

The question of diversification of routes for natural gas supplies is being debated in European policy circles particularly with reference to Russia's Nord Stream and South Stream gas pipeline projects. These pipelines have traditionally been referred to as "transit avoidance" projects, as one explicit goal in both cases is that they would partly or wholly replace existing infrastructure on the territories of Ukraine, Belarus and/or Poland.

Supply systems and failure events

Reliability theory is used in the engineering sciences in order to analyze the reliability of a system that is exposed to uncertain events of failure. Concerning supply systems for fuel, water, or electricity, one key determinant is the difference between serial and parallel systems. If the two end-points of a supply system are connected only serially, only one failure event somewhere along the supply chain is sufficient to interrupt the flow. As a result, a typical solution is to include one or more parallel lines. If this is the case, a single failure event would interrupt only a part of the flow. Parallel lines may moreover be able to pick up – temporarily at least – part of the flow from the line that is damaged. Thus, if two parallel lines exist in total, less than 50% of the flow would be lost from a failure event.

How many lines should one build in total? If pipelines were free, one would build an infinite number of lines. For a fixed probability of any one line failing, and assuming that that probability is strictly below unity, an infinite number of lines would make the probability of a supply shortfall at the end of the system fall to zero. That would be the optimal design, if building and operating lines were costless. Alas, pipelines are never free. In the case of natural gas pipelines in particular, capital expenditures are substantial. Moreover, the discussion above assumes that the only possible reaction to a failure event is to divert part of the flow to other supply lines, and/or to reduce the flow. Two elements modify the calculation: storage, and the possibility to repair damaged lines. In a dynamic context, the volume of storage may be chosen so as to reduce (as much as remains cost-effective overall) the time gap between the incident and the resumption of normal deliveries after the infrastructure has been repaired.

Transit avoidance pipelines would be a reasonable response if transit through a given route were at a high risk of severe and repeated disruption. So far, however, there has not been a single cut in Russian gas supplies to Europe that could be attributed to the transit country alone, and not a single case where the Russian authorities were not to blame, in part or in full. The part of the risk which is due solely to transit is therefore extremely low even in the case of Ukraine, and essentially zero in the case of Poland and Belarus. Transit avoidance, in other terms, seems to be the wrong solution from a pure reliability theory approach.

Economic aspects of transit avoidance

The other part of the analysis, which ideally should be combined with a reliability theory approach, is to look at standard calculations of net present value between different potential gas infrastructure projects. The latter calculation would naturally depend on what time horizon one is considering. In addition, while risks of failure matter, all cost considerations should be taken into consideration, i.e. capital expenditure costs for the various options (including the option of upgrading and modernizing existing lines), operation and maintenance costs, and other costs related to transit, notably the remuneration of state-actors along the lines, in the form of transit fees. Such a calculation would be a valid approach towards justifying the construction of a transit avoidance line. However, no comprehensive comparison of various options for transporting natural gas from the Russian Federation to the European Union has ever been made available in the public domain. It is therefore not clear whether the transit avoidance projects that are promoted by the Russian Federation for European markets are good solutions from a strictly economic viewpoint. While estimates of capital expenditure costs are often published, the private companies that are directly involved in such projects display considerable resistance when asked to provide estimates of operation and maintenance costs, and of how remuneration is shared between the companies involved. As precise data on those other costs are missing, estimates have to be used instead. The few estimates that do exist in analytical or academic literature typically conclude that Nord Stream is economically less efficient than at least some of the overland alternatives. In other words, the transit avoidance projects are being pursued in spite of being economically sub-optimal, as well as sub-optimal from a risk analysis viewpoint. The next question, quite naturally, is why then have these projects not been dropped?

Locked in secrecy

Private corporations involved in gas pipeline projects are typically unwilling to release detailed cost information into the public domain. Why is that? One needs to consider the broader economic structure first in order to guide the analysis. The key feature to bear in mind is that the market for large-scale international gas pipeline projects is an oligopoly with very high barriers for potential new entrants, and hence very little scope for any meaningful competition. On the Russian side there is no alternative, it must be Gazprom. Gazprom finds arrangements with major companies in the destination countries. In many European countries there is only one major energy company to deal with, while, in the case of Germany, Gazprom does business with all major energy companies.

Given this very specific market structure, one could still wonder whether some of those companies may have developed break-through technologies that they wish to conceal from potential competitors. This may or may not be the case. Of course, if it is the case, then it could come as a justification for strict confidentiality about certain cost items. But there is a much more basic reason for wanting confidentiality. If the cost structure, profit margins and their distribution between project partners remain unknown, transit avoidance projects cannot be compared to alternative projects. None of the corporate partners involved have any interest in

revealing details of their predictions for operating costs and profit margins, as this may indirectly hurt the chances of their projects being developed. Gazprom, i.e. the Kremlin, has a preference for transit avoidance. Corporate partners in the destination countries are only too happy to get involved: they might get nothing at all (or considerably less) if another pipeline project were preferred. This creates a lock-in effect which requires commercial secrecy on all sides. Commercial secrecy in turn translates into state secrecy. As the number of players is small, the details of the negotiations surrounding pipeline infrastructure, transit arrangements and long-term supply contracts are mostly concealed from public view. Even ex post it is not possible to arrive at reasonable estimates of the costs of imported natural gas in certain countries (chiefly Germany and Austria), given that national statistical offices refuse to provide a breakdown of natural gas import values by country of origin. This behavioral pattern effectively leads to beggar-thy-neighbor national energy policies on the part of individual EU member states. A change in legislation favoring greater transparency, on the other hand, would go a long way towards leveling out such distortions and should be a component of any plans for a future common energy policy for the European Union. Ultimately, a more efficient and more secure approach to gas pipeline projects for the European Union would be to legislate that cross-border energy supply infrastructure entering the European Union should be, at least on EU territory, subject to open and transparent competitive tendering.

Target function of the supplier

It is increasingly well understood within European policy circles that the Russian Federation seeks to control the political and foreign policy orientation of the countries in its "near abroad." A whole string of coercive measures – from unilateral trade restrictions to military action – have been applied. As a result, some observers of the region have openly wondered how far Russia may be prepared to go. In the case of Ukraine more specifically, various acts of political subversion seem in evidence, from mass propaganda to direct and public statements from members of Russia's ruling elites that sound more like thinly-disguised threats than anything else. With respect to energy supplies, one government official from an EU member state summarized the situation as follows: "Russia wants to run the place [Ukraine], or shut it down."

A more formal way of expressing the thinking behind such aggressive behavior is to think of the target function of the power in question, and then run through the list of possible means (policy instruments) that the country may resort to in order to achieve its aims.

A target function for the Russian Federation would take into consideration both foreign policy objectives and economic or commercial goals. While the former may partly be explained by the latter, the simplest formulation is given as a utility function that depends positively on the profits of state-controlled corporations, e.g. Gazprom, and on the extent of political control that is gained over the target countries, e.g. Ukraine.

Many policy instruments are available. Beyond classical measures which would typically be referred to as "soft power" instruments, such as (legal) corporate expansion through cross-border mergers and acquisitions, the Russian Federation has deployed coercive measures as well. Coercive measures in international relations are defined as an action or policy carried out by one state in order to modify the policies of another state by inflicting direct damage on its interests, or by threatening to do so. There are many examples of coercive measures which may be mentioned. Targeting the other country's most important exported goods is one type of measure (e.g. Georgian wine and mineral water, Moldovan wine). Targeting one of the other country's most significant imported goods is another type of coercive measure, e.g. timber deliveries to Finland. That latter category of actions is in fact a meta-category for energy supply disruptions. It is clear that energy supply disruptions, either a substantial price hike or a partial or total cut in supplies, can have deeply debilitating effects on a country's economy.

On the other hand, Russia does depend on revenue from oil and gas sales. Shutting down the entire European natural gas market, or at least a large part of it, would have strongly negative consequences on the Russian economy and on the budgetary stability of the Russian state. Unfortunately, there is an asymmetry in terms of time horizons. As noted by Kari Liuhio in a [2009 study](#), "...due to relatively small emergency storages, the Union needs energy almost immediately but Russia can cope even if the energy-related financial inflows would stop for a longer period."

National resilience

A country that may become a target of an energy supply disruption may consider a number of options in order to better prepare itself for such an event. As with any defense strategy, both preventive and deterrence measures may be considered. A strong state will usually deploy both types of measures, whereas smaller powers may prefer to focus only on preventive measures. Among the latter, one general category of preventive measures is to increase the country's resilience to the type of attack that is expected. At the macro-level, the country's energy demand, its domestic supply of energy, its energy mix and the diversification of its sources of imports are the key variables to look at in a medium- to long-term perspective. Further planning and preparation is also made for the management of the crisis period itself, notably drawing on domestic supply stockholdings and on energy solidarity mechanisms with allied countries for rapid, short-term supply substitutions. The ability to substitute fuels at short notice in industry and power generation is likewise crucial, as is the ability to enforce some degree of rationing on domestic demand. At the structural level, the core issue is the resilience of the defending country's domestic energy system, i.e. its ability to continue to fulfill key objectives in spite of severe disruptions. The core objective is that the energy system should be able to deliver acceptable levels of supplies to as many end-users as possible (following a previously designed order of priority) given a radically different pattern in terms of external supplies (e.g. no supplies at all at some entry points, but increased supplies at other entry points, including storage sites).

This includes the ability to operate parts of the infrastructure in reverse flow. Detailed simulations are therefore carried out in order to identify necessary improvements to existing infrastructure.

From this perspective, public authorities should plan for different types of supply cuts: partial versus total, and of short or long duration. At the country level a relatively long supply cut, if it occurs, would effectively turn into an economic battle of attrition: the first country to reach subjectively unacceptable economic losses is then the defeated party.

Collective resilience

In the previous section the issue of resilience was approached in its classical form, i.e. a two-country setting with one attacking country and one defending country. However countries can develop common items of infrastructure, as well as energy solidarity mechanisms for times of crisis, thereby increasing each other's national resilience. To some degree this is being developed inside the European Union. On July 7, 2009 the European Council approved funding as part of the recovery plan for investments in gas infrastructure, a part of which is directly designed to improve collective resilience. But energy system resilience is only one component of preventive policies. Another important plank of preventive measures for security of gas supply includes measures that reduce the probability of disruptions occurring in the first place.

This issue brings us back to the discussion about the target function of the supplier. A supply cut may be thought of by the supplier as a coercive measure. However that coercive measure carries costs for the supplier. If the costs for the supplier of a given coercive measure can be raised, the probability that the supplier will carry it out will be reduced. On the other hand, if the infrastructure is set up in such a way as to turn a coercive measure into a relatively cheap undertaking, then the probability of that coercive measure being applied will rise. Concretely, if the Russian Federation has at its disposal a large number of supply lines to European markets, and is thus able, in principle, to shut down countries separately without losing substantial revenues, then such measures are more likely to occur. By extension, if only a single line existed through which the entire flow of gas from Russia to European markets were transported, then the cost of any kind of disruption, regardless of its nature, would be unacceptably high for both sides. In essence, this means that the risk-minimizing strategy for Europeans is to ensure that the bulk of Russian gas continues to transit through Ukraine. In parallel, EU member states as well as Ukraine need to work individually and collectively on increasing their energy system resilience.

Conclusions

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It is in the best interest of the European Union and Ukraine, collectively speaking, to ensure that Ukraine's transit infrastructure is secure and operates normally. It is not in the best joint interests of this group of countries to allow Gazprom to develop and operate a large number of separate supply corridors to Europe. In other words, the optimal policy from a security of supply perspective is to cancel both Nord Stream and South Stream, and invest and upgrade Ukraine's transit capacity instead. In parallel, the energy system resilience of both the EU and Ukraine need to be increased through separate as well as collective actions and policies. Apart from improving security of supply, this group of policy choices would also offer important support for the continued economic and political independence of Ukraine. The latter is clearly in the collective interest of the European Union for the longer term. It is also the only ethically acceptable choice.

Edward Hunter Christie is an economist at the Vienna Institute for International Economic Studies (wiiw).