Avoiding lost swing value and hidden portfolio risk

A non-mathematical overview of maximising gas swing portfolios through hedging

A white paper by Lacima

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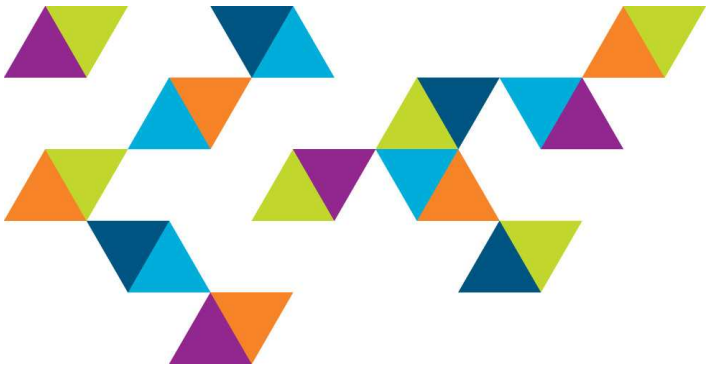

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1 Introduction

Over the past 5 to 10 years there have been major changes in the trading of European gas contracts and in the operational management of these contracts. There has been a significant increase in the market trading of gas, while in the UK an increase in competition has led to a decreased use of long term gas supply agreements. Additionally, mainland Europe has also been actively trying to head in a direction that improves short term gas trading liquidity. The increased liquidity and competition has resulted primarily in the ability to take more advantage of the available flexibility and constraints in the existing long term agreements and consequently, we do not believe that agreements of this type will disappear completely from the market at any time soon. Increasing computation power has also resulted in marked improvements in applying optimisation methods to maximise the profit from these agreements and, with optimising techniques also improving, it is becoming easier to maximise the value derived from these agreements.

15 to 20 years ago only rudimentary techniques were available to value the available flexibility and embedded constraints in long term gas contracts. However, over the past 5 to 10 years we have seen major changes in the ability to optimise these contracts and nowadays there are methods available that can, within reasonable time frames, and for most of the flexibilities and constraints that these contracts exhibit, determine accurate values not just for a single contract but for whole portfolios of such contracts.

With the rapid increase in available computational power, the optimisation of the whole portfolio together with associated network constraints is becoming possible. Incorporating the constraints of the contract, and optimising the portfolio to minimise the loss from these constraints, has the potential to add significant value.

2 Gas swing contracts

A gas swing contract is an agreement for the supply of gas with terms that enable the purchaser to change how much gas he has an obligation to take over a period of time. The more flexibility the purchaser has to nominate the amount of gas to take, the more swing he is said to have. Some of the flexibilities that are offered under these contracts include; variability in gas that can be taken per day, per season and/or per year; being able to move gas not taken over one period of time to another period of time; or being allowed to change the amount you are required to take because of how much you have already taken. To satisfy the needs of both the supplier and receiver of gas, many of these flexibilities exist simultaneously in long term gas swing contracts.

As a counterpoint to the flexibility available in gas contracts, there are usually also constraints and penalties specified in the agreements that are generally inserted to ensure that physical limits aren't breached. One such constraint is that in each gas year, there is an absolute minimum volume of gas (usually termed take-or-pay or minimum bill) for which the buyer will be charged at the end of the year (or some pre-determined penalty date), regardless of the actual quantity of gas taken. Typically, there is also an absolute maximum annual quantity which can be taken, above which no further gas will be supplied or only supplied with large penalties.

There are many other constraints that can also exist in these agreements, examples of which can include a rolling annual maximum, rolling minimum bill, banking gas, clawback rights, depletion rights and many more (it is not the aim of this paper to explain the different constraints in detail but to highlight the impact from not accurately and realistically optimising them). Each of the constraints are negotiated elements of the contract to ensure both the supplier and receiver perceive benefit in the agreement.

Another feature commonly embedded in many types of European based gas swing contracts is called indexation, which is the linking ('indexing') of the amount paid for the gas to one or more other commodities, such as a particular oil price or basket of oil prices. The incorporation of these

additional variables significantly increase the complexity in the behaviour of the payoff of the contract. While swing contracts have been used for many years to manage the requirements for the supply of gas, so too have indexation features in managing the exposure to competing fuel sources such as fuel oil and diesel. It has only been very recently that it has been possible to ascribe a value to this added complexity in swing contracts.

We believe that it is important to value swing contracts accurately, because not doing so can lead to significant reductions in profit and potentially significant misrepresentation of the risks posed by these contracts.

The impact from not accurately measuring optionality and constraints

The misrepresentation of both the value and the risk of the contract comes from the fact that ignoring any one of the available optionalities and constraints in the modelling can have the impact of reducing the operationally obtainable value from these variables, and hiding some of the real risk. For example, for a particular contract the optimal solution might call for a certain amount of volume for make-up and carry-forward. If the carry forward was not well optimised, it is likely to result in a poor decision for the carry forward volume for all possible future market outcomes. This would also then cascade into decisions on the make up volume which give away significant value to the counterparty. Figure 1 below shows how the full value of the contract is related to some of the different flexibilities and constraints. It shows the impact on intrinsic and extrinsic value from optimising the unconstrained swing (represented by the ‘daily swing’ box in the diagram), several flexibilities that add value (‘price tranches’, ‘make-up’ and ‘carry-forward’), as well as the effect of two common constraints (‘early termination’ and ‘tax’). The height of each bar clearly demonstrates how full value is obtained as additional value to the intrinsic case.

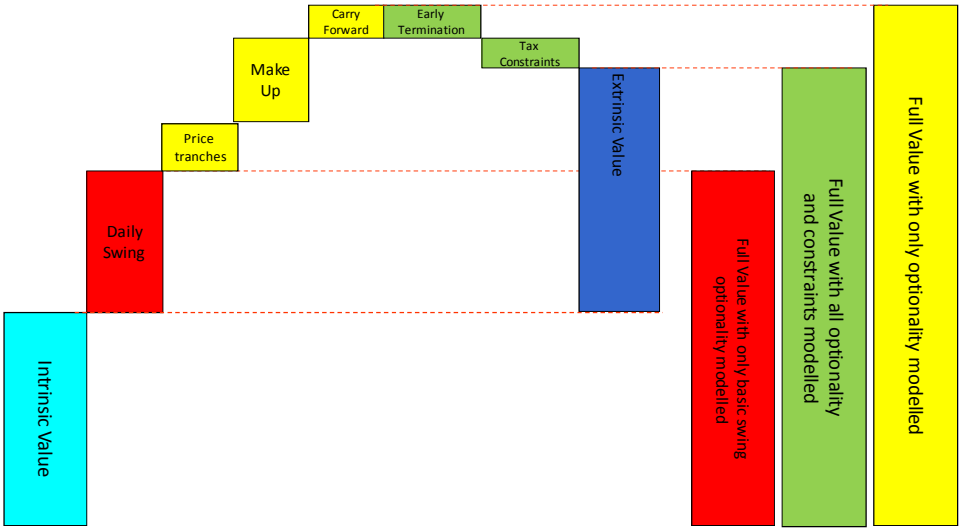

Figure 1. Intrinsic and extrinsic value

If, however, one of the optionalities or constraints is not modelled accurately then one can expect the value outcome as shown in Figure 2. The light coloured boxes represent what the value would have been if the contract was fully optimised, while the brightly coloured boxes clearly show the value that can be lost from not accurately optimising any one variable. The value obtained from the flexibility is likely to decrease and this may be exacerbated by a loss in value from poorly modelled constraints. This may result in a total loss in value that can be as much as 50% of the available extrinsic value with a corresponding misrepresentation of the risk of the contract.

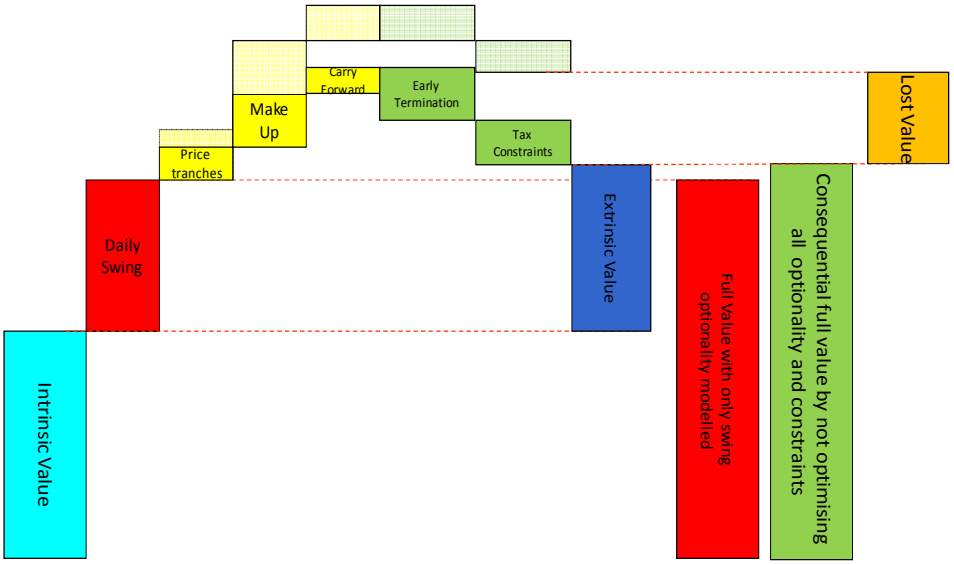

Figure 2. Impact of sub optimal optimisation

It is therefore critical that all the significant flexibilities and constraints are accurately modelled in order to realise maximum value from swing contracts.

3 Avoiding lost value from portfolios of swing contracts

Our discussion so far has focused on the ability to accurately value and hedge an individual swing contract - the issues that we have flagged are magnified when we are trying to address a portfolio of such contracts. To achieve this, a method of valuation needs to be employed that allows all the swing contracts in the portfolio to be optimised consistent with each other. In other words, each simulation of gas prices and other relevant risk factors, needs to be applied consistently across all swing contracts in the portfolio to obtain a consistent portfolio cash flow at each point of time.

Our conversations with market participants show that there is increasing analysis of portfolio wide optimisation using either Least Squares Monte-Carlo simulation or Stochastic Dynamic Programming techniques, with

varying levels of approximation to manage the computational demands. At Lacima we have performed a significant number of tests of the two methods and have found that using Stochastic Dynamic Programming enables results to be obtained with less computation power and with far more robust and accurate results than Least Squares Monte-Carlo, which typically requires a large amount of user intervention.

4 Pitfalls in hedging swing portfolios

The main features of swing contracts which make them difficult to value and risk manage are the constraints on the quantity of gas which can be taken. The main volumetric constraint is that in each gas year there is a minimum volume of gas for which the buyer will be charged at the defined contract price (which may depend on other market indices, such as oil), at the end of the year (or penalty date), regardless of the actual quantity of gas taken. A seller of daily swing takes on an un-hedged risk profile which is a complex mixture of a sold daily settled swap and a sold strip of daily call options. It is this nature of the volume uncertainty which gives swing and indexation contracts a risk profile which is difficult to manage. Hedging such a contract can therefore be a complex task. This is further complicated with indexation contracts as now the fixed contract price is changing in accordance with changes in other commodity prices.

There are two generally accepted methods for hedging – delta hedging, where the hedge position is based on the sensitivity of the contract price to the underlying prices and the hedge is updated frequently, and static hedging where the required mix and quantity of trades to obtain the desired risk profile are determined at relatively infrequent intervals.

Delta hedging

The natural approach to hedging for many market participants is to delta hedge the contract, but this can present a number of practical problems. Spot delta hedging (hedging with a position in the underlying spot commodity) is not generally feasible in most power and gas markets due to the difficulty in trading the spot asset, and so the delta with respect to the available liquid futures contracts is often calculated. Calculating these futures deltas for long dated swing contracts often presents severe computational difficulties. The contract must be re-valued for a shift in each futures contract which, depending on the length and complexity of the contract, can take many minutes to potentially hours. Furthermore, calculating accurate deltas using either a lattice or simulation based approach is computationally demanding, and can increase the computation time to impractical levels. Finally, delta hedges are generally sensitive to both the rebalancing interval and to misspecification of the model. If the rebalancing interval is much greater than a day and/or the assumed model for the underlying price dynamics does not capture the daily dynamics of the volatility, the delta hedge can perform poorly.

Static hedging

It is therefore appropriate to look at the performance of intrinsic hedging strategies as well as hedging strategies that involve the use of standard forwards and European call and put options. The intrinsic hedging strategy is based on the assumption that the spot price follows the forward curve with certainty. The optimal exercise decisions under this assumption yield the static hedge – the hedge involves taking positions in the forward contracts with underlying volumes equal to the negative of the static strategy take volumes. Since the spot price generally does not follow the forward curve exactly, then the intrinsic hedge will be an imperfect hedge. The intrinsic hedge can be improved considerably by adding static call and put option positions. The static hedge can be calculated by searching for the positions in the standard options which

minimise the hedging error (with respect to the swing contract) over a set of simulated outcomes for the hedging strategy[1].

Figure 3 illustrates the performance of a standard intrinsic and static monthly forward, call and put hedge, for a standard swing contract by plotting the potential portfolio values against the probability of achieving those values. The purple line ('Unhedged') shows the distribution of cashflows for an unhedged swing contract from the perspective of the seller, the green line ('intrinsic') shows the distribution of cashflows for the sold swing contract together with the intrinsic forward contract hedge. Finally the redline line ('static fwds, calls and puts') shows the distribution of cashflows for the sold swing contract, together with a hedge based on monthly forwards, as well as call and put options on the nearest monthly forward contract. The 'Unhedged' swing contract has by far the greatest risk as shown by the range of values that the distribution covers. The 'Intrinsic Hedge' has a significantly narrower range of values for the distribution, indicating a much lower risk profile. Finally the 'static fwds, calls and puts' has the smallest range of values, roughly half that of the 'Intrinsic Hedge', and therefore the lowest risk.

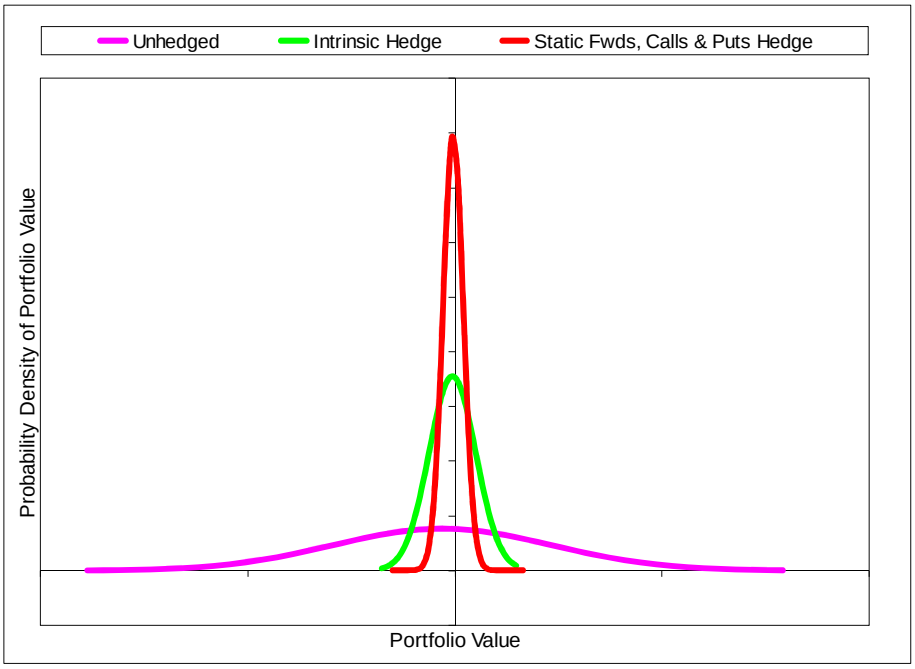

Figure 3. Hedge outcomes for intrinsic and static hedged

[1] See the EnergyRisk Masterclass article "Swing Contracts Part 2: Risks and Hedging", March 2008 for a detailed analysis of static hedging.

In summary, the intrinsic hedge provides a significant reduction in the risk compared to the unhedged swing position. Adding static call and put positions noticeably improves the hedge. The hedge can be further improved by regular rebalancing of the static hedge.

5 Avoiding lost value and hidden risk through managing network constraints

The discussion so far has mainly centred on single swing contract positions; how to value these contracts and the importance of incorporating their flexibilities and constraints accurately. It has also been discussed that a portfolio of swing contracts needs to have each individual contract accurately modelled to be able to make sure that the net portfolio distribution can be accurately hedged. There is an additional element that has not been discussed so far that can also provide a significant loss in portfolio value and misrepresentation of the portfolio risk. If a portfolio of swing, storage, retail demands and generation assets cannot deliver the required gas through the available network, then these transport and storage constraints can significantly impact the value that is derivable from the swing contracts. Figure 4 shows a simple diagram that highlights the impact on the different variables in a portfolio of swing contracts.

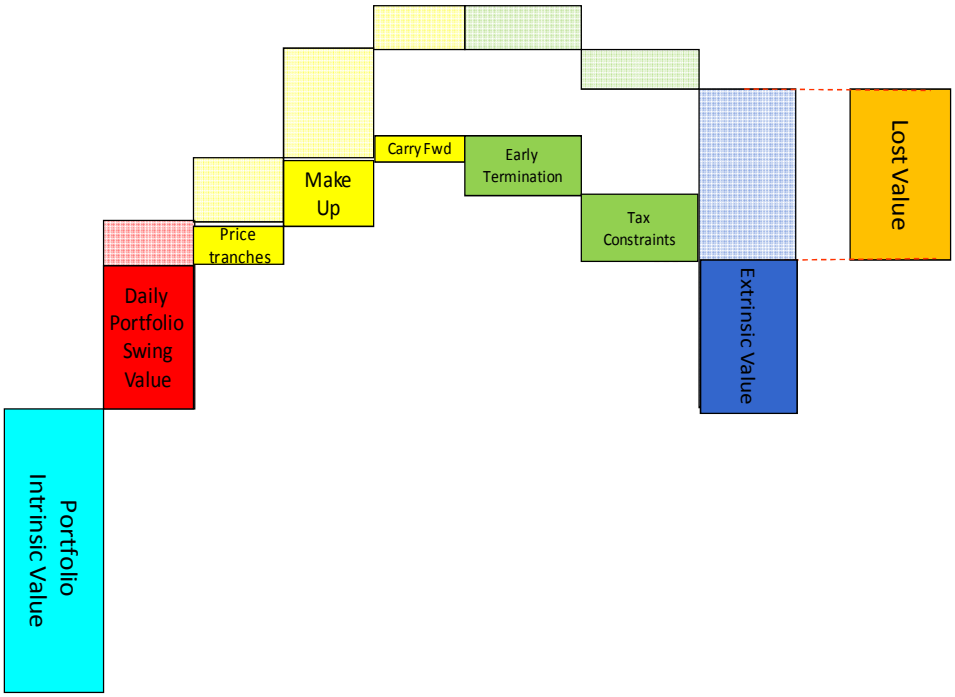

Figure 4. Lost value due to network constraints

As for a single contract portfolio, the impact is in the change in volume that can be delivered under the network constraints relative to the otherwise optimal volumes. In this case however it directly impacts daily swing value and then cascades through the rest of the variables in the contract. As before, each light coloured empty box in figure 4 represents value that is lost due to the 'extra' constraints of the network. Each contract that is constrained in this way can lose a significant amount of value. Depending on the degree of constraint, the value lost has been found to generally be greater than the amount the contract is constrained by. So for example a 10% volume reduction can lead to a 10-20% loss in extrinsic value. Aggregate the constraints over the portfolio and a 1-3% loss in total value is easily possible.

6 Conclusions

The valuation and optimisation of gas swing and indexation contracts are highly specialised areas of an energy organisation's business that require accurate and robust models to extract maximum value and to hedge effectively.

We believe that there is a need to better quantify and manage the flexibility inherent in assets such as gas swing and indexation contracts. Systems must be able to extract embedded value from these structured contracts and handle complex characteristics such as physical constraints, path-dependant valuations and optimisations, and to be able to integrate them into a portfolio-centric view of risk.

With our advanced models developed from industry leading research, Lacima provides software solutions that help you to value and optimise gas swing and indexation portfolios with far greater accuracy than possible with any general energy trading and risk systems or available tools.

The solutions available within our flagship energy risk management, valuation and optimisation application, *Lacima Analytics*, provide the most accurate and robust framework for your requirements. Lacima Analytics' solution for swing provides operations and valuation teams with the ability to quickly and efficiently manage a full range of swing contracts from a single contract to a whole portfolio, and from a simple take or pay to fully indexed contracts with depletion, carry-forward and make-up as well as with inter-year constraints or optionalities. Key benefits include the following:

- Daily decision support for operational decisions on optimal take volumes
- Price or mark-to-market a single gas swing contract or a whole portfolio
- Perform scenario analysis for a wide range of user defined price profiles
- Calculate full distributions for revenues, profits and take volumes on single contracts or whole portfolios
- Quick data upload including market curves, historical data, valuations and previous runs
- Full data management allows any previous results to be recreated as all data is saved and managed in the system
- Detailed reporting as well as simple export functionality to enable automated reporting from other systems

7 About Lacima

Lacima is a specialist provider of software and advisory services dedicated to valuation, optimisation and risk management for global energy markets. We help you to maximise your profit potential and make more informed decisions by providing tools that yield more accurate valuations, hedging analysis and risk exposure analysis for portfolios of financial contracts and physical assets.

Clients of our software and services include structuring, valuation and risk teams in vertically integrated energy companies, energy retailers, financial institutions and large energy consumers in Europe, North America and Australasia.

Our software solutions have been developed and implemented by peer-recognised experts in energy analytics, offering an unparalleled level of expertise and personalised support.

For further information, visit www.lacimagroup.com or email info@lacimagroup.com.