

Characteristics and Strategies Analysis of Land Use and Transportation Planning for Small and Medium Sized Cities in PRC in the Context of Low Carbon Development

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Abstract

Based on the characteristics and development trends of SMCs strategies and policy guidelines for land use and transport planning are analyzed in this study. In regional and urban planning, apply public transit-oriented development to optimize the urban spatial structure, take shortest path as the target of mixed land use. Build appropriate street blocks and residential areas making blocks scale suitable for walking and bicycling. In road network design, put pedestrians and cyclists in the first place; meanwhile, establish convenient, fast public transport. Affect the use of private cars through transportation demand management, enhance the attractiveness of non-motorized transport modes, attract private car users to choose public transport, bicycling and walking instead of driving and maximize the benefits of non-motorized transport modes users.

Keywords: *Small and Medium Sized Cities, Land Use, Non-motorized Transport*

1 INTRODUCTION

It is estimated that the PRC's urban population, which was 691 million (51.27 % of the total population) in 2011, will reach 943 million (70% of the population) by 2030. By the end of 2010, the PRC had 657 designated cities, of which 287 cities were above prefecture level and 370 county-level designated cities. Among the 287 prefecture cities, 162 cities could be defined as small and medium sized cities (SMCs), accounting for 56.45%. Among the 370 county-level designated cities, only a few developed cities have urban resident population close to or above one million. Most of these cities have urban population between tens of thousands and hundreds of thousands. Due to the lack of official statistics, all county-level designated cities are here defined as SMCs. In this way, at least 532 cities belong to SMCs currently. The administrative area of SMCs and its influence zones reached 9.27 million square kilometers, and its aggregate economic volume arrived at 55.34% of the whole country by the end of 2010 [1]. It is predicted that there will be more than 500 medium cities by 2030, which will accommodate 0.25 billion people; and more than 1000 small cities have to be accommodate 0.1 billion people. SMCs are growing faster than large or mega cities, by economic development, which stimulates significant expansion of developed or constructed urban areas, unless forceful land use policies intervene. Growing population and expanding urban areas increase transportation demands. Such demands, together with the increased income level from the fast economic development, boost motorization in urban transport sector. Non-motorized transport mode will continue to decline without a proper urban planning or incentive policies.

In recent years, Chinese government has adopted a series of policies to cope with climate change at both national level and smaller economic sector level. The 12th five-year plan clearly stated low-carbon green development as its target, specifically proposed to transit urban development model to taking a sustainable path, widely promoting different types of low-carbon pilot demonstration project and encouraging low-carbon actions in the whole society. Under the background of Low Carbon Development (LCD), as an important means to guide the development of

cities, land use and transportation planning how to face the faster urbanization? This is a vital scientific issue for small and medium cities urgent to be solved. However, most of existing research focuses on large cities rather than small and medium cities which will follow the same old disastrous path as large cities if there are not proper policy guidelines. Through the characteristics and trends analysis of land use and transportation planning of SMCs, this paper proposed to strategies for low carbon development aiming to build up foundations of policy guidelines for SMCs.

2 CHARACTERISTICS OF LAND USE AND TRANSPORTATION PLANNING IN SMCs

Sichuan province is located in the southwest of China, which includes a lot of SMCs, it can be thought showing the general characteristics of SMC development in the PRC. Chinese SMCs have the following characteristics as described below.

2.1 Faster Expansion of Urban Constructed Areas and Lower Efficiency of Land Use

During 1997~2009, 5.27 million hectares of land have been developed to meet the land resource demand which resulted in annual increase of 1% [2]. Expansion of urban construction areas has reduced the areas primarily used for agriculture. Figure1 shows two opposite directions of land use change: urban construction (left of Figure 1) and agriculture (right of Figure 1) in Sichuan province. The year-end cultivated farmland dropped from 4.62 million hectares in 1992 down to 3.97 million in 2009 while the urban constructed area increased from 851 square kilometers to 1510 square kilometers (the number went up to 1630 in 2010).The problems of losing farmland due to urbanization has raised concerns among scholars, decision makers and the public, particularly those whose livelihoods depend on land resources in rural areas. To prevent the aggravation of such phenomena, in 2006 the PRC central government announced the “red line of 1.8 billion mu (120 million hectares)” to secure the land resources for food production.

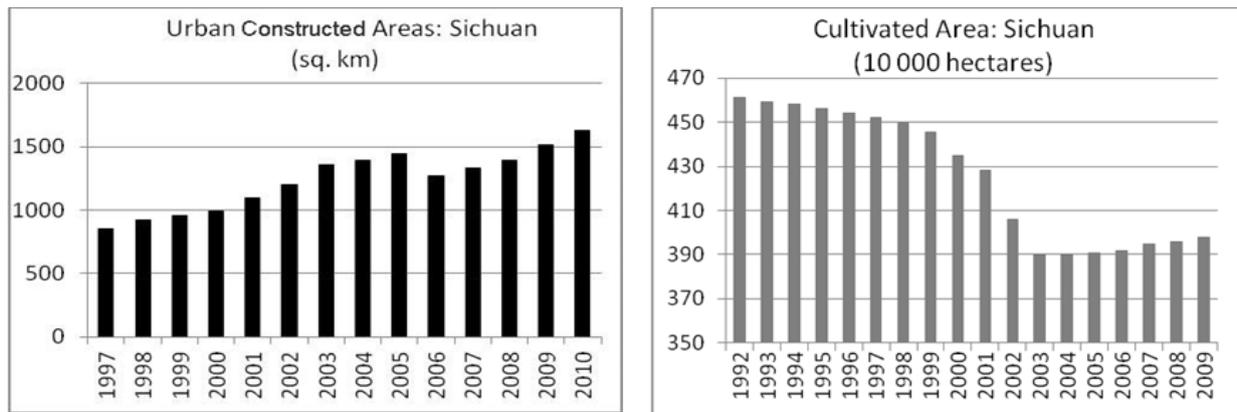


FIG.1 EXPANSION OF THE AREA OF URBAN CONSTRUCTION AND DECREASE OF CULTIVATED LAND IN SICHUAN PROVINCE (Source: [3, 4])

On the other hand, since the reform of tax-sharing system leads to the deficit of the fiscal income of the local governments. The current fiscal situation motivated local (county) governments to turn to revenues from the land lease, and even it became a main income source of local government at the present stage [5]. According to Sichuan Province Statistical Yearbook, the land leasing fees make 35% of the local revenue during 2001-2003, and it went up to more than 40% during 2004-2008. According to the report submitted to the National People’s Congress by the Ministry Finance in 2010, the land leasing fees make 42.86% of the local government revenue. It is just because that fiscal stimulation allows the local government to develop more urban area resulting in urban expansion and urban infrastructure provision. This structure stimulates the spatial expansion of SMCs pursuing for economic growth.

By lacking in integrated planning such as TOD or mixed design concept in land use, they usually have low level of population density with low level of public services such as public transportation.

Efficient utilization of land resources requires a proper planning based on the principles of sustainability. A proper allocation of land use based on different functions facilitates labor pooling, reduces average travel distance and time,

reduces average manufacturing costs, and promotes spillovers in technology and management.

2.2 Increase of Transport Demands

Spatial expansion of SMCs and population growth increase travel distance and drive up the transport demands. The road construction and water and electricity supply system act as an important trigger for the economic boost. Therefore, road development in SMC towns and their inter connections with other places has been highly prioritized in urban planning of many SMCs.

When cities are expanded and more cities emerge, transportation demands also increase particularly due to the increasing demands for consumer goods and mobility. The increase in population mobility can be measured by freight ton-kilometers and passenger-kilometers. The total passenger-kilometers increased from about 9 billion passenger-km in 1996 to 28 billion in 2010 (an increase of 300%), and the total freight ton-kilometers increased from 37 billion ton-km to 142 billion ton-km in the same period (an increase of nearly 400%) as illustrated in [错误!未找到引用源。](#).

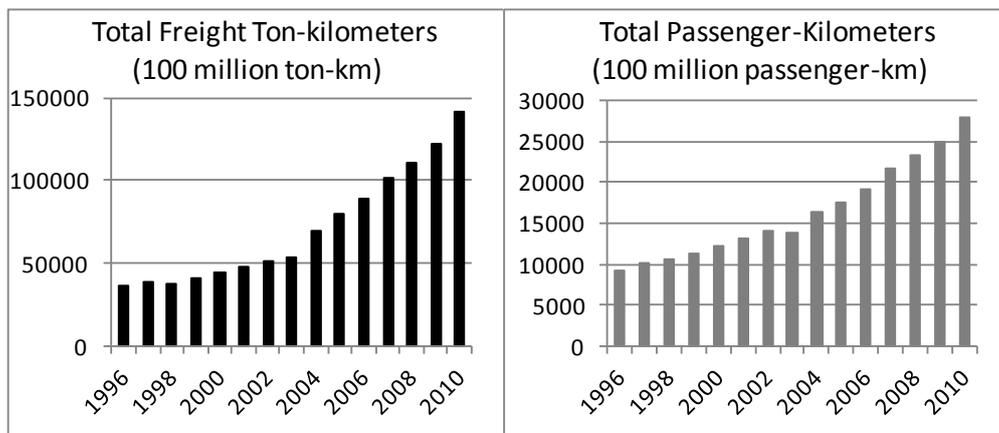


FIG.2 INCREASE OF TRANSPORTATION DEMANDS (Source: [3])

The growing transportation demands correlate with the economic development. Since the late 1970s, the government of the PRC has intensively invested in urban transportation including road constructions. At the national level, the length of urban roads went up from 26,966 kilometers in 1978 to 294,123 kilometers by the end of 2010, and per capita area of road was increased from 2.93 m² to 13.19 m² in the same period (Figure 3).

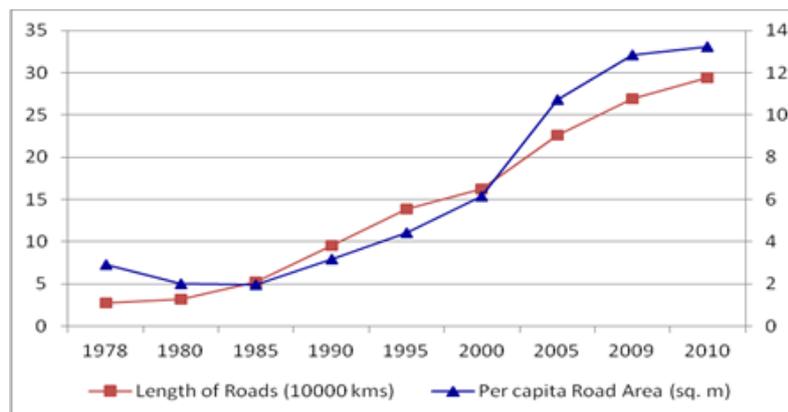


FIG.3 NATIONAL URBAN ROAD DEVELOPMENT (Source:[1])

According to *Green Book of Small and Medium-Sized Cities* [6], the ten studied SMCs (Kunshan city in Jiangsu province, Wujin district of Changzhou city, Changsha county in Hunan province, Zouping county in Shandong province, Shuangliu county in Sichuan province, Haicheng city in Liaoning province, Ningguo city in Anhui province, Jungar Banner in Inner Mongolia Autonomous Region, Zhaodong city in Heilongjiang province, Wuan city in Hebei province) shared the common economic structure and the development trend: low and decreasing agricultural areas (primary), high and growing manufacture industries (secondary), and growing service sector

(tertiary). In 2010, GDP per capita of the ten cities averaged RMB 84,165 (US\$13,300), 3 times that of the national level (RMB 29,992 (US\$4,700)), and the growth rate of the GDP per capita from 2009 was 17%. The transportation system is also well developed in these cities. The length of paved roads within urban areas of these cities averaged 1,842 kilometers, and 99% of the rural villages are connected by paved roads.

These 10 cities are in a leading position of SMC development in the PRC. If the same growth pattern of the 10 cities is pursued by other SMCs, the transport demands will further drive urban expansion and construction and will drive motorization in transportation sectors; forming a vicious circle.

2.3 Declining of Non-motorized Transport (NMT) Mode in SMCs

Non-motorized transport (bicycling and walking) is still a main transport mode in many SMCs because of shorter average travel distance and lower income level. Motorization is indicated by the modes of urban transport chosen by the public. A few limited case studies conducted by our research team in different years on passengers' choice for urban transportation modes show lower motorization in SMCs compared to that of other large cities (Table 1).

TABLE 1 PASSENGER TRANSPORT MODES IN CITIES OF DIFFERENT SIZES

Modes of Urban Passenger Transport[%]	Cities Studied [population in millions]		
	Anning (0.34)	Changsha (7.1)	Beijing (>20)
Public Transport	29.19	24.3	39.3
Business Vehicles	4.46	2.26	3.59
Taxi	1.3	2.15	2.15
Motorcycle	3.36	5.12	--
Private car	8.91	9.75	27.9
Bicycle	2.85	6.71	17.9
Pedestrian	45.75	45.2	8.6
Other	1.14	2.54	0.61
Year of Study	2009	2007	2010

Non-motorized transport mode (cycling and walking) is much higher in Anning (48.6%) with a population of 0.34 million than in Beijing (26.5%) with a population of 20 million, obviously because the average travel distance is shorter in smaller cities. Bicycle use is low in Anning, mainly because of its hilly landscape. Private vehicle use is 8.91% in Anning when it is 27.9% in Beijing. Enhanced income level is one of the important factors that contribute to the increase of private vehicles. Public transport is still lower in SMCs than in large cities in general, but Anning is a special case. With its' high rate of public transport use, Anning sets a good example for other SMCs. However, along with the higher income level and demands of traveling outside, motorization is increasing in SMCs when NMT is already declining despite its comparatively (60% of all travel modes in 2009).

At the national level, motorization has been increasing at the fastest pace among all the factors of urbanization described above. In 2010 the total procession of civil motor vehicles is seven times than that in 1996, and the number of private cars is over 20 times, increasing from 2.9 million units in 1996 to 60 million in 2010. Motorization is also indicated by the ownership of private cars per 100 households (Figure 4). At the national level the car ownerships per 100 households in cities went up from 0.3 in 1999 to 10.9 in 2010, 30 times higher.

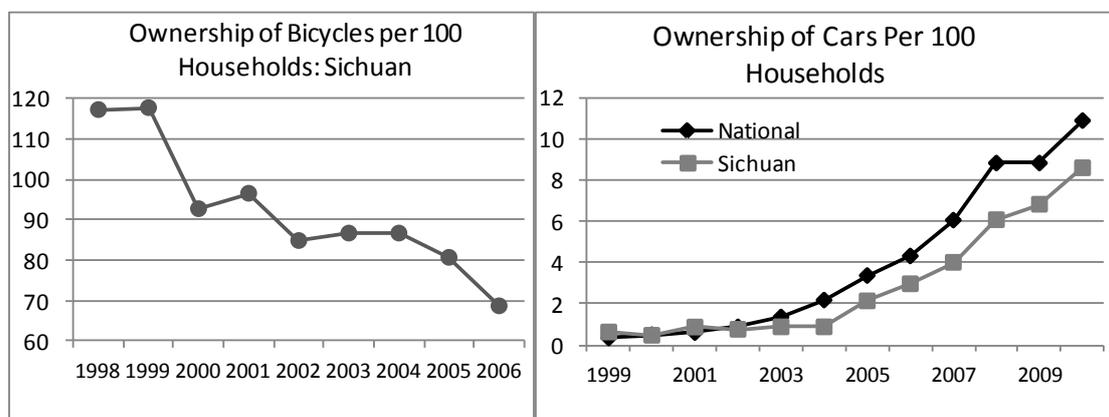


FIG. 4 INCREASE OF PRIVATE CAR OWNERSHIP AND DECREASE OF BICYCLES (Source: [3, 4])

In Sichuan province the car ownerships per 100 households was 0.6 in 1999 and 8.6 in 2010. On the other hand, the ownership of bicycles per 100 households went down from 117 in 1998 to 69 in 2006 in Sichuan, a decrease of 41%. Bicycle ownership at the national level has also gone down, but starting in 2000 it was removed officially from the statistic item labeled as “major durable consumer goods owned by households”.

3 MAJOR BARRIERS FOR LCD OF SMCs IN THE PRC

Based on the above analysis, LCD of SMCs in the PRC is facing the following barriers.

3.1 Private Vehicle Oriented Growth Pattern

With urbanization speeded up, the population accelerating to transfer into cities, and cities extending around, the range of people’s employment and living broadening, transportation demands mount up. A lifestyle of SMCs depends more on the use of private cars compared to the large cities because a convenient public transportation system is often economically and technically not feasible in many SMCs. Although increasing motorization causes traffic congestion, LCD is still highly potential in SMCs if appropriate precaution measures are set to prevent them from taking the same path as larger cities.

3.2 Unclear Coordination between Regional and Urban Planning and Lack of the Integration of Transport Planning into SMC Planning

At present, urban system planning, land use planning, and regional planning are authorized by several different programming entities in China. Moreover, space planning and transport planning are in the charge of different departments. So, the transverse and longitudinal connection among these planning programs is weak, and this weakens the integrity of planning seriously. Urban planning plays a perennial and structural role for the city development. Once the city structure is established by the urban planning, it is very difficult to adjust. Even more serious is that wrong planning and construction steps promote high-carbon life philosophy in people’s subconscious; its influence is profound and difficult to eliminate. The roles and functions of SMCs in the regional context are not fully realized in their urban planning and transport planning. Moreover, urban transport planning in many SMCs hardly considers various local characteristics of SMCs such as their historical backgrounds, economic capacity, social structures and ecological environment.

3.3 Lack of Consistent Development of Public Transport in Rural and Urban Areas of SMCs

The planning of public transport networks in SMCs’ rural and urban areas are imbalanced and highly lack of consistency. The public transport services and network accessibility to remote rural (and undeveloped) areas of SMCs is extremely weak. The main reasons are the inconsistency among different transport policies for rural and urban area of SMCs, lack of public fund as well as lack of the integrated public transport management mechanism in order to reach a regulated public transport market for most SMCs’ urban-rural areas.

3.4 Lack of Finances and Economic Policies for Low Carbon Transport

Carbon-efficient transport modes such as public transport development in most SMCs get only a small public or private investment. Although the construction of major public transport especially the infrastructures (e.g. road and stations) requires a large initial investment and a long payback period, financial support from the government is insufficient. Moreover, the economic incentive policies for the SMC rural roads investment and SMC urban-rural public transport service are still weak.

3.5 Lack of Low-carbon Transport Awareness and Education in SMCs

During the development stage of SMCs, the low-carbon transport concept is still detached from the residents’ daily lives. Most people in local SMCs are not aware of vehicle emission standards and low-carbon transport mode (e.g. public transport). The education of low-carbon transport in local communities is also weak. The priority of SMCs’ transport development is promoting public transport efficiency, higher mobility and accessibility, transport safety,

and convenience.

3.6 Lack of Data for Low-carbon Transport in SMCs

Statistics system is always weak in both national and local level authorities. Most transport-related data in SMCs are too little to make quantitative analysis which results in inaccurate decision-making. Moreover, the information transparency, especially the one related to energy security and environment, is weak in SMCs.

4 NATIONAL STRATEGIES ANALYSIS FOR LAND USE AND TRANSPORT PLANNING OF SMCs

Despite the trend toward increasing emissions, opportunities exist for developing low-carbon urban transport in the PRC, especially for small and medium cities taking advantage of their smaller scale and area. In view of above characteristics and barriers of SMCs, strategies and policy guidelines for land use and transport planning of SMCs are analyzed in this study.

4.1 Regional Planning Leading Ordered Regional Transportation

Because the development of regional rural area, towns, small and medium cities mainly depend on road networks, which makes transportation trips more be inclined to private cars, consequently, transportation trips randomly scattered in the whole regional space, showing a state of disorder. Once the disorder transportations formed, it is very difficult to rebuild regional space structure and transportation system. In addition, in China, regional transit usually based on the evaluation criterion of “all counties traversed by high way” and “all villages traversed by cement pathway”. With economic level increasing, in this way, all regions will transfer into high energy consumed spatial pattern of growth dominated by private cars ultimately. Therefore, more reasonable regional spatial pattern of growth should be public transit-oriented development (TOD), by integrated regional space planning and limiting the use of private cars.

4.2 Integrated Land Use Planning

Increase the volume ratio of city, the intensive use of land resources is essential for the sustainable and low-carbon development of city and human being. Under the guidelines of overall urban planning, build up low-carbon urban space structure, city density should be considered firstly. More and more researches proved that by controlling density the compact city can be realized and so transportation reduced to achieve the purpose of low carbon development [7]. In the world, all the high energy consumed cities are low density [8].

In China, as mentioned in *Characteristics of Land use and Transportation planning in SMCs*, land lease became a main income source of local government at the present stage. It is because that land economy is taken as the way of rich by cities, the range of urban land use expanding endlessly and urban density becoming low and low. From 2003, national urban development land per capita has already exceeded the upper limit (115 m²/capita) set by *urban land use classification and planning development land standards* [9]. If there is no restriction to the scale of land use, urban disorder expansion of SMCs will inevitable result to private cars use, taking the same path as larger cities and repeat their congestion ultimately.

Hence, in China, SMCs should follow TOD pattern of growth, urban space expanding along public transport corridor. Research is generally believed that reducing transport demands and traveling distance, engaging walking, bicycling and public transit and limiting cars are the general principles of sustainable land use and transportation planning [10]. Recently, China has put forward the national policy of giving priority to the development of public transit; however, it is clear that the priority of public transit should firstly ensure the priority of important transport corridors, and full scale priority is hardly realized.

Therefore, integrated Land Use Planning should follow three important principles which are included:

1) Taking shortest path as the target of mixed land use

There are only two methods to achieve the short path city: enhance the multiformity of functional zone and arrange

variety functional zones in a mixed pattern. Mixed land utilization will encourage the development of public transport; however, simplified mixed land utilization can hardly reach the aim of avoiding long distance travel, therefore, a “high efficiency mixed land utilization” need to be advocated, especially for the long distance commuting.

2) *Appropriating blocks scale suited to pedestrian and bicycle user*

The construction mode to build boulevard and avenue is inclining to auto-oriented urban construction; meanwhile, the big scale of block also lead to a long walking distance for transfer. Researches have showed that the long transfer distance is one of the reasons to decrease the proportion of public transit mode. Mixed land utilization need to combine the reasonable land scale. A reasonable land scale also gives a more convenient environment for bicycling.

3) *Determined development intensity based on public transport accessibility levels*

Once urban transport mode and network are determinate in the overall planning, the accessibility level of different areas in the city is certain. Urban structure of TOD advocates large communal facilities focus on the regional centers of cities and combined with public transit hubs.

4.3 Low-carbon Transportation System

Low carbon urban structure needs supported by low carbon transportation system, and transportation system is an indivisible part of urban structure essentially. Based on the development characteristics and trend of medium and small scale cities, avoiding the drawbacks of high carbon emission and congestion caused by transport, small and medium cities’ construction has to first fit for pedestrian and bicycling, develop cost-effective public transport, limit the number of private cars.

Current infrastructure development in many cities is in favor of motor vehicles, it is the main reason for the drop of non-motorized transport modes (walking and bicycling). Bicycling should be given to particular attention in all traffic modes. In Netherlands, beyond 30% of all travel is by bicycling [11]. In small and medium cities of China which recognized as the kingdom of bicycles, presently, bicycling modal split rate is 20-40% [12], with inhabitants’ income increasing, motorized travel has been mounting up; if there is no guiding or restriction, more and more people would give up bicycles and intend to driving private cars.

Therefore, in small and medium cities of China, taking pedestrian and bicycle users as the first in policy and transport planning is very important. Rapidly develop non-motorized traffic, establish an urban traffic system based on “non-motorized traffic + urban public transit” which can effectively relieve the traffic congestion, reduce the environment pollution, and meet the goal of low-carbon development.

4.4 Affecting Vehicle Use

SMCs in China can set a range of measures that directly influence vehicles use and the traffic quantity of private transportation. First approach is adopting of demand management measures that would reduce the number amount of motorized automotive travel trips. These concrete measures include both non-pricing controls on vehicle ownership and use, and pricing controls. Pricing controls include congestion charges, selling car ownership permits, and high parking fees. The other approach is adopting of technological measures that reduce the carbon CO₂ emissions of motorized vehicles per unit of travel trip.

4.5 Maximize the Benefits of Pedestrian, Bicycle and Public Transport Users

The major people who are not using individual vehicles, but are walking, cycling or using public transport should gain the most from demand management scheme [13]. Through reducing the number of private cars for trips, public transport system has opportunity to improve operating situation by increasing the speed of public transport and people are able to walk and cycle safer. In order to maximize these benefits, more public transport should be provided to those who use public transport instead of their own cars. On the other hand, financial or tax policies can be adopted to stimulate people to shift to non-motorized transport mode, for example, in Amsterdam, bicycle users can obtain 750 Euro subsidy each year and tax-free. The revenue from demand management efforts such as

congestion charges, selling car ownership permits, or high parking fees is reinvested into improving public transport system.

Additional, potential benefits such as reducing air pollution level and providing more public space accrue to all urban citizens, and these gains also need to be highlighted and promoted.

5 CONCLUSION AND OUTLOOK

With rapid urbanization in China, CO₂ emissions caused by urban transports are increasing rapidly. These growing emissions also pose an enormous challenge to urban transport. Despite the trend toward increasing emissions, opportunities exist for developing low-carbon urban transport in China.

These all require that SMCs should take LCD as a new growth engine to achieve two goals of economic growth and carbon emission reduction together. It is noted that the establishment of low-carbon transport is not only the work for transport sector, but also related to the urban planning department, the administration department and the finance department and requires the participation of the whole society. In the planning of land-use and public transportation network and the design of traveling environment, transfer conditions etc., we should always put people in the first place and implement people-oriented concept. In particular, it needs to apply planning, policy guidance, economic and administrative measures to put pedestrians and cyclists in the first place, and attract private car users to non-motorized transport and public transport.

Taking into account the characteristics of small and medium sized cities, following instructions should be applied:

- [1] Let public transportation lead urban planning and development, optimize the urban spatial structure and form, meanwhile focus on mixed land use, construct the residence, companies, shopping centers etc. next to the public transportation network maximally. It is remarked that it is important to reserve land for the construction of bus station, bus lanes and interchange, line extension etc.
- [2] Build appropriate street blocks and residential areas making blocks scale suitable for walking and bicycling.
- [3] In road network design, put pedestrians and cyclists in the first place; meanwhile, establish convenient, fast, comfortable, safe and economic public transport and use public bicycles to solve the last kilometer problem.
- [4] Restrict the use of private cars through transportation demand management, enhance the attractiveness of non-motorized transport modes, attract private car users to choose public transport, bicycling and walking instead of driving and maximize the benefits of non-motorized transport modes users.

Finally, hope that through the establishment of low-carbon transport pilots for small and medium sized cities, the successful experience can be popularized the whole country, increase the public awareness for the importance of low-carbon transport and convert, in the concept level, the existing high-carbon life style.

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