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BEST Cities:

Benchmarking and Energy Savings Tool for Low Carbon Cities

Software User Guide v.1.4

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PART I: Hardware and Software Requirements

Hardware and Software

The **B**enchmarking and **E**nergy-**S**aving **T**ool for Low Carbon **Cities** (**BEST Cities**) is designed to work with either a PC or Mac. For PC users, please first be sure that you have one of the following Windows operating systems: Microsoft Windows XP (32 bit), Windows Vista (32 bit and 64-bit), or Windows 7 (32 bit and 64 bit). For Mac users, Mac OS X v10.6 or v10.7 (32 bit and 64 bit) is required.

Next, please download an auxiliary software called Adobe Air from http://get.adobe.com/air/. Then download and install the BEST Cities tool from http://best-tool.lbl.gov/BEST_Tool.air

This user guide is available in pdf form at https://china.lbl.gov/tools/benchmarking-and-energy-saving-tool-low.

Tool Housekeeping

Tool Updates. When the BEST Cities tool gets an update, either due to de-bugging, or expansion or revision of functionality, users will be prompted to download the latest version of the tool when they run the tool. When prompted, please follow the update instructions shown on the screen.

Data Collection Worksheet Location. To facilitate data collection, users can use a separate, stand-alone worksheet to gather data for input to the BEST Cities. The worksheet is located inside the "Documents" box at the lower-right corner of the tool.

Input Data File Location. Once users create a city profile and input and save required data, the city file with input data is saved on user's computer as .xml file.

Graphics and Reports Export. Analysis from the tool, including graphics or simple reports (in .csv format), can be exported to the user's computer.

PART II: Low Carbon Cities and Best Cities Methodology

1. Purpose of the BEST Low Carbon Cities Tool

The **B**enchmarking and **E**nergy-**S**aving **T**ool for Low Carbon **Cities** (***BEST Cities***) is a dynamic decision-making tool, designed to assist local policy makers and urban planners in prioritizing strategies for energy and carbon saving at the city level in China.[1]

China's 12th Five-Year Plan (2011-2015) targets a reduction in carbon intensity of the economy (CO_2 emissions per unit of GDP) by 17%. In the "Low Carbon Development 2014-2015 energy saving action plan," the State Council calls for interim targets of more than 4% in 2014 and more than 3.5% in 2015. The State Council also calls for energy intensity saving (energy consumption per unit of GDP) of more than 3.9% per year for 2014 and 2015. The longer-term goal is to reduce carbon intensity by 40-45% from 2005 to 2020.

With targets for low-carbon development featuring prominently in the 12th FYP and longer-term planning, cities must determine ***how*** to meet targets and promote a climate-friendly city. The BEST Cities tool can help.

2. Methodology Overview

The ***BEST Cities*** tool has three main modules:

(1) Inventory and Benchmarking,
(2) Sector Prioritization, and
(3) Policy Analysis for low carbon development.

Whereas other tools may focus on energy but not carbon, or provide a policy database but not a prioritization mechanism, the BEST Cities methodology combines these components to facilitate development of a low carbon action plan. Figure 1 provides an overview of the tool (BEST Cities home page). Table 1 summarizes the features of the tool.

[1] Though designed to support China's rapidly developing cities, the tool may be used for cities internationally.

Figure 1. BEST Low Carbon Cities – Overview of Functions

Table 1. Design Features of BEST Low Carbon Cities

Feature	BEST Low Carbon Cities
Principal Components	3 Modules: Inventory and Benchmarking; Sector Prioritization; Policy Analysis
Sectors Covered	9 Sectors: Industry, Public & Commercial Buildings, Residential Buildings, Transportation, Power & Heat, Public Lighting, Solid Waste, Water & Wastewater, Urban Green Space
Benchmarking KPIs	35 Key Performance Indicators (KPIs): across 9 sectors and city-wide
Sector Prioritization	3 Criteria: sector improvement potential, sector carbon emissions, city authority in each sector
Policy Recommendations	72 energy efficiency and carbon emissions reduction policies across 9 sectors
Policy Attributes	3 Attributes: carbon savings potential, first cost to government, speed of implementation
Policy Prioritization	3 Criteria: match city capabilities with each policy's needs for human resources (technical and managerial), finances, and enforcement
Program Output	Ability to export numerous graphs and reports, including benchmarking graphs, priority policies, and policy details.

3. Low Carbon Development Plans and Actions

The main purpose of the BEST Cities tool is to assist with preparing and implementing a low carbon development plan. The tool may be useful for city officials, urban planners, and energy and environmental specialists. Figure 2 shows the main steps in low carbon development, akin to climate action planning. BEST Cities includes the Energy and Carbon Inventory step, Benchmarking to inform the target setting step, and Policy Analysis to help cities choose policy strategies and implement them.

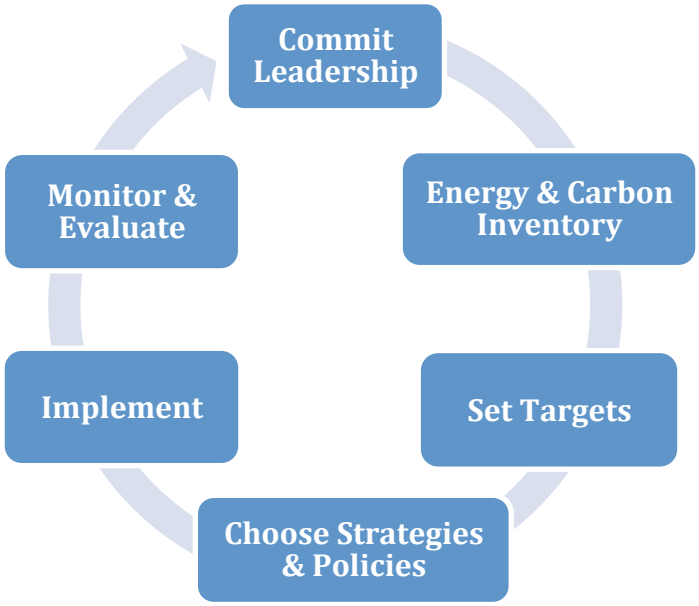


Figure 2. Steps in Low Carbon Development

4. Data Gathering

The design of BEST Cities aimed for moderate data requirements – sufficient for inventory, benchmarking, and policy selection, but not too time-consuming to collect. For the City & Sector Data section, the user is asked to input city-wide information on population, total primary energy consumption, total greenhouse gas (GHG) emissions, gross domestic product (GDP), the city's climate zone, the city's Human Development Index (HDI), and the share of industry and service sector GDP. The user is also asked to input annual energy consumption data by fuel for each of the nine end-use sectors in the tool.

BEST-Cities has been designed to consider data availability in China. Much of the required data is available to city authorities in local statistical yearbooks or through other sources. Because many Chinese statistics are reported in units of 10^4, the BEST Cities tool follows these units. To facilitate data gathering, the tool is accompanied by a spreadsheet, shown in Appendix 1. The tool can still function if missing some data, though a more complete dataset is necessary to give more accurate results. Once the data are entered, the tool generates the city's Energy & Carbon

Inventory, providing final energy use and CO_2 equivalent emissions for each of the nine end-use sectors.

5. Energy and Carbon Inventory

Energy and Carbon Inventory. The tool quickly assesses local energy use and carbon-related greenhouse gas emissions (carbon dioxide (CO_2) and methane (CH_4)) across nine city sectors:

- Industry,
- Public and Commercial Buildings,
- Residential Buildings,
- Transportation,
- Power and Heat,
- Street Lighting,
- Water and Wastewater,
- Solid Waste, and
- Urban Green Space.

Since the user enters fuel consumption in physical units (e.g. metric tons of coal consumed), the Inventory component of BEST Cities uses fuel energy conversion factors from China's National Bureau of Statistics (NBS, 2011) and uses CO_2 and CH_4 emissions factors from the Intergovernmental Panel on Climate Change (IPCC, 1996; IPCC 2006). China-specific carbon sequestration conversion coefficients (EC, 2012) and energy unit conversion factors for power and heat by Province are used (NBS, 2011).[2]

Though most of the greenhouse gas emissions calculated by the tool are energy-related, a few sector have non-energy emissions or sequester carbon. Emissions from the Solid Waste sector are methane emissions from decomposition of organic waste. For the Urban Green Space sector, the tool calculates the uptake of CO_2 by urban vegetation, i.e., carbon sequestration. As a result, emissions for the Urban Green Space sector are negative.

6. Benchmarking of Low Carbon Indicators

Benchmarking. Cities can use the tool to benchmark their energy and carbon performance to other cities inside and outside China, and identify those sectors with the greatest energy and carbon saving potential. The tool conducts benchmarking on 35 low-carbon Key Performance

[2] Due to data limitations, emissions calculations are based on production – not consumption - for both power generation and heat. For electricity, the conversion factor is based on total fuel consumption for power generation within a province divided by total electricity output. For a province with a substantial power imports, the production-side calculations may over- or understate the emissions factor of power consumed depending on the origin of the imported electricity. For heat, such issues are unlikely, since there is not long distance trade of heat.

Indicators (KPI), as well as related indicators on air quality (e.g., Air Quality Days, PM2.5 concentration) and urbanization (e.g., population density).
BEST Cities includes a database of more than 200 cities, with available indicator data for each city. The indicator data were compiled from multiple datasets. Because each dataset focuses on different indicators, the coverage of KPIs for each city varies. As users voluntarily share their KPI data, the tool will incorporate it into the KPI database for better benchmarking.

Table 2 lists the indicators for each city sector, as well as city-wide indicators on energy, carbon, and the economy. One indicator per sector (in **blue** text) is designated as "Representative" and used later to estimate the improvement potential and priority policies for each sector.

Note that many of the indicators in Table 2 have targets specified in the 12th FYP. For example, Industrial Energy Intensity (tce/10^4 RMB), is a key indicator for the Industrial sector, while Share of Renewable Energy in Electricity Supply (%) is an important indicator for a low carbon Power and Heat sector.

Figure 3 gives an example of benchmarking results for the Industry sector, on industrial economic energy intensity (tonnes of coal equivalent per 10,000 RMB). The example City A is compared to other cities of similar population, in rank order. From this result it can be see that City A (shown in the golden bar) has a relatively high industrial energy intensity, likely due to a heavy industrial base.

Though BEST Cities doesn't directly calculate annual progress on particular targets, the tool does provide the indicator and benchmarking information for a city to track their performance.

Table 2. Key Performance Indicators for Low-Carbon Cities in China

KPI #	KPI Name	Unit of measure
City-wide		
CW01	Primary Energy Consumption per capita (city-wide, per year)	tce/person
CW02	GHG Emissions per capita (city-wide, per year)	tCO_{2e}/person
CW03	GDP per capita (city-wide, per year)	10^4 RMB/person
CW11	Energy Intensity (city-wide, economic)	tce/ 10^4 RMB
CW12	Carbon Intensity (city-wide, economic)	tCO_{2e}/ 10^4 RMB
Industry*		
IN01	**Industrial Economic Energy Intensity** (Final Energy consumption/unit industrial value added)	tce/10^4 RMB
IN02	**Industrial Carbon Intensity** (GHG emissions/unit of industrial value added)	tCO_2e /10^4 RMB
IN03	**Share of Fossil Fuel in Industrial Energy** (excluding heat and electricity)	%
IN04	**Share of Electricity Use in Industrial Energy**	%
Public and Commercial Buildings		
BL01	**Public buildings electricity intensity**	kWh/m^2
BL03	**Share of Green Buildings** (% of city-wide floor space designated as "Green" building or similarly labeled building)	%
Residential Buildings		
BL02	**Residential buildings energy use per capita**	tce/person
BL05	Share of District heating supplied by cogeneration facilities	%
Transportation		
TR01	**Transportation energy use per capita**	tce/person
TR02	**Extent of Public Transit Lines** (length of rail and bus lines in city area)	km/km^2
TR03	**Mode Share of Non-motorized Transport** (% of trips by walking and bicycling)	%
TR04	**Mode share of public transit** (% of trips by bus and rail)	%
Power & Heat		
PH01	**Share of Renewable Energy in local electricity supply**	%
Street Lighting		
SL01	**Electricity Intensity of Street Lighting** (Grid-connected electricity consumed per km of lit roads per year)	kWh/km
Solid Waste		
SW01	**Municipal solid waste disposed per capita** (per year)	kg/person
Water & Wastewater		
WW01	**Water consumption per capita** (per year)	m^3/person
WW02	**Electricity intensity of potable water supply**	kWh/m^3
WW03	**Energy intensity of Wastewater treatment**	tce/10^4 m^3
Urban Green Space		
UG01	**Urban Green Space per capita**	m^2/person

Notes: All indicators are on a yearly basis.

Indicators in blue are "Representative" and used to calculate the Sector Improvement Potential.

* The Industry sector also includes Indicators for energy intensity – physical (tce/tonne) or economic (tce/10^4 RMB) – for Industrial sub-sectors: Steel Production, Building Materials, Cement Production, Flat Glass Production, Chemical Industry, Synthetic Ammonia Production, Ethylene Production, Textile Production, and Food Industry.

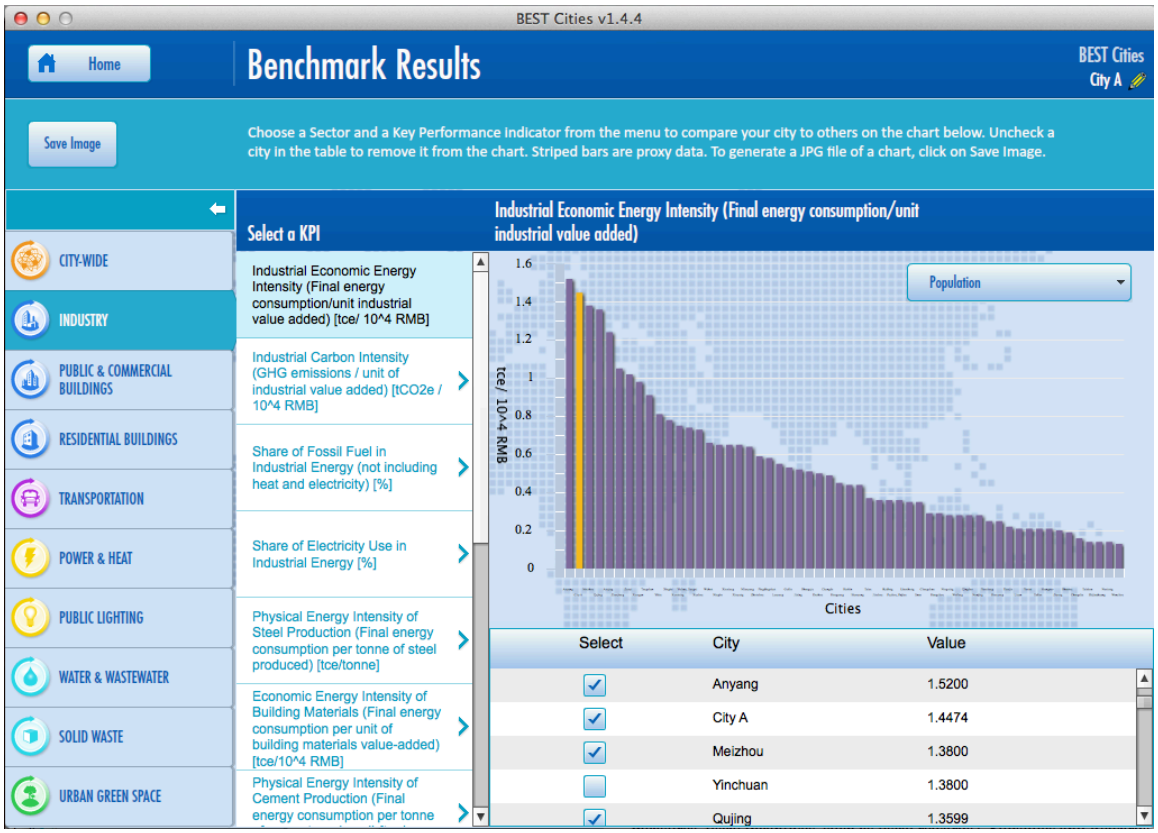


Figure 3. Industry Sector Benchmark Results: Industrial Energy Intensity (tce/10,000 RMB)

7. Sector Improvement Potential and Prioritization

In the next component of the tool, BEST Cities considers the carbon saving potential determined from benchmarking, as well as the city's level of authority for decision-making in each city sector, to prioritize sectors with the greatest potential for energy and carbon saving. This component has three sections: 1) Sector Improvement Potential, 2) City Authority, and 3) Sector Prioritization Results.

Sector Improvement Potential. Based on the earlier benchmarking results, BEST Cities estimates the Sector Improvement Potential for one "Representative" KPI for each sector. For example, for the Residential Buildings sector, the Representative KPI is residential buildings energy use per capita. For the Power and Heat sector, the Representative KPI is the share of renewable energy

in the local electricity supply. The BEST-Cities sector improvement potential value is calculated as:

$$\text{Sector Improvement Potential [\%]} = \frac{|\,\mathrm{KPI_{City}} - \mathrm{KPI_{average\ better}}\,|}{\mathrm{KPI_{City}}} \qquad \text{(eq. 1)}$$

$$\mathrm{KPI_{average\ better}} = \frac{\sum KPI_{equal\ to\ or\ better\ than\ the\ city\ being\ benchmarked}}{\#\ of\ cities\ equal\ or\ better} \qquad \text{(eq.2)}$$

where the $KPI_{average\ better}$ is the mean of the values of all chosen peer cities with better performance.

In the Residential Building sector, for example, if ten peer cities used less energy per capita than your city (i.e., the ten peer cities performed "better" than your city), the improvement potential is the difference between the average value of those ten peer cities' residential energy per capita, and that of your city, divided by the residential energy per capita in your city,

The improvement potential is a simple, rough estimate, for the purpose of selecting policy strategies to pursue for energy and carbon savings. If the user desires, the calculated potentials can be overridden based on their knowledge of the actual savings potentials in each sector.

City Authority. Decision-making authority is another consideration in prioritizing low carbon actions at the city level. While some actions—such as improving energy efficiency of local government buildings—can easily be undertaken within local jurisdiction, other actions—such as renewable electricity supply—may need approval from higher levels of government. If a sector has a large improvement potential but limited city authority, it can still be worthwhile for a city to undertake the coordination needed for action in the sector. Appendix 3 provides definitions of city authority utilized in the BEST Cities tool.

Sector Prioritization. The overall Sector Prioritization Score considers the magnitude of sector greenhouse gas emissions, as well as the potential for improvement and the city's jurisdictional authority in each sector.

Sector Prioritization Score = Sector Improvement Potential (%)
x Sector CO_2e Emissions (10^4 tCO_2e) x City Authority [eq. 3]

For example, in many Chinese cities, the Power and Heat sector is very carbon-intensive, has high emissions, and has much potential for improving the share of renewable energy in electricity generation. De-carbonizing electric power supply would result in large carbon savings. Yet local government officials currently have limited authority to change the generating mix for the Power sector. As a result, the Power and Heat sector may not have the highest Sector Prioritization Score.

8. Policy Analysis and Prioritization

Policy Analysis. ***BEST Cities*** helps city authorities prioritize action across city sectors and evaluate the appropriateness of more than 70 policy strategies that can save energy and carbon. By identifying those strategies most relevant to local circumstances, the tool helps local government officials develop a low carbon city action plan that can be implemented in phases, over a multi-year timeframe.

The *Policy Analysis* module of the tool has five parts: 1) City Capability, 2) Policy Appraisal, 3) Policy Review, 4) Policy Matrix, and 5) Priority Policies.

City Capability. BEST Cities examines three areas of city government capabilities for each sector: (1) Finance, (2) Human Resources, and (3) Policy Enforcement. The tool asks the user to characterize city capabilities as High, Medium, or Low for each area, for each sector. For example, in the Residential Buildings sector, city officials might have a Medium level of financing for residential building programs; High human resources, in terms of skilled staff; and Medium enforcement capabilities with numerous construction companies. Appendix 5 gives the definitions of capabilities for the three areas of City Capability.

Policy Appraisal. In the Policy Appraisal component of the tool, the focus shifts from sector to individual policies. This component of BEST Cities matches City Capabilities in each sector with the capabilities (or competencies) needed for each of the 72 policies in the tool's database, to identify feasible low carbon actions for the city to implement. See Table 3 for a summary of low carbon policies included the tool.

The Policy Appraisal section ranks policies based on the results of the assessment of the capabilities of the city in terms of project finance, human resources, and policy, regulation, and enforcement in each prioritized sector, comparing each policy's minimum requirements against the self-assessed levels of capabilities and opportunity in the city. The color-coding of appraisal results works on the simple traffic light system: green indicates good compatibility, yellow marginal compatibility, and red poor compatibility. The initial appraisal is undertaken to give guidance to the city; it is not prescriptive and it is the responsibility of the city to determine which policies will be taken further.

Policy Review. The Policy Review section displays all policies selected through the Policy Appraisal along with their attributes: Speed of Implementation, Carbon Savings Potential, and First Cost to Government. This is a very useful summary of recommended policies, which the user can sort by clicking on any of the policy attributes. The estimated range of values for these policy attributes are from the BEST-Cities database, based on the size of the city; see Appendix 6 for the values. The tool also allows the user to override the estimated values and enter a more specific value of Carbon Savings Potential or First Cost, based on the city's own analysis. The Policy Review can be exported as a report.

Table 3. BEST-Cities Policies and Programs

Sector	Policy/Program	Sector	Policy/Program
Industry	Benchmarking	Transportation	Bicycle Path Networks
	Energy Audit / Assessments		Bike Share Programs
	Industrial Energy Plan		Clean Vehicle Programs
	Stretch Targets for Industry		Complete Streets
	Incentives and Rewards for Industrial Energy Efficiency		Vehicle CO_2 Emission Standards
	Industrial Energy Efficiency Loans and Innovative Funds		Mixed-Use Urban Form
	Tax Relief		Integrated Transportation Planning
	Energy or CO_2 Tax		Public Transit Infrastructure: Light Rail, BRT, and Buses
	Industrial Equipment and Product Standards		Parking Fees and Measures
	Differential Electricity Pricing		Public Education on Transport Options
	Energy Management Standards		Vehicle License Policies
	Energy Manager Training		Commuting Programs
	Recycling Economy and By-product Synergy Activities		Vehicle Fuel Economy Standards
	Low-carbon Industrial Parks		Congestion Charges, and Road Pricing
	Fuel-switching		Bicycle Path Networks
Public & Commercial Buildings	More Stringent Local Building Codes	Power & Heat	Minimum Performance Standards for Thermal Power Plants
	Green Building Guidelines for New Buildings		Load Curtailment Incentives/Demand Response/Curtailable Rates
	Expedited Permitting for Green Buildings		Power Investment subsidies and tax incentives for Renewable Energy
	Targets for Efficient and Renewables in Buildings		Time-based Electricity Pricing Schemes: Inclining Block Pricing and Time-of- Use Pricing
	Building Energy Labeling and Information Disclosure		Transformer Upgrade Program
	Mandatory Building Energy-Efficiency Audit		District Heating Networking Maintenance and Upgrade Program
	Public Education Campaigns on Building Energy Efficiency and Conservation		Renewable Energy and Non-fossil Energy Targets or Quotas
	Municipal Building Energy Efficiency Task Force	Public Lighting	Public Lighting Plan
	Energy Performance Contracting and Energy Service Companies		Audit and Retrofit Programs
	Retrofit Subsidies and Tax Credits for Existing Buildings	Water & Wastewater	Public Education Measures
	Subsides for New Buildings that Exceed Building Code		Methane Capture and Reuse/ Conversion

	City Energy and Heat Maps		Active Leak Detection and Pressure Management Program
	Cooperative Procurement of Green Products		Prioritize Energy Efficient Water Resources
	Financial Incentives for Distributed Generation in Buildings		Facility Operator Training Program
Residential Buildings	Reach Standards for Efficient Appliance and Equipment		Water Management Plan
	Building Workforce Training		Improve Efficiency of Pumps and Motors
	Green Building Guidelines for New Buildings		Codes, Consumer Education, and Incentives for Water-Efficient Products
	More Stringent Local Building Codes		Public Education Measures
	City Energy and Heat Maps	Solid Waste	Recycling and Composting Mandate and Program
	Building Energy Labeling and Information Disclosure		Landfill Methane Recovery
	Targets for Efficient and Renewables in Buildings		Integrated Solid Waste Management Planning
	Expedited Permitting for Green Buildings		Waste Composting Program
	Retrofit Subsidies and Tax Credits for Existing Buildings		Waste Vehicle Fleet Maintenance, Audit and Retrofit Program
	Subsides for New Buildings that Exceed Building Code		Anaerobic Digestion
	Energy-Efficient Equipment and Renewable Energy Technology Purchase Subsidies		Public Education Program
	Public Education Campaigns on Building Energy Efficiency and Conservation	Urban Green	Urban Green Space
			Urban Forestry Management

Policy Matrix. The Policy Matrix provides a graphical, color-coded display of priority policies in a 3 x 3 matrix, sorted by First Cost and CO_2 Emissions Reduction Potential. Check boxes allow the user to alter the display based on their preferences for Speed of Implementation.

Detailed Policy Recommendations. From multiple sections of Policy Analysis, the user can click on the name of a policy to view more information. BEST Cities contains a database of more than 70 low carbon policies, including a 2-4 page explanation and characterization of each policy. The detailed policy sheets include:

- Policy Description
- Implementation Strategy and Challenges
- Monitoring Metrics
- Case Studies
- Policy Attributes:

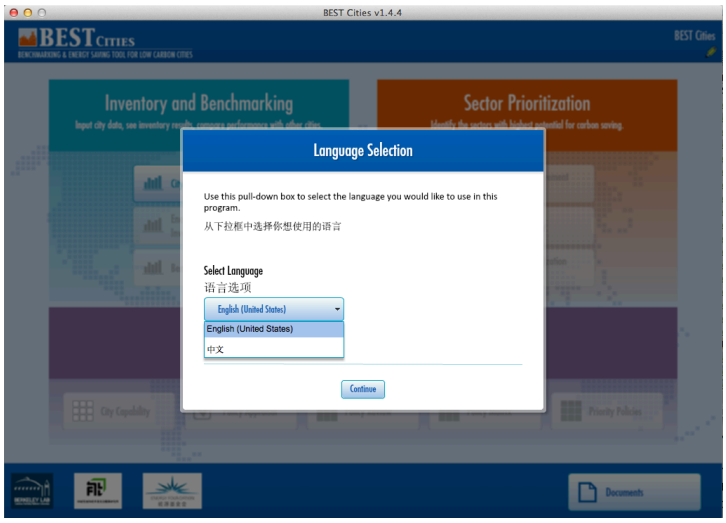
    - Carbon Savings Potential,
    - First Cost to Government,
    - Speed of Implementation
- Tools and Guidance
- References

Priority Policies. This final component of the tool presents a ranked listing of priority policies for your city's Low Carbon Development Plan. The Priority Policies can be exported as a report and utilized in other documents as needed by the city.

PART III: Screen-by-Screen User Guide

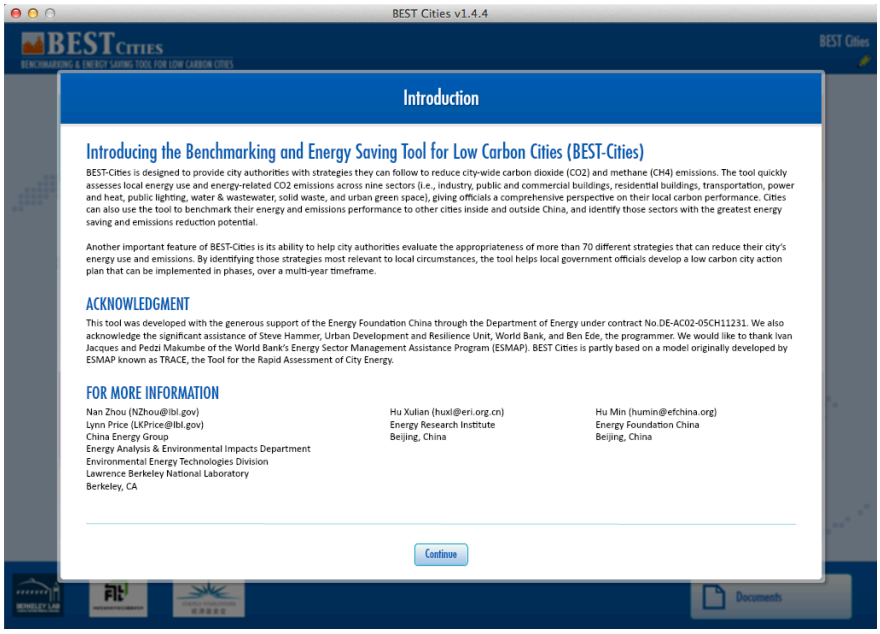
Screen 1: Language Selection

When the BEST Cities tool is first launched, the user can select to view the tool in English or Chinese.



Screen 2: Introduction

The second screen appearing after launch of the tool is the Introduction, including an overview, Acknowledgements in tool development, and contact information for inquiries or feedback about BEST Cities.



Screen 3: City and Climate Selection

The **City and Climate Selection** screen allows users to specify a new city for data entry, or to load city data previously entered. City data input into BEST Cities is saved on user's computer or server as .xml file.

Specifying the Chinese province in which the city is located enables benchmarking with provincial data, for example Industrial energy intensity (energy per unit GDP).

BEST Cities also utilizes the city's climate zone for benchmarking purposes. For example, to compare energy consumption in Residential Buildings, which is strongly influenced by heating and cooling demand, it is appropriate to benchmark with cities in the same climate zone.
The **City and Climate Selection** screen shows the China climate zone map; this information is also included in Appendix 2 of the User Guide.

Screen 4: BEST Low Carbon Cities Homepage

All main functions of the BEST Cities tool are accessed from the homepage. The "Home" button on other pages returns the user to this screen.

The homepage shows the three main modules of the ***BEST Cities*** tool:

(1) Inventory and Benchmarking,
(2) Sector Prioritization, and
(3) Policy Analysis for low carbon development.

The pencil icon allows user to change city name, climate, and province.

"Documents" gives user access to details of more than 70 Policy Recommendations

Navigation and Data Units

Much of the BEST Cities tool is organized by city **sector**, with a menu of city sectors on the left-hand side of the screen. Clicking on a sector brings up the associated screen, for data, energy and carbon inventory, benchmarking, improvement potential, city authority, city capabilities, etc.

Data units follow the conventions in Chinese statistics, often using increments of ten thousand, 10^4 (rather than Western scientific notation with increments of 10^3). Energy units are converted to common units of metric tonnes of coal equivalent (tce) and presented as 10^4 tce. Greenhouse gas emissions are expressed as tonnes of CO_2 equivalent (tCO_2e), including carbon-based greenhouse gasses as appropriate (CO_2 and CH_4). Emissions are expressed as 10^4 tCO_2e. Metric units are used for other parameters (e.g., square meters of building area or green space).

Screen 5: City & Sector Data

The screens for City and Sector data gather information on your city as a whole, and for specific sectors. Fill in data as completely as possible, since any missing data may affect benchmarking and policy results. If a particular piece of data cannot be obtained, or is not applicable to your city, leave the box blank.

Enter only numbers in the "Quantity" cells.

In the appropriate cells, note the Year and Data Source for each data point.

The City Data section asks for city-wide information on population, total primary energy consumption, total greenhouse gas (GHG) emissions, gross domestic product (GDP), the city's climate zone, the city's Human Development Index (HDI), and the share of industry and service sector in city GDP. For the Sector Data, input annual energy consumption data, by fuel, for each of the nine end-use sectors in the tool. BEST-Cities has been designed to consider data availability in China. Much of the required data is available to city authorities in local statistical yearbooks or through other sources.

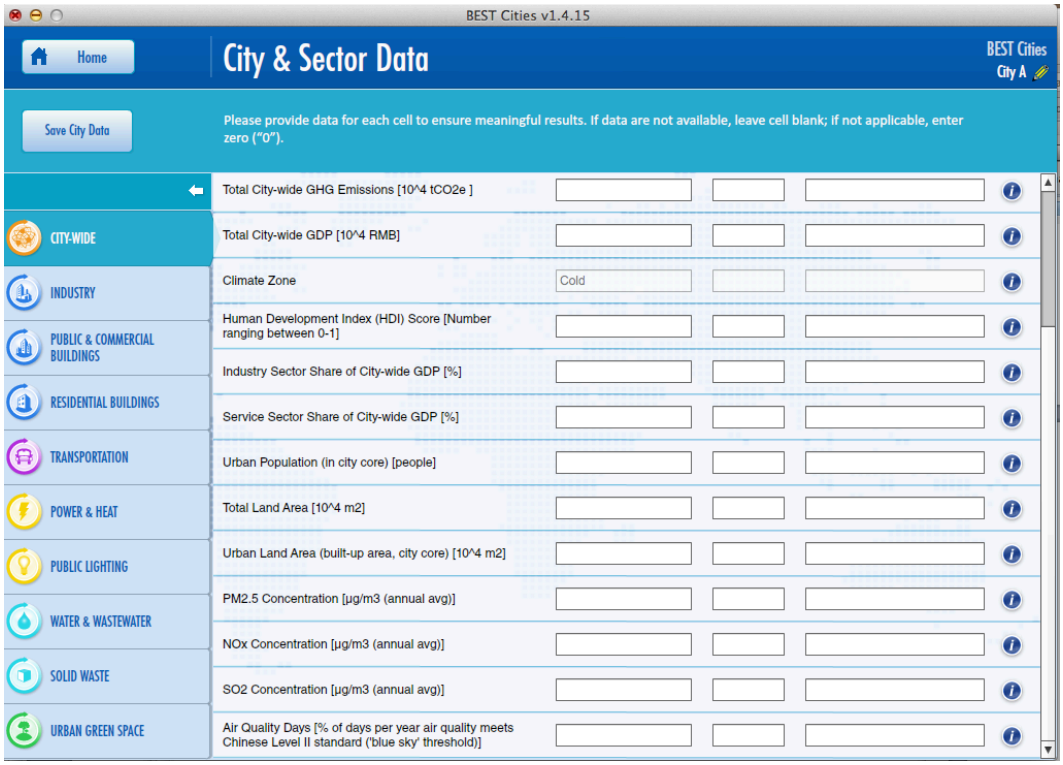
The screen shots below show most of the data required city-wide and for each sector. In the tool, you must scroll down (using the scroll bar on the right-hand side of the screen) to see all the data fields. Appendix 1 summarizes all the data needed in a spreadsheet (in Chinese) to help with data gathering.

Start by entering the City-wide Data. You may enter the data in any order, and continue on to any sector. However, if you move on to another screen before completing data entry, the tool will give a warning:

> *Data are missing. Please provide data for each cell to ensure meaningful results. If data are not applicable, enter zero ("0"). Choose "return" to fill in missing data now. Choose "Continue" if data are not available at this time; come back later to fill in blank cells. Warning: your results will not be accurate if data are missing.*

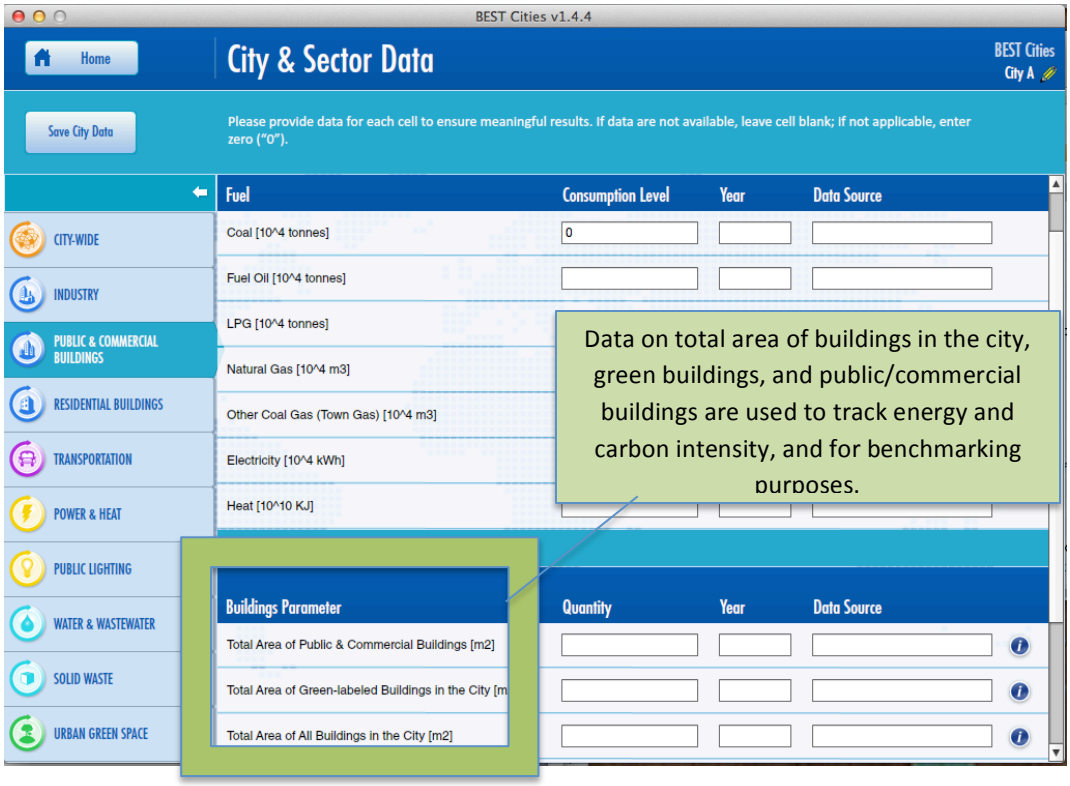
Save your city data (using the "Save City Data" button in the upper left-hand corner of the screen) whenever you quit the BEST Cities software; the tool will also prompt you to save your city data.

Screen 5.1: City-wide Data

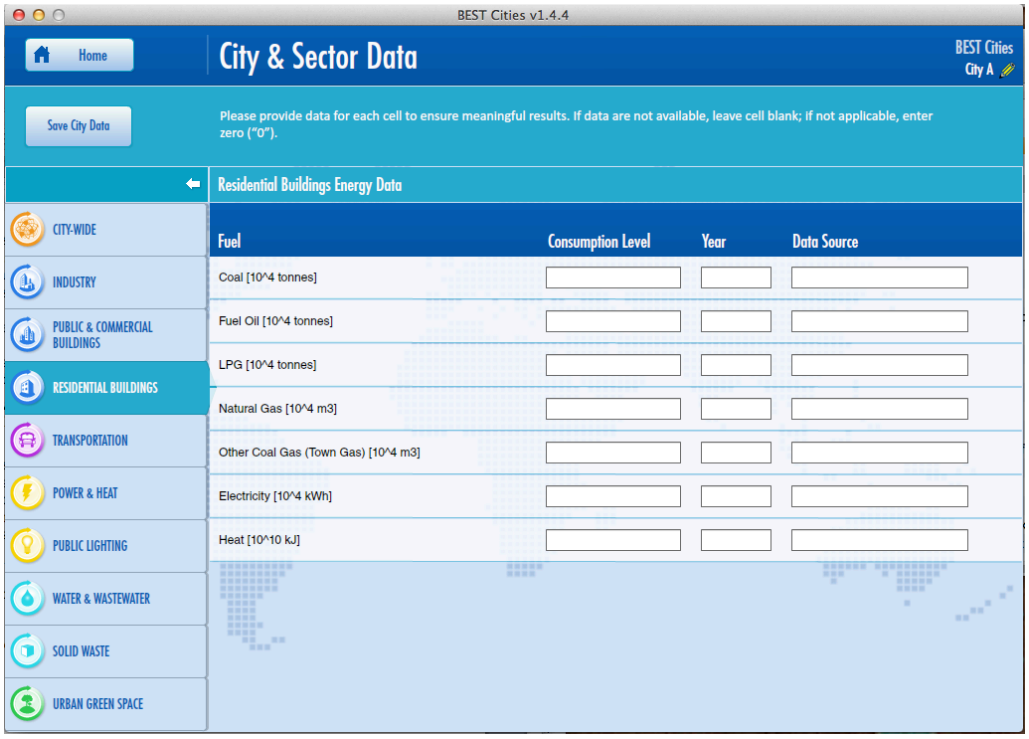


Screen 5.2: Industry Data

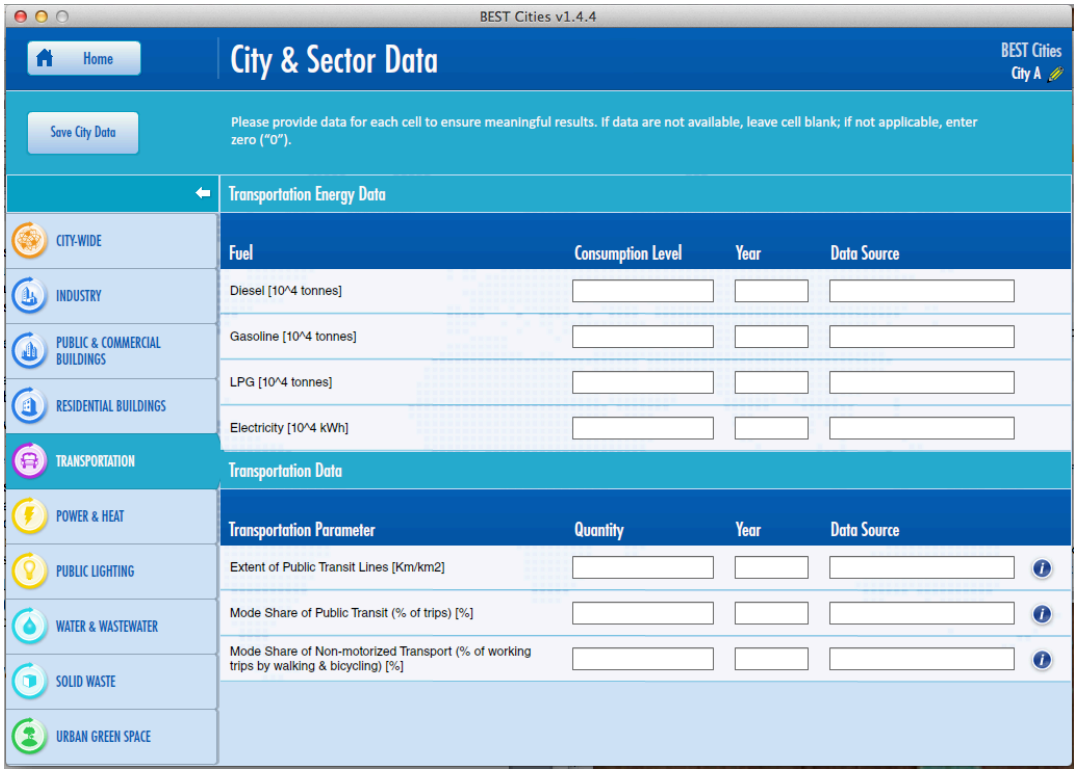
Screen 5.3 Public & Commercial Buildings Data



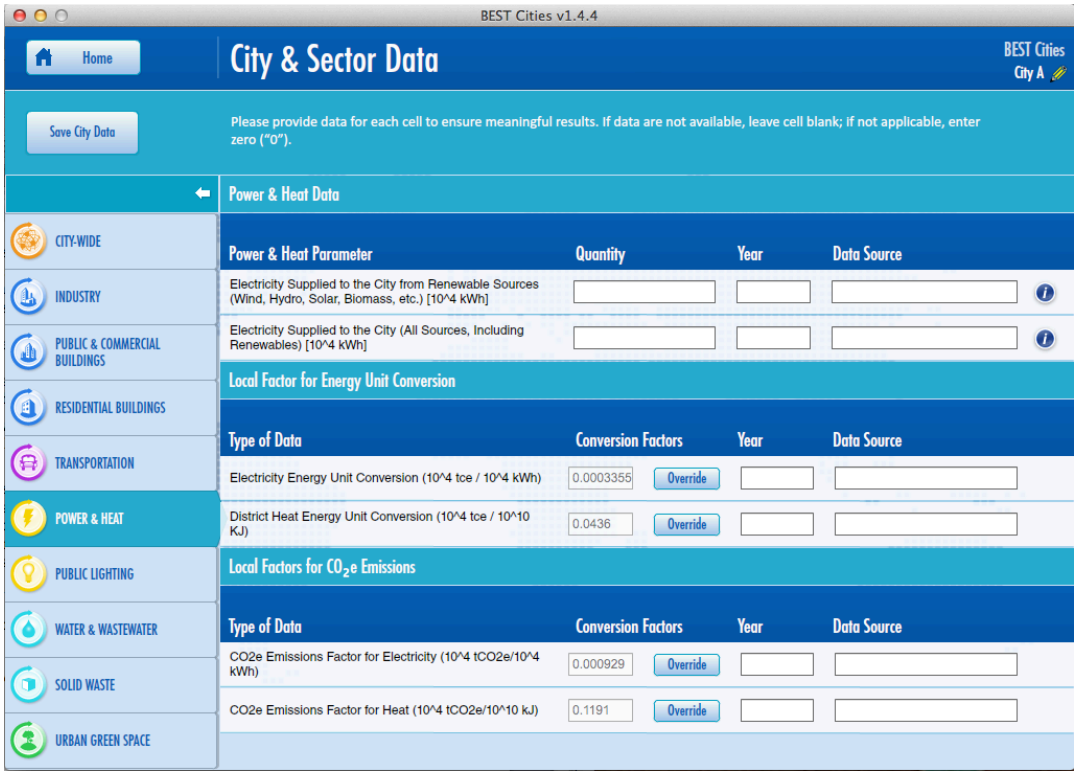
Screen 5.4: Residential Buildings Data



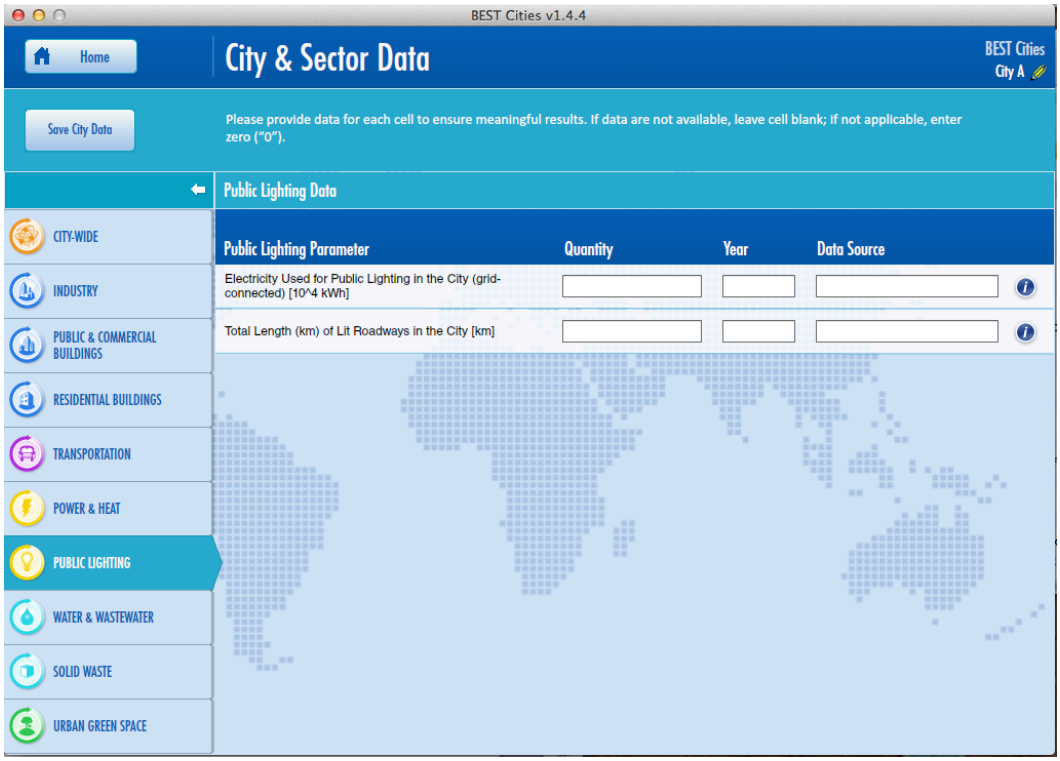
Screen 5.5: Transportation Data



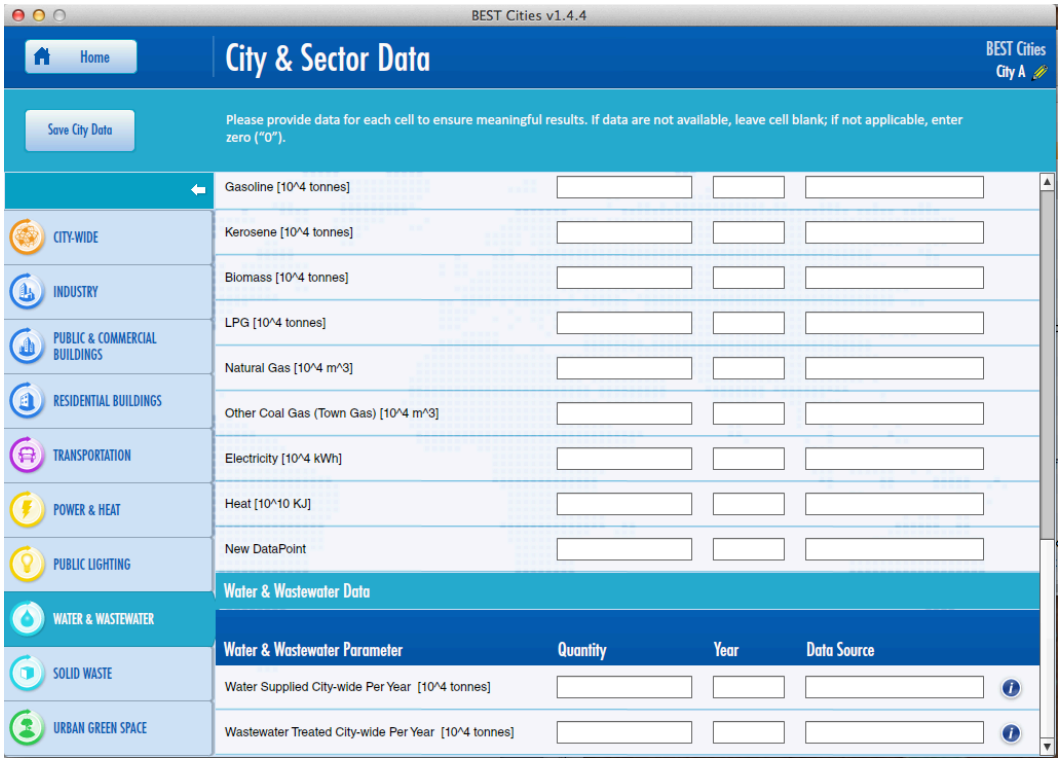
Screen 5.6: Power & Heat Data



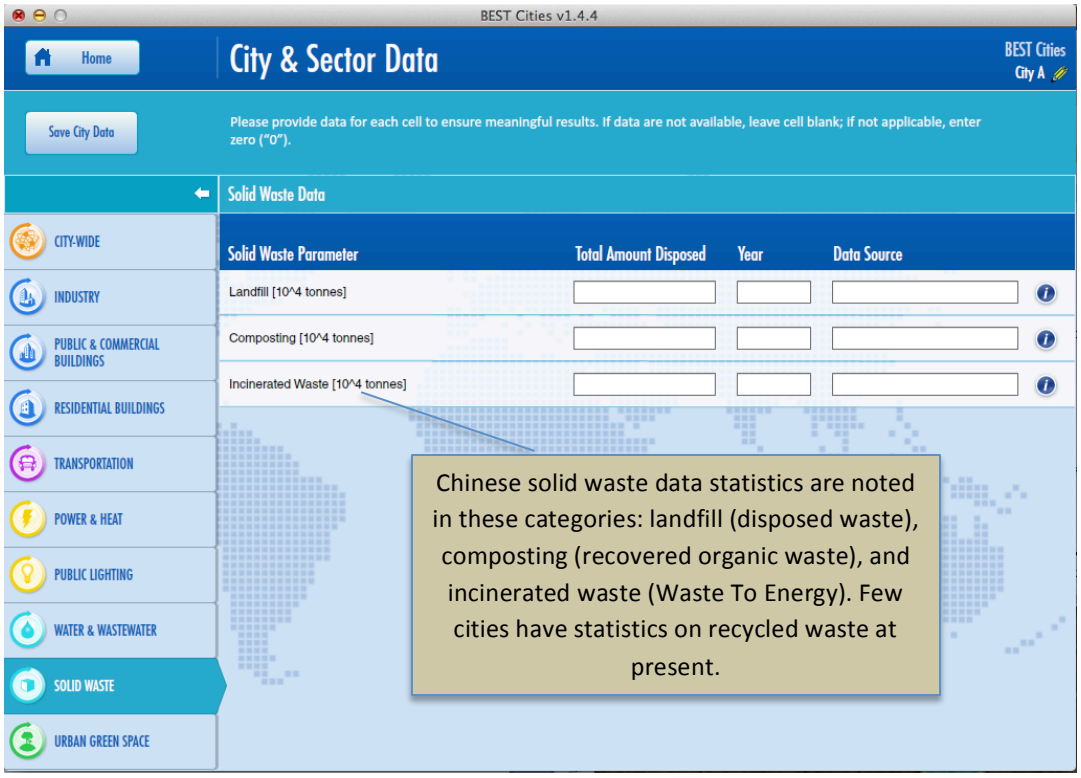
Screen 5.7: Public Lighting Data



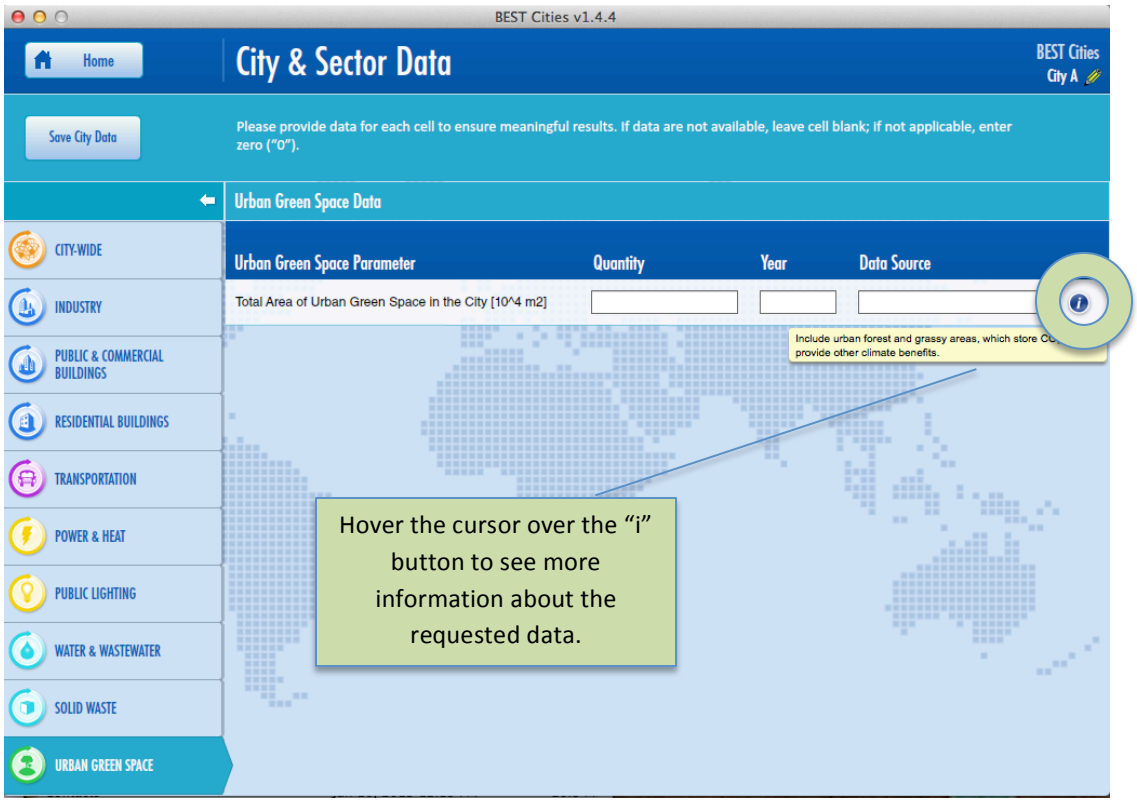
Screen 5.8: Water & Wastewater Data



Screen 5.9: Solid Waste Data



Screen 5.10: Urban Green Space Data



Screen 6 Energy & Carbon Inventory

Once the city and sector data are entered, the tool generates the city's Energy & Carbon Inventory, providing final energy use and CO_2 equivalent emissions for each of the nine sectors. Since the user enters fuel consumption in physical units (e.g. metric tons of coal consumed), the tool uses fuel energy conversion factors from China's National Bureau of Statistics (NBS, 2011) and uses CO_2 emissions factors from the Intergovernmental Panel on Climate Change (IPCC, 1996; IPCC 2006). The tool also uses China-specific carbon sequestration conversion coefficients (EC, 2012) and province-level energy unit conversion factors for power and heat (NBS, 2011).[3]

The City-wide inventory show the total *primary* energy consumption and carbon emissions reported by the city, as well as the sector *final* energy totals calculated by the BEST Cities tool. Because the tool is calculating sector end-use energy, and attributing emissions to the sector using the energy, electricity (power) and heat are included in the other end-use sectors on this screen. Due to these different approaches to energy and carbon accounting, the *reported* total city-wide inventory and the sum of the *calculated* sector inventories will result in different numbers.

The inventory screens for each sector show the fuel, energy consumption in units of 10^4 tce, and carbon emissions in units of 10^4 t CO_2e.

[3] Due to data limitations, emissions calculations are based on production – not consumption - for both power generation and heat. For electricity, the conversion factor is based on total fuel consumption for power generation within a province divided by total electricity output. For a province with a substantial power imports, the production-side calculations may over- or understate the emissions factor of power consumed depending on the origin of the imported electricity. For heat, such issues are unlikely, since there is not long distance trade of heat.

Screen 6.0 Energy unit conversion factors and carbon emissions factors

6.0.1 Fuel Energy Conversion Coefficients

	Fuel	Energy Conversion Coefficient	units	Year	Data Source
P1	Coal	0.7143	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P2	Coke	0.9714	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P3	Crude Oil	1.4286	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P4	Diesel	1.4571	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P5	Fuel Oil	1.4286	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P6	Gasoline	1.4714	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P7	Kerosene	1.4714	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P8	Biomass	0.4645	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P9	LPG	1.7143	10^4 tce/ 10^4 tonne	2010	China Energy Statistical Yearbook 2011
P10	Natural Gas	1.33E-3	10^4 tce/10^4 m3	2010	China Energy Statistical Yearbook 2011
P11	Other Coal Gas (Town Gas)	1.786E-5	10^4 tce/10^4 m3	2010	China Energy Statistical Yearbook 2011

6.0.2 Energy Unit Conversions for Power & Heat, by Province

Province	P12: Electricity energy unit conversion (10^4 tce /10^4 kWh)	P13: District Heat energy unit conversion (10^4 tce/10^10 kJ)
Anhui	3.24E-04	0.0399
Beijing	2.73E-04	0.0406
Chongqing	2.88E-04	0.049
Fujian	2.43E-04	0.0379
Gansu	2.67E-04	0.0415
Guangdong	2.73E-04	0.041
Guangxi	2.20E-04	0.0574
Guizhou	2.90E-04	0.0523
Hainan	2.95E-04	0.0117
Hebei	3.28E-04	0.0465
Heilongjiang	3.91E-04	0.0567
Henan	3.43E-04	0.0489
Hubei	2.00E-04	0.0615
Hunan	2.46E-04	0.0438
Inner Mongolia	3.99E-04	0.0596
Jiangsu	2.80E-04	0.0374
Jiangxi	3.14E-04	0.0512
Jilin	3.60E-04	0.0501
Liaoning	3.69E-04	0.0484
Ningxia	3.57E-04	0.0461
Qinghai	1.77E-04	0.0378
Shandong	3.36E-04	0.0436
Shanghai	2.77E-04	0.041
Shanxi	3.43E-04	0.0459
Shaanxi	3.20E-04	0.0435
Sichuan	2.08E-04	0.0285
Tianjin	3.21E-04	0.0421
Xinjiang	3.13E-04	0.0426
Yunnan	2.52E-04	0.051
Zhejiang	2.65E-04	0.0376

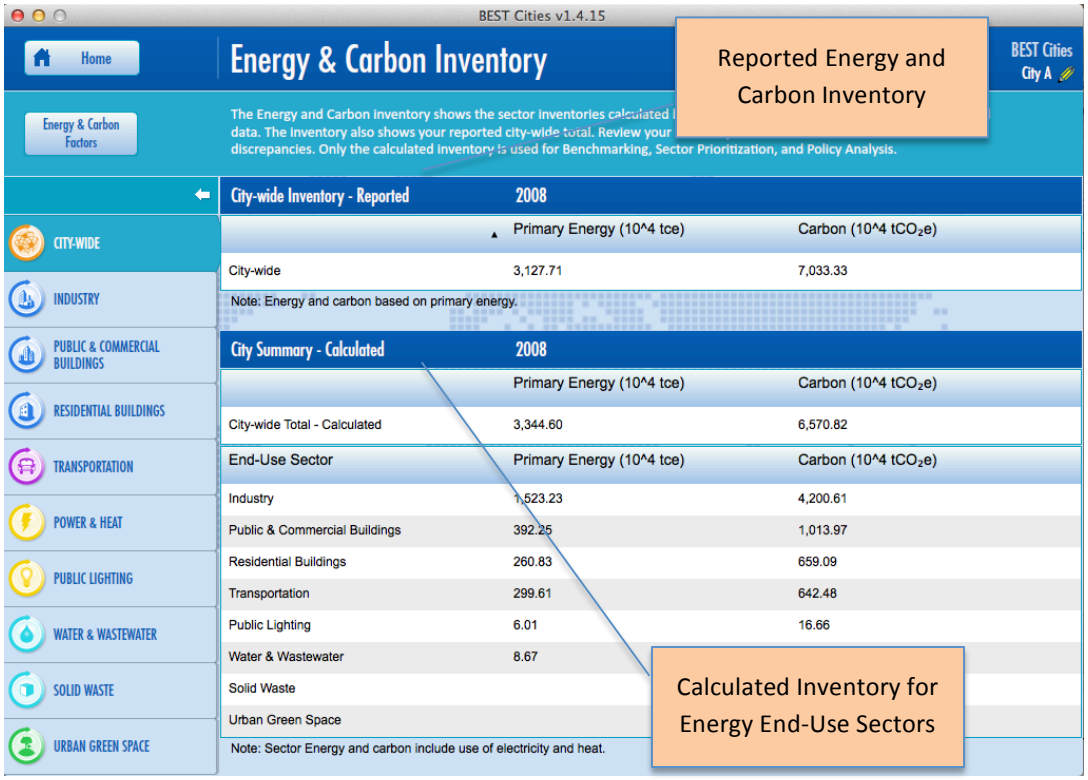
6.0.3 Carbon Emission Factors for Selected Fuels

	Fuel	CO2e Emission Factors for Fuels (10^4 tCO2e/10^4 tce)	Source
Q1	Coal	2.812	IPCC 1996
Q2	Coke	2.769	IPCC 1996
Q3	Crude Oil	2.147	IPCC 1996
Q4	Diesel	2.168	IPCC 1996
Q5	Fuel Oil	2.265	IPCC 1996
Q6	Gasoline	2.028	IPCC 1996
Q7	Kerosene	2.104	IPCC 1996
Q8	Biomass	3.209	IPCC 1996
Q9	LPG	1.846	IPCC 1996
Q10	Natural Gas	1.642	IPCC 1996
Q11	Other Coal Gas (Town Gas)	3.166	China Energy Statistical Yearbook 2011

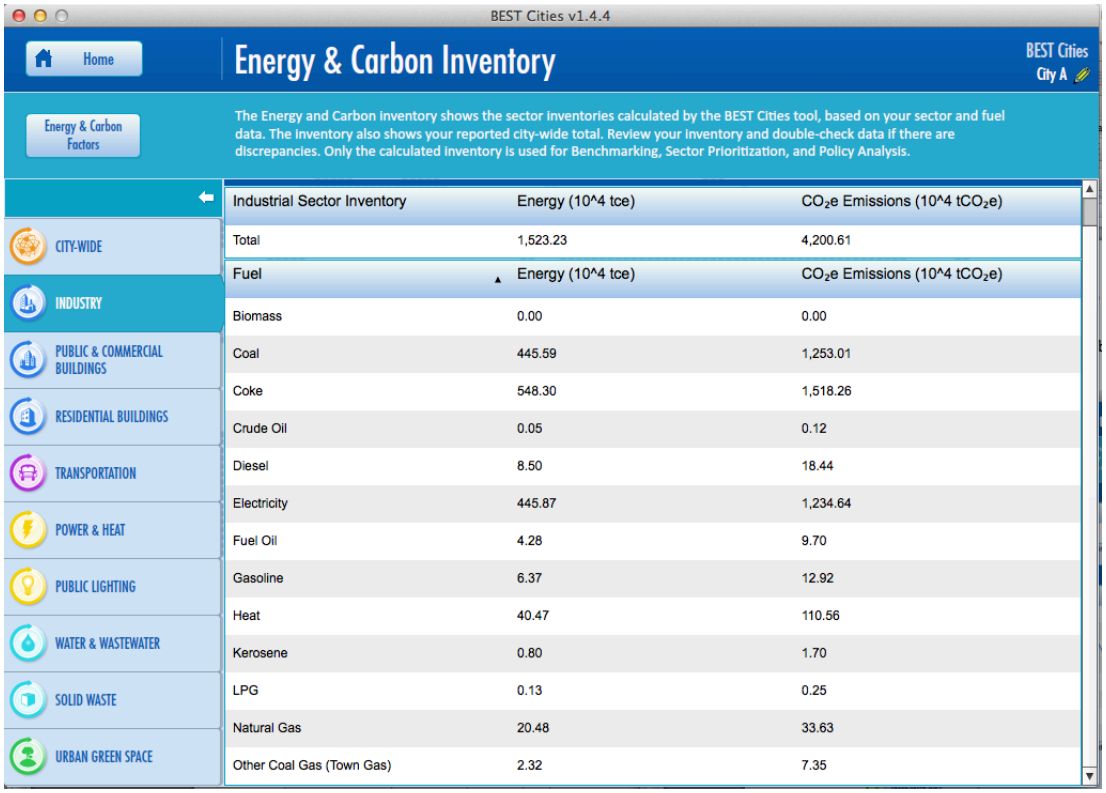
6.0.4 CO2e Emission Factors for Power & Heat (by Province)

Province	Q12: CO2e Emission Factor for Electricity (10^4 tCO2e /(10^4 kWh)	Q13: CO2e Emission Factor for Heat (10^4 tCO2e /10^{10} kJ)
Anhui	9.040E-04	0.1080
Beijing	6.590E-04	0.1002
Chongqing	6.940E-04	0.1346
Fujian	5.370E-04	0.0999
Gansu	6.280E-04	0.1126
Guangdong	6.470E-04	0.1058
Guangxi	4.850E-04	0.1588
Guizhou	7.190E-04	0.1449
Hainan	6.970E-04	0.0251
Hebei	9.060E-04	0.1248
Heilongjiang	1.049E-03	0.1515
Henan	9.150E-04	0.1332
Hubei	3.410E-04	0.1438
Hunan	5.670E-04	0.1257
Inner Mongolia	1.076E-03	0.1647
Jiangsu	7.470E-04	0.1026
Jiangxi	8.220E-04	0.1377
Jilin	9.230E-04	0.1370
Liaoning	9.940E-04	0.1298
Ningxia	9.730E-04	0.1267
Qinghai	2.140E-04	0.0756
Shandong	9.290E-04	0.1191
Shanghai	7.490E-04	0.1069
Shanxi	9.460E-04	0.1247
Shaanxi	8.610E-04	0.1184
Sichuan	3.390E-04	0.0714
Tianjin	8.840E-04	0.1143
Xinjiang	7.790E-04	0.1148
Yunnan	4.970E-04	0.1413
Zhejiang	6.690E-04	0.1037

Screen 6.1 City-wide Energy & Carbon



Screen 6.2 Industrial Sector Inventory



The other energy-based sectors have a similar format for their energy and carbon inventory results:

6.3 Public & Commercial Buildings Sector Inventory

6.4 Residential Buildings Sector Inventory

6.5 Transportation Sector Inventory

6.6 Power & Heat Sector Inventory

6.7 Public Lighting Sector Inventory

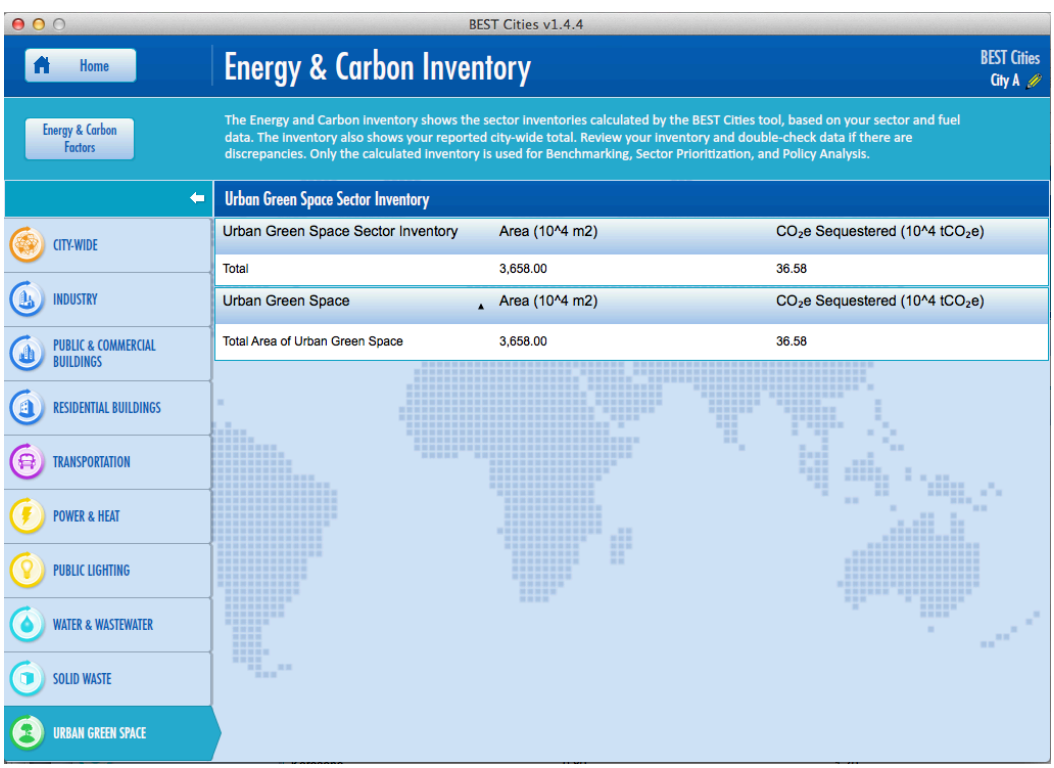
6.8 Water Supply & Wastewater Treatment Inventory

6.9 Solid Waste Sector Inventory

The Solid Waste sector inventory shows the amount of waste treated in each waste category and emissions (mainly CH_4) due only to landfilled waste.

6.10 Urban Green Space (Carbon Sequestration)

Unlike the other city sectors, which consume energy and emit greenhouse gasses, Urban Green Space sequesters carbon. Even if the amount of carbon sequestration is relatively small, the inclusion of trees and other vegetation has multiple environmental, climatic, and social benefits. The inventory screen for Urban Green Space shows the area of green space and the amount of CO_2e sequestered.



Screen 7: Benchmark Results

Utilizing City and Sector Data, as well as results of the Energy and Carbon Inventory, BEST Cities calculates 35 Key Performance Indicators (KPIs) for your city. The tool then conducts benchmarking of those KPIs with other cities in China and internationally, drawing on a database of more than 200 cities. The KPIs are reported as ratios so that they can be easily compared across cities.

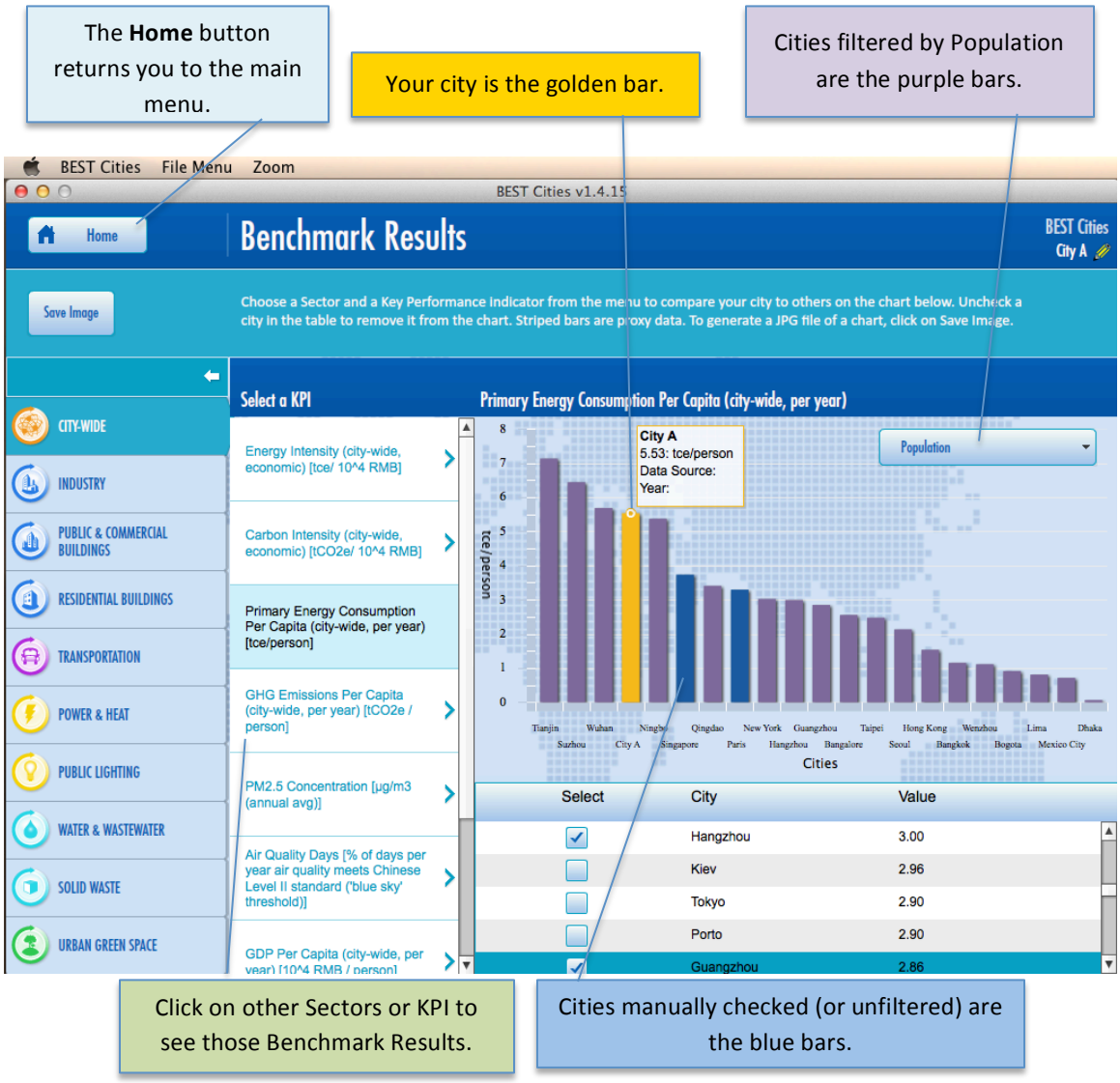
Filtering and Selecting Comparator Cities: To conduct meaningful benchmarking, the BEST Cities tool allows for filtering of comparator cities by Population, Climate Zone, Human Development Index (HDI), and Industrial share of GDP. A drop-down menu in the mid-right corner of the screen allows selection of a filter. Appendix 3 lists the numerical ranges for each filter variable. Your city appears as a golden bar in the graph, while the filtered comparator cities appear as purple bars. The tool also allows users to select or de-select particular cities for benchmarking. The user can scroll through the list of cities with data for a particular indicator, and check or un-check the box in front of each comparator city. These manually-selected (unfiltered) comparator cities will appear as blue-colored bars in the graph.

Screen 7.1 shows an example of benchmarking for a City-wide Indicator: Primary Energy Per Capita (tce/person). In the example, City A is compared to other cities of a similar population size, from a database of 288 cities. The data for City A are shown in the golden bar, the comparator cities filtered by Population are shown in purple bars, and cities manually selected from the checklist are shown in blue bars.

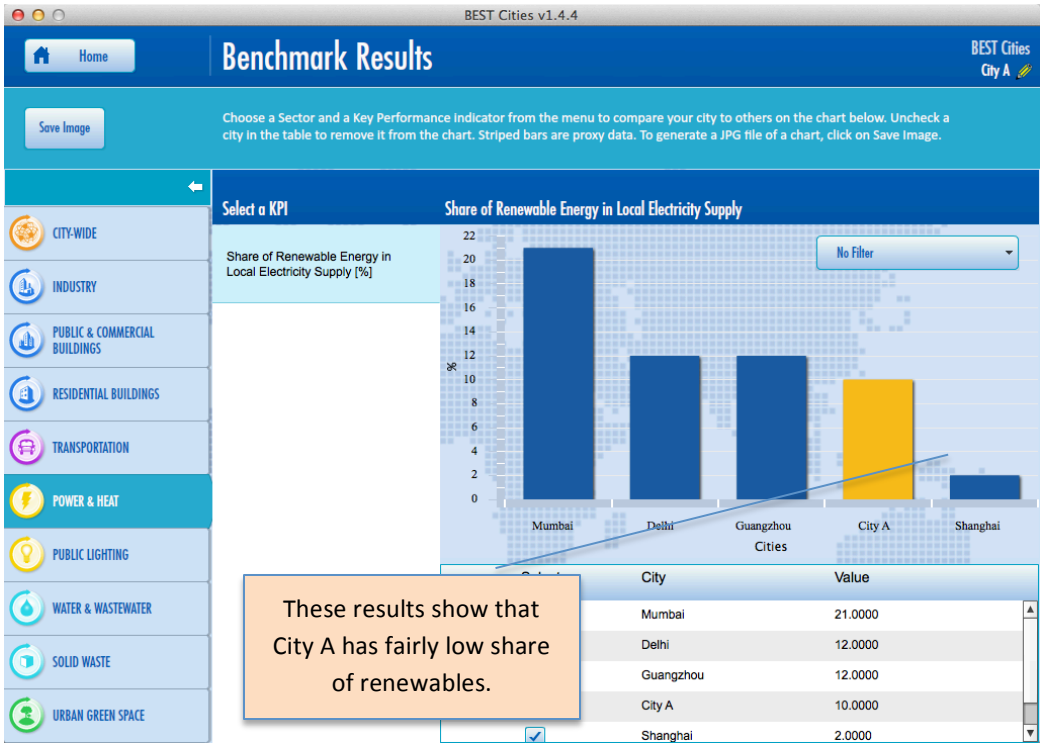
Screen 7.2 gives an example of benchmarking for the Power & Heat sector: Share of Renewable Energy in Local Electricity Supply (%). Fewer cities in the database had this data, so no filter is applied. City A shows a value of 10% renewable energy, ahead of Shanghai at only 2%, but not as good as Guangzhou and Delhi at 12% and Mumbai at 21%.

Screen 7.3 looks at Transportation energy per capita (tce/person), as a benchmark of the overall energy intensity of the Transportation sector.
To generate a JPG file of a chart, click on Export.

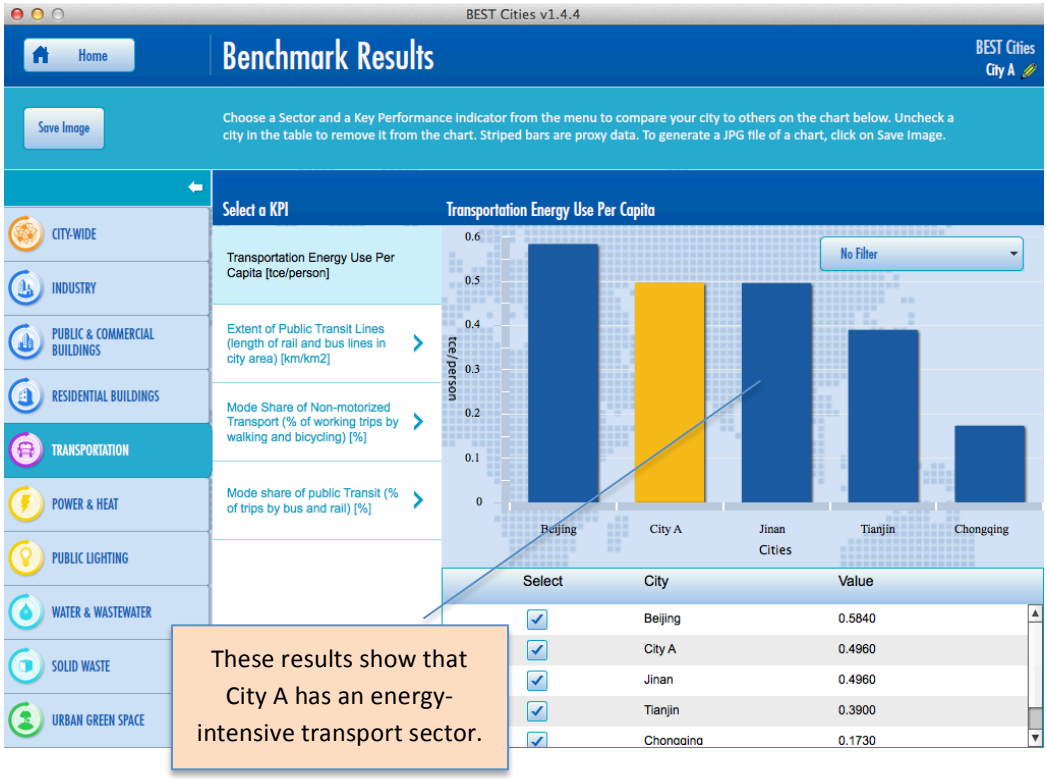
Screen 7.1: Benchmark Results—City-wide Energy per Capita



Screen 7.2: Benchmark Results— Power & Heat – Renewable Share

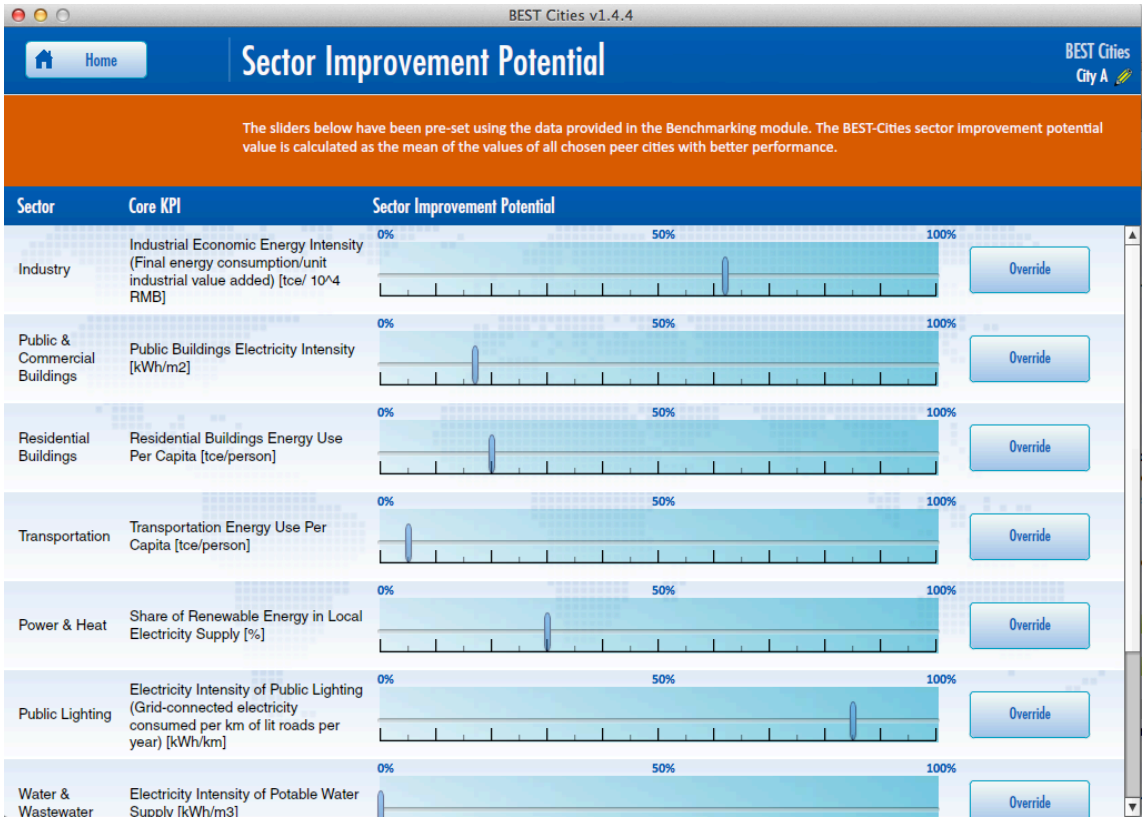


Screen 7.3 Benchmark Results – Transportation Energy per Capita



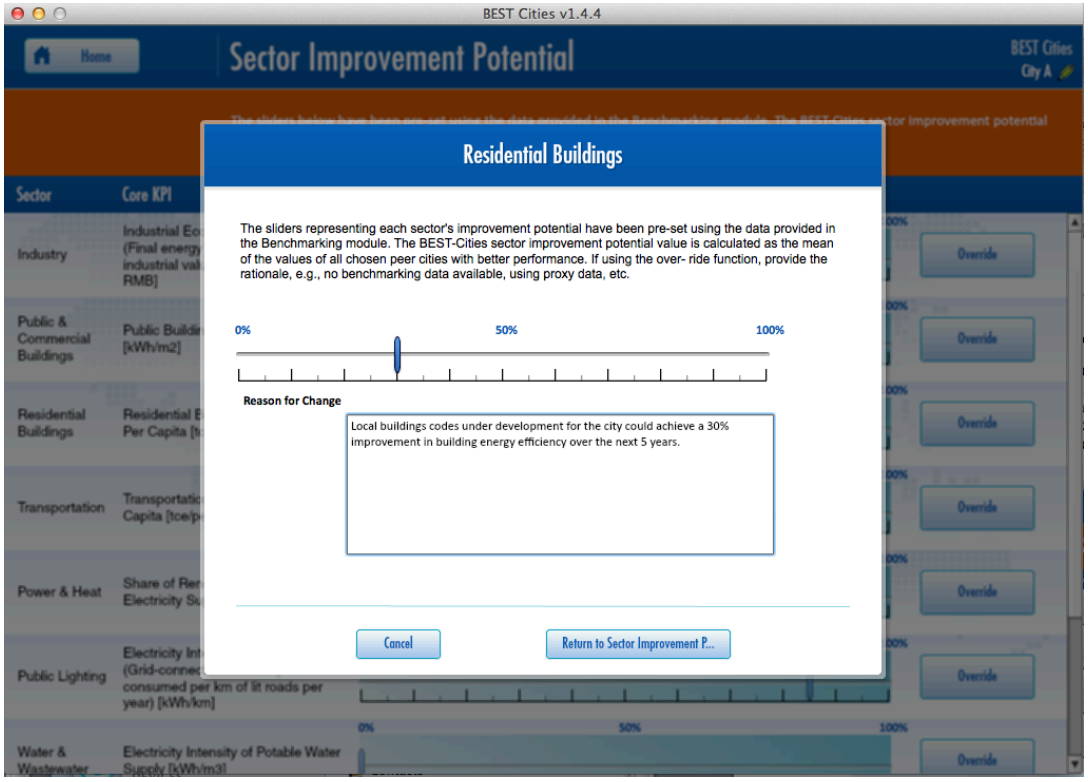
Screen 8: Sector Improvement Potential

The sliders on the Sector Improvement Potential screen have been pre-set using the data provided in the Benchmarking module. The BEST Cities sector improvement potential is calculated as the mean of the values of all chosen peer cities with better performance.



Screen 9: Sector Improvement Potential Override

If you have more detailed analysis of energy or carbon saving potential in a city sector, you can utilize the Override function. Move the slider bar to represent the results of your city's analysis, and provide a reason for the override.



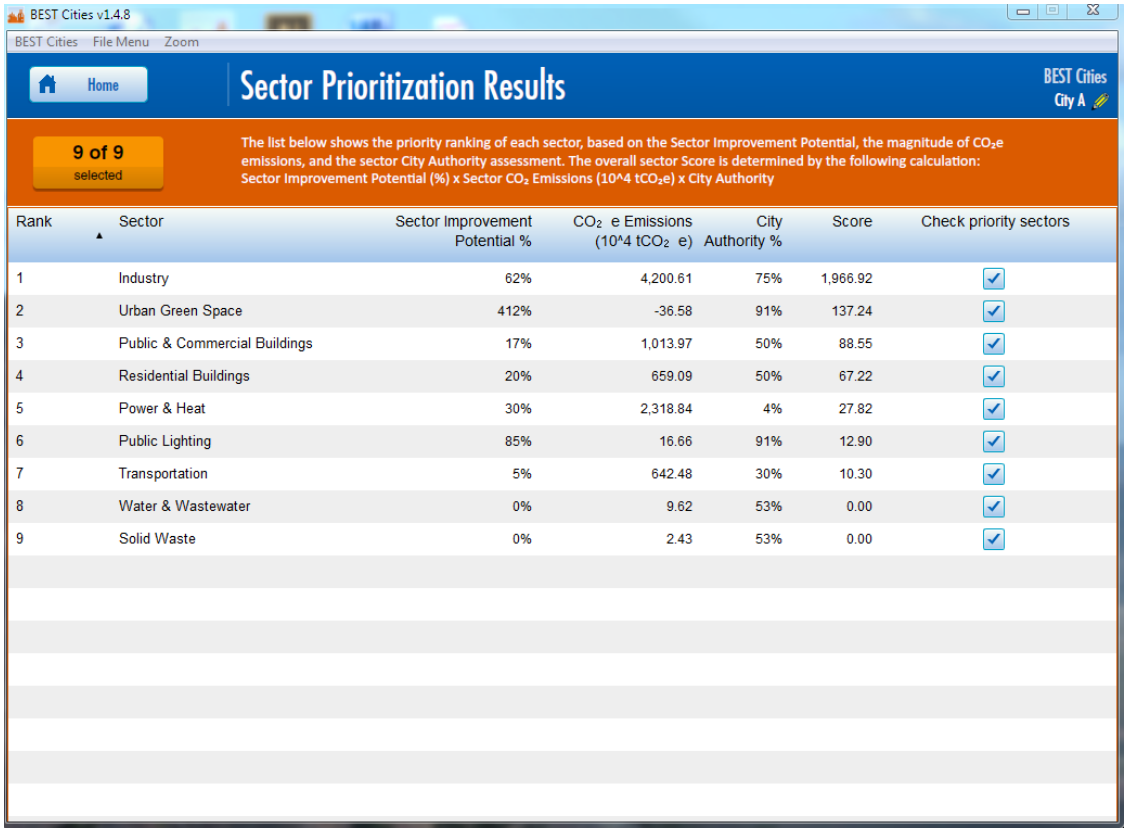
Screen 10: City Authority

Decision-making authority is another consideration in prioritizing low carbon actions at the city level. While some actions—such as improving energy efficiency of local government buildings—can easily be undertaken within local jurisdiction, other actions—such as renewable electricity supply—may need approval from higher levels of government. If a sector has a large improvement potential but limited city authority, it can still be worthwhile for a city to undertake the coordination needed for action in the sector. Appendix 3 provides definitions of city authority utilized in the BEST Cities tool.

The City Authority screen has slider bars to select the level of authority, from 0 to 100%. Explanations (also color-coded) are included on the right-hand side of the screen.

Screen 11: Sector Prioritization Results

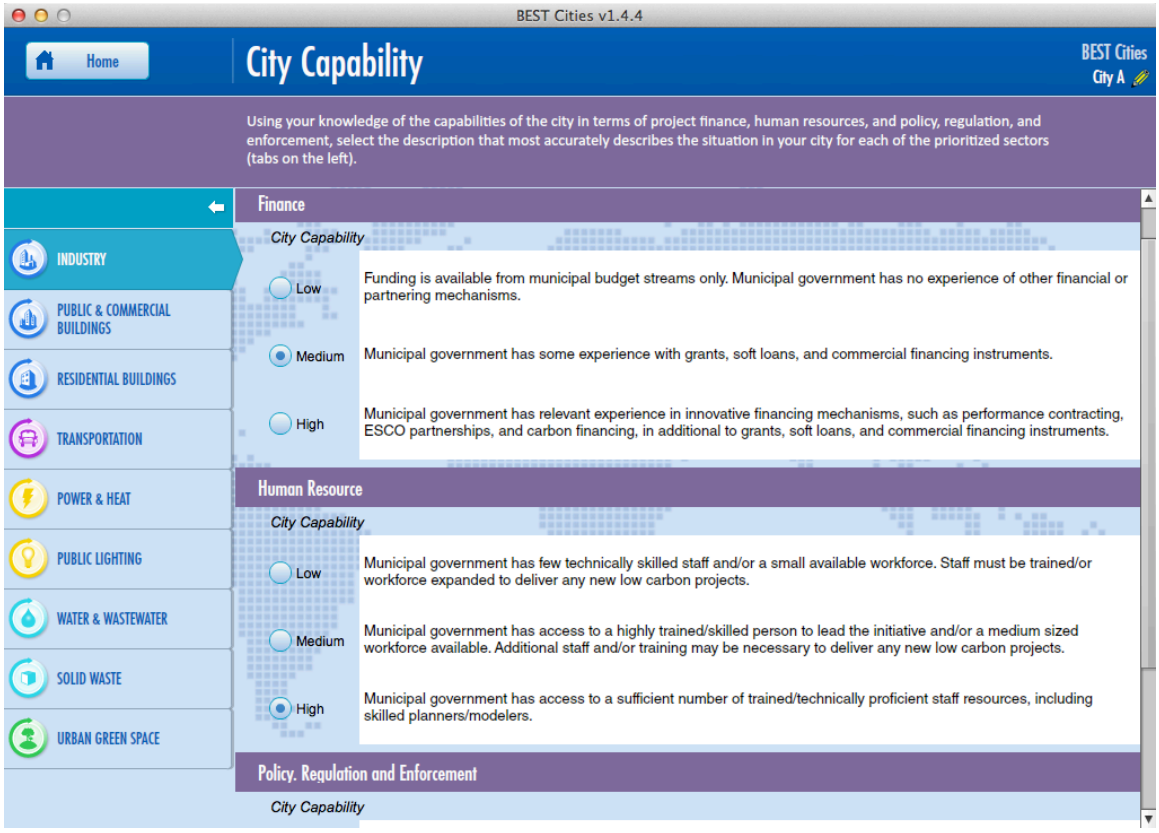
Upon viewing the Sector Prioritization Scores, the user can decide whether or not to consider policies in all sectors. By unchecking the box for a sector, the user can remove it from the priority list and not consider actions in that sector. By keeping all sectors checked, the user will have the opportunity to view all recommended policies and then choose priority actions.



Rank	Sector	Sector Improvement Potential %	CO_2 e Emissions (10^4 tCO_2 e)	City Authority %	Score	Check priority sectors
1	Industry	62%	4,200.61	75%	1,966.92	✓
2	Urban Green Space	412%	-36.58	91%	137.24	✓
3	Public & Commercial Buildings	17%	1,013.97	50%	88.55	✓
4	Residential Buildings	20%	659.09	50%	67.22	✓
5	Power & Heat	30%	2,318.84	4%	27.82	✓
6	Public Lighting	85%	16.66	91%	12.90	✓
7	Transportation	5%	642.48	30%	10.30	✓
8	Water & Wastewater	0%	9.62	53%	0.00	✓
9	Solid Waste	0%	2.43	53%	0.00	✓

Screen 12: City Capabilities

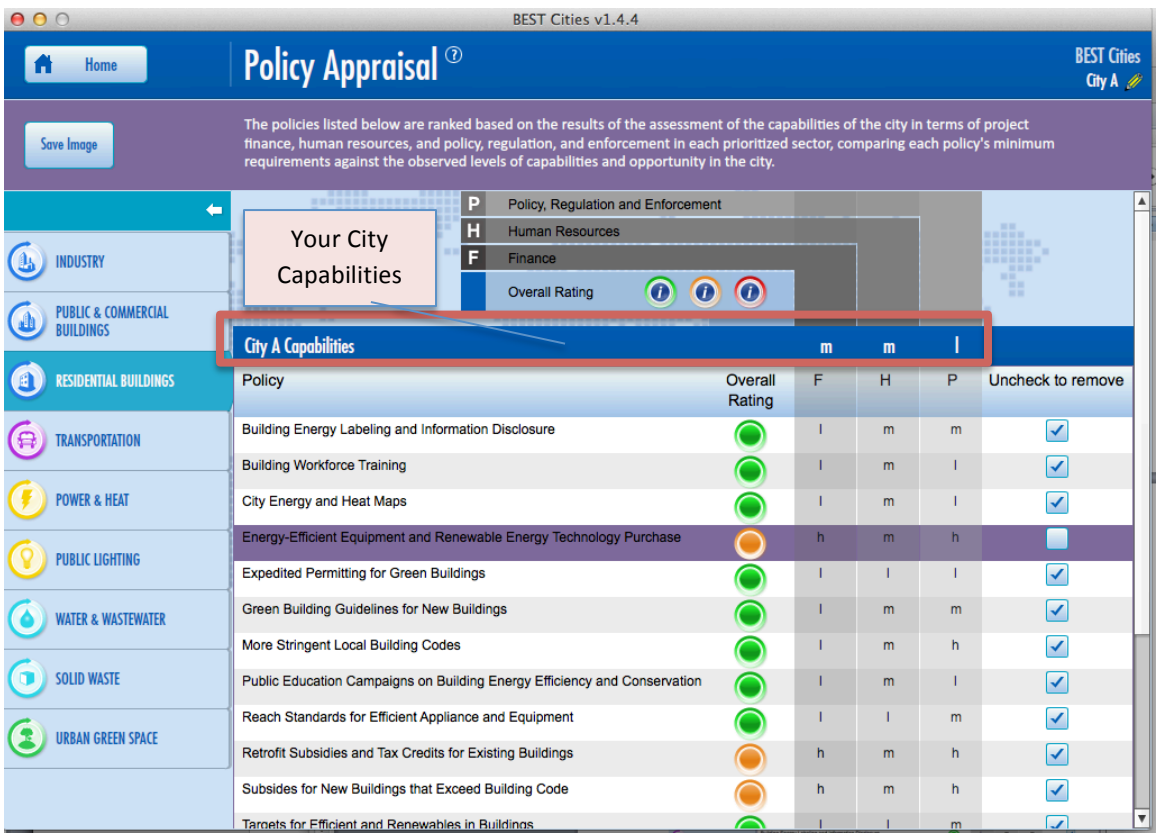
A self-assessment of City Capabilities in each sector is used to recommend policy actions in each sector. Appendix 5 provides definition of High, Medium, and Low capability. For each sector, and each area of Capability—Finance, Human Resources, Enforcement—select the capability level that best reflects your city.



Screen 13: Policy Appraisal

The Policy Appraisal screen matches city capabilities in each sector (entered by the user of the tool) with the capabilities needed for individual policies (from the BEST Cities policy database).

In the example screen for the Residential Buildings sector, City A Capabilities (your city capabilities) for the sector are noted in the blue row in the mid-upper part of the screen. Each of the policy options for Residential Buildings is listed in a row below, and show the capabilities needed for each policy. The Policy Appraisal screen the uses a "traffic signal" approach. "Green" means that city capabilities are well-suited to that policy. "Yellow" means that some city capabilities may be weak and extra attention should be given if city chooses to pursue that policy action. "Red" means that city capabilities are weak in more than one area for a particular policy, and the city may want to first undertake policies with a greater likelihood for success. By default, all the policies are selected for consideration in the city's low carbon development plan. You may choose to un-check a policy with a poor match of capabilities (i.e., with a "red" stop light) to remove it from further consideration. Or you may keep all policies checked and pursue enhancement of city capabilities for policy implementation.



Screen 14: Detailed Policy Recommendations

From multiple sections of Policy Analysis, the user can click on the name of a policy to view more information. BEST Cities contains a database of more than 70 low carbon policies, including a 2-4 page explanation and characterization of each policy. The detailed policy sheets include:

- Description
- Implementation Strategy and Challenges
- Monitoring Metrics
- Case Studies
- Policy Attributes:
    - Carbon Savings Potential,
    - First Cost to Government,
    - Speed of Implementation
- Tools and Guidance
- References

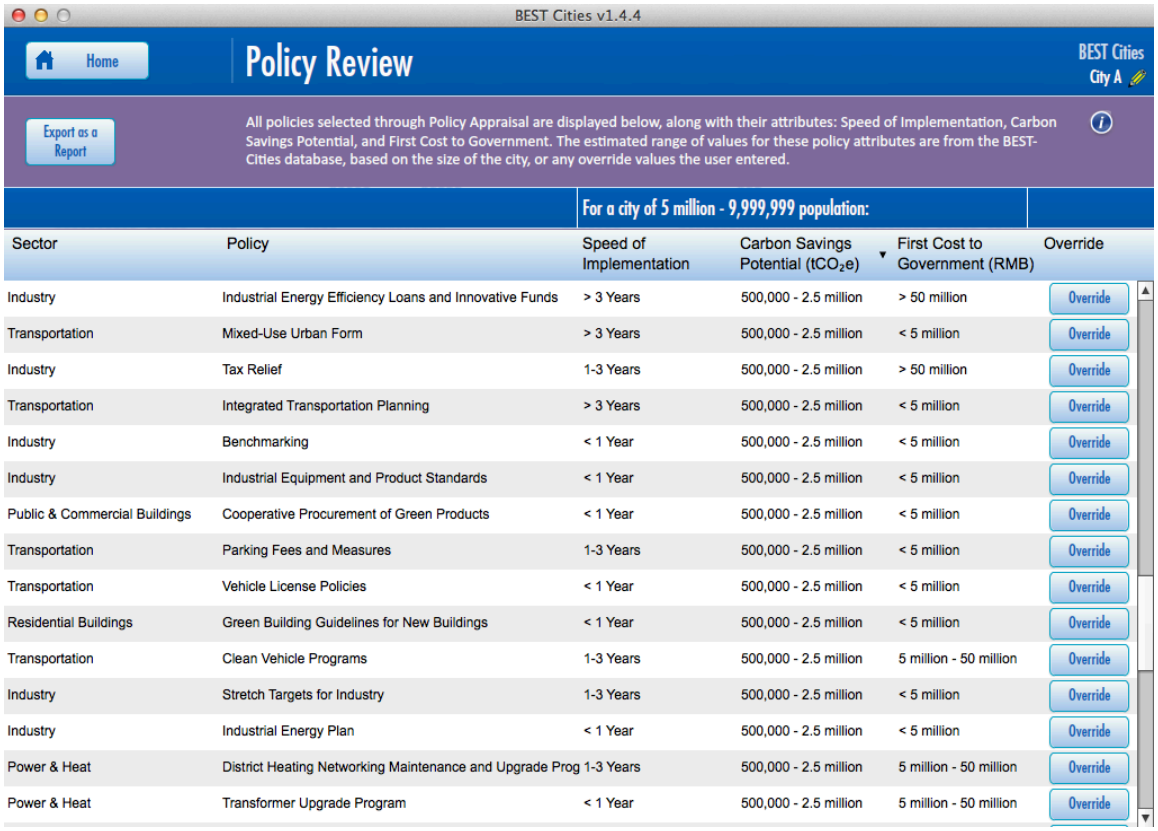
Appendix 7 contains an example of a detailed policy recommendation.

Screen15: Policy Review

Policies selected in **Policy Appraisal** all show up on the **Policy Review** screen, meaning the user has essentially decided to pursue them, and the only question left is how to prioritize their implementation.

To enable comparison of "low/medium/high" rankings across different sectors, this screen assigns very broad numerical categories to each ranking for both the cost and carbon impact categories. These categories necessarily vary by the size of the city, as the same recommendation will inevitably cost more and deliver a greater carbon impact in a large city than if it were implemented in a small city. The BEST Cities tool dynamically adjusts the numerical estimates displayed on this screen based on the city population data first entered on Screen 4. This system was first described for **Detailed Policy Recommendations**, and the **Policy Review** screen employs the same strategy.

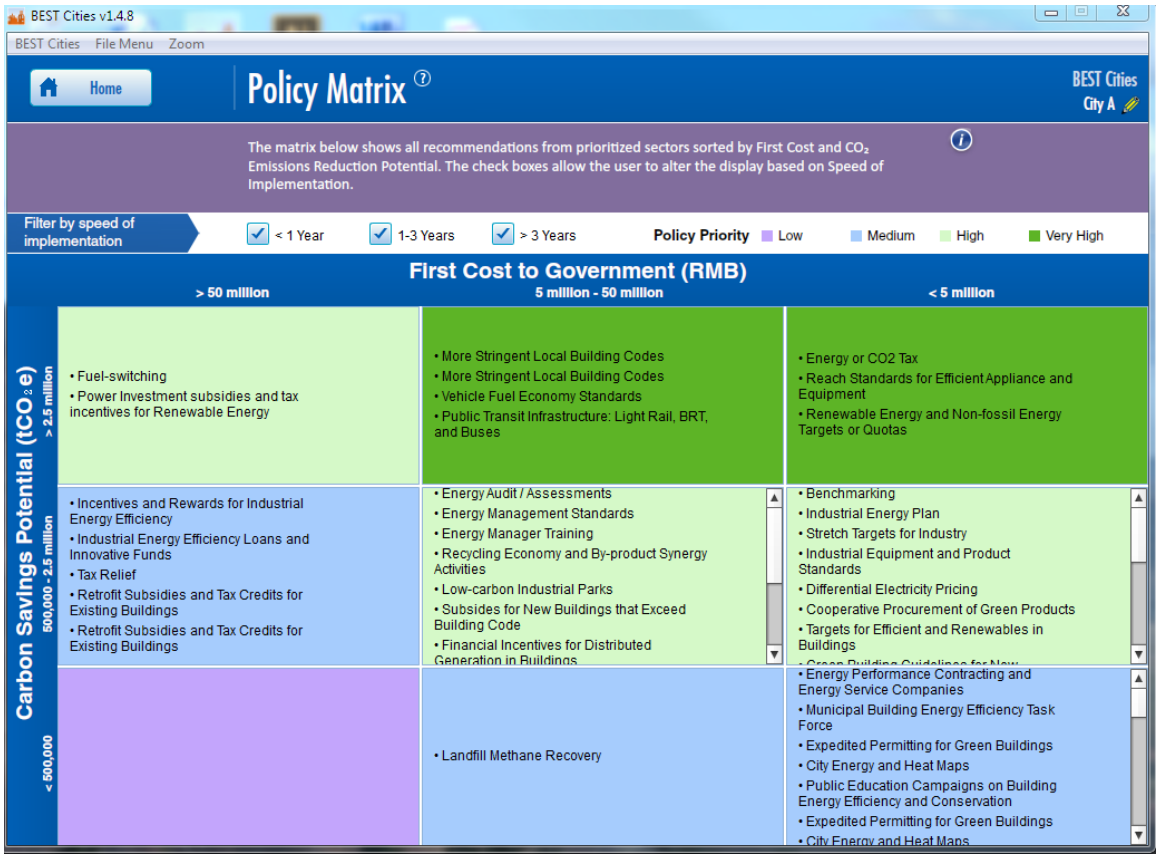
The "Export as Report" function (button in upper-left corner of screen) creates a .csv file of the analysis shown on the screen. This report can be opened in Excel or Word or similar software, for editing and use in other reports the city might prepare.



Sector	Policy	Speed of Implementation	Carbon Savings Potential (tCO_2e)	First Cost to Government (RMB)	Override
Industry	Industrial Energy Efficiency Loans and Innovative Funds	> 3 Years	500,000 - 2.5 million	> 50 million	Override
Transportation	Mixed-Use Urban Form	> 3 Years	500,000 - 2.5 million	< 5 million	Override
Industry	Tax Relief	1-3 Years	500,000 - 2.5 million	> 50 million	Override
Transportation	Integrated Transportation Planning	> 3 Years	500,000 - 2.5 million	< 5 million	Override
Industry	Benchmarking	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Industry	Industrial Equipment and Product Standards	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Public & Commercial Buildings	Cooperative Procurement of Green Products	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Transportation	Parking Fees and Measures	1-3 Years	500,000 - 2.5 million	< 5 million	Override
Transportation	Vehicle License Policies	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Residential Buildings	Green Building Guidelines for New Buildings	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Transportation	Clean Vehicle Programs	1-3 Years	500,000 - 2.5 million	5 million - 50 million	Override
Industry	Stretch Targets for Industry	1-3 Years	500,000 - 2.5 million	< 5 million	Override
Industry	Industrial Energy Plan	< 1 Year	500,000 - 2.5 million	< 5 million	Override
Power & Heat	District Heating Networking Maintenance and Upgrade Prog	1-3 Years	500,000 - 2.5 million	5 million - 50 million	Override
Power & Heat	Transformer Upgrade Program	< 1 Year	500,000 - 2.5 million	5 million - 50 million	Override

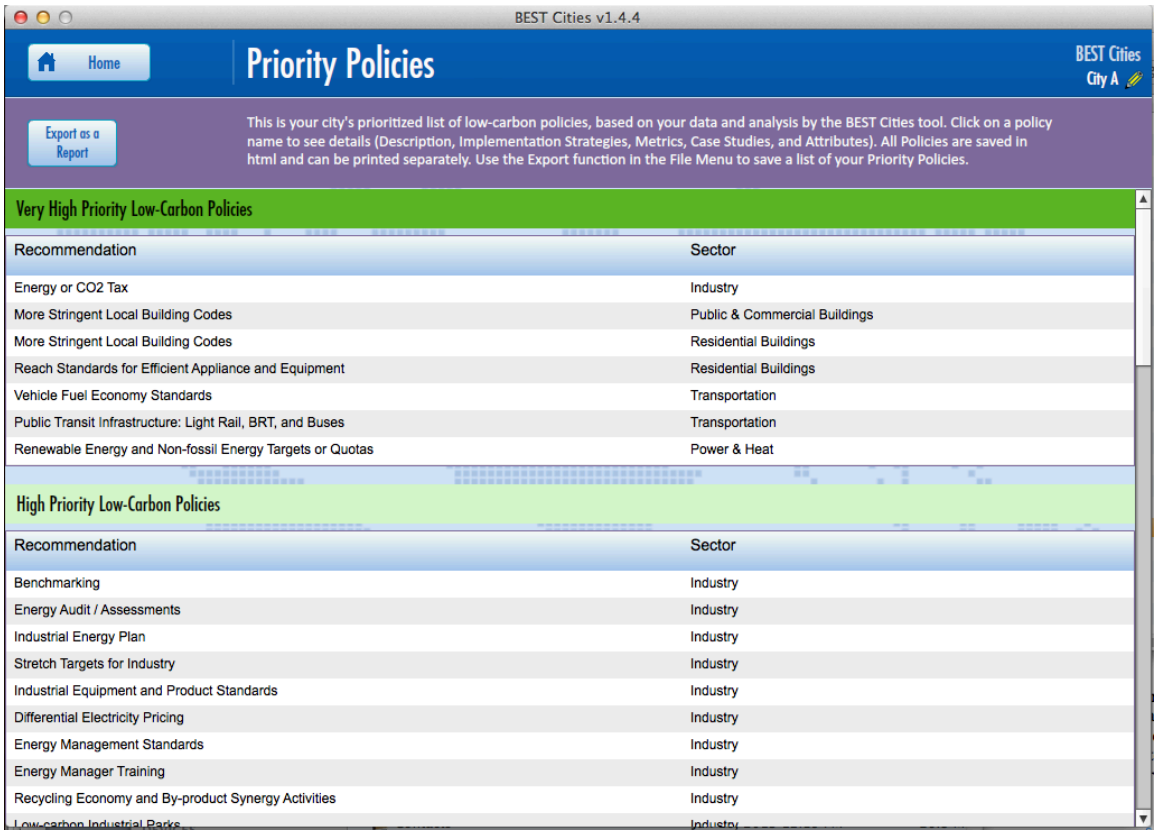
Screen16: Policy Matrix

The Policy Matrix shows all recommendations from the prioritized sectors sorted by First Cost and CO_2 Emissions Reduction Potential. The check boxes allow the user to alter the display based on their preferences for Speed of Implementation. In the example of City A, the policies with low cost and high carbon savings potential include "Reach" Standards for Efficient Appliances and Equipment, for the Residential Buildings sector, since that sector has a fairly large potential for improvement, and because the city capabilities for implementing policy in that sector are sufficient for this particular policy (appliance standards). The highest priority policies are found in the upper right cells of the matrix (color-coded with bright green).



Screen17: Priority Policies

Finally, the Priority Policies section of the tool shows the city's prioritized list of low-carbon policies, based on data and analysis by the BEST-Cities tool. The user can click on a policy name to see details (Description, Implementation Strategies, Metrics, Case Studies, and Attributes). All Policies are saved in html and can be printed separately using the export function.



PART IV: Related Tools: BEST Cities, GREAT, ELITE Cities, Urban RAM

As the most recent of the four bilingual low-carbon tools developed by the China Energy Group to assist Chinese policymakers and researchers with low carbon planning, the BEST Cities tool builds upon the experiences and functionalities of the three existing tools. The first two low-carbon planning tools – the Urban Form Rapid Assessment Model (Urban RAM) and the Green Resources & Energy Appraising Tool (GREAT) for Cities – were developed to help cities and regions identify and quantify the major local sources of energy consumption and CO_2 emissions.

The Urban RAM tool specifically helps cities better understand the major contributors to its energy and carbon footprint from both an embodied and operational perspective. It is distinct from the other tools in that it incorporates a life-cycle modeling approach to quantifying local energy consumption and emissions, and thereby identifies key drivers of and areas of opportunity for reducing a city's energy and carbon footprint.

The GREAT Cities tool, on the other hand, uses a bottom-energy end-use based modeling approach that can track energy consumption to a very detailed end-use and technology level for different geographic scopes. Because it is built using an accounting framework, the GREAT Cities tool can also track and quantify energy production and resource extraction beyond the scope of only energy consumption. The GREAT cities tool also distinctly provides the functionality for conducting scenario analysis to evaluate and quantify the potential energy and emission reduction opportunities and policies. Both the Urban RAM and GREAT Cities tools complements the BEST Cities tool by providing more detailed and nuanced perspectives on the key sources of local energy use and energy-related CO_2 emissions. While GREAT Cities can also be used by local policymakers to evaluate potential energy and CO_2 reduction strategies, it differs from BEST Cities in that it requires users to have more information about these strategies and design representative policy scenarios to quantify potential savings.

The Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities) was developed as a benchmarking tool to help Chinese policymakers evaluate the performance of their city against benchmark performance goals for 33 key indicators in 8 different categories and an overall weighted performance. The benchmark performance for each indicator and overall performance are set using Chinese targets or exemplary performance or international best-practice standards and performance. As a benchmarking tool designed to help evaluate performance, ELITE Cities is most helpful to local policymakers in defining and evaluating the status and progress of low carbon eco-cities. This is similar to the benchmarking functionality that is also offered by the BEST Cities tool. However, unlike BEST Cities, ELITE Cities does not provide users with information on specific strategies to reduce local energy use and CO_2 emissions and thus cannot directly inform cities in the development of low carbon action plans. Figure 1 provides a graphical representation of the key areas of focus for the four low-carbon tools.

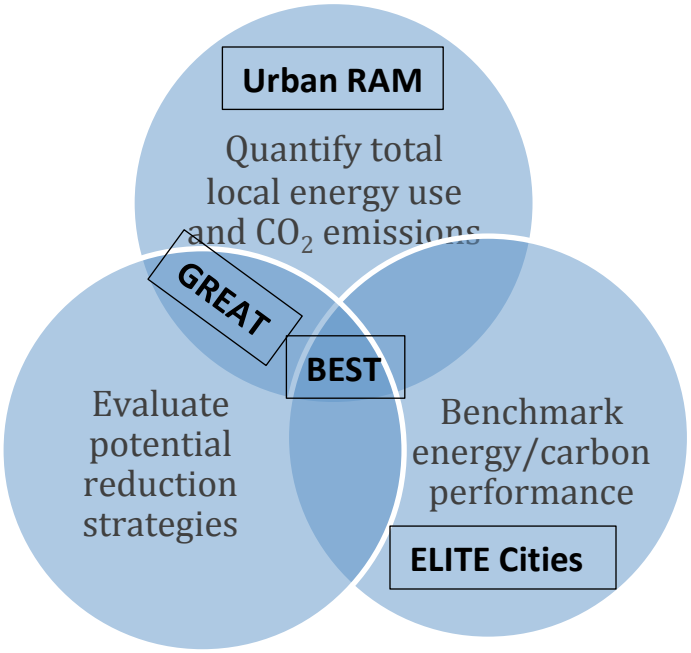


Figure 4. Overview of China Energy Group's Low Carbon Tools and Focus Areas

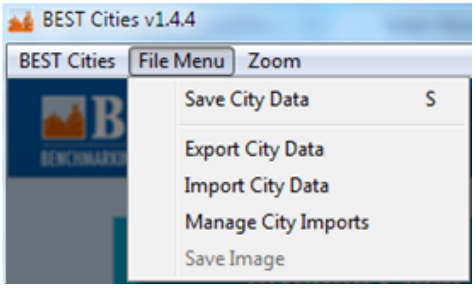
In summary, the BEST Cities tool combines elements from previous tools to provide both a quick assessment and benchmark of a city's energy consumption and low carbon performance. However, it differs from other tools in that it uniquely provides policymakers with specific information on concrete and appropriate reduction strategies that can be incorporated into low carbon action plans.

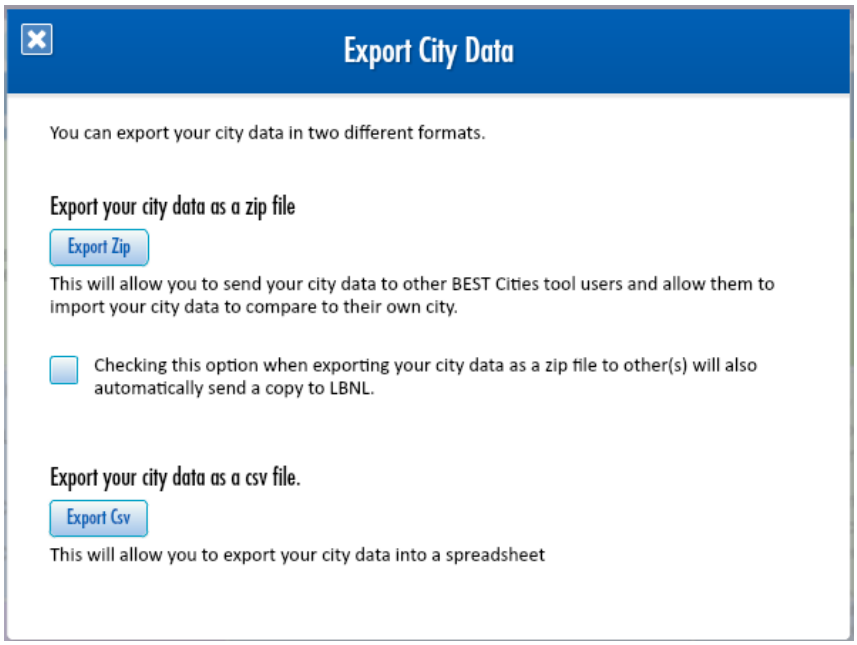
For more information or to download these tools, please visit:

- Urban RAM: http://china.lbl.gov/tools-guidebooks/urban-ram
- GREAT: http://china.lbl.gov/tools-guidebooks/great
- ELITE Cities: http://china.lbl.gov/tools-guidebooks/elite-cities

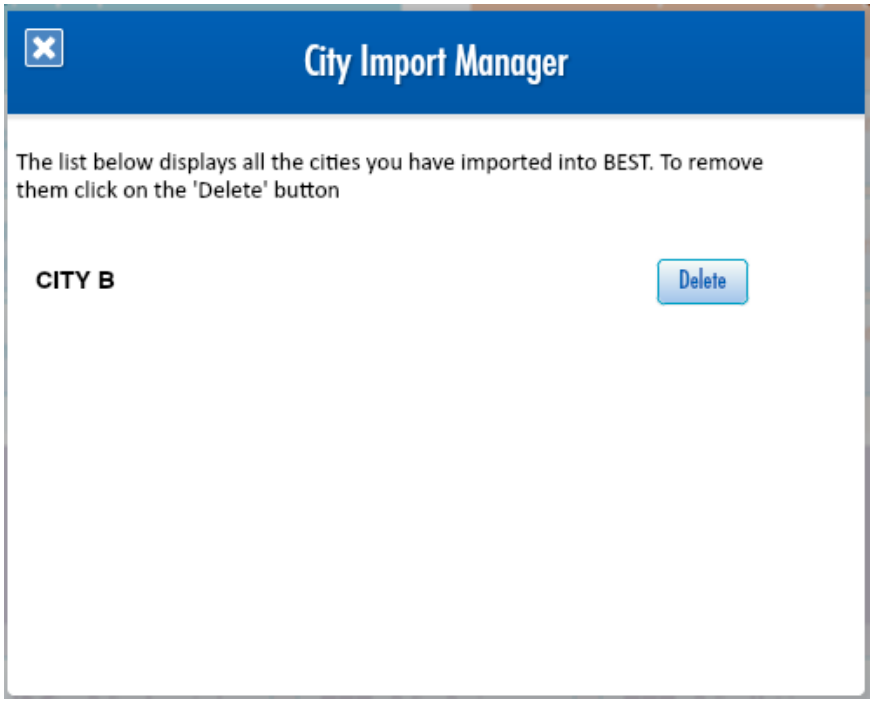
PART V: Data Sharing and User Feedback

In occasion where users would like to share data of different cities, user may do so through "Export City Data", "Import City Data", and "Manage City Imports" tab inside the "File Menu" sitting on top of the tool screen. City data can be exported either as a zip file or a csv file. Users can then send this data file as a mail attachment to other users. Users can also send their city data to LBNL that can be incorporated as part of benchmarking data in the future. To do so, simply check the box that locates beneath "Export Zip" tab.





Users who receive an exported city data file can import the data stored within to the tool through "Import City Data" tab. If users would like to remove the imported city data file, please do so through "Manage City Imports", from where users can delete an individual city data file.



For more questions and feedback regarding the BEST Cities tool, or to contribute benchmarking data for the tool, please contact any one of the following.

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APPENDICES

Appendix 1: Data Gathering Spreadsheet (in Chinese)

	BEST Cities Highest Priority
	additional data for the ELITE Cities tool
	BEST Cities – Other Data
	Calculated Indicators

City-Wide Data (城市总体指标数据)

Indicators	指标
City-wide Population Density (people/m^2)	城市总体人口密度 （人/平方米）
Urban Population Density (people/m^2)	城市核心区人口密度 （人/平方米）
Service as % of GDP	第三产业占 GDP 比重（%）
Industry as % of GDP	工业占 GDP 比重（%）

Decomposed Indicator	**分解指标**	**数据**	**数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）**	**年份**	**资料来源**	**备注（如果是估算或替代数据，请注明方法）**
Population (persons)	人口 （人）					
Urban Population (in city core)	城市人口（核心区）					
Total Land Area (10^4 m^2)	总面积（平方公里）					
Urban Land Area (in city core) (10^4 m^2)	城市占地面积 （城市核心区）（平方公里）					
GDP	全市生产总值（万元）					

Tertiary sector GDP	第三产业增加值 （万元）					
Industry GDP	工业增加值 （万元）					
HDI	人类发展指数					

Energy & Climate & Environment Data (能源气候环境数据)

Indicators	指标	计算结果
Energy Intensity (city-wide, economic) (tce/ 10^4 RMB)	能源强度（全市，全经济范围）（吨标煤/万元）	
Carbon Intensity (city-wide, economic) (tCO_{2e}/ 10^4	碳强度（全市，全经济范围）（吨二氧化碳当量/万	
GDP per capita (104RMB/capita)	人均国内生产总值（万元/人）	
Primary Energy Consumption per capita (tce/capita)	人均一次能源消费量（吨标煤/人）	
CO_2 Emissions per capita (tons/capita/year)	人均二氧化碳排放（吨/人/年）	

Decomposed Indicator	分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方
Annual CO_2 emissions (10^4 tons)	全市每年二氧化碳排放					
Annual Primary Energy Consumption (10^4tce)	全市每年一次能源消费量（万吨标准煤）					
PM2.5 Concentration ($\mu g/m^3$ annual avg)	PM2.5 浓度（$\mu g/m^3$年平均）					
NO_x Concentration ($\mu g/m^3$ annual avg)	氮氧化物浓度（$\mu g/m^3$年平均）					
SO_2 Concentration ($\mu g/m^3$ annual avg)	二氧化硫浓度（$\mu g/m^3$年平均）					
Air Quality Days (% of days per year air quality meets Chinese Level II standard; "blue sky" threshold)	空气质量（每年空气质量大中国二级标准天数百分比，蓝天数百分比）					
备注：可再生能源包括风电，太阳能，水电，地热能，生物质能，不包括核电						

Industry Data (工业数据)

Decomposed Indicator	**分解指标**	**数据**	**数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）**	**年份**	**资料来源**	**备注（如果是估算或替代数据，请注明方法）**
Total Industrial Value-Added (10^4RMB)	工业增加值（万元）					
Steel Production Final Energy Consumption (10^4tce)	钢铁生产终端能源消费量（万吨标准煤）					
Steel Production Physical Amount (10^4 tonnes)	钢铁产量（万吨）					
Building Materials Final Energy Consumption (10^4 tonnes) [1]	非金属矿物制品业终端能源消费量 （万吨标准煤）					
Building Materials Value-Added (10^4 RMB)	非金属矿物制品业增加值 （万元）					
Cement Production Final Energy Consumption (10^4 tce)	水泥生产终端能源消费量（万吨标准煤）					
Cement Production Physical Amount (10^4 **tonnes)**	水泥产量（万吨）					
Flat Glass Production: Final Energy Consumption (10^4tce)	平板玻璃终端能源消费量（万吨标准煤）					
Flat Glass Production Physical Amount (10^4 tonnes)	平板玻璃产量（万吨）					
Chemicals Final Energy Consumption (10^4 tce)	化学原料及化学制品制造业终端能源消费量（万吨标准煤）					
Chemicals Value-Added (10^4 RMB)	化学原料及化学制品制造业增加值（万元）					
Synthetic Ammonia Production Final Energy Consumption (10^4 tce)	合成氨生产终端能源消费量（万吨标准煤）					
Synthetic Ammonia Production Physical Amount (10^4 tonnes)	合成氨产量（万吨）					
Ethylene Production Final Energy Consumption (10^4 tce)	乙烯生产终端能源消费量（万吨标准煤）					
Ethylene Production Physical Amount (10^4 tonnes)	乙烯生产产量（万吨）					

Textile Production Final Energy Consumption (10^4 tce)	纺织业终端能源消费量（万吨标准煤）					
Textile Production Value-Added (10^4 RMB)	纺织业附加值（万元）					
Food Industry Production Final Energy Consumption (10^4 tce)	食品制造业终端能源消费量（万吨标准煤）					
Food Industry Production Value-Added (10^4 RMB)	食品制造业增加值（万元）					

备注：建筑材料在这里指非金属矿物制品业

	工业能源消费量	年份	资料来源	备注
原煤（万吨）10^4tn				
焦炭（万吨）10^4tn				
原油 （万吨）10^4tn				
柴油（万吨）10^4tn				
燃料油（万吨）10^4tn				
汽油（万吨）10^4tn				
煤油（万吨）10^4tn				
生物燃料（万吨）10^4tn				
液化石油气（万吨）10^4tn				
天然气（万立方米）10^4cu.m				
其他煤气（万立方米）10^4cu.m				
电力（万千瓦时）10^4kWh				
热力（万百万千焦）10^{10}KJ				

Public & Commercial Buildings Data (公共建筑数据)

Indicator	指标	
Residential Building Energy Intensity (kWhe/m^2/year)	居住建筑能耗强度 （千瓦时/平方米/年）	
Public Building Electricity Intensity (kWh/m^2/year)	公共建筑电耗强度 （千瓦时/平方米/年）	

Decomposed Indicator	**分解指标**	**数据**	**数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）**	**年份**	**资料来源**	**备注（如果是估算或替代数据，请注明方法）**
Total Area of Public & Commercial Buildings (m2)	公共建筑总面积 (平方米）					
Annual Residential Building Energy Consumption (10^4tce)	全市每年居住建筑能源消费总量 （万吨标准 煤）					
Total floorspace of residential buildings (m^2)	全市居住建筑楼面面积（平方米）					
Annual Public Building Electricity Consumption (kWh)	全市每年公共建筑电力 消费量（千瓦时）					
Total floorspace of public buildings (m^2)	全市公共建筑楼面面积（平方米）					
Total Area of Green-labeled Buildings in the City (m^2)	城市绿色标识建筑总面积（平方米）					
Total Area of All Buildings in the City (m^2)	城市所有建筑总面积（平方米）					
Total Installed Capacity of Renewable Energy Systems Installed in Public & Commercial Buildings in the City (kW)	城市公共建筑可再生能源技术发电装机量（千瓦）					
Total Installed Capacity of CHP Systems Installed in Public & Commercial Buildings in the City (kW)	城市公共建筑热电联产系统装机量（千瓦）					
District Heating Supplied City-wide from Co-generation Facilities in the City (10^{10}KJ)	城市热电联产供应的集中供热（万百万千焦）10^{10}KJ					

	公共建筑能源消费量	年份	资料来源
原煤（万吨）10^4tn			
燃料油（万吨）10^4tn			
汽油（万吨）10^4tn			
煤油（万吨）10^4tn			
液化石油气（万吨）10^4tn			
天然气（万立方米）10^4cu.m			
其他煤气（万立方米）10^4cu.m			
电力（万千瓦时）10^4kWh			
热力（万百万千焦）10^{10}KJ			

Residential Buildings Data (居住建筑数据)

	居住建筑能源消费量	年份	资料来源	备注
原煤（万吨）10^4tn				
燃料油（万吨）10^4tn				
液化石油气（万吨）10^4tn				
天然气（万立方米）10^4cu.m				
其他煤气（万立方米）10^4cu.m				
电力（万千瓦时）10^4kWh				
热力（万百万千焦）10^{10}KJ				

Power & Heat Data (电力&热力数据)

Indicators	指标	计算结果
Share of Renewable Electricity Supply in Local Electricity Consumption (%)	全市可再生能源电力供应占电力消费比例（%）	
Proportion of Primary Energy from Renewable Sources (%)	一次能源中可再生能源比重 （%）	

分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
全市电力消费总量 （万千瓦时）					
全市可再生电力供给量 （万千瓦时）【1】					
发电耗煤系数 （克标煤/千瓦时）					
发热耗煤系数 （万吨标准煤/万百万千焦）					
发电等量二氧化碳排放系数 （万吨等量二氧化碳/万千瓦时）					
发热等量二氧化碳排放系数 （万吨等量二氧化碳/万百万千焦）					

备注：【1】可再生能源包括风电，光伏面板，水电，地热能，生物质能，不包括核电和太阳能热水器

Water & Wastewater Data (水&废水数据)

Indicators	指标	计算结果
Municipal Water Consumption per Capita per Day (liter/capita/day)	人均每天生活用水量 （升/人/天）	
Industrial Water Consumption per 10,000 RMB (liter/ 10,000 RMB)	万元工业总产值用水量 （升/万元）	
Wastewater Treatment Rate of total wastewater (%)	废水处理率 （%）	
Drinking Water Quality of total drinking water (%)	来自二类及以上地表水源地饮用水占全部饮用水比例（%）	
Recycled Water Use of total Municipal Water (%)	生活用水中再生水使用比例（%）	
Energy Intensity of Municipal Water Supply(kWhe/l)	自来水供应能耗强度（千瓦时/升）	

Decomposed Indicator	**分解指标**	**数据**	**数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）**	**年份**	**资料来源**	**备注（如果是估算或替代数据，请注明方法）**
Total Water Supplied City-wide Per Year (104 tonnes)	全市每年水供应总量 （万吨）					
Total Amount of Wastewater Treatment (104 tonnes)	全市每年废水处理量 （万吨）					
Total Municipal Water Consumption (104 tonnes)	全市每年生活用水总量 （万吨）					
Total Industrial Water Consumption (104 tonnes)	全市每年工业用水总量 （万吨)					
Total Annual Industrial Ouput Value (10,000 RMB)	全市每年工业总产值 （万元）					
Total Amount of Wastewater Generation (104 tonnes)	全市每年废水排放总量 （万吨）					
Total Amount of Drinking Water comes from Grade II or above Water Sources (m3)	全市每年来自二类及以上水源地饮用水量 （立方米) 【1】					

Total Amount of Recycled Water Use in total Municipal Water (m3)	全市每年生活用水中再生水使用量（立方米）					
Total Energy Consumption to Supply Municipal Water (kWhe)	全市每年供应自来水能源消费量（千瓦时）					

备注：

【1】地表水环境质量标准 GB 3838-2002

依据地表水水域环境功能和保护目标，按功能高低依次划分为五类：

I 类——主要适用于源头水、国家自然保护区

II 类——主要适用于集中式生活饮用水地表水源地一级保护区、珍稀水生生物栖息地、鱼虾类产卵场、仔稚幼鱼的索饵场等

III 类——主要适用于集中式生活饮用水地表水源地二级保护区、鱼虾类越冬汤、洄游通道、水产养殖区等渔业水域及游泳区

IV 类——主要适用于一般工业用水区及人体非直接接触的娱乐用水区

V 类——主要适用于农业用水区及一般景观要求水域

	水供应能源消费量	年份	资料来源	备注
原煤（万吨）10^4tn				
焦炭（万吨）10^4tn				
柴油（万吨）10^4tn				
燃料油（万吨）10^4tn				
汽油（万吨）10^4tn				
煤油（万吨）10^4tn				
生物燃料（万吨）10^4tn				
液化石油气（万吨）10^4tn				
天然气（万立方米）10^4cu.m				
其他煤气（万立方米）10^4cu.m				
电力（万千瓦时）10^4kWh				
热力（万百万千焦）10^{10}KJ				

	废水处理能源消费量	年份	资料来源	备注
原煤（万吨）10^4tn				
焦炭（万吨）10^4tn				
柴油（万吨）10^4tn				
燃料油（万吨）10^4tn				
汽油（万吨）10^4tn				
煤油（万吨）10^4tn				
生物燃料（万吨）10^4tn				
液化石油气（万吨）10^4tn				
天然气（万立方米）10^4cu.m				
其他煤气（万立方米）10^4cu.m				
电力（万千瓦时）10^4kWh				
热力（万百万千焦）10^{10}KJ				

Solid Waste Data (固体废弃物数据)

Indicators	指标	计算结果
Municipal Solid Waste Intensity (kg/capita/year)	人均城市生活垃圾强度 （千克/人/年）	
Municipal Waste Treatment Rate of Total Collected MSW (%)	城市生活垃圾无害化处理率 （%）	
Industrial Recycling Rate (%)	工业固体废物综合利用量 （%）	

Decomposed Indicator	分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
Total Collected Municipal Solid Waste (10^4 tons)	全市每年城市生活垃圾清运量 （万吨）					
Total Landfill (10^4 tons)	全市每年垃圾填埋量（万吨）					
Total Composting (10^4 tons)	全市每年垃圾堆肥量（万吨）					
Total Incinerated Waste (10^4 tons)	全市每年垃圾焚烧量（万吨）					
Total Treated Municipal Solid Waste (10^4 tons)	全市每年城市生活垃圾无害化处理量 （万吨）					
Total Industrial Solid Waste Generation (10^4tons)	全市每年工业固体废物产生量 （万吨）					
Total Utilized Industrial Solid Waste (10^4tons)	全市每年工业固体废物综合利用量 （万吨）					

Transportation Data (交通数据)

分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
公交线网（公交车，电车，地铁，轻轨等）长度					
全市人均每年出行次数总计（次）					

全市人均每年公交出行次数总计（次）					
公交站点 500 米半径覆盖面积（平方公里）					
全市建成区面积 （平方公里）					
市政车辆（包括出租车）总数（辆）					
市政车辆中节能和新能源汽车数（辆）【1】					
全市人均每年工作出行次数（次）					
全市人均每年步行和自行车工作出行次数（次）					

备注：【1】节能和新能源汽车包括电动车，混合动力车，生物燃料和 1.6L 排量及以下的轿车

	交通能源消费量	年份	资料来源	备注
柴油（万吨）10^4tn				
汽油（万吨）10^4tn				
液化石油气（万吨）10^4tn				
电力（万千瓦时）10^4kWh				

Indicators	指标	计算结果
Public Transportation Network Penetration (km/km2)	公交线网密度 （公里/平方公里）	
Public Transportation Share of Trips of all trips (%)	公共交通分担率 （%）	
Mode Share of Non-motorized Transport of working trips(%)	工作出行非机动化（步行和自行车）比例（%）	
Access to Public Transportation of Built Area (%)	公交站点 500 米半径覆盖面积占建成区总面积比例 （%）	
Municipal Fleet Improvement of Total Vehicles (%)	节能和新能源汽车占公车比例 （%）	

Public Lighting Data (公共照明数据)

分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
城市街道照明用电量（万千瓦时）					
城市照明街道长度（公里）					

Economy & Health Data (经济&健康数据)

Decomposed Indicator	分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
Total number of economically active population (persons)	经济活动人口总数（人）					
Total number of employed population (persons)	就业人员总数 （人）					
Annual environment protection spending (10,000 RMB)	全市每年环保支出 （万元）					
Annual R&D investment spending (10,000 RMB)	全市每年研发支出 （万元）					
Areas of organic certification of agriculture land (km2)	被认证的有机农用地面积（平方公里）					
Total Areas of agriculture land (km2)	农用地总面积 （平方公里）					

Indicators	指标	计算结果
Employment percentage of eligible adults (%)	就业率 （%）	
Environmental protection spending ratio of annual GDP (%)	全市每年环保支出占 GDP 比例（%）	
R&D investment ratio of annual GDP (%)	全市每年研发投资占 GDP 比例（%）	

Organic certification of agricultural land percentage of total agricultural land (%)	被认证的有机农用地占农用地比例（%）	

Land Use Data（土地利用数据）

分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
城市绿地总面积 （平方公里）					
全市混合用地面积（平方公里）					

Indicators	指标	计算结果
Green Space Intensity (m2/capita)	人均绿地面积（平方米/人）	
Share of Mixed Use Zoing in total area (%)	混合用地比例（%）	
Urban Land Use Intensity (m2/capita)	城市人均用地面积 （平方米/人）	

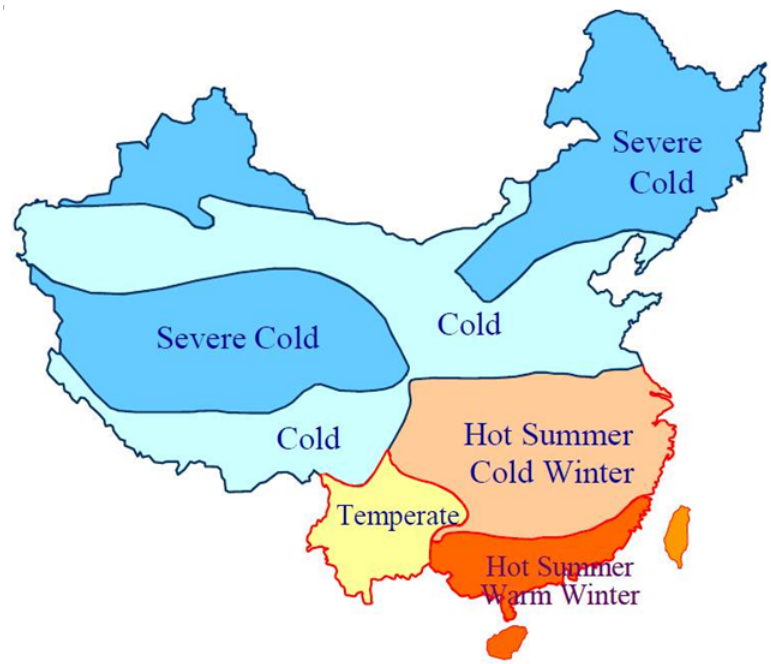
Societal Wellbeing Data （社会健康数据）

Decomposed Indicator	分解指标	数据	数据类型 (请注明是统计数据，估算数据，替代数据还是专家判断）	年份	资料来源	备注（如果是估算或替代数据，请注明方法）
Total number of health care practitioner (persons)	全市卫生技术人员总数（人）					
Total number of works from higher education (persons)	全市受高等教育（大学及以上）从业人员总数（人）					
Total number of households	全市家庭数（户）					
Total number of households with internect connectivity	全市连互联网家庭数（户）					
Total floorspace of affordable housing (m2)	全市经济适用房楼面面积（平方米）					
Total floorspace of housing (m2)	全市居住建筑楼面面积（平方米）					

生态城市规划情况调查	完成情况
1. 城市编制了碳清单吗？	
2. 城市在城市服务机构和公共建筑开展过能源审计吗？	
3. 城市审计过水消费和分配系统的损失吗？	
4. 城市审计过生活垃圾来源和种类吗？	
5. 城市审计过居民流动性（交通出行）模式吗？	
6. 城市会例行调查市民对城市环境质量的观点吗？	
7. 城市建立了低碳发展规划吗？	
8. 城市有网络平台向市民公布低碳生态城市建设进展吗？	
9. 市政府有部门专门管理和跟踪所有政府部门开展的低碳发展活动吗？	
10. 城市有低碳生态城市区或者工业园示范项目吗？	

备注：如果已经完成，请在”完成情况“下填 1，如果未完成，请在”完成情况“下填 0

Appendix 2: China's Five Climate Zones



English	Chinese (中文)
Severe Cold	严寒地区
Cold	寒冷地区
Temperate	温和地区
Hot Summer Cold Winter	夏热冬冷地区
Hot Summer Warm Winter	夏热冬暖地区

Appendix 3: Categories for Benchmark Filters

The following categories are used in Benchmarking to filter cities into peer city groups:

a. Population
   i. ≤ 499.999
   ii. 500.000-999.999
   iii. 1 million – 4.999.999
   iv. 5 million – 9.999.999
   v. ≥ 10 million
b. Climate zone
   i. Severe Cold
   ii. Cold
   iii. Hot Summer/Cold Winter
   iv. Hot Summer/Warm Winter
   v. Warm
c. HDI
   i. 0 – 0.199
   ii. 0.2 – 0.399
   iii. 0.4 – 0.599
   iv. 0.6 – 0.799
   v. 0.8 – 1.0
d. Industry Share of GDP
   i. 0 – 0.399
   ii. 0.4 – 0.499
   iii. 0.5 – 0.599
   iv. 0.6 – 1.0
e. Service Sector Share of GDP
   i. 0 – 0.299
   ii. 0.3 – 0.399
   iii. 0.4 – 0.499
   iv. 0.5 – 1.0

Appendix 4: Definitions of City Authority (for Sector Prioritization)

BEST Cities - City Authority (Level of Control) Definitions

Level of Control	% Control	Description
National Stakeholder	1-5%	Policy is formulated at the national level in consultation with municipal governments.
Provincial Stakeholder	5-30%	Policy is formulated at the provincial level in consultation with municipal governments on issues outside of its jurisdiction.
Multiple Agency Jurisdiction	30-50%	Municipal government has some control of one or more aspects of the sector (regulatory and budgetary) but will need to work with other agencies to introduce change.
Policy Formulator	50-75%	Municipal government is responsible for formulating policy or local regulations but may not have an enforcement role.
Budget Control	75-90%	Municipal government has full financial control over the provision of services, purchase of assets, and development of infrastructure, but it may lack some enforcement role or powers.
Regulator/Enforcer	90-100%	Municipal government has strong regulatory control over the sector and is able to create and enforce legislation, and where possible sanction those entities out of compliance.

Appendix 5: Definitions of City Capabilities (for Policy Prioritization)

BEST Cities - Definitions of City Capability

Area	City Capability	Description
Finance	Low	Funding is available from municipal budget streams only. Municipal government has no experience of other financial or partnering mechanisms.
	Medium	Municipal government has some experience with grants, soft loans, and commercial financing instruments.
	High	Municipal government has relevant experience in innovative financing mechanisms, such as performance contracting, ESCO partnerships, and carbon financing, in additional to grants, soft loans, and commercial financing instruments.
Human Resources	Low	Municipal government has few technically skilled staff and/or a small available workforce. Staff must be trained/or workforce expanded to deliver any new low carbon projects.
	Medium	Municipal government has access to a highly trained/skilled person to lead the initiative and/or a medium sized workforce available. Additional staff and/or training may be necessary to deliver any new low carbon projects.
	High	Municipal government has access to a sufficient number of trained/technically proficient staff resources, including skilled planners/modelers.
Policy Enforcement	Low	Municipal government is responsible for master or strategic planning, but engagement with other agencies is weak. Municipal government has limited capacity to regulate at the local level. Enforcement is weak.
	Medium	Municipal government has the ability to regulate local activity in this sector. Enforcement is in need of strengthening, however.
	High	Municipal government is responsible for all regulatory standards and policies. Municipal government has enforcement powers, which it uses effectively.

Appendix 6: Policy Attributes and Numerical Ranges based on City Size

- Speed of Implementation: low (<1 year), medium (1-3 years), high (>3 years)

- Carbon Impact Potential: low, medium, high

Carbon impact potential in $TC0_{2e}$ (note variation across different sized cities)

	Population				
	< 500,000	500,000 – 999,999	1 million – 4,999,999	5 million – 9,999,999	>10 million
Low	<50,000	<125,000	<250,000	<500,000	< 1 million
Medium	50,000 – 249,999	125,000 – 625,000	250,000 -1.25 million	500,000 – 2.5 million	1 – 5 million
High	>250,000	>625,000	>1.25 million	>2.5 million	>5 million

- First Cost : low, medium, high
-

First Cost (in RMB) (note variation across different sized cities)

	Population				
	< 500,000	500,000 – 999,999	1 million – 4,999,999	5 million – 9,999,999	>10 million
Low	<500,000	<1.25 million	<2.5 million	<5 million	< 10 million
Medium	500,000 – 5 million	1.25 million – 12.5 million	2.5 million – 25 million	5 million – 50 million	10 million – 100 million
High	>5 million	>12.5 million	>25 million	>50 million	>100 million

Appendix 7: Example Policy Recommendation: Energy Audit & Assessment

Description

Conducting an energy audit or assessment of an industrial enterprise involves collecting data on the major energy-consuming processes and equipment in a plant as well as documenting specific technologies used in the production process and identifying opportunities for energy efficiency improvement throughout the plant, typically presented in a written report. Standardized tools, informational materials, and other energy-efficiency products are often provided during the audit. Some audit programs, like the U.S. Department of Energy's Energy Savings Assessments program, provide a directory or network of accredited auditors.

Energy audits or assessments are sometimes coupled with benchmarking, as a way to quickly identify the energy-savings potentials before conduct a full energy assessment. For more information on benchmarking, please see policy "Benchmarking". To incentivize use of energy audits or assessments as well as adoption of recommended energy efficiency technologies and measures, fiscal incentives, such as fiscal rewards ("Subsidies and Rewards for Industrial Energy Efficiency"), energy efficiency loans and funds ("Industrial Energy Efficiency Loans and Innovative Funds"), or tax relief ("Tax Relief") can be provided. Other policies, such as a national or sub-national energy or CO_2 taxes ("Energy or CO_2 Taxes") or differential electricity pricing ("Differential Electricity Pricing for Industry") could also incentivize industrial plants to achieve higher savings through conducting energy audits and implementing the recommended energy-saving measures.

Implementation Strategies and Challenges

Implementation Activity	Description
Identify implementing organization	The local government designates an existing governmental agency, a local research institution, or a third party to implement the energy auditing program.
Establish the energy audit program design	The designated implementing organization determines the energy audit or assessment program design by identifying key elements of the program, including program scope (targeting sectors and industries), program duration (1 year or multiple year program), program budget (e.g., government funding for subsidies, technical assistance and training), and program requirements (e.g., types of energy auditing, required standards to use, required data reporting, and monitoring).

Identify qualified energy auditors	The designated implementing organization identifies qualified energy auditors through a certification or accreditation process, or hires qualified third-party energy auditors. A list of the qualified energy auditors can be publicized and available for industrial enterprises to contact. The auditor should consult plant personnel regarding the scope of the audit, seek information regarding areas of priority, discuss the planned audit methodology, and define the audit timeline.
Develop and provide standardized auditing methodologies and tools	The implementing organization can work with industrial associations, industrial companies, and research institutes to develop energy auditing standards, software tools, and data collection templates. Specific standards or tools can be developed for specific industrial sectors.
Provide training and technical assistance	The implementing organization can provide training and technical assistance related to conducting energy audits to energy auditors, energy managers at the industrial companies, or to the top management of the companies, through online or in-class training, guidebooks, information sheets, case studies, and other information dissemination channels.
Conduct energy audits/assessments	Energy audits are conducted in industrial plants, either using in-house energy engineers or third-party energy auditors that meet the qualifications of the program.
Develop a database of energy audit results	To better use the results of energy audits, the implementing organization can develop a database to collect, aggregate, and analyze the results of energy audits, including identified energy savings potentials, cost savings, recommended energy-saving measures, implementation rates, and realized energy and cost savings, by industrial sectors.
Announce awards and/or publicize case studies	The implementing organization can incentivize industrial companies to conduct energy audits and to implement energy-saving measures through awards or case studies to provide positive publicity to the top energy-saving enterprises.

Implementation challenges include a lack of financial support for energy audit programs, lack of standardized energy auditing/assessment standards, methodologies, software tools, or templates; lack of qualified energy auditors; lack of databases for aggregating and analyzing energy auditing results for policy decision purposes; lack of post-audit evaluations regarding implementing rates of recommended energy-saving measures.

Monitoring Metrics

Monitoring metrics for energy audits/assessments include:

- Number of industrial facilities that undertake energy audits/assessments per year
- Average estimated energy and cost savings per facility
- Average estimated energy audit costs per facility and per unit of energy saved
- Recommended energy-saving measures
- Implementation percentage of energy audit recommendations

Case Studies

Industrial Assessment Centers (IACs), U.S. Department of Energy
http://www1.eere.energy.gov/manufacturing/tech_deployment/iacs.html
The U.S. Department of Energy (DOE)'s Industrial Assessment Centers, located at 24 universities throughout the U.S., perform in-depth assessments of small- and medium-sized industrial facilities including a detailed evaluation of potential savings from energy efficiency improvements, waste minimization and pollution prevention, and productivity improvements (U.S. DOEa, n.d.). Each manufacturer typically identifies about $55,000 (342,025 RMB) in potential annual savings on average. Nearly 16,000 IAC assessments were conducted between 1981 and 2013. Manufacturers are eligible to receive an IAC assessment if they meet these criteria: (1) facility is classified within Standard Industrial Codes (SIC) 20-39; (2) facility is located within than 150 miles of a participating IAC university; (3) facility's gross annual sales are below $100 million (621.9 million RMB); (4) facility has fewer than 500 employees at the plant site; (5) facility's annual energy bills more than $100,000 (621,861 RMB) and less than $2.5 million (15.5 million RMB); and (6) facility does not have professional in-house staff to perform the energy assessment. Typical assessment reports include more than a dozen recommendations with average payback period of less than 2 years. Average annual savings for measures recommended by IACs exceeded $240,000 (1.49 million RMB) per plant and range from $50,000 (310,930 RMB) to $3,000,000 (18.66 million RMB). Potential returns on investment for IAC audits from DOE are from $10 (62.2 RMB) to $20 (124.4 RMB) for each audit dollar. Each university receives $200,000 (1.24 million RMB) to $300,000 (1.87 million RMB) per year for up to 5 years to help university teams gain practical training on core energy management concepts through DOE's IAC program.

Save Energy Now, U.S. Department of Energy
http://www1.eere.energy.gov/manufacturing/tech_deployment/

In 2006, the U.S. DOE's Industrial Technologies Program initiated the Save Energy Now program that provides trained energy experts to perform Energy Savings Assessments at the most energy-intensive manufacturing facilities in the U.S. (U.S. DOEb, n.d.). The assessments targeted the largest energy-consuming manufacturing plants, consuming 1 trillion Btu or more annually in six industries (over 80% of the assessments were in these industries): chemical manufacturing, paper manufacturing, primary metals, food, non-metallic mineral products, and fabricated metal products. The purpose of the assessments is to identify immediate opportunities to save energy and money, primarily by focusing energy-intensive systems such as process heating, steam, compressed air, fans, and pumps. In 2006, the Save Energy Now program completed 200 assessments at large manufacturing plants and found that the typical large plant can reduce its energy bill on average by over $2.5 million (15.5 million RMB) per plant, for a total of $500 million (3.11 billion RMB) in identified energy cost savings and over 4 million metric tons of CO_2 emissions reductions.

Comprehensive Industrial Energy Efficiency Program, San Diego, California, U.S.
http://www.sdge.com/save-money/no-cost-audits/comprehensive-industrial-energy-efficiency-prorgam
The Comprehensive Industrial Energy Efficiency Program (CIEEP) of San Diego Gas and Electricity (SDG&E) offers its industrial customers a no-cost facility audit to identify their comprehensive energy efficiency solutions. Customers from the industrial sector include printing plants, plastic injection molding facilities, component fabrication facilities, lumber and paper mills, cement plants and quarries, metals processing, petroleum refineries, chemical industries, assembly plants, and water and wastewater treatment plants. Four sub-programs, including audits, calculated, deemed, and continuous energy improvement, comprise the core product and service offerings for the industrial sectors.

Energy Audit Program, France
In 1999, an energy audit program called “Aide à la décision” (Decision Making Support Scheme) was launched in France. This program covered both the industry and building sectors, except for individual single houses. There are two types of energy audits defined in the program, including simplified energy audits aimed at a wide evaluation through a quick assessment and detailed energy audits with comprehensive detail energy audits and feasibility studies. For the industrial sector, the annual goals of the program for the period of 2000-2006 were to conduct 600 pre-audits in enterprises with energy use less than 5,000 tonnes of oil equivalent (toe) per year (7,143 tce per year), and 400 general audits in industries with the energy use more than 5,000 toe/year (7,143 tce/year). The expected energy savings from the industrial sector was 58000 toe/year (82,857 tce/year). With these objectives, the annual budget allocation for industrial energy audits was €11.4 million Euros (96.2 million RMB).[1] Subsidies were given to industrial sectors in the program in the form of co-payments for energy auditing costs. These subsidies varied from 50% to 70% of the audit cost depending on the different types of energy audits.

[1] Based on the historical exchange rate in 2002: http://www.oanda.com/currency/historical-rates/.

Subsidies or incentives were paid to the clients only after the energy auditors fulfilled the requirements of the audit specifications and the auditing reports were evaluated by the regional delegations of French Environment and Energy Management Agency (Despretz, 2002).

Energy Audit Program, Finland

Finland has had an active energy audit program since 1992. The program focuses on energy audits in several sectors, including buildings and processes in the service (both private and public[2]) and industrial sectors, as well as energy-intensive process industry. Finland's Voluntary Agreement Scheme (VA Scheme), which covered around 85% of total industrial energy use and more than 50% of the building stock in the service sector, was launched in 1997. Because the VA Scheme required all participating enterprises and organizations to conduct energy audits, it was a key instrument for promoting the implementation of energy audits. After voluntarily signing agreements with the government, the enterprises agreed to reduce energy consumption and committed to conduct energy audits and implement suggested cost-effective energy-saving measures found in the audits.

The Finnish Ministry of Trade and Industry (MTI) was the Ministry in charge of energy-efficiency actions in the industrial and service sectors. MTI's Energy Department was administrator of the energy audit program, and supervised "large-scale energy audit projects with a total audit cost over 170,000 Euros" and "non-standard projects of pilot nature" (Väisänen and Reinikainen, 2002).

Subsidies were used as a main instrument to promote energy audits since 1992. Around 40% to 50% of energy audit costs were covered by subsidies. Once the VA Scheme was established, subsidies for power plants and district heating plants and networks were also available starting in 1998. The MTI in Finland provided 50% subsidies to industrial enterprises and municipalities that signed agreements with the MTI (Väisänen and Reinikainen, 2002). The Finnish government also granted a 10% subsidy for investments in energy-saving measures that were recommended in the energy audit reports.

Attributes

- ### Carbon Savings Potential

  Medium

  The energy savings potential of energy auditing programs is highly related to: 1) the potential of energy savings that is able to be identified through high-quality energy audits; 2) the implementation rate of recommended energy saving measures; 3) the number of energy audits that are conducted. Based on the average energy-savings potential and implementation rates as the audits conducted by the U.S. Industrial

[2] Public service sector refers to municipalities and non-governmental organizations.

Assessment Centers, it is estimated that for a local city the annual energy-savings and emission reduction potential is medium, in the range of 0.5 Mtce to 1.0 Mtce.[3]

- **First Cost**

  Medium
  The cost for local governments to implement industrial energy audits varies with the number of energy audits required. Using the U.S. Industrial Assessment Center's funding level as a reference, the total cost for a local government is estimated to be medium, in the range of 10 million RMB to 30 million RMB.4

- **Speed of Implementation**

  1 -3 years

- **Co-Benefits**

  Reduced carbon dioxide and other pollutant emissions, improved air quality, enhanced public health, increased productivity, energy and cost savings for enterprises.

Tools and Guidance

Hasanbeigi, A., L.Price, 2010. *Industrial Energy Audit Guidebook*. Lawrence Berkeley National Laboratory (LBNL-3991E). Berkeley, CA. http://china.lbl.gov/publications/industrial-energy-audit-guidebook.
Industrial Energy Audit Tools. *Industrial Assessment Center*. University of Missouri-Columbia. http://iac.missouri.edu/webtools.html.
U.S. Environmental Protection Agency (U.S. EPA). *Plant Energy Auditing: ENERGY STAR*. http://www.energystar.gov/index.cfm?c=industry.bus_industry_plant_energy_auditing.

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U.S. Department of Energy (U.S. DOE)b. *Better Plants Initiative*. http://www1.eere.energy.gov/manufacturing/tech_deployment/betterplants/index.html
Despretz, H., 2002. *SAVE II Project Audit II: Country Report France*. http://www.motiva.fi/files/1921/CR_FR.pdf.
Väisänen, H., and E. Reinikainen, 2002. *SAVE II Project AUDIT II: Country Report Finland*. http://www.motiva.fi/files/1945/CR-FIN.pdf.

[3] See Shanghai Memo (internal).
[4] See Shanghai Memo (internal).

Appendix 8: Attributes & Capability Requirements for 72 Policy Recommendations

	Policy Attributes (Sorting Tags)			Capability Requirements		
Urban Green Space Policy Recommendations Write-ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
U01: Urban Green Space Program	<1year	Low	Low	Low	Medium	Low
U02: Urban Forestry Management Program	>3year	Low	Low	Low	Medium	Medium

Building Policy Recommendations Write-Ups	**Sector**	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
B01: Energy-Efficient Equipment and Renewable Energy Technology Purchase Subsidies	Residential	1-3years	High	High	High	Medium	Medium
B02: Subsides for New Buildings that Exceed Building Code	Both	1-3years	High	Medium	High	High	Medium
B03: Retrofit Subsidies and Tax Credits for Existing Buildings	Both	1-3years	High	Medium	High	Medium	Medium
B04: Cooperative Procurement of Green Products	Commercial & Public	<1year	Low	Low	High	High	Medium
B05: Energy Performance Contracting and Energy Service Companies	Commercial & Public	<1year	Low	Low	Medium	Medium	Medium
B06: Municipal Building Energy Efficiency Task Force	Commercial & Public	<1year	Low	Low	Low	High	Medium
B07: Expedited Permitting for Green Buildings	Both	<1year	Low	Low	Low	Medium	Medium
B08: Targets for Efficient and Renewables in Buildings	Both	1-3years	Low	Medium	Low	Medium	Medium
B09: More Stringent Local Building Codes	Both	>3year	Medium	High	Low	Medium	High
B10: Green Building Guidelines for New Buildings	Both	<1year	Low	Medium	Low	Medium	High

B11: Financial Incentives for Distributed Generation in Buildings	Commercial & Public	1-3years	Medium	Medium	Medium	Medium	High
B12: City Energy and Heat Maps	Both	<1year	Low	Low	Low	Medium	Low
B13: Building Energy Labeling and Information Disclosure	Both	1-3years	Low	Medium	Low	Medium	Low
B14: Mandatory Building Energy-Efficiency Audit and Retrofits	Commercial & Public	1-3years	Medium	Medium	Medium	Medium	Medium
B15: Reach Standards for Efficient Appliance and Equipment	Residential	1-3years	Low	High	Low	Low	Low
B16: Building Workforce Training	Residential	<1year	Low	Low	Low	Medium	Low
B17: Public Education Campaigns on Building Energy Efficiency and Conservation	Both	<1year	Low	Low	Low	Medium	Low

Industry Policy Recommendations Write-Ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
I01: Benchmarking	<1year	Low	Medium	Low	Medium	Low
I02: Energy Audit / Assessments	1-3years	Medium	Medium	Low	Medium	Low
I03: Industrial Energy Plan	<1year	Low	Medium	Low	Medium	Low
I04: Stretch Targets for Industry	1-3years	Low	Medium	Low	Medium	Medium
I05: Subsidies and Rewards for Industrial Energy Efficiency	1-3years	High	Medium	High	High	Medium
I06: Industrial Energy Efficiency Loans and Innovative Funds	>3years	High	Medium	High	Medium	Medium
I07: Tax Relief	1-3years	High	Medium	High	High	High
I08: Energy or CO_2 Tax	1-3years	Low	High	High	High	High
I09: Industrial Equipment and Product Standards	1-3years	Low	Medium	High	High	High
I10: Differential Electricity Pricing	<1year	Low	Medium	High	High	High
I11: Energy Management Standards	<1year	Medium	Medium	Low	Medium	Low
I12: Energy Manager Training	<1year	Medium	Medium	Low	Medium	Low
I13: Recycling Economy and By-product Synergy Activities	1-3years	Medium	Medium	Medium	Medium	Medium
I14: Low-carbon Industrial Parks	>3years	Medium	Medium	Medium	High	Medium

I15: Fuel-switching	1-3years	High	High	Low	Low	Low

Power Policy Recommendations Write-Ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
P01: Minimum Performance Standards for Thermal Power Plants	1-3years	Medium	High	High	High	High
P02: Renewable Energy and Non-fossil Energy Targets or Quotas	>3years	Low	High	High	High	High
P03: District Heating Networking Maintenance and Upgrade Program	1-3years	Medium	Medium	Medium	Medium	Low
P04: Transformer Upgrade Program	<1year	Medium	Medium	High	High	High
P05: Time-based Electricity Pricing Schemes: Inclining Block Pricing and Time-of- Use Pricing	1-3years	Medium	Medium	High	High	High
P06: Load Curtailment Incentives/Demand Response/Curtailable Rates	1-3years	Medium	Medium	High	High	High
P07: Power Investment subsidies and tax incentives for Renewable Energy	1-3years	High	High	High	High	High

Street Lighting Policy Recommendations Write-Ups						
SL01: Street Lighting Plan	<1year	Low	Low	Low	Medium	Low
SL02: Audit and Retrofit Programs	<1year	Low	Low	Medium	Medium	Low

Solid Waste Policy Recommendations Write-Ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
SW01: Integrated Solid Waste Management Planning	<1year	Low	Low	Low	Medium	Low
SW02: Recycling and Composting Mandate and Program	1-3years	Low	Low	Medium	Medium	Low
SW03: Landfill Methane Recovery	1-3years	Medium	Low	Medium	Medium	Medium
SW04: Anaerobic Digestion	1-3years	Low	Low	Medium	Medium	Medium
SW05: Waste Composting Program	1-3years	Low	Low	Medium	Medium	Medium

SW06: Waste Vehicle Fleet Maintenance, Audit and Retrofit Program	<1year	Low	Low	Low	Low	Low
SW07: Public Education Program	<1year	Low	Low	Low	Medium	Low

Transportation Policy Recommendations Write-Ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
T01: Integrated Transportation Planning	>3year	Low	Medium	Low	Medium	Low
T02: Mixed-use Urban Form	>3year	Low	Medium	Low	Medium	Low
T03: Vehicle CO2 Emission Standards	1-3years	Medium	High	High	High	High
T04: Vehicle Fuel Economy Standards	1-3years	Medium	High	High	High	High
T05: Commuting programs	<1year	Low	Medium	Low	Low	Low
T06: Bike Share Programs	1-3years	Low	Low	Low	Low	Low
T07: Improved Bicycle Path Network	1-3years	Medium	Medium	Low	Low	Low
T08: Complete Streets	1-3years	Low	Low	Low	Low	Low
T09: Public Transit Infrastructure: Light rail, BRT, and Buses	>3year	Medium	High	High	Medium	Medium
T10: Congestion Charges, and Road Pricing	1-3years	Low	Medium	High	Medium	Medium
T11: Parking Fees and Measures	1-3years	Low	Medium	Medium	Medium	Medium
T12: Vehicle License Policies	<1year	Low	Medium	Low	Low	Medium
T13: Public Education on Transport Options	<1year	Low	Low	Low	Medium	Low
T14: Clean Vehicle Program	1-3years	Medium	Medium			

Water Policy Recommendations Write-Ups	Speed of implementation	First Cost to Government	Carbon Savings Potential	Finance	Human Resource	Enforcement
W01: Water Management Plan	<1year	Low	Low	Low	Medium	Low
W02: Codes, Consumer Education, and Incentives for Water-Efficient Products	<1year	Low	Low	Low	Medium	High
W03: Prioritize Energy Efficient Water Resources	1-3years	Low	Low	Low	Medium	Medium

W04: Improve Efficiency of Pumps and Motors	1-3years	Medium	Medium	Low	Medium	Low
W05: Active Leak Detection and Pressure Management Program	1-3years	Low	Low	Low	Medium	Low
W06: Methane Capture and Reuse/Conversion	<1year	Low	Low	Medium	Medium	Medium
W07: Public Education Measures	<1year	Low	Low	Low	Medium	Low
W08: Facility Operator Training Program	<1year	Low	Low	Low	Medium	Low