Quantum: Valuing Pre-operational Assets

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Arbitration claims can involve assets before they become operational. Such assets can pose challenges for a valuation exercise, as early-stage assets may face additional or unique risks and do not possess an operational history to benchmark projections against.

These issues are not unique to arbitration and valuations of such assets are routinely performed in the normal course of business – investors buy and sell pre-operational projects, and project developers will have considered all risks when making the initial decision to invest.

This chapter discusses the framework for pre-operational risks and provides a methodology for how to account for them in a valuation.

Framework: the value ladder

The fundamental value of an asset is forward-looking, resting on the cash flows it can generate for investors in the future. The value of a pre-operational asset is no different. However, the value will need to consider two factors not relevant to operating assets: the risk that an asset may not become operational, and the costs required to reach the operational stage. All else being equal, the value of a pre-operational asset will be less than the value of its operating equivalent.

It is first useful to consider the parties' perspectives of a transaction involving a pre-operational project. The buyer would not typically pay a substantial premium over efficiently incurred costs if they could develop a comparable project themselves or find another in development. Similarly, a seller would not typically sell for less than the efficiently incurred

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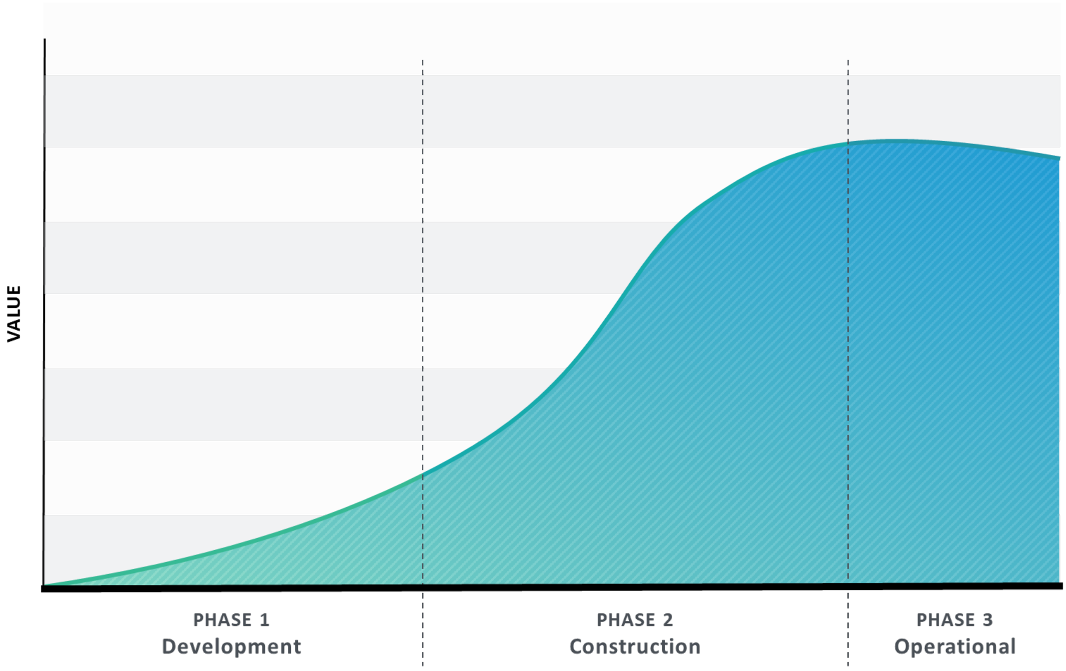
costs plus a return, acknowledging that a buyer's alternative would be to incur similar costs and take the same time and risks to develop another project.

Applying this perspective, Figure 1 illustrates the evolution of a stylised, successful energy project, such as a photovoltaic power station, a combined-cycle gas turbine plant or a gas production platform.

FIGURE 1: ILLUSTRATIVE VALUE EVOLUTION - DEVELOPMENT STAGES



The figure traces value through three broad phases:

- *Development*: Project value typically starts at zero[2] and grows as the project incurs costs and passes initial development milestones, such as obtaining permits, securing land rights and conducting environmental impact assessments, as well as completing studies confirming technical and financial feasibility.
- *Construction*: Entering the construction phase, project value grows as it incurs the capital costs of building infrastructure and resolves related risks.
- *Operation*: For projects with a fixed life, project value levels off once the project commences operations and performance tests are satisfactory, and then declines over time as the remaining useful life of the asset runs down.[3]

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[2] A net present value (NPV) of zero means the present value of future cash flows from the project's operations equals the present value of investment costs after a fair market rate of return. Particularly efficient projects, or projects that have benefited from market developments, may have positive NPV. Negative NPV projects would not typically go ahead.

[3] Project value can change both before and during operation due to inflation effects, changes in expected market rates of return or growth forecasts.

The main project-specific drivers of value creation in the first two phases are invested costs and risk resolution. Past investments enhance project value to the extent that they reduce prospective outlays. Put simply, a buyer of a half-finished asset would appreciate that they would need to spend less to complete the project than if they bought it on day one.

With respect to risk, a project may face binary or quasi-binary[4] hurdles, particularly in the development phase: for example, if permits become unobtainable, the value is zero. This same effect means that project value can jump as the project passes major development milestones that increase the chance of success.

Taking the analogy of a coin flip, assume the chance of passing a milestone is 50 per cent and that the pay-off on success is 100. Before the milestone, the project faces two scenarios, one in which its value is 100 and another in which it is zero. In expectation, project value is 50 (50 per cent x 100 + 50 per cent x 0). Flipping the coin resolves the risk and assigns one of the two possible outcomes: project value jumps to zero or 100.

The pre-operational phase can be likened to a series of coin flips of different value and importance as the project advances along the value ladder towards the operational phase. That is not to say that outcomes are random. The key point is that development milestones are associated with *ex-ante* probabilities that subsequently translate into certainties (or even changes in the probability going forward) and explain value increases or decreases.

Figure 2 expands on Figure 1, separating the overall value into the two project-specific sources discussed above and illustrating the jumps in value on passing development milestones. At the beginning of a project's life cycle, investments are usually relatively small, arising from development expenses for project scoping, permits and environmental, technical or financial assessments.[5] The green-shaded area represents value increases from past investments.[6] The blue shaded area represents value increases from risk resolution. Passing development milestones increases the chance of project success.

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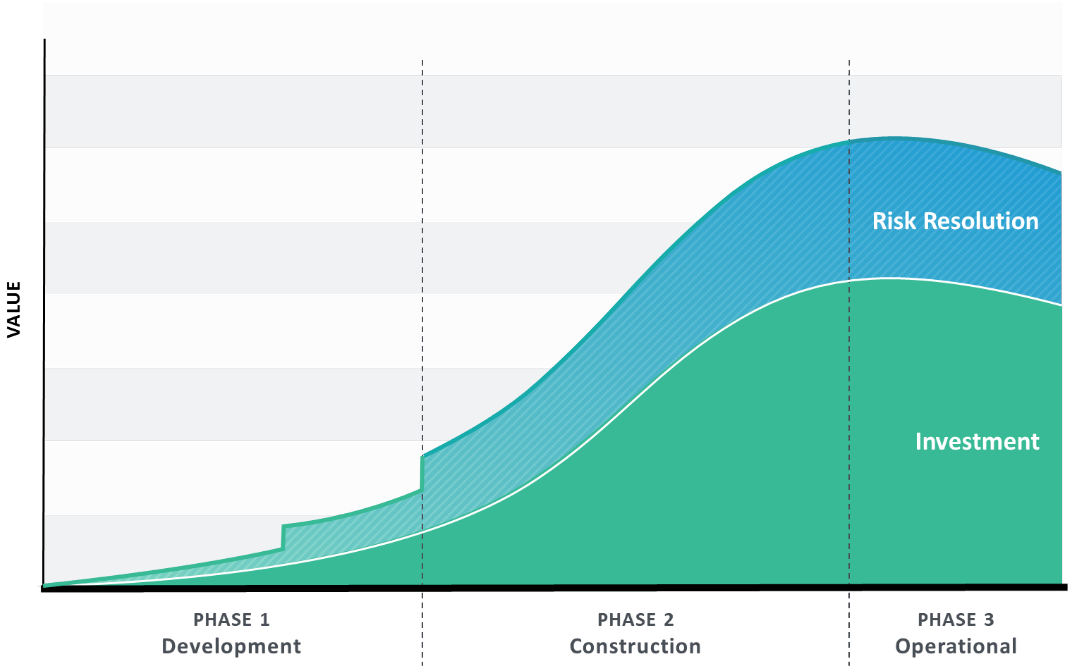
4 By binary development hurdles we refer to fork-in-the-road issues, such as obtaining a permit or failing to do so. Often the outcome is not discrete; for example, permits can be conditional or come with requirements that entail additional costs or risks that can give rise to a range of outcomes rather than success or failure.

5 For some assets, expenses during an early stage can be a relatively larger share of total investments than depicted in Figure 1, such as in the case of concession payments for the right to develop.

6 The chart assumes all investments are efficient. A project would not be worth 200 just because the investor spent 200 if other market participants could reach the same stage by spending 100.

FIGURE 2: ILLUSTRATIVE VALUE EVOLUTION - RISK AND INVESTMENTS



Does this mean that the value of the asset can always be equated to incurred costs plus compensation for risk and time? Unfortunately, it is not that simple. The stylised figures shown above focus on successful development and resolution of project-specific risks. If a project incurs higher than expected costs, completion takes longer than expected, production turns out lower than anticipated or market discount rates increase, the project value on the commencement of operations could fall below the value during an earlier stage of development,[7] or even below invested costs.

Moreover, some assets face particular exposure to changes in market conditions, such as commodity prices. An investment into infrastructure for the extraction of shale gas deposits, for example, may become uneconomic if gas prices decline, even if the project evolves smoothly. Similarly, an exploration licence before any investment can become more valuable if gas prices increase.

Nevertheless, Figure 2 illustrates why invested amounts can be a useful cross-check for analysing market value. In a highly competitive or regulated market with limited intangible assets, we would expect the value of an efficient project to have a strong correlation to the amounts expended with adjustments for time and risk. Where a valuation leads to a significant departure from the above diagram, the valuer should be able to explain the source of the divergence.[8]

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[7] More generally, project value at any given stage of development can drop below the value of a previous stage if risks resolve negatively to destroy value more than sunk investment costs increase it.

[8] These can include specific efficiencies or intangible value for the project in question, or changing market conditions such as interest rates or commodity prices.

To properly account for these types of market changes in a valuation, it is necessary to value the operational phase using a forward-looking approach. The key question is then how to account for the remaining unresolved risks faced by the asset.

Modelling risk

We develop a framework for accounting for risk within the discounted cash flow (DCF) method. A DCF analysis forecasts the expected stream of future cash flows and discounts them back to a given date at a rate that reflects risks and the time value of money. In our experience, DCF is the most common approach to valuing assets in the energy industry, operational and pre-operational alike. In a DCF, risks are accounted for in the discounting or the cash flows, or both.[9]

Valuing a pre-operational project using a DCF starts with developing a forecast of revenues and costs for an operational asset. Performing DCF analysis for operational energy assets can draw on a wealth of available data. When projecting operations of energy assets, the valuer typically has access to detailed analysis of technical characteristics of the asset, such as estimates of production, operating costs and capital costs. This includes technical data from decades of experience conducting engineering and financial due diligence in the industry.

The energy industry is also characterised by extensive market data. For commodities such as oil and gas, forward contracts reveal price expectations several years into the future. Several international agencies and many private companies publish long-term forecasts of commodity and energy prices looking 20 or 30 years ahead.

The next step of the valuation accounts for the two realities discussed earlier that characterise pre-operational assets: uncertainty in reaching the operational phase and capital costs to be incurred.

Pre-operational risk

Risks are inherent in project development. Textbooks on corporate finance refer to this type of uncertainty as 'non-systematic', meaning they are project-specific and not correlated with the wider economy. Textbooks caution that discount rates should reflect only systematic risk, and that project-specific risks should be reflected in the forecast of the future cash flows.[10]

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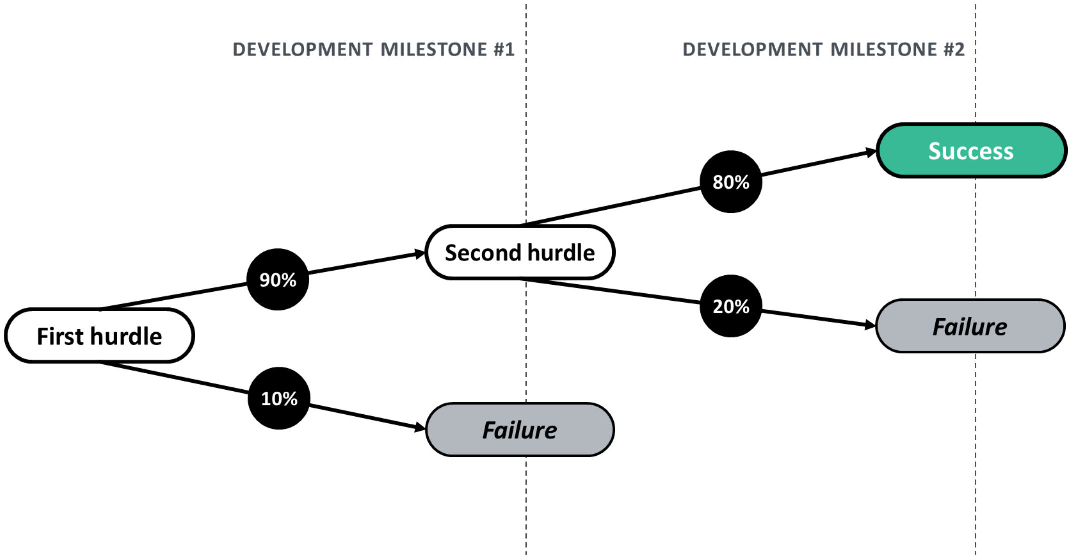
9 As a textbook reference for the valuation of operational and pre-operational assets, see, for example, Brealey, R. A., Myers, S. C., and Allen, F., *Principles of Corporate Finance*, Tenth Edition, New York McGraw-Hill, (2011), p. 222-223.

10 See, for example, Brealey, R. A., Myers, S. C., and Allen, F., *Principles of Corporate Finance*, Tenth Edition, New York McGraw-Hill, (2011), p. 222.

The value ladder described above explains that a pre-operational project faces several development hurdles. For example, if environmental permits cannot be obtained, or a test drill reveals it is not economic to extract natural gas reserves, the project could be abandoned. In valuation terms, there is an *ex-ante* probability that the project will pass the next development milestone successfully and a probability that it does not.[11]

Above, we likened the development phase to a series of coin flips. Figure 3 illustrates how more sophisticated probabilistic modelling can be implemented in practice. Assume passing the first development hurdle – for example obtaining a permit – has an 80 per cent chance of success. The second development hurdle – for example, agreeing on land lease rights on economic terms – has a 90 per cent chance of success. Assume that, without an environmental permit and a lease agreement, the developer would not be able to pursue the project further, in which case it has a value of zero. Abstracting from other risks, the two probabilities representing development risk would combine into an overall success probability of 72 per cent (80 per cent x 90 per cent).[12]

FIGURE 3: PROBABILISTIC MODELLING OF PRE-OPERATIONAL RISKS



The success and failure probabilities are applied directly to all the project's subsequent future cash flows.[13] Applying a 72 per cent chance that the project would reach operational stage and generate cash flows is equivalent to applying a 28 per cent discount to all cash flows. Cash flows adjusted for risk in this way are also referred to as expected, mean or probability-weighted cash flows.

[11] Other development hurdles may not be binary but can still be modelled in a probabilistic way. Following a technical feasibility study, the valuer can test the project's viability in high and low case scenarios, for example. It may require technical input to assess the likelihood of the respective scenarios.

[12] In practice, care must be taken when combining probabilities.

[13] Note that this can include capital investments; if a project fails to get permits, investments would not go ahead.

The timing of these milestones can have important implications for value. Imagine two projects that will each cost $10 million to complete, and each has a milestone with a 50/50 probability of success or failure. Suppose further that for the first project, success or failure materialises during the early development stage that requires an initial investment of $1 million. If the investor finds the project will fail, the investor can then abandon the project, limiting their total loss to $1 million. For this project, an investor would require an *ex-ante* expected pay-off of at least $11 million.[14]

Suppose for the second project, success or failure materialise only at the end, after having invested the full $10 million. In this case, the expected *ex-ante* pay-off must be at least $20 million for the project to proceed.[15]

These examples illustrate the concept of value at risk (VaR), which provides a quantitative measure of the exposure and likelihood of loss for a particular project. In the first project, the investor had a 50 per cent chance of losing a maximum of $1 million, whereas in the second it is the full $10 million. The higher the VaR, the greater the compensation required for a successful outcome.

Real-world examples would be a photovoltaic (PV) power plant versus an oil well. The PV installation can determine success or failure early in the development where the primary risk is securing the necessary permits. However, oil wells can entail greater risk, as the investor can only know for certain if the well is productive after drilling. A successful well will, therefore, tend to have a higher value when compared to invested costs than a PV plant because the investment has a higher VaR.

Having adjusted cash flows for non-systematic pre-operational risk, no further adjustment to the discount rate is needed. Adjusting both the cash flows and the discount rate would double-count the impact of the non-systematic risks.

Remaining capital investments

The second significant distinguishing feature of a pre-operational asset is the remaining capital investment. These expenses have a clear effect in that they represent large negative cash outflows for the project. However, in addition to the pure cost, the existence of large capital investments can create leverage due to the relatively fixed nature of the payments. Outlays for development and construction are often more certain and closer in time than the expected cash flows once the project commences operations. For example, a common arrangement for energy projects involves engaging outside contractors for engineering, procurement and construction. The contractual arrangement often involves a largely fixed price, which does not vary, or only to a limited extent, with market conditions.

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14 The NPV is the weighted average of the potential outcomes: $P_{failure}$ x $CF_{failure}$ + $P_{Success}$ x $CF_{Success}$, where ‘P’ is the probability and ‘CF’ are the cash flows. For the first project the value that sets the NPV to zero is $11 million: 50 per cent x -$1 + 50 per cent x (-$10 +$11).

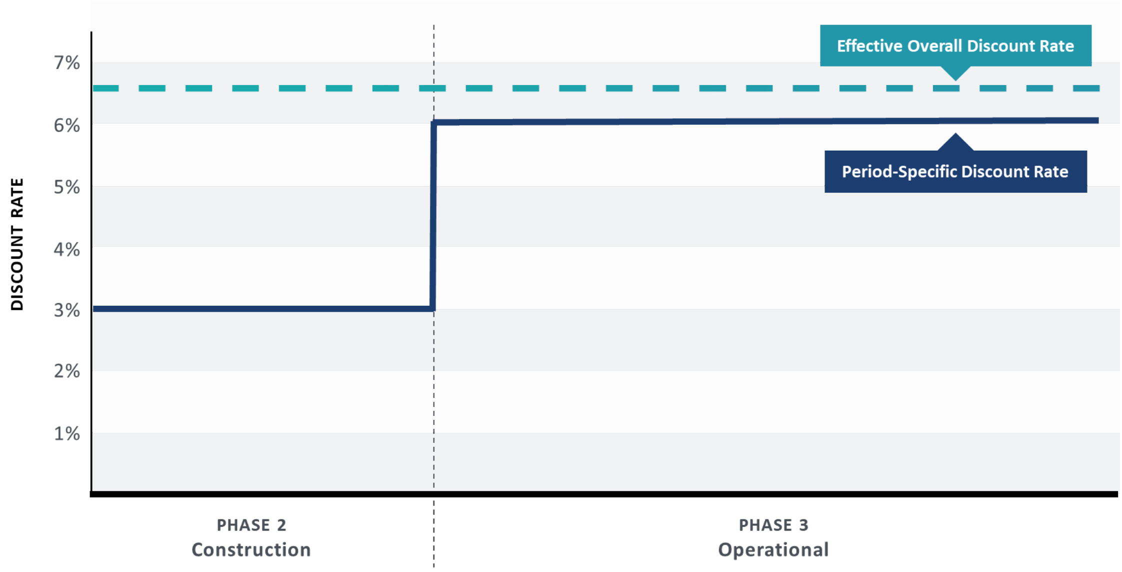
15 50 per cent x -$10 + 50 per cent x (-$10 + $20).

The fixed payment commitments during development and construction magnify the impact of fluctuations in the future value of the operating asset on the value of the pre-operational asset, similarly to the way the existence of debt obligations magnifies the impact of fluctuations in future project value on equity holders today. Corporate finance theory refers to this as operating or capital leverage.

The relatively fixed nature of capital costs suggests applying a relatively low discount rate. Because the construction costs are negative cash flows, applying a low discount rate increases their present value and in turn decreases project value.

Figure 4 illustrates that this approach is conceptually similar to the inclusion of a premium in the project's overall discount rate, which reflects the leverage effect of construction. Figure 4 assumes a 3 per cent discount rate applied during an assumed 2-year construction period, and a 6 per cent discount rate applied during an assumed 10-year operating period, illustrated by the dark blue line. In this illustration,[16] the effect of applying a low discount rate during the construction period produces the same result as applying a 6.5 per cent discount rate overall, indicated by the light blue line.

FIGURE 4: EFFECT OF OPERATING LEVERAGE ON OVERALL PROJECT DISCOUNT RATE



Combining different discount rates depending on the nature of cash flows raises the overall discount rate because of the risks resulting from operating leverage.[17] But although an equivalent discount rate can always be calculated, it always relates to the cash flows at issue, so no standard premium can be added to a discount rate to account for capital leverage.

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[16] Figure 4 assumes an investment of $150 million and operating cash flows of $250 million, each spread evenly across time. The pattern of cash flows determines the effective discount rate associated with a certain combination of discount rates applied to construction costs and operating cash flows.

[17] Capital expenditure does not stop when the construction phase ends, of course. The effect of ongoing capital expenditure on project risks must therefore be reflected in the discount rate applied to cash flow generation of the operating asset.

A common shortcut

In practice, a common shortcut to account for the range of pre-operational risks is to add premiums to the discount rate, similar to the effect of capital leverage discussed above. A higher discount rate reduces the present value of future cash flows, which can appear to reflect the higher risk.

However, while providing a more straightforward approach, textbooks on corporate finance typically advise against the use of such discretionary risk premiums.[18] Explicit risk adjustments to cash flows require the valuer to carefully consider the particular risks at hand and design an approach to account for those risks in the analysis. They can be converted into a risk premium, but it is more likely that cash flow adjustments inform risk premiums than the other way around.[19]

Quantifying risk

While the approaches to risk described above may require subjective assumptions, such as probabilities of permit acquisition, a valuer can employ methods that can increase the objectivity of the inputs and, therefore, the accuracy of a valuation. The choice of approach typically depends on available information and data.

A primary source that a valuer should examine is the existence of transactions in the target asset. It is relatively common for energy infrastructure assets to be bought and sold, as different developers specialise in certain phases of a development cycle.[20] Often, a party to a dispute will only have acquired the asset at an earlier stage of development.[21]

Where this type of data exists, analysis can calibrate a valuation model directly to the transaction price to obtain relevant pre-operational risk discounts or success and failure probabilities. In very simple terms, if the transaction price was 100 and the valuer determines the project's value at operating stage at 200 (that is, before accounting for pre-operational risks),[22] then the transacting parties must have assigned a success probability of 50 per cent.

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[18] See, for example, Brealey, R. A., Myers, S. C., and Allen, F., *Principles of Corporate Finance*, Tenth Edition, New York McGraw-Hill, (2011), pp. 225-226.

[19] Similarly, we can adjust for operating or capital leverage by increasing the discount rate as shown in Figure 4. While it is possible to mimic leverage through the inclusion of a risk premium in the discount rate, it is preferable to establish the magnitude of the premium using first principles.

[20] Where no transactions have occurred, and the owner has developed the project since inception, the owner may have prepared models supporting the initial decision to invest, which will typically reflect all the risks that the project was expected to bear at the time. This can provide an upper bound on the risk measure for the project-specific risks, assuming that risks have not changed.

[21] Data from transactions not only extend to sale and purchase of interests but also can include rounds of equity issuance as a fundraising process.

[22] Setting aside the costs involved in reaching the next milestone.

If the dispute arose relatively close in time to the project's acquisition and little to no development occurred before the valuation date, the transaction price itself would represent an obvious benchmark for a valuation. This does not mean that the project's value should equal the transaction price, as changes in market conditions – among other factors – can affect project value. Rather, the valuation would involve updating the project's value at operating stage (previously 200) and then applying the 50 per cent success probability to obtain the updated valuation for the pre-operational project.

Some sufficiently large assets, or potentially the parent company, may have a traded share price, which shows the development of value day by day. These prices can also be analysed to understand developments in the value of a project.

Asset-specific prices should usually be the preferred data source, as the information revealed will capture the specific feature of a project. Nevertheless, in the context of arbitration, the valuer must be careful to ensure that the transactions are not contaminated by the issues related to the dispute.

Another method of using market data is to identify transactions involving suitably comparable companies. In ideal circumstances, the valuer may find a transaction that is sufficiently comparable so that it can be used directly as a value benchmark for a particular asset.[23] More commonly, valuers will find a sample of companies and take an average of their values. Importantly, in increasing the sample size, the valuer will face a trade-off as assets in the sample potentially become less comparable to the asset being valued. The primary downside to a comparables analysis is that the valuer's judgement of what asset is comparable may be too subjective. The identification and selection process should be clearly described to avoid issues of bias.

Useful valuation data can also be determined from sources other than transactions. For assets lacking the relevant permits, parties may agree on a payment schedule where some or all instalments are conditional on the project reaching future development milestones. Like transaction prices, the sequence of payments and their relative magnitudes can provide insights into pre-operational risk discounts and relative probabilities of failure and success.[24]

For example, assume the purchase agreement involved a payment of 20 on closing the transaction and a further 10 on obtaining permits. Assume we can establish the value of the fully permitted project at 40. The uncertainty surrounding the permits brings about two

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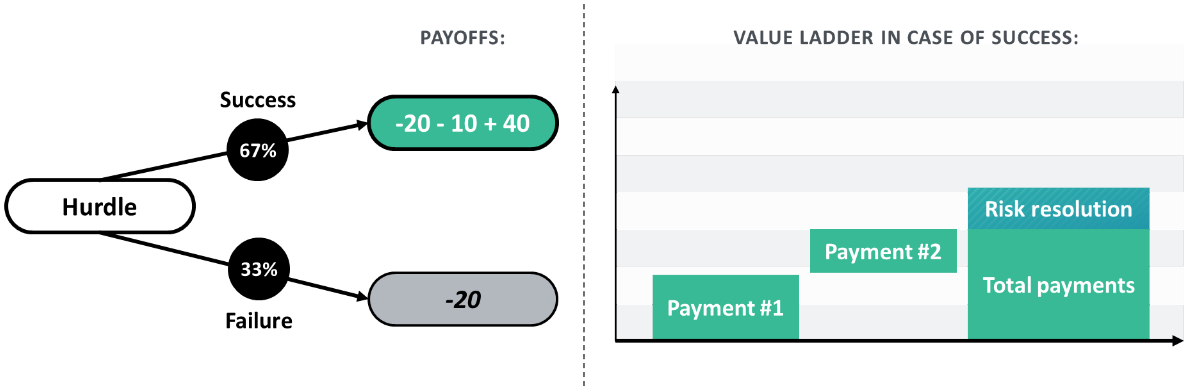
[23] For example, a valuer may collect data on a sample of projects in the same industry and at a similar development stage from which they would derive a value metric to enable comparisons. The valuer may observe that fully permitted and ready-to-build photovoltaic power station trades at a price of $0.4 million per MW of installed capacity on average, which the valuer would scale up to the size of the project to obtain an estimate of its value.

[24] Utilising information on the sequencing of payments does not necessarily require the disclosure of the actual purchase agreement as relevant intelligence can be purchased from specialised industry consultants and publishers.

possible scenarios: one in which the project fails to obtain permits, which results in a pay-off to the buyer of negative 20 (the upfront payment), and another scenario where the project succeeds, which results in a pay-off of 10 (equal to the value of the permitted project less the upfront payment of 20 and the milestone payment to the seller of 10). For the buyer to break even in expectation, the success scenario must, therefore, have a probability of at least 67 per cent, see Figure 5.[25] Resolving the uncertainty around permits adds value and explains the jumps along the value ladder.

FIGURE 5: ILLUSTRATION OF CONTINGENT MILESTONE PAYMENTS AND SUCCESS PROBABILITY



Other sources to consider are market publications and academic literature. The importance of the energy market in the economy has stimulated wide bodies of research devoted to analysing risk. Academic literature typically centres around specific topics with good data availability. For example, there have been multiple studies analysing past experience of hydropower projects, which have been in use for over 100 years, and many have been sponsored by global development banks that published data on the costs and time it took to build them. The data allows researchers to develop metrics of cost overruns and schedule delays, which can be used to inform any assessment of risks, particularly during construction phase.[26]

Regulators must also think carefully about developer and construction risk when designing incentive regimes for new investments. Failing to provide adequate compensation can result in shortfalls from targets while providing too high a return imposes costs on consumers.

As an example, a study commissioned by the UK Department of Energy and Climate Change surveyed development and construction risk premiums as applied in 'hurdle rates' for various renewable energy technologies, finding that premiums can range from 0.5 per cent for solar PV and onshore wind assets in construction to 6 per cent for offshore wind projects

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25 This illustration also assumes that development expenses in the relevant period are negligible.

26 See, for example, Baurzhan, S., Jenkins, G.P., Olasehinde-Williams, G.O. 'The Economic Performance of Hydropower Dams Supported by the World Bank Group, 1975–2015', Energies 2021, 14, 2673; and Plummer Braeckman, J, Disselhoff, T., Kirchherr, J. 'Cost and Schedule Overruns in Large Hydropower Dams: An Assessment of Projects Completed since 2000', International Journal of Water Resources Development 2019.

in development.[27] The scale of the various premiums provides a broad measure of the scale of risk that the projects face at the outset, as well as the compensation that investors require. There are ways to convert such risk premiums into success and failure probabilities, which may be desirable as risk premiums have certain theoretical and practical shortcomings.[28]

While literature can provide an objective input, care must be taken when applying findings based on statistical averages and distributions to any given project.

Whichever data the valuer has available to drive the quantification, the basic framework is the same. The valuer must develop a DCF analysis of the project at the operational stage, which ultimately drives the value of the asset. The valuer should then factor in pre-operational risk, including success and failure probabilities, considering the best available evidence. As a final step, the valuer should be able to explain the valuation results in relation to the project's expected position along the value ladder and the evolution of value over time.

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[27] https://www.gov.uk/government/publications/nera-2015-hurdle-rates-update-for-generation-technologies, p. 39. For the avoidance of doubt, the authors of the study do not express any views as to how their findings should be used in the context of a DCF valuation.

[28] We note that the study commissioned by the UK Department of Energy and Climate Change mentioned above sense-checked its survey findings by doing probabilistic modelling of success and failure rates, see pp. 41–42 of the study.