WWJMRD 2019; 5(3): 34-39
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
Impact Factor MJIF: 4.25
E-ISSN: 2454-6615

Danh Chan Nguyen
Ho Chi Minh City University of Transport, Vietnam

Le Hung Duong
Ho Chi Minh City University of Transport, Vietnam

Correspondence:
Danh Chan Nguyen
Ho Chi Minh City University of Transport, Vietnam

Compressed natural gas as an alternative fuel for bus in Vietnam

Danh Chan Nguyen, Le Hung Duong

Abstract
In recent years, climate change has had a negative impact on many countries around the world, including Vietnam. In that regard, the environmental control in transportation activities has received special attention from all levels and sectors. City Hanoi, Ho Chi Minh City and Da Nang were prioritized by the Prime Minister for pilot application of clean fuel NPG and CNG in public passenger and bus transport. After investing in piloting the first 30 buses of the city meeting EURO 4 emission standards in 2017, Vietnam continues to invest in many buses using CNG clean fuel. This will contribute to the development and improvement of the quality of the city bus network. The pilot bus using clean fuel CNG is a breakthrough in the city's passenger transport activities, in accordance with the Government's guidelines, using clean fuels in transport activities should continue to be replicated. To reduce environmental pollution. Buses using clean fuel CNG meet EURO 5 emissions standards, becoming one of the solutions to realize the dream of a green, safe, civilized city. The outstanding advantage of CNG buses is to reduce environmental pollution and save 30% of fuel compared to diesel buses. Using CNG helps to reduce up to 20% of carbon dioxide, 30% of nitrous oxide, 70% of sulfur oxides compared to fuels from oil and reduce up to 50% of hydrocarbon emissions compared to gasoline engines.

Keywords: compressed natural gas, environmental protection, bus, EHRO standard

1. Introduction

Currently, environmental pollution is a hot topic on newspapers and has received a lot of attention from people. In particular, the problem of water pollution in Vietnam has become more and more serious. Through the media, we can easily see the images, as well as articles that reflect on the current state of the environment. Although the departments and unions tried to call for environmental protection, water protection ... but it seems that it is not enough to improve the pollution situation become more serious. There are many environmental problems in Vietnam, as a result of the Vietnam War, as well as Vietnam's rapid industrialization after the economic reform in 1986, also called Doi Moi. According to a report from the Vietnamese government in 2001, a number of key issues have been raised, including soil and forest resource degradation, loss of biodiversity, water pollution, air pollution and management solid waste management. Vietnam is a fast developing country, with more than 90 million people in 2014. However economic development does not care about environmental protection as the deforestation situation is increasing, uncontrollable gas standards discharging vehicles, causing gasoline pollution due to motorbike exhaust, poor urban planning has caused a great pressure on the air environment, air quality in big cities is decreasing.

Ho Chi Minh city with an area of 2.095km^2, population about 7.6 million people and about 2 million visitors, the number of personal vehicles with more than 5 million motorcycles, 500 thousand cars of all kinds cause Overloading of the infrastructure system, leading to the UTGT, environmental pollution caused by traffic vehicles. Currently, Ho Chi Minh city does not have a mass transit system (Metro, Tramway, BRT ...) but mainly buses and taxis. Although the city plans to invest in the construction of urban railways, it is expected that by 2020 one or two routes will be operational. Therefore, in the period from now to 2020, the bus will still be the main mode of public transportation of the city and after 2020 the bus will

remain an important means of transportation in the public passenger transport system. Plus of the city. The urban public transport system, despite the remarkable achievements achieved during 2003 - 2012, especially the development of urban bus transport services. The bus fleet did not increase in quantit y but the quality and capacity of transport actually changed. Urban bus traffic increased from 36.2 million passengers per year in 2002 to approximately 413 million passengers by 2012, while the number of buses in 2002 was 2100 with an average capacity of 20.2. And the number of buses in 2012 is 2954 vehicles with an average capacity. In order for the public passenger transport system to reach its goal of meeting 15% of the travel needs of the people by 2015, it is necessary to continue to innovate in the quantity and quality of the mass transit along with the Arrange and develop a more suitable bus route network. However, since the majority of buses were invested in 2002 - 2003, they have been in operation for nearly 10 years. According to survey results, vehicle quality is one of the main factors that passengers are not satisfied. Air pollution is a hot issue concentrated in developed cities, industrial zones and clusters ... which has become a concern of the whole society. Air pollution is considered one of the leading agents at risk of serious impacts on public health. With the aim of providing an overall picture of the quality of the environment, the Ministry of Natural Resources and Environment has developed the National Environmental Report 2013 with the theme of Air Environment. The report specifically analyzes the current status of the environmental impacts (excluding the environmental protection in the home and in the production area) in the period of 2008-2013, showing the causes of pollution, thereby giving solutions to overcome. The coming years.

Climate and weather factors (including radiation regime, temperature, rainfall ...) have a certain influence on the air environment. In Vietnam, the climate has a clear differentiation by region. The North has a tropical monsoon climate, the South has a tropical climate while the plateau region is characterized by a temperate climate. The hot, dry climate and high heat radiation are factors that promote the dispersal of polluted gases, and heavy rain can contribute to reducing air pollutants. In addition, greenery coverage is also a factor that significantly reduces the amount of emissions in the atmosphere. According to statistics in our country, although the total forest area has increased, reaching the coverage level of 40%, but the quality of forests is continuing to deteriorate. For urban areas, the density of trees has not reached the coverage level. Specifically, in the capital Hanoi and Ho Chi Minh City. Ho Chi Minh City has an area of less than 4m2 per person, lower than the requirements of the standard (10-15 m2/person) and does not meet the role of green lung to minimize air pollution.

2. Trends in replenishing natural gas reserves

Natural gas reserves have increased rapidly over time. Between 1990 and 2004, 24 mines were discovered, with an average increase of about 26 billion cubic meters per year from new mines and the discovery of the mines. Most of the mines were found from new exploration areas under the first oil and gas contracts, only a few mines were discovered in the second exploratory exploration.

The addition of remaining gas reserves in the future is partly due to the growth of mines dependent on the results of drilling and mine development on the basis of better geological and geophysical research results. And mining technology, the rest mainly hopes to discover new gas fields in the new exploration areas of the Red, Phu Khanh, Tu Chinh - Vung May, and non-structured traps and mixed traps. The explored areas of Nam Con Son basin, Cuu Long and Malay-Tho Chu basins.

With the addition of natural gas reserves growth, condensate reserves will also increase, particularly in the Nam Con Son and Red River basins, where mines are often at great depths with high temperature and pressure conditions. Therefore condensate reserves will increase significantly. In addition, Vietnam has discovered a number of giant gas fields in the south of the Red River basin but have a very high CO2 content (> 60 ÷ 90%). Therefore, the study of technological solutions and favorable economic conditions to encourage and facilitate the development of these mines will be potential sources of significant additional (about 250 billion m3) of gas reserves. For Vietnam in the future.Natural gas is made up of plankton, aquatic organisms including algae and protozoa. When these microbes die and accumulate on the ocean floor, they are gradually buried and their bodies are compressed under sedimentary layers. Over millions of years, pressure and heat have transformed these organic substances into natural gas

Fig. 1: Bus running on CNG and CNG station in Vietnam

CNG (Compressed Natural Gas) is a compressed natural gas composed mainly of hydrocarbons (chemical compounds containing carbon and hydrogen). Along with coal, oil and other gases, natural gas is fossil fuel. Natural gas, often found alongside oil fields in the Earth's crust, is mined and refined to provide about 25 percent of the world's energy supply.

In the future, it will replace fuels such as gasoline, oil ... As fuels are mined later than crude oil, the reserves are still abundant while crude oil is becoming exhausted.

Advantages of natural gas:

- Save on fuel costs because they are cheaper than other fuels, thereby reducing product costs and improving the competitiveness of your business.
- Reduced maintenance costs of machinery compared to using FO, DO, Coal.
- It is a clean fuel that does not emit hazardous substances which cause environmental pollution when burning like CO2, SOx, NOx.
- High fuel efficiency, longevity of equipment compared to other popular fuels such as DO, FO, Coal ...
- Safe to use high quality equipment in accordance with US and European standards, strict management and operation procedures; In addition, CNG is lighter than air, so it quickly rises up when leaking, thus minimizing the risk of fire and explosion due to gas buildup.

According to businesses, in addition to price subsidy issues, the city also needs to invest more gas charging stations. Currently, the CNG fueling station is too little, far away from the focal terminals. Enterprises want to charge gas for vehicles to run to these stations, consuming more costs and time. Experience in Korea, when businesses build CNG gas supply station will be supported by the State 700,000 USD, the amount of businesses must spend very small. Meanwhile in Vietnam, if you want to invest CNG charging station, businesses have to spend about 1 million USD / station. This is an amount beyond the ability of enterprises in the transport industry. In order to step by step formulate a civilized, modern and environmentally friendly public transport system, according to the bus investment plan for the 2014-2020 period and the new investment demand for the period of 2018-2020, it will be 3,121. bus. In which, about 75% of the buses are expected to use clean fuel (CNG fuel, electric cars, ...). In order to meet the demand of supplying gas for bus system using clean fuel CNG (gas) this year, it is expected that the Department will deploy to build gas charging station at Saigon bus operator station in Park B area. September 23, District 1, with an area of about 500m2 and 2 stations at Cho Lon bus operating station, District 6 with an area of about 500m2 each.

3. CNG system for automobile

3.1. CNG system

CNG fuel is compressed in a 200-bar pressurized tank. When starting, the valve engine opens to the CNG fuel entering the pressure reducer. At the pressure reducer, the fuel pressure is reduced to the working value, due to the vacuum in the venturi throat is lower than the atmospheric pressure, so CNG is drawn into the feeder, the supply of CNG is controlled by the pressure reducer with the vacuum in the venturi tube. The CNG fuel enters a mixture of air mixed into the fuel mixture into the combustion chamber.

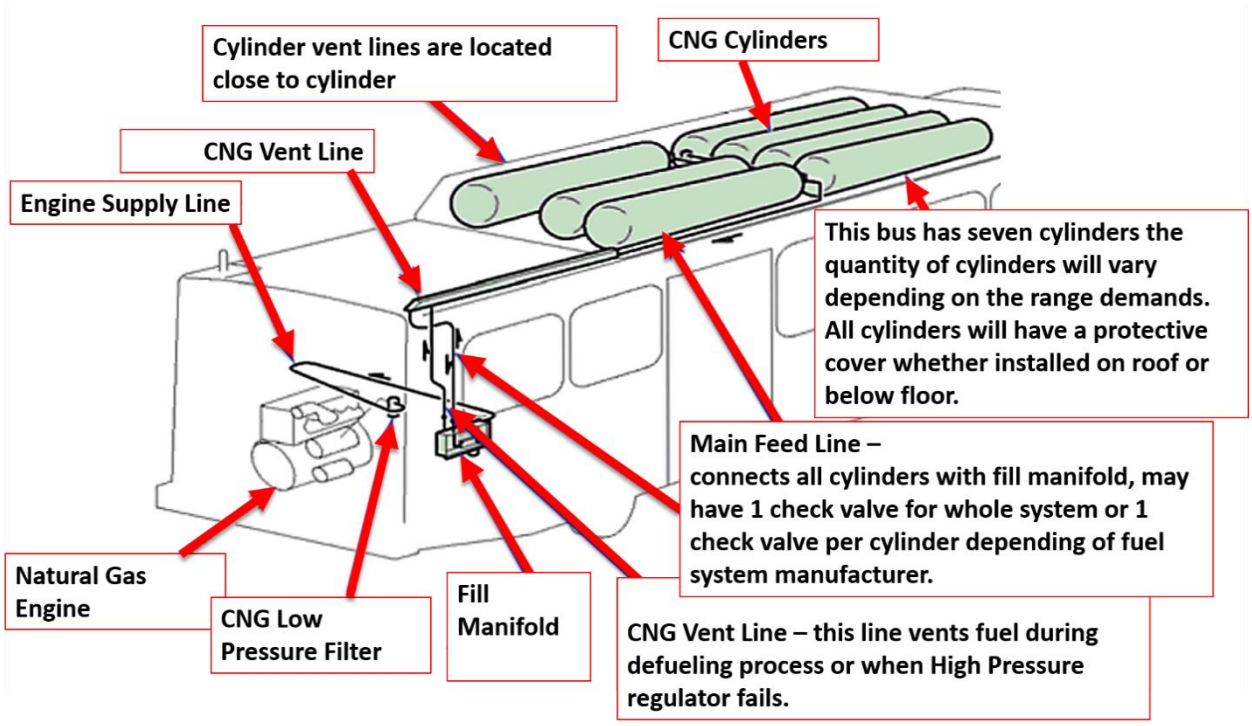

Fig. 2: CNG fuel system

Transit bus engines powered by natural gas work like gasoline powered spark-ignited engines. The CNG fuel system on the bus transfers high-pressure natural gas from the storage cylinders to the engine. The high pressure gas is reduced to a lower pressure compatible with the engine fuel management system. Once the fuel is in the engine the air-fuel mixture is ignited by the spark plugs just like a gasoline engine.

About 12000 transit buses in the united states are fueled by CNG; thousands of refuse trucks and delivery fleets are also powered by CNG. Natural gas as a vehicle fuel is safer than gasoline or diesel, CNG is lighter than air, if a CNG leak should occur, the gas will disperse rapidly upwards into the atmosphere and dissipate. Diesel, gasoline are heavier than air, and will pool on the ground when a leak occurs, creating a fire hazard. The risk of fire with CNG is

very low when handled properly, the ignition temperature is about 1,200°F, compared with about 600° F for gasoline. It also has very narrow flammability limits, it will only burn in concentrations of 5-15%, below 5% is too lean and above 15% is too rich to burn. The high ignition temperature and limited flammability range make accidental combustion of CNG unlikely.The venturi type blender is commonly used for all types of gas fuels (LPG, CNG, ...) because of the simple mixing, suitable for gas fuel. Therefore, the structure of the supply system using the mixer will simply make the price cheaper. The continuous supply of CNG limits the ability to control the air / CNG ratio. To overcome this disadvantage, we use the option of using a mixer coupled with a throttle and power valve.

When fueling – The CNG enters the bus through the fill valve/fill manifold; flows through the one-way check valve and into the storage cylinders. During engine operation – the gas leaves the cylinders through the fuel lines and flows through the Manual Shut-Off Valve and high pressure fuel filter. The gas then travels through the high pressure regulator where the storage pressure (3600psi) drops to a lower operational pressure of about 125psi. The fuel now flows to an electronic fuel shut off valve and into the low pressure filter and then into the low pressure regulator. At the low pressure regulator the fuel drops to engine management pressure which is between 45-100psi, depending on type of engine. After the low pressure regulator fuel flows into the engine through a modulated solenoid (single point injection) to premix with the air as in enters the intake. On other engines the fuel is injected into the intake ports through set of injectors (multi-point injection).When the ignition is switched on, the current through the coil generates a magnetic induction valve for CNG compressed from the high pressure container to the pressure reducer, at the pressure reducer the fuel pressure is reduced to the value of Taking about 0.8 to 1.5 bar, then the fuel is passed through the low-pressure filter before entering the throttle, the throttle is controlled automatically by the microprocessor, CNG flow is provided Controlled by the pressure reducer, the circulation section of the throttle and the vacuum in the venturi, the circulation of the throttle is controlled corresponding to the percentage of throttle position via the butterfly position sensor chicken. The fuel enters a mixture of air mixed into a mixture of fuel entering the combustion chamber. CNG gas is not only determined by the amount of vacuum in the venturi but also by the change in flow rate on the intake manifold, the flow rate control of the intake manifold is made by the dedicated processor receiving the signal. From the sensor. When using a power mixer the power of the motor is reduced by about 5- 8% due to the loss of air intake in the throat and the CNG displacement.

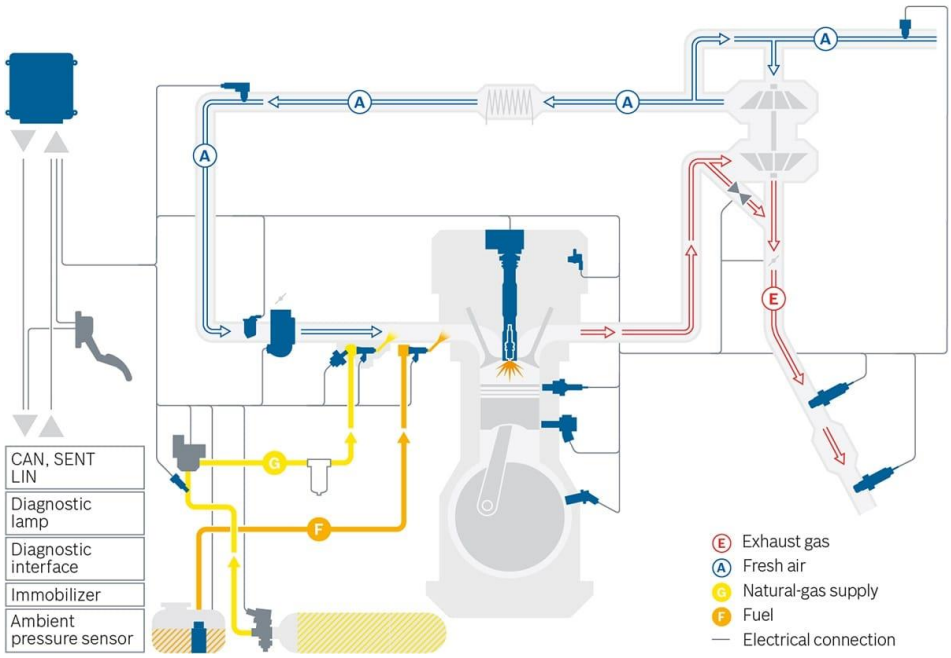

Fig. 3: CNG system using mixer combined with throttle and power valve

CNG system includes CNG tank, solenoid valves, pressure regulators, CNG nozzles. Due to the unique nature of CNG fuel, the pressure required to deliver fuel to the nozzle is 5 bar to prevent vaporization on the fuel line. The control system consists of sensors that record information about the operating mode of the engine, the ECU processes the information received from the sensors and sends control signals to the CNG nozzles to control the opening time. Nozzle supply CNG. Control signals to the nozzles are time pulses corresponding to the amount of CNG that need to be injected into the intake manifold. Sensors in the system include: scaler position sensor, motor speed sensor, intake air temperature, oxygen sensor. In the microprocessor there is an additional CNG fuel pressure sensor, from which the ECU signal emits control signals to the nozzle. The CNG injection system on the intake manifold improves engine performance and emission levels. Unlike the mixer, this system pumps fuel under pressure of about 5 bar. This allows for a precise amount of fuel supply according to the working mode of the engine. On the other hand, due to the absence of venturi throat, the load factor is significantly improved. CNG fueling is done in a separate way, thus reducing the flame retardation in the intake manifold, improving the fuel supply uniformity for the engine's cylinders. The control of CNG flow loaded into the lang lang is made by microprocessor. The cylinders are categorized into 4 categories:

Type 1 is an all steel cylinder made of metal formed in the

shape of a cylinder. These types of tanks are the heaviest tanks on the market, but also the most affordable or cost-effective. Type I tanks are typically painted with a protective coating on the outside of the tank.

Type 2 cylinders are made with a thinner, steel liner. The metal liner is wrapped with a composite wrapping around the body of the cylinder; this is called a "hooped wrapped" cylinder. The wrapping is made of glass fiber or carbon fibers or a combination of both. The metal cylinder takes about 50% of the pressure and the wrapping the rest. Type 2 cylinders are lighter than Type 1 cylinders due to the reduction in metal and the use of lighter-weight composite materials.

Type 3 is made with an all-aluminum cylinder liner wrapped entirely in a composite or fiberglass wrap. This is what is called a "fully wrapped" cylinder. The composite material wrapped around the metal liner is typically made of glass fiber or carbon fibers.

Type 4 is an all composite cylinder, it does not use any metal it is their structural design. These cylinders are made with a "gas-tight" thick rubber membrane. The plastic liner is then reinforced with a composite material using the "full wrapped" method, where the entire cylinder is wrapped. The composite material wrapped around the metal liner is typically made of glass fiber or carbon fibers.

All cylinders are manufactured to meet an industry standard. The main difference between cylinders is cost and weight; type 1 cylinders are the least expensive and also the heaviest.

On the environment, the chemical composition of compressed CNG is mainly CH4 (from 70% -90%, depending on the mining location) and some other gases such as Ethane (1% -8%), Propane (2%), Butane and Pentan (less than 1%). In addition, natural CNG gas also contains a small amount of inert gas such as Nito (0.2% - 5%), CO2 (0.2% -9%). However, when put into use, the exhaust gas of CNG vehicles is good for the environment many times more than the exhaust gas of vehicles using gasoline and oil to operate. Emission of CNG vehicles with CO concentration is less than 150-300 times higher than Vietnam standard; HC concentration is 2.5-5.7 times lower. Meanwhile, just burning 12g C of fossil fuels (such as gasoline, oil) to generate energy has released into the environment 44g of CO2 - a greenhouse gas, causing climate change to be worrisome. CNG gas vehicles are almost no noise. In economic terms, the current CNG price is VND 14,685 / kg and the average cost of each vehicle must be about 39.56 kg for 100 km. Compared to DO oil vehicles, the current DO oil price is about VND20,400 /liter. On average, the car costs 37 liters / 100km. Thus, you only need to do a multiplication and a simple subtraction can see the economic benefits of using CNG gas vehicles. However, one must note: the cost of investing in CNG vehicles is higher than that of oil-powered vehicles. However, if both the economic benefits and environmental benefits are balanced, vehicles using CNG to operate are the optimal solution for the development of public passenger transport of HCMC. One of the most densely populated cities in the country and facing with traffic congestion and environmental pollution caused by the exhaust of vehicles. Throughout the pilot period, the Department of Transport. Ho Chi Minh City has found that buses using CNG clean fuels have significantly reduced environmental pollution compared to buses using diesel. Specifically: Reducing the amount of toxic emissions that pollute the environment; Reduce greenhouse gas CO2 emissions; Reduce noise and vibration. Initially successful in building quality service bus routes through the provision of GPS systems, automatic ticketing ...; The passengers and the people of the city support because the vehicle is highly comfortable and reduce environmental pollution. Especially, with the support of Vietnam Oil and Gas Group, Southern Petroleum Gas Company, CNG buses save about 30% of fuel costs compared to Diesel vehicles, thereby reducing the price. The city has 2.470 buses using Diesel, an average of 60,838 kilometers per year. Thus, the total number of kilometers of vehicles using diesel fuel is: 150.269.470 km / year. If converted to CNG buses, the entire city would minimize the amount of emissions and toxic emissions. TP's air environment. Ho Chi Minh City will be healthier, people's medical expenses will decrease, life expectancy will increase, and the state can reduce costs to prevent climate change.

Production and putting buses using CNG gas into operation is one of the major guidelines of the Government, Ministry of Transport and Ho Chi Minh City People's Committee. Ho Chi Minh City People's Committee has proposed and received permission from the Government and Ministry of Transport to allow Saigon Passenger Car Company to be exempted from tax when importing nearly 30 buses using CNG. In the plan to develop public passenger transport by 2020, Ho Chi Minh City clearly defines the priority of developing green transport to protect the environment and adapt to climate change. Samco's delivery of 300 buses using CNG is part of this plan. The remaining problem is the implementation of the guidelines of departments, agencies and related units. Mr. Nguyen Hong Anh, General Director of Samco, said that if nothing changes, this week Samco will submit to the Department of Planning and Investment and Department of Transportation to plan to produce 300 buses using CNG (the vehicle has just produced new test). On the basis of the project of Samco, Department of Planning and Investment and Department of Transportation will consider and propose a mechanism to support Samco to produce cars. Particularly for transport units, it is still using subsidy norms for vehicles running on fuel and oil for CNG vehicles. The price subsidy for gasoline and oil vehicles is about 20% - 25% higher than the actual fuel consumption costs of vehicles using CNG and the difference is considered by the transport units as support. for investment and use of its environmentally friendly buses. However, in the long term, cooperatives still want to have the support of the State more specifically. The price of VND 2.6 billion / bus using CNG is quite high compared to the price of VND 1.7 billion - VND 1.8 billion / bus of the same type but using gasoline and oil as fuel.

4. Conclusion

In order to implement the new bus replacement project, especially buses using clean fuel CNG, the price subsidy level in 2018, the Department of Transportation is proposing to increase VND 300 billion to offset fuel prices. 13% increase compared to the estimate; changing vehicles, especially vehicles using clean CNG fuel; adding new routes. Regarding the bus unit price norms, in 6/2018, the City Department of Finance cooperated with the Department of Transport and City to submit the council to set up labor norms and techniques of the City to appraise to

the City People's Committee in 2018. to approve a new set of norms for new investment vehicles; At the same time, it will adjust the norm compared to the current situation. In the coming time, it is necessary to effectively use the price subsidy. In particular, focusing on innovating the management thinking of bus activities, which is taking passengers as service centers, associated with technology application; create bus revenues such as advertising on buses, socializing to implement bus service infrastructure investment; socialize and put competition in services, bus bidding; cost structure on reasonable fares, using smart bus tickets. In particular, in the context of the current personal transport development which greatly affects public transport activities, the public transport development project to control the need for personal transport needs to be implemented. For businesses and cooperatives engaged in public passenger transport activities by bus in the city, they continue to pay attention to investment in the management and management of the enterprise; as well as investment in vehicles and passenger service. For city residents, it is necessary to participate in bus travel more and more.

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