

Natural Gas Demand Forecasting in Sichuan Province based on Scenario Analysis

Yi Liu

School of Southwest Petroleum University, Xindu 610500, China

Abstract

The strategic goals of "carbon peaking" and "carbon neutrality" advocate green and low-carbon lifestyles. As one of the clean energy sources, natural gas plays a very important role in the low-carbon energy transition in Sichuan Province, so it is important to forecast the natural gas demand according to the actual development of Sichuan Province. In this paper, the LEAP model is used to forecast the natural gas demand in Sichuan province under different economic growth scenarios, different energy saving and emission reduction scenarios, and comprehensive scenarios from 2020 to 2030, with 2020 as the base year. It also focuses on the natural gas consumption demand of each industry under different energy-saving and emission reduction scenarios, as well as the share of the demand. The results of the study show that: (1) natural gas demand in Sichuan province continues to rise steadily under all scenarios from 2020 to 2030, with the largest natural gas demand in Sichuan province under the very large energy consumption scenario, and the natural gas demand under the very large energy consumption scenario reaches $2.914 \times 10^{11} \text{m}^3$ in 2030. (2) Higher economic growth rates and stronger emission reduction measures both contribute to the natural gas demand in Sichuan province become larger. (3) Under different energy saving and emission reduction scenarios, the natural gas consumption demand of Sichuan Province in all sectors basically remains stable. Among the industries in all sectors, the natural gas consumption demand of industry accounts for the highest proportion, with the natural gas demand accounting for more than 50% of the total demand, which is more than and with a stable upward trend, followed by the residential living sector as well as other industries.

Keywords

Carbon Peak; Carbon Neutral; Natural Gas Demand Forecasting; LEAP Model; Scenario Analysis; Sichuan Province.

1. Introduction

With the rapid development of China's economy, the demand for energy continues to increase. At present, China has become the world's largest energy consumer and largest carbon emitter. The large amount of energy consumption constantly generates pollutant gases, which have a great impact on human life. The "Double Carbon" strategy proposed in the "14th Five-Year Plan" advocates the green and low-carbon development of various industries in China, and the low-carbon transformation of energy is imminent. As an efficient and clean fossil energy source, natural gas plays an important role in the energy transition of Sichuan Province. Accelerating the development of the natural gas industry and increasing its share in primary energy consumption is one of the important initiatives in China's low-carbon energy transition[3].

Sichuan Province, located in southwest China, is a major energy-consuming province. In the past 40 years, Sichuan's total energy consumption has grown from 25.518 million tons of standard coal to 216.2 million tons of standard coal, with an average annual growth rate of

5.5%.In 2016, Sichuan adopted the Outline of the Thirteenth Five-Year Plan for the National Economic and Social Development of Sichuan Province[4], which puts forward that by 2020, the province's total energy consumption will be controlled at 229 million tons of standard coal or less; the energy consumption per unit of GDP will drop by 16% compared with the 2015 by a cumulative 16%; carbon dioxide emissions per unit of GDP by 19.5% compared to 2015, and total carbon emissions under effective control. Sichuan has abundant natural gas resources, coupled with a large population base and high urban gasification rate, Sichuan's natural gas consumption in 2021 is located in the third largest in China.

With the acceleration of urbanization and rapid economic development in Sichuan, the demand for natural gas in Sichuan is expanding. The large demand also increases the uncertainty of the natural gas market, which has a considerable impact on the low-carbon energy transition in Sichuan. Therefore, identifying the influencing factors of natural gas consumption demand in Sichuan Province and analyzing the forecast of natural gas consumption demand in Sichuan Province based on scenario simulation analysis is an important measure for the low-carbon energy transition of Sichuan Province under the goal of "dual-carbon", which is of great significance for the economic and social development of Sichuan Province.

2. Current Situation of Natural Gas Consumption in Sichuan Province

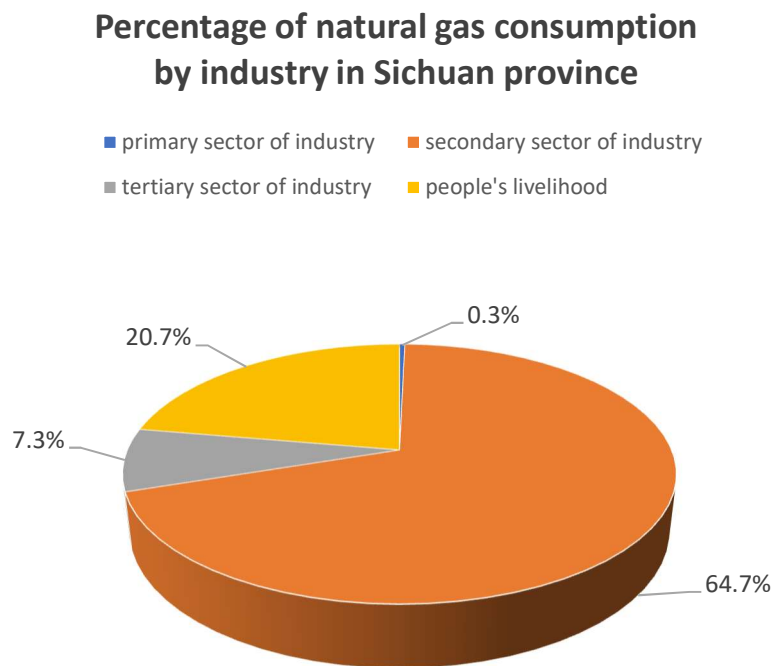


Figure 1. Percentage of natural gas consumption by industries in Sichuan Province

In recent years, the overall economy of Sichuan Province has been improving steadily, and the consumption of natural gas is also increasing. 2012, the total consumption of natural gas in Sichuan Province was 15.3 billion cubic meters, accounting for 32.83% of the national consumption of natural gas. 2020, the total consumption of natural gas in Sichuan Province will be 26.18 billion cubic meters[5], accounting for 7.23% of the national consumption of natural gas. The average annual growth rate of natural gas consumption is 6.9%[6]. Meanwhile, in response to the national call for low-carbon development, energy consumption in Sichuan Province has gradually shifted from coal-based to natural gas and other clean energy. According to the survey, in 2012, natural gas consumption in Sichuan Province accounted for 12.04%, in

2020, natural gas consumption in Sichuan Province accounted for 21.30%, a very significant increase, which indicates that natural gas and other clean energy has occupied an important position in the structure of energy consumption in Sichuan Province.

In 2020, the total natural gas consumption in Sichuan Province will be 26.18 billion cubic meters, and the terminal natural gas consumption will be dominated by the secondary industry, with a consumption of 16.94 billion cubic meters, accounting for 64.7% of the overall consumption; the consumption of the primary industry will be 0.9 billion cubic meters, accounting for only 0.3% of the overall consumption; the consumption of the tertiary industry will be 1.9 billion cubic meters, accounting for 7.3% of the overall consumption; and the consumption of residential life will be 5.43 billion cubic meters. consumption was 5.43 billion cubic meters, accounting for 20.7% of the overall consumption.

3. Model Construction

3.1. Overview of the LEAP Model

Among the many scenario analysis methods, the LEAP model is a classic and practical tool for energy analysis. The LEAP model is a scenario-based energy-environmental analysis tool developed by the Stockholm Environment Institute. The advantage of the LEAP model is that it utilizes scenario analysis in energy demand planning and climate change assessment. Researchers can use the LEAP model to set up different scenarios based on the current development status and published policies, as well as different understandings of future socio-economic and energy development, and input the key indicators of future energy demand and climate change in various scenarios into the model, which will provide reference for decision makers by predicting the demand for different energy sources and greenhouse gas emissions under different scenarios.

The LEAP model provides several modules for researchers, and its main functions include energy demand forecasting, energy conversion analysis, resource analysis, and environmental impact assessment. Among them, the energy demand forecast module (Demand) is the core functional module in the LEAP model, and its main function is to establish a reasonable data structure according to the actual situation of the study, as well as set up the relationship between the energy demand and the key variables under different scenarios to calculate the energy demand in a certain period of time in the future. The energy transformation module (Transformation) is based on the results of the forecast of terminal energy demand, with reference to the conversion efficiency of various energy sources in the production process, and calculates the amount of energy supply that needs to be invested in order to reach a balance between supply and demand. For self-produced energy can not meet the demand, the model can also be set according to the scenario to calculate the need to import the type and amount of energy. Resource module (Resource) is used to analyze the availability of basic resources (including fossil energy and new energy), and can also be used to analyze the economic and social feasibility of basic resources and fuels in self-production and import and export. For example, although some resources can satisfy energy demand and are economically viable, if the production process of the resource will cause serious environmental and social impacts, the final energy planning decisions should also try to give up or reduce the use of the resource. LEAP model and software research team also developed a country-level initial data-set for 104 developing countries, including China. These data combine historical data on energy balances from IEA reports, emission factors from the IPCC, UN population development projections, development indicators from the World Bank, GHG emission sources and sinks for non-energy components from the World Resources Institute (WRI), and energy resource data from the World Energy Council. These data are not used for projections, but only to maintain continuity in the production of international data by countries and for more detailed historical data

analysis in developing countries. The initial data-set provided for China (China-Starter) adds stock change, statistical differences and Non-Energy Sector to the data branches. The key assumptions provide the main economic and social development indicators and data between 1971 and 2008, such as GDP, industrial value added, population, income level, and transportation status. During the research process, the researcher can select the initial data needed according to the specific context.

Since natural gas is a primary energy source that can be directly used directly as an end-use energy source, this paper uses the Energy Demand Forecasting Module in LEAP to analyze the scenario of natural gas consumption demand.

3.2. Data Sources

This article takes 2020 as the base year, and the data of Sichuan Province's GDP, GDP of each industry, population, urbanization rate, energy consumption, etc. in the base year are obtained from the "2021 Sichuan Statistical Yearbook", the "Outline of the 13th Five-Year Plan of Sichuan Province", the data of departmental surveys and the relevant development planning reports, etc. The data of GDP growth rate and population growth rate are calculated based on data of previous years with reference to the "Outline of the 14th Five-Year Plan of Sichuan Province". The data of GDP growth rate and population growth rate are calculated according to the data of past years. The urbanization rate and other data come from the Medium and Long-term Plan for Population Development of Sichuan Province. Sectoral technical variables (energy use efficiency of energy-consuming equipment, energy intensity of each sector) are set on the basis of a synthesis of the changes in energy intensity over the past ten years in Sichuan Province and various plans and reports issued, as well as domestic and foreign related literature.

3.3. Construction of the LEAP Modeling Framework

3.3.1. LEAP Model Structure

Table 1. LEAP model of natural gas consumption in Sichuan Province

	Gas-consuming sectors	Sub-sector	Sub-sector	Energy Consumption
	Natural Gas Demand in Sichuan Province	People's Livelihood	City	
Countryside				
Industry Sector		Primary sector of industry	Agriculture, forestry, fisheries and livestock	
		Secondary sector of industry	Industries	
			Building Industry	
		Tertiary sector of industry	Traffic, Transportation	
			Wholesale trade, Retail trade, Accommodation, Restaurants	
			Other industries	

Natural gas is a primary energy source that can be used as an end-use energy source, therefore, this paper only considers the consumption of natural gas by the end-use sector. With reference to China's energy statistics system and the international common way of dividing energy consumption sectors, the natural gas consumption sector in Sichuan Province is firstly divided into two sectors: industrial sector and residential sector. The residential sector is divided into rural and urban sectors. The industrial sector is divided into primary industry, secondary industry and tertiary industry. The primary sector includes agriculture, forestry, animal husbandry and fishery, the secondary sector is subdivided into industry and construction, and

the tertiary sector is divided into transportation, warehousing and postal services, commerce (wholesale and retail trade[7], accommodation and catering) and other industries. This is shown in Table 1 below.

3.3.2. Calculation Method

Total end-use energy demand is the sum of energy demand by sector, and energy demand by sector is the level of activity in each sector multiplied by energy intensity. Here, the level of activity in each sector multiplied by energy intensity is the sum of industry value added (except for the residential sector) or people (residential sector) and energy intensity scores for each sub-sector.

The energy demand for each sector is calculated using the formula:

$$E_n = \sum_i (A_{Li} \times E_{ii}) \quad (1)$$

Where E_n is the end-use energy demand, i is the type of sector, A_{Li} is the activity level of the sector in dollars or persons, and E_{ii} is the energy intensity of the sector, i.e., the energy demand per unit activity level. Since this paper focuses on forecasting natural gas demand for consumption, E_n is the natural gas energy demand of each sector in m^3 . The calorific value of one cubic meter of natural gas combustion is roughly between 8,000 and 8,500 calories, which is 33,494.4 to 35,587.8 kJ. Combined with the relevant data, this paper natural gas in accordance with 0.0342GJ/ m^3 measured natural gas demand in Sichuan Province.

4. Scenario Simulation Analysis

4.1. Scenario Setting

The year 2021 is the first year of China's "14th Five-Year Plan", because the data before 2021 are more complete, and the policies and measures introduced are clearer. Therefore, this paper selects 2020 as the base year to forecast the natural gas demand in Sichuan province under different scenarios from 2020 to 2030.

Through relevant studies, it is found that GDP, energy intensity, urbanization rate, energy conservation measures, etc. are important influencing factors of natural gas consumption in Sichuan Province. Based on the research results, this paper sets up four scenarios, namely, the base scenario (BS), different economic growth rate scenarios (LGDP, HGDP), different energy saving scenarios (LES, DES), and comprehensive scenarios (ED, MD), to analyze the impact of each factor on future natural gas demand in Sichuan Province.

4.1.1. Base Scenario (BS)

The base scenario is the control situation for other scenarios. The base scenario set in this study is based on 2020 data, and the GDP growth rate is set according to the average annual growth rate of the GDP of Sichuan Province, and the growth rate is set at 10%. The industrial structure is set according to the 2020 Sichuan National Economic and Social Development Statistics Bulletin. In 2020, the resident population of Sichuan is 83.71 million, and the population growth rate is set at 0.13% according to the average annual growth rate in the past five years. In 2020, the urbanization rate of Sichuan is 54%, and is expected to reach 60% in 2025 and 66% in 2030. In 2020, according to the official website, the rural gasification rate of Sichuan is estimated to be 0.9%, and the rural gasification rate is estimated to be 0.4%. shows that the rural gasification rate in Sichuan Province is 83.2%, and is expected to reach 90% in 2025 and 96% in 2030, which is set as the base scenario. Energy demand develops naturally on the basis of the past, and the energy intensity decline rate is set with reference to the average decline rate in Sichuan Province from 2016 to 2020 as well as relevant literature, and it is assumed that no further energy-saving and emission-reduction measures will be taken.

4.1.2. Different Economic Growth Scenarios (LGDP, HGDP)

Different economic growth rates are categorized into low economic growth rate (LGDP) and high economic growth rate (HGDP), in which the LGDP scenario assumes that the average annual growth rate of GDP is taken as the expected value of economic growth rate of Sichuan Province during the "14th Five-Year Plan" (6%), while the HGDP scenario assumes that the average annual growth rate of GDP is taken as the expected value of economic growth rate of Sichuan Province during the "12th Five-Year Plan" (12%). The HGDP scenario assumes that the average annual GDP growth rate takes the expected value of Sichuan's economic growth rate during the "12th Five-Year Plan" (12%). The GDP growth rate of each industry in Sichuan Province is set with reference to the average annual growth rate of GDP of each industry from 2016 to 2020, and the rest of the parameter settings are the same as those of the base scenario.

4.1.3. Different Energy Saving and Emission Reduction Scenarios (LES, DES)

The different energy saving and emission reduction scenarios are divided into low energy saving and emission reduction scenarios (LES) and deep energy saving and emission reduction scenarios (DES). The biggest difference between LES and DES is the intensity of the energy saving keypad and the different measures. The low energy saving and emission reduction scenarios (LES) refer to the energy saving and emission reduction policies of the base scenario, promote the low carbon economy, promote the use of natural gas and other clean energy, and contribute to the green transformation of the energy resources of Sichuan Province [8]. Specifically, the GDP growth rate slows down, the proportion of the secondary industry decreases, industries reduce the control of natural gas energy intensity, and natural gas and other clean energy sources increase in the proportion of end-use energy consumption demand. The Deep Energy Saving and Emission Reduction Scenario (DES) is a low emission reduction scenario to further promote a low carbon economy and build a low carbon society, with GDP growth slowing down further, the share of the secondary industry declining further, the control of natural gas energy intensity in various industries reduced further, and natural gas and other clean energy sources accounting for a higher share of end-use energy consumption.

4.1.4. Integrated Scenarios (ED, MD)

The composite scenario is to consider the more extreme case of energy consumption, which is divided into the very large energy consumption scenario (ED) and the very small energy consumption scenario (MD). Among them, the extremely large energy consumption refers to the natural gas demand in Sichuan Province at the high status level, and the GDP growth rate in the scenario is set to the growth rate of the HGDP scenario, which further reduces the rate of decline in energy consumption intensity. Very small energy consumption means that natural gas demand in Sichuan Province is at a comparative status level, the GDP growth rate in the scenario is set to the growth rate of the LGDP scenario, and the rate of decline in energy consumption is higher. The remaining parameters are consistent with the base scenario.

4.2. Natural Gas Demand in Sichuan Province under Different Scenarios

4.2.1. Natural Gas Demand in Sichuan Province under Different Economic Growth Scenarios

Figure 2 shows the natural gas demand in Sichuan Province under different economic growth scenarios. According to the figure, natural gas demand in Sichuan Province is growing with GDP growth from 2020 to 2030. Natural gas demand is measured according to $0.0342\text{GJ}/\text{m}^3$, under the BS scenario, the natural gas demand in Sichuan is in the growth stage, and the natural gas demand in Sichuan province in 2030 is $2.579 \times 10^{11}\text{m}^3$, with a growth rate of 17% and an average annual growth rate of 1.59%; under the HGDP scenario, the economic growth rate of various industries in Sichuan province is faster, and the natural gas demand is in the stage of rapid growth. In 2030, the natural gas demand in Sichuan under the HGDP scenario is

$2.845 \times 10^{11} \text{m}^3$, with a growth rate of 29.1% and an average annual growth rate of 2.59%; under the LGDP scenario, the economic growth rate of industries in Sichuan is slower, and the natural gas demand grows at a slower rate; in 2030, the natural gas demand in Sichuan under the LGDP scenario is $2.333 \times 10^{11} \text{m}^3$ with a The growth rate is 5.9%, and the average annual growth rate is 0.57%. The impact of economic growth rate on natural gas demand in Sichuan Province is mainly reflected in the following: the higher the GDP growth rate, the higher the gross domestic product of each place, the sustained and stable growth of the population, the higher the activity level, and the slower decline of the energy intensity, which leads to a rapid growth in the demand for natural gas and other energy sources in each sector.

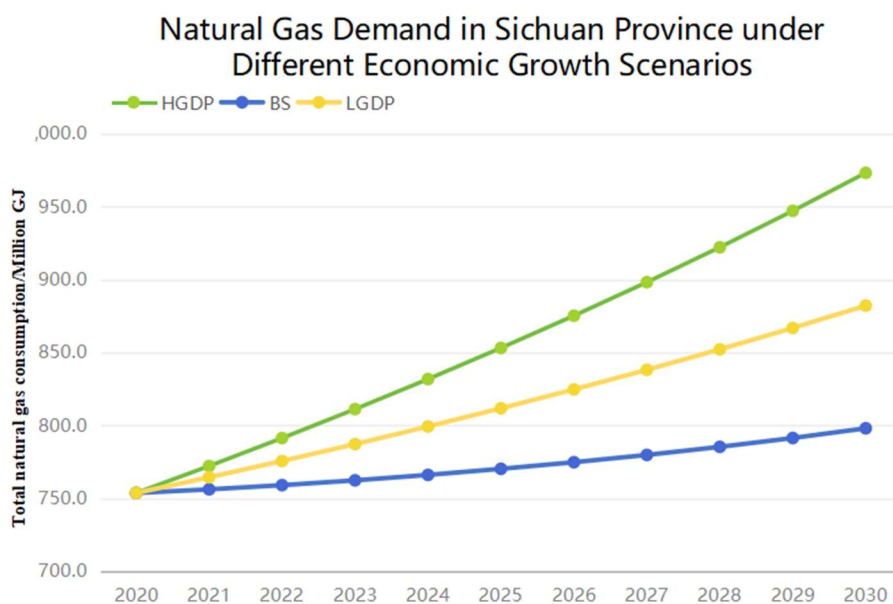


Figure 2. Natural gas demand in Sichuan Province under different economic growth rates

4.2.2. Natural Gas Demand in Sichuan Province under Different Energy Saving and Emission Reduction Scenarios

Figure 3 shows the demand for natural gas in Sichuan Province under different energy saving and emission reduction scenarios. From 2020 to 2030, under different energy saving and emission reduction scenarios, the demand for natural gas in Sichuan Province is generally on an upward trend. Under the BS scenario, in 2030, the demand for natural gas in Sichuan Province will be $2.579 \times 10^{11} \text{m}^3$, with a growth rate of 17%, and the average annual growth rate will be 1.59%; under the LES scenario, in 2030, the natural gas demand in Sichuan Province is $2.616 \times 10^{11} \text{m}^3$, with a growth rate of 18.7% and an average annual growth rate of 1.73%; under the DES scenario, natural gas demand in Sichuan Province is $2.749 \times 10^{11} \text{m}^3$ in 2030, with a growth rate of 24.6% and an average annual growth rate of 2.24%[9]. Under the LES scenario, Sichuan Province promotes a low-carbon economy and reduces the share of the secondary industry. At the same time, the industrial sector accelerates energy transformation, adopts low-carbon energy sources to replace high-carbon energy sources, and the demand for clean energy sources such as natural gas increases. Under the DES Scenario, Sichuan Province further promotes a low-carbon economy and further reduces the share of the secondary industry. At the same time, the industrial sector not only uses a large amount of clean energy, but also further increases the proportion of clean energy such as natural gas in the overall energy structure, which makes the demand for natural gas in Sichuan Province further increase. The demand for natural gas in the residential sector is also gradually increasing with the improvement of the living standard of the residents and the advancement of urbanization.

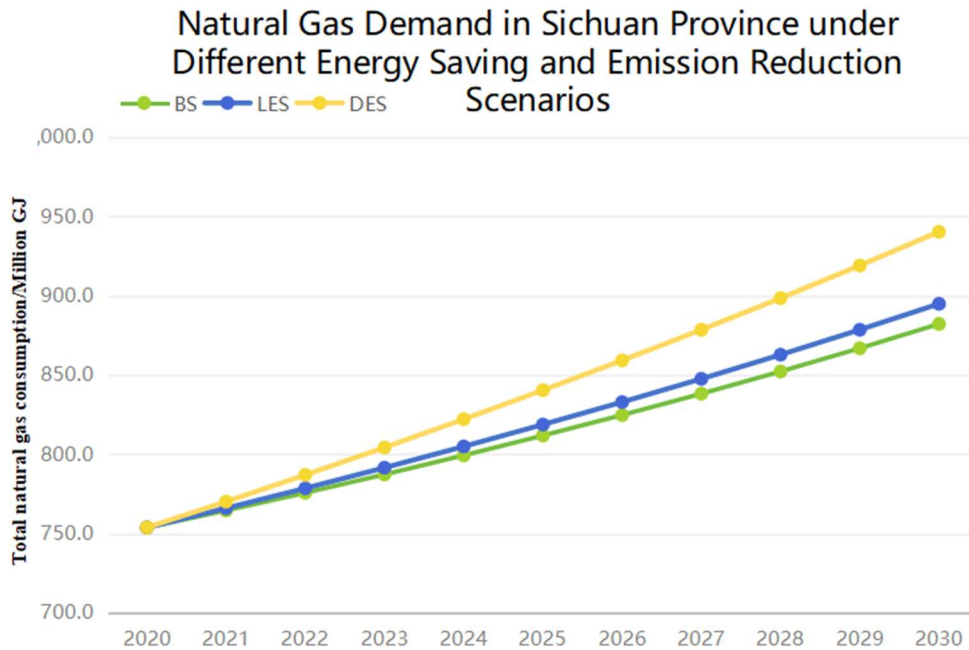


Figure 3. Natural Gas Demand in Sichuan Province under Different Energy Saving and Emission Reduction Scenarios

4.2.3. Natural Gas Demand in Sichuan Province under the Integrated Scenario

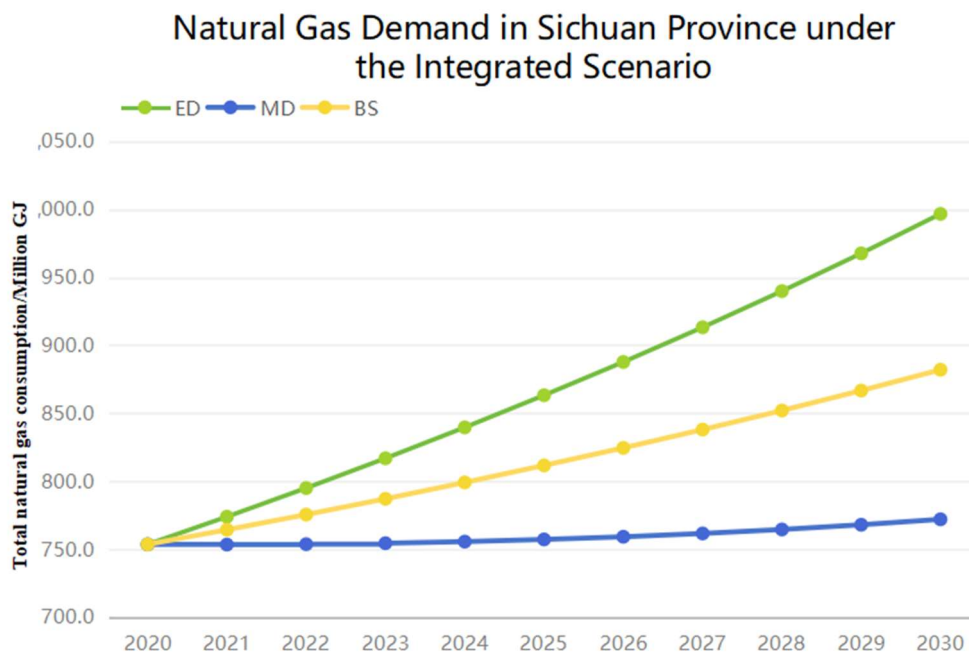


Figure 4. Natural Gas Demand in Sichuan Province under the Integrated Scenario

Figure 4 shows the demand for natural gas in Sichuan Province under the composite scenario. From 2020 to 2030, the demand for natural gas in Sichuan Province under the composite scenario is generally on an upward trend. Under the BS scenario, in 2030, the demand for natural gas in Sichuan Province is $2.579 \times 10^{11} \text{m}^3$, with a growth rate of 17%, and an average annual growth rate of 1.59%; under the ED scenario, in 2030, the demand for natural gas in Sichuan Province is $2.914 \times 10^{11} \text{m}^3$, with a growth rate of 32.2% and an average annual growth rate of 2.83%; under the MD scenario, in 2030, natural gas demand in Sichuan Province is $2.258 \times 10^{11} \text{m}^3$, with a growth rate of 2.4% and an average annual growth rate of 0.24%. Under the high energy consumption scenario (ED), the demand for natural gas in Sichuan Province rises sharply because of the accelerated GDP growth rate, the fast growth rate of the gross

domestic product of all industries, and the lower rate of decline in energy intensity compared with the other scenarios. Under the low energy consumption scenario (LECS), GDP growth slows down and the rate of decline in energy intensity is higher than in the other scenarios. During the period 2020-2021, the demand for natural gas in Sichuan Province has a slight downward trend, but because of the large industrial base in Sichuan Province, the demand for natural gas turns into a sustained upward trend with the continuous rise in the level of regional activity.

4.3. Projections of Natural Gas Demand by Industry under Different Energy Efficiency and Emission Reduction Scenarios

Since this study is based on the "dual-carbon" background of natural gas demand forecasting in Sichuan Province, it is particularly important to accelerate the energy transition, increase the proportion of clean energy, and fulfill the national goal of "carbon peaking and carbon neutral". Therefore, this section focuses on analyzing the demand for natural gas in Sichuan Province by industry and its share under different energy saving and emission reduction scenarios.

4.3.1. Demand for Natural Gas in Different Sectors in the Baseline Scenario

Figure 5 shows the natural gas demand of different industries in Sichuan Province in 2020-2030 under the baseline scenario. From the viewpoint of the natural gas demand structure of different industries, industry is the main industry of natural gas consumption in Sichuan Province, with an overall share of 54.5% and an average annual natural gas demand of $1.298 \times 10^{11} \text{m}^3$, and the share of consumption demand continues to rise steadily. This is followed by residential life, with an overall share of 15.6%, which is the second mainstay of natural gas consumption in Sichuan Province. This is followed by transportation, postal & storage, with a demand share of 9.9%. Construction, wholesale, retail, accommodation and catering, agriculture, forestry, fishery and animal husbandry as well as other industries accounted for 9.3%, 5.4%, 0.57% and 4.7% respectively. The industry with the smallest share of natural gas demand was construction, with an overall share of only 0.1%.

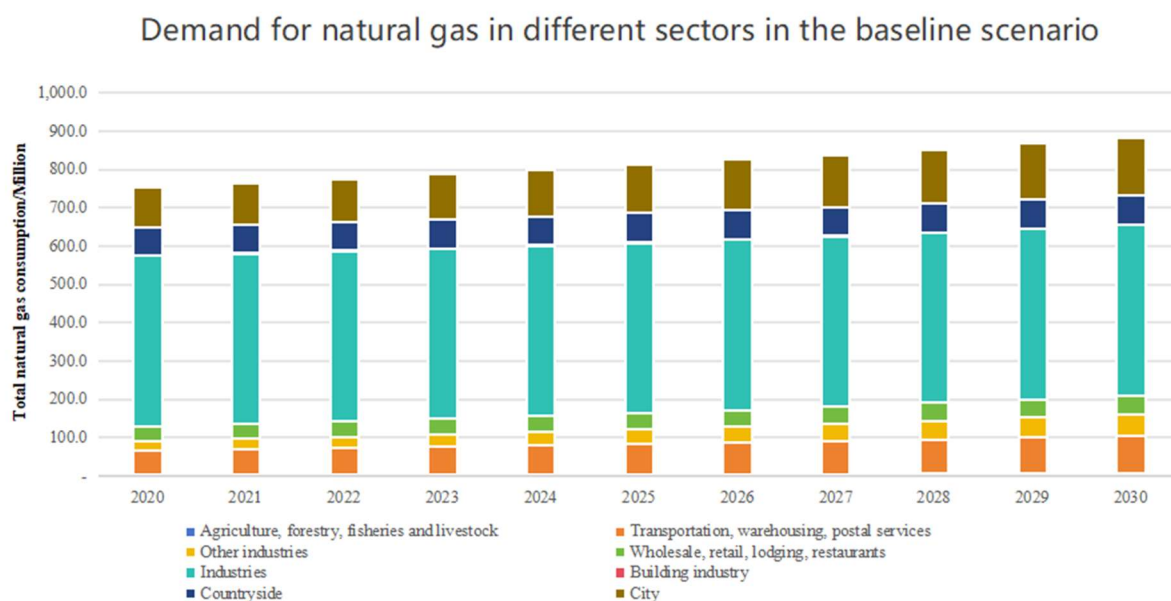


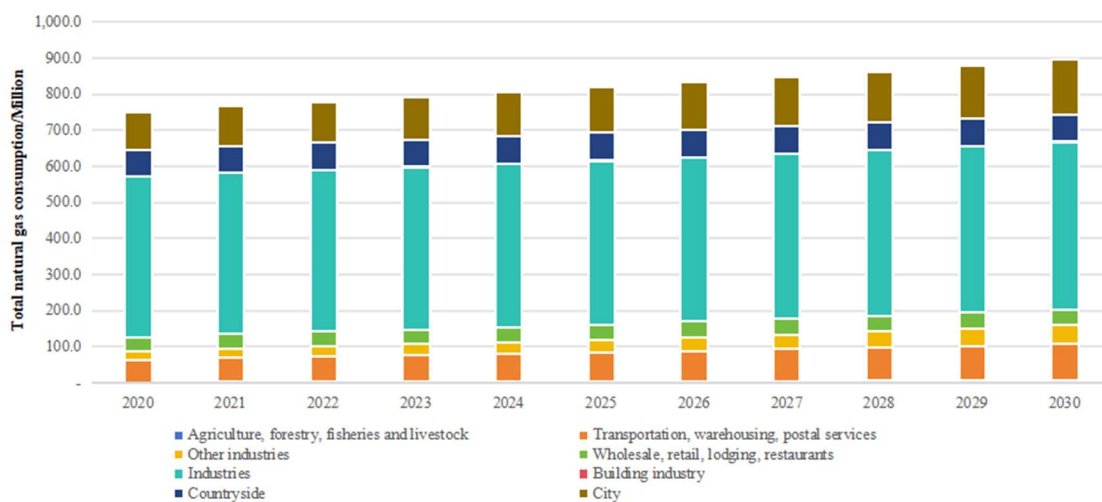
Figure 5. Demand for natural gas in different sectors in the baseline scenario

4.3.2. Demand for Natural Gas in Different Sectors under LES and DES Reduction Scenarios

Figures 6 to 7 show the natural gas demand of different industries in Sichuan Province in 2020-2030 under the Low Emission Reduction Scenario and Deep Emission Reduction Scenario.

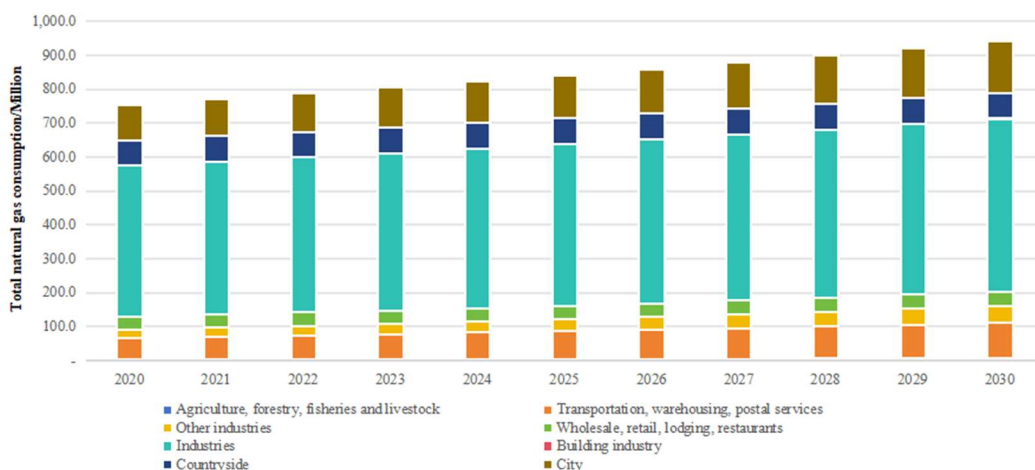
Compared with the baseline scenario, the natural gas demand of each industry in the low and deep emission reduction scenarios increases, and the average annual natural gas demand of each industry is $2.38 \times 10^{11} \text{m}^3$ (BS), $2.4 \times 10^{11} \text{m}^3$ (LES), and $2.46 \times 10^{11} \text{m}^3$ (DES), respectively. Among the industries, the most significant increase in natural gas demand was in industry, where the average annual demand increased from $1.298 \times 10^{11} \text{m}^3$ (BS) to an annual average of $1.326 \times 10^{11} \text{m}^3$ (LES) and $1.39 \times 10^{11} \text{m}^3$ (DES), and the overall share increased to 55.2% (LES) and 56.4% (DES) than . Transportation, postal services, warehousing, wholesale and retail industries all have varying degrees of growth. From the trend of natural gas demand changes in Sichuan province by industry in 2020-2030, it is found that compared with the baseline scenario, the natural gas demand of all industries in the low emission reduction scenario and deep emission reduction scenario have a stable upward trend, and the natural gas demand of all industries in the deep emission reduction scenario has a greater increase. This shows that the greater the intensity of energy saving and emission reduction, the greater the demand for clean energy such as natural gas in each industry, and the greater the share of natural gas in the consumption of various energy sources.

Demand for natural gas in different sectors in the LES scenario



Figures 6. Demand for natural gas in different sectors under LES scenario

Demand for natural gas in different sectors in the DES scenario



Figures 7. Demand for natural gas in different sectors under DES scenario

5. Conclusion and Recommendations

This paper sets up four different scenarios based on the LEAP model, forecasts and analyzes the natural gas demand in Sichuan Province in 2020-2030 under different scenarios, and focuses on the natural gas demand of various industries in Sichuan Province under different energy saving and emission reduction scenarios.

(1) In terms of the overall situation, natural gas demand in Sichuan Province maintains a steady upward trend in all scenarios. In terms of sub-scenarios, a faster economic growth rate will increase the demand for natural gas while keeping other factors constant, and the demand for natural gas in Sichuan Province under the high economic growth rate scenario will reach $2.845 \times 10^{11} \text{m}^3$ in 2030; stronger emission reduction measures will also increase the demand for natural gas, and the demand for natural gas in Sichuan Province under the deep emission reduction scenario will reach $2.749 \times 10^{11} \text{m}^3$; under the combination of economic growth and stronger emission reduction measures, the demand for natural gas will be maximized, and in 2030, the demand for natural gas in Sichuan Province under the very large energy consumption scenario will reach $2.914 \times 10^{11} \text{m}^3$.

(2) Under different energy saving and emission reduction scenarios, the natural gas consumption demand of various sectors in Sichuan Province basically remains stable, and the stronger the energy saving and emission reduction, the higher the natural gas demand. Among the various sectors, the natural gas consumption demand of industry accounts for the highest proportion and has a stable upward trend, followed by the residential living sector and other industries. Therefore, Sichuan Province should guarantee the stable development of the natural gas industry and provide better protection for the natural gas industry. On the government side, relevant policies should be issued to promote the development of the natural gas industry, maintain the orderly development of the whole industrial chain from upstream development to downstream market consumption, and safeguard the infrastructure. In terms of technology, enterprises should be encouraged to develop new technologies to reduce energy consumption and losses in the process of natural gas extraction and transportation, so as to maximize the supply of natural gas. At the same time, the urbanization rate and gasification rate of Sichuan Province should be accelerated. Accelerating the energy transition and moving closer to a deep emissions reduction scenario will ensure stable economic development in Sichuan Province while rapidly realizing the "dual-carbon" goal.

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