Hydrogen-water nexus in Kazakhstan

Department of alternative energy
KMG Engineering

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I. Overview of Hydrogen deployment in Kazakhstan
II. Barriers for H₂ industry development in RoK
III. Hydrogen-water nexus
Hydrogen Energy in Kazakhstan

- As part of the execution of paragraph 7 of fixing control over the execution of instructions of the President of the Republic of Kazakhstan following the results of the 33rd plenary meeting of the Council of Foreign Investors under the President of the Republic of Kazakhstan, the Ministry of Energy, together with the Ministry of Ecology, Geology and Natural Resources, and JSC NC Kazmunaygas, should develop proposals for the development of hydrogen energy as part of the activities of the Competence Center in new technologies being created. 10 June 2021

- Coordination on the establishment of a Competence Center for Hydrogen Energy at KMG Engineering LLP chaired, Chairman of the Board of JSC NC KazMunayGas. 22 October 2021

- Approval of the Supervisory Board on the new organizational structure of KMG Engineering LLP. January 19, 2022

- Official launch of the first Competence Center for Hydrogen Energy and Hydrogen Technology Research Laboratories in Kazakhstan. April 1, 2022

The Center has been transformed into the Department for Alternative Energy in order to expand its activities since 1 November 2022
Why does Kazakhstan need hydrogen?

Driver 1: Export potential
Two main markets - China and Europe

Driver 2: Carbon tax
CBAM, ETS

Driver 3: Decarbonization
Existing decarbonization actions are insufficient

Potential hydrogen supply and end-users in Kazakhstan

The timeframe for hydrogen end-use in Kazakhstan
Blue and green hydrogen have great potential in Kazakhstan
• Natural gas reserves and existing gas injection facilities for blue hydrogen
• Renewable Energy Resources (RES) for Green Hydrogen

Kazakhstan is closely located between the two largest hydrogen markets. China and Europe will become the largest markets for hydrogen in 2050 with a combined demand of 330 million tons (or 50% of global demand).

According to the World Bank report:
Hydrogen will be mainly used in the domestic market in the production of
• Ammonia
• Methanol
• Steel production

The total volume of the hydrogen market in the Republic of Kazakhstan will amount to 160 billion US dollars. Decarbonization and the Carbon Tax are also major drivers for the development of hydrogen technologies.
Department of alternative energy

To implement the low-carbon development program of JSC NC KazMunayGas, the introduction and development of hydrogen energy is considered as an alternative method. To accomplish the tasks, a team of young, promising, motivated specialists with high-quality international education (graduates of universities in Japan, South Korea, USA, Russia, Nazarbayev University), with experience in research projects and in industry, has been created.

Department for Alternative Energy

Comprehensive analysis of hydrogen technologies
- Review and analysis of international experience in transferring the economy to environmentally friendly fuels (programs, strategies, roadmaps, hydrogen energy standards);
- Detailed analysis of data, research and development, domestic and foreign experience in the production of "blue and green" hydrogen;
- Energy, environmental, economic modeling of production and use of hydrogen.

Research cooperation on hydrogen energy projects
- Search and comprehensive analysis of research projects on hydrogen energy (on the production, storage and transportation, use of hydrogen) for the purpose of partnership and implementation;
- Scientific and technical support of selected research projects and preparation of documentation, reports;
- Preparation of conclusions and recommendations for improving the quality and efficiency of research projects;

Support and advice on pilot projects of KMG on hydrogen energy
- Expert analysis on the designation of production problems and preparation of conclusions and recommendations for pilot projects;
- Consultations in the development of standards, programs and strategies for hydrogen energy (National Roadmap);

Laboratory of Hydrogen Technologies

Research work in the Atyrau branch
- Equipment and launch of the laboratory, organization and planning, development of a quality manual, commissioning;
- Determination of the prospects for the development of a research topic, preparation of experiments on the manufacture of alloys and structural analyzes for the efficient and safe storage and transportation of hydrogen.
Research work in the laboratory block

Cooperation with local and foreign institutions and universities in the framework of R&D projects:
- Kazakh-German University
- Nazarbayev University
- Reiner Lemoine Institute (Germany)
- Tokai University (Japan)
- Green Spark KNT (Italy)

- Development of research projects for the production, storage and use of hydrogen, including metal hydrides as a material for storing and transporting hydrogen
- Green hydrogen production
- Development of fuel cell systems
- Projects for the transportation of hydrogen through the pipeline in the form of gas
- Study of hydrogen embrittlement
- Project scaling up to TRL 7-9

Scientific backlog of the Laboratory for the study of hydrogen technologies:

Purchased equipment for 2022:
- Particle size analyzer
- Differential Scanning Calorimeter
- Gas analyzer

Equipment in KMGE branches:
- Scanning electron microscope (Aktau branch)
- X-ray diffraction analyzer (Atyrau branch)

Application for 2023:
- Ball mill
- Electrochemical sensor
- Heating plate
- Distiller
- Ultrasonic bath
- Scales
- Laboratory furniture

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Publications

Toward a Hydrogen Economy in Kazakhstan, October 2022, Asian Development Bank Institute

The Concept of Large-Scale Blue Hydrogen Production in West Kazakhstan, November 2022, Society of Petroleum Engineering

Realizing the benefits of a hydrogen industry in Kazakhstan, July 2023, International Journal of Hydrogen Energy
Barriers for H2 industry development in RoK

- Preference, and recommendation according to the standards of the Kazakhstan Regional Association Ecological initiative “ECOJER” / In the frame of TC №117 “New energy and alternative energy”/ “Hydrogen technologies”.

- Proposals, and recommendations within the framework of the working group on the Concept for the development of hydrogen energy in the Republic of Kazakhstan until 2040 (Ministry of Energy of the Republic of Kazakhstan).

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- Safe use of hydrogen
- No clear vision for the future of the hydrogen industry: stakeholders are not pushing forward the development of the industry.

Japanese standards related to hydrogen storage materials (material hydrides)
Development of a technical and economic calculation for the production of blue hydrogen

- Limited demand for hydrogen in Kazakhstan (currently only two refineries use “gray” hydrogen).
- The existing industrial infrastructure does not allow for the use of hydrogen without extensive modernization (energy sector).
- There is no demand for low-carbon hydrogen.

Barriers for H2 industry development in RoK

- Creating a value chain
- Infrastructure

- Resources
- Limiting factors
- Subsidiaries and affiliates companies of KMG
- Fields and their plans for gas utilization
Barriers for H2 industry development in RoK

- Introduction, educational training, seminars (Retraining of current specialists)
  
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<td>2023</td>
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<td>Mitsubishi Heavy Industries</td>
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- Training, visiting ongoing projects
  
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<td>TOO Green Spark, Aksai city, Kazakhstan</td>
<td>First pilot project for green hydrogen production</td>
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<td>Hydrogen diplomacy</td>
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<td>2024</td>
<td>Reiner Lemoine Institute, Germany</td>
<td>Assessment of water resources for hydrogen production</td>
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Assessment of water resources for hydrogen production based:

- Qualitatively analyzed data on the water resources of the RoK, as well as the existing potential of renewable energy sources.
- Visualization of estimated data on the availability of water resources in a certain region.
- Analyze various hydrogen production scenarios

Hydrogen production poses a risk to Kazakhstan's water resources:

- Blue hydrogen water consumption (13-17 kg water/H\(_2\)kg)
- Green hydrogen water consumption (9-18 kg water/H\(_2\) kg)
- Blue hydrogen from coal consumes almost four to five times more water (41-86 kg of water /H\(_2\) kg)
Water situation, water for hydrogen

- Water management by basin approach, 8 basins: Aral-Syrdarya, Esil, Ertis, Ile-Balkhash, Tobyl-Torgay, Shy-Talas, Nura-Sarysy, Zhaiyk-Caspian basins;

- The total amount of water resources is around 100 km³ of which 57 km³ are formed on the territory of Kazakhstan and the rest of the volume comes from riparian countries;

- The main water consumers: agriculture - 65%; industry – 25%; public utilities and household needs;

- Main issues on water sector:
  - water quality for drinking water;
  - old and physical deterioration of water infrastructure;
  - nonrational use of water;
  - water stress on irrigation period in southern regions;
  - insufficient protection against floods;
  - low volume of recycled water in industry (processing for purification);
  - pollution of water bodies;

- Water for hydrogen
  - Industrial and house-hold waste water;
  - flood and precipitation water;
  - Available surface water;

Water consumption by economic sectors in Atyrau and Mangystau regions
Hydrogen-water nexus

Collaboration with Reiner Lemoine Institut developing the web Atlas of hydrogen:

Zhaiyk-Caspian basin, 4 region: Atyrau, Aktobe, Mangystau, West Kazakhstan regions.

- assessment of water resources through remote sensing
  - surface water (lake, rivers);
  - contract territories of ground water
  - precipitation;

- potential of renewable energy
  - solar (GHI, PVOUT);
  - wind (wind speed, wind power density);

- other
  - DEM (Digital Elevation Model);
  - land cover;
  - nature reserves;
  - roads;
  - gas pipeline;
  - urban area, settlements;

- Cost of hydrogen
  - LCOE
  - LCOH
Final remarks

- KMG will start the green hydrogen use from 2025.
- Low-carbon hydrogen derivatives are in the scope of ongoing conceptual studies.

- Analysis of hydrogen production opportunities in Kazakhstan
  - Green hydrogen
  - Blue hydrogen

- Hydrogen storage experiments
  - Synthesis of metal hydrides
  - Study scaling

- Formation of the hydrogen energy market

- Standards and regulations
- CCUS
- R&D
- Pilot projects

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TH2ANK YOU!