Urban form as a "first fuel" for low-carbon mobility in Chinese cities

Strategies for energy and carbon saving in the transport sector

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Overview

- **One Case Study: City of Jinan, Shandong, P.R. China**

- **Two main questions:**
  - **(1) influence of urban form on low-carbon mobility in China?**
  - **(2) successful policy strategies and implications for China?**

- **Three tools for analyzing low-carbon mobility:**
  - **BEST Cities, ELITE Cities, Urban RAM**

- **Policy Strategies and Infrastructure Choices**
  - **Integrated Transport Planning, with Mixed-Use Urban Form**
  - **Public Transit Infrastructure, with Non-Motorized Transport**
  - **Vehicle License Policies, Clean Vehicle Policies**

- **Conclusions: People, Accessibility, Clusters, Connectivity**
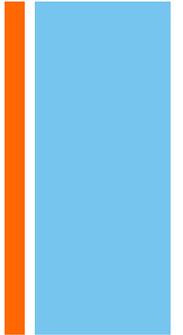
+ Chinese Urban Context: Jinan, Shandong

Jinan BRT Lines

[Source: http://www.chinastc.org/en/project/48/403]

- Jinan population: 6.1 million
- Transport 10% urban energy, rising 5+% annually
- Road-dominated, increasing car ownership & trips
- Bus-dominated transit
- BRT since 2008
- Metro under construction
- Revival of bicycling

Jinan Metro Plans
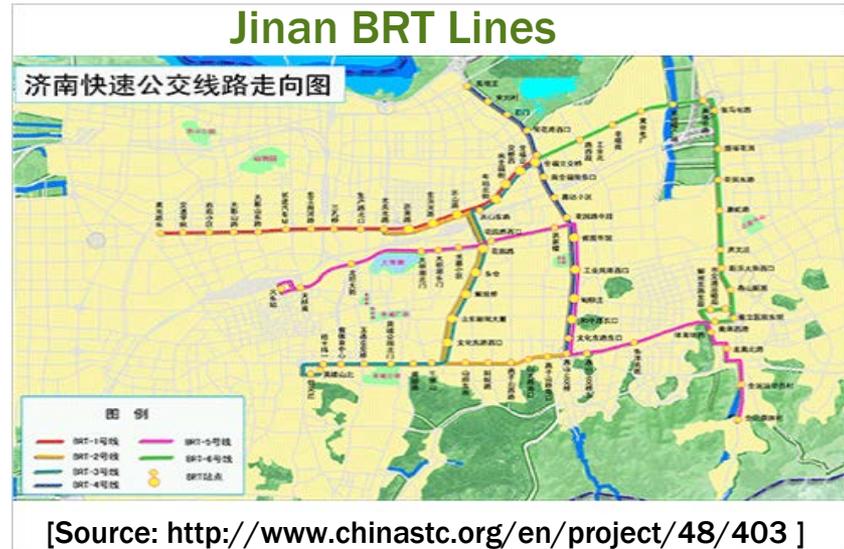
[Source: Jinan Urban Transport Planning 2015-2019.]

+ 3 Tools for Low-Carbon Cities in China (and elsewhere)

BEST Cities

- *Benchmarking and Energy-Saving Tool for Low-Carbon Cities*

- **3 components:**
  (1) Inventory & Benchmarking
  (2) Sector Prioritization
  (3) Policy Analysis

- **9 sectors:** industry, buildings, transportation, power & heat, etc.

- **33 Indicators:** city-wide and sector-specific, for international external benchmarking

- **72 Policies**: evaluate savings potential, city capabilities and priority policies

|	>$1 million	$100,000 - $1 million	<$100,000
>200,000	high	very high	very high
100,000 - 200,000	med	high	high
<100,000	low	med	med

3 Tools for Low-Carbon Cities in China (and elsewhere)

Urban RAM

- *Urban Rapid Assessment Model*
- **Life-cycle view:** operational and embodied energy and carbon
- Attributes electricity and industrial energy to urban consumers
- Findings show high contribution of **food** and residential **goods** to total urban embodied energy.
- **Transportation** operational and embodied energy ~10% and growing.

ELITE Cities

- *Eco and Low-carbon Indicator Tool for Evaluating Cities* (ELITE Cities)
- Scores **33 key indicators** representing **8 categories** to **compare** and rank cities in China
- Jinan scored 70/100 in **Land Use**; 66/100 in **Mobility**, and only 44/100 in **Air Quality**
- Limited green space [10/50 m2/capita], low accessibility to transit [50/90 %} and low public transit use [30/60 %} are all areas for improvement.
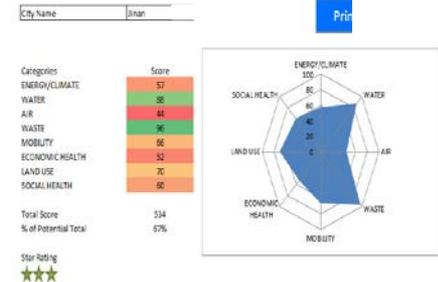
Urban Form & Transport Indicators in BEST Cities (aggregate view for benchmarking across cities)

- **Transportation Energy per capita [tonnes coal equivalent (tce)/person]**

- **Extent of Public Transit [km/km2], length of bus and rail service across urban area**

- **Mode Share of Non-motorized Transport [%]**, *share of trips by walking and bicycling*

- **Mode Share of Public Transit [%]**, *share of trips by bus and rail*

- **Urban Green Space per capita [m2/person]**

- **Population Density [people/m2]**

Paris
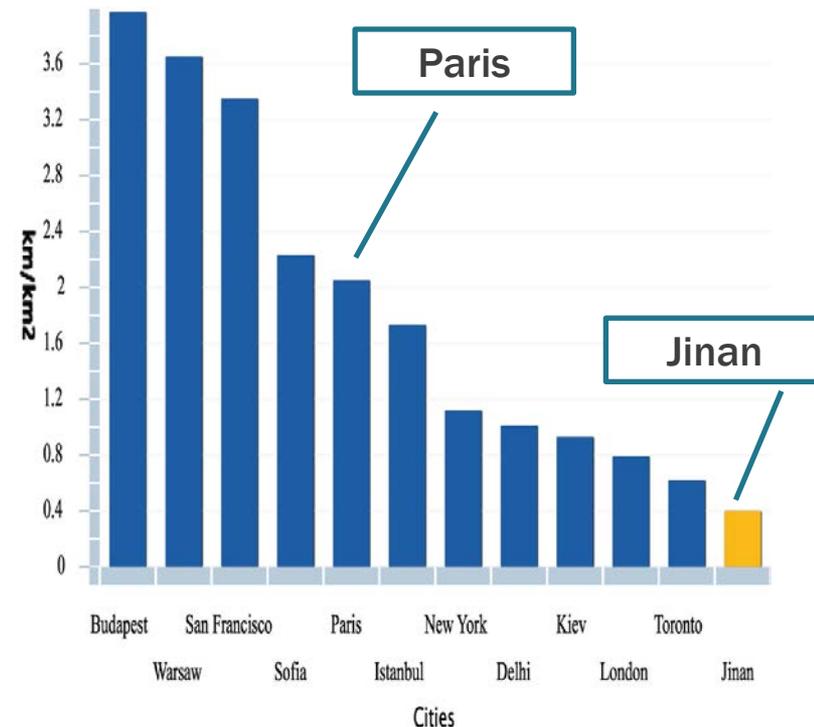
Jinan

Extent of Public Transit in Jinan and Selected International Cities [km/km2]

Transportation Policies Recommended for Jinan by the BEST Cities Tool
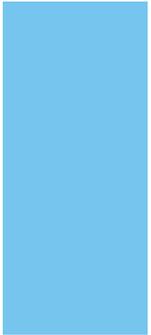
Policy	Speed of Implementation	Carbon Savings Potential (tCO$_2$e)	First Cost to Government (RMB)
Very High Priority			
Public Transit Infrastructure: Light Rail, BRT, Buses	> 3 Years	>2.5 million	5 million – 50 million
Vehicle CO$_2$ Emission Standards	1–3 Years	>2.5 million	<5 million
Vehicle Fuel Economy Standards	1–3 Years	>2.5 million	5 million – 50 million
High Priority			
Integrated Transportation Planning	> 3 Years	500,000 - 2.5 million	<5 million
Mixed-Use Urban Form	> 3 Years	500,000 - 2.5 million	<5 million
Congestion Charges and Road Pricing	1–3 Years	500,000 - 2.5 million	<5 million
Parking Fees and Measures	1–3 Years	500,000 - 2.5 million	<5 million
Vehicle License Policies	< 1 Year	500,000 - 2.5 million	<5 million
Clean Vehicle Programs	1–3 Years	500,000 - 2.5 million	5 million – 50 million

Urban form influences 3 key variables affecting urban transport energy and carbon

Urban Form

|	
Population density and distribution; clusters	Land-use mix; mixed-use zoning
Access to pathways for walking and biking	Quality of access: trees, safety, covered bus stops, nearby amenities
Access to public transit	Distance from destinations: proximity, isolation
Ease of use for each transport mode: fare payment, speed, frequency	Extent of each transport mode
Connectivity of transport modes; street and intersection density	

3 Variables

- (1) vehicle kilometres travelled (VKT),
- (2) mode share, and
- (3) energy and carbon intensity of each transport mode.

Jinan Urban Form: *Superblock* 4x VKT vs. *Traditional*, *Grid*, or *Enclave* Forms
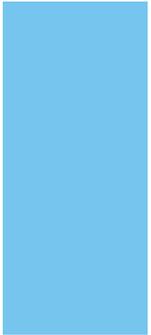
Average Household Weekly Travel Mode Share across the Four Neighborhood Typologies
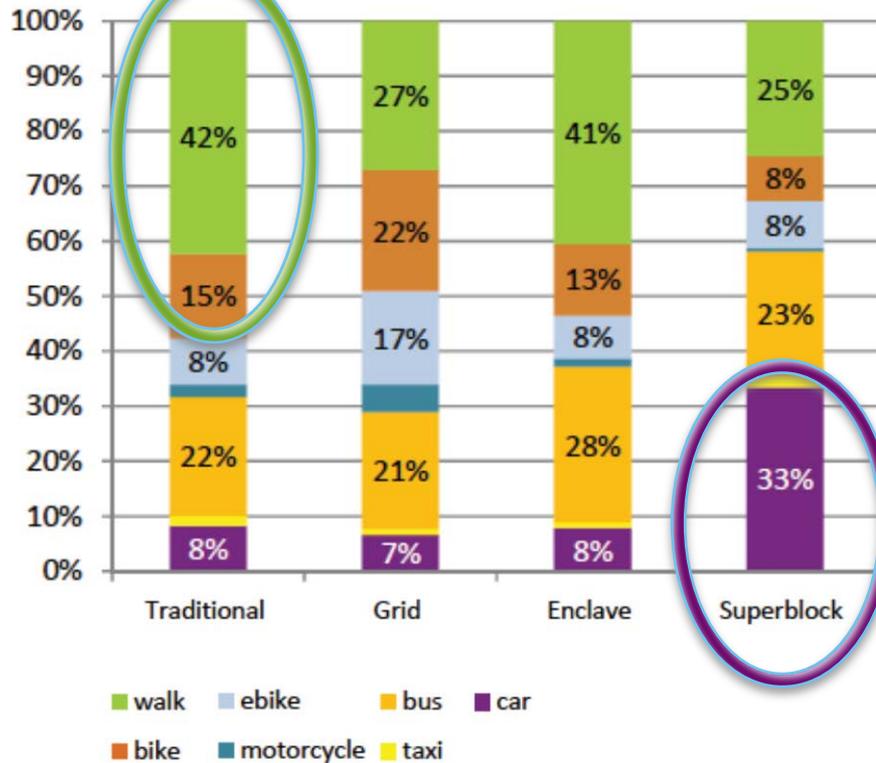
Average Household Weekly Travel Distance (Km) across the Four Neighborhood Typologies.
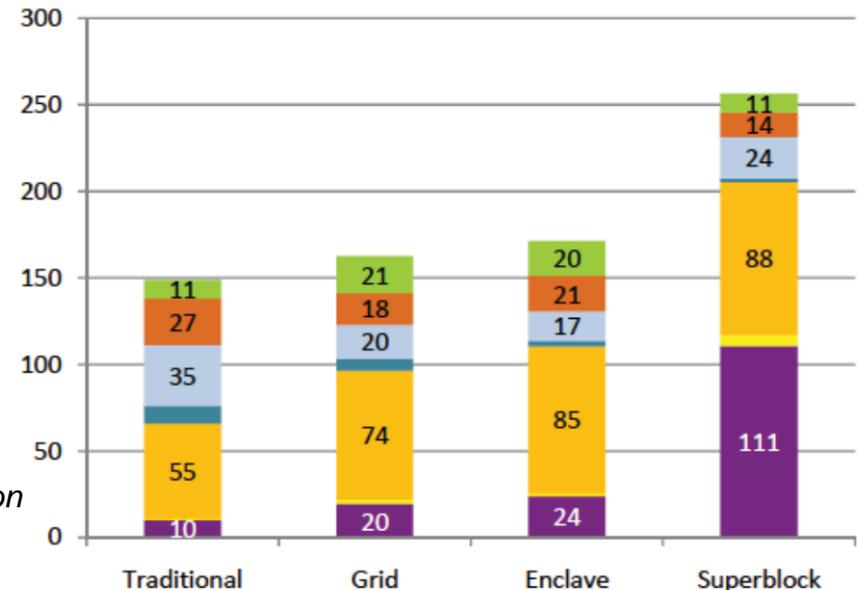
Yang, J. 2010. *Does Energy Follow Urban Form? An Examination of Neighborhoods and Transport Energy Use in Jinan*, China. Master's Thesis, Massachusetts Institute of Technology. May. (Graphics reproduced by Calthorpe Associates 2010.)

Clustered Distribution is crucial, not only aggregate (average) density

a. Dispersed densities
200 m
200 m

b. Concentrated densities

c. Highly concentrated densities

Source: Adapted from OECD 2012.
Note: Red line represents a mass transit line.

Unfocused density
45% of jobs and homes in area are within walking distance of station.
400

Transit-oriented density
80% of jobs and homes in area are within walking distance of station.
400M
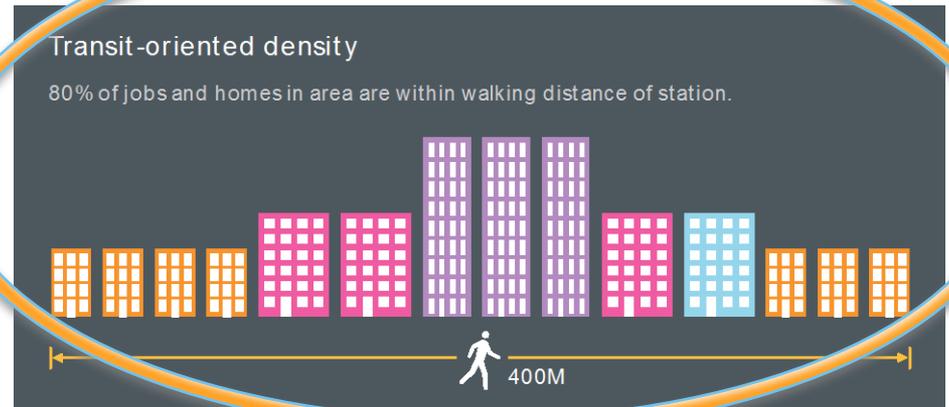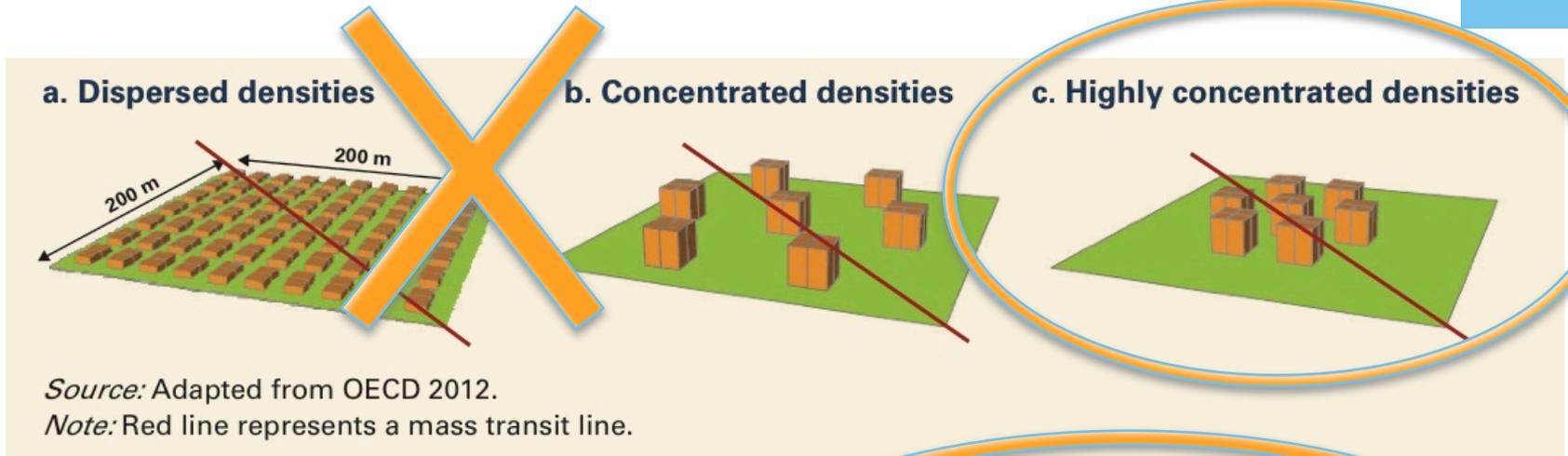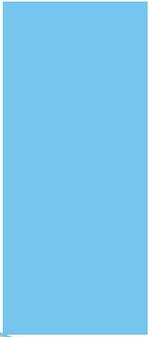
[Source: Suzuki, Cervero, and Iuchi, World Bank, 2013.]

Human-scale details matter, not only technology, infrastructure, business

Walk *under* trees…
Integrated-Boulevard Corridor

Walk *without* trees…
Below-Expressway Corridor
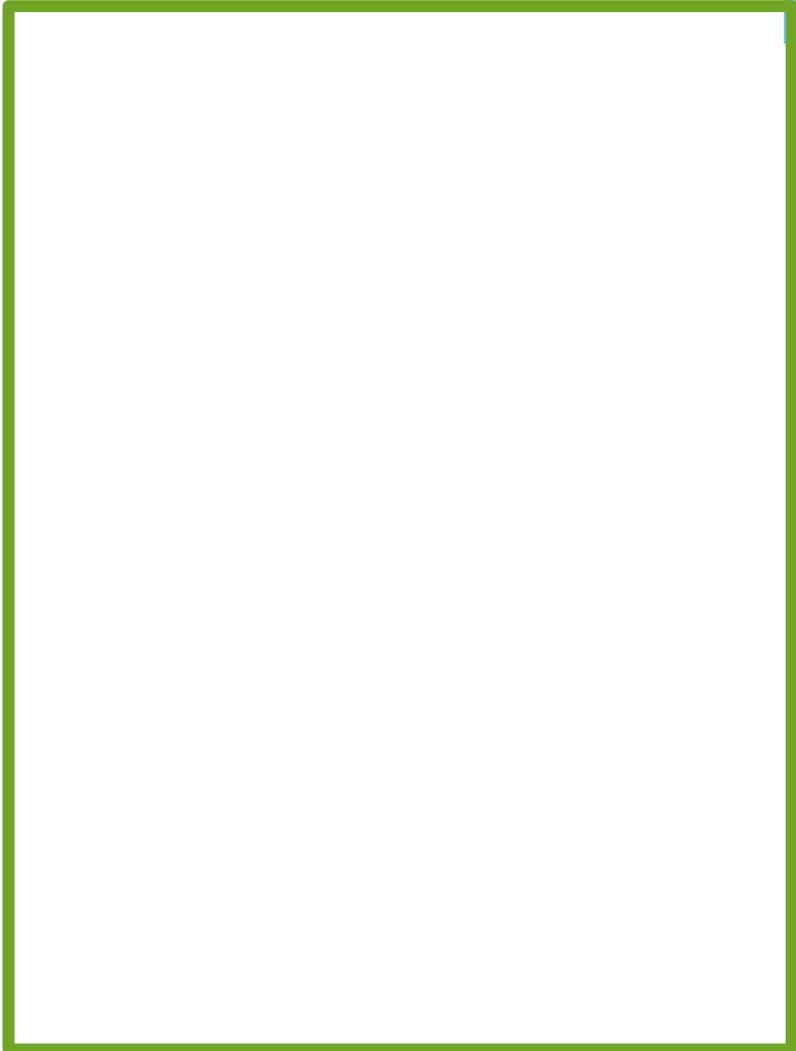
+ Conclusions

- **Though Transportation is typically 10% of energy and carbon in Chinese cities, the share is growing rapidly.**

- **High Priority Policy Strategies & Infrastructure:**
    - **Integrated Transport Planning, with Mixed-Use Urban Form**
    - **Public Transit Infrastructure, with Non-Motorized Transport**
    - **Vehicle License Policies, Clean Vehicle Policies**

- **Emphasize Mobility for *People*, Accessibility, Clusters, Connectivity**
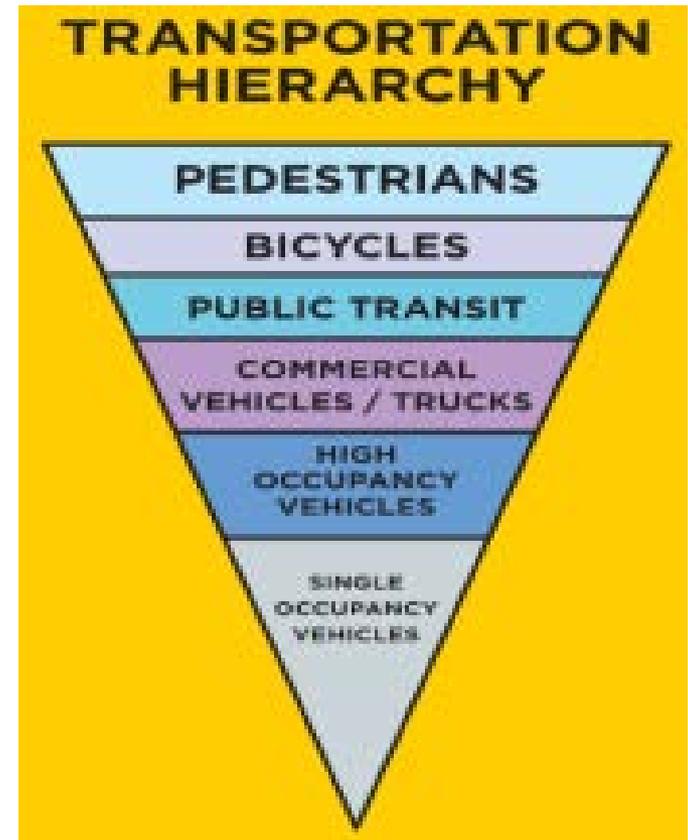
TRANSPORTATION HIERARCHY

PEDESTRIANS
BICYCLES
PUBLIC TRANSIT
COMMERCIAL VEHICLES / TRUCKS
HIGH OCCUPANCY VEHICLES
SINGLE OCCUPANCY VEHICLES

Discussion ~ Thanks!

- How to prioritize and promote **mixed-use urban form** and **non-motorized** transport?

[These are "at-the-source" strategies for large-scale, enduring benefits – not "shiny" techno solutions.]

- How to leverage funding, public understanding, business support for **equitable** low-carbon mobility?

- How to integrate low-carbon transport and land-use decisions?