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## Characterization of economic and ecological advantages and challenges in development of conventional and unconventional hydrocarbon, non-hydrocarbon and renewable energy sources for resource-based economy in Kazakhstan

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In global socioeconomic development facing climate change challenges to minimize the output of greenhouse gas (GHG) emissions and moving to a more low-carbon economy (LCE) the major driving force for success in achieving Sustainable Development Goals (SDGs) is the cost of energy generation. One of the main factors for energy source selection in the power supply and energy type generation process is the price parameters often influenced at different degree by government policies incentives, technological and demographic challenges in different countries. We research the energy sources situation and possible development trends for developing country Kazakhstan with resource-based economy. In general, the economic aspects affect the quality and quantity of energy generated from different sources with incentives for environmental concern. Traditional energy sources in Kazakhstan, such as coal, oil and natural gas remain low-cost in production due to high reserve base, which leads to steady growth in this area. In general, the cost for generating 1 kWh of energy from the cheapest carbon source of energy sub-bituminous coal is about 0.0024 \$, for natural gas 0.0057 \$, conventional oil 0.0152 \$ (conventional diesel is 0.0664 \$) and for expensive unconventional oil 0.0361 \$, whereas renewable hydrocarbons could potentially become more competitive with unconventional oil production (methanol 0.0540 \$, biodiesel 0.0837 \$, bioethanol 0.1933 \$ for generating 1 kWh). Furthermore, we consider the main non-traditional and renewable energy sources of energy from the sun, wind, water, and biofuels, hydrogen, methane, gasoline, uranium, and others. There is a difference between the breakeven prices of conventional gas and biomethane (0.0057 \$ and 0.047 - 0.15 \$ respectively averaging 0.0675 \$ per 1 kWh for biomethane) which is often related to the difference in their production methods. The main advantage of biomethane is environmentally friendly production. We also propose an assessment of fuel by environmental characteristics, where one of the hazardous sources Uranium is forth cheap 0.0069 \$ per kWh, but the environmental damage caused by its waste is the greatest. At the same time hydropower is seven times more expensive than uranium, but it does not cause direct health damage issues, however influencing significantly ecosystem balance. Hydrogen fuel is the most expensive among others. Overall in Kazakhstan energy-producing from the sun, wind and biogas is more expensive comparing with

global trends from 0.4 to 5.5 cents per 1 kWh, but remains cheaper for hydropower. In addition, based on the research findings we analyzed the potential for sustainable non-renewable and renewable energy development in the future for the case of the resource-based economy in Kazakhstan.