Energy Foundation China
Low Carbon Cities Program Strategy:
Catalyzing Carbon Neutrality for Chinese Cities

This strategy was presented to EF China board in Mar 2021, and subjects to regular updates.
Background

President Xi’s new commitment reveals a new horizon for climate control.

The Philanthropic World, has to:

• Set up ambitious goals to response the call
• Think about leapfrogging rather than marginal improvement
• Identify key arenas and make intensive investment
• Pursue profound and real-world changes

Carbon emissions peak

Well-off society

Carbon neutrality

2030

<2030

2035

2060
Background
Cities are the most important battlefield for China’s carbon neutrality.

- **Chinese cities will accommodate more than one billion people** by 2050.
- Cities account for over **75%** of China’s carbon emissions.
- Cities are central for **infrastructure and industrial investment** that contribute significantly to city carbon emissions.
- **City development pattern** has large impact on carbon emission and is highly lock-in for the future.
Challenge

Status quo: many top emitters continue to show a strong trend of carbon growth
Challenge

Complexity: different cities need varied mitigation strategies

**Developed City (e.g. Beijing)**
- High indirect emissions, growing transport and services emissions; Infrastructure growth slowing down

**Fast Developing City (e.g. Nanjing)**
- High industrial emissions, growing indirect emissions; Rapid infrastructure growth

**Resource-based City (e.g. Yulin)**
- Dominant industrial emissions
- Continued heavy industrial infrastructure growth

**Service/Tourism City (e.g. Haikou)**
- High transport and services emissions; Stable infra. growth

Legend
- **Indirect Emission**
- **Emission from Industry**
- **Emission from Transportation**
- **Emission from Services**
- **Emission from Agriculture**
- **Emission from Household**
- **Future Vision for CO₂ Emission (1t/capita)**
Technical Approach

Mitigate by transforming **key urban physical elements** identified in EF China’s Urbanization Strategy

- **Land & Space**
  - Scale
  - Form
  - Intensity

- **Housing & Infrastructure**
  - Layout
  - Efficiency
  - Lifecycle

- **Fiscal & Finance**
  - Diversity
  - Greenness

- **Industry & Services**
  - Capacity
  - Structure
  - Efficiency

- **People**
  - Structure
  - Distribution
  - Behavior

- **Governance**
  - Integration
  - Transparency
6 Strategic Priorities and 18 Working Areas

**Structural Change & Integration**
17. Zero Emission Zones
18. Structural change

**Future Looking Data Infrastructure**
15. City MRV system
16. Big data system for low carbon, smart public services

**Green Building and Housing**
11. Green/ultra-low energy/zero carbon buildings
12. Direct current buildings
13. Built-in distributed renewable energy
14. Clean heating and cooling

**Renewable Energy Infrastructure**
1. Micro smart grid
2. Co-generation center with renewables
3. User-side energy storage and cascade utilization
4. Prosumers and virtual power plants

**Sustainable Transportation Infrastructure**
5. EV charging facilities
6. Right-of-ways for urban green transport
7. City cluster green transport facility

**Livable Service Infrastructure**
8. Comfortable streets and public spaces
9. Urban green and eco-system
10. Urban amenities and service facilities
Theory of Change

**LCCP Strength & Legacy**
- Deeply Understand the Population Growth and Migration

**Identify Partners**

**Build Mitigation Measures Into Pathways**
- Stakeholders
  - State Council
  - NDRC/NEA
  - MEE
  - MNR
  - MOHURD
  - MOT
  - MIIT
  - Local Cities
  - Market Players
  - Financers
  - Peer EFC Programs
  - Peer iNGOs

**Intervene and Invest in Strategic Priorities**
- Laws & Regulations
- High-level Directives
- Standards & Codes
- Cross sec. Planning
- Pilots
- Fiscal, Finance & Carbon Market
- MRV
- Capacity Building

**Catalyze Real World Change**
- City Carbon Neutrality

**Strategic Priorities**
- Carbon Neutrality For Chinese Cities
- Cross sec. Planning
- Pilot Projects
- Fiscal, Finance & Carbon Market
- MRV
- Capacity Building

**Emerald Cities**

**LCCP Vision & Goals**

**LCCP Strength & Legacy**
- Identify Partners
- Build Mitigation Measures Into Pathways
- Intervene and Invest in Strategic Priorities
- Catalyze Real World Change
Actions
Implementable actions for each specific Strategic Priorities are selected by interviewing top experts in related fields.
“Must Do” Actions

**Structural Change & Integration**
- 9. Territory planning integrating low carbon development
- 10. Low carbon city regeneration technical guideline
- 11. Zero buildings & district pilots
- 12. Carbon-neutral district promotion policies and incentives
- 13. Cross-sector integration standards and design guidelines
- 14. Regional and cities zero emission goals, roadmap and measures
- 15. Zero emission cities and zones pilots and demonstration
- 16. Incentive policy, mechanism/assessment for reaching the emission peak in advance
- 17. Provincial and city level tri-reach planning pilot
- 18. Roadmap, policy and tech tools of carbon neutrality
- 19. Carbon neutrality city vision and strategy development pilots

**Renewable Energy Infrastructure**
- 1. Pilot of distributed energy system

**Sustainable Transportation Infrastructure**
- 2. Policies, guideline and standards on public transportation, logistic and inter-city passenger
- 3. E-vehicle infrastructure development policies & planning
- 4. Public transit and NMT development pilot

**Green Building and Housing**
- 7. Clean heating pilots in north China city and rural areas
- 8. Green buildings, green districts and green city pilots

**Livable Service Infrastructure**
- 5. City regeneration pilots
- 6. Territory planning guidelines and standards
High Priority Actions

1. Guideline on design of distributed energy system
2. Compact development guideline
3. Building demolition protocol
4. Guidelines on clean heating in south China
5. Direct current buildings & prefabrication buildings pilots
6. Policies & technical standards for smart construction industry
7. Establishment of city development database
8. Integrated big data methods and analysis tools
9. Establishment of city carbon neutrality tracking and ranking system
10. Green financing for new building, green building and energy saving
11. Financial incentive mechanism to distributed energy
12. Carbon-neutral TOD and compact development pilots
13. Tri-reach analysis model
14. Investment criteria for carbon-neutral cities
15. Carbon-neutral pathway and policy analytical tools
16. Develop future city planning guideline

Structural Change & Integration

Future Looking Data Infrastructure

Green Building and Housing

Renewable Energy Infrastructure

Carbon Neutrality For Chinese Cities

Sustainable Transportation Infrastructure

Livable Service Infrastructure
Medium Priority Actions

Structural Change & Integration
10. Land circulation policy integration with low carbon indicators
11. Land pattern and carbon emissions intensity modeling
12. Knowledge sharing and dissemination
13. Multi-plan integration capacity building and training
14. Training and international communication

Future Looking Data Infrastructure
9. Big data and transportation model

Green Building and Housing
7. Pilots of clean heating in north China city and rural areas
8. Building energy service & business big data model

Sustainable Transportation Infrastructure
1. E-bike management and promotion guideline
2. E-bike management and promotion pilot
3. Develop urban car use restricting policy;
4. Support autonomous vehicle and smart transportation pilot

Renewable Energy Infrastructure
5. Low carbon city regeneration financial incentives
6. Disseminate land use policies and technical guidelines
<table>
<thead>
<tr>
<th>Strategic Priorities</th>
<th>Working Areas</th>
<th>Developed cities</th>
<th>Fast developing cities</th>
<th>Resource-based Cities</th>
<th>IV. Cities with specific theme, e.g. tourism</th>
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<tbody>
<tr>
<td>Renewable Energy Infrastructure</td>
<td>1. Micro smart grid</td>
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<td>2. Co-generation center with renewables</td>
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<td>3. User-side energy storage and cascade utilization</td>
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<td>4. Prosumers and virtual power plants</td>
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<td>5. EV charging facilities</td>
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<td>Sustainable Transportation Infrastructure</td>
<td>6. Right-of-ways for urban green transport</td>
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<td>7. City cluster green transport facility</td>
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<td>Livable Service Infrastructure</td>
<td>8. Comfortable streets and public spaces</td>
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<td>9. Urban green and eco-system</td>
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<td>10 Urban amenities and service facilities</td>
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<td>Green Building and Housing</td>
<td>11. Green/ultra-low energy/zero carbon buildings</td>
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<td>12. Direct current buildings</td>
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<td>13. Built-in distributed renewable energy</td>
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<td>14. Green heating and cooling</td>
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<td>Future Data Infrastructure</td>
<td>15. City MRV system</td>
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<td>16. Big data system for low carbon, smart public services</td>
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<td>Integrated Infrastructure</td>
<td>17. Zero Emission Zones (community/industry park/campus, etc.)</td>
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<td>18. Structural change</td>
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</table>
Internal Collaboration

Chinese Cities

Livable Service Infrastructure

Renewable Energy Infrastructure

Sustainable Transportation Infrastructure

Structural Change & Integration

City Carbon Neutrality

Industry-city integration, Industry energy efficiency

NEV, innovative transport

Grid reform, market-based mechanism

New growth, finance and fiscal model

Environment goals, MRV

Communication, behavior change

Dialogue

Infrastructure and housing, Industry and services

Next generation infrastructure vision and goals

Infrastructure electrification

AQ and health impact

EFC Task Force

EFC Other Program

LTS

UT

ET

AQ

TT
THANK YOU
Initiatives and Tactics

PROGRAM

Low Carbon Cities Program

INITIATIVES

I: Decarbonize Strategic Sectorial Infrastructures
   - Renewable energy infrastructure
   - Sustainable transportation infrastructure
   - Livable service infrastructure
   - Low/zero carbon buildings

II: Promote Cross-Sectorial Integration and Structural Change
   - Infrastructure integration, Zero Emission zones, comprehensive urban retrofit, TOD, PEDF, etc.
   - Strategic, comprehensive planning
   - Social demographic transition, population migration and behavior change
   - Green financial, land, carbon drivers and mechanism in supporting infrastructure & structural upgrading

TACTICS
Action Development

Possible Actions Identification upon the vision and strategic approaches

Interview with the field experts

Carbon potential and ambition analysis

Actions prioritizing
### Actions Leading to The Changes (1)

#### Decarbonize Sectorial Infrastructure

<table>
<thead>
<tr>
<th>Sustainable Transportation Infrastructure</th>
<th>Green Buildings And Housing</th>
<th>Livable Services Infrastructure</th>
<th>Future Data Infrastructure</th>
<th>Renewable Energy Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Policies, optimization planning guideline and standards on public transportation, logistic and inter-city passenger</td>
<td>• Key tech, policy and financing of clean heating in north China city and rural areas</td>
<td>• Public facility standards</td>
<td>• Guidelines and standards for future data center energy efficiency</td>
<td>• Guideline on design of RE distributed energy system</td>
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<tr>
<td>• E-vehicle infrastructure planning and policies</td>
<td>• Building demolition protocol to extend the lifetime of buildings</td>
<td>• Life-cycle guidelines</td>
<td>• Financial incentive mechanism to distributed energy implementation</td>
<td>• Financial incentive mechanism to distributed energy implementation</td>
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<tr>
<td>• Future city planning guideline and policies</td>
<td>• Clean heating in south China (cold winter &amp; hot summer climate zone)</td>
<td>• Public space and public life demonstration, e.g., Huangpu river public space system demonstration</td>
<td>• Distributed energy system pilot</td>
<td>• Distributed energy system pilot</td>
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<tr>
<td>• E-bike management and promotion guideline</td>
<td>• Policy and technical standards for smart construction industry</td>
<td>• Green financing for new building, green building and energy saving</td>
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<tr>
<td>• Urban car use restricting policies</td>
<td>• Green financing for new building, green building and energy saving</td>
<td>• Scale up policies for green buildings, green districts and green city</td>
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<tr>
<td>• E-vehicle infrastructure planning</td>
<td>• Policy and technical standards for green buildings, green districts and green city</td>
<td>• Scale up policies for green buildings, green districts and green city</td>
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<tr>
<td>• Public transit and NMT development pilot</td>
<td>• Pilots of clean heating in north China city and rural areas</td>
<td>• Zero buildings &amp; district pilots</td>
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<td>• E-bike management and promotion pilot</td>
<td>• Direct current buildings</td>
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<tr>
<td>• Autonomous vehicle and smart transportation pilot</td>
<td>• Prefabrication buildings pilots</td>
<td>• Prefabrication buildings pilots</td>
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<tr>
<td>• Training and education</td>
<td>• Big data supported building energy service &amp; business model</td>
<td>• Big data supported building energy service &amp; business model</td>
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<tr>
<td>• Development of big data and transportation model</td>
<td>• Training</td>
<td>• Training</td>
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</tbody>
</table>
## Actions Leading to The Changes (2)

### Promote Cross-sectorial Integration and Structural Change

<table>
<thead>
<tr>
<th>Zero Emission Zones, Comprehensive Urban Retrofit, TOD, etc.</th>
<th>Strategic Planning</th>
<th>Social Demographic Transition, Population migration and behavior change</th>
<th>Green Fiscal And Financial Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Carbon-neutral district promotion policies and incentives</td>
<td>● Incentive policy, mechanism /assessment for peaking/dual reach/trip reach/neutrality</td>
<td>● Urban demographic and population migration database</td>
<td>● Natural capital driven fiscal policies</td>
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<td>● Cross-sector integration standards and design guidelines</td>
<td>● Multi-plan integration development planning guidelines</td>
<td>● Communication towards behavior change</td>
<td>● New taxation policies for fiscal alternatives</td>
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<tr>
<td>● Regional and cities zero emission goals, roadmap and measures</td>
<td>● National infrastructure plans</td>
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<td>● Green financial policies for sectors</td>
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<td>● TOD and compact development guideline</td>
<td>● TSP technical policy system, e.g., standards</td>
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<td>● Green financing pilot for new infrastructure and retrofit projects</td>
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<td>● Zero emission cities and zones pilots and demonstration</td>
<td>● Provincial and city level peaking/dual reach//tri-reach/neutrality planning pilot</td>
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<tr>
<td>● Carbon-neutral TOD and compact development pilots</td>
<td>● TSP planning pilots</td>
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<td>● Knowledge sharing and dissemination</td>
<td>● Training and International communication</td>
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<tr>
<td>● Establishment of city development database</td>
<td>● Peaking/dual reach/tri-reach/neutrality analysis model and tools</td>
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<td>● Multi-plan integration capacity building and training</td>
<td>● TSP evaluation tools</td>
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<tr>
<td>● Integrated big data methods and analysis tools</td>
<td>● Training and international idea exchange</td>
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</table>
34 experts from the areas of economy and society, industry, building & energy, transportation, city planning and funders;

66 recommendations

58 activities are selected and put into 3 baskets: A, B, C in sequence of importance.
Pilots Selection

- Carbon reduction potentials
- Carbon neutrality feasibility
  - local political supports
  - local development status
  - local technical implementation capacity
- Typicality
  - Developed cities approaching carbon peaking or peaked, e.g., BJ, SH, SZ, GZ
  - Rapidly developing cities facing critical pathway transition, e.g., QD, NJ
  - Less developed, industrial-heavy, energy and resource intensive cities, e.g., YL
  - Key area with specific theme: i.e. zero emission island of Hainan
Impacts - transportation

CO2 emissions and reduction potential

-- Vehicle Transportation Sector
CO2 emissions and reduction potential -- 1335 MtCO2e

Zero-emission building -- 459 Mt

Energy saving -- 298 Mt

Control system improve -- 107 Mt

Heat supply efficiency -- 108 Mt

renewable supply -- 364 Mt
CO2 emissions and reduction potential
-- 16648 MtCO2e

Industry transformation
-- 2154 MtCO2e

Industry innovation
-- 8858 MtCO2e

Energy
-- 5636 MtCO2e
Urban expansion: where are we and where could we end?

118,200 km² (100%) + 56,300 km² (47.6%) = 174,500 km² (147.6%)
City/regional buildings codes map: where are we?

- **Severe Cold**
  - Residential Building: 75%
  - Commercial Building: 65%
- **Cold**
  - Residential Building: 75%
  - Commercial Building: 65%
  - Ningxia (in progress)
  - Residential: 75%
- **Hot Summer & Cold Winter**
  - Residential Building: 65%
  - Commercial Building: 65%
  - Hebei
  - Residential: 75%
  - Commercial: 65%
- **Temperate**
  - Residential Building: 50%
  - Commercial Building: 65%
  - Qinghai (Trial)
  - Residential: 75%
- **Hot Summer & Warm Winter**
  - Residential Building: 65%
  - Commercial Buildings: 65%
- **Severe Cold**
  - Residential Building: 75%
  - Commercial Building: 65%
  - Heilongjiang
  - Residential: 78.3%
  - Liaoning
  - Commercial: 65%
  - Jilin
  - Residential: 75%
  - Beijing
  - Residential: 80%
  - Tianjin
  - Residential: 65%
  - Henan (Cold zone)
  - Residential: 75%
  - Jiangsu
  - Residential: 65%
  - Commercial: 65%
  - Shanghai
  - Residential: 65%
  - Commercial: 65%

Local code higher than national code in the region.
Buildings energy: where are we?

Energy Use Intensity (kgc/㎡·a)

Bubble’s size indicates the total energy use

Energy Use per Capita (tce/capita)

Percentage changed compared to 2010

- Building energy use
- National energy consumption
- Building area
- Population
- Urbanization rate
Infrastructure and related industry growth

1) Urbanization rate and infrastructure construction

- **Urbanization Rate**: 2000 to 2018
- **Length of Railways in Operation**: 2000 to 2018
- **Civil Aviation Routes**: 2000 to 2018
- **Building Area**: 2000 to 2018

2) Output of industrial products

- **Cement**: 2000 to 2018
- **Crude Steel**: 2000 to 2018
- **Electrolytic Aluminum**: 2000 to 2018
- **Plain Glass**: 2000 to 2018
City fiscal map: where are we?

High percentage of fixed assets investment drives the overall growth, where around 20% are infrastructure investments. Local public infrastructure investments mainly rely on land revenue (>50% of local total revenue in recent years), which drives the fast expansion of urban land and infrastructure.
Infrastrucure decision makers at national level

MNR: Set major transportation infrastructure standards

MOH/URD: Set major industrial infrastructure standards

MOT: Decide spatial layout and Right-of-Way (ROW) of all infrastructures

MEE: Set environment and carbon standards for sectors, cities and regions

NDRC/NEA: Set buildings (including district heating) energy efficiency standards, municipal infrastructure design, construction and maintenance standards, urban retrofit guidelines

MIIT: Decide and coordinate strategic infrastructure investment, e.g., national and urban rail, national and regional power, industry, transport infrastructure development plans, renewable energy plans

SC: High level directives
21 Priorities in THE URBANIZATION STRATEGY

1. Population Migration and Agglomeration
2. New Consumption Patterns and Lifestyles
3. Urban Sprawl/Shrinking
4. Urban Retrofit and Renewal
5. Urban Rail & Land/Space Integration (TOD)
6. Energy Intensive Infrastructure Control
7. New Services & Digital Infrastructure
8. District-Level Near Zero Solutions
10. Building Energy Retrofit & 100% Ultra Low Energy Buildings
11. Innovative Heating Solutions
12. Integrated City Cluster Transport Solutions
13. Low Carbon Mobility and Housing for Super Dense Areas
14. NEV-Charging Infrastructure
15. DC/RE-Based Distributed Energy Solutions
16. Industry Park Revitalization & Integration with Cities
17. Energy and Resource Intensive Industry Transition
18. Industry Upgrading to Services and Higher Value Chain
19. Innovative Financing, e.g., Natural Capital Accounting
20. New Governance Co-Management Multi-Plan Integration (MPI)
21. Data Disclosure and New Technology Application

People, Land & Space, Housing & Infrastructure, Industry & Services, Fiscal & Finance, Governance

“New infrastructure” in the Stimulus Plan