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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.

1. Introduction

Importing states and regions employ myriad strategies to enhance energy security, from stockpiling to diversification to efficiency programs [1,2]. 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).

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 [3]. 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 [4].

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 [5,6] for LNG] offering new indicators [7,8], or expanding the catalogue of risk factors [9]. Other models offer new tools, such as SWOT (strengths, weaknesses, opportunities, and threats) and Delphi analyses [10]. Hayes and Victor [11] 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. [12] 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 [13,14]. 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 [13] ([15] 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 [16–19]. 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 [16].

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 [13] 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:

$$\sum_{i=1}^{n} S_{i,t} \geqslant D_t \tag{1}$$

where for each $S_{i,t}$