Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

MODERATOR

Le Yin
Senior Program Officer
Energy Foundation China
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

KEYNOTE PRESENTATION

Michael P. Walsh
Board Member Emeritus
International Council on Clean Transportation
Motor Vehicle Pollution Control in PRC
How It All Began

A Retrospective and Prospective Study on
20 Years’ Mobile Source Emissions Control in Megacities of PRC

November, 2023

Michael P. Walsh
Board Member Emeritus,
International Council on Clean Transportation
1995 The World Bank Launches B – 9 – 3 Project

- ECE Emissions Standards on Paper But Not Enforced
- Poor Quality Fuels – High Sulfur, Only Leaded Gasoline
- NEPA Takes the Lead To Develop a Vehicle Pollution Control Program
- Support Team – CRAES, BARI, Tsinghua, World Bank Consultants/Experts
- Broad Scope of Work
  - Collect All Available Vehicle Emissions Data; Create Inventory
  - Develop Compliance Strategies for New & Existing Vehicles
  - Explore Options to Produce Cleaner Vehicles and Fuels
Some of the Key Players
An International Advisory Team

- NEPA (Li Pei) wanted to review the global experience before deciding how PRC would proceed.
- I recruited international experts:
  - Jan Karlsson from the Swedish EPA knew the European Program and
  - Takuro Miyazaki from Japanese EPA knew the Japanese program.
- Our goal was to provide objective information regarding US, EU, and Japanese programs to enable PRC to make wise decisions.
- Professors Hao Jiming and He Kebin and several Tsinghua graduate students were very involved as well.
- Our first meeting was in September 1995.
A 2 Year Process Ensued Debating and Discussing Many Issues

• For Example:
  – Should PRC Develop its Own Driving Cycles?
  – Qualified Test Laboratory Availability (CATARC?)
  – Compliance Program? Type Approval System, Europe or US Approach?
  – Staffing Needs – How Many, What Skill Set (CRAES?)

• NEPA Decision: Follow Europe
  – Some Familiarity with UN ECE System
  – Largest International Manufacturer, VW, based in Europe
  – US, Japan Too Complex
Major Remaining Challenge – Fuel Quality

- Amendments to Atmosphere Pollution Control law passed by the Standing Committee of the National People's Congress on August 29, 1995, Authorized NEPA To Adopt Vehicle Emissions Standards
- But It Did Not Confer Legal Authority To NEPA To Set Fuel Quality Standards
- At Request of the State Council, NEPA Convened A Major Workshop in Shanghai in March 1997
  - Attendees Included Representatives From Major Ministries And Commissions That Had Responsibilities In The Areas Of Vehicle Manufacturing, Planning, Finance, Science And Technology Support For Vehicles, Oil Refining And The Environment, Including Several Cities.
  - The Environmental Bureaus Of Three Major Cities (Beijing, Shanghai, And Guangzhou) Stated That They Wanted And Needed Unleaded Gasoline.
Participants in Fuels Workshop

Seminar showed public alignment of unconditional support for unleaded gasoline by each of the ministries including the State Planning Commission, the Finance Ministry and the State Science and Technology Commission.
Starting To Create A World Class Vehicle Emissions Control Program

• Regarding Fuels State Council Announced:
  • From January 1, 2000, Only Lead-free Gasoline Could Be Produced in PRC,
  • From July 1, 2000, All Cars Must Use Unleaded Gasoline
  • From July 1, 1999, Gasoline Stations In Major Cities, Including Provincial Capitals And Special Economic Zones, Should Only Sell Lead-free Gasoline.
  • From July 1, 2000, All Gasoline Stations Nationwide Should Only Sell Lead-Free Gasoline.

• Regarding Vehicles
  • From January 1, 2000, Car Manufacturers Must Make All Their Models Suitable For Use With Lead-free Gasoline.
  • From April 1, 2000, All New Cars Must Comply With Euro 1 Catalyst-based Emissions Standards.
  • Beijing Introduced Euro 1 Standards For Heavy Duty Gasoline* and Diesel Engines By January 1 2000.
  • Nationally, SEPA Introduced Heavy Duty Standards According To The Following Schedule:
    • Euro 1 Certification July 1, 2000; Production July 1, 2001
    • Euro 2 Certification July 1, 2003; Production July 1, 2004.

* All heavy duty engines in Europe were diesel so US EPA 1982 standards were used
International Cooperation and Collaboration
Very Important To Help PRC Over The Years
(Partial List)

- Argonne National Labs (Michael Wang)
- Chuck Freed (Former US EPA)
- US EPA (Margo Oge and Staff)
- European Union (Misc.)
- Energy Foundation China (Michael Walsh)
- International Council on Clean Transportation
The integrated “vehicle-fuel-traffic” emission control system

• After 20 years of practice, PRC has established the integrated “vehicle-fuel-traffic” emission control system

Simultaneously improving vehicle emissions and fuel quality standards
• Continuously tighten emission standards for new vehicles
• Fully implement of China 6/VI emission standard

Intelligent decisions
• Big-data intelligent transportation system promotes precise vehicle emission control

Clean transportation energy
• Promoting new energy vehicles
• Promoting the application of ethanol gasoline, biodiesel and other biofuels

Vehicle emission control strategies

In-use vehicle supervision
• I/M programs integrated by annual emission inspection
• Remote sensing and OBD
• Phasing-out older vehicles

Transportation optimization
• Prioritizing public transport strategy
• Optimization for freight transportation structures

Some major actions in 2018-2020

- Three-Year Action Plan of Blue-Sky Defense
- Action Plan for Battle Against Diesel Truck Pollution
- Action Plan for optimization of freight transportation structures
New Car Emissions Standards Have Been Greatly Tightened
PRC Which Started Late Has Surpassed Euro 6

Fuel and vehicle now have been synchronized as a system to enhance the emission control of new vehicles: China 6/VI regulations in terms of fuel-neutral concept, pollutant emission limits, evaporative emission limit, on-board monitoring (OBM) requirements are more strict than Euro 6/VI.
Advanced technologies for in-use vehicle monitoring

- The in-use inspection and maintenance (I/M) programs: annual emission inspection, random inspection, mini-PEMS and remote sensing
- Beijing initiated the first-ever remote OBD monitoring program in the world

In-use inspection and maintenance
- Annual inspection
- Random on-road inspection
- Mini-PEMS
- Remote-sensing

OBD monitoring
Diversification of transportation energy and application of biofuel

- E10 ethanol gasoline is sold in 15 provinces in PRC to varying extents, with ~ 3 million tonnes of bioethanol supplied
- Shanghai has implemented the widespread use of biodiesel in buses and trucks
- More efforts are needed to promote development of biofuels in PRC
Going Forward, New Energy Vehicles Are Key To Solving Air Pollution and Climate Problems

- PRC launched a series of policies to promote the production and sale of NEVs (mostly electric vehicles), including purchase subsidies, tax exemptions, infrastructure construction, and privileges in vehicle registration.

- The Result: PRC is The World’s Largest Producer and the Largest Market.

- New energy vehicles account for 26% of Chinese vehicle sales in 2022.

Source: IEA
Promotion for sustainable travel modes and optimization for freight transportation structures

- **Prioritizing Public Transport**: Megacities have made remarkable progress in public transport development, like Shanghai and Beijing having subway operating mileages exceeding 700km.
- **Road-to-rail and Road-to-waterway**: Railway cargo share grew at an annual growth rate of ~7% from 2017 to 2020. The adjustment of the transportation structure is still in its initial stage.

Development of public transport in Shanghai

Trend of freight volume and structure in PRC
Blue Skies after the megacities’ efforts

Beijing
Shenzhen
Shanghai
Chengdu
Outlook

- Deep emission abatement is critical for improving air quality and addressing climate change synergistically.
- Enhancing the leading role of standards and technologies and increasing control of vehicle emissions from internal combustion engines (ICEs).
- Clean and low-carbon energy transition for the transportation sector can heavily promote the green development of the automotive industry.
- Strengthening infrastructure development and improving service performance to facilitate green travel systems and optimize freight structure.
- Exploring intelligent and innovative solutions for managing vehicle emissions in the era of the IoT and big data.
Thank You
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

Cheng Huang
Vice Director
Shanghai Environmental Monitoring Center

Ye Wu
Professor
Tsinghua University

Qinwen Tan
Director
Chengdu Academy of Environmental Sciences

Shaojun Zhang
Associate Professor
Tsinghua University

BEIJING
SHANGHAI
CHENGDU
SHENZHEN

Day 1 Conference | 15 November
Two Decades of Progress in Vehicle Emission Control:
Insights and Opportunities for Asia

Ye Wu
Professor
Tsinghua University
20 years’ mobile source emission control in megacities of PRC

Ye Wu
Tsinghua University

Nov. 15 2023
Our Team

Project team

Ye Wu
Professor
Tsinghua University (THU)

Yan Ding
Chief Scientist
Chinese Research Academy of Environmental Sciences

International scientific committee

Jiming Hao
Member of CAE and NAE

Michael Walsh
Board Member Emeritus of the ICCT

Hang Yin
VECC

Yanyan Yang
Beijing

Cheng Huang
Shanghai

Qinwen Tan
Chengdu

Min Yan
Shenzhen

Honglei Xu
TPRI

Ying Liu
Beijing

Hui He
ICCT

Shaojun Zhang
THU

Xiaomeng Wu
THU

Wei Zhou

Kebin He

Hong He

Anumita Roychowdhury

Leonora Rojas-Bracho

Lennart Erlandsson

Jim Blubaugh

Supat Wangwongwatana
Megacities serve as pioneers in building integrated “Vehicle-Fuel-Traffic” control system

<table>
<thead>
<tr>
<th></th>
<th>Area (km²)</th>
<th>Population (million)</th>
<th>GDP per capita (k CNY)</th>
<th>Vehicle population (million vehicles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>16,410</td>
<td>21.9</td>
<td>165</td>
<td>6.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually 2.4%↑</td>
<td>Annually 10.0%↑</td>
<td>Annually 9.1%↑</td>
</tr>
<tr>
<td>Shanghai</td>
<td>6,341</td>
<td>24.9</td>
<td>157</td>
<td>4.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually 2.2%↑</td>
<td>Annually 8.6%↑</td>
<td>Annually 11.5%↑</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>1,997</td>
<td>17.6</td>
<td>158</td>
<td>3.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually 4.7%↑</td>
<td>Annually 8.1%↑</td>
<td>Annually 12.5%↑</td>
</tr>
<tr>
<td>Chengdu</td>
<td>14,335</td>
<td>20.9</td>
<td>85</td>
<td>6.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually 3.2%↑</td>
<td>Annually 11.1%↑</td>
<td>Annually 11.1%↑</td>
</tr>
</tbody>
</table>

National level: Population: 1.4 billion, GDP per capita: 72k CNY (eq. to 10k USD)
City-specific practices tailored to unique characteristics

**Beijing: Remote OBD monitoring**

**Shanghai: Public transportation**

**Shenzhen: E-mobility**

**Chengdu: Big data application**

- **Common measures**
  1. Policy support
  2. Fiscal purchase subsidy
  3. Promoting the construction of public charging infrastructures

- **Special measures**
  1. Providing fiscal subsidy for operations
  2. Providing incentives and subsidy for extra emission reduction
  3. Building supporting charging infrastructure
  4. Except from traffic restrictions
  5. Providing incentive incentives for the right of operation
  6. Raising the section price of procurement service
  7. Compiling and releasing norms and standards in terms of RECs

- **Traffic big data**
- **Dynamic traffic emission simulation**
- **Intelligent vehicle emissions mapping and management system**

- **Operating mileage of rail transit (km)**
  - Shanghai
  - Beijing
  - Shenzhen
  - Chengdu
  - Suzhou
  - Hangzhou
  - Nanjing
Beijing: Remote OBD monitoring for heavy-duty diesel vehicles
Beijing has successfully decoupled the deterioration of air pollution from fast motorization

- Beijing's annual average NO$_2$ and PM$_{2.5}$ concentrations met the national ambient air quality standards (NAAQS) for the first time in 2019 and 2021, respectively.
- The decreasing trend of NO$_2$ concentration over the past two decades has aligned closely with the significant reduction in NO$_X$ emissions from on-road vehicles.

The trend of vehicle population and NO$_2$ concentration in Beijing, 2000-2020
Enhancement of the control on in-use vehicles

- Beijing has established a comprehensive I/M system for in-use vehicle emission control, including annual inspection, mini-PEMS, on-road random inspection, etc.
- Promoting advanced supervision technologies and accelerating the construction of the supervision platform to enhance the real-world monitoring of in-use vehicles

### Real-world emission monitoring system and key technologies for HDVs

<table>
<thead>
<tr>
<th></th>
<th>Standard measurements</th>
<th>Advanced sensing and IOT technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PEMS</strong></td>
<td>1-2 vehicles /day 1-2 h / vehicle</td>
<td>Environment sensing</td>
</tr>
<tr>
<td><strong>Dynamometer</strong></td>
<td>1-2 vehicles /day 1-2 h / vehicle</td>
<td>Chasing 50-80 vehicles/day 3-10 min/vehicle</td>
</tr>
<tr>
<td></td>
<td>Small volume, Drivers could intervene</td>
<td>Remote sensing 1000+vehicles /day 5-10s / vehicle At fixed point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OBD monitoring Will cover all in-use HDDVs in 2022</td>
</tr>
</tbody>
</table>
From On-board Diagnostic (OBD) to On-board Monitoring (OBM)

- **OBD-I & OBD-II**: Electronic Control Unit (ECU) collects the real-time data from on-board sensors to diagnose the operation of the vehicle engine, emission control system, and fuel system.

- **Remote OBD monitoring**: Incorporated with emission sensors, the on-board terminal collects and uploads real-time driving and emission data of pollutant concentrations ($\text{NO}_x$).

**OBD-I**
- 1982
- General Motors designed OBD-I system

**OBD-II**
- 1994
- SAE standardized OBD-II

**Remote OBD monitoring**
- 2017
  - Beijing mandates HDVs to equip OBM
  - Incorporates emission sensors
- 2020
  - PRC mandates Stage VI HDVs to equip OBM
  - Online system
  - Real-time emission monitoring

- **Offline check**
- **Diagnostic Trouble Code and MIL**

**On-board terminals**

**Cloud**

**Upload data**
Development of Beijing and national OBD regulations

- **Beijing:** the first city in the world to require **remote online monitoring** of heavy-duty vehicle emissions and energy consumption in the full life cycle

- The implementation of OBD-based remote monitoring in Beijing further promoted the development of national standards (China VI for heavy-duty vehicles)

---

**June, 2018**
China VI standard (including OBD monitoring requirements) was released

**May, 2020**
Beijing OBD Remote Terminal Installation Management Measures

**Jun, 2018**
Local standard for OBD monitoring was released in Beijing

**Jan, 2020**
Beijing Regulations on Installation of Remote OBD Monitoring Terminals

**Dec, 2017**
Local standard for OBD monitoring was released in Beijing

**Dec, 2021**
Technical specification for emission remote supervision system of heavy-duty vehicles (HJ 1239.3-2021)

**July, 2023**
China VI-b implemented, requiring the installation of OBD monitoring terminals and the uploading of collected data
Beijing established a Heavy-duty Diesel Vehicle On-board Emission Monitoring Platform, more than 160,000 heavy-duty diesel vehicles have been connected.
The strict and efficient remote OBD leads to a significant reduction of NO\textsubscript{X} emissions from heavy-duty diesel vehicles (HDDVs) in Beijing.

Annual NO\textsubscript{2} concentrations decreased by 37\%, with ~40\% attributed to diesel vehicle emission controls.
THANK YOU
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

SHANGHAI

Cheng Huang
Vice Director
Shanghai Environmental Monitoring Center

Day 1 Conference | 15 November
Shanghai: Public Transport Development

Cheng Huang
Shanghai Academy of Environmental Sciences
Shanghai Environmental Monitoring Center

Nov 15, 2023
Overview of road transportation in Shanghai

- **Area:** 6430 km²
- **Population:** 24.9 million (+2.1%/year)
- **GDP per capita:** 175,384 Yuan (+6.8%/year)
- **Vehicle ownership:** 4.66 million (+11.3%/year)
- **Daily passenger trips:** 54 million (+1.7%/year)
- **Total freight:** 1.55 billion (+5.9%/year)

* The following data are for 2021
* % represents the growth rate from 2000 to 2021

**Distribution of Traffic Flow in Shanghai**

- Mobile sources
- Other sources

**PM₂.₅:** 39.5%

**CO₂:** 27.0%
Public transport priority policies implemented in Shanghai

- 1994: Private Car License Auction
- 1997: Unleaded gasoline
- 1999: China I Emission Standard
- 2004: Public Transport Priority Strategy fully implemented
- 2007: Public Transport Priority Strategy fully implemented
- 2012: Yellow Label Car Restriction
- 2015: Yellow label cars are phased out
- 2015: Start the old car limit
- 2017: 2035 Long-Term goals —— 1000km Subway and 40% of Trips by Public Transportation
- 2019: Early Implementation of China VI Emission Standard
- 2020: 2035 Long-Term goals —— 1000km Subway and 40% of Trips by Public Transportation

Vehicle ownership (millions)

- 1990: 0
- 1991: 1 million
- 1992: 2 million
- 1993: 3 million
- 1994: 4 million
- 1995: 5 million
Shanghai synchronously initiated the construction of rail transit system and license control policy.
The total length reached 729 km by 2020, the longest in the world.
The growth rate of vehicle population has been effectively controlled, much lower than other large cities (comparable to the level of Singapore).
The proportion of public transport travel continues to increase

- By 2020, the public transport trips accounted for 35% of the total travels, lower than Tokyo, Seoul and London. The proportion of rail transit trips increased from 1% in 2000 to over 20%.
- The traffic volume by vehicles in the central urban area has become stable since 2010, and its traffic and environmental pressures have been further alleviated.

### Comparison of CO₂ emissions in different transport modes

<table>
<thead>
<tr>
<th>Cities</th>
<th>Slow traffic</th>
<th>Individual traffic</th>
<th>Public transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>26.3</td>
<td>38.0</td>
<td>35.7</td>
</tr>
<tr>
<td>Paris</td>
<td>40.3</td>
<td>40.1</td>
<td>20.1</td>
</tr>
<tr>
<td>New York</td>
<td>37.0</td>
<td>35.6</td>
<td>27.4</td>
</tr>
<tr>
<td>Tokyo</td>
<td>37.0</td>
<td>12.0</td>
<td>51.0</td>
</tr>
<tr>
<td>Seoul</td>
<td>20.4</td>
<td>23.1</td>
<td>56.5</td>
</tr>
<tr>
<td>Singapore</td>
<td>23.0</td>
<td>33.0</td>
<td>44.0</td>
</tr>
<tr>
<td><strong>Shanghai</strong></td>
<td><strong>45.0</strong></td>
<td><strong>21.0</strong></td>
<td><strong>35.0</strong></td>
</tr>
<tr>
<td>Beijing</td>
<td>40.4</td>
<td>32.1</td>
<td>27.5</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>50.0</td>
<td>18.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>45.0</td>
<td>25.8</td>
<td>29.2</td>
</tr>
<tr>
<td>Chengdu</td>
<td>53.0</td>
<td>21.0</td>
<td>26.0</td>
</tr>
</tbody>
</table>

**Note:** Modal split (%)
Emission reductions by the public transport priority policy

- Vehicle population in Shanghai is expected to be 50%~60% lower than the national average (Mode 1) and the fastest growing city (Mode 2)
- By 2020, total vehicle emissions of CO₂, NOₓ, and VOCs were reduced by an average of 20%~25% compared to Mode 1 and Mode 2, respectively

Emission reductions benefited from the changes of transport modes
Significant improvement in traffic-related air pollution

- The ambient concentrations of NO₂ in urban areas have decreased significantly
- NO, CO, and BC concentrations at urban roadside stations annually decreased by 11.3%, 8.2%, and 16.3%, respectively, since 2014

**Spatial distribution of NO₂ concentration**

**Concentration changes at roadside stations**

Source: Shanghai Environmental Monitoring Center
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

CHENGDU

Qinwen Tan
Director
Chengdu Academy of Environmental Sciences
Chengdu: Big data intelligent transportation system for precise emission control

Qinwen Tan

Chengdu Academy of Environmental Sciences

Nov 15, 2023
The automobile ownership of Chengdu has exceeded 6.3 million in the mid 2023, making Chengdu the city with the largest vehicle fleet in PRC.

Instead of license control measures, Chengdu emphasizes addressing traffic and environmental issues through intelligent transportation technologies.
Dynamic vehicle emission modeling based on ITS

- By integrating traffic big data (e.g., 8000+ traffic sensors) and machine learning techniques, Chengdu has developed a data-driven dynamic model and decision-making system for intelligent vehicle emission control.
The evolution of the decision-making system

Starting from 2018, the system has undergone several rounds of updates and enhancements, aiming for higher resolution and real-time functions.

The latest version supports a 72-hour dynamic tracking of traffic emissions and benefits of vehicle emission control in both short- and long-term scenarios.
Case 1: Tracking vehicle emission changes during the COVID-19 pandemic

- The pandemic led to a sharp reduction in traffic activities, this system accurately tracked the emission reduction resulting from the traffic changes during the COVID-19 pandemic.
- The traffic flow in Chengdu decreased by 59%, average vehicle speed increased by 16%, resulting a reduction of 50-60% of vehicle emissions in the urban area.

Real-time display of traffic and emissions

Dynamic tracking during the COVID-19 pandemic

- Spring Festival and the start of Level-1 control period
- End of the level-1 control period
Case 2: Benefit assessment for low-emission zone policy

- The implementation of the Low Emission Zone (LEZ) policy will significantly reduce traffic intensity and vehicle emissions, leading to improved air quality.
- The LEZ policy can be further integrated with NEV promotion as a Green and Low-Carbon Zone that mitigates both air pollution and CO₂ emissions.

Policy benefits evaluation

<table>
<thead>
<tr>
<th>Control scenario</th>
<th>BAU scenario</th>
<th>NOₓ Reduction benefits of LEZ policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEZ S1</td>
<td>LEZ S2</td>
<td></td>
</tr>
</tbody>
</table>
Case 3: Application in 2023 Chengdu FISU World University Games

- The decision-making system was successfully applied during the Games, supporting real-time tracking of daily traffic and emissions throughout the event.
THANK YOU
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

SHENZHEN

Shaojun Zhang
Associate Professor
Tsinghua University

Day 1 Conference | 15 November
Shenzhen: A pioneer city promoting new energy vehicles

Shaojun Zhang
Tsinghua University

Nov. 15 2023
Shenzhen led the transition to NEVs in PRC

- Shenzhen has successfully deployed 400 thousand new energy vehicles (NEVs) by 2020, with the highest electrification rate (11%) among major cities in PRC.

### The growth of NEVs in Shenzhen, 2009-2020

#### City | NEV amount (thousand) | Total vehicle population (million) | Electrification rate (%)
--- | --- | --- | ---
Beijing | 412 | 6.57 | 6.3
Shanghai | 424 | 4.69 | 9.0
Guangzhou | 269 | 3.08 | 8.7
Shenzhen | 397 | 3.59 | 11.1
Shenzhen became the first city in the world with 100% electrification of buses and taxis.

The number of electric trucks has ranked the top across the world in the past five years.

**Composition of NEVs promoted in Shenzhen, 2020**

- Electric bus: 16,500, electrification rate: 100%
- Electric taxi: 21,600, electrification rate: 100%
- Electric logistics vehicle: 85,900, electrification rate: 17%
- Electric ride-hailing: 48,000
- Electric sanitation vehicle: 2,500
- Electric mud truck: 4,200
- Electric official and police vehicle: 600
- Electric private vehicle: 217,300

New energy vehicle ownership in 2020: 397,000
Comprehensive supports for the promotion of NEVs

The rapid e-mobility promotion in Shenzhen are comprehensively supported by the development of infrastructure, industrial chains, subsidies and transportation policies.

<table>
<thead>
<tr>
<th>Supporting infrastructure</th>
<th>Industry chain development</th>
</tr>
</thead>
<tbody>
<tr>
<td>93,000 public charging piles built</td>
<td></td>
</tr>
<tr>
<td>Vehicle-to-pile ratio of 4.3:1</td>
<td></td>
</tr>
<tr>
<td>More than 2,000 NEV related enterprises</td>
<td></td>
</tr>
<tr>
<td>Highest density of NEV enterprises in the world</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economic subsidies</th>
<th>Green logistics zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-lifespan subsidies</td>
<td></td>
</tr>
<tr>
<td>Charging subsidies</td>
<td></td>
</tr>
<tr>
<td>Reduced parking fees</td>
<td></td>
</tr>
<tr>
<td>“Green Logistics Zones” in busiest areas: only allowing electric trucks to enter</td>
<td></td>
</tr>
</tbody>
</table>
Shenzhen places great importance on the local ecosystem of the NEV industry

More than 2,000 NEV-related enterprises gathered in Shenzhen, making it one of the cities with the highest density of NEV enterprises in the world
Pilot of “Green Logistics Zones”

- Shenzhen took the lead in setting up Green Logistics Zones in busy commercial areas and transportation hubs, which encouraged the adoption of electric logistics vehicles.
- Shenzhen had 86,000 electric light-duty trucks by 2020 (electrification rate of 22%).

<table>
<thead>
<tr>
<th>NOx Concentration Reduction</th>
<th>69.1 μg/m³</th>
<th>59.6 μg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>153.1 μg/m³</td>
<td>135.4 μg/m³</td>
<td></td>
</tr>
</tbody>
</table>

- Green logistics zones
- Freight corridors
- Port area
NEVs deliver air quality improvements and GHG mitigation

The promotion of NEVs has reduced both the air pollutants and GHG emissions:

- NO\textsubscript{X} 11,000 tons
- HC 2,400 tons
- PM\textsubscript{2.5} 300 tons
- CO\textsubscript{2} 540,000 t

Since 2014, ambient NO\textsubscript{2} concentrations in Shenzhen have significantly improved, with 35% of the improvement attributed to fleet electrification.

Air quality improvements due to the fleet electrification in Shenzhen

[Map showing air quality improvements before and after fleet electrification]
Two Decades of Progress in Vehicle Emission Control: Insights and Opportunities for Asia

QUESTIONNAIRE: MOTOR VEHICLE EMISSION REDUCTION

Please scan the QR code to provide your valuable contribution
ROUNDTABLE DISCUSSION: Prospectives of leapfrogging and opportunities for Asian cities in mobile source emissions control
Q & A

Ittipol Pawarmart
Head of Automotive Emission Laboratory
Thailand's Ministry of Natural Resources and Environment

Ye Wu
Professor
Tsinghua University

Michael P. Walsh
Board Member Emeritus
International Council on Clean Transportation

Myron Alcanzare
Senior Transport Researcher
Clean Air Asia

MODERATOR
Lu Fu
China Director
Clean Air Asia
A RETROSPECTIVE AND PROSPECTIVE STUDY ON 20 YEARS’ MOBILE SOURCE EMISSIONS CONTROL IN MEGACITIES OF PRC

LAUNCH CEREMONY

A Retrospective and Prospective Study on 20 Years’ Mobile Source Emissions Control in Megacities of China

Scan to download
ASIA WITHOUT AIR POLLUTION

Please scan the QR code to provide your valuable contribution

QUESTIONNAIRE