

Hydrogen energy in Kazakhstan: status quo and perspective

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January, 2023 Tokyo



КМГ
ИНЖИНИРИНГ

Outline

- **Introduction**
 - Energy transition in Kazakhstan
 - About our center
- **Why does Kazakhstan need hydrogen?**
 - Decarbonization in Kazakhstan
 - Carbon regulation and hydrogen
 - Export potential
- **Establishing hydrogen technologies in Kazakhstan**
 - Low-carbon hydrogen production
 - Hydrogen storage & transportation
 - Hydrogen utilization
- **Conclusion**
 - Recommendations for establishing hydrogen economy in Kazakhstan
 - Plans for our center

Introduction

- Kazakhstan is a major fossil energy exporter:
 - 9th largest coal exporter
 - 9th largest crude oil exporter
 - 12th largest natural gas exporter
- Kazakhstan is a major fossil energy consumer:
 - Fossil fuel-dominated energy generation
 - Economy is driven by energy-intensive extracting and processing of natural resources

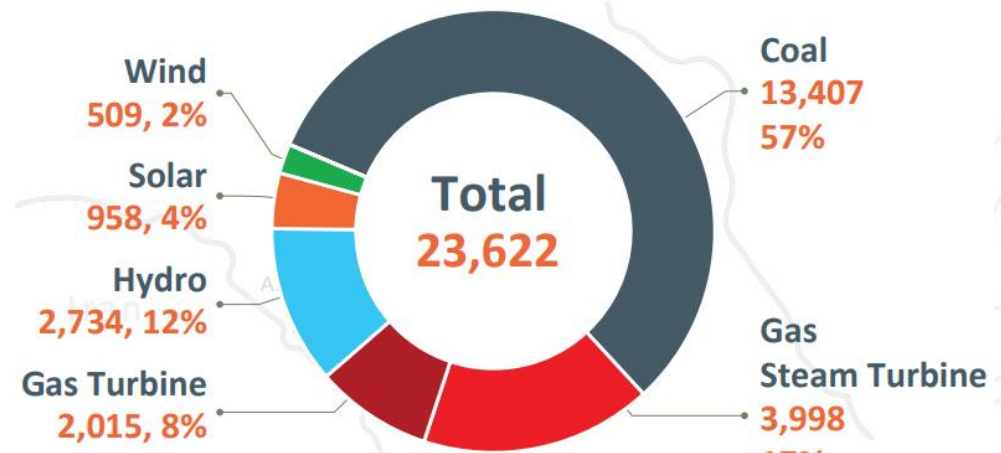


Figure 1. Power generation in KZ as of 2020 (Source: KazEnergy 2021)

- Kazakhstan recognizes the importance of the climate agenda
 - The power capacity by RES is increasing in Kazakhstan (1.47 GW capacity as of 2020)
 - But RES is not a solution to all emission sectors
 - The development of hydrogen and CCS/CCUS

Introduction

- National Company “KMG”/ KazMunaiGas/ Kazakh Oil and Gas
- Subsidiary **KMG Engineering** → research, technical and engineering support for the processes of oil and gas production, transportation and processing of oil and gas in the country.



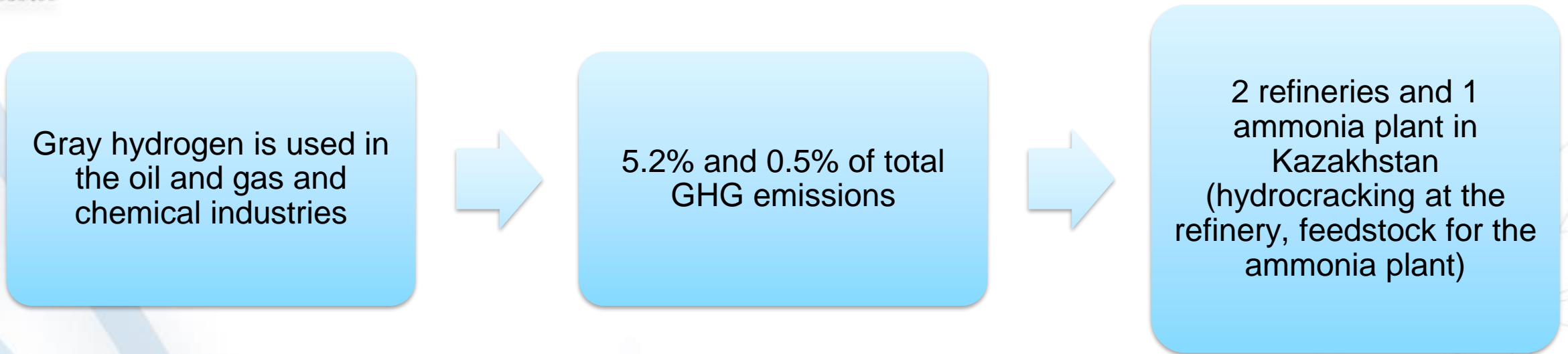
- 12th of December 2013
- 2019г. – rebranding into KMG Engineering.
- Branches in Aktau and Atyrau were established 50 years ago

- Hydrogen Energy Competence Center functionates since April 2022
 - Was opened at subsidiary (KMG Engineering) of National Oil Company (KazMunaiGas or KMG)
 - Hydrogen thinktank and R&D support with laboratory
 - One of our core tasks is «Development of a concept for hydrogen economy in Kazakhstan»

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Existing areas of production and use of hydrogen



- Low carbon hydrogen in refineries or ammonia plants can be produced using CCUS on existing SMR plants or using green hydrogen.
- In the case of CCUS, the captured CO₂ can be stored in geological structures or used for enhanced oil recovery (EOR).
- The geography of CO₂ storage sites and potential areas for enhanced oil recovery is located near the same refinery and ammonia plant (Abuov et al. 2020).

Why does Kazakhstan need hydrogen?

We studied the experience of other countries: Japan, Australia, Germany, Russia

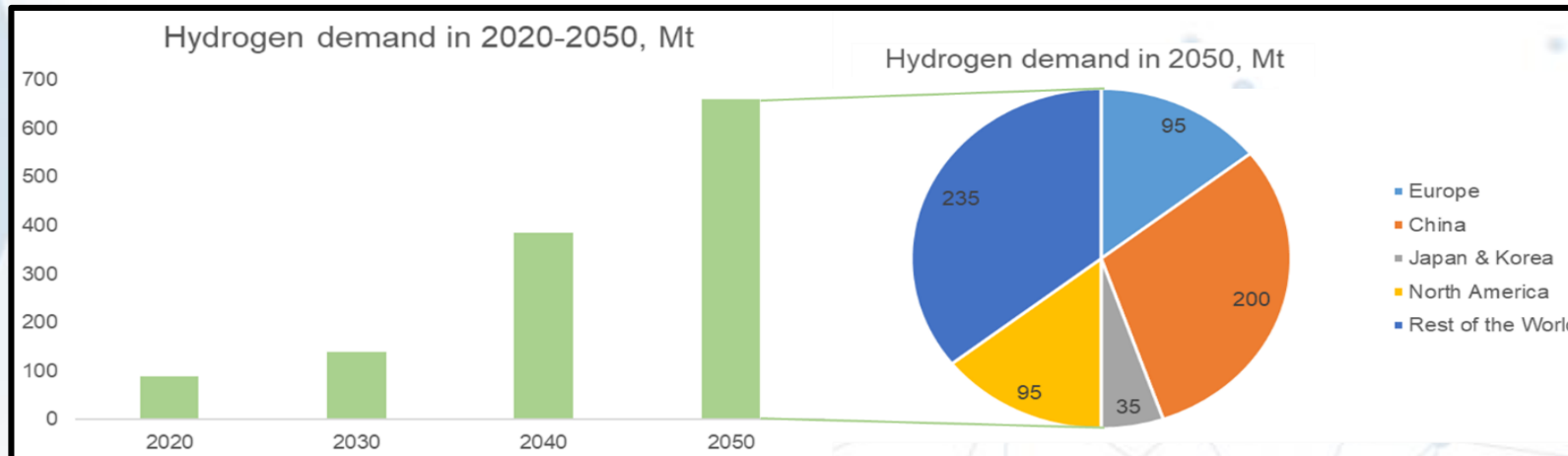
Driver 1: Export potential
Two main markets - China and Europe

Driver 2: Carbon tax
CBAM, ETS

Driver 3: Decarbonization
Current decarbonization measures in
Kazakhstan are insufficient

Driver 1: Export potential

- Hydrogen production in the world amounted to 90 Mt in 2020
- 39 countries have adopted a hydrogen strategy
- Construction of an enterprise for the production of green hydrogen in the Mangistau region by Svevind
- Kazakhstan and the European Union signed a memorandum of understanding and strategic partnership in the renewable hydrogen chain
- 660 Mt demand expected in 2050 (*Hydrogen Council & McKinsey 2020*)
- Expected the largest markets are:
 - China (200 Mt)
 - Europe (95 Mt)



Source: Zholdayakova et al. 2022 (data from Hydrogen Council & McKinsey 2020)

Driver 2: Carbon tax

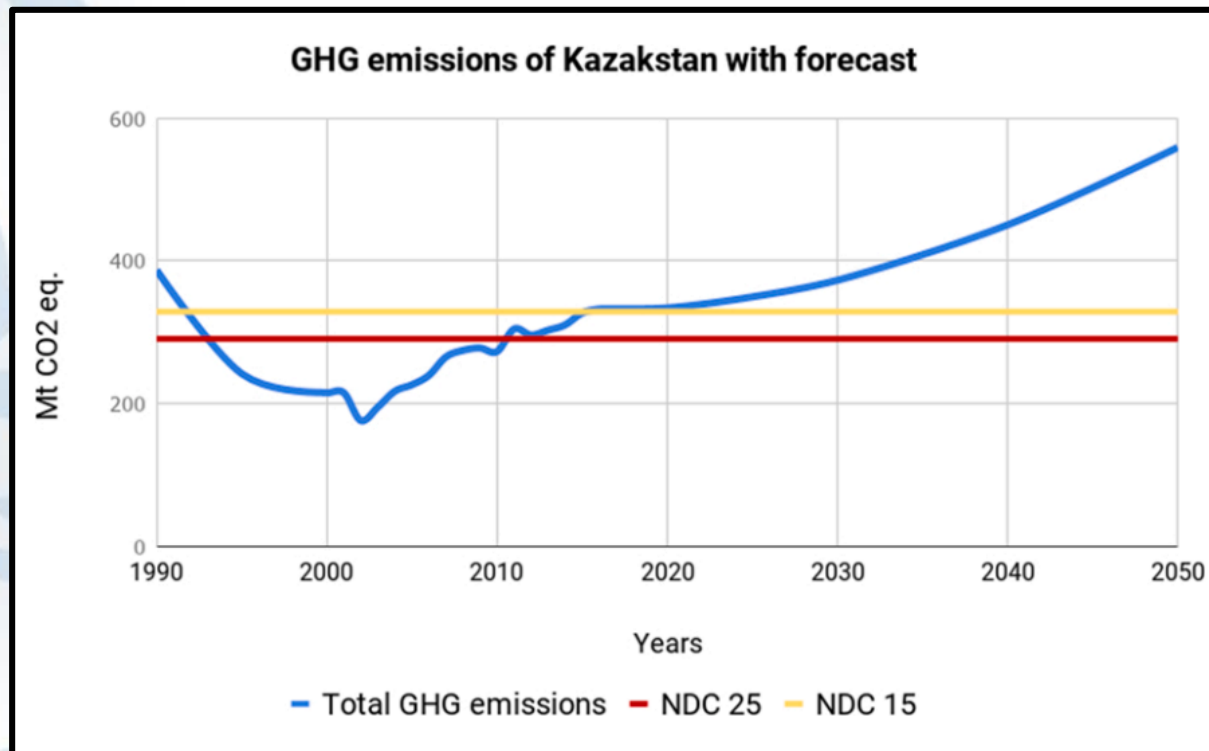
- External carbon tax poses financial risks for Kazakhstani exporters
 - EU Carbon Border Adjustment Mechanism (CBAM) from 2026
 - \$80/t CO₂ (2021)
 - Losses from export earnings in Kazakhstan may amount to more than **\$1 billion annually**
- Canada and the US are also considering the deployment of cross-border carbon regulation → the geography of the carbon tax will only grow
- There is also an internal carbon tax in Kazakhstan
 - Emission Trading System (ETS) \$1 (2013)
- **The use of hydrogen can significantly reduce the carbon footprint of manufactured export products**



CO₂
TAX

Driver 3: Decarbonization

- Regulatory documents to reduce GHG emissions in Kazakhstan:
 - Concept of green economy (2013)
 - Paris agreement (2016)
 - Carbon neutrality (2020)



Source: Abuov et al. 2020

- Current decarbonization measures (RES, gasification) are not sufficient to achieve the stated goals → GHG emissions continue to grow
- The use of hydrogen can significantly reduce GHG emissions from the sectors of heavy industry (metallurgy, chemistry and oil and gas) and transport in Kazakhstan

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Establishing hydrogen technologies in Kazakhstan: **Production**

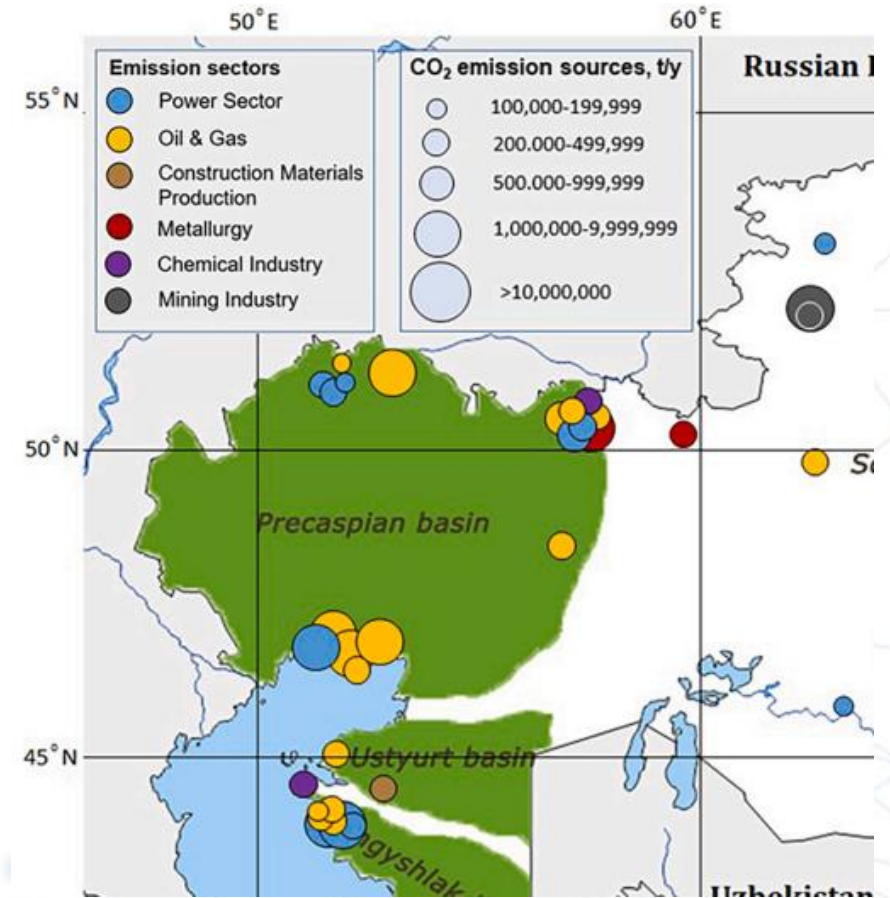
- Great potential exists for **blue hydrogen** production
 - Cheap natural gas and coal
 - Current gas production is tightly used, but the resource base can be expanded
 - Abundant coal resources for gasification
 - Plenty of CO₂ storage sites to launch hydrogen with CCUS
- Great potential exists for **green hydrogen** production
 - Kazakhstan has rich renewable resources (both solar and wind)
 - Installed RES capacity is tightly used for power generation
 - Green hydrogen projects should rely on the off-grid renewable power supply (Svevind, etc.)
- The potential **limitation**
 - Kazakhstan might experience water scarcity in the future
 - Both blue and green hydrogen require water feedstock: the availability of water resources for low-carbon hydrogen should be investigated

CO₂ sources in West Kazakhstan

- There are large CO₂ emitters in West Kazakhstan
- Emitters are obliged to decrease their GHG emissions as part of carbon-neutrality plan of Kazakhstan
- Blue hydrogen can be a part of these emissions

Motives for hydrocarbon producers

- “CCUS as service” is a next business of Oil & Gas
- Oil & Gas can provide CCUS services to large CO₂ emitters in region or beyond
- CCUS can prolong oilfield’s lifetime for another 50-60 years
- Being decarbonization leader in region



KPO and large CO₂ emitters in West Kazakhstan (Source: Abuov et al. 2020)

Establishing hydrogen technologies in Kazakhstan: **Production**

Gray, blue and green hydrogen production technologies (data from IEA 2020 and Hydrogen Council 2020)

Hydrogen color	Gray hydrogen		Blue hydrogen		Green hydrogen
Production technology	SMR	Coal gasification	SMR	Coal gasification	Water electrolysis
Resources estimate for Kazakhstan	Tight natural gas supply, but resource base can be expanded	Abundant coal resources	Tight natural gas supply, but resource base can be expanded	Abundant coal resources	Abundant renewable energy resources, but installed RES capacity is limited
Carbon intensity (kg CO ₂ eq/kg H ₂)*	9	20	1	2	0
Water footprint (kg water/kg H ₂)**	14-17	41-86	13-17	41-86	9-18
Production cost (USD/kg H ₂)*	1.0-1.9	1.6-1.8	1.4-2.4	2.0-2.2	2.5-6.6

Establishing hydrogen technologies in Kazakhstan: **Storage & Transportation**

- Kazakhstan is a landlocked country
 - **Long distances:** pipeline or railways
 - **Short distances:** all transportation methods
 - Shipping is available only to export transit countries via Caspian Sea (Azerbaijan and Iran)

- Hydrogen transportation infrastructure
 - The joint effort of interested stakeholders (green & blue hydrogen developers, transit countries and hydrogen importers)
 - Similar infrastructure exists for crude oil export (Caspian Pipeline Consortium)



Hydrogen transportation options for Kazakhstan

Transportation type	Distance, km	Cost*, USD/kgH ₂	Phase
Pipelines	1000-5000	0.6-3.3	Gas
Railways	500-5000	Not evaluated	Gas, liquid and solid
Trucking	<1000	0.2-3.3**	Gas, liquid and solid
Shipping	500-1000	<2.2	Liquid

Establishing hydrogen technologies in Kazakhstan: **Utilization**

- Emission sectors in KZ ETS and transport sectors were considered for hydrogen utilization
 - Power and heat
 - Metallurgy
 - Oil and gas
 - Mining
 - Production of construction materials
 - Transport (not regulated by KZ)
- Hydrogen utilization areas were identified in each sector and were classified as below
 - Existing (gray hydrogen use)
 - Near-term utilization areas
 - Long-term utilization areas

Establishing hydrogen technologies in Kazakhstan: **Utilization**

Hydrogen utilization perspectives in Kazakhstan emission sectors

Regulated sectors	Emission's share*, %	Target hydrogen utilization area	Decarbonization effect from hydrogen utilization	Perspectives in Kazakhstan
Metallurgy	8	- Direct reduction in iron production	Major	Near-term
Construction materials	1.9	- Heating in cement kilns	-	Unknown
Chemicals	0.5	- Ammonia production - Heating and drying	Major	Existing (gray hydrogen)
Mining	2	- Trucks on fuel cells	-	Unknown
Power and heat	25.7	- Seasonal power storage - Residential and industrial heating	Minor	Long-term
Oil and gas	5.2	- Oil refining (Hydrotreating)	Minor	Existing (gray hydrogen)
Non-regulated GHG emissions	56.7	- Transport (FCEVs, hydrogen stations)	Major	Long-term

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Conclusion

The role of hydrogen

- clearly defined in the long-term energy and decarbonization strategy
- identify target utilization sectors (steel, chemicals, oil&gas, transport, etc.) for the coming decades and quantify the amount of hydrogen
- carbon regulation (especially CBAM may force Kazakh exporters)

Potential of export

- the two largest hydrogen markets – the EU and China present an opportunity to develop hydrogen export with a priority for low-carbon hydrogen

*R&D investment
Appropriate regulations*

Conclusion

Hydrogen Production

- **Blue hydrogen** in Kazakhstan may have low carbon intensity and low cost
- **Green hydrogen** production (high Capex is expected)
- The effects of hydrogen export on the water security

Hydrogen Storage and Transportation

- pipeline and railways (land-locked country)

Hydrogen Utilization (Stimulation at a local scale)

- Near-term utilization areas for low-carbon hydrogen in existing industrial clusters (ammonia plants, refineries and iron/steel factories)
- Long-term utilization areas are energy storage in the power sector, residential heating and transportation.

Plans/Collaboration

Analysis of Possibilities of Hydrogen Production in Kazakhstan

- Green Hydrogen
- Blue Hydrogen

Experiment Hydrogen Storage

- Preparation of Metal hydride
- Scale-up project

- Founding, investment for pilot projects
- Formation of the hydrogen market
- Possibilities of export
- Research of hydrogen standards, regulations
- R&D system



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**Thank you for your
attention!**

Rakhmet!

ご清聴ありがとうございます。