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Can the Arab's natural gas secure the Europeans' gas requirements? the case of liquified natural gas (LNG)

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A B S T R A C T

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This article examines the possibility of answering the question" can the Arab's natural gas secure the gas requirements in Europe? "To answer the question, an economic analysis of natural gas was conducted to examine reserve, supply, demand, and international trade first. Second, an economic model to examine distances and transportation costs, for transferring goods from various points of supply to various points of demand, was adopted. The North-West Corner model approach, a QM for Windows-based economic strategy to solve the transportation model problem structure in linear programming, has been used in this regard. Our findings demonstrate that the model is suitable for application since it provides the least distances and the least transportation costs compared to other alternatives. The model estimated that a cost of $309.41 is required to transfer one MMBtu of LNG from origins to final destinations. A decrease of $34.304/MMBtu, 10%, compared to $343.714 /MMBtu. It is concluded that the Arab's gas could fulfil gas requirements in Europe, and mutual benefit can be accomplished for both parties. European countries will benefit from acquiring new places with less distances and lower delivery costs, and Arab countries would have the chance to get new consumers and play a role in the market given their collective gas reserves and their advantageous strategic locations.

1. Introduction

1.1 Introduction

Natural gas's share of total energy consumption represents about 25% at the current level and is expected to increase further in the coming years making it a more appealing source of energy in many nations as it is used daily by homes, businesses, communities, manufacturing, and other entities. The demand for natural gas, on the other hand, is largely seasonal and is influenced by a variety of variables, including weather, income, demographic trends, and consumer preferences (Dahan, 2011).

Despite the invasion of Ukraine by Russia last spring, which supplies 40% of Europe's gas needs, the west has continued to impose sanctions on Russia in response to its action (Di Bella et al., 2022). Now, Europeans worry that Russia will use it as retaliation for the sanctions. The query is whether Russia would back out of its commitment, or would it keep supplying gas to Europe specifically to honour long-term agreements and commitments? These actions served as a warning to all natural gas consumers that it is time to look for alternative sources (suppliers) to meet their gas needs in the future.

The purpose of this research is to study the possibility for Europeans to secure new sources for their gas requirements from the Arab world, especially those that have high levels of reserves. The Arab nations which include Saudi Arabia, Qatar, Oman, United Arab Emirates, Kuwait, Bahrain, Yemen, Egypt, and Algeria, store about 28% of the world's natural gas reserves.

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Qatar, Oman, United Arab Emirates, Algeria, Egypt, and Yemen are currently among the world's top exporters of liquefied Natural Gas (LNG), they all exported about 30 % of LNG traded globally in 2021.

1.2 Research Objectives

- To analyse the overall market of natural gas in the world.
- To analyse the current trade of LNG, prices, and transportation costs.
- To examine and analyse the possibility of developing new sources for Europeans for securing LNG requirements in the future.
- To build a transportation model that can supply natural gas to Europe with short distances and less delivery costs.

1.3 Research Questions

- What is the current reserve, supply, demand, and trade of natural gas?
- What other alternative locations that can supply liquified natural gas to Europe with less distances and less transportation costs?
- What is the model/models that would provide optimal solutions?
- Does the model provide better result compared with current transportation cost?

2. Literature Review

As we investigate relevant material, we will focus on two issues related to this one. The theoretical research that is relevant to our work will be covered first (Dantzig, 1951; Khan, 2014; Kamba et al., 2020). Our second focus is on the model's structure, which will be determined empirically and used to calculate the ideal transit costs (Babu et al., 2013).

Several specialists have meticulously researched the importance of energy for the effective operation of the contemporary economy during the past few years, especially following the start of the Russian-Ukrainian War. In the event of a disruption in the energy supply, the economy runs the risk of collapsing and people lose access to necessities like heat and light. It has been concluded that the energy sector is essential to a country's strategic operation because of the aforementioned. Access to energy resources, or energy security, is the main objective of any nation's energy policy.

Danylets (2022) discussed how energy weapons have changed through time, from the upheavals in the Middle East in the later part of the 20th century to the Russian invasion of Ukraine in 2022). Considering Russia's military aggressiveness in Ukraine, he concluded that it is plausible to assert that energy weapons have advanced and are now prepared to "fire" considerably more powerfully.

Mohammed et al. (2023) looked into how the market for renewable energy in 2022 reacted to the conflict in Ukraine and compared this reaction to that of conventional energy sources. Their data demonstrate that whereas renewable energy markets saw favourable and significant cumulative abnormalities during the post-war period, traditional energy markets were badly damaged. They concluded that renewable energy became increasingly important both during and after the Russian invasion of Ukraine due to its ability to support diversifications and hedging tactics.

Murărașu (2022) examined the rise in the European Union's reliance on Russian-delivered natural gas against the backdrop of the tensions between Russia and Ukraine. According to the study's findings, the European Union has a growing propensity to rely on imported Russian gas, primarily because of the member states' declining domestic supply year over year. The trend is expected to continue over the medium term, but if investments in the gas sector are included in the European taxonomy of sustainable financing, the trend might be reversed.

Event research was a strategy adopted by Umar et al. (2022). The study of the data shows a significant rise in the abnormal returns linked to the renewable energy industry. Except for the gas oil index, the traditional energy and metals markets typically do not experience significant abnormal returns on the event day. European markets for renewable energy were also among the first to adjust to conflict. Like how the effect peaked on the t+1 day, replication in other markets did not take place. To ascertain the likelihood of short- and medium-term gas supply diversification, Lambert et al. (2022) conducted interviews with researchers from Europe and several other worldwide locations to determine the possibility of short- and medium-term gas supply diversification. They discovered that while experts generally agreed that the EU wouldn't be able to replace Russian supplies with sufficient new gas supplies until the end of the winter of 2022–2023, in the longer term (2023–2030), the USA and Qatar might both be recognized as important LNG suppliers to the EU. Chen et al. (2023) discussed the effects of sanctions and counter sanctions on the energy trade on the relationship between the EU and Russia as well as the worldwide pattern of energy commerce. They used the global multi-region comparative static CGE model to simulate changes in macroeconomic indicators in key countries all over the world. According to their findings, these limits will hurt both parties' economies and cause a change in how energy is traded. As energy purchases from the EU are transferred to non-Russian markets and Russian energy exports are likewise redirected to Asian markets, energy trade between the EU and Russia will be substantially decreased. On the other hand, many scholars and researchers have worked hard over many years to figure out the best way to address the issue of high transportation costs and how to keep it at its minimum level. To find the shortest path and the least expensive option, Uddin et al. (2011) developed a network model using the north-west corner rule (Gangatharan, 2019). To test for transportation cost optimality, Fatimah and Wibawanto (2015) used the Northwest Corner Method (NWCM) (Metlo, 2016) and Steppingstone Method (SSM). When applying these techniques in comparison to a program created by Perum Bulog Sub Divre Semarang in February 2015, their work demonstrated considerable results. Ranasinghe and Rathnayaka (2021) developed a software to find the Initial Basic Feasible solution to the transportation problem using the North-West Corner Rule (NWCR). They concluded that the suggested program was more advantageous for decision-makers who frequently deal with supply and demand mismatches.

According to Putra et al. (2020), the North-West technique resulted in superior cost reduction than the stepping stone method. Mhlanga et al. (2014) talked about the retail supply chain optimization network. They examined several variables to determine the best course of action and concluded that focusing on these variables would reduce transportation costs. To determine the ideal shipping costs experienced by an Indonesian company when sending its goods to destinations, Pasaribu (2019) employed the North-West Corner approach. The technique is helpful and simple to apply in calculating these costs, the author stated. The North-West model was used by Mhlanga et al. (2014), although they criticized the method's excessive repetitions and offered several changes. To arrive at the best optimal solution, Mishra (2017) used the Northwest Corner Method, the Minimum Cost Method, and Vogel's Approximation Method. He discovered that the decision-maker would be able to choose from any of the three models' best output. Three corner rules, the North East Corner Rule (NECR), South West Corner Rule (SWCR), and South East Corner Rule (SECR), were researched by Aliu et al. (2022). They examined the three models and concluded that NECR and SWCR minimize transportation costs better. Quddoos et al. (2012) used a novel approach known as the ASM-Method to find the best resolution for a variety of transportation issues. They concluded the method is useful since it involves very basic arithmetic and logical calculations and suggested that it should be adopted in place with other methods.

3. Hypothesis & Research Methodology

To test the hypothesis that the Arab gas would be able to fulfil the gas requirements in Europe in the future, a descriptive economic analysis will be conducted first. This methodology consists of analysing the natural gas industry and its growth in the world's gas markets. The analysis will include reserve, supply, demand, price, transportation, and international trade. Second, the North-West Corner method, a QM for Windows-based economic strategy, will be utilized to find the best answer to the transportation cost problem. The transmission of commodities from multiple places of supply to numerous points of demand is the focus of this strategy. The North-West corner gets its name since the fundamental variables are selected from the very left top corner of the given matrix form and once the array values are entered and the matrix form is complete, the calculator tool will immediately update us with the least transportation cost.

4. Analysis

4.1 Reserve of Natural Gas

The world's natural gas reserve is estimated for 188.1 trillion cubic meter in 2020 compared with 179.9 trillion cubic meter in 2010 with a growth rate of 4.6%. In 2020, the total reserve has been shared by seven regions which include north America, south and central America, Europe, Africa, Asia, the middle east, and Commonwealth of Independent States, with the Former Soviet Union having the world's largest natural gas deposit of 38 trillion cubic metres, followed by Iran 32 trillion cubic metres, Qatar 24.7 trillion cubic metres, Turkmenistan 19.5 trillion cubic metres, and the United States coming in fifth place with 12.9 trillion cubic metres, Fig. 1.

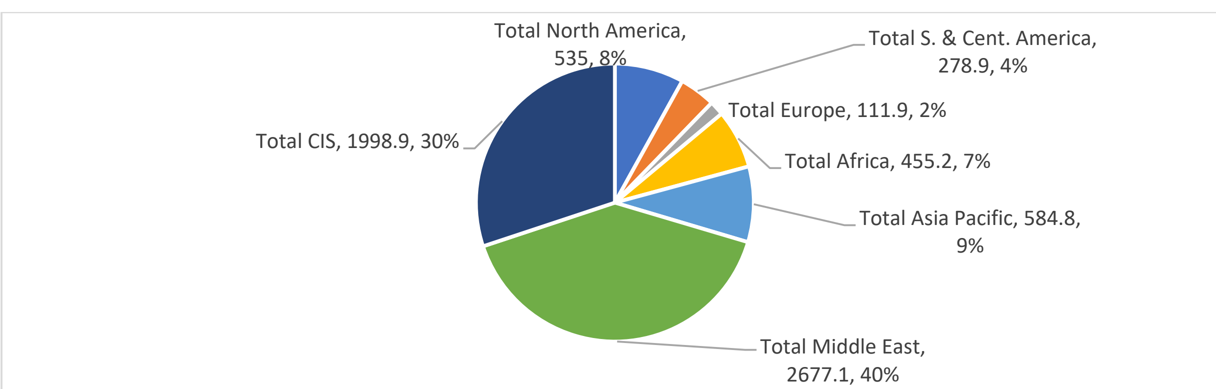

Fig. 1. Natural Gas Reserve by region in 2020 (Trillion cubic foot)

*At present the CIS unites: Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan, and Ukraine

4.2 Production of Natural Gas

For many nations, natural gas has emerged as one of the most significant energy sources. The price of liquefied natural gas (LNG) has decreased by 30% because of technological and liquefaction advancements, which spurred many nations to increase their production to meet the growing demand (Lochner, 2011). The world's total gas production in 2020 was 3853.7 billion cubic meters (bcm) compared with 3150.8 billion cubic meters in 2010, growing at an average rate of 3.1% annually. Most of the gas production coming from the North American region as the largest producer which produced about 29 % of total gas, while the Commonwealth of Independent States (CIS) supplied about 21 % followed by the Middle East with 18% and the Asia Pacific in the fourth place with 17%, Fig. 2.

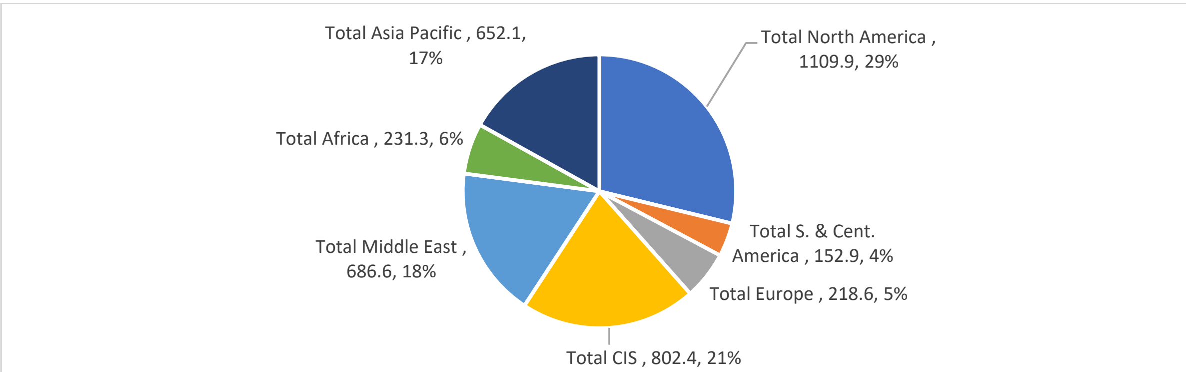

Fig. 2. Natural gas production in 2020 (Billion cubic meters)

4.3 Consumption of Natural Gas

Natural gas consumption increased during the past twelve years from 3160.5 billion cubic meters (bcm) in 2010 to 3822.8 billion cubic meters in 2020, representing an average annual growth rate of 2.9 % and was counted for over 24.5% of global energy consumption. In 2020, the highest consumption rates were recorded in regions like North America with 27% followed by Asia Pacific with 23%, the Middle East with 14% and Europe in the fourth place with 13.8%, Fig. 3.

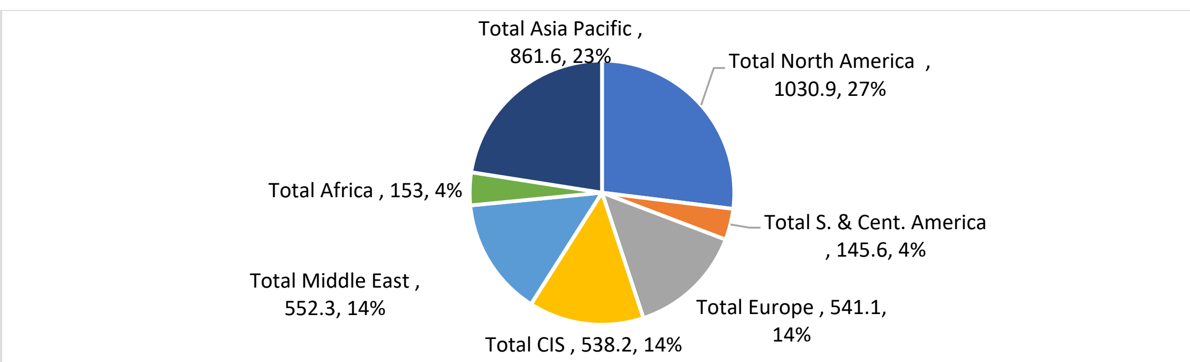

Fig. 3. Natural Gas Consumption in 2020 (Billion Cubic Meters)

4.4 Prices of Natural Gas

Frequently, the cost of LNG is expressed in US dollars per million BTU (MMBTU). Prices in the Pacific Basin are frequently higher than in the Atlantic Basin because of the high demand and poor domestic supply. In the European and Asian markets, the price of a basket of alternative fuels is used to determine LNG's cost, while in the North American market, the Henry Hub price is utilized. Over the previous ten years, the cost of importing LNG has decreased, falling an average of (3.6%) per year, from $7.57 per million BTU in 2010 to $7.3 per million BTU in 2019.

In Europe, the price of natural gas reached its highest of $70/MMBtu in August 2022. This increase in the price resulted from the fact that many European countries aggressively imported more gas for building their stockpiles to secure any deficiency that may result from the war in Ukraine. This behaviour is not only affected Europe, but it also led to significant rise in the gas prices in the United States and Japan as well.

4.5 Transportation of Natural Gas

Even though pipelines are used to transport the majority of the gas sold on the world market, mainly in Europe and North America, LNG is often shipped in huge tankers with a capacity of between 25,000 and 160,000 cubic meters. The cost of moving products between areas depends on a variety of factors, including the size of the cargo, the distance travelled, the cost of fuel, the cost of insurance, the cost of labour, and the cost of administrative fees. They are also affected by how long the contract is, with shorter contracts often having higher rates.

4.6 Trade of Natural Gas in Europe

The second-largest consumer of natural gas in the world is regarded as being in Europe. The largest consumers are the residential, industrial sectors, and power generation sector. About 40.57% of the market's entire demand for gas was met via pipelines in 2021, while 59.43% came in the form of LNG, Fig. 4.

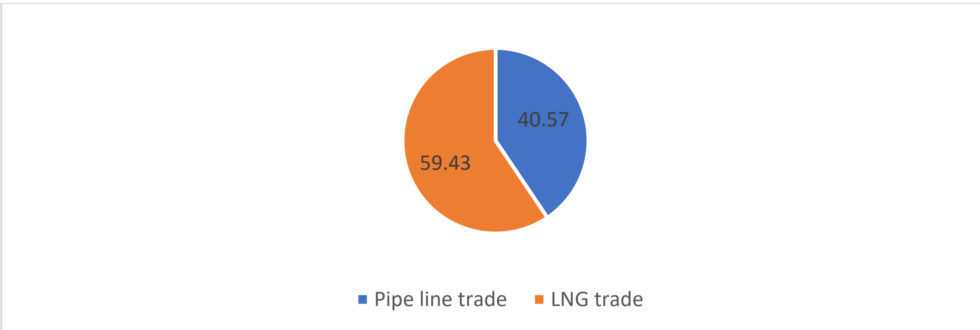

Fig. 4. Trade of natural gas in Europe (Billion Cubic Meters)

The biggest exporters of pipelines to the market are Russia, Norway, Algeria, Azerbaijan, and Libya, who provided roughly 73.1% of the necessary pipe gas, about 16% came from Algeria and Libya. On the other hand, Qatar is one of the major LNG suppliers to the market, providing roughly 65.43% of the total LNG needed for the market along with Algeria, Nigeria, Russia, and Egypt, about 37.3% of the total market came from Qatar, Algeria, and Egypt. The top importers of LNG are Spain, France, the United Kingdom, Turkey, and Italy, who together accounted for around 71.72% of the total market.

5. The Suggested Model

5.1 Travel Distances

The Sea-Distances.org program is used to compute the distances between the six Arab countries representing the supply side and the eight European countries representing the demand side, Table 1.

Table 1
Distances Between Sources & Destinations (Nautical Miles)

	Spain	France	Turkey	Italy	Belgium	Greece	Portugal	UK
Qatar	4657	4414	3840	4262	6277	3441	5434	6626
Oman	4180	3937	3031	3785	5804	2968	4961	6153
Algeria	279	406	1186	1139	1707	1224	864	2056
UAE	4503	4260	3354	4108	6123	3287	5280	6472
Egypt	1473	1238	375	1090	3431	524	2364	3709
Yemen	4440	3011	2437	2859	4874	2260	3878	4600

Source: Data generated by the author using the Sea-Distances.org program measured in nautical miles.
One nautical mile is equivalent to one kilometre.

5.2 Transportation Cost

The transportation costs between sources and destinations for our model are estimates, according to the LNG freight cost calculator made public by Capra Energy Group. Using a tanker with a 160,000 m3 LNG capacity, an average speed, the overall distance travelled, canal tolls, port fees, heel and boiloff gas, these costs are determined, Table 2.

Table 2
LNG Total Freight Cost ($/MMBtu)

	Spain	France	Turkey	Italy	Belgium	Greece	Portugal	UK
Qatar	4.55	3.46	3.12	3.69	4.87	3.08	4.27	4.89
Oman	4.25	3.41	2.83	3.39	4.57	2.79	3.97	4.59
Algeria	1.16	0.64	1.19	1.18	1.47	1.15	0.62	1.2
UAE	4.54	3.69	3.11	3.68	4.86	3.07	4.26	4.88
Egypt	2.02	1.21	0.65	1.19	2.61	0.61	1.75	2.34
Yemen	4.25	3.41	2.83	3.39	4.57	2.79	3.97	4.59

5.3 Actual Trade of LNG Between Sources & Destinations in Europe

In 2021, the actual volumes of liquefied Natural Gas (LNG) carried between all sources and all destinations in Europe are shown in Table 3.

Table 3

Current Quantities of LNG Delivered from Source to Destination (million cubic metre)

From	To: Spain	France	Turkey	Italy	Belgium	Greece	Portugal	UK
Qatar	2.4	0.7	0.3	6.5	3.2			6
Australia	0.1							
Malaysia								
USA	5.8	4.3	4.5	1	0.2	2.9	2	4
Nigeria	4.3	3.5	1.5	0.3		0.5	2.8	
Russia	3.3	4.7			1.9	0.4		3
Indonesia								
Trinidad	1.1		0.2	0.2				0.2
Oman						0.2		
Algeria	2.1	4.5	6.1	1.3	0.1	0.9	1.2	0.7
UAE								
Egypt	0.4	0.2	1.3	0.3	0.1	0.8		0.3
Bruni								
Angola	0.4							
Papua New Guiea								
Peru	0.1	0.1						0.8
Total Demand	20	18	13.9	9.6	5.5	6.3	6	15

Source: bp-stats-review-2021-full-report

According to the calculation made using Capra Energy Group's LNG freight cost calculator, the overall transportation costs are anticipated to be $343.714per MMBtu. Table 3-A below lists the actual volumes of LNG traded between suppliers and consumers for each nation separately, along with the associated transportation expenses.

Table 3-A

Actual Quantities of LNG Traded for Countries in Europe with the Transportation Costs

	Spain		France		Turkey		Italy		Belgium		Greece		Portugal		UK	
	LNG	Cost	LNG	Cost	LNG	Cost	LNG	Cost	LNG	Cost	LNG	Cost	LNG	Cost	LNG	Cost
Qatar	2.4	10.92	0.7	2.422	0.3	0.976	6.5	23.985	3.2	15,584					6	29.34
Australia	0.1	0.89		0		0		0	0	0						0
Malaysia		0		0		0		0	0	0						0
USA	5.8	14.964	4.3	13.717	4.5	18.27	1	4.05	0.2	0.578	2.9	10.817	2	5.18	4	10.48
Nigeria	4.3		3.5	11.62	1.5	5.865	0.3	1.167	0	0	0.5	1.935	2.8	7.644		0
Russia	3.3	27.093	4.7	34.31		0		0	19	16.872	0.4	2.656			3	25.71
Indonesia		0		0		0		0	0	0						0
Trinidad	1.1	3.124		0	0.2	0.748	0.2	0.744	0	0					0.2	0.574
Oman		0		0		0		0	0	0	0.2	0.558				0
Algeria	2.1	2.436	4.5	2.88	6.1	7.259	1.3	1.534	0.1	0.147	0.9	1.035	1.2	0.744	0.7	0.84
UAE		0		0		0		0	0	0						0
Egypt	0.4	0.808	0.2	0.242	1.3	0.845	0.3	0.357	0.1	0.261	0.8	0.504			0.3	0.702
Bruni		0		0		0		0	0	0						0
Angola	0.4	1.36		0		0		0	0	0						0
Papua New Guinea		0		0		0		0	0	0						0
Peru	0.1	0.484	0.1	0.488		0		0	0	0					0.8	3.904
Total demand	2.0		18		13.9		9.6		5.5		6.3		6		15	
Transportation cost		76.226		65.679		33.923		31.837		33.442		17.489		13.568		71.55

Total Transportation Cost $343.714 per MMBtu

6. Findings

To determine the shipping route that will reduce the cost of transportation of LNG between the 6 origins and the 8 destinations, we used the North-West corner approach. Table 4 illustrates the ideal resource distribution for each country and provides the optimum least transportation cost of $309.41 per MMBtu.

Table 4

North-West Model & the Least Transportation Cost Model

	Spain	France	Turkey	Italy	Belgium	Greece	Portugal	UK	Total Supply
Qatar		18	13.9	2.5	5.5	6.3	5.7		93.9
Oman	6.7			7.1					13.8
Algeria							0.3	15	15.3
UAE	8.8								8.8
Egypt	2.6								2.6
Yemen	1.9								1.9
Total Demand	20	18	13.9	9.6	5.5	6.3	6	15	

New Transportation Cost $309.41 per MMBtu

Source: Statistical Review of World Energy Report 2021, 70th edition. (supply/demand in billion cubic meters).

The data on the table generated by the model as the optimal solution with the minimum transportation costs.

The model demonstrated that the six Arab nations can provide the Europeans' need for gas more effectively than in the past with fewer destinations and lower transportation costs. The model for example predicts that the combined destinations would be lowered by 74%, and that the overall transportation cost to the European market would be decreased by 10% for every MMBtu supplied. For instance, Spain would only purchase the required quantity of gas from Oman, UAE, Egypt, and Yemen, as opposed to the initial 10 suppliers of Qatar, Australia, USA, Nigeria, Russia, Trinidad, Algeria, Egypt, and Angola.

7. Conclusion

The North-West Corner Method approach was utilized in the study to investigate the prospect of locating the best answer to the issue of new sources for Europeans to meet LNG requirements with the least distances and transportation expenses. Our findings have demonstrated the model's suitability for application because it predicted lower transportation costs than the actual. The model has estimated that it would cost $309.41/MMBtu to transport LNG from its origins to its final destinations. Compared to the predicted real cost of $343.714/MMBtu, this figure is $34.304 less per MMBtu, a decrease of 10%. It is determined that European countries will benefit from acquiring new places with lower delivery costs if they implement the solution found by our model.

However, even though there will be more competition for gas in the future, one can get the conclusion that both the Arabs and the Europeans can gain from the situation. Given their combined gas deposits and favourable strategic locations, the Arabs would have the opportunity to find new clients and play a role in the European market, while the Europeans would profit from gaining new sources with shorter delivery distances and reduced delivery costs.

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