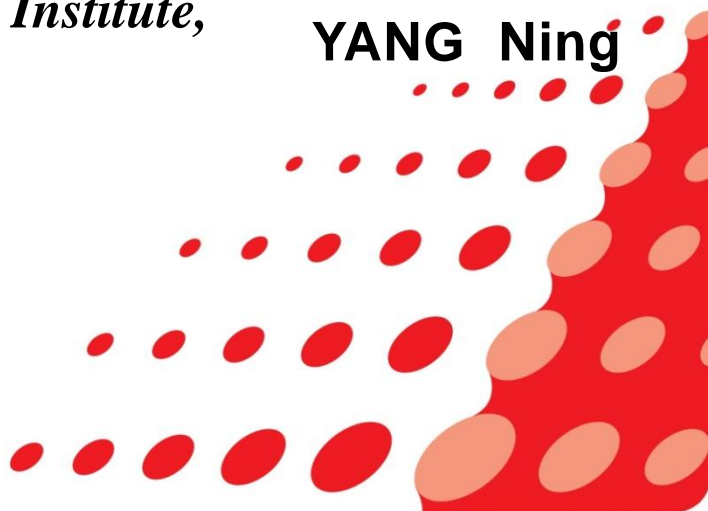




Prospects for Renewable Fuels in the Transport Sector —Prospects for Natural Gas Vehicle (NGV)

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With the increasing awareness of environmental protection, energy shortages and rising oil prices, natural gas, as a cheaper clean fuel, is more widely used in alternative fuel vehicles, which aims to adjust the energy structure, reduce environmental pollution, and improve air quality. Natural gas vehicles (NGV), compressed natural gas vehicles (CNG) as well as liquefied natural gas vehicle (LNG) have been developed worldwide since 20th century.



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The Current Status of the World NGV

- **The NGV Population & Distribution**
- **The NGV development Characteristics**

The NGV Population & Distribution

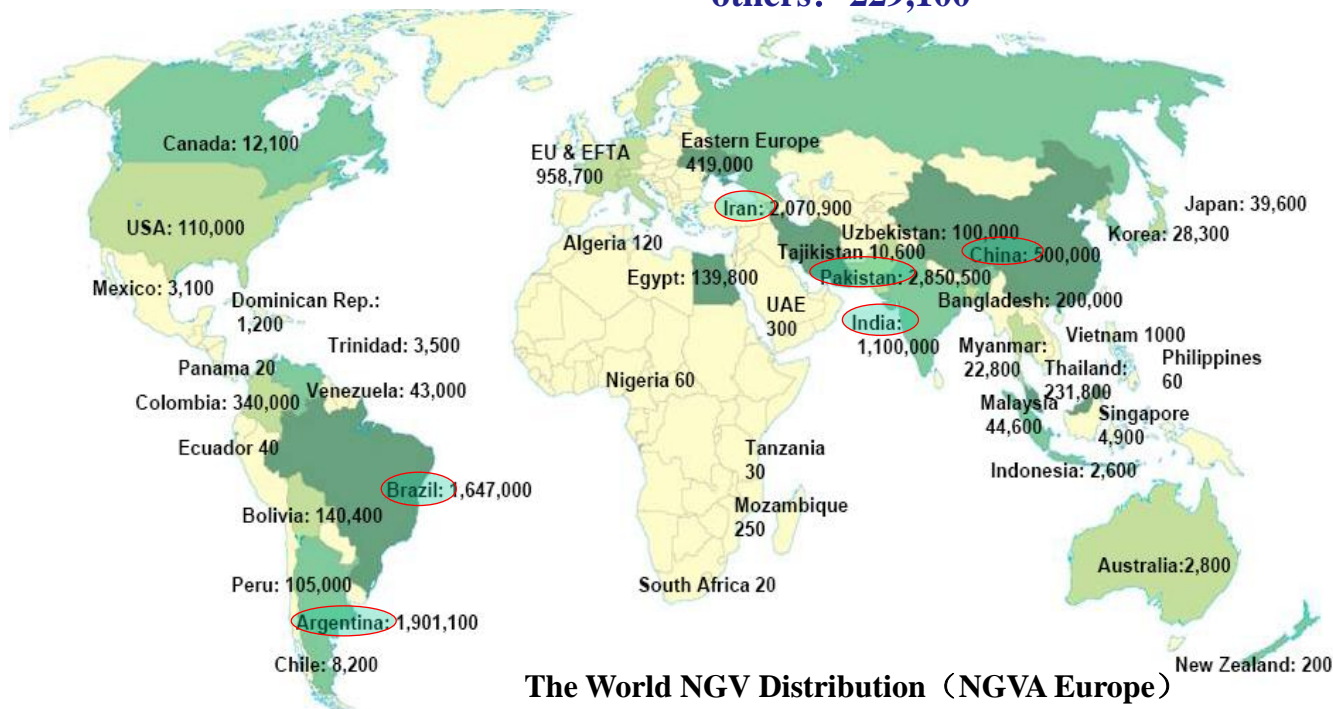
Nations: 82

NGV numbers: 4 million (2004) → 13 million (2010, about 1.33% of global NGV)

Refueling stations: 18,600

NG consumption: 43.4bcm

- **Car: 12,193,600**
- **Bus: 414,800**
- **Truck: 210,800**
- **others: 229,100**

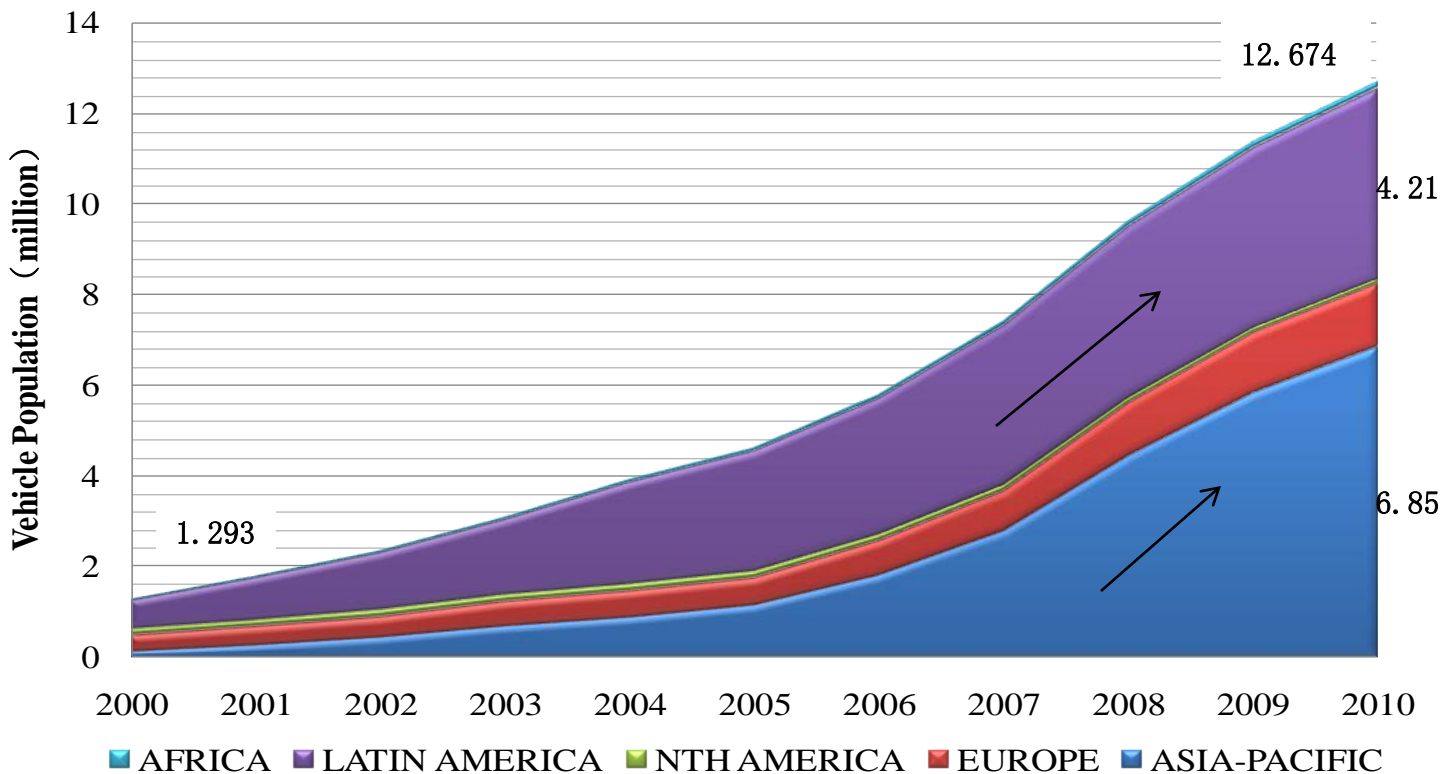


The World NGV Distribution (NGVA Europe)

The NGV Population & Distribution

2000-2010 annual growth of global

REGION	ASIA-PACIFIC	EUROPE	NTH AMERICA	LATIN AMERICA	AFRICA	WORLD
Average growth	42.1%	14.1%	-0.1%	18.2%	15.3%	24.2%

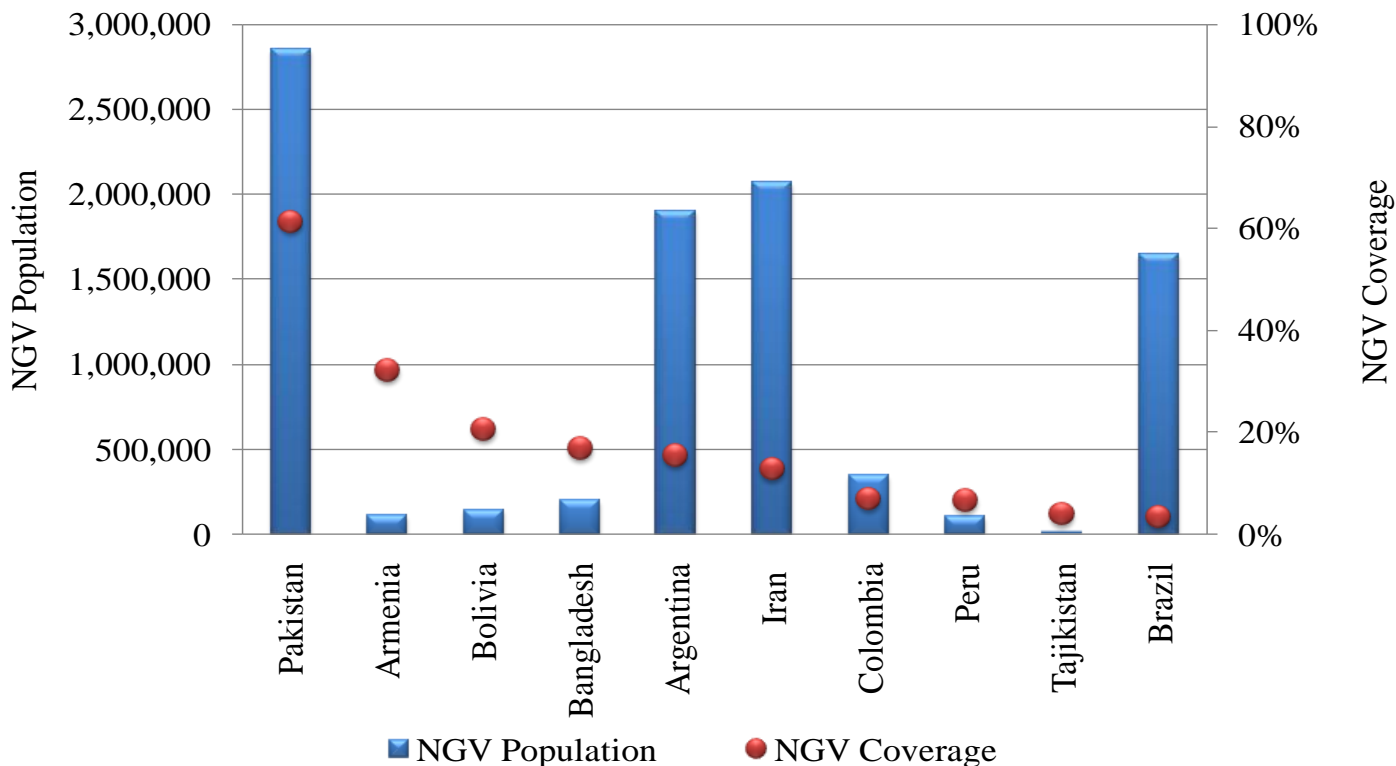


Variation of NGV Population Worldwide (NGV Global)

The NGV Population & Distribution

The world NGVs are dominated by CNG & LNG vehicles, in which CNG vehicles accounts for 80%~90%.

NGVs are widely adopted by countries due to various advantages.



the Top Ten NGV Coverage Countries (NGV Global)

The NGV Development Characteristics

1. Government strongly supports the development of CNG business in large-scale by taking advantage of resources.

To save foreign exchange and reduce costs, “lean oil, rich gas” countries are in the overall development of CNG cars, mainly refit cars.

Pakistan has the highest NGV coverage, reaching 61.1%.



The NGV Development Characteristics

2. CNG business develops as an aspect of energy diversity.

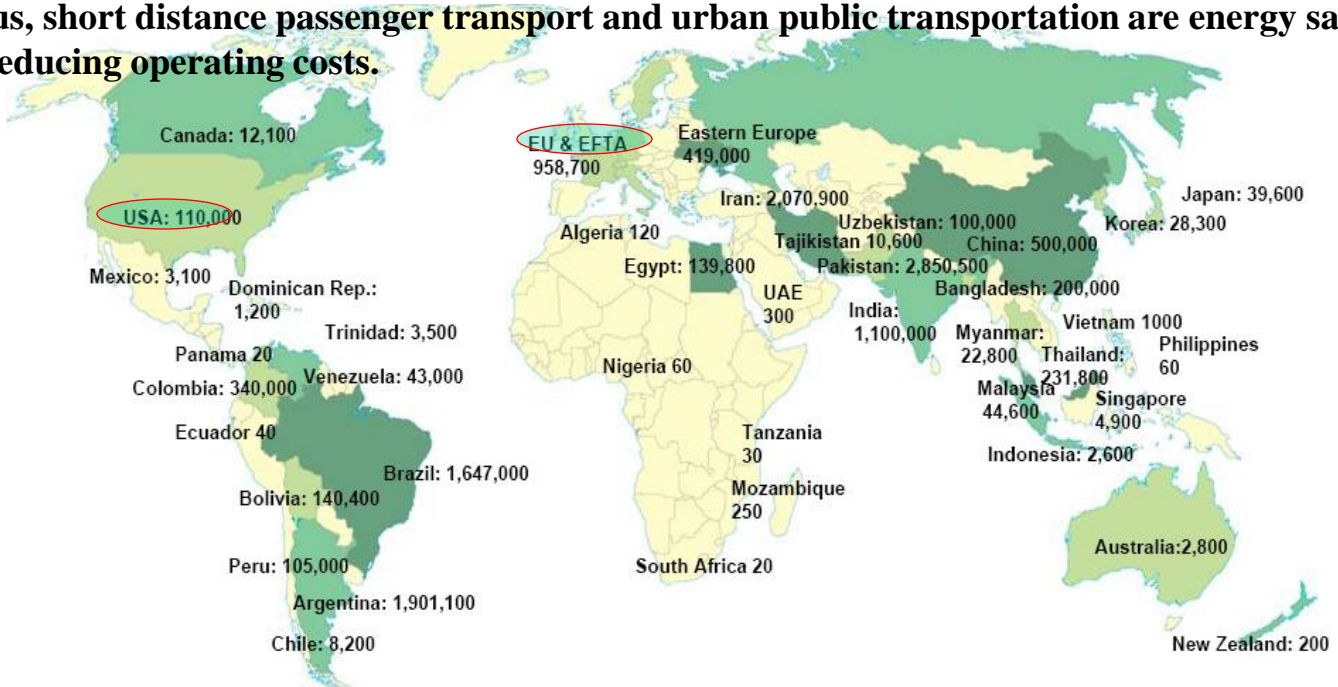
CNG business grows rapidly. CNG vehicles are mainly used in households and taxis, and gradually to the government vehicles and public transportation. Both manufacture & refit vehicles are equally developed.



3. CNG and LNG vehicles are in synchronous development in Europe and America

CNG vehicles are used to fixed-line vehicles (such as bus, school bus, cleaning cars) . The priority is given to the development of CNGV technologies.

The application of LNGV technologies are relatively mature in Europe and USA. LNGV are more safe, environment friendly, lightweight and longer driving-range than CNGV. LNG inter-city bus, short distance passenger transport and urban public transportation are energy saving with reducing operating costs.



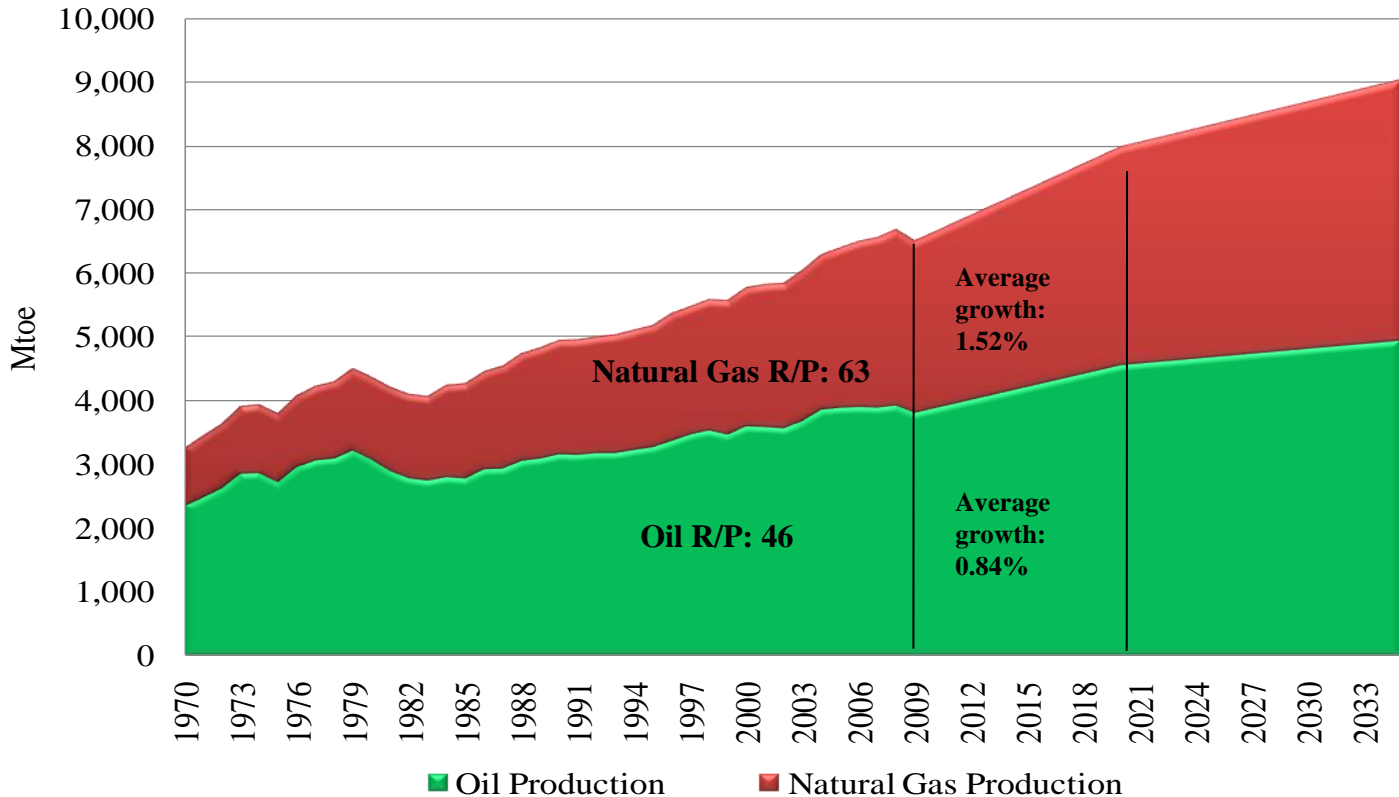
The Factors of the World NGV

- **Impetus**
- **constrains**



The Impetus of the World NGV

1. Abundant natural gas resources



the World Oil and Gas Yield Trend (BP and IEA WEO)

The Impetus of the World NGV

2. Cleaning and environmental characteristics of natural gas

Natural gas is recognized as clean energy, without residue and waste water after combustion. It presents the features of safe, high heat value and clean.

Contrast of Combustion Emissions

	Natural Gas	Oil	Coal
CO ₂	40	80	100
NO _x	20~40	70	100
SO _x	0	70	100

IEA Natural Gas Prospects (1986, 1991)

Contrast of Gas Vehicle and Fuel Vehicle Emissions

	CNG	LNG	Gasoline	Diesel	LPG
CO emissions	0.32-0.48	Slightly lower than CNG	3.27-6.75	0.08-0.4	0.71-1.07
HC emissions	0.21-0.61		0.3-0.5	0.05-0.14	0.09-0.14
NO _x emissions	0.06-0.19		0.09-0.22	0.4-0.94	0.1-0.21

IEA Calculated the emissions data for different fuels by FTP



The Impetus of the World NGV

3. Lower cost compared to conventional fuel vehicles

- NGV save 20% to 70% fuel cost per unit distance than traditional fuel vehicles.
- No carbon deposit could reduce engine wear and extend engine life, expand the periods of oil change, save maintenance costs.

Contrast of CNG and other Fuels Price (NGVA Europe)

Country	NG prices as % of price for other fuels			Country	NG prices as % of price for other fuels		
	CNG/Premium Gasoline	CNG/Regular Gasoline	CNG/Diesel		CNG/Premium Gasoline	CNG/Regular Gasoline	CNG/Diesel
Argentina	32	47	48	Liechtenstein	81	84	81
Armenia	43	53	55	Lithuania	0	60	77
Bangladesh	31	38	54	Luxembourg	0	33	45
Belarus	35	50	50	Malaysia	34	35	40
Bolivia	0	0	44	Mexico	38	42	60
Brazil	22%~81%	65	83	Moldova	0	24	31
Bulgaria	0	66	68	Netherlands*	0	32	47
Canada	46	0	68	Norway	0	48	61
Chile	35	0	66	Pakistan	53	0	72
China	52	32%~84%	70	Philippines	22	0	26
Colombia	61	0	95	Poland	0	40	49
Croatia	0	37	54	Portugal	0	45	61
Czech Republic	0	51	0	Russia	29	31	46
Egypt	22	51	31%~95%	Serbia	0	50	58
Estonia	0	45	0	Singapore	45	50	62
France	0	48	56	Slovakia	0	48	62
Germany	0	52	61	Spain	0	43	61
Greece	0	45	52	Switzerland	65	65	77
Hungary	0	53	55	Thailand	29	29	34
India	29	32	52	Trinidad & Tobago	35	38	80
Indonesia	37	47	39	Turkey	46	46	64
Italy	0	41	51	Ukraine	0	46	57
Japan	38	40	59	United Kingdom	0	51	57
Korea	36	0	42	U.S.A.	47	0	45
Latvia	0	41	48	Uzbekistan	20	29	33

*Comparison of CNG and other fuels in the same calorific value



The Impetus of the World NGV

3. Lower cost compared to conventional fuel vehicles

Compared with the CNG, 1 cubic meters of LNG is equivalent to 2.5 cubic meters of CNG under 25MPa.

LNG cylinders are lightweight and space saving compared to CNG. Both are in the same price range.

Therefore, the economics of LNG is superior to that of CNG.





The Impetus of the World NGV

4、The Incentives are continuously released by Countries.

- **The incentives are toward NGV refit and R & D support.**
 - Pakistan government will implement tax-free policies on NGV and equipments.
 - Bangladesh Government has strongly supported the NGV industry. NGV refit parts enjoy duty-free imports. Banks and leasing companies provide loans for vehicle modification.
- **Subsidies or tax exemption on the stations, so that Oil and Gas Sales companies willing to invest in sales networks**
 - Pakistan Government implement duty-free concessions on the station equipment.
 - Iran Government implement duty-free concessions on the station equipment and NGV.
 - Some local governments in China implement administrative allocation of land for station construction, free of deed, financial resources to support the building, while exempt from income tax within 5 years, free of all administrative fees.
- **Restrict vehicle emissions with the laws and regulations , encouraging the use of NGV**
 - China promulgated the “Natural Gas Utilization Policy” in 2007 , providing natural gas vehicles are the “first class” gas project.
- **Governments encourage the use of CNG and other NGV fuels, making them competitive with petroleum products in the market price.**
 - By reducing or exempting excise duties and road surcharge, the NGVs are competitive to the oil fuel vehicles.



The constraints of the World NGV

1. Does not meet the traditional driving habits.

➤ **Compared with traditional vehicles, CNG vehicles have short driving mileage.**

- CNG vehicles are equivalent to 1/4 driving mileage of gasoline vehicles with the same volume of storage containers.
- LNG vehicle is more energy-efficient. The driving mileage is about half of the diesel vehicle.

➤ **Compared with gasoline vehicles, CNG vehicles have a inferior engine performance.**

- The intake efficiency of NGV engine is low.
- Natural gas needs more energy to light due to slow burn speed.
- Decreasing about 15% dynamic.



The constraints of the World NGV

2. Difficulty in Refueling system construction

➤ Heavily rely on gas pipeline network

- Land acquisition and planning of the network building.

➤ Many restrictions in gas station construction on account of great density of city.

- Safe distance limitation.

➤ Difficult to take new tube from the existing pipe network and low inlet pressure of pipe network

- The network has not taken into account needs of stations.
- The station has a small hours displacement, in particular, that can not meet the demand for bus filling

3. Energy policies of tendency to other alternative energy

EU to develop biomass energy

- Development of bio-fuels - to curb growing emissions from the transport industry.
- The European Parliament and EU Council adopted the Directive on the promotion of the use of biofuels for transport in March 2003. It specifies that the Member States should take measures, the minimum share of biofuels in transportation is at least 5.75 % by 2010.
- “Climate and Energy” package, published in early 2008: the share should be increased to 10% in 2020.
- Tax leverage is the main tool in EU. They give some or all of the tax relief, and even give some financial subsidies for the vehicles which are use of biofuels and other renewable energy-powered.

The Prospect of the World NGV



The Prospect of the World NGV

In the next 20 to 30 years, despite fuel vehicles are still the mainstream of transport fuels, but natural gas will become an important supplement to vehicle fuel.

Especially in the “lean oil, gas rich” countries, with large-scale natural gas development, pipeline construction speedup, and the network stations improvement, NGVs will be gradually expanded the scope of application, natural gas resource-rich developing countries will become the new CNG development areas.

Meanwhile, as CNG vehicles are not suitable for long-haul freight, LNG vehicles will be further developed.



Thank you !

