

# Priorities for the development of the petrochemical industry as part of the fuel and energy complex of Kazakhstan

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**Abstract.** The article presents the results of a study on the development of the petrochemical industry, which is part of the structure of the fuel and energy complex of Kazakhstan. The development of the petrochemical industry of the country is carried out through the creation of a petrochemical cluster and the construction of plants for the production of petrochemical products (polyethylene, butadiene, polypropylene, polyethylene terephthalate), which are geographically located in the western region of the country, where the main hydrocarbon reserves are concentrated, large oil and gas production enterprises operate, there are necessary infrastructure facilities. Forecast indicators of the development of petrochemistry, technical and economic characteristics of petrochemical projects are given. Information is presented on the development of the petrochemical cluster and the organization of the production of each petrochemical product separately. The authors carried out forecast calculations for import substitution and export in the implementation of petrochemical development projects in Kazakhstan. The purpose of the article is to conduct a predictive analysis of the development of the petrochemical industry in Kazakhstan, since this branch of the national economy is still at the stage of formation.

## 1 Introduction

In the industrial structure of the national economy of Kazakhstan, the fuel and energy complex (FEC) is the main sector. Revenues from the export of products of the fuel and energy complex sectors account for half of the state budget. In Kazakhstan, the main natural resources for the functioning and development of the fuel and energy complex are coal, natural uranium, crude oil, natural gas, gas condensate. The industries of the fuel and energy complex of the country are formed on the extraction, transportation, processing, sale of each of the indicated natural and raw materials: the coal industry, the nuclear industry, the oil and gas industry, the petrochemical industry.

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In 2023, the Government of Kazakhstan adopted a new Concept for the Development of the Fuel and Energy Complex for 2023–2029 [1]. The main priorities of the Concept are systematized in Table 1.

**Table 1.** Priorities for the development of the fuel and energy complex of Kazakhstan.

Industry	Priority	Indicator	Achievement period
Electric power	Commissioning of new capacities	The power of generated electricity is 11.7 gigawatts	2029
Coal industry	Increasing coal	117 million tons	2028
Atomic industry	Digitalization of the leading company National Atomic Company Kazatomprom	Automation and digitalization of the entire production	2028
Oil industry	Increase in crude oil production	76 million tons	2029
Gas industry	Growth of production up to 30 billion m <sup>3</sup>	Up to 30 billion m <sup>3</sup>	2029
Petrochemical industry	Implementation of investment projects	1.8 million tons	2029

Grouped and systematized by the authors based on the source [1].

The information presented in Table 1 shows that the oil, gas and petrochemical industries are the structure-forming fuel and energy complex of Kazakhstan. The petrochemical industry is the main priority for the diversification of the oil and gas complex of Kazakhstan. The issues of investing in the development of the manufacturing sector for the production of refined products and petrochemicals are becoming relevant in order to reduce the dependence of oil and gas exporting countries on world prices for hydrocarbon products. The growth in the production of value-added processed products in the oil and gas industry increases the country's GDP and the income from their exports in the national fund.

## 2 Materials and methods

Scientists from different countries are studying the issues of the functioning of the petrochemical industry, its features, its role in the fuel and energy complex and in the system of national economies, the effectiveness of investments in the development of petrochemicals. J.Price studied the place of petrochemical complexes in the world energy markets, the issues of replacing traditional fuels with methanol, ethanol and liquefied natural gases, ways to improve global fuel efficiency standards [2]. Issues of oil refining and petrochemistry, planning of the petrochemical industry and the history of its development, integration of oil refining and petrochemical enterprises, features of the petrochemical industry, design and risk management under uncertainty are presented in the book by Y. Khalid [3]. The authors M.Smith, M.Whalen, A.Hussain and others reveal promising investments in the US petrochemical industry, what may be barriers to the implementation of investment projects in the petrochemical industry, how to optimize the management of such projects [4]. The development of the petrochemical industry, as part of the Saudi Arabian fuel and energy complex diversification policy until 2030, was studied by the authors K. Alkathlan, T. Alkhateeb, H. Mahmood & W. Bindabe [5]. The problems of world production of petrochemical products are substantiated by the authors I. Guliyev, E. Mehdiyev and others [6]. The potential for the development of the petrochemical industry was revealed by D. Galliamova & M. Shinkevich [7], the cluster approach to the

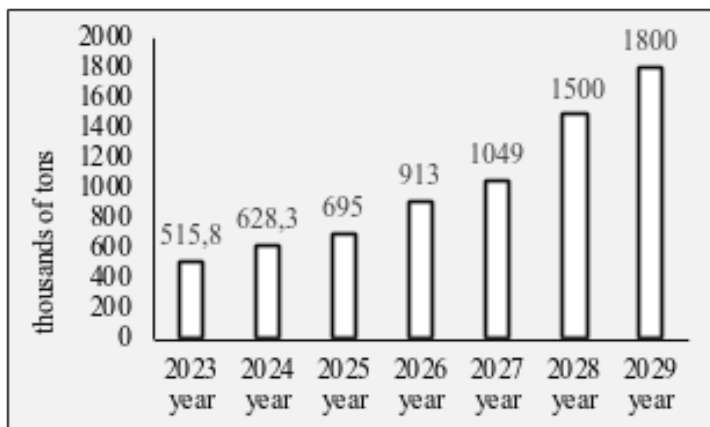
development of oil refining was considered by T. Permyakova and R. Faizullin [8], the evaluation of the effectiveness of oil refining investment projects was presented by E. Yakovleva [9], M. Kashirina and A Malafeeva [10]. The results of scientific research on the issues and problems under consideration were published by Kazakh scientists S. Smagulova [11], N. Nurlanova and A. Omarov [12], A. Suleimenova and A. Panzabekova [13], O. Egorov and O. Chigarkina [14, 15]. Literature review can be carried out on different aspects.

The authors of this article are implementing a scientific project on the effectiveness of investments in the petrochemical industry of Kazakhstan. In this regard, the article discusses the results of research on the development of the petrochemical industry of the Republic of Kazakhstan over the past 2–3 years and, in the future, which are not reflected in the publications of other authors.

### 3 Results and Discussion

The petrochemical industry of Kazakhstan is currently at the stage of formation. According to the authors' calculations, the share of petrochemical production in the total fuel and energy complex of Kazakhstan in 2022 was only 1%, while crude oil production was 70%. The main task of Kazakhstan is to increase the share of petrochemical products with high added value and reduce the share of exports of crude oil and gas condensate.

According to the Development Concept for the Fuel and Energy Complex of Kazakhstan, the volume of petrochemical production in 2029 will be 1,800 thousand tons (Figure 1).



**Fig. 1.** Forecast of petrochemical production in Kazakhstan.

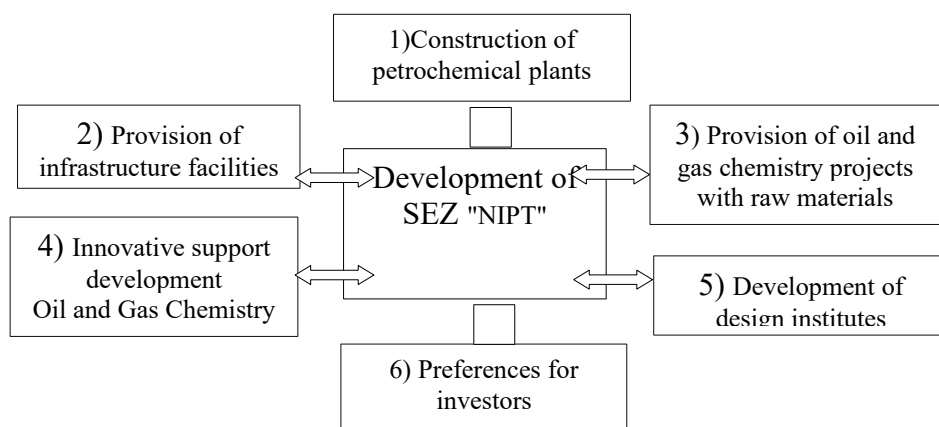
Figure 1 shows that by 2029, relative to 2023, Kazakhstani petrochemical products should increase by almost 3.5 times.

To achieve these indicators, priority areas for the development of the country's petrochemical industry have been identified:

- Development of the Special Economic Zone "National Industrial Petrochemical Technopark".
- Construction of a plant for the production of polypropylene.
- Construction of a plant for the production of polyethylene.
- Construction of a plant for the production of butadiene.
- Construction of a plant for the production of polyethylene terephthalate.

The special economic zone "National Industrial Petrochemical Technopark" (SEZ "NIPT") on the territory of 3.6 thousand hectares was created as a cluster in the Atyrau region of the Republic of Kazakhstan in 2007 with a term of operation until the end of 2018. In the Western region of Kazakhstan, where the main hydrocarbon reserves have been built and oil and gas are being produced, there are the necessary infrastructure facilities, and a petrochemical cluster is being formed.

In Figure 2, the authors show a grouping of activities for the further development of the SEZ "NIPT".



**Fig. 2.** Directions for the development of the Special Economic Zone "National Industrial Petrochemical Technopark" in Kazakhstan.

- Plants for the production of petrochemical products (polyethylene, butadiene, polypropylene, polyethylene terephthalate) will be located on the territory of the SEZ "NIPT", since the necessary infrastructure has been created and the extraction of oil and gas raw materials is carried out on the territory of the Western region of Kazakhstan.

The construction of petrochemical plants in one area will promote synergy in the production of basic petrochemical products in one cluster. So, for the production of polyethylene, the intermediate product ethylene can be used to produce polypropylene with improved qualities and monoethylene glycol, which, in turn, is necessary for the production of polyethylene terephthalate. Hydrogen obtained in the production of basic petrochemical products will be used in the production of carbamide (fertilizer). Thus, the synergy of projects for the production of polypropylene and polyethylene contributes to the organization of 3 new productions of petrochemical products. Currently, 15 petrochemical projects have been registered on the territory of SEZ "NIPT".

- Petrochemical plants require special infrastructure. On the territory of SEZ "NIPT" infrastructure facilities: access road (5.3 km), access railway (8.5 km), railway station (7.1 km), substations (110/35/10 kV and 220/110/ 35 kV), power lines (110 kV and 220 kV), fuel gas pipeline (6.7 km), combined-cycle gas turbine power plant (310 MW), water treatment and wastewater treatment plant (15 thousand m<sup>3</sup>/day), compressed air and nitrogen production plant (85 thousand m<sup>3</sup>/hour). It is planned to build the second stages of the last two installations.

Power is supplied from a combined cycle gas turbine power plant. Water supply is supplied to water treatment facilities from the Astrakhan-Mangyshlak main water pipeline. Fuel gas comes from the Makat-Northern Caucasus gas pipeline. A gas pipeline will be built for reserve gas consumption from the Central Asia-Center main line. As of 2023, the completion of the infrastructure on the territory of the SEZ "NIPT" is 72.2% [16].

- For the effective functioning of petrochemical plants, the main issue is the provision of hydrocarbon raw materials at an affordable cost. One of the important aspects of reducing the price of raw materials, as a rule, is the reduction of transportation costs. In addition, the close placement of raw materials for factories guarantees the uninterrupted organization of production processes and the resolution of issues in the operational mode in the event of unaccounted for risks related to the availability of raw materials reserves. SEZ "NIPT" is located in the Atyrau region, where about 25 oil and gas producing enterprises operate, including large companies such as Tengizchevroil, Embamunaigas, Maten Petroleum. The Tengiz and Kashagan oil fields provide petrochemical projects with raw materials.
- Innovative support for the petrochemical industry includes the training of professional personnel, financing of research and development work for the development of petrochemistry, the creation of special laboratories according to world standards. Until 2025, transparency is expected in the financing of subsoil users in the amount of 1% of the cost of extracting hydrocarbon resources for the development of scientific research.
- Further development of design institutes in the petrochemical industry. There are currently no special design institutes in petrochemistry in Kazakhstan. It is planned to create a design organization on the basis of the vertically integrated national company JSC NC KazMunayGas - the main quasi-state structure for managing the oil and gas complex of Kazakhstan.
- For investors and participants of SEZ "NIPT" there are various tax preferences, amounting to 0% (land tax, property tax, customs duties). Simplified procedures have been developed for attracting foreign specialists, registering export-import operations, and providing public services.

The main technical and economic indicators of investment projects for the construction of plants for the production of polyethylene, butadiene, polypropylene, polyethylene terephthalate (PET) are presented in Table 2.

**Table 2.** Technical and economic indicators of priority petrochemical projects in Kazakhstan.

Index	Production			
	Polypropylene (1-stage) / (1-stage)	polyethylene	butadiene	PET
Investments, billion \$	2.6 / 6.5	7.6	0.96	0.98
Plant capacity, output, thousand tons per year	500 / 1250	1250	186	600
In 2022	548 / 700	875	440	812
Commissioning of the plant, year	2022 / 2025	2029	2024	2028

The creation of a petrochemical cluster in the Atyrau region began with the introduction in 2022 of the 1st stage of the polypropylene production complex. The plant is the first petrochemical plant built in Kazakhstan after independence. The operator is Kazakhstan Petrochemical Industries Inc. LLP, which organized the production complex in the following composition:

- Propane dehydrogenation plant with a capacity of 503 thousand tons per year. Propane processing will be carried out using Lummus Catofin technology.
- Installation of propylene polymerization with a capacity of 500 thousand tons per year. Propylene processing will be carried out using Lummus Novolen technology.
- Finished product warehouse for product packaging 1.5–1.8 thousand tons per day.

The polypropylene project involves the processing of propane into propylene with subsequent production of polypropylene. The end products from polypropylene can be:

packaging materials (films, containers, bags, bottles, containers for transporting goods), raw materials for the production of electronics (insulating shells), raw materials for the manufacture of consumer goods (furniture, toys, household goods), in the production of construction materials for the production of medical instruments (inhalers, syringes, geotextiles), etc.

To create a production facility for the production of polyethylene, the operator KLPE LLP is implementing three projects: the construction of a gas separation plant with a capacity of 9.1 billion cubic meters per year with the extraction of 1.6 million tons of ethane per year, the construction of an ethane pipeline for transporting liquid ethane from Tengiz to Karabatan with a length of 205 km and directly the plant for the production of polyethylene. The construction of a polyethylene production plant includes the following main technological units:

- Installation of steam cracking.
- Installation of polymerization.
- Auxiliary ethylene dimerization unit.

The main raw material for the polyethylene production plant is ethane, which will be supplied through a pipeline from a gas separation unit. The supply of resources necessary to ensure the operation of the plant, including electricity, steam, industrial and other water, is planned from Karabatan Utility Solutions LLP. The high demand for polyethylene is due to the fact that a large number of household and industrial products and goods are made from this polymer, such as, for example, polyethylene pipes, building and packaging materials, etc.

The construction of the plant for the production of butadiene is being carried out by JSC NC KazMunayGas jointly with the Russian enterprise PJSC Tatneft. The project for the production of butadiene and synthetic rubbers is high-tech and includes:

- Installations for dehydrogenation of butane.
- Installation of extraction of butadiene.
- Installation of polymerization for receiving synthetic rubbers.

Rubbers (styrene-butadiene-styrene) and divinyl styrene synthetic rubber) are widely used in the production of automobile tires and road surfaces, as well as in the production of rubber products.

Construction of a plant for the production of polyethylene terephthalate with a capacity of 600 thousand tons. scheduled for completion in 2028. Polyethylene terephthalate materials are used in the manufacture of audio, video and X-ray films, car tires, beverage bottles, films with high barrier properties, fibers for fabrics. In the structure of world consumption of polymers, polyethylene terephthalate accounts for 8% or about 25 million tons per year.

When implementing projects for the development of the petrochemical cluster in Kazakhstan, imports will decrease with an increase in exports of Kazakhstani petrochemical products (Tables 3 and 4).

**Table 3.** Forecast of imports for the main types of petrochemical products, thousand tons.

Petrochemical products	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Polypropylene	33.4	28.7	14.6	14.1	12.9	12.2	11.4	10.5	9.6	8.5	7.4
Polyethylene	176.3	183.3	190.7	198.3	206.2	214.5	223.1	185.6	168.9	150.6	130.5
Butadiene	1.6	1.6	1.7	1.8	1.9	2	6	6.1	6.2	6.3	7.4
PET	60.5	62.5	65.4	68	70.7	73.6	12.8	0	0	0	0

**Table 4.** Export forecast for the main types of petrochemical products, thousand tons.

Petrochemical products	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Polypropylene	33.4	31.3	110.4	257.7	454.3	601.2	598	594.6	591	578.2	583.2
Polyethylene	0	0	0	0	0	0	0	722.6	994.6	993.6	928.5
Butadiene	0	0	0	0	0	0	181.5	181.5	181.5	181.5	181.5
PET	0	0	0	0	0	0	295	350.4	347.3	343.9	340.5

## 4 Conclusion

As a result of the implementation of projects for the development of the petrochemical industry in Kazakhstan:

- Import substitution will be: for polypropylene - by 90%; for polyethylene - 50%; for butadiene - 70%; PET - 100%.
- Annual exports are planned to be increased to: for polypropylene - 583.2 thousand tons; for polyethylene - 928.5 thousand tons; for butadiene - 181.5 thousand tons; PET - 340.5 thousand tons.

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