Evaluation guide for green and smart cities

Jianfang Zong, Yan Li, Ling Lin, Wei Bao
China National Institute of Standardization, No.4 Zhichun Road, Haidian District, Beijing
zongjf@cnis.gov.cn

Abstract. A green and smart city is the top-down design of a smart city, and a new-type city integrating intelligence, intensity, green development and low carbon. This paper puts forward a system of evaluation indicators for measuring green and smart cities from ten aspects: resource utilization, environmental governance and environmental quality, ecological protection, urban management and informatization, green and smart transportation, green and smart medical care, green and smart facilities, network security and citizens' experience.

1. Introduction
Green and smart cities are the development goal of new-type smart cities, and new-type cities integrating intelligence, intensity, green development and low carbon. With the implementation of the construction of green cities and the development of smart cities, green development and smartness have become one of the inevitable ways to solve urban development problems. Green and smart cities mean not only the green development of urban communications and information infrastructure, but also the implementation of green, environmental protection and energy conservation concepts throughout the production and consumption of information services, and will not adversely affect the global climate and environment. The system of indicators established in the evaluation guide for green and smart cities is a method system composed of a set of scientific and systematic evaluation indicators and for the quantified calculation and scientific evaluation of construction achievements of green and smart cities, is an action guide to the construction of green and smart cities, and hopefully plays a role in leading, inspection, evaluation and so on of the construction and deployment of green and smart cities.

A green and smart city is the top-down design of a smart city, and a new-type city integrating intelligence, intensity, green development and low carbon. Sustainable cities featuring green economy, green infrastructure, green transportation and green environment shall be achieved through the integration of the green concept using information technology Internet of Things, big data, cloud computing and other intelligent means, the comprehensive application of multiple subjects and fields such as system engineering and ecology, economics and management, and the reduction of energy consumption, energy conservation and emission reduction in the process of production and consumption.

This paper puts forward a system of evaluation indicators for measuring green and smart cities from ten aspects: resource utilization, environmental governance and environmental quality, ecological protection, urban management and informatization, green and smart transportation, green and smart medical care, green and smart facilities, network security and citizens' experience.
2. Main principles for establishment of the evaluation indicator system

2.1 Goal-oriented principle
The establishment of the system shall be oriented by the realization of the goals such as green urban resources and environment, convenient public services, refined urban management, livable living environment, intelligent infrastructure and long-standing network security.

2.2 Principle of synergy between innovation-driven development and green development
The application of green technology in smart cities shall be reflected. Green and smart cities shall be regarded as an important carrier of innovation-driven development. Through integration and sharing, coordinated development and multiple participations, cities featuring sustainable development, energy conservation and environmental protection development and low-carbon cycle development shall be achieved.

2.3 People-oriented principle
We shall take action for people. The guidance is for the convenience of people and for the benefit of people. And the guidance shall take the following factors into full consideration: such as the strategic positioning, historical culture, resources and environment, information technology basis and the level of economic and social development of cities. And the guidance shall fully embody the connotation and characteristics of green and smart cities.

2.4 Operability principle
We shall pay attention to the operability of indicator application, and take into full consideration the difficulty of indicator acquisition, the quantifiable degree of indicators and the possibility to achieve calculation.

3. Evaluation indicator system of green and smart cities

3.1 Basic requirements
An urban plan shall meet requirements for green, ecological, low-carbon and smart development, or a city has prepared an urban plan as per green, ecological, low-carbon and smart ideas. Main roads, pipelines, green land, waters and other infrastructures in a city have been constructed and put into use. Main public service facilities in a city shall have been constructed and put into use. A city shall have a monitoring or evaluation system covering major implementation and operation management data of a green and smart city;

The system of evaluation indicators for green and smart cities shall mainly include ten indicators, namely resource utilization, environmental governance, environmental quality, ecological protection, green and smart transportation, green and smart medical care, green and smart facilities, information resources, network security and citizens' experience. Each indicator includes assessment items and scoring items. The result of assessment items is satisfaction or dissatisfaction, and the total points of scoring items are 100 points. At the same time, 1 bonus point item of green development is set. Total points of the bonus point item are 10 points.

The total points of the evaluation of green and smart cities may be calculated as per formula (1).

\[ Q = \sum_{i=1}^{10} Q_i + E \]  

In which, \( Q \) is the total points of evaluation of a green and smart city, with the aggregate score of 110 points; \( Q_i \) is the points of all sub-indicators; and \( E \) is the score of the bonus point item.
3.2 Evaluation indicator system

An evaluation indicator system for green and smart cities shall establish mainly based on the requirements of green development indicator and in combination with the requirements of GB/T 33356[1], ISO 37120[2] and other indicators [3-11]. The evaluation indicator system is set out in Table 1 as shown below.

| Sub-indicator | Item No. | Part I Main indicator system | Scoring standard | Point | Score | Remarks |
|---------------|----------|------------------------------|------------------|-------|-------|---------|
| I. Resource utilization (38 points) | 1. | Plan and indicators for comprehensive utilization of urban energy resources shall be formulated. | If attention is paid to saving energy resources, and the reduction rate of energy consumption per unit GDP is higher than 5%, the score will be 2; if the reduction rate ranges from 2% to 5%, the score will be 1; if the reduction rate is lower than 2%, the score will be 0. | —— | 2 | Assessment item |
| | 2. | Environmental quality control measures and indicators such as urban air, water, noise and soil shall be formulated. | Atmospheric and environmental indicators such as air quality, water quality and noise level shall comply with national standards. | —— | 2 | Assessment item |
| | 3. | Adherence to the protection of the ecological environment. | If the city achieves resource recovery of domestic waste and construction waste, and the resource recovery rate of domestic waste reaches 35%, the score will be 2; if the management of construction waste is standardized, and the comprehensive utilization rate reaches 30%, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 4. | If the municipal water supply system is reasonably constructed, and the coverage rate of water supply reaches 100%, the score will be 2; if the rate reaches 90%, the score will be 1; otherwise, the score will be 0. | If the municipal water supply system is reasonably constructed, and the coverage rate of water supply reaches 100%, the score will be 2; if the rate reaches 90%, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 5. | If the water quality in the city conforms to the current national standard GB 3838 Environmental quality standard for surface water, the score will be 2; if the city’s minimum water quality indicator meets the requirements for IV Category under the current national standard GB 3838 Environmental quality standard for surface water, the score will be 1; otherwise, the score will be 0. | If the water quality in the city conforms to the current national standard GB 3838 Environmental quality standard for surface water, the score will be 2; if the city’s minimum water quality indicator meets the requirements for IV Category under the current national standard GB 3838 Environmental quality standard for surface water, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| II. Environmental governance and environmental quality (12 points) | 6. | If the urban flood control design conforms to the current national standard GB 50201 standard for urban flood control and GB/T 50805 code for design of urban flood control projects, the score will be 2; if the city’s minimum water quality indicator meets the requirements for IV Category under the current national standard GB 3838 Environmental quality standard for surface water, the score will be 1; otherwise, the score will be 0. | If the urban flood control design conforms to the current national standard GB 50201 standard for flood control and GB/T 50805 code for design of urban flood control projects, the score will be 2; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 7. | If the municipal water supply system is reasonably constructed, and the coverage rate of water supply reaches 100%, the score will be 2; if the rate reaches 90%, the score will be 1; otherwise, the score will be 0. | If the municipal water supply system is reasonably constructed, and the coverage rate of water supply reaches 100%, the score will be 2; if the rate reaches 90%, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 8. | If the surface water quality in the city reaches the approved urban water environmental quality standard, the score will be 2; if the city’s minimum water quality indicator meets the requirements for IV Category under the current national standard GB 3838 Environmental quality standard for surface water, the score will be 1; otherwise, the score will be 0. | If the surface water quality in the city reaches the approved urban water environmental quality standard, the score will be 2; if the city’s minimum water quality indicator meets the requirements for IV Category under the current national standard GB 3838 Environmental quality standard for surface water, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 9. | If the city achieves resource recovery of domestic waste and construction waste, and the resource recovery rate of domestic waste reaches 35%, the score will be 2; if the management of construction waste is standardized, and the comprehensive utilization rate reaches 30%, the score will be 1; otherwise, the score will be 0. | If the city achieves resource recovery of domestic waste and construction waste, and the resource recovery rate of domestic waste reaches 35%, the score will be 2; if the management of construction waste is standardized, and the comprehensive utilization rate reaches 30%, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |
| | 10. | If the city achieves resource recovery of domestic waste and construction waste, and the resource recovery rate of domestic waste reaches 35%, the score will be 2; if the management of construction waste is standardized, and the comprehensive utilization rate reaches 30%, the score will be 1; otherwise, the score will be 0. | If the city achieves resource recovery of domestic waste and construction waste, and the resource recovery rate of domestic waste reaches 35%, the score will be 2; if the management of construction waste is standardized, and the comprehensive utilization rate reaches 30%, the score will be 1; otherwise, the score will be 0. | —— | 2 | Assessment item |

Table 1. Evaluation Indicator System of Green and Smart Cities
| Item | Description | Points |
|------|-------------|--------|
| 25.  | If the ratio of land nature reserve area reaches 40%, the score will be 2; if such ratio reaches 30%, the score will be 1; otherwise, the score will be 0. | 2 |
| 26.  | If the area of marine protected area reaches 30%, the score will be 2; if such ratio reaches 20%, the score will be 1; otherwise, the score will be 0. | 2 |
| 27.  | A low-carbon urban development plan shall be formulated. The plan shall meet the requirements of the urban and rural planning in the region. The urban development direction and city structure shall be deployed as a whole. The urban land use, supporting facilities and city-industry integration shall be balanced. | 5 |
| 28.  | A green and smart building plan shall be formulated to define the development goal of green and smart buildings in the city. | 5 |
| 29.  | A green and smart city information management system shall be established, to implement information-based management of green and smart city. | 5 |
| 30.  | Newly-built civil buildings shall all meet one star or above standard for green buildings under the current national standard GB/T 50378 assessment standard for green building. The proportion of newly-built large public buildings (offices, shopping malls, hospitals, hotels, etc.) whose area reaches the two-star and above standard for green buildings shall not be lower than 50% of the total area of newly-built large public buildings. All public buildings funded by the government shall reach the two-star and above evaluation standard for green buildings. If all the above requirements are met, the score will be 5; if not all the above requirements are met, the score will be 3; otherwise, the score will be 0. | 5 |
| 31.  | If the opening rate of public information resources is higher than 70%, the score will be 5; if such rate is higher than 50%, the score will be 3; otherwise, the score will be 0. | 5 |
| 32.  | If the sharing rate of information resource departments is higher than 60%, the score will be 5; if such rate is higher than 50%, the score will be 3; if such rate is higher than 40%, the score will be 1; otherwise, the score will be 0. | 5 |
| 33.  | An urban smart transportation plan shall be formulated and guiding measures and control indicators, such as green transportation and smart transportation shall be formulated. If the urban traffic operation index is released, and the urban traffic management department has the ability to calculate and analyze the urban traffic operation index, and identify and understand the urban road traffic operation status in real time; if there is the ability of public release (via at least one form of releases by public media such as variable intelligence board, TV, radio, mobile phone application software), the score will be 2; if the analysis of urban traffic operation index reaches the level of secondary roads and above (the urban road network includes expressways, trunk roads, secondary roads and branches), the score will be 1. Otherwise, the score will be 0. | 2 |
| 34.  | If information on the coming buses and trains is released, and real-time driving or arrival information of buses and trains is provided by through the network, mobile phone, electronic stop signs, the score will be 2; otherwise, the score will be 0. | 2 |
| 35.  | If utilization rate of electric payment for public transportation through one-stop card, mobile payment, near-field communication payment or otherwise when urban rail transit, public buses and trains or other forms are adopted, the score will be 2; otherwise, the score will be 0. | 2 |
| 36.  | If clean-energy public vehicles are adopted, the score will be 2; otherwise, the score will be 0. | 2 |
| 37.  | If attention is paid to the rate of green transportation, and the ratio of green transportation, such as pedestrian transportation, bicycle transportation and regular bus transportation, in urban transportation exceeds 70%, the score will be 2, if such ratio exceeds 50%, the score will be 1, otherwise, the score will be 0. | 2 |
| 38.  | If the ratio of traffic operation index reaches the level of secondary roads and above (the urban road network includes expressways, trunk roads, secondary roads and branches), the score will be 1. Otherwise, the score will be 0. | 2 |
| 39.  | If an urban smart medical care plan is formulated, and guiding measures and control indicators for smart medical care are formulated, the score will be 2; otherwise, the score will be 0. | 2 |
| 40.  | If attention is paid to the popularity of electronic medical records in medical institutions at or above the second level, and the number of medical institutions at or above the second level that have established electronic medical records accounts for more than 80% of the total number of medical institutions at or above the second level in the city, the score will be 2; if such popularity exceeds 50%, the score will be 1, otherwise, the score will be 0. | 2 |
| 41.  | If attention is paid to the appointment rate of medical institutions at or above the second level, and the number of people registered by telephone, website, mobile phone application software or otherwise accounts for more than 80% of the number of people seeking medical treatment at medical institutions at or above the second level each year exceeds 80%, the score will be 2; if such rate exceeds 50%, the score will be 1; otherwise, the score will be 0. | 2 |
| 42.  | If the popularity of fixed broadband households reaches 80%, the score will be 2; if such popularity reaches 60%, the score will be 1; otherwise, the score will be 0. | 1 |
| 43.  | If the penetration rate of fiber to home users reaches 80%, the score will be 2; if such rate reaches 60%, the score will be 1; otherwise, the score will be 0. | 1 |
| 44.  | If the popularity of mobile broadband households reaches 80%, the score will be 2; if such popularity reaches 60%, the score will be 1; otherwise, the score will be 0. | 2 |
| 45.  | If the coverage rate of multi-scale geographic information reaches 90%, the score will be 2; if such rate reaches 70%, the score will be 1; otherwise, the score will be 0. | 2 |
| 46.  | If the ratio of the platform's online provision of space information for departments and the public reaches 50%, the score will be 2; if such rate reaches 40%, the score will be 1; otherwise, the score will be 0. | 2 |
| 47.  | If the ratio of provision of high accurate location services for users reaches 50%, the score will be 0; if such rate exceeds 40%, the score will be 1; otherwise, the score will be 0. | 2 |
| 48.  | An organization and coordination mechanism of green and smart city network security shall be established. By relying on the organization and coordination mechanism of green and smart city construction: a network security working mechanism of green and smart cities shall be established; the network security responsibilities at all levels shall be implemented. | Assessment item |
| 49.  | The city has established an effective notification and early warning mechanism to report member units, who cover all key information infrastructure and rectify reported incidents or hidden dangers in a timely manner. And the city has established a notification and early warning mechanism to report member units who cover more than 80% of key information infrastructure, and rectify reported incidents or hidden dangers in a timely manner. | Assessment item |
| 50.  | If the rate of provision of high accurate location services for users reaches 50%, the score will be 0; if such rate exceeds 40%, the score will be 1; otherwise, the score will be 0. | Assessment item |
4.1 The comprehensive utilization rate of general industrial solid waste

The general industrial solid waste comprehensive utilization rate refers to the ratio of general industrial solid waste that is comprehensively utilized to the industrial solid waste production volume. General industrial solid waste includes blast furnace slag, steel slag, red mud, non-ferrous metal slag, fly ash, coal slag, sulfuric acid slag, waste gypsum, desulfurization ash, carbide slag and salt mud. Industrial solid waste refers to solid waste generated in industrial production activities. The comprehensive utilization rate of general industrial solid waste is demonstrated in %.

4.2 Harmless treatment rate of domestic waste

The harmless treatment rate of domestic waste refers to the ratio of the amount of waste that has undergone harmless treatment to the total amount of domestic waste. Harmless treatment of domestic waste refers to the adoption of advanced processes and scientific technology in the process of treating domestic waste to reduce the impact of waste and its derivatives on the environment, reduce waste discharge and recycle resources. The harmless treatment rate of domestic waste is demonstrated in %.

4.3 Vegetation coverage

Vegetation coverage is the ratio of the total green coverage area to the total area in the residential area. Vegetation coverage area refers to the vertical projection area of all vegetation in the city: such as trees, shrubs and lawns, and it includes public green space, residential green space, unit affiliated green space, protective green space, production green space, road green space and scenic forest coverage area, roof green coverage area and scattered tree coverage area. Vegetation coverage is demonstrated in percentage(%).
4.4 Public availability rate of public information resources
Public availability rate of public information resources = ratio of the number of public information resource categories accessible by API to the total number of public information resource categories that need to be opened. It is demonstrated in %. The total number of public information resource categories that need to be opened is 20. Specifically such categories include government data sets in 20 categories of livelihood security service-related areas such as credit, public security, transportation, medical care, health, employment, social security, geography, culture, education, science and technology, resources, agriculture, environment, safety supervision, finance, quality, statistics, meteorology and enterprise registration supervision. The specific types and quantities of open public information resources that can be accessed by API in each category are not required for the time being.

4.5 Inter-departmental information resources sharing rate
Inter-departmental information resources sharing rate = ratio of the number of departments formulating catalogues of information resources and sharing the same to the total number of government departments. It is demonstrated in %. The formulation of an information resource catalogue and the sharing of the same mean a department formulates an information resource catalogue within its scope of powers and duties and shares all non-confidential information resources with other departments. If only a small amount of information resources are shared with other departments, these resources shall not be included.

5. Conclusion
Building a green and smart city is not only a breakthrough to solve urban problems, but also a necessary way to achieve sustainable urban development [12]. Therefore, it is important to build a green and smart city. Green and smart city is a new type of society that integrates green concept, information driven and clean technology into the construction of a smart city to realize environment-friendly and resource-saving. This paper attempts to establish the evaluation index system of green smart city, aiming at providing technical support for the construction of green and smart city and sustainable basis for the evaluation of green smart city, which has guiding significance for the construction of green smart city in China [13-18].

References
[1] GB/T 33356 Evaluation indicators for new-type smart cities
[2] ISO 37120 Sustainable development of communities-Indicators for city services and quality of life
[3] GB 3096 Environmental quality standard for noise
[4] GB 3838 Environmental quality standard for surface water
[5] GB 15618 Environmental quality standard for soils
[6] GB/T 36333 Smart city - Top-level design guide
[7] GB50201 Standard for flood control
[8] GB/T 50378 Assessment standard for green building
[9] GB/T 50805 Code for design of urban flood control projects
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[11] SL 190 Standards for classification and gradation of soil erosion
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