STRANDED ASSETS CAUSED BY NEAR-SIGHTED GAS INVESTMENTS DURING THE LOW-CARBON ENERGY SYSTEM TRANSITION

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Overview

The increasing levels of greenhouse gases in atmosphere have led to more sever global warming issues, and the climate change mitigation becomes urgent in the following decade. As the carbon dioxide from burning fossil fuel is the primary source, decarbonization policies are expected to be made globally to fulfil the Paris Agreement, which may make many fossil fuel resources unburnable and energy infrastructures no longer economic prior to the end of lifetime. These are defined as stranded assets, and as a significant amount of investments would have already been made, financial stability may be threatened during this transition towards the low-carbon economy. Among all energy sectors, natural gas assets are subject to great controversies as natural gas is broadly viewed as the bridging fuel during the energy transition phase. Its demand levels are expected to grow in short-term to compensate the decreasing use of coal and oil, whereas in long-term, gas would still be phased out due to its carbon emission. Such feature leads to higher risks in natural gas assets getting stranded subject to the varying policies, and the potential losses in intensive capital investment could therefore be rather serious.

This article aims to analyse the magnitude of potential asset stranding in gas production and transmission industry on a worldwide basis. A detailed examination on the influences from both import regions' foresights and export regions' perspectives is conducted. For the import regions, how their imperfect demand projections and their respective contracting preferences could signal the market expansion have been simulated. Regarding the export regions, the perspectives on future market dynamics and prices by natural gas suppliers is the key of investigation. Insights on the possible cooperation between supply and demand sides to mitigate the asset stranding risks are also provided.

Methods

Gas-GAME (Gas Global Agent-based Market Expansion model) is used to simulate investment in and operation of international gas trading assets. This model has a unique feature combination including 1) an agent-based framework, 2) explicit representation of contracting process, 3) market power simulation, 4) bilateral investment decision making between importers and exporters, 5) imperfect foresight. Hence, how the investors' different perspectives to future natural gas market would influence the overall industry development can be simulated. Subsequently, the potential stranded assets caused by excessive capital investments and changes in climate change policies can be analysed.

Five import markets as demand agents and nine export regions as supply agents are simulated respectively. Each is allowed to behave according to its own rule and they can interact with each other. The model has a two-module structure with a single-period *Market Equilibrium Module* (MEM) and a forward-looking *Infrastructure Expansion Module* (IEM). From the base period, the MEM uses a Mixed Complementarity Problem (MCP) approach to calculate the global gas flow with fixed capacities of production and transmission. The Nash-Cournot market equilibrium and import prices generated by MEM are then used in the IEM to simulate the capacity expansion decisions by supply agents, which would then be updated for the next time-period. This process would run repeatitively until the last period.

In MEM, supply agents maximise their own economic objectives subject to the equilibrium condition, when none of the suppliers can gain more profit via unilateral change in export volumes, if the other supply agents remain unchanged. The IEM takes a heuristic approach and uses take-or-pay contracts to underpin new capacity investment. The process includes (a) demand-supply contracting: long-term contract requests generated by demand agents are presented to supply agents, who then decide on accepting or rejecting these requests based on their own economic evaluation; (b) contract-based capacity expansion: infrastructure expansion proceeds to fulfil the ability of delivering enough volumes for all contracts in the future period.

In order to study to what extent would the developed infrastructure be stranded, three alternative scenarios, as compared to a base one, are simulated

Results

The base case assumes that global natural gas demand would follow the "Sustainable Development Scenario" by IEA World Energy Outlook 2017 while the contract requests by importing regions are calculated based on the "New Policies Scenario". By 2060, Russia would have the highest volume, at 350 BCM/yr production capacity stranded among all exporting regions. Middle East and Norway also have over half of their production capacities not utilized, at around 250 BCM/yr and 170 BCM/yr respectively. From 2010 to 2060, around 3.5 trillion dollars are invested into natural gas production and transmission infrastructure, while the overall profits generated by the exporting countries sum up to 9.4 trillion.

The first alternative scenario describes the condition when importing regions set only 70% of their total future demand as their contract request volumes. In this way, how the importing regions send market demand signals towards suppliers would affect the gas market development, infrastructure construction, and asset stranding can be analysed. Nearly 20% capital saving with the same profit level can be achieved in this scenario. Russia has its production capacity utilized at over 75% on average throughout the projection period, reducing its investment by over 100 billion dollars. In contrast, its gas export profit has a 60-billion-dollar increase. ASEAN countries, Australia, and Norway all manage to reduce their unnecessary infrastructure moderately, leaving 10-20% spare capacities.

Another alternative scenario investigates the changes in asset stranding from the exporting region's aspect. At what profitability level the suppliers would agree to sign contracts and therefore further conduct infrastructure expansion has significant impacts on market expansion. In this scenario, the exporting regions use 25% Internal Rate of Return, as compared to 12% in the base one, for contract approval. Global supply tightness becomes influencial in 2040s and an average price increase by 20% is observed throughout the period. As a result, overall gas trade profits till 2060 would rise to 9.8 trillion whereas the capital investment manages achieve saving by 22%. Russia has its profit increase by 18%. In contrast, Australia and Middle East suffer profit reductions by 48% and 7% respectively. Gas infrastructure utility rate generally reaches over 70%.

The third scenario looks into how collaboration and communication between import and export regions would help reduce stranded assets. Instead of following the "New Policies Scenario" for future demand projection, it is assumed that import regions form their contract requests based on the the "Sustainable Development Scenario". Moreover, the export regions hold positive perspectives to future gas prices and use 30% higher-than-current prices for contract evaluation. The results show that total capital investment is 15% lower than the base scenario and gas prices remain rather steady. Australia reduces over 200 billion capital expenditure while losing only 60 billion in its profit. Similarly, Norway has its investment cut by 120 billion with barely no profit reduction. Overall capacity usage is significantly improved compared to the base.

Conclusions

The issue of natural gas infrastructure stranding during the upcoming low-carbon energy transition is of great significance as worldwide financial stability, which is heavily dependent on energy sector, can be closely related to it. In this work, Gas-GAME, an agent-based game-theoretical global gas market model, is used to evaluate to what extent the gas production and transmission assets may be stranded. The unique model features like bilateral investment decision making and contracting process representation allow an investigation on alternative gas market developments influenced by import and export regions' perspectives. The base scenario indicates a high level of stranded assets in Russia, Middle East, and Norway by 2060. Three alternative scenarios representing reduced contracting requests by import regions, conservative contracting approval by export regions, and collaboration by both sides are also simulated to study how gas production and transmission capacities can be optimally developed. Corresponding impacts on natural gas prices in these markets are also analysed. When import regions plan ahead on sustainable gas consumption and communicate the requests with suppliers to ensure their investment confidence, total capital expenditure can be reduced by 15% globally while a similar level of gas trade can be maintained.