新能源
公交发展路径及能耗研究

The Development Planning and Energy Consumption Research of New-energy Transit

北京工业大学 · 城市交通学院

College of Metropolitan Transportation

Beijing University of Technology

陈艳艳 教授

Prof. CHEN Yanyan

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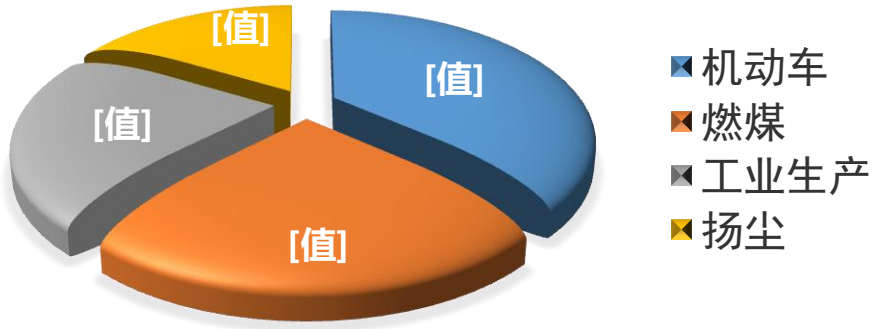
背景

6%↑

近五年，北京市交通运输业与社会车辆总能耗（单位：万吨标煤）平均增长率为**6%**

31.1%

机动车排放PM2.5贡献率为**31.1%**，挥发性有机物约占全市总量1/3，氮氧化物约占全市一半以上



35项

2013年初至今，国家到北京市共发布了**17**项与大气污染控制相关，**18**项与新清能源车辆推广相关政策法规，国家领导多次做出重要批示

数据来源：北京市交通委、北京市节能减排中心

一、课题研究背景

序号	文号	文件名称
1	环发[2012]30号	重点区域大气污染防治“十二五”规划
2	交政法发[2011]315号	公路水路交通运输节能减排“十二五”规划
3	国发〔2013〕37号	大气污染防治行动计划
4	发改能源〔2014〕819号	大气污染防治成品油质量升级行动计划
5	国办发〔2014〕23号	2014-2015年节能减排低碳发展行动方案
6	环发〔2013〕104号	京津冀及周边地区落实大气污染防治行动计划实施细则
7	京政办发〔2013〕27号	北京市2013-2017年清洁空气行动计划
8	京政办发〔2013〕49号	北京市2013-2017年清洁空气行动计划重点任务分解
9	京政办发〔2013〕53号	北京市2013-2017年机动车排放污染控制工作方案
10		北京市示范应用新能源小客车管理办法
11	京政办发〔2014〕9号	北京市2013-2017年清洁空气行动计划重点任务分解2014年工作措施
12	京经信委发〔2014〕39号	北京市示范应用新能源小客车生产企业及产品审核备案管理细则
13	京政办发〔2014〕39号	北京市电动汽车推广应用行动计划(2014-2017年)
14	京财经一〔2014〕449号	北京市示范应用新能源小客车财政补助资金管理细则
15	京公安交管局〔2015〕13号	关于纯电动小客车不受工作日高峰时段区域限行措施限制的通告

国家和北京市新能源汽车推广部分相关法律法规

北京市公共电气车现状
Status of buses in BEIJING

截止2014年底

by the end of 2014

- 营运车辆21,967辆

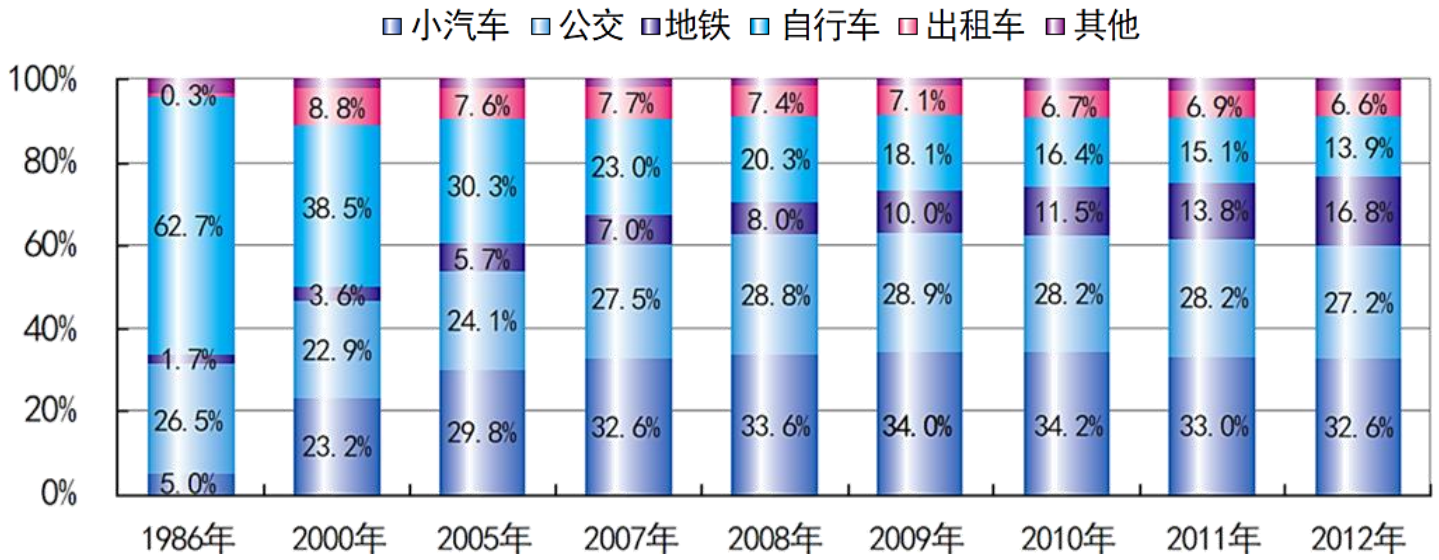
  operation buses: 23,592 vehicles

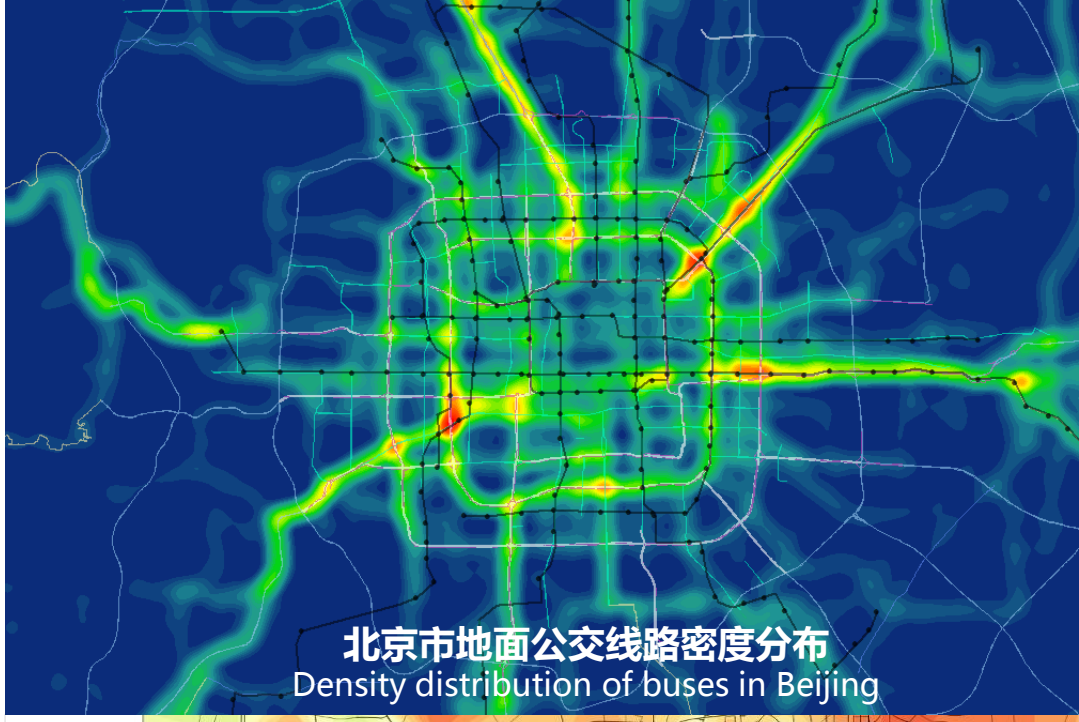
- 营运线路878条

  serving routes: 813 routes

- 年行驶里程13.27亿公里

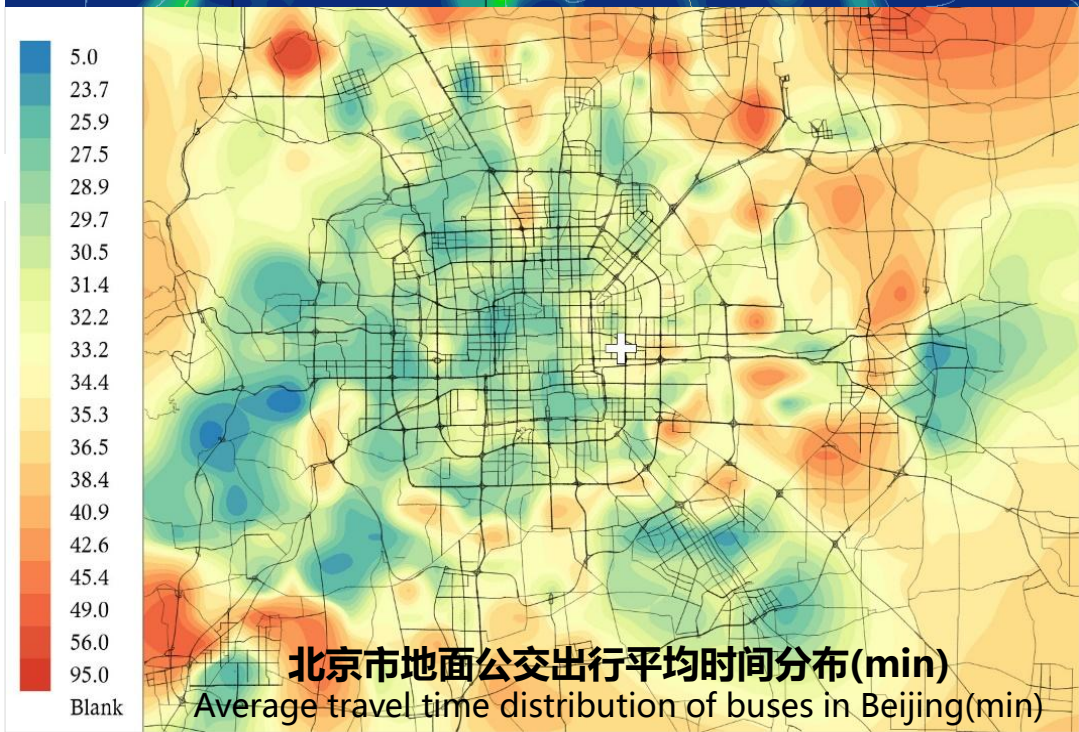
  annual travel miles:1.327 billion km





北京市地面公交线路密度分布

Density distribution of buses in Beijing



北京市地面公交出行平均时间分布(min)

Average travel time distribution of buses in Beijing(min)

北京市公共电气车现状
Status of buses in BEIJING

截止2014年底

by the end of 2014

- 日均客运量1284.13万人次

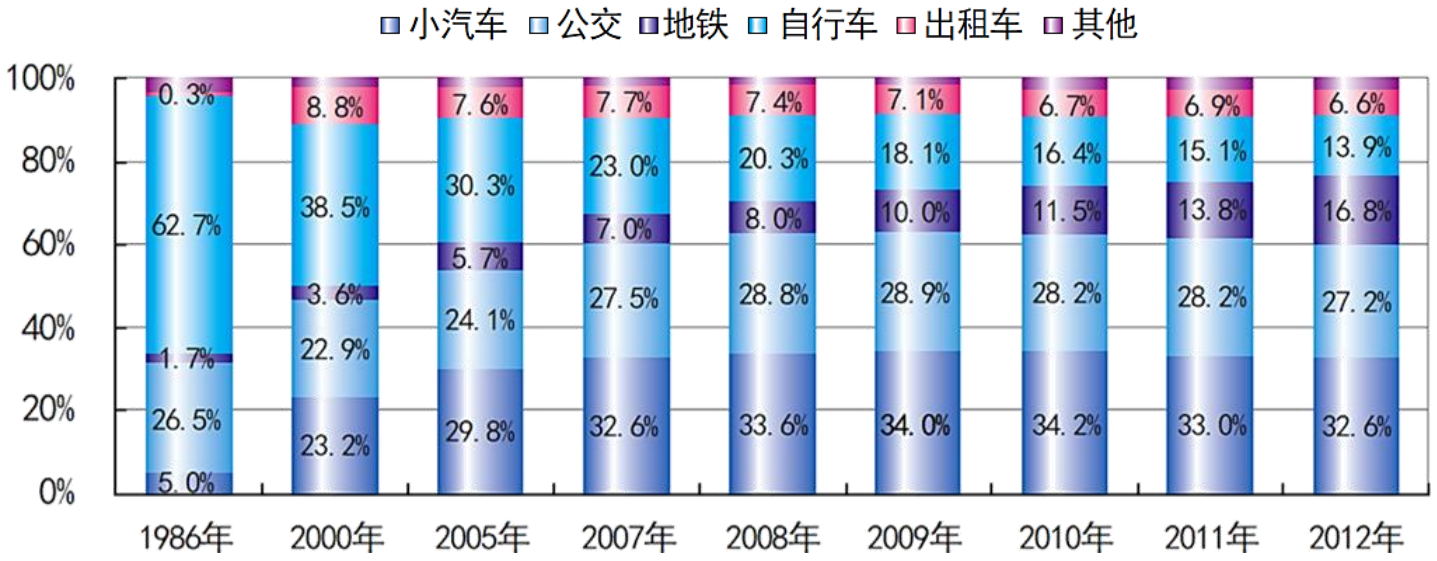
  Passenger volume: 12.84million per day

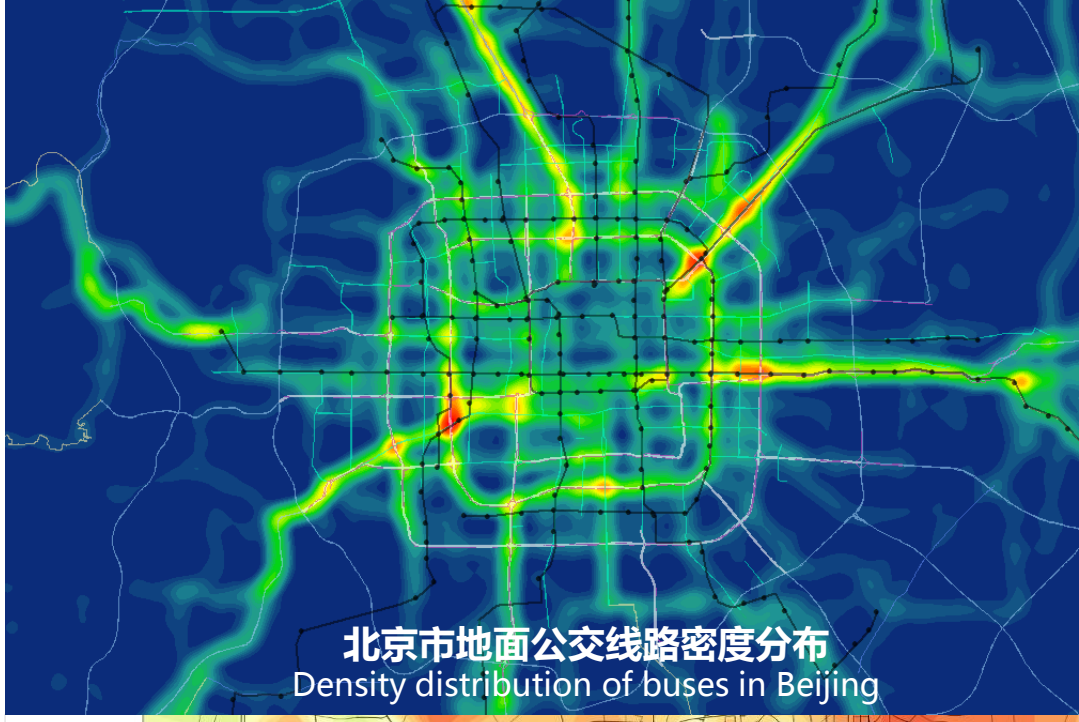
- 中心城区公交线网密度达3公里/平方公里

  Density of bus routes in central area: 3km/km2

- 500m站点覆盖率达90%

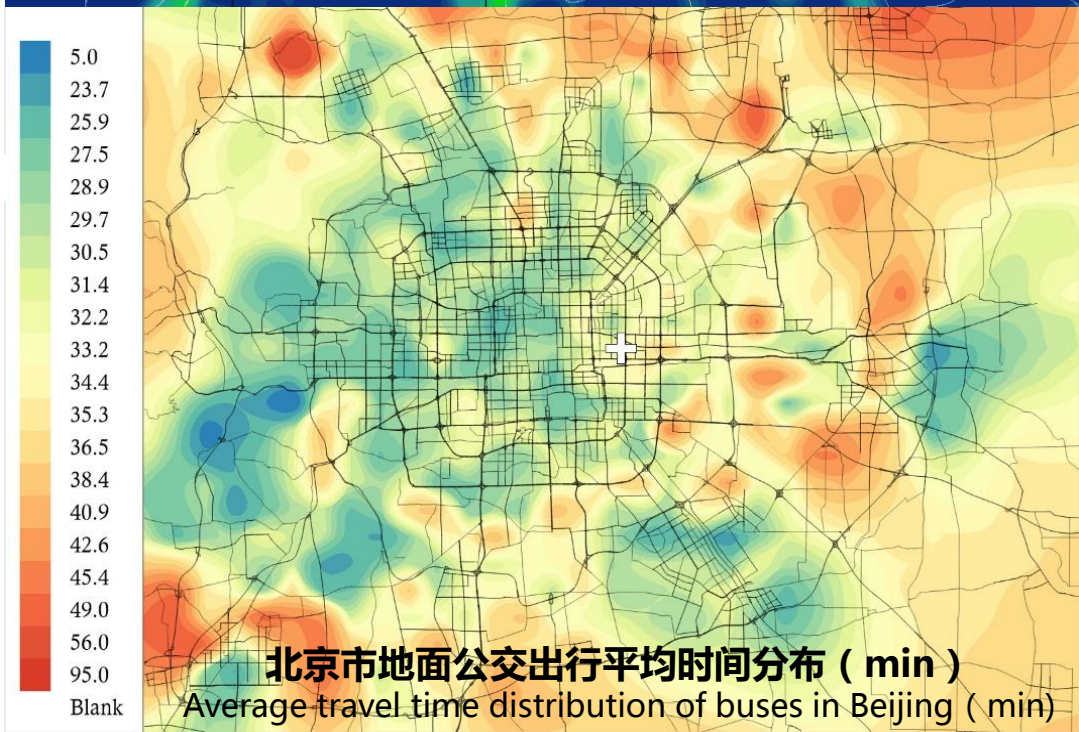
  Public transportation covering rate(search radius 500m):90%





北京市地面公交线路密度分布

Density distribution of buses in Beijing



北京市地面公交出行平均时间分布（min）

Average travel time distribution of buses in Beijing（min）

北京地面公交新能源发展路线
Development outlines of new energy buses in BEIJING

- 近年来，北京市**柴油公交车**的排放标准也在逐渐变化，由国III、国IV逐渐更新换代为**国V**标准。

  Discharge standard of **diesel-fueled buses** in Beijing is changing. CN-III、CN-IV are replaced by **CN- V**(discharge standard in China) in recent years.

- 目前公交行业**平均排放水平**处于**国IV**，且其能源结构是以**柴油**为主，**天然气**为辅，另有少量**电动车**。

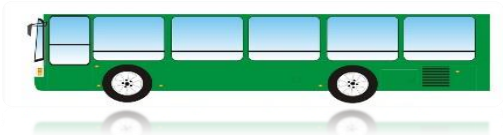
  Average Discharge Level of buses is **CN-IV** for the time being ,most buses fueled by **diesel**, and **gas fueled** buses in the middle, and few **electric powered** buses can be seen.

- 依据国际经验判断，正处于**低排替代期**，主要采用清洁燃料替代技术，并小规模示范新能源车.

  According to experiences from worldwide. **We now are experiencing emission reduction period that characterize getting rid of heavy emission fuels,** new energy fuel is used to replace the conventional fuel, new energy buses come into application in limited areas.

北京地面公交新能源发展路线
Development outlines of new energy buses in BEIJING

2017年底 全市新能源和清洁能源汽车力争达到 **20** 万辆。



65% 新能源公交车辆

50% 纯电动环卫车辆

50% 纯电动邮政车辆

300 辆纯电动旅游客运

25% 燃油总量

5% 污染物

2017年

——《北京市 2013-2017 年清洁空气行动计划》

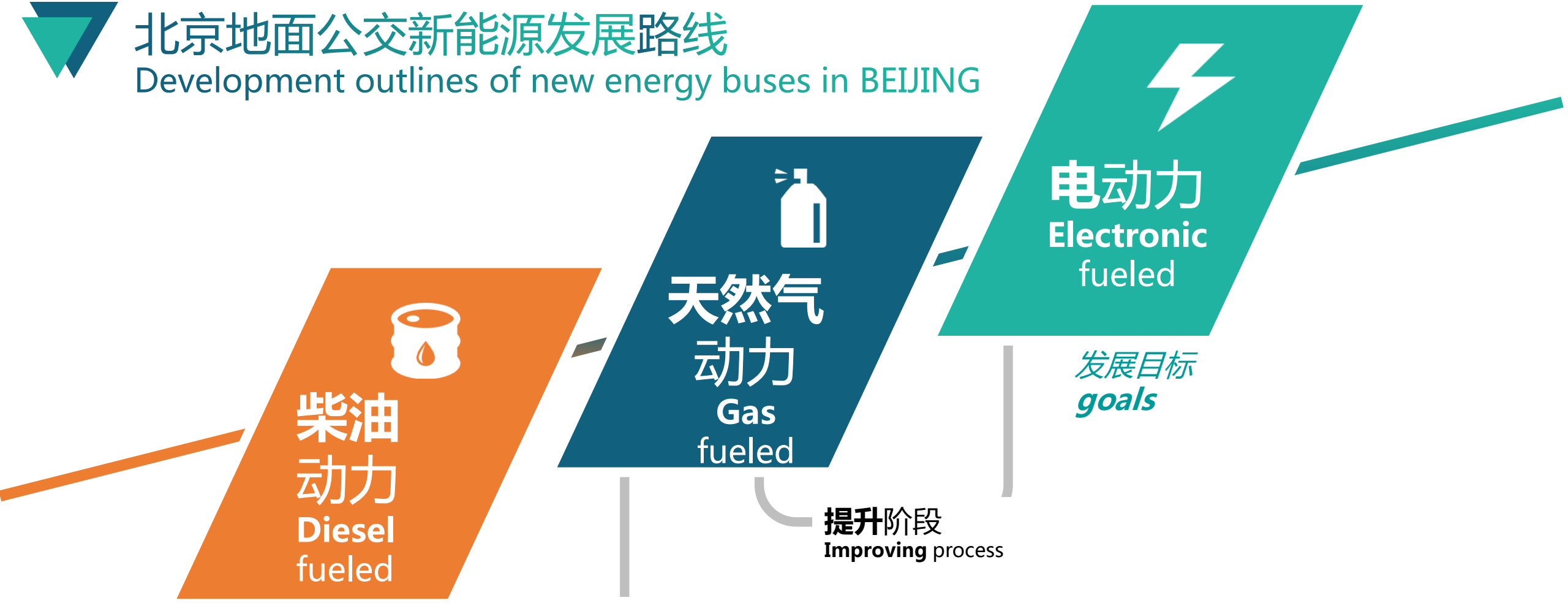
北京地面公交新能源发展路线
Development outlines of new energy buses in BEIJING

车辆分类 buses types	更换为新能源 Updated and fueled by new energy buses		PM2.5(%)	NO_x (%)	CO (%)	CO_2 (%)	HC (%)	实施年份 Application year
国三、国四公交车 CN-III、CN-IV buses	天然气汽车 CNG	国Ⅲ天然气汽车 CN-Ⅲ CNG	-62	-22	-9	-9	63	2017年前 Before 2017
国三、国四公交车 CN-III、CN-IV buses		天然气汽车 环境友好汽车 CNG EEV	-31	-36	-44	-14	186	2017年前 Before 2017
国三、国四公交车 CN-III、CN-IV buses	液化天然气汽车 LNG vehicles		-30	-39	-63	4	-304	2017年前 Before 2017
国三、国四公交车 CN-III、CN-IV buses	柴电混合动力车 Hybrid of Diesel&electronic fueled buses		-	-9	47	-4	-88	2017年前 Before 2017

实现2017年公交行业车辆油耗比2012年减少40%目标

Realize the goal that fuel consumption of buses in 2017 can reduce 40% compared with 2012

北京地面公交新能源发展路线
Development outlines of new energy buses in BEIJING



发展思路如下：
Developing planning:

- 近期：形成**天然气车为主**，柴油及**电驱动车为辅**的能源结构；
  Short period: **gas fueled buses superior to diesel& electric fueled** buses ;
- 中远期：形成以**电驱动为主**的能源结构
  Long period: **buses powered by electric will dominate** the service fleets

北京地面公交新能源发展路线
Development outlines of new energy buses in BEIJING

各个阶段面临 **典型问题 • 探索**
Problems • **Discovery** in every steps

柴油
动力
Diesel
fueled

天然气
动力
Gas
fueled

电动力
Electronic
fueled

运行特性与油耗间
关系如何？
How`s the relationship between
Operation characteristics and **fuel consumption?**

天然气在减排的同时
如何影响**能耗**？
How does **gas** have a influence on
energy consumption while it makes
a contribution to energy conservation?

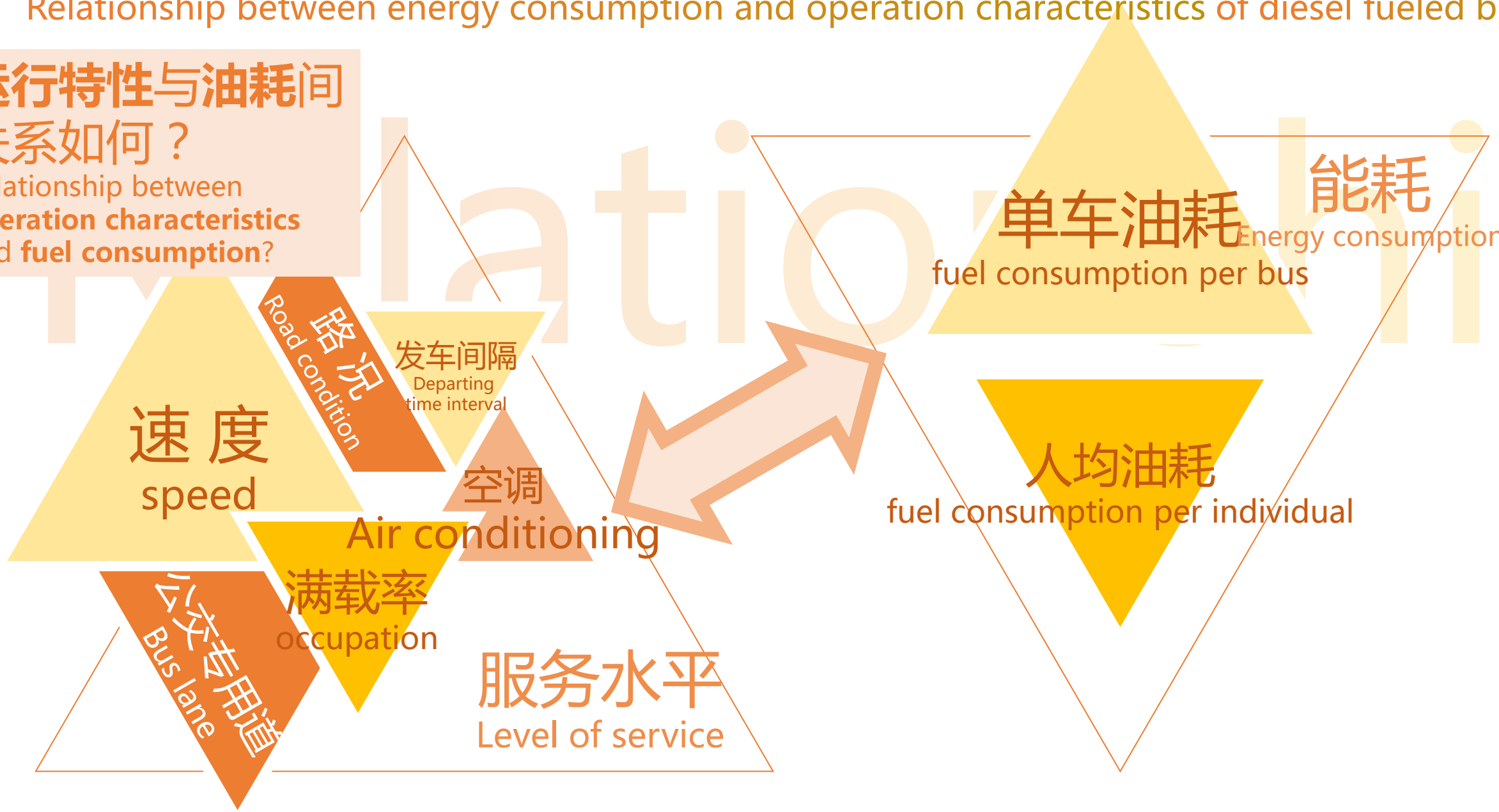
我们
该如何发展**电动公交**？
How to deal with the development
problems of **electric powered buses?**

柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled bus

运行特性与油耗间关系如何？

Relationship between **operation characteristics** and **fuel consumption**?



柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled buses

柴油
动力
Diesel
fueled

(1) 数据来源 Data Sources

1. 北京交通节能减排中心公交能耗监测平台数据

Energy consumption of buses observation platform in Energy conservation and emission reduction center in BEIJING

采样间隔：每秒

Sample intervals: every second

数据内容：线路、车辆ID、时间、总油耗、瞬时油耗、瞬时速度、经纬度等

Data columns: route name、vehicle id、travel time、total fuel consumption、instantaneous fuel consumption、longitude& latitude.

分析数据：12条线路，共109辆次全程逐秒行车能耗数据

Data analyzed:12 routes, energy consumption data of 109 vehicles covering every seconds in the whole trip.

Fuel Consumption LOS

柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled buses

柴油
动力
Diesel
fueled

(1) 数据来源 Data Sources

2. 公交车加油日志数据

Diaries of buses refueling

采样间隔：每日

Sample intervals: every day

数据内容：线路、车辆ID、加油时间、加油日期、加油量等

Data columns：route name、vehicle id、refueling timestamp、volume of refueling.

分析数据：3条线路，51辆车，连续4天共204次加油数据

Data analyzed: 3 routes，51 vehicles covering 204 times refueling records in 4 days.

Fuel Consumption LOS

柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled buses

(1) 数据来源 Data Sources

柴油
动力

3. 北京市市政交通一卡通（IC卡）刷卡数据

IC-card deal records from Beijing Public Transport Group

采样间隔：上、下车刷卡时各生成一条数据

Sample intervals: boarding and alighting records

数据内容：卡ID、刷卡时间、刷卡线路、上/下行方向、刷卡站编号等

Data columns: IC id、deal time、rotes、direction、station code

分析数据：与能耗监测平台数据和公交加油日志数据日期相同的IC卡数据

Data analyzed: IC data during the same time period with Energy consumption of buses observation platform observation data and diaries of buses refueling records.

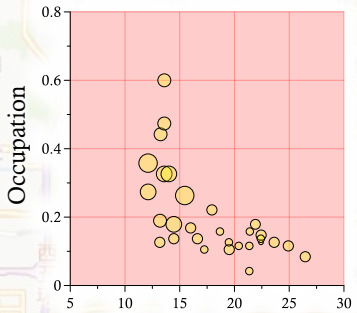
Fuel Consumption LOS

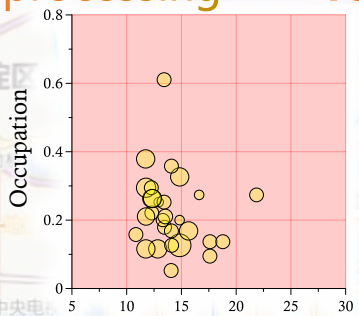
柴油动力公交车能耗与运行特性间关系

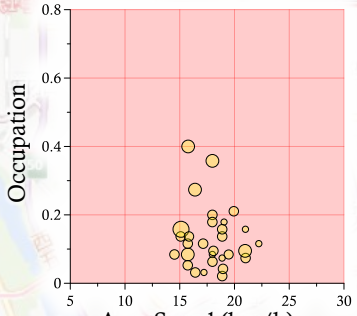
Relationship between energy consumption and operation characteristics of diesel fueled bus

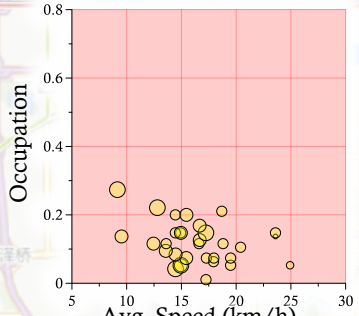
(2) 数据清洗 · 预处理 —— 以673路单机柴油车为例

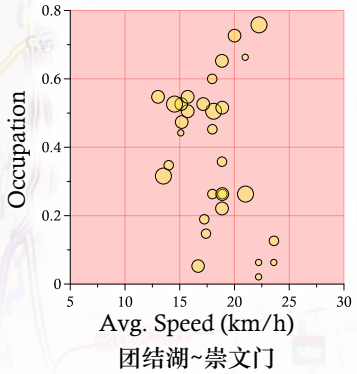
Data filter out · pre-processing ——route 673 diesel bus

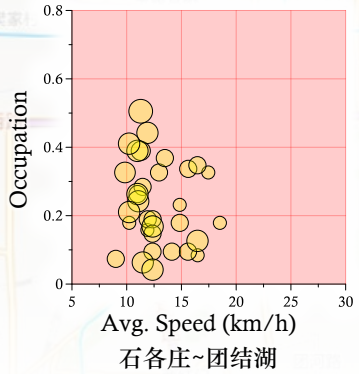


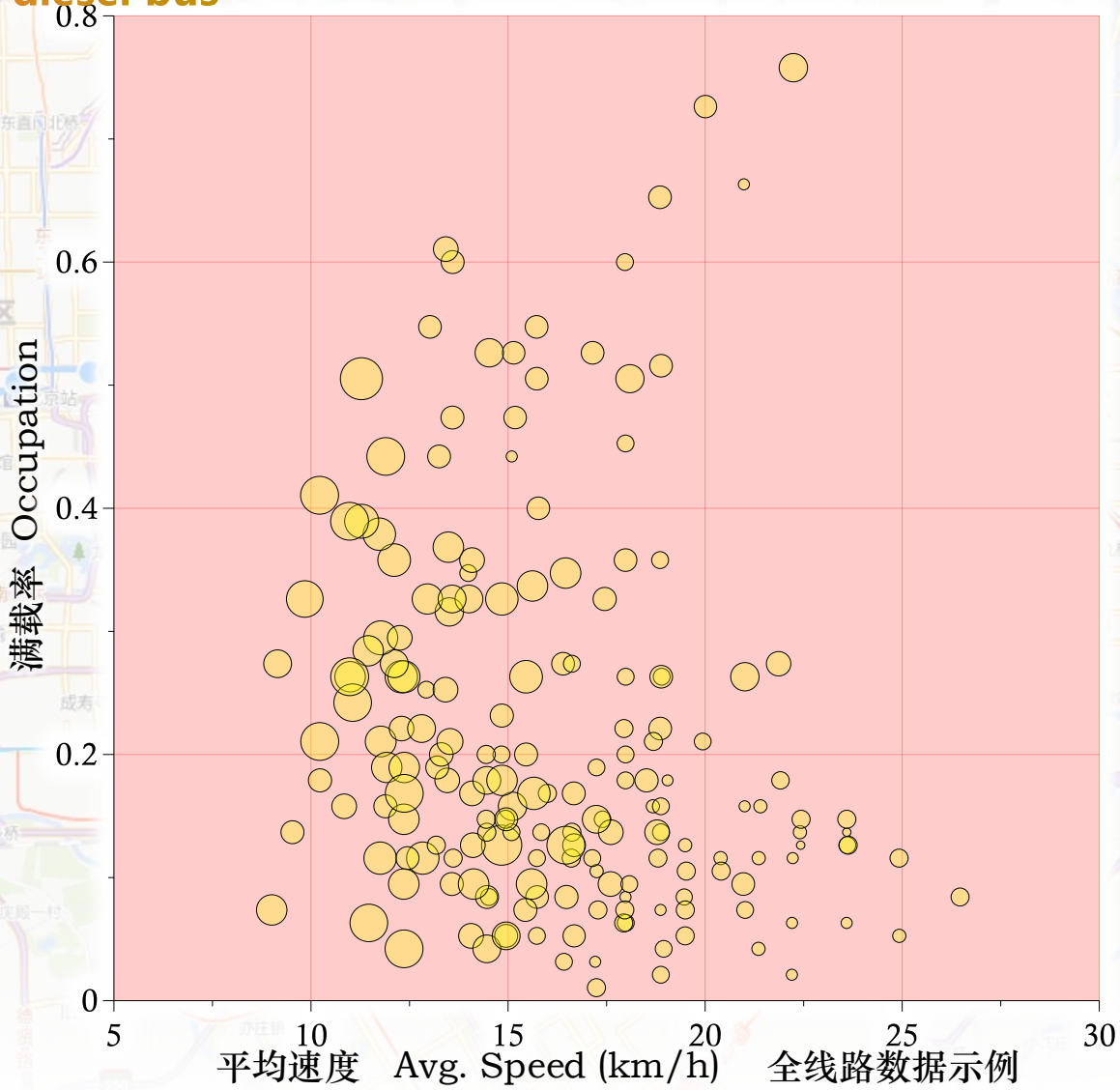










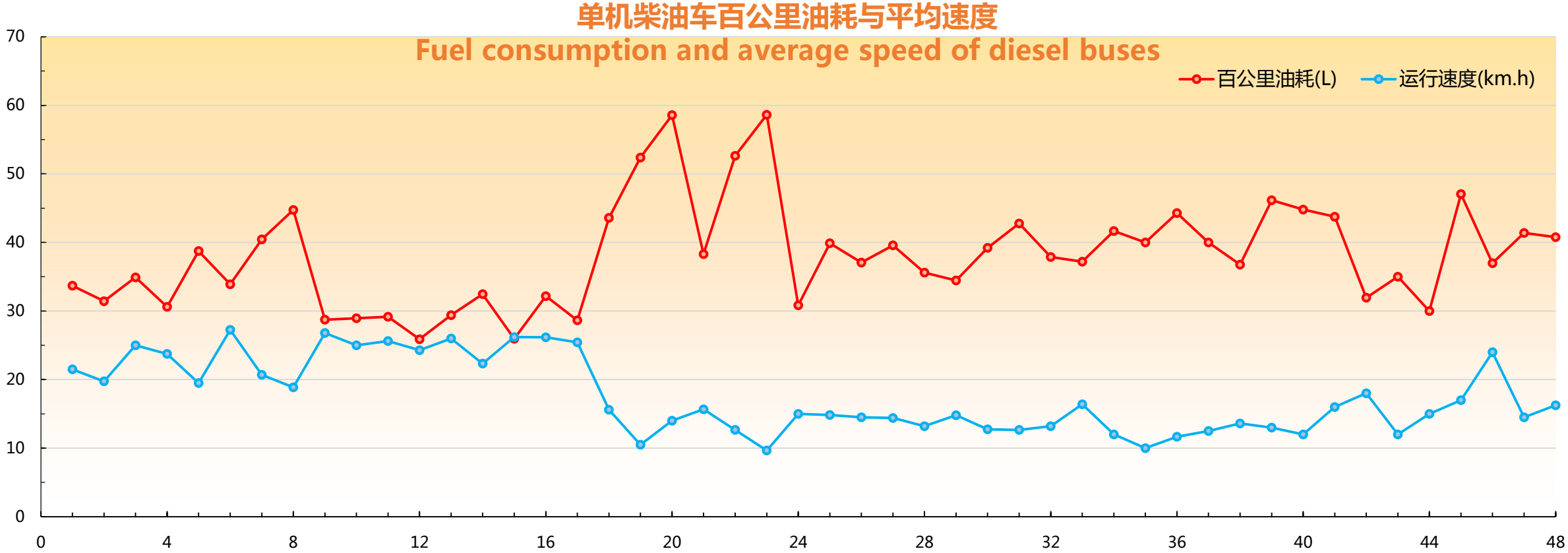


柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled bus

(3) 速度与单车油耗

speed and fuel consumption per bus



- 基于早高峰（8:00AM~9:00AM）间48辆次公交车的能耗与速度数据统计；
  Statistics based on the fuel consumption and speed data come from 48 buses in peak hours(8:00AM~9:00AM)
- **车辆运行速度**（约10~30 km/h区间）**与百公里能耗间呈现了较为明显的负相关关系。**
  There is a significant negative correlation between average speed and fuel consumption.

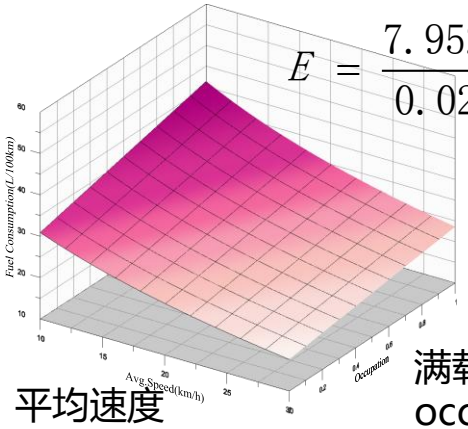
柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled bus

(4) 满载率、车型、公交专用道、速度综合因素与油耗

relationship between factors like occupation、vehicle types、bus lanes、speed and fuel consumption

Fuel consumption per bus

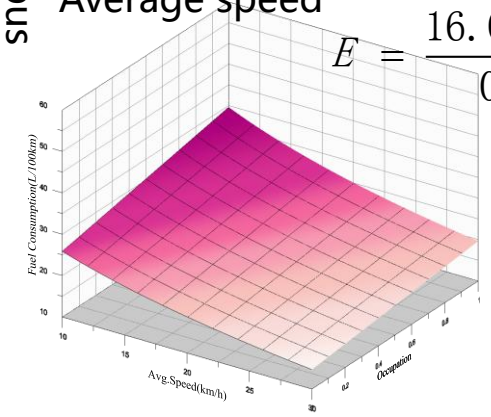


$$E = \frac{7.952Q + 23.504}{0.029V + 0.475}$$

无专用道
Regular lane

满载率
occupation

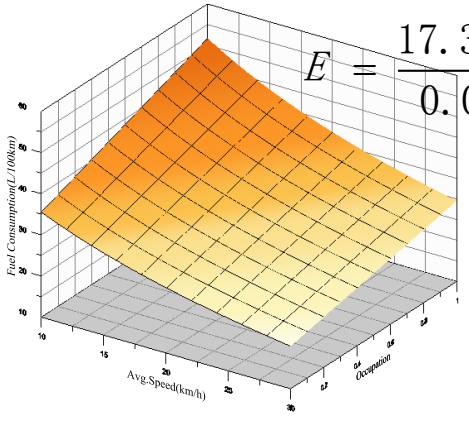
平均速度
Average speed



$$E = \frac{16.0531Q + 47.588}{0.07V + 1.14}$$

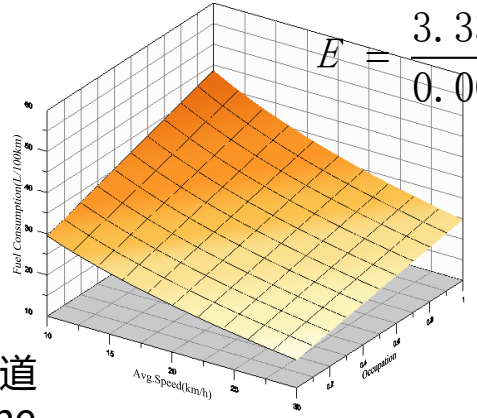
有专用道
Bus lane

单机车
bus



$$E = \frac{17.305Q + 38.07}{0.04V + 0.671}$$

无专用道
Regular lane

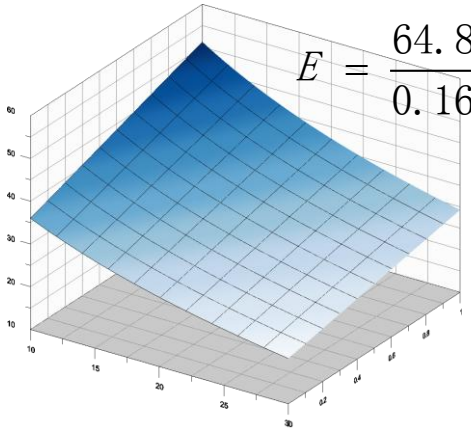


$$E = \frac{3.335Q + 6.962}{0.009V + 0.146}$$

有专用道
Bus lane

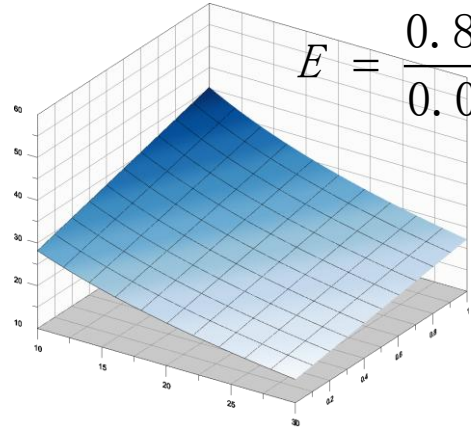
有专用道
Bus lane

双层车
Double deck



$$E = \frac{64.872Q + 154}{0.16V + 2.678}$$

无专用道
Regular lane



$$E = \frac{0.887Q + 2.059}{0.021V + 0.329}$$

有专用道
Bus lane

双机车
Hybrid bus

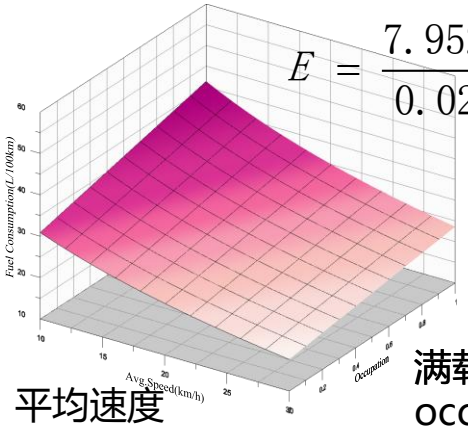
柴油动力公交车能耗与运行特性间关系

Relationship between energy consumption and operation characteristics of diesel fueled bus

(4) 满载率、车型、公交专用道、速度综合因素与油耗

relationship between factors like occupation、vehicle types、bus lanes、speed and fuel consumption

Fuel consumption per bus

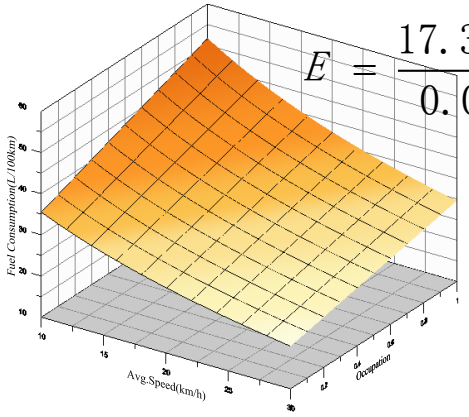


$$E = \frac{7.952Q + 23.504}{0.029V + 0.475}$$

无专用道
Regular lane

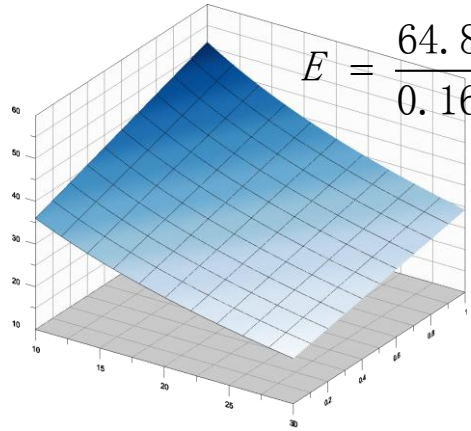
满载率
occupation

平均速度
Average speed



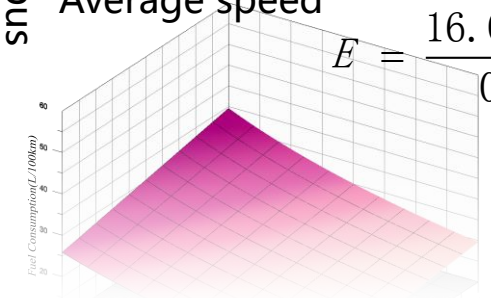
$$E = \frac{17.305Q + 38.07}{0.04V + 0.671}$$

无专用道
Regular lane



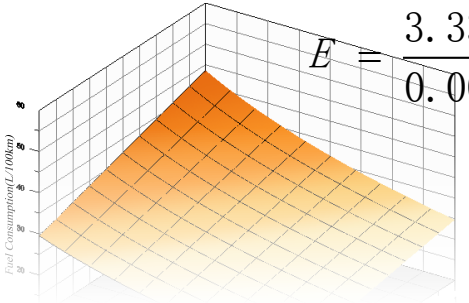
$$E = \frac{64.872Q + 154}{0.16V + 2.678}$$

无专用道
Regular lane



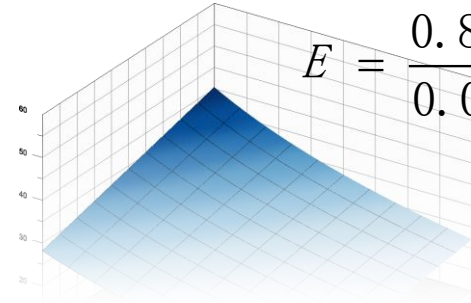
$$E = \frac{16.0531Q + 47.588}{0.07V + 1.14}$$

有专用道
Bus lane



$$E = \frac{3.335Q + 6.962}{0.009V + 0.146}$$

有专用道
Bus lane



$$E = \frac{0.887Q + 2.059}{0.021V + 0.329}$$

有专用道
Bus lane

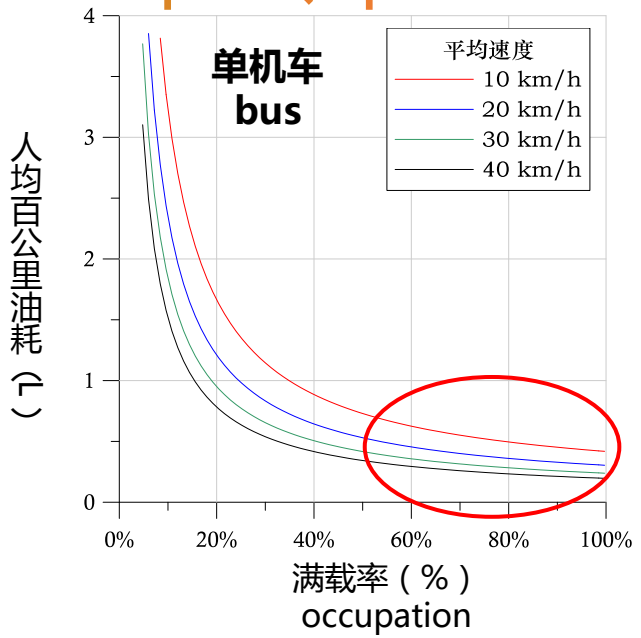
- 满载率越高单车百公里油耗越高；
  The more higher occupation, the more higher fuel consumption;
- **满载率对油耗影响程度随平均车速提高而降低，改善路况、施画专用道以提高速度可以缓解满载率增高带来的油耗上升；**
  Occupation has little influence on fuel consumption as average speed grows. Road condition changes and bus lanes can make a contribution to reduce the fuel consumption caused by higher occupation.
- 相同满载率、速度状态下，油耗排序 **双机车>双层车>单机车**。
  Fuel consumption ranks **double engines>double deck>buses** in the condition that operation buses with same occupation and speed

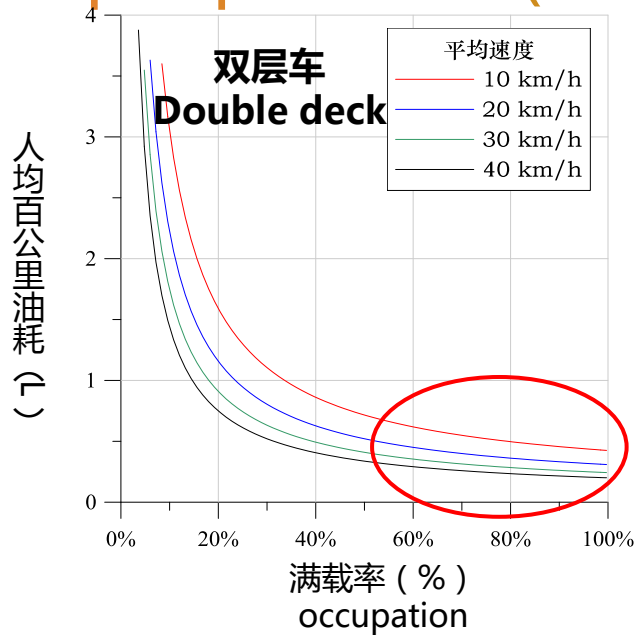
柴油动力公交车能耗与运行特性间关系

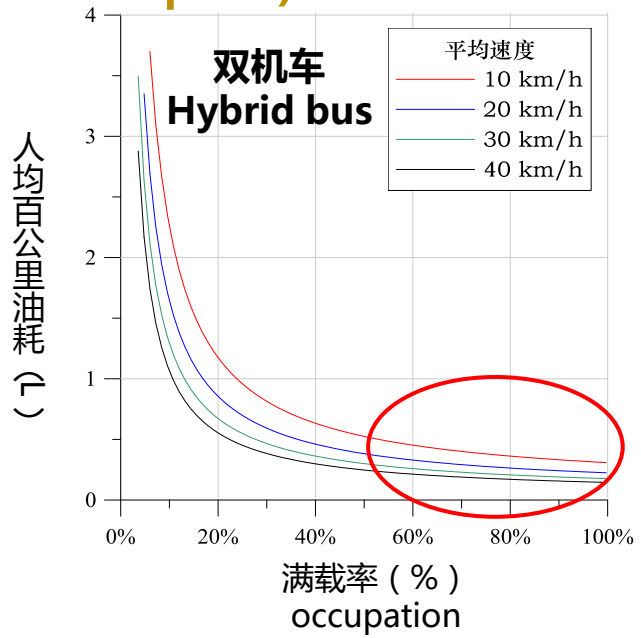
Relationship between energy consumption and operation characteristics of diesel fueled bus

(5) 满载率、速度与人均能耗（总能耗）

Occupation、speed and energy consumption per individual (total energy consumption)







- 假设，有**总量一定的乘客**需乘公交车周转，则**满载率与发车次数成反比，人均油耗与总油耗成正比**；

  Assume that there are **constant passengers** need to interchange, **occupation is negative correlation with departing times while positive correlation can be get between fuel consumption per person and total fuel consumption**.

- **提高车速可以有效降低人均油耗或总油耗。**

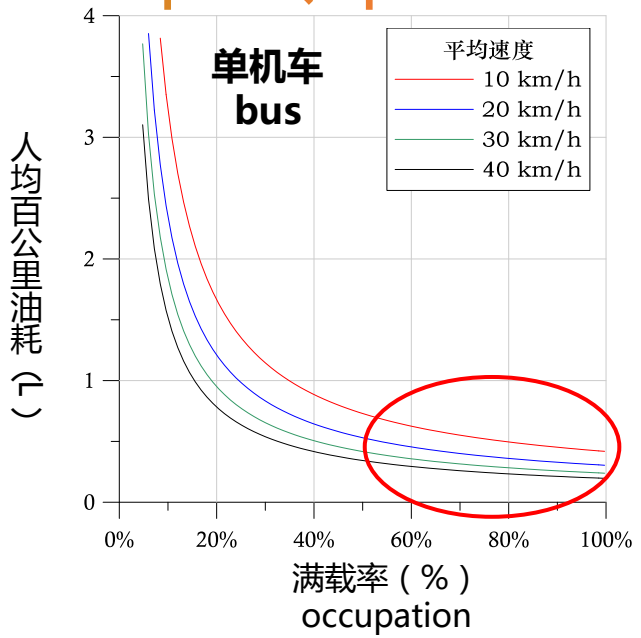
  Fuel consumption per individual or total fuel consumption can be reduced effectively when improving speed.

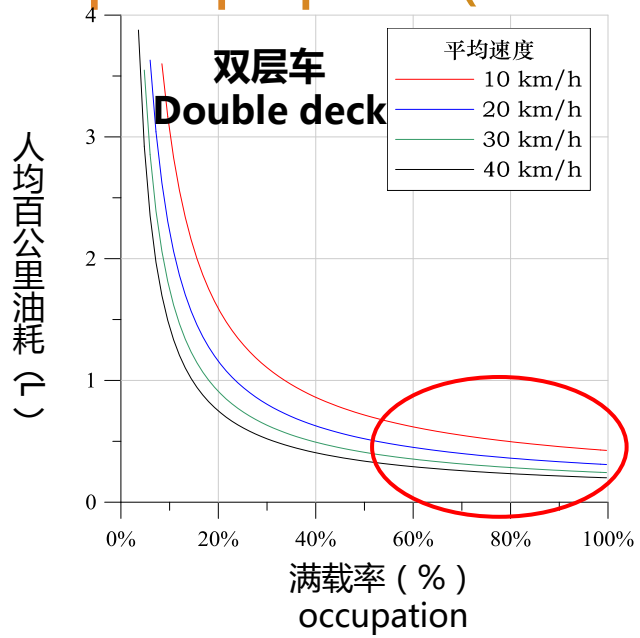
柴油动力公交车能耗与运行特性间关系

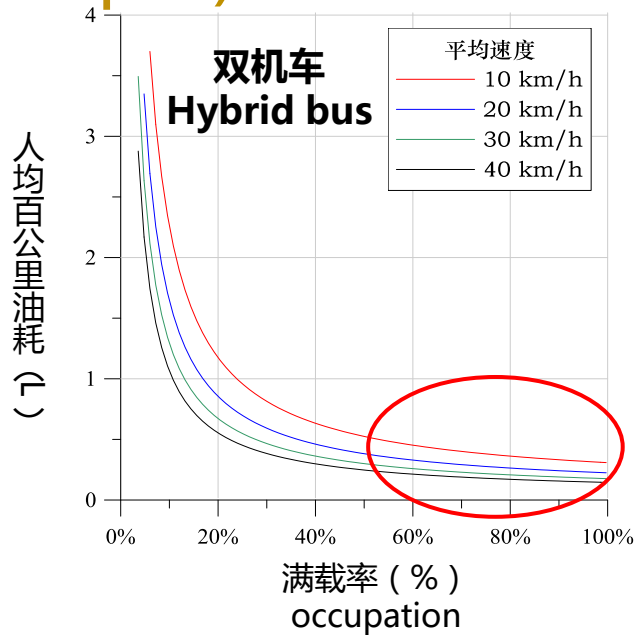
Relationship between energy consumption and operation characteristics of diesel fueled bus

(5) 满载率、速度与人均能耗（总能耗）

Occupation、speed and energy consumption per person (total energy consumption)







- 在满载率过高，**服务水平很差的情况下**，适量增加发车次数以降低满载率可以明显提高服务水平，同时不会造成人均油耗（总油耗）的大量上升，也即**可以牺牲少量的油耗增加以换取服务水平的提升**；

  When bus is operating with higher occupation and **lower service level**, depart buses more frequently in case of reducing the occupation appropriately can improve service level significantly, at the same time, **it can get improvement of service level with little fuel consumption increase.**

- 在满载率、速度、客运总量相同的情况下，**人均油耗（总油耗）双级车>双层车>单机车**；

  Fuel consumption ranks in **hybrid bus>double deck>bus** sequence when the occupation、speed、passenger volume is the same.

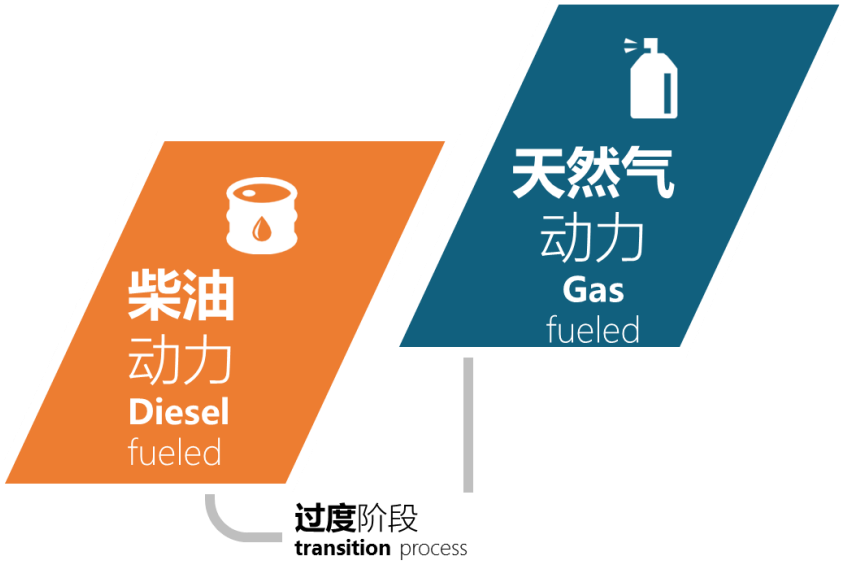
天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

背景·问题

Background •problems

- 近年来，北京市在推广**LNG公交车**的同时也在进行公交**能耗考核**，而按照现有国家标准《综合能耗计算通则(GB-T2589)》将不同类型能源换算为**标准煤**后发现，在完成相同运输工作的情况下，**天然气车的能耗高于柴油车**。这与鼓励使用天然气车的公共交通发展政策和能源类型应用方向相矛盾，一定程度上**抑制**了天然气车的推广应用；



Energy evaluation is conducted while **liquid nature gas buses** are popularized in Beijing in recent years, when different types energy are altered into **TCE** according to the nation standard《General principles for calculation of total production energy consumption(GB-T2589)》, energy consumed by gas fueled buses is higher than diesel fueled buses when finish the same delivery assignment. It is contradict with the public transit policy and energy application direction and it prevent the gas fueled buses from being used.

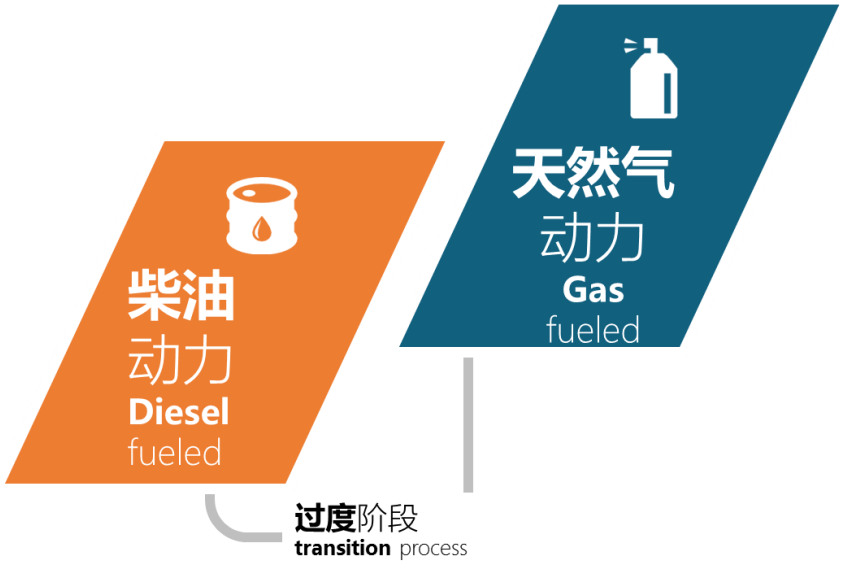
天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

背景·问题

Background •problems

- 在这样的背景下，我们对LNG与柴油车的能耗情况进行细致分析，探索了影响两种燃料能耗差异幅度的**影响因素**，同时得到一种**换算方法**，可以将LNG车辆的能耗转化为完成相同工作的**“当量柴油能耗”**以便于考核，促进天然气动力公交车在过度阶段的推广应用。



Under this background, detail comparison analysis concerning LNG and diesel fueled buses are conducted, exploring **factors** that will influence the level of energy consumption between these two fuels, in order to motive the popularizing of LNG buses in the transition step ,an **alter approach** can be get to **alter** the energy consumption consumed by LNG buses **into** energy consumption consumed by **diesel fueled buses** to see how much diesel does LNG buses consume.

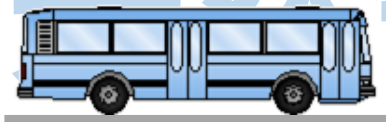
天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

1. 明确目标
goals identified

寻找一种合理的统计计算方法，**为任意天然气车线路提供线路情况相同的柴油汽车能耗量。**
in order to alter the energy consumed by LNG buses into volume consumed by diesel buses, an proper model will be needed for the routes served by LGN buses.

天然气车 LNG Buses



能耗（标煤）
Energy consumption (TCE)

柴油车 DIESEL Fueled Buses

?

能耗（标煤）
Energy consumption (TCE)

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

2. 现有方法
methods available

（1）若某条线路**同时存在**天然气车和柴油车，则采用该线路**柴油车能耗值**与**天然气车能耗值**作比。

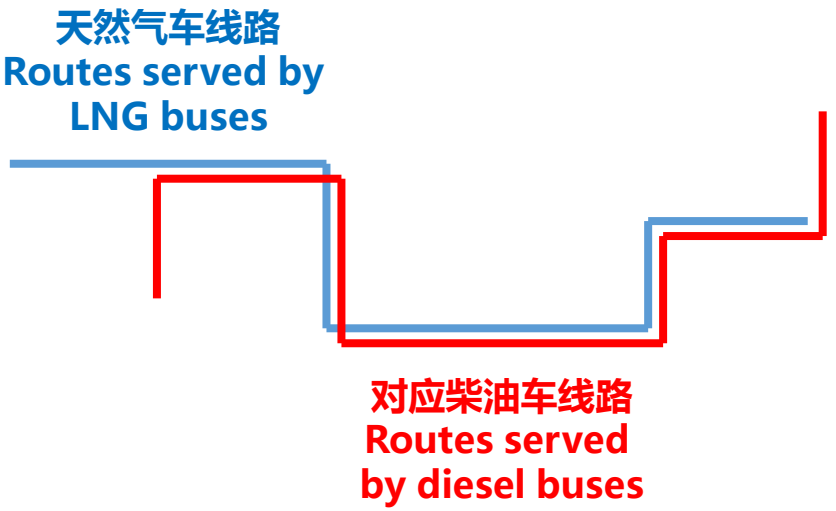
If **both LNG and diesel buses** serve for the route, the ratio between **diesel buses` energy consumption** and **LNG buses`** will be used to evaluate the energy consumption.

【问题】

weakness

随着LNG线路的逐渐增多，符合该条件的线路逐渐减少，从长远发展来看，该方法可行性较差。

In the long period , this method perform poor feasibility since more and more LNG buses provide service ,and limited routes can be evaluated using that method.



可行性较差

Poor feasibility

天然气动力与柴油动力能耗对比分析
Comparison between gas fueled buses and diesel fueled buses

2. 现有方法
methods available

（2）若某条线路**只有天然气车运行**，则选用该线路**历史上使用柴油车**时的能耗值与**现年天然气车**的能耗值作比。

If **only LNG buses** serve for the route, then diesel buses` energy consumption **in the past** will be used to compared with LNG buses energy consumption **at present**.

【问题】

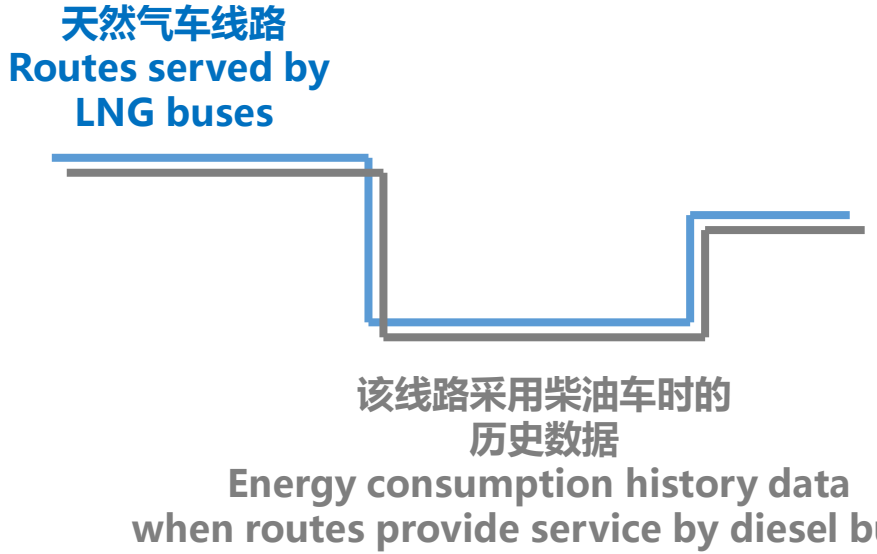
weakness

① 公交车线路随时间推移进行调整，以前的柴油车线路与现年的天然气车线路存在差异；

Routes are changing as time goes by, there is a difference between diesel buses, served in the past , and LNG buses served at present.

② 柴油车能耗情况与车龄、排放标准、车型关系较大，现年北京市柴油车能耗整体水平与以前存在差异。

The consumption of diesel buses has a significant relationship with the factors like buses age、discharge standard, buses type, energy consumption differences does exist when buses compared with buses served in the past.



时效性较差

Poor timeliness

③ 交通拥堵水平存在波动，交通运行状态随时间的变化带来的能耗水平变化也会影响历史数据的时效性。

Traffic congestion level fluctuates a lot, energy consumption fluctuates as the traffic operation status changes, resulting in poor timeliness.

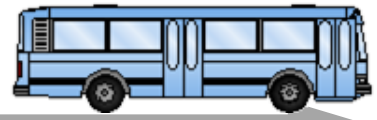
天然气动力与柴油动力能耗对比分析
Comparison between gas fueled buses and diesel fueled buses

3. 解决方法
solutions

提出一种以**大量现年公交车能耗及运行数据为基础**的，以**工况分类**为核心思想的，能够为任意天然气车线路提供相同线路条件下的柴油车的**当量能耗值**，进而完成**核定折算系数**的计算。

To overcome the weakness of the method came up before, a new calculation model, **based on the massive buses` , which served at present , energy consumption and condition classification** will be used to calculate the ratio. This solutions can alter the energy consumed by LNG buses into volume consumed by diesel buses .

天然气车 LNG Buses



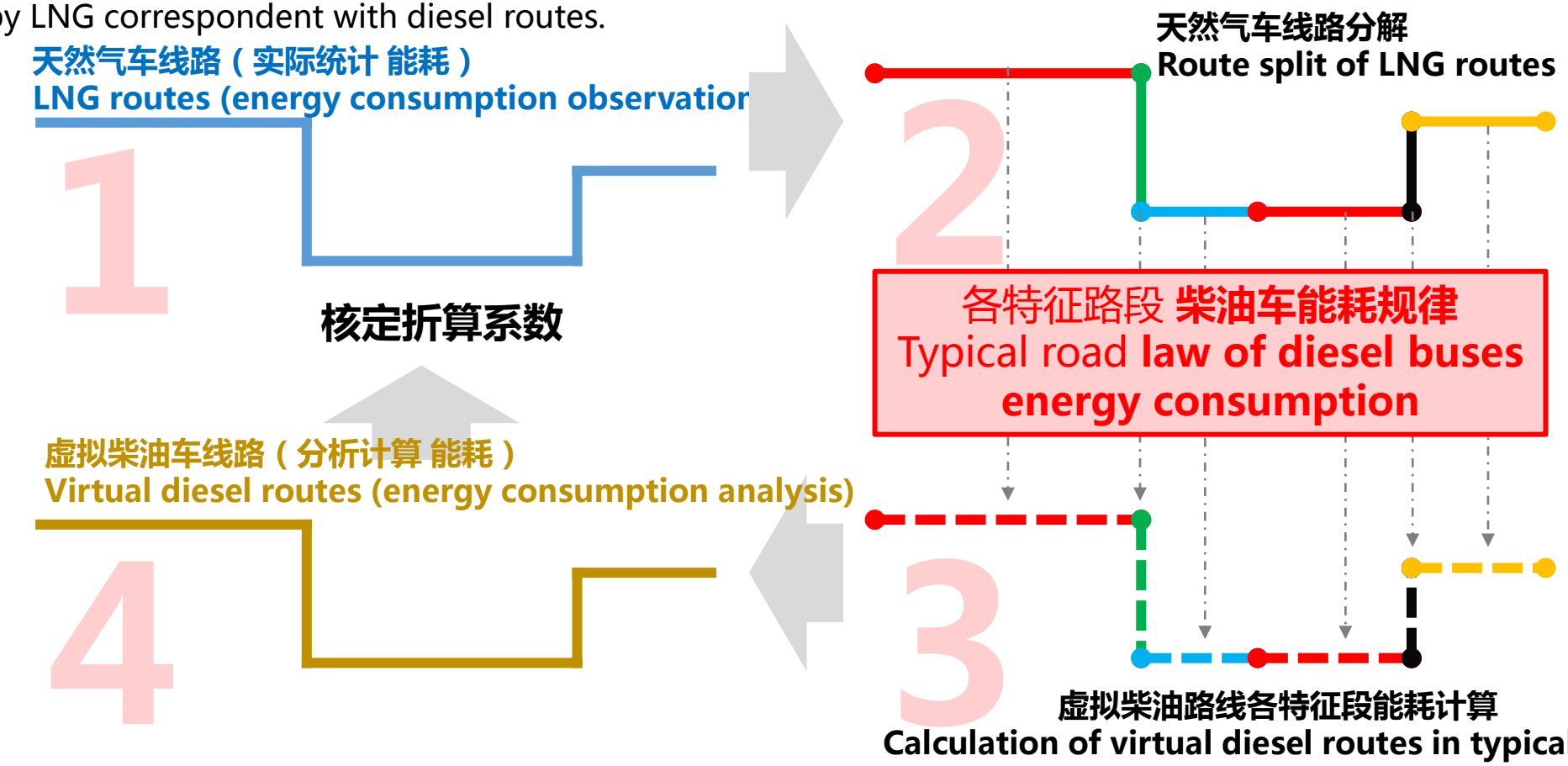
柴油车 DIESEL Fueled Buses √

天然气动力与柴油动力能耗对比分析
Comparison between gas fueled buses and diesel fueled buses

4. 实现方法
realization methods

构造与**任意一条天然气**车路线相同的**虚拟柴油汽车线路**，解决与天然气车线路对应的柴油车线路的问题。

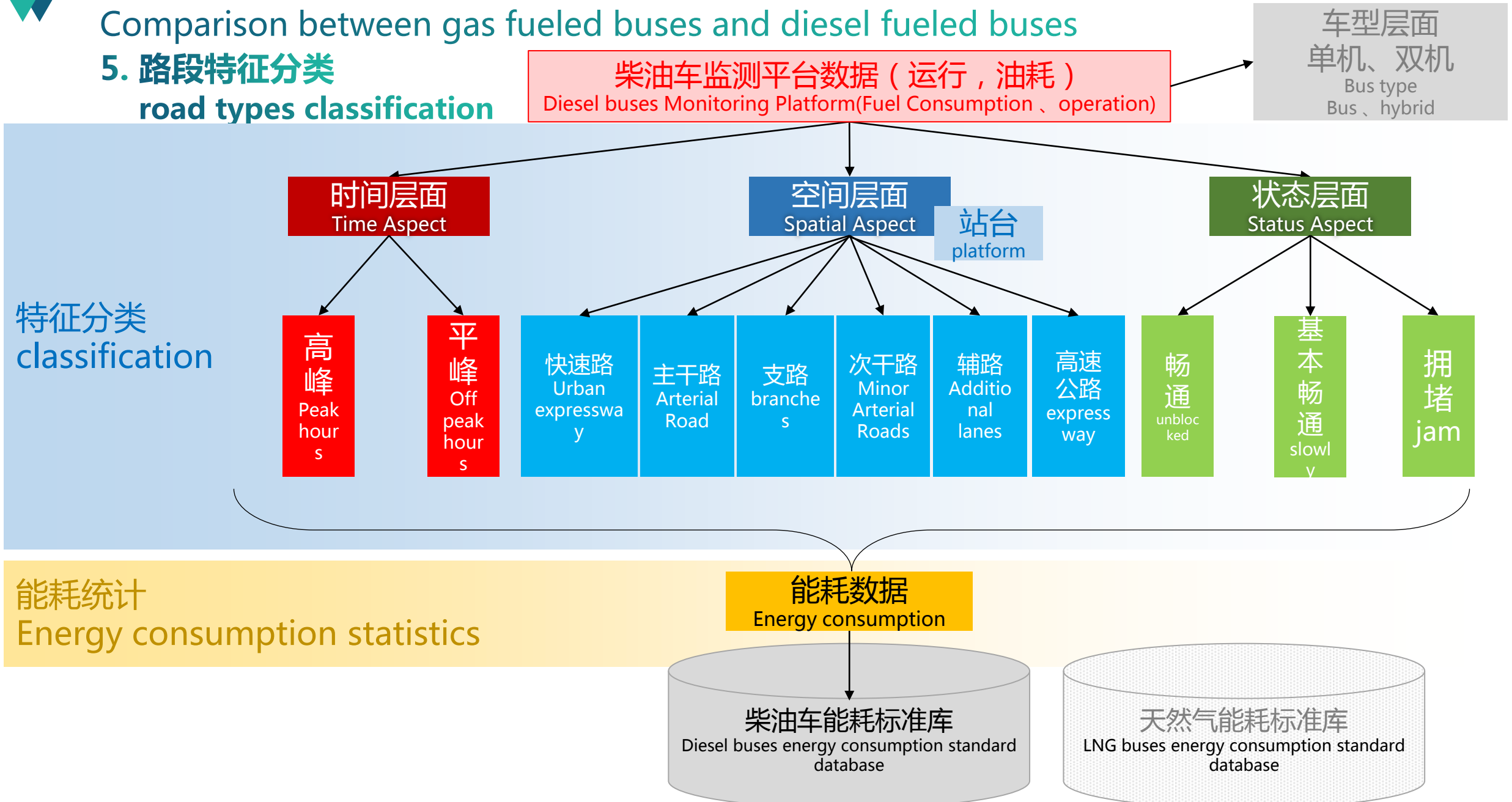
virtual routes served by diesel buses will be established according to the routes served by LNG buses, in that case routes served by LNG correspondent with diesel routes.



天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

5. 路段特征分类
road types classification



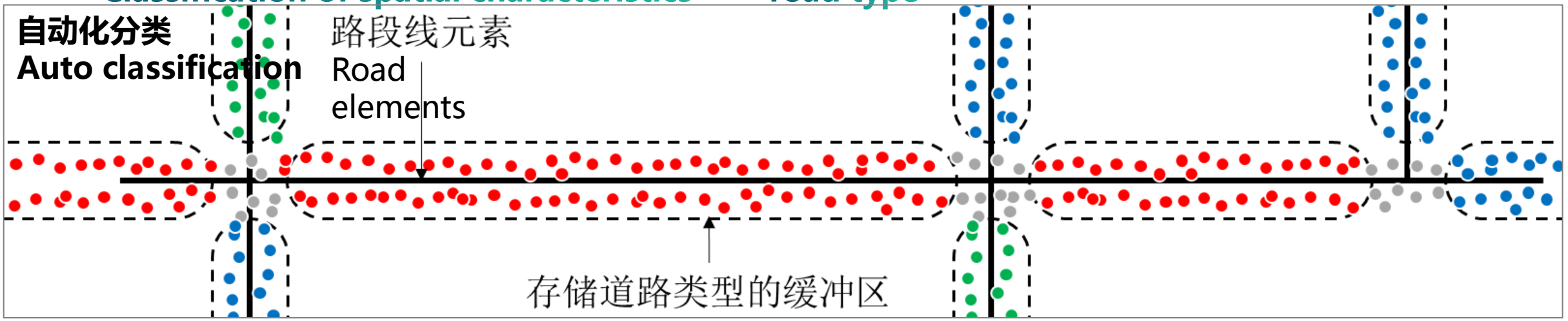
天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

6. 空间特征分类——以道路等级分类为例

Classification of spatial characteristics—— road type

自动化分类
Auto classification



分类结果
Classification results

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

7. 时间、状态特征分类

Time、status classification

OBJECTID	数据ID
Shape	图形
time_	时间（日期、时分秒）
selfID	车辆自编码
latNew	纬度
longtNew	精度
OriMlg	原始数据里程
OriOilTotl	原始数据油耗总量
OriInstOil	原始数据瞬时油耗
Time_Day	日期
Time_hh	时
Time_mm	分
Time_ss	秒
AM_PM	上下午
Time_sDfrc	相邻数据时间差
Peak_hour	高平峰分类
RoadType	道路分类
InStop40	是否在车站内部
Totl_Inst_Oil	瞬时油耗
Spd_dbg1	瞬时速度

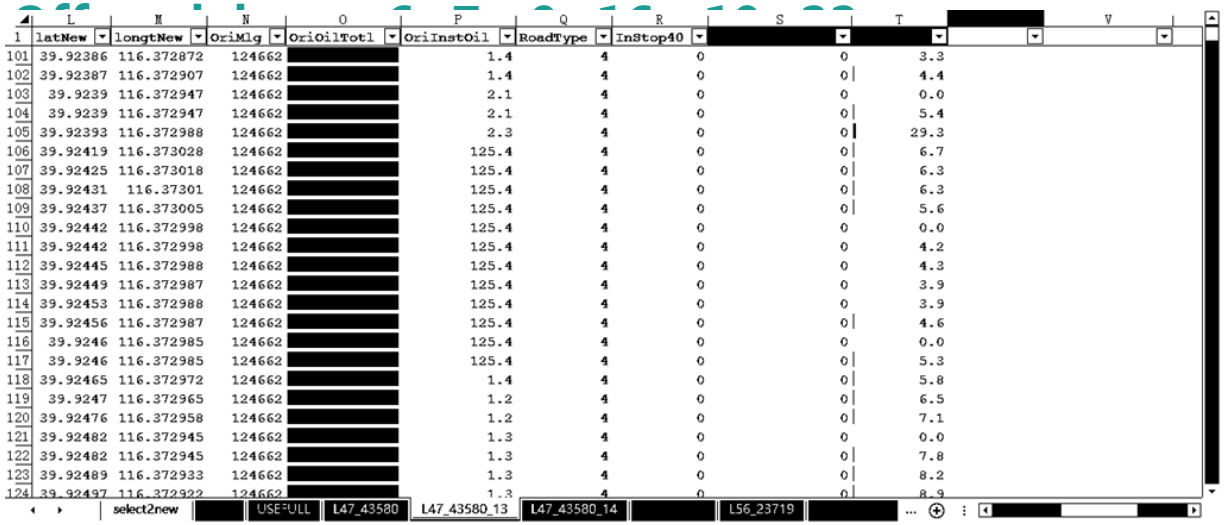
时间段分为高峰、平峰时段。

Time windows: peak hours and off peak hours

高峰7~9，16~19

Peak hours 7~9，16~19

平峰6~7，9~16，19~22



	L	M	N	O	P	Q	R	S	T	V
1	latNew	longtNew	OriMlg	OriOilTotl	OriInstOil	RoadType	InStop40			
101	39.92386	116.372872	124662		1.4	4	0	0	3.3	
102	39.92387	116.372907	124662		1.4	4	0	0	4.4	
103	39.9239	116.372947	124662		2.1	4	0	0	0.0	
104	39.9239	116.372947	124662		2.1	4	0	0	5.4	
105	39.92393	116.372988	124662		2.3	4	0	0	29.3	
106	39.92419	116.373028	124662		125.4	4	0	0	6.7	
107	39.92425	116.373018	124662		125.4	4	0	0	6.3	
108	39.92431	116.37301	124662		125.4	4	0	0	6.3	
109	39.92437	116.373005	124662		125.4	4	0	0	5.6	
110	39.92442	116.372998	124662		125.4	4	0	0	0.0	
111	39.92442	116.372998	124662		125.4	4	0	0	4.2	
112	39.92445	116.372988	124662		125.4	4	0	0	4.3	
113	39.92449	116.372987	124662		125.4	4	0	0	3.9	
114	39.92453	116.372988	124662		125.4	4	0	0	3.9	
115	39.92456	116.372987	124662		125.4	4	0	0	4.6	
116	39.9246	116.372985	124662		125.4	4	0	0	0.0	
117	39.9246	116.372985	124662		125.4	4	0	0	5.3	
118	39.92465	116.372972	124662		1.4	4	0	0	5.8	
119	39.9247	116.372965	124662		1.2	4	0	0	6.5	
120	39.92476	116.372958	124662		1.2	4	0	0	7.1	
121	39.92482	116.372945	124662		1.3	4	0	0	0.0	
122	39.92482	116.372945	124662		1.3	4	0	0	7.8	
123	39.92489	116.372933	124662		1.3	4	0	0	8.2	
124	39.92497	116.372922	124662		1.3	4	0	0	8.9	

select2new | USEFULL | L47_43580 | L47_43580_13 | L47_43580_14 | L56_23719

天然气动力与柴油动力能耗对比分析

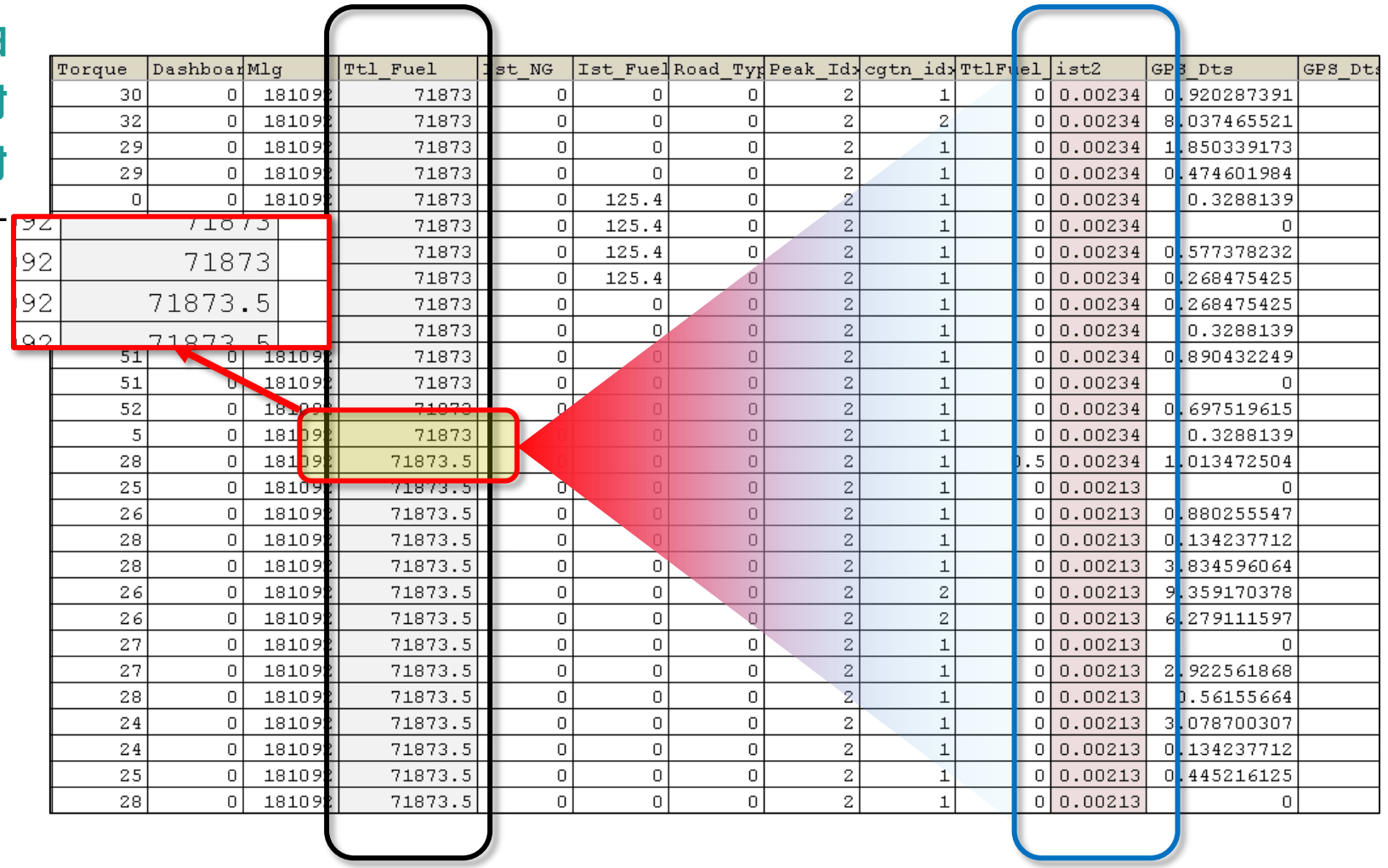
Comparison between gas fueled buses and diesel fueled buses

8. 油耗校准

fuel consumption calibration

为了校核瞬时油耗数据，将**累计油耗数据**相邻做差，并**平均分布到差值对应的时段内**，得到**基于累计油耗的瞬时油耗**用于校核。将瞬时油耗进行累计计算，用于校核累计油耗数据。

In order to calibrate instantaneous fuel consumption, differences between adjacent **cumulative fuel consumption** is calculated, then differences are **even distributed into the correspondent time windows**. So instantaneous fuel consumption can be obtained **based on the cumulative fuel consumption.** cumulate the instantaneous fuel consumption to calibrate the cumulative fuel consumption.



Torque	Dashboar	Mlg	Ttl_Fuel	Ist_NG	Ist_Fuel	Road_Typ	Peak_Idx	cgtn_idx	TtlFuel	ist2	GPS_Dts	GPS_Dts
30	0	181092	71873	0	0	0	2	1	0	0.00234	0.920287391	
32	0	181092	71873	0	0	0	2	2	0	0.00234	8.037465521	
29	0	181092	71873	0	0	0	2	1	0	0.00234	1.850339173	
29	0	181092	71873	0	0	0	2	1	0	0.00234	0.474601984	
0	0	181092	71873	0	125.4	0	2	1	0	0.00234	0.3288139	
92	71873		71873	0	125.4	0	2	1	0	0.00234	0	
92	71873		71873	0	125.4	0	2	1	0	0.00234	0.577378232	
92	71873.5		71873	0	125.4	0	2	1	0	0.00234	0.268475425	
			71873	0	0	0	2	1	0	0.00234	0.268475425	
			71873	0	0	0	2	1	0	0.00234	0.3288139	
51	0	181092	71873	0	0	0	2	1	0	0.00234	0.890432249	
51	0	181092	71873	0	0	0	2	1	0	0.00234	0	
52	0	181092	71873	0	0	0	2	1	0	0.00234	0.697519615	
5	0	181092	71873	0	0	0	2	1	0	0.00234	0.3288139	
28	0	181092	71873.5	0	0	0	2	1	0.5	0.00234	1.013472504	
25	0	181092	71873.5	0	0	0	2	1	0	0.00213	0	
26	0	181092	71873.5	0	0	0	2	1	0	0.00213	0.880255547	
28	0	181092	71873.5	0	0	0	2	1	0	0.00213	0.134237712	
28	0	181092	71873.5	0	0	0	2	1	0	0.00213	3.834596064	
26	0	181092	71873.5	0	0	0	2	2	0	0.00213	9.359170378	
26	0	181092	71873.5	0	0	0	2	2	0	0.00213	6.279111597	
27	0	181092	71873.5	0	0	0	2	1	0	0.00213	0	
27	0	181092	71873.5	0	0	0	2	1	0	0.00213	2.922561868	
28	0	181092	71873.5	0	0	0	2	1	0	0.00213	0.56155664	
24	0	181092	71873.5	0	0	0	2	1	0	0.00213	3.078700307	
24	0	181092	71873.5	0	0	0	2	1	0	0.00213	0.134237712	
25	0	181092	71873.5	0	0	0	2	1	0	0.00213	0.445216125	
28	0	181092	71873.5	0	0	0	2	1	0	0.00213	0	

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

9. 归类统计
clustering statistics

- 上述工作完成了对各个数据点时间层面、空间层面、状态层面的分类，并完成了各个点对应瞬时油耗的计算。

  what we did is data classification by time、spatial and status aspect, and instantaneous fuel consumption is also calculated.

- 对各个组合分类的百公里油耗进行统计分析，得到各路线的柴油车、天然气车能耗特征值。

  MPG statistics analysis is conducted group by EVERY TYPE. diesel、LNG buses for every route energy consumption can be obtained.

- **扩大样本量，即得到全局的，具有一般性的柴油车能耗标准库、天然气车能耗标准库。**

  We can obtain the diesel、LNG BUESE fuel consumption database after expanding sample size.

右图为单车能耗计算结果

Figure on the right is the result of energy consumption of a bus

Peak_hours		快速路	主干路	次干路	支路	辅路	其他	未分类
1	RoadType	1	2	3	4	5	6	0
	Mileage(Stop)	5.1	15.3	3.1	4.5	3.5	1.3	3.7
	Mileage(NoStop)	4.9	12.1	2.3	3.1	2.7	0.6	3.6
	OilTotl	0.0	1.0	1.0	1.0	2.0	0.0	0.0
	Oil/100Km(Stop)	0.0	6.6	32.5	22.1	57.8	0.0	0.0
	Oil/100Km(NoStop)	0.0	8.2	44.1	32.7	74.1	0.0	0.0
	Time(stop)	645	4330	1325	1321	957	2665	890
	Time(Nostop)	515	3179	1050	663	590	2300	840
	Speed(Stop)	28.3	12.7	8.4	12.3	13.0	1.8	14.8
	Speed(NoStop)	33.9	13.7	7.8	16.6	16.5	0.9	15.4

Other_hours		快速路	主干路	次干路	支路	辅路	其他	未分类
0	RoadType	1	2	3	4	5	6	0
	Mileage(Stop)	3.8	29.4	11.8	8.4	2.2	1.3	3.3
	Mileage(NoStop)	2.7	22.9	8.3	5.5	1.8	0.9	3.2
	OilTotl	0.0	8.0	4.0	3.0	1.0	3.0	1.0
	Oil/100Km(Stop)	0.0	27.2	33.8	35.7	44.7	238.1	30.5
	Oil/100Km(NoStop)	0.0	34.9	48.0	54.7	54.8	329.9	31.0
	Time(stop)	505	6459	3531	2449	527	6534	1048
	Time(Nostop)	436	4716	2605	1388	408	6417	1030
	Speed(Stop)	27.0	16.4	12.1	12.3	15.3	0.7	11.3
	Speed(NoStop)	22.6	17.5	11.5	14.2	16.1	0.5	11.3

non-Peak_hours		快速路	主干路	次干路	支路	辅路	其他	未分类
2	RoadType	1	2	3	4	5	6	0
	Mileage(Stop)	1.3	3.7	1.7	1.2	1.1	0.0	0.5
	Mileage(NoStop)	1.3	2.9	1.2	0.9	0.8	0.0	0.5
	OilTotl	0.0	1.0	1.0	1.0	0.0	0.0	0.0
	Oil/100Km(Stop)	0.0	26.8	58.6	82.7	0.0	0.0	0.0
	Oil/100Km(NoStop)	0.0	34.8	85.4	111.6	0.0	0.0	0.0
	Time(stop)	99	745	505	371	212	11	146
	Time(Nostop)	94	505	344	279	123	1	144
	Speed(Stop)	48.1	18.0	12.2	11.7	17.8	15.1	12.9
	Speed(NoStop)	48.6	20.5	12.2	11.6	23.1	22.0	12.9

All_Day		快速路	主干路	次干路	支路	辅路	其他	未分类
	RoadType	1	2	3	4	5	6	0
	Mileage(Stop)	10.2	48.4	16.6	14.1	6.7	2.6	7.5
	Mileage(NoStop)	8.9	37.9	11.8	9.4	5.3	1.5	7.3
	OilTotl	0.0	10.0	6.0	5.0	3.0	3.0	1.0
	Oil/100Km(Stop)	0.0	20.7	36.1	35.4	44.5	115.2	13.4
	Oil/100Km(NoStop)	0.0	26.4	51.0	53.0	56.5	199.9	13.6
	Time(stop)	1249	11534	5361	4141	1696	9210	2084
	Time(Nostop)	1045	8400	3999	2330	1121	8718	2014
	Speed(Stop)	29.3	15.1	11.2	12.3	14.3	1.0	12.9
	Speed(NoStop)	30.5	16.2	10.6	14.6	17.1	0.6	13.1

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

10. 标准库建立

database of standard establishment

柴油车标准库

standard database of diesel fueled buses

分时段

Different Time windows

分道路类型

Different road types

分交通状态

Different traffic conditions

百公里能耗

Mile per gallon

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	30.9	476.8	31.8	0.0	139.5
Fuel	6.6	209.9	11.2	0.0	50.0
Fuel/100	21.2	45.0	35.1	0.0	35.9
Speed	29.2	14.6	19.9	0.0	14.5
All_Fuel	40.9				15.5
kgce	26.9	55.8	44.5	0.0	45.5
	51.9				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	120.4	1225.3	97.6	0.0	347.8
Fuel	21.5	547.1	40.8	0.0	119.7
Fuel/100	17.8	42.1	33.4	0.0	33.1
Speed	39.8	14.8	16.0	0.0	18.2
All_Fuel	40.7				17.2
kgce	22.6	56.6	53.0	0.0	43.6
	51.6				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	3.0	85.4	3.8	0.0	28.0
Fuel	2.3	134.0	5.7	0.0	32.3
Fuel/100	153.2	156.9	149.9	0.0	115.3
Speed	6.8	4.0	4.6	0.0	4.7
All_Fuel	144.9				4.3
kgce	94.2	199.0	190.1	0.0	146.2
	183.8				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	2.1	209.2	16.3	0.0	50.3
Fuel	3.2	345.5	24.8	0.0	66.4
Fuel/100	150.4	147.9	140.3	0.0	108.4
Speed	6.7	3.9	4.0	0.0	4.7
All_Fuel	158.3				4.1
kgce	190.8	209.4	193.5	0.0	167.4
	200.8				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	4.3	269.6	15.5	0.0	78.0
Fuel	0.8	58.4	3.5	0.0	13.9
Fuel/100	23.5	21.7	22.4	0.0	17.8
Speed	32.6	30.2	31.0	0.0	30.0
All_Fuel	20.8				30.2
kgce	22.7	27.5	28.4	0.0	22.6
	26.4				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	16.1	646.9	48.9	0.0	193.9
Fuel	3.3	145.8	11.0	0.0	39.7
Fuel/100	20.4	22.5	22.6	0.0	17.3
Speed	34.7	30.1	31.0	0.0	30.3
All_Fuel	22.1				30.3
kgce	25.9	28.6	28.7	0.0	25.9
	28.0				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	23.6	121.7	12.5	0.0	33.4
Fuel	3.5	17.5	2.0	0.0	3.8
Fuel/100	15.0	15.9	16.4	0.0	14.4
Speed	48.5	47.0	45.4	0.0	46.9
All_Fuel	14.1				47.1
kgce	19.0	18.2	20.8	0.0	14.4
	17.8				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	102.1	369.2	32.4	0.0	103.6
Fuel	15.0	55.8	4.9	0.0	13.6
Fuel/100	14.7	15.1	15.2	0.0	13.1
Speed	47.5	46.7	45.9	0.0	46.4
All_Fuel	14.7				46.8
kgce	18.6	19.2	19.3	0.0	16.7
	18.7				

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

10. 标准库建立

database of standard establishment

LNG车标准库

standard database of diesel fueled buses

分时段

Different Time windows

分道路类型

Different road types

分交通状态

Different traffic conditions

百公里能耗

Mile per gallon

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	87.7	678.9	190.4	33.5	152.9
Fuel	20.7	304.6	89.3	12.8	54.4
Fuel/100	23.6	44.9	46.9	38.3	35.6
Speed	23.6	15.8	15.1	17.0	18.4
All_Fuel	42.1				18.0
kgce	43.3	82.3	86.1	70.2	65.3
	77.3				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	344.2	2416.5	751.1	163.9	476.1
Fuel	87.8	917.2	271.2	64.2	146.0
Fuel/100	25.5	38.0	36.1	39.2	30.7
Speed	25.0	18.0	18.7	18.5	20.9
All_Fuel	35.8				20.2
kgce	46.8	69.7	66.3	71.9	56.3
	65.7				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	14.5	118.8	43.4	8.3	26.0
Fuel	11.5	197.4	56.7	7.6	30.9
Fuel/100	79.3	166.1	130.4	92.0	119.0
Speed	7.8	4.2	5.2	7.3	5.4
All_Fuel	144.1				6.0
kgce	145.6	304.9	239.4	168.9	218.4
	264.5				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	53.9	349.2	121.8	29.8	55.2
Fuel	47.2	518.9	138.5	32.6	74.4
Fuel/100	87.6	148.6	113.7	109.4	134.8
Speed	8.3	4.5	5.5	6.5	5.0
All_Fuel	133.1				6.0
kgce	160.8	272.8	208.7	200.8	247.4
	244.3				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	30.3	371.4	100.1	20.8	80.5
Fuel	4.9	77.7	25.4	4.7	16.5
Fuel/100	16.1	20.9	25.4	22.8	20.5
Speed	31.4	31.0	29.7	27.8	30.4
All_Fuel	21.4				30.0
kgce	29.5	38.4	46.6	41.8	37.7
	39.3				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	130.1	1289.6	399.0	109.1	258.8
Fuel	21.3	279.0	89.3	26.7	49.0
Fuel/100	16.3	21.6	22.4	24.5	18.9
Speed	32.0	31.2	30.0	28.7	31.5
All_Fuel	21.3				30.7
kgce	30.0	39.7	41.1	44.9	34.7
	39.1				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	42.9	188.6	46.9	4.5	46.5
Fuel	4.3	29.5	7.2	0.5	7.0
Fuel/100	10.0	15.7	15.4	10.5	15.1
Speed	46.3	45.7	47.7	51.2	46.6
All_Fuel	14.7				47.5
kgce	18.4	28.7	28.3	19.2	27.6
	27.1				

0	快速路	主干路	次干路	支路	辅路
RoadType	1	2	3	4	5
Mlg	160.2	777.7	230.3	25.0	162.1
Fuel	19.4	119.3	43.4	4.9	22.7
Fuel/100	12.1	15.3	18.8	19.7	14.0
Speed	46.1	45.5	46.9	48.3	45.9
All_Fuel	15.5				46.5
kgce	22.2	28.2	34.5	36.2	25.7
	28.4				

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

11. 核定折算系数计算方法

Conversion coefficient calculation method

对于任意天然气车路线，以各时段发车数为权重，利用柴油车能耗标准库对该线路不同道路等级路段、不同交通状态下的能耗总量进行求和，即可得到与该天然气车线路对应的虚拟柴油车线路全天油耗总量，进而得到能耗总量。

For any natural gas bus route, take departing frequency in different time windows as the weight , sum the energy consumption according to the different road type、traffic conditions based on diesel energy consumption standard database, then energy consumption of virtual diesel routes correspondent to LNG routes can be calculated, and total energy consumption can obtained too.

$$E_{oil} = C \cdot \sum (T \cdot S \cdot \frac{P_{t,v}}{100} \cdot)$$

其中：

Eoil——虚拟柴油车全天能耗总量

total energy consumption of virtual diesel buses.

C——柴油标准煤折算系数

conversion coefficient of altering diesel into TCE.

T——各时段发车辆次

number of departing in different time windows

S——线路中各等级道路总长度

total length of different road types of every route.

Ptv——与时段、道路等级对应的柴油车百公里油耗标准值（标准库）

standard mpg correspondent to different time windows、road types.

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

11. 核定折算系数计算方法

Conversion coefficient calculation method

为简化计算，可忽略时段影响、交通状态影响，只考虑道路等级影响。N为全天发车总班次。

In order to simplify the calculation ,ignoring time period、traffic condition, and road types are considered only. N is departure frequency in one day.

$$E_{oil} = C \cdot \sum (N \cdot S \cdot \frac{P}{100} \cdot)$$

核定折算系数计算

$$\text{核定折算系数} = \frac{E_{oil}}{E_{ng}}$$

Conversion coefficient calculation

① 对于任意天然气车线路，统计其日均实际用气量得到日均天然气能耗（标煤）量。

For any LNG routes, nature gas consumption can get when count the real nature gas volume.

② 利用本研究方法计算与其对应的虚拟柴油线路日均柴油能耗量。

The daily mean energy consumption of virtual diesel routes will be calculated using this method.

③ 将天然气能耗与柴油能耗作比，得到该线路的核定折算系数。

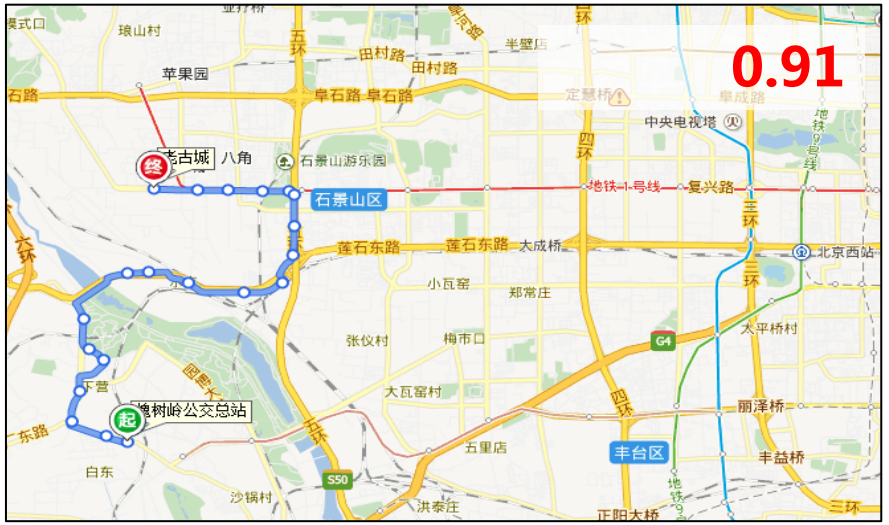
天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

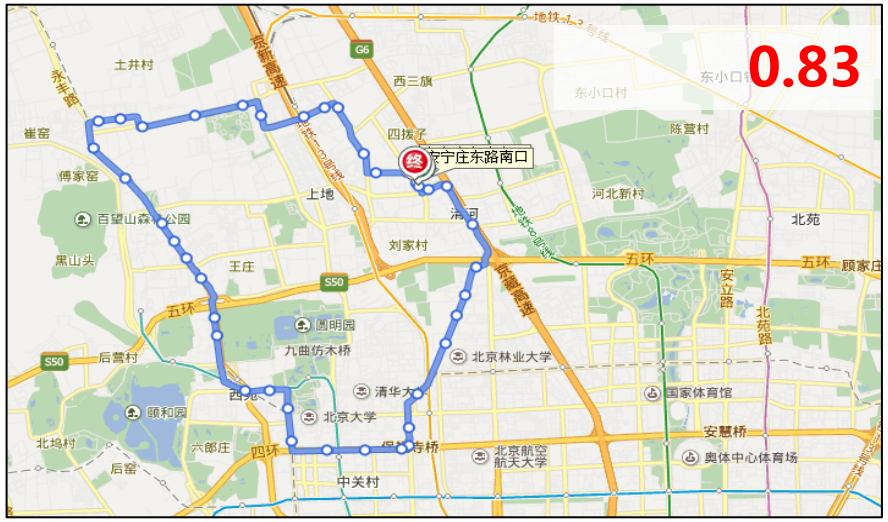
12. 结果分析
result analysis

121路 主干路专用道，畅通
Route 121 arterial lane unblocked

324路 主干路道路条件较好，畅通
Route 324 arterial lane unblocked



327路 道路条件一般，较畅通
Route 327 average road conditions, unblocked



333路 路况较差，拥堵
Route 333 poor road conditions, jam

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

12. 结果分析

Result analysis

可见，在道路条件较好、施划公交专用道、拥堵水平较低路段上运行线路的核定折算系数**较高**，而在道路条件较差、无专用道、拥堵水平较高的路段上运行线路的核定折算系数**较低**。

conversion coefficient factor is **higher** when the routes serve at the case with good road conditions、bus lanes, unblocked roads, while it is **lower** when routes serve at the case with poor road conditions、regular lanes、jam roads.

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

12. 结果分析

Result analysis

① 在制定城市天然气公交车进行核定折算系数时，对于运行在**道路条件较差**、**无专用道**、**拥堵水平较高**路段上天然气公交车线路，应设置**更低的核定折算系数**，反之给与更高的核定折算系数。

When settle down the conversion coefficient factors, **lower conversion coefficient factors** will be used when LNG routes serve at the case with **poor road conditions ,regular lanes、jam road,** otherwise, higher conversion coefficient factors will be used.

② **为了促进天然气公交车能耗水平的降低，促进天然气车公交车应用的推广，应改善公交车运行环境，如施划公交专用道、采用公交优先控制、改善道路条件，同时也是对公交服务水平的提升。**

In order to reduce the LNG buses energy consumption, promoting popularization of LNG buses, operation conditions of buses need to be changed ,like bus lanes、bus priority、good conditions;

天然气动力与柴油动力能耗对比分析

Comparison between gas fueled buses and diesel fueled buses

12. 结果分析

Result analysis

① 近年来，北京市公交车辆的排放标准也在逐渐变化，由国III、国IV逐渐更新换代为国V标准。随着公交车辆的跟新换代，柴油车、LNG车的动力性能、排放规律也会发生较大变化。因而，反映一段时间内柴油车、天然气车排放规律差异的**核定折算系数是不断变化的**，为保证核定折算系数的实效性，应随时间推移动态更新核定折算系数，建立以季度、年为周期的核定折算系数的定期**动态更新机制**。

Discharge standard is changing in Beijing，CN- III 、 CN- IV are replaced by CN-V. dynamic performance and law of emission of diesel and LNG buses is changing as the buses updates. So, **conversion coefficient factors**, reflecting emission laws of diesel and LNG buses ,**is changing** . Updating the conversion coefficient factors as time goes by is really needed to keep the timeliness of the factors. **Dynamic updating mechanisms** in different time windows(season, year) should be established.

北京市电动公交前景展望
Prospect of electronic fueled buses in Beijing

2014年

提出以公交电动化为突破口，聚焦主要线路和重点区域，大力推进公交电动化。2014 年，投运电驱动公交车不低于 900 辆。

4500辆

——《北京市电动汽车推广应用行动计划（2014-2017 年）》

北京市电动公交前景展望

Prospect of electronic fueled buses in Beijing

1. 北京纯电动公交应用现状
status of electronic buses in Beijing

天然气 动力 Gas fueled

电动力 Electronic fueled

（1）纯电动微循环线路公交
Microcirculation of pure electric power buses

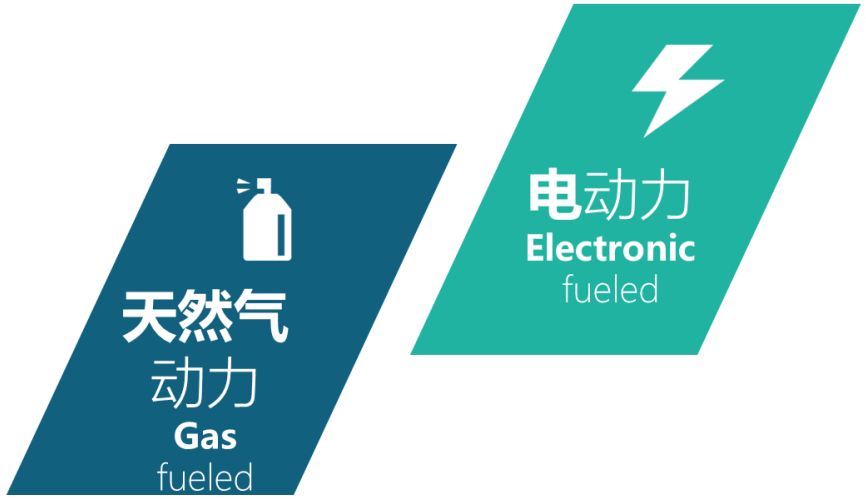
- 北京公交集团于2015年初在北京南部城区正式开通了的**4条微循环线路**，全部为全新的6米级纯电动公交车，该车车身为亮黄色，被公交车称为**“小黄蜂”**。

4 routes of microcirculation, started by Beijing Public Transport Group, start service in the south of Beijing in 2015, electronic buses is new and 6 meters wide with bright yellow skin, named **“Bumblebee”**.

数据来源：
交通部公路院ITSC电动汽车专项技术支持组
Data source:
ITSC electric auto specific technical group of RIOHMOT

北京市电动公交前景展望
Prospect of electronic fueled buses in Beijing

1. 北京纯电动公交应用现状
status of electronic buses in Beijing



（1）纯电动微循环线路公交
Microcirculation of pure electric power buses

- 实际运营过程中“小黄蜂”并没有实现原规划中的“**5分钟**发车间隔”，单次充电一般仅能满足**四次发车**的用电量，而单次充电一般需**半小时**，且往往需要排队，导致了“小黄蜂”发车间隔会超过**10分钟**，影响了运营效率。除此之外，旁的道路上，影响了交通通畅。

Bumblebee can`t reach requirements that departing every **5min** in the operation, only **departing 4 buses** can be meet when charge once, it will take **half an hour** when charge once and usually need to queue a line to charge , as a result that departing frequency will be more than every **10min**. Resulting in poor operation effectiveness and traffic conditions.

数据来源：
交通部公路院ITSC电动汽车专项技术支持组
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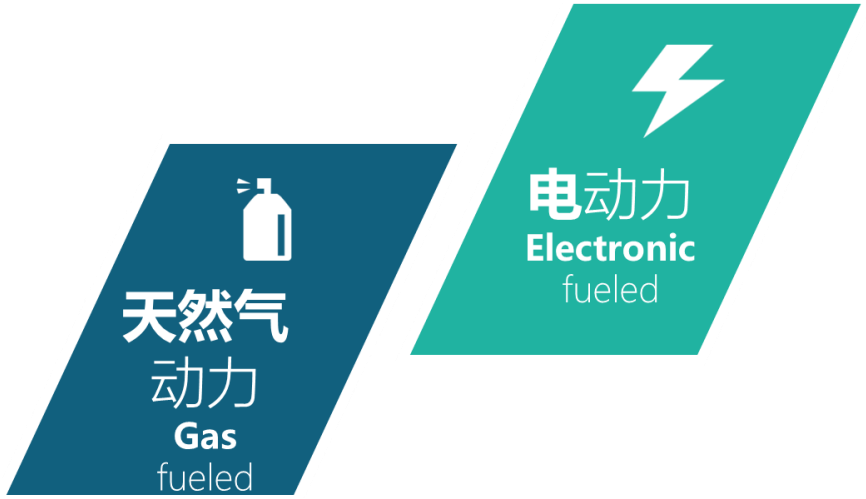

（1）纯电动微循环线路公交
Microcirculation of pure electric power buses

- 桥下停车场空间仅能容纳十辆车左右，同时场内仅配有两台**充电桩**。

Parking space under bridge can only holds 10 buses, and only two **charging piles** is available.

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（2）纯电动常规线路公交

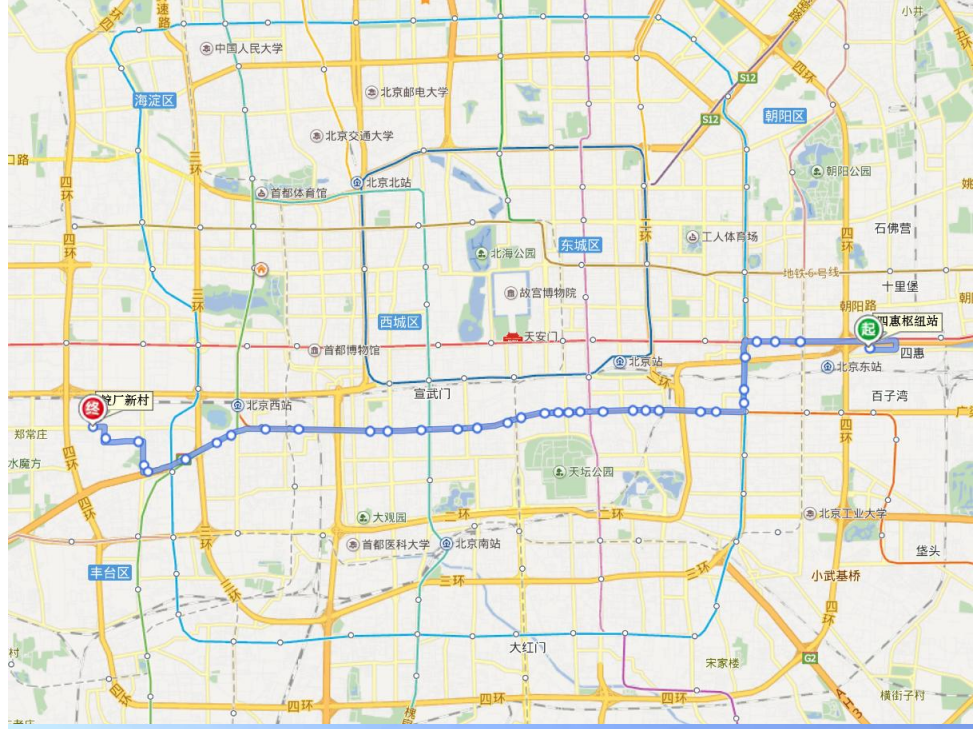
electronic powered regular routes

- 北京公交集团于2015年初3月开始了国内首次**18米纯电动**公交（北汽福田制造）空载试运营和载客运营。线路全程约单程约25公里，共计34站。

  electronic buses with 18 meters wide(made by Beijing auto) come into operation with and without passengers in march,2015 started by Beijing Public Transport Group. The route is 25km and 34 stops.

- 该车型在城市正常载客情况下最高可行驶**100km**，极限情况下可供完成两次往返，为避免突发问题，车内备有应急备用电池可供更换。该车配备较高的**隔音技术**，车内噪音控制理想。

  This type buses can serve **100km** with regular passengers, and in extremely conditions it can serve round trip, backup battery is equipped in the buses in order to deal with the emergency. **sound insulation technique** can control the noise in bin.



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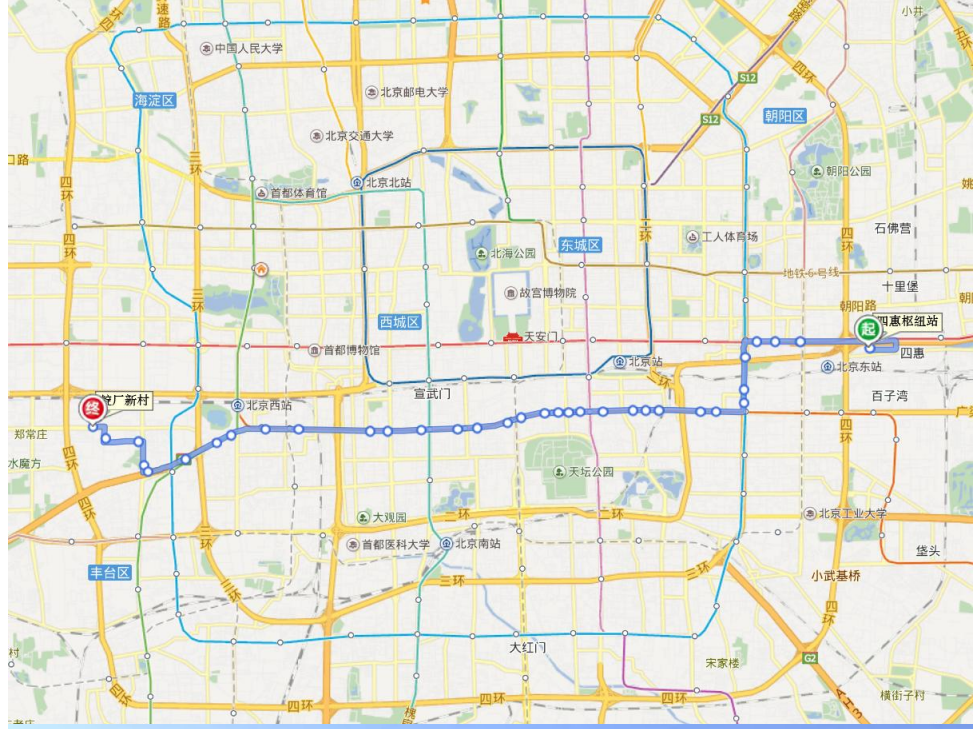
- 目前仅在靛厂新村场站设有一处充电站，完整充电一次约**3小时**，未来将在四惠公交场再增设一个充电站。

  Only one charging pile is available at Stop DIANCHANGXINCUN by the time being. It takes **3 hours** to finish the charging process , while another charging pile is under planning at Stop SIHUI.

- 北京郊区县因**线路较短**，目前正在**规模化推广**纯电动公交。

  Electronic buses is popularized in suburbs area in Beijing since **its short service range.**



北京市电动公交前景展望

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2. 北京纯电动公交应用展望

Prospect of electronic powered buses in Beijing

- 至2017年，北京公交集团计划**淘汰老旧公交车约8000辆**，更新车辆全部为新型**环保公交车**，每年新增公交车中，新能源和清洁能源公交车比例将达到**70%**。预计到**2017年**，公共电汽车将保持在**21000辆**，其中**清洁能源**公交车约占38%；**新能源**公交车约占28%；清洁能源和新能源公交车比例将达到公共电汽车规模的**65%以上**。

  About 8,000 buses will be eliminated by BEJING Public Transport Group by the end of 2017, buses updated are all **environment friendly** . The proportion of added buses fueled by new energy and clean energy can reach **70%**. **It will reach 21,000 buses in 2017**, which **clean energy** powered buses accounts for 38% while **new energy** accounts for 28%,and new& clean energy buses can beyond **65%.**

充电设施建设加速

根据北京市电动汽车推广应用行动计划(2014-2017年)，北京将加大公交、出租、分时租赁、物流、公务、环卫 **6 个公共领域及1个私人领域**的示范推广工作。

到2017年，在社会公共停车场、交通枢纽停车场、大型商超停车场、高速公路服务区、电动汽车专业销售（4S）店、具备条件的加油站等建设**10000个**快速充电桩。另外，有关部门还将研究推进建设京津冀一体化充电服务网络。

北京市电动公交前景展望
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2. 北京纯电动公交应用展望
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- 目前制约北京市主城区发展纯电动公交的阻力主要来自**三个方面**，也是目前大城市发展纯电动公交的共性问题。

Three obstacles we are facing when popularize electronic powered buses nowadays in central area in Beijing , It is also the common difficulties that prevent super city from popularizing electronic buses.

- **充电桩**布设难度较大。若采用慢充（如磷酸铁锂电池）车，则在夜间充电时需**一车一桩**，对场地的要求较高；若采用快充（如太酸锂电池）车，充电桩建设成本又**十分高昂**。

  Constructing Charging station is difficult. Buses equipped with average charging battery(eg:Lithium iron phosphate Battery) requires enough parking space, **for one charging station can only charge one bus**; if buses equipped with fast charging battery(eg:LTO) , it is **expensive** to construct a charging station.

- **线路里程**较长。目前的慢充车一般行驶里程约160km，为保险起见通常只允许运行**120~140km**，而北京公交线路中需要单车单日运行的里程约为**180~220km**，若换用慢充车则势必需要增加车辆总数，进而导致成本问题。

  Routes` Service range is far. The range of average charging buses is 160km, considering operating safety and regularly, **120~140km** is regular range of buses served. The service range of per buses is **180~220km** every day, if buses equipped with average batteries will add more additional buses and result in more additional cost.

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- **电池衰减**。快充太酸锂电池抗衰减性能较好，但慢充磷酸铁锂电池的衰减较快，由衰减导致的电池更新需求同样是制约北京电动公交发展的阻碍之一。

  Battery ages. Fast charging batteries like LTO perform better anti-age characteristics. While average battery (eg:Lithium iron phosphate Battery) ages fast. Timely updating for aged battery hinder from electric powered buses being popularized in Beijing.

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2. 北京纯电动公交应用展望
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- 虽然电动公交目前仍在着一些问题，但在节能减排的发展趋势下，在提升电动车本身技术水平的同时也应该不断努力**探索**应用推广电动车的**可行模式**。

  Although problems does exist when popularizing electric powered buses, under the circumstance that energy conservation and emission reducing is popular around the world, **exploring feasibility patterns or popularizing electric powered buses** should be boosted while improving electric powered buses technology.

- **纯电动公交车**的发展自诞生伊始就与**电池技术**紧密联系在一起，在发展纯电动公交时同样应该**理性审视**技术发展水平，在推广应用时应考虑线路特征严谨考察**适用性**。

  There is a closely relationship between **electric powered buses** and **battery technology** when the electronic powered buses coming into being. **Judging the technology reasonable** is needed to develop the electric buses, feasibility need to be considered when popularizing the electronic buses, routes limited by technology and cost can slow down the promotion of electronic buses. Sustainable of buses will decline when popularizing the buses deliberately, and it is contrary to the initial purpose to develop electric bus .

谢 谢！

Thank you!

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