Decision-making for supplying energy projects: A four-dimensional model

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Abstract

Importing states and regions employ myriad strategies to enhance energy security, from stockpiling to diversification to efficiency programs. As has occurred in recent years, importers can seek diversification by initiating pipeline and liquefied natural gas projects, meaning they may also have to select suppliers. However, most extant pipeline evaluation models erroneously assume suppliers are known and thus neglect supplier selection. We propose a decision-making tool to augment these older models: a systematic and replicable four-dimensional model to help policymakers and managers identify suitable suppliers and prioritize the best courses of action for overcoming obstacles. The first three dimensions—timeframe, supply availability and infrastructure constraints—filter out unsuitable suppliers. The fourth dimension then assesses the political, geopolitical and commercial stability of the remaining candidates. To demonstrate the model in practice, we assess the original Nabucco pipeline proposal, which was designed to transport gas from the Caspian and Middle East regions to Europe.

Keywords: Strategic planning; Resource supply; Natural gas; Pipelines; Geopolitical analysis; Nabucco pipeline

1. Introduction

Importing states and regions employ myriad strategies to enhance energy security, from stockpiling to diversification to efficiency programs.[1] Some natural gas importers pursue greater "independence" by promoting the exploration and production of indigenous gas, including shale gas. Importers without sufficient resources, however, may seek to avoid deep dependencies by diversifying suppliers and product portfolios, for example, by accessing new suppliers, expanding import pipeline networks, and procuring tanker delivery of liquefied natural gas (LNG).

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Europe is a prime example of a region seeking greater diversification. Within days of Russia's annexation of Crimea in March 2014, European Union (EU) leaders asked the European Commission (EC) to formulate a plan for reducing dependence on Russia. Almost immediately, numerous suppliers and routes were touted by policymakers and journalists. But which suppliers and routes would be the optimal choice? As past experience demonstrates, decision-makers may be unaware of where they should invest their resources and attention.[2] Will Europe repeat the experience of the ill-fated Nabucco pipeline? By which decision-making criteria should suppliers be selected?

Numerous models for evaluating natural gas pipeline exist, such as feasibility studies and technical reviews; however, as we argue in this article, most assume that the supplier and transit countries are known and that the suppliers can offer sufficient gas over the project's lifetime to warrant the effort. But these assumptions may be erroneous. Decision-makers initially may not know exactly which countries will supply the pipeline, and individual suppliers may not have sufficient available resources on their own: a patchwork of suppliers may be necessary. Then again, those who do have sufficient supplies may be compromised by high political, commercial or geopolitical risks. For oil and gas projects, these factors need to be part of the decision making process.[3]

Despite these observations, we do not assert that the older evaluation models are invalid; rather, we propose an additional tool to aid in the decision-making process, a four-dimensional supplier selection model that assesses whether suppliers will have resources available throughout the lifetime of the project and incorporates infrastructure and risk considerations. The four dimensional model (the "4-D" model) works as a filter by identifying shortcomings that could eliminate a potential supplier from consideration and aids policymakers and managers in pinpointing the issues that should or must be addressed to move a project forward.

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The development of the 4-D model grew out of a study commissioned by the strategic planning department of one of Europe's largest power companies; we thus know from first-hand experience that the model also can be used in scenario building. Although the model was created with pipelines in mind, it could be modified and potentially used to evaluate other types of commodity supply relationships, including for LNG, biofuel feedstocks, or critical materials. After the initial analysis of a project has been conducted, the model can easily be updated and recalculated. To make the model accessible to users with a wide variety of backgrounds, the model contains one straightforward quantitative formula. However, if preferred, the entire model can be operationalized into quantitative variables. At the moment, a systematic decision tool, such as the 4-D model we offer, is lacking in the literature. In addition to its applicability to Europe's situation, we believe the model could be used by policymakers and managers in any importing regions or countries. Indeed, consumer-driven pipelines may become more common as importers seek surety.

This article proceeds as follows: First, we review existing approaches to pipeline projects. Next, we explain our methodology and the 4-D model in detail. In the last section, we apply the model to a case study, the original 3300-km-long Nabucco pipeline.

2. Review of pipeline evaluation models: scant attention to suppliers

Numerous approaches to evaluating pipelines exist and can be roughly divided into three categories, depending on their focus and how they address the supplier question. The first is a broad category of models that provide pipeline evaluation tools, such as technical reviews and feasibility studies. Suppliers are presumed to be known. The second category comprises studies that focus on specific regions and their particular circumstances; some of these "snapshot" studies also examine the suppliers. The models in the third category focus primarily on energy security and dependencies, of which pipelines play a significant role, and are highly attuned to the critical role of suppliers.

The models in the first category focus on improving how pipelines are evaluated, such as speeding the feasibility process[4] for LNG offering new indicators,[5] or expanding the catalogue of risk factors.[6] Other models offer new tools, such as SWOT (strengths, weaknesses, opportunities, and threats) and Delphi analyses.[7] Hayes and Victor[8] study the factors associated with successful pipeline projects and concomitantly offer a comprehensive protocol for evaluating the partners, but presume the suppliers are known. In a later work reporting the study's results, Victor et al.[9] contribute the important insight that major pipeline projects are successfully realized only when they have significant state backing. For the most part, the methods in the first category do not provide any guidance on how to select supplier countries or estimate the long-term availability of supplies.

The studies in the second category focus on the challenges associated with pipeline diversification for a particular region at a particular point in time.[10] These studies review potential suppliers and offer some methodological insights, such as how to estimate the non-contracted gas that could be available from a potential supplier[11] offers a similar tool, but from the exporter's perspective). The studies in this category, however, do not offer comprehensive models for selecting suppliers.

The third category of studies stems from the energy security literature and extends beyond natural gas. These studies typically ascertain the import dependence of a country or region and then evaluate the extent to which the dependency constitutes a threat. These assessments cover a broad range of energy sources and transportation infrastructure, including gas pipelines.[12] As with the studies in the second category, these models do not provide a comprehensive supplier selection tool; some, however, do evaluate the risks associated with suppliers but rely on simple proxies for measuring political and geopolitical stability.[13]

In sum, most pipeline evaluation methodologies contain one or more of the following assumptions: (1) the suppliers throughout the project are known; (2) the suppliers have sufficient gas across the lifetime of a pipeline; (3) the infrastructure exists to feed the pipeline; or (4) the suppliers are politically, commercially and geopolitically stable. These assumptions connote certainties that we believe may not hold for many future pipeline projects. We thus offer the 4-D model as an additional tool to complement the older models.

3. Method: the 4-D model

This section elaborates the four dimensions of the 4-D model and provides guidance on how to conduct each level of analysis. As illustrated in Fig. 1, the objectives of the 4-D model are to find potential suppliers that can contribute gas over the lifetime of the project and to identify the courses of action

that will best help overcome any hindrances to contracting the suppliers. In order to achieve this goal, the first step ascertains the pipeline's timeframe.

3.1. The 1st Dimension: the timeframe

One of our core assumptions is that a pipeline's capacity needs to be filled when the pipeline is launched—and when capacity increases are planned—otherwise underutilization would result in a prolonged payback period, compromising the pipeline's profitability and its attractiveness to investors. Considering that potential suppliers may have multiple long-term gas export commitments of different durations, meaning that resources may be available only at certain time points for new pipelines, decision-makers should match the construction and launch of a pipeline to potential supply. Estimates for construction and delivery dates are often released by pipeline companies. When this data is incomplete, however, analysts will have to estimate dates based on the best-available information, such as interviews and press releases, including by subcontractors to the pipeline and other involved parties, such as governmental ministries.

3.2. The 2nd Dimension: supply availability

Whereas the timeframe is often supplied by the pipeline company, attaining the data for supply availability is more complicated. It requires creating a composite picture of each potential supplier's ability to contribute gas to the project over a longer period of time. More specifically, the objective is to estimate the total amount of non-contracted gas that could be available for the timeline identified in the 1st Dimension. If a company or country is in direct negotiations with suppliers, this data may be provided. Absent this, or to double check the supplier's figures, analysts may have to conduct their own research.

To create informed estimates, we borrow insights from Bilgin[14] and Wietfeld[15] and recommend assessing the supply availability of each potential supplier country for all critical points along the pipeline's timeframe by taking gas production, adding any imports, and then subtracting consumption and export commitments. Formalizing this, the project is considered to be able to acquire sufficient gas supplies if:

$$\sum_{i=1}^{n} S_{i,t} \geqslant D_t \qquad (1)$$

where for each $S_{i,t}$

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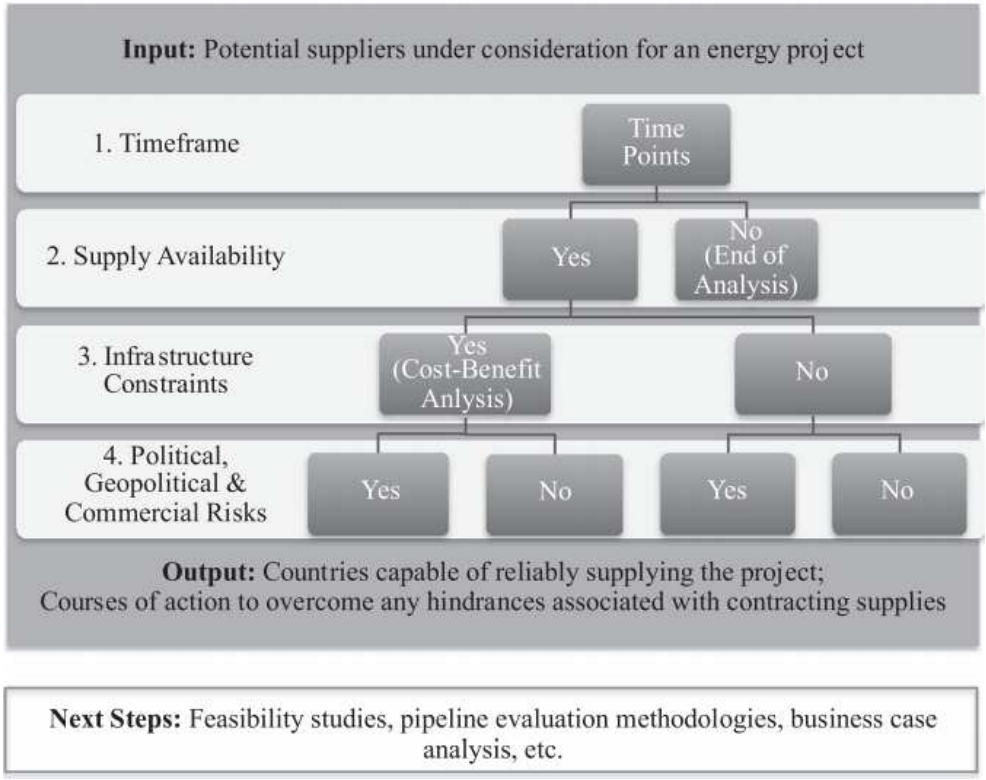
$$S_{i,t} = max\{(P_{i,t} + I_{i,t}) - (C_{i,t} + E_{i,t}), 0\} \qquad (2)$$

where $S_{i,t}$ is the non-contracted gas of country i at time t, D_t the transport capacity of the planned project at time t, t the dates identified within the first dimension, n the number of evaluated countries, $P_{i,t}$ the gas production of country i at time t, $I_{i,t}$ the gas imports of country i at time t, $C_{i,t}$ the gas consumption of country i at time t and $E_{i,t}$ is the gas export commitments of country i at time t.

The reason for (2) is the observation that countries can over-contract their gas production, as the analysis of Iran in Section 4.2 demonstrates. The assumption (2) is that other gas supplying countries are

not expected to level out the shortages of the over-contracted supplier, which (1) would otherwise imply.

Fig. 1: The 4-D model



Producing the input for these calculations requires gathering data from a variety of sources. Countries often release their own production and consumption data (including future predictions) and this can be cross-checked and supplemented with third-party data, such as the reviews provided by the International Energy Agency (IEA) or the United States' (US) Energy Information Agency (EIA). To acquire information on present and future export and import commitments, we recommend Wietfeld's approach of compiling all available information on current and future gas delivery contracts.[16] For information on present gas export and import contracts, one might consider BP's Statistical Review of World Energy. Estimates of future contracts are more difficult to ascertain and require mining the data sources mentioned above as well as press releases and other industry-specific sources.

The resulting data may contain significant variations in a supplier's potential non-contracted gas, for example, future export commitments may be given as a range. If this is the case, then we advise building two scenarios to capture the upper and lower extremes—the best- and worst-case scenarios (see Table 1).

Table 1: Overview of scenario assumptions

Factors	MaxAV	MinAV
Expected production	Highest possible	Lowest possible
Expected imports	Highest possible	Lowest possible
Expected consumption	Lowest possible	Highest possible
Expected exports	Lowest possible	Highest possible
Contract renewal/New contracts	No	Yes
Utilization of LNG & GTL	IEA estimate	100%

The best-case scenario of maximum availability (MaxAV) assumes that maximum supply will be available to a pipeline with minimal constraints. Specifically, it assumes the highest possible gas production in the country with lowest possible domestic consumption. Furthermore, imports to the country are set at maximum and possible exports at minimum over the contracted period. Concomitantly, it assumes that the contracts expiring within the projected period will not be renewed. Uncertain future contracts are expected not to materialize and the expected utilization rate for LNG and GTL (gas-to-liquids) terminals can be borrowed from the IEA's World Energy Outlook (WEO).

Conversely, the worst-case scenario assumes that the minimum amount of gas will be available (MinAV) and incorporates the lowest possible gas production, highest possible consumption, minimal imports and highest possible exports as specified in the supply commitments. Expiring contracts within the projected period are assumed to be renewed and potential but uncertain contracts are expected to materialize. The utilization rate of LNG and GTL terminals is set at 100%.

The MaxAV and MinAV scenarios might reveal an extremely wide range of possibilities. Under such circumstances, analysts may consider creating a middle scenario that assesses likely availability—LikelyAV—based on the analyst's expertise and knowledge and subjective perception of likely outcomes. Because of space constraints, we do not produce a LikelyAV here.

3.3. The 3rd Dimension: infrastructure constraints

The 3rd Dimension further elaborates on the ability of producing countries to supply gas by focusing on the infrastructure necessary to connect the potential supplier with the project. Simply put, even

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if a supplier has sufficient gas, can the gas reach the project? This dimension requires identifying all existing, under-construction, and planned feeders plus acquiring knowledge of their intended capacities and timelines. This data can also be culled from the aforementioned sources.

If this analysis reveals a dearth of infrastructure, so much so that all suppliers are ruled out, a secondary filter—a quasi-cost-benefit analysis—can be employed. Which suppliers could offer the most gas and pose the least amount of obstacles, in terms of distance, international boundaries to be crossed, and known significant problems (such as those posed by the Nagorno-Karabakh region for any pipelines traversing Azerbaijan and Armenia)? Regarding the problems, we recommend considering their severity and how readily they might be overcome, for example, do the project's backers have any leverage or do major states have an interest in an obstacle's resolution?

With the first three dimensions, one can evaluate to what extent a country can supply gas to a proposed project. However, a fourth assessment must be conducted: is the potential supplier country politically, commercially and geopolitically stable?

3.4. The 4th Dimension: political, commercial, and geopolitical risks

Even if the first three dimensions reveal favorable conditions for a pipeline, the risks associated with the potential supply and transit countries may prove insurmountable. If decisions about pipelines were driven solely by resource availability and commercial considerations, then the world's pipeline map would look starkly different than it actually does. The Ceyhan-Tbilisi oil pipeline, for example, would have a different routing. When it comes to pipelines, the political, commercial, and geopolitical risk factors of the suppliers and transit countries can trump all other favorable attributes.

The 4th Dimension's analysis tool is influenced by a model that was used by a major US oil and gas company to assess risks in diverse countries. Whereas other "political risk" models are not industry specific, such as that offered by The Political Risk Services Group, our model is oriented toward energy and focuses on the critical issues that experience has shown can torpedo energy projects. The data can be acquired through in-house expertise or consultancies specializing in these types of assessments, such as the Economist Intelligence Unit (EIU) or The Political Risk Services Group. Other sources include publically available datasets and information, such as the World Bank's Worldwide Governance Indicators and the CIA World Factbook.

The 4th Dimension analysis is split into the three categories: first, the risks posed by domestic political instability and problems; second, the commercial and economic difficulties posed by a country that could negatively impact energy projects[b]; and third, the geopolitical risks presented by external political tensions and issues. For each of these categories, the analyst must answer the questions posed in Table 2. Values are given for each answer, ranging from a "1", indicating a strong positive answer, to "5", indicating a strong negative response. By calculating a weighted average, analysts can derive a total score.

Many political risk firms provide grades for countries, and our model also lends itself well to grading, such as the 1 to 5 scale used in parts of Europe or the A to F scale used in the United States. While quantitative scores are useful, we would advise that numbers should always supplement a qualitative assessment containing fine-grained information. It is the qualitative analysis that indicates problem areas and thus serves as a guide for policymakers, diplomats, project managers and other industry executives.

The filtering aspect of our model will be elaborated in Section 4, when we apply the model to a historical case study of the original Nabucco pipeline. This analysis is a modified version of the project we conducted for our industry client and will take us back to late 2010, just before the Arab Spring uprisings, before the Arab Gas Pipeline (AGP) stopped operating, and before the Nabucco pipeline was scaled down to Nabucco West. We do not conduct our analysis with hindsight, rather, we place ourselves in the shoes of decision-makers at that point in time, who apply the model to select suppliers and to decide where to invest scarce resources, such as time, energy and funding.

[b] Corruption is not included; despite conventional wisdom, it was found by the oil and gas company to be a troublesome but manageable problem.

4. Results: demonstrating the 4-D model with the Nabucco pipeline as case study

As part of its diversification strategy, the EC has proposed the development of a southern gas corridor that would help it both bypass Russia and exploit Middle Eastern and Caspian gas potential. In line with the EC's energy policy goals, the originally planned Nabucco pipeline would have connected the EU with gas fields in the Caspian region and the Middle East, and provided as much as 31 bcm/a, independently of Russian-controlled infrastructure. However, acquiring supply for Nabucco—and for Europe—was fraught with difficulties and over the years numerous countries were heralded as potential suppliers. Where should decision-makers have devoted their attention? This is one of the answers the 4-D model can provide.

4.1. The 1st Dimension: Nabucco's timeframe

Initially, Nabucco's company, Nabucco Gas Pipeline International, released timelines showing the construction and delivery dates for all expansions with periodic announcements of new dates. Over the years, however, the announcements became sporadic and the information piecemeal. To establish the timeline for our study, we took the launch date released closest to late 2010 and calculated the expansion dates by adding the previously announced durations of each expansion.[17] This timeline comprises a construction start date of 2012; an operational start in 2016 with 8 billion cubic meter per annum (bcm/a), an expansion to 16 bcm/a in 2018; a final capacity expansion to 31 bcm/a in 2022; and, as the pipeline would have been in operation for several decades, we include year 2030.

4.2. The 2nd Dimension: supply availability

In the many public discussions about potential suppliers for Nabucco, seven countries were mentioned with some regularity: Azerbaijan, Kazakhstan, Turkmenistan, Egypt, Iran, Iraq, and Qatar.[18] The supply potential of the seven countries is impressive: in 2009 they held 71.6 trillion cubic meters (tcm) of proven gas reserves, which comprises around 38% of the world's proven gas reserves.[19] Supplies were promised to Nabucco by several countries (Azerbaijan: 5 bcm/a, Iraq: 3.5–7 bcm/a, Egypt: 3 bcm/a, Iran: 20–30 bcm/a, Qatar: 20–30 bcm/a) and the total amounts, 51.5–75 bcm/a, would have been more than enough to have filled Nabucco's maximum capacity of 31 bcm.[20]

To assess the non-contracted gas—the gas that could possibly have been available for Nabucco for several decades—we accumulated data on current and future production, consumption, import and export figures. For the production and consumption data, we relied on the New Policies Scenario of the IEA's WEO 2010;[c] [21]

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for exports and imports, we used the BP Statistical Review[22] as our starting point and then expanded the data by searching additional sources, such as press releases and industry reports, for fine-grained information about all import and export contracts. We plugged this data into formula (1) provided in Section 3.2.

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[c] As the IEA's five-year increments did not precisely coincide with Nabucco's timeline, we used the nearest IEA years and an equal annual rate of increase.

Table 2: Guiding questions for the 4th Dimension

Political risk	Commercial risk	Geopolitical risk
Are the government's institutions stable?	Is the government receptive to foreign investment?	Does the government have a stable foreign policy?
Are all political elites loyal to the leader/regime/system of government?	Does it respect extant legislation (i.e. what is the risk of nationalization)?	Does it have positive relations with major powers?
Can the government maintain civil order?	Does it have a history of respecting contracts with foreign companies?	Does the country have territorial integrity?
Is there ethnic/religious amity and tolerance?	Is the public satisfied with the government's economic performance (vs. dissatisfaction, which raises the likelihood of riots)?	Does it have positive relations with its direct neighbors and with other regional actors ("relations beyond neighbors")?
Is the country's demographic constellation stable?	Is the government able to protect energy and other infrastructure?	
Is a succession mechanism in place (i.e. will civil war erupt if a power vacuum follows the leader's death)?		

As indicated in Table 3, the results indicate that six of the seven countries had sufficient gas to appear in at least one of the scenarios. Iran did not have enough gas supplies to cover its expected consumption and export contracts in either scenario. Gas from the six remaining countries would have been sufficient to supply Nabucco in the MaxAV scenario and with a slight shortfall of 2 bcm in 2022 in the MinAV scenario.

Table 3: Results from 2nd Dimension – available non-contracted gas

	2016	2018	2022	2030
MaxAV (bcm)				
Azerbaijan	0	5	20	29
Iraq	15	19	27	51
Egypt	0	0	2	1
Kazakhstan	5	5	5	8
Turkmenistan	1	8	17	28
Qatar	25	31	35	36
Potential gas supplies for Nabucco[a]	47	68	107	154
Capacity of Nabucco	8	16	31	31
MinAV (bcm)				
Azerbaijan	0	0	0	5
Iraq	16	20	29[b]	52
Potential gas supplies for Nabucco	16	20	29	57

Capacity of Nabucco	8	16	31	31

[a] Several column totals may appear incorrect due to rounding errors.

[b] In the MinAV scenario, Iraq has more gas for Nabucco than in other scenarios. This anomaly arose because of intra-supplier trade: imports may appear as greater supply availability.

4.3. The 3rd Dimension: Nabucco's infrastructure constraints

The results from the 2nd Dimension reveal that abundant supply from six suppliers could have been available for Nabucco. But, could these supplies have reached Nabucco when the pipeline would have needed them? In this section we review each country's existing, under-construction and planned pipeline infrastructure.

For Egypt's gas to reach Nabucco's starting point in Turkey, one or two additional feeders would have to be constructed. First, the AGP would have to be extended 323 km from Homs, Syria to Kilis, Turkey—a plan that has been discussed, but for which no firm commitments materialized.[23] Or, second, an approximately 80 km link would have to be constructed from Aleppo, Syria to Turkey (and rely on the Syrian gas grid to compensate for the missing section of the AGP in Syria). However, Turkey reportedly was not interested in constructing such a pipeline.[24]

At least two possibilities exist for bringing gas from Kazakhstan and Turkmenistan. Constructing a Trans-Caspian gas pipeline (TCGP) (the lines in Fig. 2 traversing the Caspian westwards, from Kazakhstan and Turkmenistan to Azerbaijan) has been discussed for decades and in the 1990s received significant backing from the US government; however, even up until 2010, none of the efforts for a TCGP had come to fruition.[25] One significant problem for a TCGP is that the Caspian's five littoral states have not been able to achieve an agreement over whether the Caspian is a sea or a lake, which affects territorial demarcations as well as resource ownership. The other possible line would run south to Iran; an option rejected by the Nabucco company because of Iran's political situation.[26]

Two routes have been primarily discussed for transporting Qatar's gas northwards. In 2009 Turkey and Qatar began discussing a major pipeline across Saudi Arabia (the line westwards from Qatar to Jordan), joining the AGP in Jordan and Syria (depicted by the line running from Egypt to Jordan and then northwards to Syria), but by 2010 no agreement had been reached on either the specific routing or the construction period.[27] A second route under discussion would transverse Saudi Arabia, Kuwait and Iraq to Turkey (the line from Qatar northwards to Iraq); however, as with the first pipeline, no concrete advancements have been made.[28] Moreover, both routes would have to cross Saudi Arabia and relations between the two countries were still tense at the time Nabucco was under discussion.

Azerbaijan and Iraq are the only countries that could contribute gas in the worst-case scenario; and, according to the figures, Azerbaijan would not have any gas to commit to Nabucco even by 2022. Unlike the countries discussed above, however, Azerbaijan has a significant advantage: its existing connection to Turkey. The only other country that appeared in the MinAV scenario was Iraq. One possible route would connect the Kirkuk gas fields in the Kurdish region to Turkey (the line from northern Iraq running northwards to Turkey), a 589 km route which was supported by the US.[29] The alternative would be an approximately 50 km feeder from the Akkas gas field to Syrian infrastructure (the westward line originating in northern Iraq) and, as mentioned above in relation to Egyptian gas, also construct about 80 km of pipeline to connect Syria to delivery points within Turkey.[30]

The analysis of the 3rd Dimension indicates that five of the six countries that were found to have sufficient supplies in the 2nd Dimension would not have feeder infrastructure in place or under construction. At this point in the analysis, the prospects for the Nabucco pipeline look bleak and one might assume the pipeline is "dead"; indeed, decision-makers may opt to terminate a project

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at this point. But, in the case that political will and industry interest is sufficient, then we have devised an interim step to ascertain in which direction the project could continue: the cost-benefit analysis, which was introduced in Section 3.3.

To help assess the benefits (potential available gas) and costs (obstacles) associated with each country, we reformulated the data from the first three dimensions. Qatar could meet 100% of Nabucco's capacity for the MaxAV scenario, but any pipelines reaching Nabucco would be long and costly and would require resolution of the Qatar–Saudi Arabia political impasse.

Turkmenistan (13% in 2016, 50% in 2018, 55% in 2022, and 90% in 2030) and Kazakhstan (63% in 2016, 31% in 2018, 16% in 2022 and 26% in 2030) could also potentially contribute significant portions of gas in the best-case scenario, but transporting the gas would require either ending the sanctions against Iran (implying that Iran terminates its nuclear program) or finally resolving the multi-state conflict over the division of the Caspian. Egypt could also deliver gas, if the connections within both Syria and Turkey were constructed. However, even under the best-case scenario, Egypt's contribution would be marginal (0% in 2016, 0% in 2018, 6% in 2022, and 3% in 2030). In contrast, under the best-case scenario, Azerbaijan could supply 31% of Nabucco's capacity in 2018, 65% in 2022, and 94% in 2030; under the worst-case scenario, however, Azerbaijan would not be able to contribute any gas until 2030. The infrastructure from Azerbaijan is in place, so the task would be to maximize Azerbaijan's commitment. Iraq also has abundant gas and could supply either 100% or close to 100% of Nabucco's capacity across all three scenarios. The missing feeder infrastructure, relative to other countries, such as Qatar, would be shorter and cross fewer international boundaries. One route would require the cooperation of Iraq, Syria and Turkey and the other route would require commitments just from Iraq and Turkey.

In sum, in terms of prioritizing the suppliers that could provide the most gas and present the least "obstacles", it would seem that Azerbaijan and Iraq should top the list. Second-place prioritization should be accorded to Turkmenistan (and possibly Kazakhstan), as the states east of the Caspian also offer significant supplies and the main problem—the status of the Caspian—is one the US has had an interest in resolving. Qatar and Egypt, because of either the marginal amount of gas (Egypt) or the relatively lengthy feeder (Qatar), would share third place.

This brings us to the final round of analysis: what are the risks associated with the potential suppliers? We present our analysis of the top priority suppliers.

4.4. The 4th Dimension: political, commercial and geopolitical risks

Even if the gas supplies and infrastructure are conceivably available, a project may still be stalled or derailed by political, commercial and/or geopolitical problems. In addition to pinpointing critical areas, this analysis indicates where diplomatic energy should be invested. To conduct the analysis, analysts must answer the questions detailed in Table 2. For the Nabucco case, the input was derived from the sources listed in Sections 3.2 and 3.4.

4.4.1. Iraq

From the vantage point of 2010, which problems could either potentially hinder Iraq's participation in the Nabucco project or indicate that it may ultimately prove to be an unreliable supplier? Table 4 summarizes our risk assessment.

4.4.1.1. Political risks. Referring back to the questions in Section 3.4, Iraq received a "4" for Government Stability, reflecting the shakiness of Prime Minister Maliki's government. Iraq was given a "5" in the Loyal Opposition category, reflecting the presence of strong, distrustful factions, several of which are supported by foreign governments (e.g. Iran and Saudi Arabia). In addition, because of the presence of rival factions, Iraq has been unable to promulgate a hydrocarbon law which would provide a stable legislative framework for foreign investors.

Fig. 2: Infrastructure necessary to transport identified non-contracted gas to Nabucco

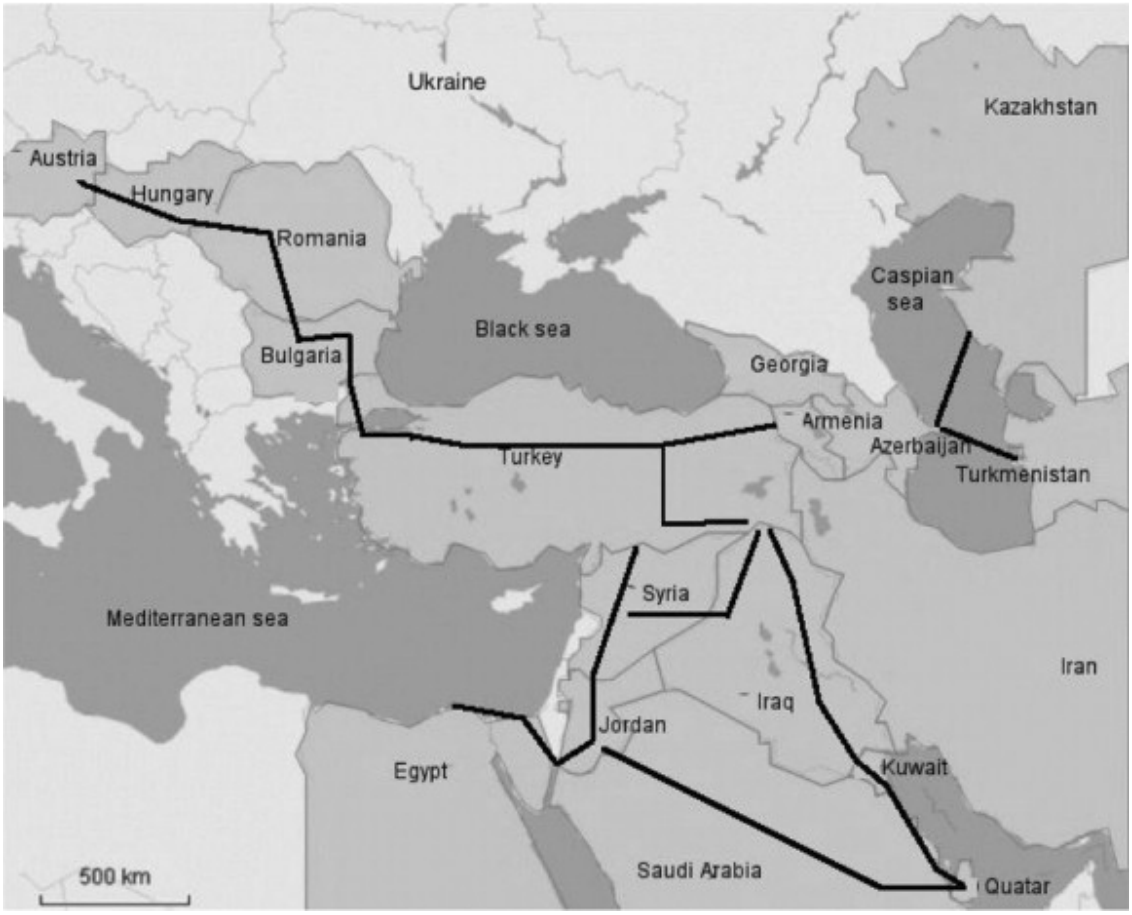

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Table 4: Evaluation of risks associated with Iraq

Political risks		**Commercial risks**		**Geopolitical risks**	
Government stability	4	Receptiveness to foreign investment	3	Stable foreign policy	1
Loyal opposition	5	Respect for extant legislation (vs. nationalization)	2	Relations with major powers	1
Maintenance of civil order	5	Contract integrity	3	Territorial integrity	4
Ethnic/religious tolerance	4	Public satisfaction (vs. riots/disorders)	n.a.	Relations with neighbors	4
Manageable demographics	5	Infrastructure security	5	Relations beyond neighbors	1
Succession mechanism	1				

Iraq received a "5" in Maintenance of Civil Order reflecting the history of violence that coincided with US troop drawdowns. Iraq is beset with ethnic and religious enmity between various groups, which has sparked discussions about whether Iraq should split into three sections, and thus received a "4" for Ethnic and Religious Tolerance. (A more severe "5" would have been given if one of the groups had threatened secession, which has not yet occurred.) With its large percentage of youth (39% below age 15) and its high unemployment rate (estimates range from 15% to 40%), Iraq received a "5" score for Manageable Demographics. Lastly, under current laws, a succession mechanism is in place, so Iraq received a "1".

4.4.1.2. Commercial risks. Iraq's desperate need for foreign currency and investment has prompted the introduction of a National Investment Law and encouraged the development of multiple international trade and investment events. However, the national government has annulled several contracts between the Kurdish government and international energy companies. On the one hand, it was upholding the law; on the other hand, the government's disinclination to seek a compromise unsettled foreign investors. For this mix of reasons, Iraq received a "3" in the category of Receptiveness to Foreign Investment and a "2" for Respect for Extant Legislation. Some contractual agreements, for example between the Iraqi government and Shell, Mitsubishi and Exxon, have been successful. However, as mentioned above, some companies have been unable to operate in the Kurdistan Region because of protests by the Bagdad authorities. Therefore, overall Iraq received a "3" for Contract Integrity.

As Iraq already suffers high levels of unrest, it is not possible, at this juncture, to assess how much of the unrest can be attributed to public dissatisfaction with economic factors (as opposed to countries that experience "bread riots" and other clearly economically driven unrest), thus this category was not evaluated (n.a.). Finally, Iraq received a "5" for Infrastructure Security, reflecting the astounding number of attacks on energy infrastructure that have occurred throughout the years.

4.4.1.3. Geopolitical risks. Because Iraq appears to have coherent and stable foreign policies, it scored a "1" in this category. It received a "1" for Relations with Major Powers: Russia and China have both forgiven part of Iraq's debt and Iraq can expect continued assistance from the US. Conversely, Iraq's

diplomatic affairs with its neighbors are problematic. Iraq has had strained relations with Kuwait, Saudi Arabia, Turkey, and Syria. Consequently, Iraq scored a "4" for Relations with Neighbors. Because of Iraq's still unresolved maritime dispute with Iran, Iraq received a "4" for Territorial Integrity. With respect to its Relations Beyond Neighbors, Iraq has no significant problems with countries that are neither neighbors nor major powers and hence scored a "1".

The analysis of the 4th Dimension can be helpful in two ways. First, is Iraq a country on which pipeline project developers or potential importing countries could rely? A weighted average of Iraq's scores is 3.2 (a C in the US system), which indicates that Iraq has weaknesses. The second way to use the results of the 4th Dimension is to pinpoint the problem areas: Iraq seems particularly plagued by internal political problems, such as significant security issues and the intra-group fighting that has obstructed adoption of a hydrocarbon law.

4.4.2. Azerbaijan

In contrast to Iraq, Azerbaijan seems to offer a more promising political environment, as previewed in Table 5.

Table 5: Evaluation of risks associated with Azerbaijan.

Political risk		**Commercial risk**		**Geopolitical risk**	
Government stability	2	Receptiveness to foreign investment	1	Stable foreign policy	4
Loyal opposition	2	Respect for extant legislation (vs. nationalization)	1	Relations with major powers	2
Maintenance of civil order	2	Contract integrity	1	Territorial integrity	5
Ethnic/religious tolerance	2	Public satisfaction (vs. riots/disorders)	1	Relations with neighbors	4
Manageable demographics	2	Infrastructure security	2	Relations beyond neighbors	1
Succession mechanism	4				

4.4.2.1. Political risks. Azerbaijan received a "2" for Government Stability because President Aliyev seems firmly in control and there is little reason to expect government or institutional breakdown. The lack of violent political factions earned Azerbaijan a "2" for Loyal Opposition. Azerbaijan warranted a "2" for the Maintenance of Civil Order, reflecting the government's adeptness at keeping order, such as during the 2007 protests against utility price increases. For both the Ethnic and Religious Tolerance and Manageable Demographics categories, Azerbaijan received a "2" as no significant internal risks were identified. Within the political risk dimension, the only category in which Azerbaijan received a "4" is Succession Mechanism. The lack of a succession mechanism could invite a power vacuum if Aliyev were to die in office.

4.4.2.2. Commercial risks. Azerbaijan received a "1" for Receptiveness to Foreign Investment, reflecting the history of positive relations with foreign investors. At the same time, it received "1" for Respect for Extant Legislation and for Contract Integrity as no significant problems have emerged. Azerbaijan also earned a "1" for Public Satisfaction. For Infrastructure Security, Azerbaijan scored a "2" as it has experienced only one minor attack in 2008.

4.4.2.3. Geopolitical risks. On the geopolitical front, the overall evaluation for Azerbaijan is less positive. Azerbaijan received a "4" in Stable Foreign Policy because of its dispute with Armenia over

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the Nagorno Karabakh territory. Moreover, Azerbaijan behaved erratically during the "flag wars" with its long-time ally Turkey, and exhibited poor diplomatic judgment when it unilaterally decided to start exploring in disputed areas of the Caspian while in the midst of negotiations with Turkmenistan. However, Azerbaijan received a "2" for its Relations with Major Powers. It has friendly and balanced relations with the US, the EU and Russia. Given the Nagorno-Karabakh conflict, Azerbaijan scored a "5" for Territorial Integrity. The unresolved Caspian Sea boundary is also problematic. Hence, Azerbaijan scored a "4" for its Relations with Neighbors. Finally, Azerbaijan received a "1" for Relations beyond Neighbors as no significant problems with other countries have been observed.

Azerbaijan's overall score is 2.25, about a B on the US grading scale. This is far better than Iraq's score, but still indicates that Azerbaijan has room for improvement, particularly in terms of its foreign policies and relations.

5. Nabucco: what happened?

Our analysis started with seven countries and ended with Azerbaijan and Iraq. The main results indicate that, of these two, the risks associated with Iraq are troublesome. It seems that Azerbaijan, with its resource potential, existing infrastructure, and relatively positive score, should have been heavily courted by Nabucco's backers—which, in all fairness to the Nabucco company, it seems they did. However, by mid-2013, the Nabucco project was terminated.

What went wrong? We return to Victor's et al.[31] survey of major pipelines and their insight that *strong* state backing is the critical ingredient for success. Although the EC awarded the Nabucco project priority status, the EC was initially uncoordinated and sluggish in its support and seems to have waited too long in exerting heavy diplomatic lobbying in the Caspian region.[32] As stated in Section 4.2, numerous supplier countries were proposed for the Nabucco pipeline. As our analysis indicates, most of these countries were unsuitable. The fact, however, that some of these countries were seriously considered as contenders indicates to us that decision makers lacked a framework for systematically and quickly selecting the best options. In our view, if decision-makers had been aware that Azerbaijan was the most suitable supplier for Nabucco, in terms of the factors assessed by the 4-D model, they would have known to court Azerbaijan earlier and with more intensity.

Turning to present-day concerns: On the heels of Russia's recent annexation of Ukraine, Europe is once again intensifying its search for alternative suppliers and routes. We offer a systematic tool that helps quickly narrow down the list of potential suppliers to the most credible and stable candidates and hope our model provides guidance.

6. Conclusion

The 4-D supplier selection model helps decision-makers and other interested parties evaluate which potential suppliers are the most suitable for long-term contractual relationships, whether for natural gas pipeline or LNG projects or, with some slight modification, for other commodities. We see the 4-D model

as a complement to conventional evaluation models; indeed, ideally the 4-D analysis would precede other analyses as it indicates for which supply relationships a feasibility analysis, for example, should be conducted.

As we see it, our model offers numerous benefits. In a nutshell, it helps filter out unsuitable suppliers and pinpoints where policymakers and managers should wield their influence. As the Nabucco case study revealed, if the EC had been seriously interested in supporting the project (which it may not have been), then it could have become active in the region much earlier and courted Azerbaijan with greater intensity.

As our discussion indicated, some potential suppliers were eliminated because of issues with the transit countries, such as the missing section of the AGP in Syria and the Qatar-Saudi Arabia tensions. We thus recommend that the 4th Dimension analysis also be conducted for transit countries. A limitation of our model is that assessing numerous countries requires significant research. However, we believe the effort expended in such research is worthwhile. Identifying the most suitable suppliers is a critical step in moving a project forward and achieving its successful completion, which may ultimately enhance the energy security of the importing region and the prosperity of all countries involved.

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