportation

Action Implementation Details

Provides access to action implementation year and implementation authority assumptions.

- Action Implementation Details

Action planning is grounded in city activity data and occurs across six sectors

CURB tracks city's energy or emissions reduction progress throughout the scenario development process

Municipal Building and Public Ligh

CO_2 Emissions Reduction Tonnes CO_2e/Year	% of Building Energy Emissions Reduced	Energy Reduction kWh/Year	$ Implementation Cost $US1000	Payback Period Years	Target Year
398,564	9.7%	487,848,849	-$162	$0	2020

2020 | 2030 | 2040

ENERGY EFFICIENCY & FUEL SWITCHING

Action		Emissions Abatement (tonnes CO2e/Year)	Percentage of Action Area	Energy Reduction (kWh/Year)	Implementation Cost ($US)	Payback Period (Years)
EXISTING MUNICIPAL OFFICE BUILDINGS						
Lighting	Go to Action					
Space Heating	Go to Action					
Cooling	Go to Action					
Building Envelope	Go to Action					
NEW MUNICIPAL OFFICE BUILDINGS						
Lighting	Go to Action					
Space Heating	Go to Action					
Cooling	Go to Action					
Building Envelope	Go to Action					

Results can be viewed instantaneously and impacts are presented in multiple terms.

PUBLIC LIGHTING ENERGY

Action		Emissions Abatement (tonnes CO2e/Year)	Percentage of Action Area	Energy Reduction (kWh/Year)	Implementation Cost ($US)	Payback Period (Years)
STREET & OTHER PUBLIC LIGHTING		150,165	38%	218,012,873	-$93,136	
Streetlights	Go to Action	150,165	38%	218,012,873	-$93,136	14.2
Traffic Signals	Go to Action					

MUNICIPAL DISTRIBUTED RENEWABLE ENERGY

Action		Emissions Abatement (tonnes CO2e/Year)	Percentage of Action Area	Energy Generated (kWh/Year)	Implementation Cost ($US)	Payback Period (Years)
RENEWABLES		248,398	62%	269,835,976	-$68,755	
Municipal PV	Go to Action	248,398	62%	269,835,976	-$68,755	9.4
TOTAL		**398,564**		**487,848,849**	**-$161,890**	

Municipal Building and Public Lighting

Progress Toward Target: 100%

Reduction in Sector Emissions: 12%

Municipal Lighting Efficiency & Controls - Existing

CO_2 Emissions Reduction Tonnes CO_2e/Year	% of Building Energy Emissions Reduced	Energy Reduction kWh/Year	$ Implementation Cost $US1000	Payback Period Years	Target Year
1,324	0.0%	1,922,800	-2,056	1.0	2020

Target Year: 2020 | 2030 | 2040

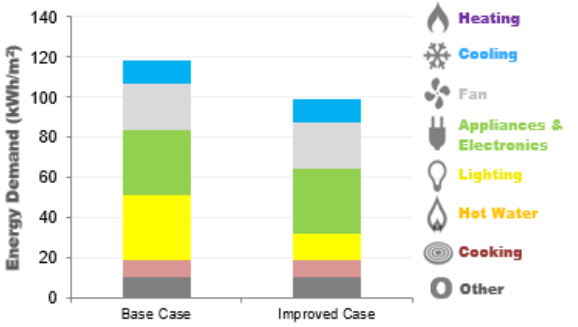
Action Implementation Assumptions:

Municipal

Reset Page to Baseline

Strategy 1	Fixture	Control
Baseline	Incandescent	None
Proposed	LED	Occupancy Controls
Saturation	Percent of Total	Floor Area
	50%	50,000 m²

Strategy 2	Fixture	Control
Baseline	CFL	None
Proposed	LED	Daylighting
Saturation	Percent of Total	Floor Area
	70%	70,000 m²



User establishes the deployment rate for each intervention and can see impact in bar above and graphs to the right

Solid Waste

Progress Toward Target: 100%

Reduction in Sector Emissions: 4%

Food and Yard Waste Management

CO_2 Emissions Reduction[1] Tonnes CO_2e/Year	% of Solid Waste Emissions Reduced	Energy Generated[2] kWh/Year	$ Implementation Cost $US1000	Payback Period Years	Target Year
51,680	4.1%	NA	-$38,424	148.1	2020

2020 | 2030 | 2040

Action Implementation Assumptions:

In this example, open dumping and incineration of food and yard waste are decreased while composting and anaerobic digestion are increased

Food Scrap Management

	Recycle	Open Dump	Landfill	Compost	Incineration	Anaerobic Digestion	Open Burning	
Baseline Management		44.1%	0.0%	38.8%	16.9%	0.0%	0.0%	
Proposed Management		38.0%	0.0%	45.0%	10.0%	7.0%	0.0%	√ =100%

Reset to Baseline

Baseline Quantity (k tonnes)		343.0	0.0	302.0	131.9	0.0	0.0
Proposed Quantity (k tonnes)		295.8	0.0	350.3	77.8	54.5	0.0

Yard Waste Management

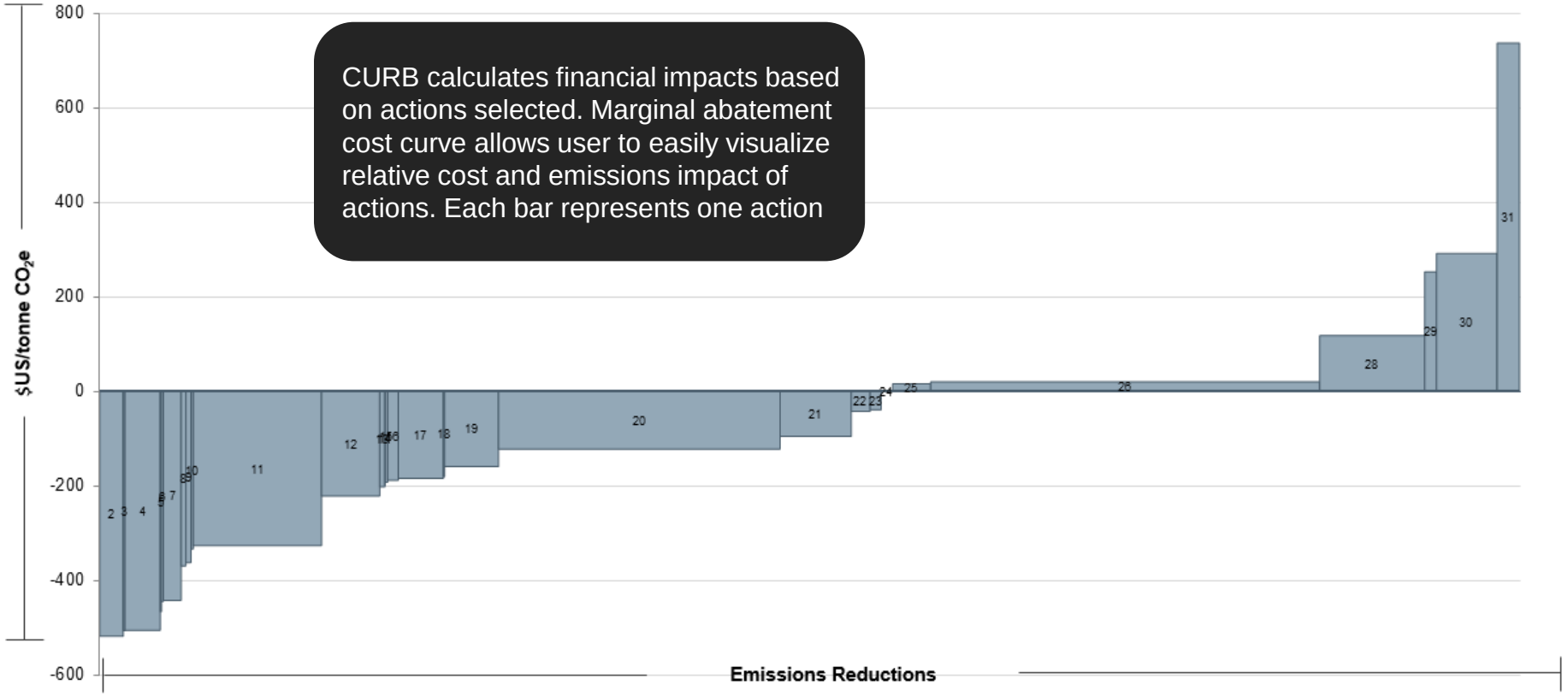
	Recycle	Open Dump	Landfill	Compost	Incineration	Anaerobic Digestion	Open Burning	
Baseline Management		50.8%	0.0%	50.8%	0.0%	0.0%	0.0%	
Proposed Management		40.0%	0.0%	60.0%	0.0%	0.0%	0.0%	√ =100%

Reset to Baseline

Emission Abatement Cost Curve

The chart below provides an emissions abatement cost curve for the selected actions. Each action is indicated by a rectangle. The width of the rectangle (on the horizontal axis) shows the emission reduction potential of the action. The height of the rectangle indicates cost of the action. Actions with positive costs are above the zero line. Actions below the zero line are expected to result in savings (or negative costs).

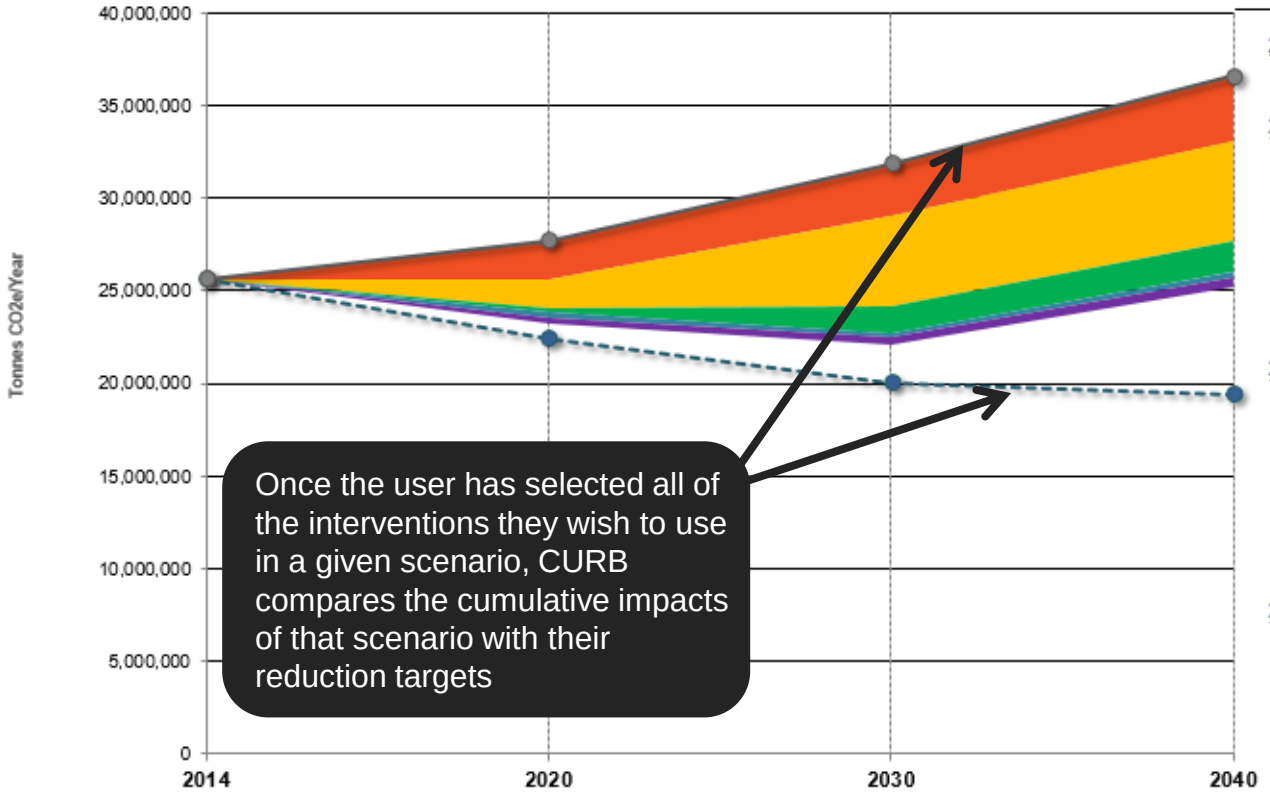
$/t CO_2e



Emission Reduction Performance of Selected Actions

The chart below shows the greenhouse gas reduction potential per sector of the City's selected actions for the years 2019, 2025, and 2040. Note that the user can adjust the targets on this page and this will adjust the values in the Target Setting page in the Inventory Module.

2019 Target: 16% | 2025 Target: 36% | 2040 Target: 43% | National/Regional Actions: Show within Sectors



Once the user has selected all of the interventions they wish to use in a given scenario, CURB compares the cumulative impacts of that scenario with their reduction targets

CO2e/Year	Emissions Metric
2014 Base Year Emissions Level	
25,626,867	Base Year
2020 Emissions Levels	
27,691,864	Baseline Forecast
19%	Target (% below 2020 baseline level)
22,430,410	Allowable Emissions
23,217,657	Achieved w/ Actions
787,248	Achievement Gap
2030 Emissions Levels	
31,822,313	Baseline Forecast
37%	Target (% below 2030 baseline level)
20,048,057	Allowable Emissions
22,053,111	Achieved w/ Actions
2,005,054	Achievement Gap
2040 Emissions Levels	
36,568,849	Baseline Forecast
47%	Target (% below 2040 baseline level)
19,381,490	Allowable Emissions
25,226,260	Achieved w/ Actions
5,844,770	Achievement Gap

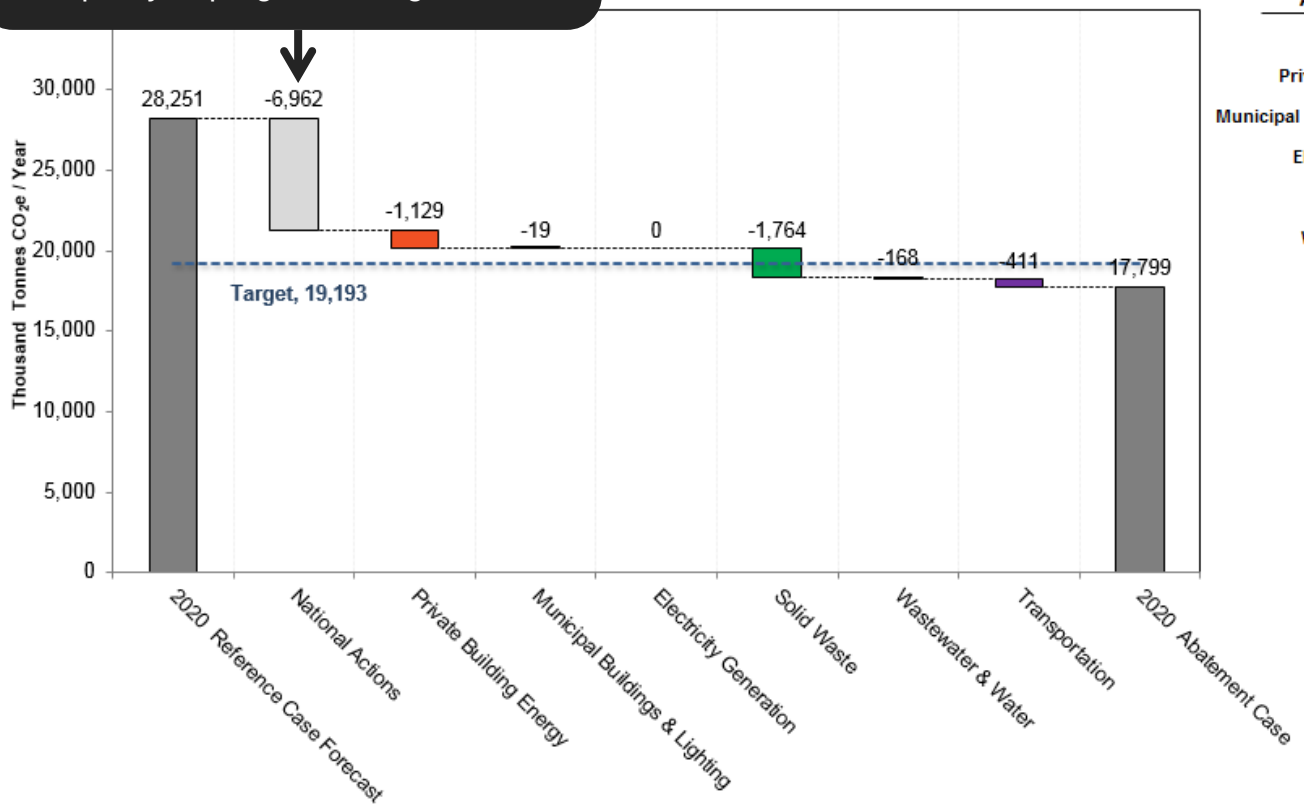
Abatement Potential per Sector in 2020

tential of the selected actions per action area for the target year. Use the toggle above to change the target year.

2020
2035
2050

CURB differentiates the impacts that result from sovereign (national) interventions with those being driven by local policy or program changes

National/Regional Actions: Show Separately



Abatement Potential in 2020

Action Area	t CO_2e/Year
National Actions:	6,961,751
Private Building Energy:	1,128,676
Municipal Buildings & Lighting:	18,937
Electricity Generation:	0
Solid Waste:	1,763,592
Wastewater & Water:	167,855
Transportation:	410,664

2020 | 2030 | 2040

CURB summarizes the emissions, energy, and financial impacts of all actions

Action Summary - 2020

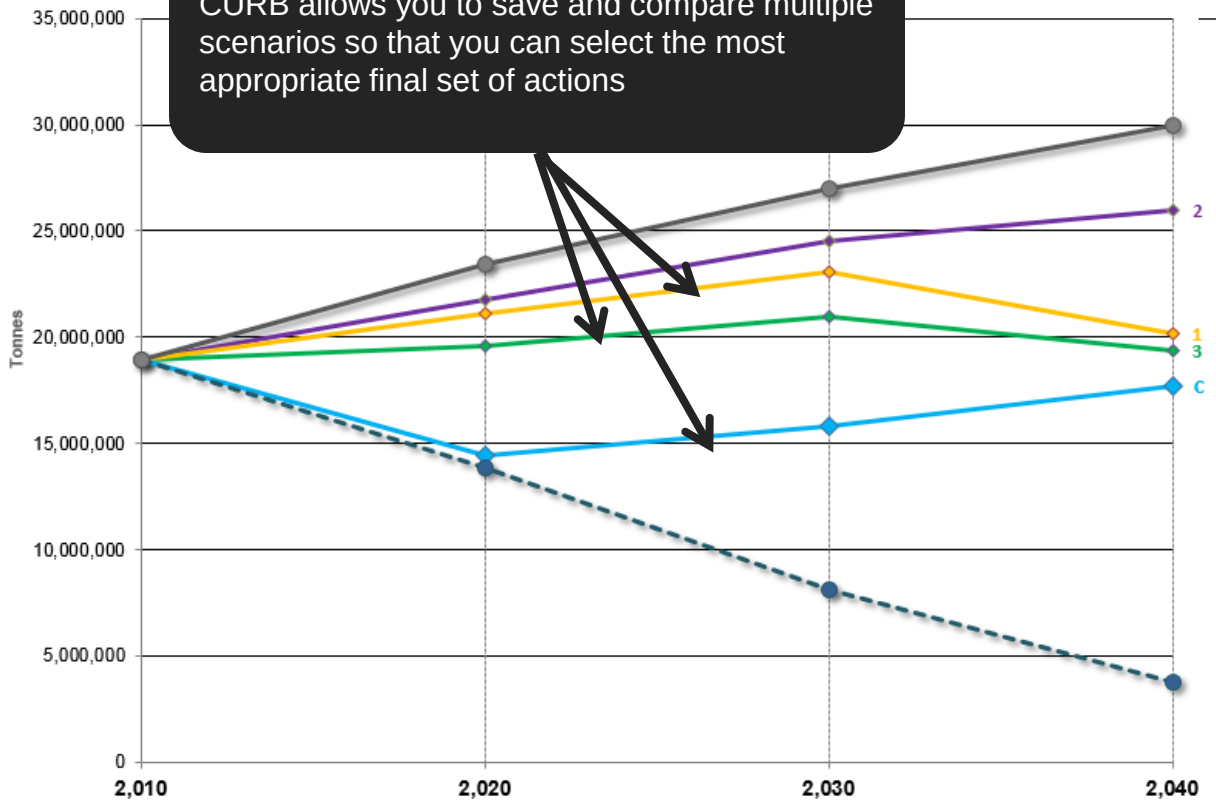
The following table summarizes the emission reduction, energy savings, and cost performance of the selected act

Sector / Action Category / Action	Local or National/ Regional Action	Emission Reductions (tonnes CO2e/year)	Percentage of Total Reductions	Energy Reduction (kWh/year)	Implementation Cost ($US1000/year)	Payback Period (Years)
PRIVATE BUILDING ENERGY		**82,547**	**16%**	**119,842,789**	**-$126,332,583**	
ENERGY EFFICIENCY & FUEL SWITCHING		82,547	16%	119,842,789	-$126,332,583	
EXISTING RESIDENTIAL BUILDINGS		82,547	16%	119,842,789	-$126,332,583	
Lighting - Residential (Existing)	Local	82,547	16%	119,842,789	-$126,332,583	1.2
Appliance and Electronics - Residential (Existing)	Local	0	0%	0	$0	NA
Space Heating - Residential (Existing)	Local	0	0%	0	$0	NA
Cooling - Residential (Existing)	Local	0	0%	0	$0	NA
Water Heating - Residential (Existing)	Local	0	0%	0	$0	NA
Water Fixtures - Residential (Existing)	Local	0	0%	0	$0	NA
Building Envelopes - Residential (Existing)	Local	0	0%	0	$0	NA
ELECTRICITY GENERATION		**933,351**	**181%**	**NA**	**$9,075**	
GRID DECARBONIZATION		933,351	181%	NA	$9,075	
Grid Decarbonization	National/Regional	933,351	181%	NA	$9,075	No Payback
SOLID WASTE		**-865,664**	**-168%**	**126,000**	**-$1,075,474**	
WASTE MANAGEMENT		-865,780	-168%	0	-$1,075,474	
Paper Waste Management	Local	-374,700	-73%	NA	-$382,388	2.6
Food Scrap & Yard Waste Management	Local	-477,980	-93%	NA	-$701,099	5.6
Other Organic Waste Management	Local	-13,100	-3%	NA	$8,013	No Payback
Plastic Waste Management	Local	379,690	74%	NA	-$786,218	1.2
WASTE-TO-ENERGY		0	0%	0	$0	
Anaerobic Digestion Optimization	Local	0	0%	0	$0	NA
Incineration Optimization	Local	0	0%	0	$0	NA

Emission Reduction Performance of Alternative Scenarios

The chart below shows the greenhouse gas reduction potential of the alternative scenarios and their component actions and implementation assumptions for the years 2019, 2025, and 2040. Use the dropdown list on the bottom right to view the target achievement of a specific scenario.

CURB allows you to save and compare multiple scenarios so that you can select the most appropriate final set of actions



Tonnes CO2e/Year	Emissions Metric
Baseline Emissions	
18,960,478	Base Year
23,468,989	2020 Baseline Forecast
27,012,625	2030 Baseline Forecast
30,002,597	2040 Baseline Forecast
Emission Targets	
13,841,149	2020 Target
27%	below base year levels
8,153,005	2030 Target
57%	below base year levels
3,792,096	2040 Target
80%	below base year levels
Performance of Selected Scenario	
14,457,834	2020 Scenario Emissions
23.7%	below base year levels
15,838,895	2030 Scenario Emissions
16.5%	below base year levels
17,705,116	2040 Scenario Emissions
6.6%	below base year levels

Select Scenario: Current Scenario

For more information

curb@worldbank.org