

# Energy Commodities, Strategic-Other Problems

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## Mathematical models

Take or Pay (ToP) contracts are a very common contract types in the oil as well as in the gas industry. In their simplest form they state that, once signed, a certain amount of commodity can be used or otherwise lost while already paid. Typically, these ToP contracts were historically used when new oil and, lately, gas pipelines were to be constructed in order to give some economic certainty to the pipelines constructor. However these type of contracts have evolved over time including several flexible clauses whose - optimal - usage from the buyer perspective, have rendered the operational portfolio problem, quite complex.

For instance, in a ToP a monthly amount and a total annual amount can be specified, therefore at least  $X\%$  of the monthly amount has to be bought every month and at least  $Y\%$  of the contracted annual amount for the year has to be bought. Hence, there might be some gas excess based on contracts of this type. Moreover some other clauses can be present, such as those named **Make-Up**. Such additional flexibility enables the buyer to "recover" some quantity after the ToP horizon have passed and the quantity has not been used. Of course the exercise of Make-Up clause can be at some cost, and typically have maximum amount of quantity. In real life Gas or oil contracts the set of clauses can be in the order of tens and interact with each other. The minimum or maximum amount of quantity applied to each clause can be a complicating factor. Indeed all the ToP contracts management deals with uncertainty from the demand that the buyer has to face.

## Modeling and algorithmic considerations:

From a modelling point of view, the portfolio management of ToP contracts with swing-like options such as Make-Up and others, is a complex, large scale, optimization problem with integer variables and a lot of source of uncertainty that cannot be neglected in modern models. The uncertainty, in turn, are of different types and produce either volume as well as price risks. For instance, price risk can be taken into account if the buyer consider alternatives of buying spot volumes on the market in future times.

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