

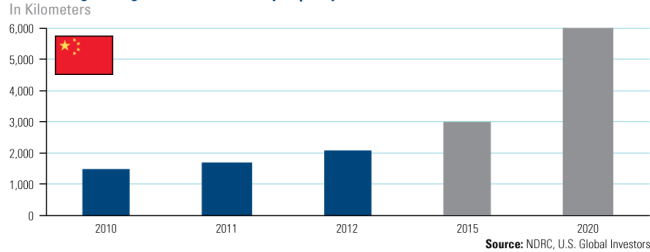


Improving Railway Technologies and Efficiency

-Case of China

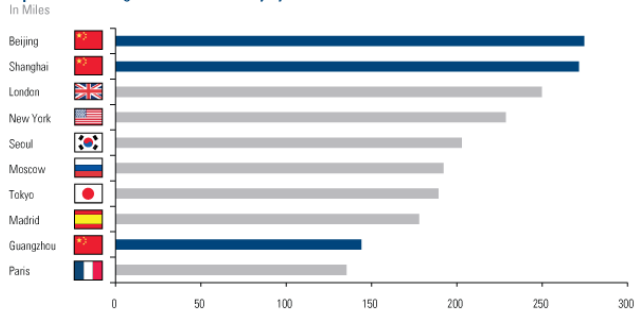
Rapid Growth

China's Length of Light Rail and Metro May Triple by 2020



Source: NDRC, U.S. Global Investors

Top Cities with Longest Metro and Subway Systems



Source: metrobits.org, Data as of 11/2011

China has been ramping up investment in inner-city mass transit project to alleviate congestion. Since the mid 2000s, the growth of rapid transit systems in Chinese cities has rapidly accelerated, with **most** of the world's new subway mileage in the past decade opening in China. The length of light rail and metro will be extended by **40 percent** in the next two years, and **tripled** by 2020



From 2009 to 2015, China built **87** mass transit rail lines, totaling **3100 km**, in **25** cities at the cost of **¥988.6 billion**.



In 2017, some **43** smaller third-tier cities in China, have received approval to develop subway lines.



By 2018, China will carry out **103** projects and build **2,000 km** of new urban rail lines.



Policy Support

1

State Council's 13th Five Year Plan

In the plan, a transport white paper titled "Development of China's Transport" envisions a more sustainable transport system with priority focused on high-capacity public transit particularly **urban rail transit** and bus rapid transit.

2

The Ministry of Transport's 3-year Plan

This plan for major transportation infrastructure construction projects (2016-18) was launched in May 2016. The plan included a investment of **1.6 trillion yuan** for urban rail transit projects.

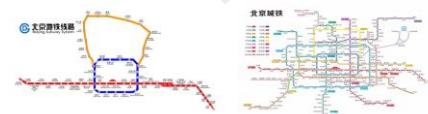
3

NRDC's Subway Development Plan

The approval processes for cities to apply for building urban rail transit projects were relaxed twice in 2013 and in 2015, respectively. In 2016, the minimum population criteria was **lowered** from **3 million** to **1.5 million** residents.



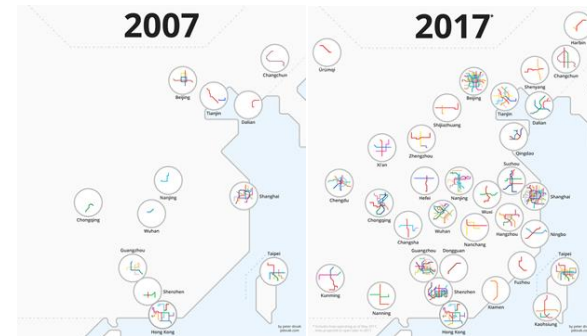
Policy



Beijing Subway in 2005

Beijing Subway in 2015

Pilot



2007

2017

Scaling

Cutting-edge Technology

01 Diverse Solutions



Electric Light Rail

BYD electric monorail can carry 10,000-30,000 people per hour and its highest speed reaches 80 km/h. Its cost is 1/5 of subway cost and its construction time is 1/3 of subway construction time.



Accessible Tram

Guangzhou metropolitan tram will be a 70% low vehicle, meaning passengers with prams and wheelchairs can also board the vehicle comfortably due to the majority of each carriage's length being situated at pavement level.

Maglev Metro

Beijing Metro opened its first maglev lines on December 30 2017. The 9 km elevated maglev line serves the western part of Beijing. The line will eventually be extended east.





Cutting-edge Technology

02 Innovations



Suspended Light Rail

China's fastest suspended railway is in Qingdao with max speed of 70 km/h. It is cheaper, more environmentally-friendly and less time-consuming to build than traditional subway trains.

Carbon Fibre Metro Car

The world's first and developed by CRRC, the composite materials used allow the car to be 35% lighter than the average metal bodied metro car, which would help to reduce rail wear.



Catenary-free

Zhuhai Light Rail deploys catenary-free technology. A box was embedded in the road surface containing a contact line that is only activated when an LRV passes overhead. A series of contact plates are fitted along the surface.



Cutting-edge Technology

03 Smart Rail



Virtual Track

Autonomous Rail Rapid Transit in Zhuzhou doesn't run on physical railway tracks. The invisible railway is embodied by dotted lines painted on the road and much cheaper to build compared to a tram or subway system.

Indigenous Automated Subway

Yanfang Line is China's first complete self-developed automated subway. The 14.4-km main route of Yanfang Line has nine stations, connecting many neighborhoods in Beijing's southwest Fangshan District.



LTR with Wifi and LED

The Optics Valley tram network opened in Wuhan. The vehicles are equipped with wi-fi and LED lighting. The fleet uses supercapacitors, which are recharged at stops, for catenary-free operation.



ICT Roadshow

01



Huawei rolled out **Urban Rail Operational Communication Solution** which allows multiple services such as train control, dispatching, PIS, and video surveillance all to be carried over one network. Allowing multiple services to be carried together improves the utilization of network resources, ensures safe urban rail operations, and generates greater revenues. Two core solutions are cloud-based **Traffic Control Integrated Automation Systems** and the next-generation **Urban Rail Data Communication System**.

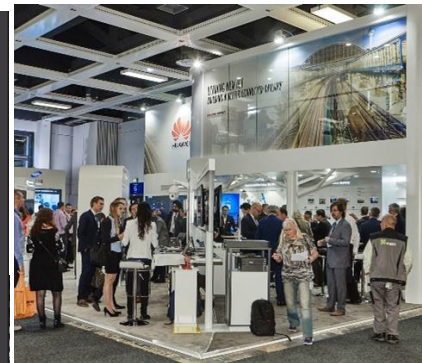
DiDi was able to use their data to calculate the **hotspot segments of subway system**. The morning and evening peak hour subway crowding is frustrating. Sometimes a few consecutive stops all have waves of pouring passengers that makes boarding and alighting difficult. In Beijing the hotspot subway sections are mostly concentrated in typical **residential area and work area**. In Shanghai the hotspot subway sections are concentrated on the 2nd line which connects the west and east of Shanghai and is surrounded by major **transport and commercial hubs**.



上海：上海高热地铁路段集中在2号线以及1号线陕西南路左右，其中2号线因贯穿上海东西向，沿线分布上海主要交通枢纽和高圈，几乎全线高热，也被当地人称为“土豪线”。

Huawei Digital Urban Rail Solution:
Safer, More Efficient And Profitable Rail Transit Operations Using LTE

#LeadingNewICT HUAWEI



ICT Roadshow

02

Shanghai now allow **QR code** payment through the whole subway network. Passengers can pay for their tickets via **Alipay** or China UnionPay simply by scanning the QR code at the entrance and exit after downloading a mobile app called "Metro Daduhui".

China Electronics Technology Group Corporation showcased its **smart transportation** products in Smart City Expo World Congress. It improves urban railway efficiency through intelligent converged communications systems, geographic information systems and rail trunked radio dispatch systems.

To maximize the advantages of urban railways, China is developing ICT-enabled applications.



Overseas Export

- 01 | Addis Ababa Light Rail
- 02 | Kuala Lumpur Automated Subways
- 03 | Kolkata LTR Train
- 04 | Boston Subway

04
The China Railway Rolling Stock Corporation, or CRRC, is building a \$60 million plant in Springfield, Mass., that will assemble new cars for Boston's subway system.

03
China will supply 14 subway trains with 112 carriages to Kolkata city, the biggest such contract for a Chinese company in South Asia.

02
CRRC will build automated subways in Kuala Lumpur, Malaysia. The system has the highest automated level, meaning the subway starts and stops by itself; door operation and emergency protocols are also fully automated without the need for any on-board staff.

01
Shenzhen Metro Group is operating light rails of Addis Ababa, Ethiopia. Professionals provide safe and high-quality light-rail services, help the country build a systematic, complete light-rail operation system and train managerial and technical employees in Ethiopia.



Problems to solve

01

1

Overcapacity

The scale of urbanization and density in today's Chinese cities was hard to foresee and this led to an underestimation of transit ridership in the early stage of metro planning and a design concept that brought about overcrowding subways as cities grow.

2

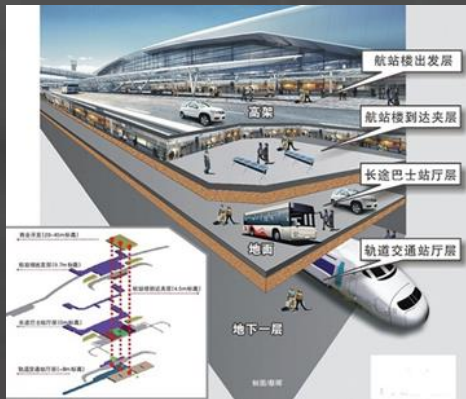
Transfer

President Xi Jinping recently announced plans to improve urban infrastructure quality and build an advanced, interconnected functional system to meet future demands. One manifestation of these plans has been an initiative to build seamlessly connected railway system with "Zero Transfer".



Problems to solve

02



Zero Transfer

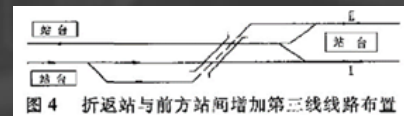
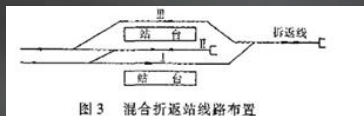
A best practice for "Zero Transfer" is the Shanghai Hongqiao Hub, a combined system with high-speed-rail service, an airport terminal, and metro connection.

Failed Attempt of "Small Groups, High Density"

Initially, light metro lines in China using **small profile** and **shorter rolling stock** were constructed to **reduce costs**. It was assumed that as ridership grows the line will operate trains at a low headway to increase capacity. It assumed that the maximum section of passenger flow in short term would only be **1/3 to 2/3** of that of long term and higher capacity design would mean a long headway and low load factor.

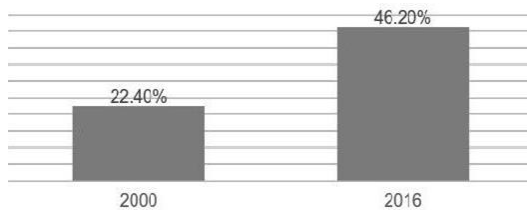
In reality, however, Guangzhou Metro Line 3, Shanghai Metro Line 16 and Shenzhen Metro Line 4 which were built this way fell under the pressure of **overcapacity shortly** after operation and had to expand to include more groups which was planned for long term.

The design used in China's small groups is usually B6, B train with a group of 6, a length of 120 m and a capacity of **1468 passengers**. In comparison, an A8 train is a group of 8 with a length of 180 m and a capacity of **2480 passengers**. With the lowest headway in China, **1 min 43 S**, a record held by Beijing Line 4, the number of trains per hour is 35. Even if that number is raised to 40, the hourly capacity of B6 design would only be $40 * 1468 = 58720$ **passengers** which is still lower than $27 * 2480 = 66960$ **passengers**, the capacity of A8 design with a higher headway of more than 2 min. There's a limit to how low the headway could be given the **turning back** time (below are two examples of China's metro turning back design). The **"High Density"** part of the paradigm was impractical and failed to compensate for the "Small Groups". Overcapacity, especially **overcrowding** at peak hours became a problem. Cities such as Beijing, Guangzhou, Wuhan and Chengdu has since started to use **higher capacity** designs on newer lines.



Challenges

China Government Debt/GDP

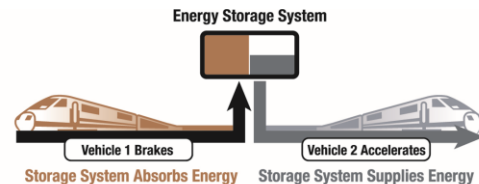


Cost

Metros are expensive and time-consuming pieces of infrastructure to build, even with China's rapid construction rates. They are also expensive to operate, with many systems now running at a loss.

Safety

In high capacity rail transit, safety is an issue and Guangzhou's high-tech camera is one way to face the challenge. Facial recognition could be used to identify suspects and the system can be connected to police databases.



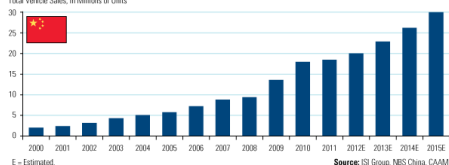
Energy

China's subways are heavy energy users. Innovations help such as Changsha's permanent magnetic trains and Beijing's energy storage device to store the train's kinetic energy.

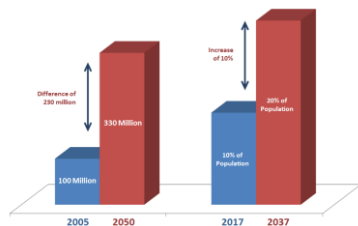
Opportunities

Aging Society and Car Culture

The Growing Car Culture in China
Total Vehicle Sales, in Millions of Units



Anticipated Changes in Chinese Population Age 65 and Over



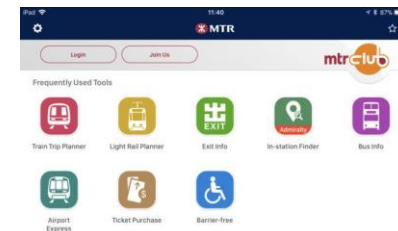
Shifting Mode

Year	Travel mode	Mode share (%)	Number of trips	Average distance (km/trip)	CO ₂ emissions per km (g/km)	Total CO ₂ emissions (tonnes/day)	CO ₂ emissions shares (%)
2009	Automobile	13.7	1,972,800	7	200	2762	77
	Public transport (by road)	19.7	2,836,800	8	30	681	19
	Metro	0.0	0	0	15	0	0
	Non-motorized transport and electric bicycles*	66.6	9,590,400	3	5	144	4
	Total	100.0	14,400,000			3587	100
2020	Automobile	15	2,610,000	10	150	3915	68
	Public transport (by road)	24	4,176,000	9	25	940	16
	Metro	16	2,784,000	18	15	752	13
	Non-motorized transport and electric bicycles	45	7,830,000	3	5	117	2
	Total	100	17,400,000			5724	100

* Non-motorized transport: walking and cycling. Electric bicycles are classified as motorized transport in this paper.

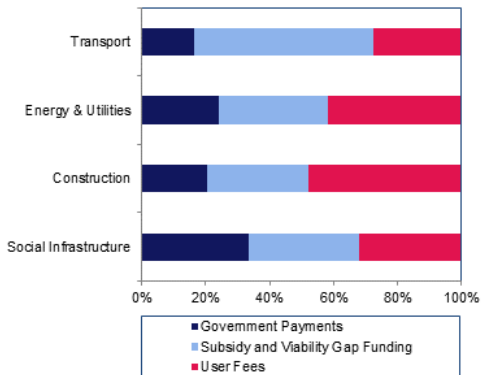
Source: Adapted from Chen et al, 2010.

Accessibility Development



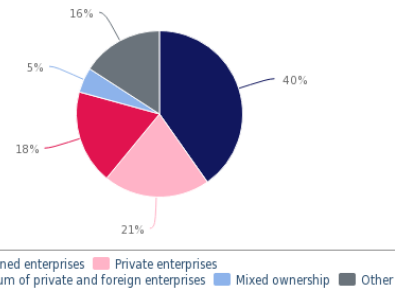
Public Private Partnership

The source of capital for urban rail development used to be from government allocation, but now there are more financing models, including public-private partnerships, build-operate-transfer arrangements and pledged supplementary lending



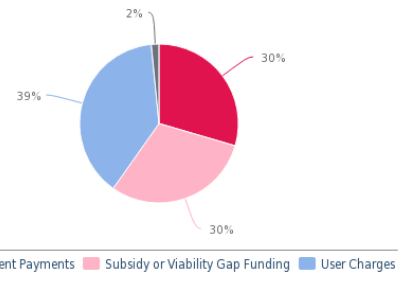
Transport projects comprise **14%** of the total number of projects in the China PPP Center's database.

In value terms transport projects represents over **40%** of China's total investment value for PPPs on account of the numerous high-value projects in the high-speed railways, metros, highways and airport sectors.



Heavy Revenue Reliance on Government

More than **60%** of planned and ongoing PPP projects in the China PPP Center's database will be funded by direct government payments or subsidy schemes like viability gap funding (VGF).

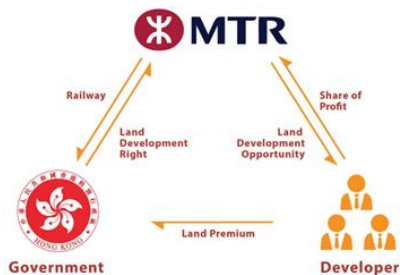


State-Owned Enterprises Dominate Contracts So Far

At least **40%** of the private partners involved in the PPPs awarded so far are in fact state-owned enterprises (SOEs).

MTR Best Practice

01 Rail Plus Property



“Through R+P, Hong Kong has demonstrated how integrating railway expansion with property development can help make public-transit systems financially self-reliant while also promoting sustainable urban growth.”

-- Lincoln Leong, the MTR’s CEO in 2016.

(R+P Financing Model, source: MTR)

As metro systems get bigger and serve more people, most continue to lose money. Hong Kong is one of the few that profits on its own without any government funding. it registered a **HK\$10.25 billion** net profit last year.

The key to Hong Kong’s success is a business model called **“Rail plus Property”** (R+P). The MTR builds a new rail line and partners with private developers to build properties above or around the new line. MTR receives a **share of the profits** that developers make from these properties. In other words, in exchange for transporting customers, the MTR receives a cut of the profits from the mall or residential block build above it.

The funds generated through the properties are then used on new projects as well as for MTR operations and maintenance. Buildings sit over about half of the **87** stations in Hong Kong, amounting to **13 million square meters** of floor area in 2016. Revenues from R+P developments above stations along MTR’s Tseung Kwan O line, for example, financed the extension of that line to serve a new town, which has since grown to a population of 380,000.

Mainland China is learning from Hong Kong in terms of integrate land use with public transport and cater for the accessibility for non-motorized travelers. **Transit-oriented Development** is gaining popularity in mainland China.



(HK MTR-owned mall, source: Tay Leong Tan)



MTR Best Practice

02 Collaborations



MTR serves nearly as many passengers in cities across the Mainland of China, Europe and Australia as they do at home in Hong Kong.



[#] Patronage number based on line boarding

Transit-oriented Development

ITDP'S PRINCIPLES OF URBAN DEVELOPMENT FOR TRANSPORT IN URBAN LIFE & TOD STANDARD KEY IMPLEMENTATION OBJECTIVES

WALK

DEVELOPING NEIGHBORHOODS THAT PROMOTE WALKING
OBJECTIVE A: The urban form must support pedestrian movement.
OBJECTIVE B: The public realm must be safe and usable.
OBJECTIVE C: The urban form must be enjoyable and attractive.

CYCLE

PRIORITIZE NON-MOTORIZED TRANSPORT NETWORKS
OBJECTIVE A: The urban form must support bicycle use.
OBJECTIVE B: Cycle paths must be safe and attractive.

CONNECT

KEEP EXISTING NETWORKS OF STREETS AND PATHS
OBJECTIVE A: Maintain existing streets and paths.
OBJECTIVE B: Address existing streets and paths that are problematic.

TRANSIT

LOCATE DEVELOPMENT NEAR HIGH-CAPACITY PUBLIC TRANSPORT
OBJECTIVE A: Locate development in close proximity to transit.

MIX

PLAN FOR MIXED USES, INCOME, AND DEMOGRAPHICS
OBJECTIVE A: Create a diverse mix of uses and building types to create a vibrant, walkable neighborhood.
OBJECTIVE B: Create a diverse mix of income levels and demographics.

DENSIFY

OPIMIZE DEVELOPMENT DENSITY AND MIX
OBJECTIVE A: Optimize density and mix to create a vibrant, walkable neighborhood.
OBJECTIVE B: Optimize density and mix to create a vibrant, walkable neighborhood.

COMPACT

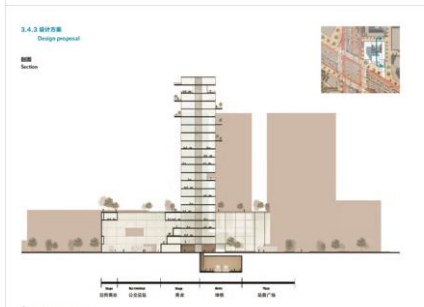
CREATE REGIONAL TRANSIT-ORIENTED COMMUNITIES
OBJECTIVE A: Create a regional transit-oriented community.
OBJECTIVE B: Create a regional transit-oriented community.

SHIFT

INCREASE MOBILITY BY REGULATING PARKING AND ROAD USE
OBJECTIVE A: The urban form must regulate parking and road use.



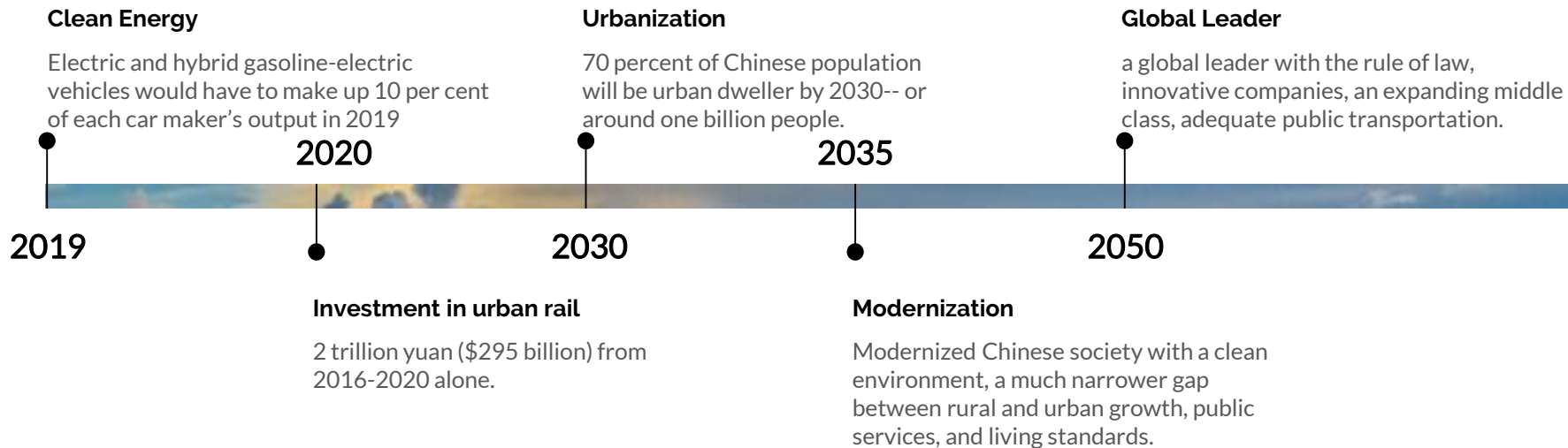
天津公交导向发展规划设计方案
Tianjin TOD Proposals
2014年7月30日
30 July 2014





Vision

"The best way to predict the future is to invent it." —Alan kay





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Promoting sustainable and equitable transportation worldwide.



Thank you.