THE COST OF U.S. LNG AND THE EFFECTS ON GAS FLOWS AND GAS PRICES IN WESTERN EUROPE

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Natural gas plays an important role in energy supply and its fields of application are diverse: heat generation, hot water preparation, power generation and industrial applications. However, the world's largest growth potential among fossil fuels is attributed to liquefied natural gas (LNG). An important region for imports of LNG is Western Europe [1]. Even if gas demand in Western Europe is expected to fall by 2040, with some studies also forecasting relatively constant gas demand, a significant decline in domestic production in Western Europe is to be expected, so that the dependency on gas imports is increasing in the long term. The additional import demand for Western Europe will be met primarily by LNG and pipeline gas from the North Sea and Russia [2, 3].

For investment decisions a good knowledge about the natural gas markets is important. Additionally, the knowledge of sensitivities to modifications of parameters such as exchange rates, U.S. fracking activities or U.S. LNG exports is a competitive advantage for investors. With a market share of 10 % of global LNG exports in 2019, the U.S. will rank third behind Qatar (22 %) and Australia (21 %) [4]. The U.S. has reached this position in a very short time. It is expected that the U.S. is further increasing its liquefaction capacities [1]. This will strengthen the role of U.S. LNG as a marginal supplier in Western Europe. The cost of LNG is composed of the natural gas price in the country of origin and the LNG process costs for liquefaction, transportation, storage and regasification. Due to the important role of the gas price at the U.S. trading point Henry Hub (HH) for U.S. LNG exports to Western Europe, the question arises, how gas flows and gas prices are changing at the beginning of the 2030s in Western Europe if the price at HH is higher or lower than expected. Furthermore, the effect of the HH price on monthly U.S. LNG exports should be analysed. Studies by other authors mostly focused on Russia's strategy and U.S. LNG export volumes, without providing detailed gas flows in Western Europe and monthly export volumes of U.S. LNG.

To answer the research questions, a base case and two further scenarios were created. One scenario HH +20 % and one scenario HH -20 %. In both additional scenarios only the price at HH was changed compared to the base case. All other parameters such as investment decisions, demand for natural gas or exchange rates are identical between the three scenarios. These calculations are based on more extensive analyses with further modifications of the HH price. However, results with changes of less than +/-20 % on the HH price are relatively linear to the presented results in this work. Variations of the HH price may happen if a cold winter in North America occurs or due to fluctuations of the oil price and its effect on fracking activities in the U.S.

The analyses in this paper are performed with the gas market model WEGA of Stadtwerke München GmbH (SWM). This model calculates worldwide gas flows and gas prices for different scenarios in daily resolution. With the help of different types at nodes and edges, the worldwide gas market is mapped in WEGA. The model also contains a database of long-term sale and purchase agreements with flexibility options, take-or-pay clauses and individual pricing formulas. WEGA assumes a slow shift from oil price indexed contracts to hub indexed contracts (e.g. to HH) or hybrid contracts [5]. The model was created with Linear Programming in the Xpress Optimization Suite. The consulting firm ÅFRY developed the model under the name Pegasus [6] and uses it for its own analyses and for the preparation of its own fee-based reports. To ensure that WEGA is up to date, SWM obtained data updates from ÅFRY and modified them with its own assumptions. For example, SWM has own assumptions on the development of the oil price, exchange rates, marginal costs of storage facilities, gas demand and production volumes from individual sources. Other input parameters are based on publicly accessible sources or come from other commercial providers, some of which maintain their own gas market models. For this reason, the results of this work are not the view of ÅFRY. For plausibility checks, NetConnect Germany (NCG), National Balancing Point (NBP) and Title Transfer Facility (TTF) future prices are frequently calculated to make sure that WEGA is generating accurate market prices for the next years. In addition, results are discussed with experts of SWM and consulting companies. Additional information on WEGA, the model assumptions, interfaces to other models and results of WEGA can be found in the papers [2, 3, 7-11].

With 48 bcm in 2033 in the base case U.S. LNG plays an important role in Western Europe. Furthermore, results of WEGA reveal that changes in the price at HH would have a significant effect on the volumes of U.S. LNG exports to Western Europe (-7 bcm in 2033 in the scenario HH -20 % and +9 bcm in 2033 in the scenario HH +20 %),

especially in the UK and France. However, the effects of changes in the price at HH on other markets in the world is much smaller. The gas market in Western Europe is very flexible. Depending on the price of LNG, Western Europe acts like a sponge and absorbs LNG much better compared to Asia and South America.

The fluctuations in U.S. LNG imports in Western Europe between the two scenarios HH -20 % and HH +20 % will be absorbed by pipeline gas. Specifically, pipeline gas from the North Sea will be directed more to Germany than to the UK if LNG imports in Western Europe increase. This is a comfortable situation for producers in the North Sea: Their gas is still needed if U.S. LNG should become cheaper. However, especially LNG exports from Qatar and Russia are very competitive. Thus, with a relatively low HH price U.S. LNG only displaces small volumes from other LNG suppliers in Western Europe. Nevertheless, U.S. LNG is not only exported to Western Europe and changes in the HH price have an effect on global LNG flows, but with Europe being the most flexible market.

Regarding monthly U.S. LNG exports an effect of the HH price could be observed especially in the summer months due to a weaker worldwide demand side. However, the global demand for natural gas from September to March is so high that U.S. LNG is competitive in all three scenarios and always finds a buyer, even at HH +20 %. The U.S. LNG export terminals are therefore fully utilized in winter. The scenario HH -20 % has the highest utilization during the summer and at HH +20 % the utilization of the U.S. LNG export terminals is lower than in the base case despite a reduction in U.S. LNG prices below their long-run marginal costs.

The gas market model WEGA also calculates daily gas prices. The results show that an increasing HH price will lead to increasing gas prices at the beginning of the 2030s in Western Europe. However, prices will not rise one to one in Western Europe, because there are other competitive sources available and less U.S. LNG is imported. On the other hand, gas prices in Western Europe will react stronger with a reduced HH price. Imports of U.S. LNG are increasing in such a situation and more expensive sources are pushed out of the merit order.

Based on the results of WEGA the effects of the HH price on revenue and profit for the U.S. can be analysed. It can be concluded that the base case scenario is the best for the U.S. in terms of maximizing sales and profits. Thus, if there are options for pricing U.S. LNG, the base case can be used for guidance.

Instead of changes in the price at HH, a weaker or stronger USD would result in similar effects. This is because natural gas is traded at HH in USD and in Western Europe in EUR or GBP. Therefore, when analysing European gas prices and gas flows, the price at HH and the exchange rates to the USD must be considered.

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