**The future of fossil fuels in a carbon-managed world: carbon-neutrality perspective for traditional hydrocarbon markets**

With the development of climate policies and various barriers to carbon-intensive products (for instance, Carbon Border Adjustment Mechanism in the EU) in traditional energy importing countries, the carbon footprint of hydrocarbon products will gain an increasingly crucial role, influencing the competitiveness of the key energy exporters. Rapid expansion of renewable energy sources and the creation of a new market for hydrogen are expected to have a negative impact on demand for traditional energy sources. This research will focus on one of the methods of managing emissions in energy sector – the evolving practice when traditional hydrocarbon producers are introducing carbon-neutral versions of conventional products: carbon-neutral oil, carbon-neutral natural gas and carbon-neutral LNG. Carbon-neutral LNG markets are new, but still much more developed than carbon-neutral oil. Despite being quite a new phenomenon (the first carbon-neutral LNG cargo was announced by Shell in June 2019), the carbon-neutral LNG market is rapidly developing. As of November 2021, 30 such cargos were supplied worldwide, with Asia as a leading destination.

This research is aimed at accumulating existing experiences of delivery of carbon-neutral hydrocarbon products, analyzing the likely transformation of market fundamentals due to the increasing requirements for carbon neutrality.

The rationale behind the research is to quantify the impact of carbon policy on hydrocarbon value chains in hydrocarbon trade. Regulations to decarbonize the oil and gas sector are expected to impose additional costs for producers and consumers. The aim of the study is to understand the implications of carbon-neutral hydrocarbon cargoes and generate a new “energy map” under these conditions. Applying different approaches to mitigating emissions from fossil fuel products can lead to different outcomes for the economics of future carbon-managed hydrocarbon markets.

This issue is barely addressed by modern scholars, mainly due to the novelty of the phenomena (the first carbon-neutral LNG shipment occurred two years ago). However, the concept of Circular Carbon Economy (CCE) addresses the topic in regard to different approaches to managing emissions (KAPSARC, 2019).

In the first stage of research, we use **case-study method** to systematically assess and describe the current practice in the carbon-neutral trade of hydrocarbons. For this we assemble existing examples of carbon-neutral cargo deliveries and analyze the approaches to carbon emissions management undertaken by the suppliers. Simultaneously we scrutinize the role of existing carbon regulation and carbon offsetting. This helps us understand the parameters for potentially acceptable “carbon neutral” products, identify the elements of the CCE that can contribute to carbon neutrality, and the implications for supply chains.

Based on the knowledge derived from the 1st stage, at the 2nd stage of research we explore the consequences of carbon regulation for hydrocarbon markets. We start by studying the LNG market, as it is more mature and relatively simple, **utilizing Nexant’s World Gas Model**. We generate scenarios around the potential costs of carbon offsets derived from the 1st stage of research to model and analyze possible restructuring of the LNG market due to the introduction of obligatory carbon regulations and use of selected CCE technologies. New LNG supply curve under different scenarios of carbon prices is produced.

The results of the research show that under obligatory introduction of carbon neutrality standards the supply curve describing the LNG market changes, adjusting positions of different producers (for instance, the lowest-cost producer Qatar), due to different approaches and technologies utilized by these producers to mitigate and offset emissions. We also give estimates for the costs of carbon-neutral LNG cargos under different scenarios, showing that it can be competitive even now, given the current natural gas market prices.