# Research and Development

In 2025 KMG's R&D policy focused on improving operational efficiency by introducing advanced technology, digitalising production and promoting low-carbon energy. The Group continued to transform into a high-tech energy holding integrating innovation across the entire value chain – from exploration to petrochemical production.

## Strategic priorities and key achievements in 2025

Our R&D efforts focused on four domains to create synergies between science and production.

**Resource replenishment and exploration.**
The Company switched to unconventional surveying methods to unlock the potential of low-permeable layers and new energy resources.

- **New energy:** KMG initiated a large-scale study of natural (white) hydrogen. Potentially productive areas are identified in the Caspian Depression with an estimated production cost of ca. USD 0.5 /kg.
- **Survey technologies:** the Company approved innovative cross-borehole electrical resistivity techniques to create high-precision seismic models and review the potential of several assets (Shygys, Mugodzhary).

**Drilling and well intervention efficiency.**
The focus on optimising well geometry and changing the well management model translated into much lower CAPEX.

- **Lower costs:** rollout of the slim-hole drilling technique at Uzen helped cut costs by 30% and save KZT 4.6 bln.
- **Technological sovereignty:** transitioning of some projects to the split service model and replacement of expensive rotary steerable systems with downhole motors served to optimise costs with no loss of quality.

**Production and development management technologies.**
To stabilise production at mature fields, the Company introduces enhanced oil recovery (EOR) methods and digital monitoring tools.

- **EOR:** commercial application of polymer flooding at Embamunaigas and Mangistaumunaigaz proved to be efficient, with 324 conformance control activities increasing production by over 380 thous. tonnes.
- **Intensification:** multi-stage hydraulic fracturing (up to seven stages) at West Prorva horizontal wells doubled flow rates compared to those initially planned.

**Refining upgrade and petrochemicals.**
The downstream business focuses on deeper refining, energy efficiency, and making products with high added value.

- **Operational reliability:** PKOP and Pavlodar Refinery started to migrate to an extended three-year time between repairs to boost refining volumes.
- **Environment and innovative solutions:** the Company intensified efforts to produce SAF and green hydrogen. Atyrau Refinery is taking steps to recover flare gas and cut emissions by four times.

**Digital transformation and AI**
A shared digital ecosystem centred around the **ABAI** information system is the cornerstone of technology development.

- **Data management:** the Company set up a corporate data bank consolidating over 23,000 geological reports. An in-house digital platform is in place to allow for automatic well testing interpretation.
- **AI in production:** AI-integrated ABAI modules are widely deployed to manage flooding and select well interventions for thous. of wells and flooding elements.

**A glance into the future**
As part of its 2026–2030 R&D programme KMG will keep moving towards decarbonisation and tech leadership. We will continue to prioritise the development of petrochemicals (methanol, urea), hydrogen energy, and CCUS technologies to ensure long-term stability amid energy transition.

## Drilling

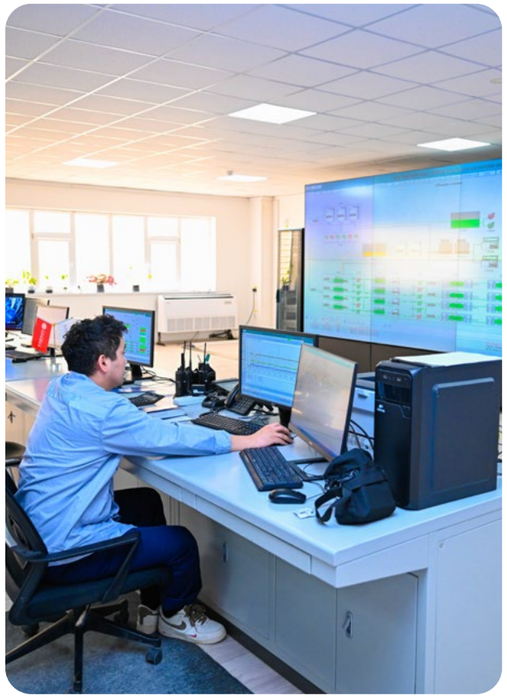
In 2025, we focused on radically cutting CAPEX and improving the quality of well construction. Our strategy hinges on cost-effective techniques and full digital process control.

**Process optimisation and cost-cutting**
We are introducing a differentiated approach to drilling combining high-tech solutions for complex projects with highly cost-efficient technologies for mature fields.

- **Cost efficiency (slim-hole technology)**
  - **Overview:** Ozenmunaigas rolled out slim-hole drilling at Uzen achieving a substantial economy in metals, cement and drilling fluids, and accelerating construction.
  - **Result:** 41 drilled wells (38 injection and three production ones). A 30% cost reduction confirmed.
  - **Financial effect:** KZT 4.6 bln saved in 2025.
  - **Plan:** the large-scale construction of 132 slim-hole wells is planned for 2026.
- **Smart engineering (replacement of rotary steerable systems with downhole motors)**
  - **Solution:** we stopped using the conventional expensive equipment. Instead, we conducted an in-depth analysis of geology at East Urikhtau (wells VU-9 and 10) and Laktybai (well OS-1) to substantiate the replacement of expensive rotary steerable systems with cheaper downhole motors for upper interval drilling.
  - **Effect:** savings of KZT 522.7 mln from construction of a single well at East Urikhtau.
- **Access to hard-to-recover reserves (slant drilling)**
  - **Innovation:** Embamunaigas is introducing 45°-angled slant drilling to recover high-viscosity oil at a depth of 125–210 m. The technology increases reservoir coverage in areas where standard deviation is impossible.
  - **Status:** a drilling rig for pilot wells is mobilised at Koschagyl and Karsak.
- **Global standards adopted at Tengiz (TCO):**
  - The company keeps using a factory model in multi-well pad drilling
  - along with advanced ICD completions and rotary steerable systems to fast forward drilling and ensure high-precision control of the trajectory.

**Digital monitoring and minimising risks**
With online drilling control, we manage uncertainties in real time to hit the pay zones of reservoirs.

- **Drilling control centre**
  - Mangistaumunaigaz, Embamunaigas, and Kazakhturkmunay put in place round-the-clock online monitoring of key parameters (bottomhole assemblies, hydraulics, ECD) at complex horizontal wells to enable instant decision-making by the Exploration Drilling Department and minimise accident risks.



- **High-precision geosteering**
  - **Effectiveness:** in 2025, the Company drilled wells at Kenbay, Asar, Saztobe, and other fields, with average effectiveness (the borehole drilled in an oil saturated zone) reaching the record 94.6%.
  - **Techniques:** the Burmasha field applied a combination of seismic modelling with real-time resistivity inversion.
- **Financial transparency**
  - New estimate standards for standalone cost items were designed to replace obsolete Soviet ones, switch to current market prices and ensure transparent pricing (piloted at Embamunaigas and Karazhanbasmunai).

**Transformation of the well management model**
To regain control over the quality of key processes, we depart from the integrated well service model which proved inefficient in overseeing specialised services.

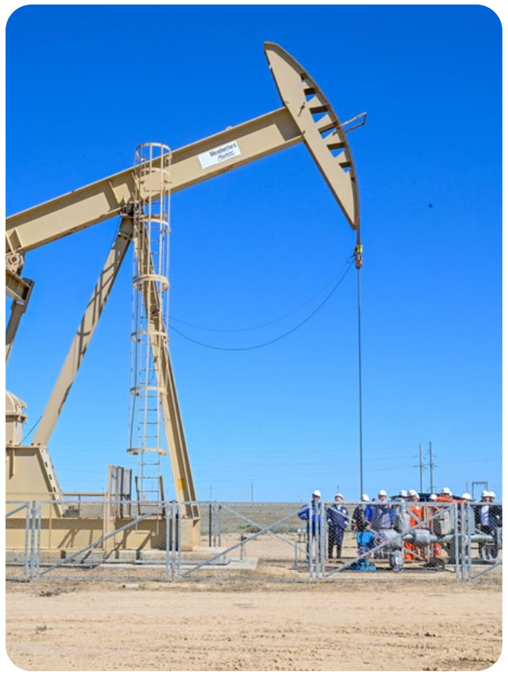
- **New strategy (split service**)
  - A concept for splitting critical services into standalone components is developed for Mangistaumunaigaz, Embamunaigas, Ozenmunaigas, and other subsidiaries and associates.
- **Eliminated from the integrated service model are:**
  - geophysics (geophysical well logging) – to guarantee data reliability;
  - drilling fluids – to control formulations and prevent accidents;
  - cementing – to extend the well life cycle.
- **Tightened oversight:** a one supervisor per rig standard is introduced for the full on-site control.

**R&D and future projects**
The 2026–2030 R&D programme comprises 15 projects addressing specific challenges faced by the Group.

- **Heat resistant cement:** we are developing a special formulation resistant to extreme temperatures during steam injection for Karazhanbasmunai's high-viscosity oil fields.
- **Eliminating formation damage:** we are completing the development of non-damaging well kill methods (Mangistaumunaigaz) to maintain formation productivity post repair.
- **Fluid audit:** we checked treatment systems and issued recommendations on digital modelling of hydraulics and eliminating cleanout quality issues.

**Technological radar (promising solutions)**
The Testing Centre is monitoring the market for breakthrough technologies:

- **Fishbones:** multilateral drilling similar to fishbone technology to stimulate carbonate reservoirs (Mangistaumunaigaz);
- **Liquid Casing:** fluid additive creating an impermeable plug to prevent lost circulation (Zhetybai);
- **Casing drilling:** the technology reduces construction period and eliminates accidents;
- **Tornado and Buran technologies:** efficient borehole cleaning and isolation of flooded sections in horizontal wells.



## Upstream

In 2025, the Upstream business continued to stabilise production at mature fields and maximise oil recovery from major projects. The key drivers were large-scale rollout of EOR methods, inflow stimulation and digital development management.

### Enhanced oil recovery (EOR)

The Company is actively scaling up chemical and thermal stimulation techniques to extend the asset life cycle.

**Polymer flooding (strategic rollout)**

- **Embamunaigas (commercial use):** commercial development started at East Moldabek (Kenbay field), with polymers injected in five wells and cumulative production reaching **4,551 tonnes**. The current deviation from the plan is due to complex geology (flow redistribution), with optimisation measures put in place.
- **Mangistaumunaigaz:** in August 2025, the company successfully started injection at West-1 and 2 sections of Kalamkas, producing extra **1,917 tonnes** of oil. The technology is to be rolled out at the East-3 section.
- **Ozenmunaigas:** a pilot project started at 14-East section of Uzen, with agent concentration adjusted to 1,320 mg/l. Currently there is fluid accumulation in the formation (temporary negative effect), with the project expected to reach design performance.
- **Karazhanbasmunai:** a trilateral contract was signed to introduce SP flooding. Pilot testing at facility II is scheduled for December 2025.

**Flooding management (conformance control and water shut-off)**

- **Scale:** the Group implemented **324 related measures**.
- **Result:** production increment totalled **383.9 thous. tonnes** of oil.
- **Best practices:** technologies proved to be highly efficient at Alibekmola (2,847 tonnes from six wells), Nuraly (1,495 tonnes), and Uzen (126.6 thous. tonnes after 260 operations).

### Well stimulation: high-tech solutions

We apply aggressive well stimulation methods to unlock new opportunities at depleted horizons.

**Next-generation hydraulic fracturing**

- **Breakthrough at West Prorva:** horizontal drilling with multi-stage hydraulic fracturing delivered results exceeding expectations by far. Wells 459 (five stages) and 460 (seven stages) were launched with flow rates of **28 tonnes** and **37 tonnes per day** respectively against the planned 15 tonnes per day.
- **Innovations at Ozenmunaigas:** the company is testing nitrogen foam fracturing and synthetic polymer fluids. The technology will be rolled out in 2026.

**Geology as growth driver (additional perforation)**

- The revision of the geological model at Uzen (transition to discrete NTG estimation) helped identify overlooked oil saturated intervals.
- The additional perforation programme at 10 wells delivered **4,216 tonnes** of oil. At well 6518, the flow rate increased more than ten-fold, from 2.2 to **25–30 tonnes per day**.

**Second life of wells (horizontal sidetracking)**

- We created a portfolio of horizontal sidetracking projects at idle wells of West Prorva and Alibekmola.

### Operational reliability and prevention of complications

We focus on increasing time between repairs and using new materials to reduce OPEX.

**Chemicalisation:** injection of scale inhibitors at Uzen increased time between repairs almost threefold, from 54 to **141** days.

**Equipment:**

- Embamunaigas used 914 special pumps to remove mechanical impurities, which increased mean time between failures by 39% to 367 days;
- Zhetybai and Kalamkas are using reinforced thermoplastic pipes to fight corrosion at the pressure maintenance system;
- Pump rods with protective EXPE coating are recommended for rollout;
- Ozenmunaigas introduced tubing with protective coating.

### Smart Field ecosystem

AI and big data are becoming an integral part of production processes.

**ABAI information system:** the key production assets (Ozenmunaigas, Mangistaumunaigaz, and Kazakhoil Aktobe) are putting in place AI-integrated flooding management modules. By 2030 the system will cover **1,660 flooding elements.**

**In-house development:** a shared digital platform is registered for well test interpretation. The rollout will start in 2026.

**Innovation:** virtual flow metering (neural network) and online telemetry systems (Karachaganak) are tested to ensure instant response to changed parameters.

### Energy efficiency and environment

**Water use:** Karazhanbasmunai drafted an excessive water disposal roadmap, including well conversion to water injection.

**Thermal methods:** Karazhanbasmunai is introducing a water-alternating-steam process to save energy. Embamunaigas is contemplating the use of thermal steam treatment at its assets.

## Refining

KMG's refining operations are undergoing deep technological transformation as the Company shifts focus from the traditional capacity maintenance to solutions maximising added value and ensuring conformance with global green standards (SAF, low-carbon hydrogen, CCUS).

### Three-year repair interval.

We are adopting three-year repair intervals instead of annual suspension.

- **Investment value**: this strategy serves to increase assets' operational readiness rate, reduce maintenance OPEX, and generate additional margins through high-volume refining.
- **Status:** Pursuant to decisions of KMG's Investment Committee, Atyrau, Pavlodar, and Shymkent refineries have entered the active phase of implementing transition to a longer interval between repairs, in line with the approved integrated plan.

### Technology upgrade at Atyrau Refinery: projects are underway to reduce losses and make premium products:

Technology upgrade at Atyrau Refinery: projects are underway to reduce losses and make premium products:

- **Zero flaring (flare gas recovery):** liquid piston compression will help recover **95%** of flare gas (up to 10,000 kg/h). With flare gas going back to the fuel system to replace purchased natural gas and condensate reused in production, the Company reduces emissions by four times and cuts environmental charges.
- **Automatic on-spot loading:** a new station will ensure 100% transitioning to on-spot loading of all light oil products to minimise losses and enhance safety.
- **Anode coke (upgrade of the delayed coker unit):** thanks to a new block of coke drums with a capacity of 1.0 mln tonnes per year, the Company will start producing anode coke essential for the metallurgical industry, increase the yield of light oil products, and enter new export niches.
- **Increased utilisation:** by building naphtha and gas condensate reception infrastructure the Company will increase the utilisation rate of secondary capacities and boost the output of high-margin petrol and jet fuel.

**1. Operational excellence and upgrades of refineries**
The key driver of EBITDA growth in refining is increasing time between repairs and process debottlenecking.

### Energy security (Pavlodar Refinery).

A 12,500 $Nm^3/h$ hydrogen production unit utilising the steam reforming technology is key for winter diesel fuel hydrotreating and production, which reduces Kazakhstan's dependence on imports.

**2. Low-carbon fuels (SAF and hydrogen)**
KMG is creating a portfolio of green chemistry projects to proactively meet ReFuelEU aviation requirements and add premium export products to its range.

### Sustainable aviation fuel (SAF).

SAF can reduce carbon emissions by 64% compared to conventional kerosene, which allows for premium pricing.

- **Quick win (co-processing) strategy:** co-processing of plant-based feedstock at Atyrau Refinery's operating hydrotreating units (Topsoe and Axens technologies) is contemplated as the fastest way to enter the market, as this solution requires less CAPEX compared to new plants.

### Green hydrogen and water security.

We are implementing circular economy principles.

- **Synergies:** we developed a green hydrogen production model via electrolysis using treated wastewater from refineries. Atyrau Refinery successfully closed the water loop to address the shortage of process water.
- **Innovation:** together with Green Spark we are running a pilot (solar power plant + electrolyser) in Atyrau. R&D is ongoing to produce titanium alloys for the safe storage of solid hydrogen. A digital hydrogen atlas is drafted to quickly assess the economic viability of green and blue hydrogen production.

**3. Digitalisation (Industry 4.0)**
A unified digital perimeter will improve asset transparency and accelerate decision-making.

- **Data lake:** over 1,000 data attributes were streamed from site systems to the corporate storage, creating the foundation for the analytical centre.
- **Stock management:** digital tools prevent the freezing of capital in illiquid stocks of spare parts.
- **AI:** we are testing predictive analytics solutions to forecast equipment failure and streamline operation.

## Technology and sustainable development

**1. Energy transition and decarbonisation**
We are actively diversifying our energy portfolio by investing in hydrogen production, renewable energy source, and stringent control over methane emissions.

### Hydrogen economy

- **Natural (white) hydrogen:** a strategic focus is placed on discovering cheap natural hydrogen, with production costs of ca. USD 0.5 / kg set to dramatically change project economics. Archive data confirmed the presence of potentially productive areas in the Caspian Depression ($H_2$ concentration of up to 98–100%). We are now looking for a partner in exploration.
- **Green hydrogen:** an R&D site is set up in Atyrau, a 200 kWh solar power plant is commissioned, and the installation of the electrolyser is nearly finished to develop competencies and ensure autonomous energy supply.
- **Storage technologies:** the Company is financing R&D aimed at building safe solid-state hydrogen cells from titanium alloys to improve logistics.

### Methane management

- **Leak detection (LDAR):** large-scale efforts involving space, airborne, and land-based monitoring tools and supported by Carbon Limits, OGCI, and UNEP's IMEO enabled us to localise critical emission sources at Kazgermunai, Embamunaigas, Mangistaumunaigaz, and Ozenmunaigas.
- **Digitalisation:** the Company is drafting a methane leak atlas to visualise emissions in real time.

### Renewable energy.

Major projects to decarbonise internal consumption are ongoing.

- **Hybrid generation (247 MW):** together with Eni we are implementing a project (wind, solar, and gas power plants) to ensure stable energy supply to our assets. The solar power plant was built in 2025.
- **1 GW wind power plant:** a joint project with TotalEnergies and Samruk-Energy in the Zhambyl Region. The final investment decision will be made in March 2026.
- **Geothermal energy:** we assessed the Uzen (Middle Triassic) potential for green electricity generation from formation water.

**2. Digital transformation and AI**
KMG is migrating to a data-driven model by introducing end-to-end solutions from well to filling station.

- **AI in the ABAI IS:** modules for flooding and well intervention management are being put in place.
- **Computer vision (TUMAR):** a video analytics solution deployed to 60 well workover and servicing crews automatically detects safety violations (no helmet, presence in the hazardous area) to reduce the risk of injury.
- **Predictive analytics:** KPI's plant (petrochemicals) launched a machine learning solution to predict dynamic equipment failures.

### Intellectual logistics.

A single Uber-like platform was created for transport management.

- **Result:** a fully transparent traffic to eliminate misstatement and improper use. The request fulfilment rate reached **97.9–100%**. In 2026–2027 the solution will be rolled out to all production and refining assets.

### Corporate data lake.

We built unified data architecture integrating streams from refineries (over 1,000 tags) and fields into a centralised storage. The solution will supply reliable analytics to accelerate decision-making.