

Adding flexibility in a natural gas transportation networks using interruptible transportation services

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In this paper we discuss the added value of interruptible transportation services in a natural gas network. We present a case study based on realistic data from the transportation network on the Norwegian Continental Shelf (NCS) and transportation regulations within the Norwegian system. The modelling framework is however general in the sense that we distinguish only between qualities of service; either guaranteed deliveries or interruptible deliveries. In the Norwegian natural gas system all transportation contracts are currently firm - all transportation services sold by the independent system operator (ISO) should be carried out according to the agreements. In our analysis we also allow for interruptible services, where the transportation will be carried out given availability of capacity on the given day.

In the natural gas transportation network there will be a trade-off between maximizing throughput in a given period, and to reach the required level of security of supply. The security of supply is a measurement of the regularity of the service offered by the system operator to the shippers. A high level is important both on the market side, for the shippers to be able to deliver in long-term contracts, and on the production side, such that the oil production on the fields will not be decreased due to decreased gas production. In order to maintain a high level of security of supply, it is necessary for the system operator to withhold some flexibility in the system to handle both planned (maintenance) and unplanned (shut-downs) events. The flexibility comes from the possibility to increase production levels in some fields, to reroute the gas and from the storage capabilities inherent in the pipelines themselves (linepack). The system operator must carefully choose the levels of booking that is offered to the shippers. If the booking levels are set high, the expected security of supply in the network will decrease, whilst if the booking levels are set low, the efficiency in the network will decrease.

The system operator must also take into account system effects which makes it impossible to a priori determine fixed capacities in the transportation network (see Midthun et al. (2009)), as well as uncertainty in network availability due to events (such as outages and technical failures). In this paper we investigate how this problem may be solved by introducing two different qualities of service: firm and interruptible. The volumes that are booked interruptible will not influence the security of supply in the network, and thus allows the network operator to sell more capacity to the shippers.

Our contribution is both a presentation of a modelling framework that allows for detailed analysis of interruptible contracts in the natural gas transportation network, as well as a case study based on realistic data and topology from the NCS. Our models are based on stochastic programming and do not include strategic behavior of the participants. This assumption is valid for most of the models, given the step-wise decision process and the flow of information, whilst for others it represents a simplification.

We have also developed a new production cost function where the effects of reduced gas production on oil production in the same field is incorporated. We have tested the modeling framework on a case study with realistic input data, and a topology that is

similar to the one found on the Norwegian Continental Shelf. The results from our case study show that there is a substantial gain in efficiency in the network when interruptible services are introduced. Both total flow and income in the system is drastically increased compared to the benchmark solution where interruptible services are not available.