A DECADE OF LNG DESIGN COMPETITIONS – A WORK IN PROGRESS

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ABSTRACT

The LNG Design Competition, a little-used Front End Engineering and Design (FEED) contracting strategy prior to the year 2000, is now commonplace. Although the design competition strategy has been in existence for FEED projects for over 10 years, it has also been used for the conceptual and pre-FEED phases of project development.

The rules for fair design competitions are generally understood, but it is important to evaluate events from the past to see if this execution method is being used effectively. As a result of this review, a discussion of ideas that work well in competition is presented as well as those that are challenged by this execution method.

This paper will review items such as:

- Liquefaction process technology and design competitions
- A review of design competitions over the last 10 years
- Challenging issues for current design competitions
- Conceptual design and pre-FEED: acceptable or “too early”?
- Offshore LNG - Do the same rules apply?
- Has the contractor’s perspective of FEED execution changed?
INTRODUCTION

In the initial paper on design competitions for LNG 14 (2004), FEED competitions were a relatively new strategy intended to produce a timelier and more cost effective project. Insight from the paper revealed that although design competitions have the potential to be very effective in achieving owner's objectives and goals for the project, they have to be carefully conducted and managed\(^1\). During this period in LNG history, projects were exclusively onshore.

In 2004, cost trends for the engineering, procurement, and construction (EPC) of onshore liquefaction projects were going down and had been trending down for a significant period of time\(^2\). The market for EPC services required contractors to realize these trends, whether realistic or not, until drastic economic changes occurred in 2005. Before 2005, projects were sanctioned for hundreds of millions of US dollars; today, project cost is measured in billions or tens of billions of US dollars. The escalation of material and commodity prices combined with the challenges of selected sites and the complexity of infrastructure has sent liquefaction costs to a new level.

In dealing with a step change in the cost of EPC projects, owner companies needed to develop an adaptable array of contracting strategies to best fit their projects. As no two projects are alike, some projects adopted a reimbursable contracting strategy while others selected a competitive lump sum turnkey (LSTK) strategy; in addition, some projects implemented a combination of both strategies. Reimbursable projects are often aligned to areas with high execution risk or cost uncertainty, which include regions such as Australia and Canada. LSTK strategies work well in areas with identifiable and manageable cost and execution risk, such as Africa and The Americas. LSTK strategies are also desired for projects using off-balance-sheet financing (a.k.a. project finance). When LSTK contracting is desired, design competitions have become commonplace in the drive to find technically qualified contractors or contracting groups who will commit and bid to a fixed EPC price and schedule. For simplicity, when referring to the participants in a design competition, contractors and contracting groups may be used interchangeably.

Figure 1. Overview of a Multi-Train LNG Complex

As the number of potential LNG projects has skyrocketed (including grassroots, brownfield, and offshore opportunities), and project CAPEX has increased to the billions of US dollars, the design competition was leveraged in other ways. This paper will discuss issues from design competitions over the last decade to determine the applicability for future projects. The insight from reviewing these competitions may aid new developers in their quest to develop
the next generation of LNG projects. Time will tell if competitions have been successful in the drive to increase execution efficiency and achieve low CAPEX for an LSTK project strategy.

**THE PURPOSE OF LNG DESIGN COMPETITIONS TODAY**

The purpose of the traditional design competition has not changed so much since the 2000s. Whether the project is onshore or offshore, or with similar or different liquefaction process technologies, the purpose of a design competition is to provide the owner a level of certainty with regard to contractor interest in the EPC phase as well as the potential to optimize CAPEX or life cycle cost. Assuming competent contractors are involved, FEED competitions strive to achieve two primary goals: the control of development cost during FEED and the assurance of more than one EPC bid at the end of FEED.

Project development costs for grassroots projects in challenging locations can be high. In addition to owner costs, development costs refer to the initial project execution phases of conceptual design, pre-FEED, and FEED (also referred to as FEL-1, FEL-2, and FEL-3)\(^3\). At each progressive level of definition, there is a higher confidence in the project cost and schedule. When working with a single contractor or contracting group in FEED (no competition), there is often a strong desire to complete the definition phase as quickly as possible to move the project to the execution phase.

This desire for speed in the development phase must be balanced against the risk of not fully defining the project; gaps in the technical definition or execution planning will result in an unrealistic cost estimate and project schedule. On the other hand, a culture of continuous change and optimization may result in a vicious cycle of spending in FEED without achieving the desired results. This vicious cycle can also occur when the initial expectations of facility cost are unrealistic, such as being based on $US/tonne with little consideration of the site-specifics of a project.

While there are many publications highlighting the changes in LNG EPC project costs over time,\(^4,5\) design competitions are commonly being used to entice contractors to bid LSTK for large EPC projects in challenging locations. With current LNG plant CAPEX in the billions of US dollars, competition has the implied benefit of controlling cost and schedule through the bid process. While design competitions allow contractors the ability to control their own destiny as participants in the development process, the technical and commercial risks, due to the step change in CAPEX, are much larger than ever before. Although competition is expected to deliver technical excellence and lowest cost, a “winner” may have succeeded in both, one, or none of these areas.

**LNG PROCESS TECHNOLOGY AND DESIGN COMPETITIONS**

The earliest design competitions (e.g. Nigeria LNG and Trinidad LNG) used liquefaction process technology as the key variable between two contractors. At the time, it was widely believed that technical differentiation, driven by process licensor selection, resulted in commercial differentiation – therefore, lowest CAPEX. While this philosophy may have been true at the time, the technical and commercial issues inside the process train are now far overcome by the site-specific execution strategies and commercial aspects of the offsites, utilities, and infrastructure parts of the project. This change in thinking from leading by process design to leading by project execution is true for both large and small scale LNG facilities. Regardless of the size of an LNG train or the size of an LNG complex, there is a significant cost in the offsites and infrastructure required to store and ship LNG.

An owner benefit when focusing on project execution for design competitions is to widen the pool of contracting groups who may bid on a project. Since competition is meant to reduce cost and optimize schedule, multiple contractors bidding on the same process technology, regardless
of the technology, would allow a focused review of the execution strategies and cost estimates from the bidders. Competition utilizing different liquefaction process technologies introduces a level of complexity in comparing the results from bidders. Experienced owners with robust contractor review teams may be well prepared to analyze the data and review these competitions, but less experienced owners with challenged oversight teams may be less able to gain insight from the differences in plant configurations or may be distracted when reviewing different process technology solutions.

Once we accept that the liquefaction process technology is not the single determining factor in optimizing CAPEX, the complete technical definition, estimate accuracy, and execution planning become areas of focus in FEED. If owner resources are constrained (limited compensation available for FEED workhours and limited schedule to complete FEED), removing the variable of liquefaction process technology will allow a greater emphasis on project execution planning. All contractors want the proper time and resources to develop a technically acceptable facility, a realistic execution plan, and a high confidence estimate. Whatever rules or constraints are set for the competition, the contracting groups want to win, but only if they have realistic confidence in their own proposal.

**LNG DESIGN COMPETITIONS IN THE LAST DECADE**

Although design competitions have been around for some time, they have become much more common in the last decade. A sample of recent LNG design competitions is listed in Table 1. For clarity, the projects have been grouped onshore and offshore. One of the most notable trends in recent years is that design competitions may now contain three contractors. This strategy was first used for offshore LNG (to secure three EPC bids), but has now migrated to onshore LNG for equally challenging LSTK projects.

**Table 1. Sample of Recent Projects Executed in Design Competition**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Type of Project</th>
<th>Grassroots or Expansion</th>
<th>Number of Contractor Groups</th>
<th>Number of Process Technologies</th>
<th>Did Project Reach EPC Phase?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>2</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>Nigeria Train 7+</td>
<td>Onshore</td>
<td>Expansion</td>
<td>2</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>PNG LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>2</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>Pluto LNG Trains 2 &amp; 3</td>
<td>Onshore</td>
<td>Expansion</td>
<td>2</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Yamal LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>2</td>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>Browse LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>2</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Mozambique LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>3</td>
<td>1</td>
<td>In progress</td>
</tr>
<tr>
<td>Malaysia LNG Train 9</td>
<td>Onshore</td>
<td>Expansion</td>
<td>2</td>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>Pacific NorthWest LNG</td>
<td>Onshore</td>
<td>Grassroots</td>
<td>3</td>
<td>2</td>
<td>In progress</td>
</tr>
<tr>
<td>Tangguh Train 3</td>
<td>Onshore</td>
<td>Expansion</td>
<td>2</td>
<td>1</td>
<td>In progress</td>
</tr>
<tr>
<td>Petrobras FLNG</td>
<td>FLNG</td>
<td>N/A</td>
<td>3</td>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td>Rotan LNG (Petronas FLNG-2)</td>
<td>FLNG</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>Bonaparte FLNG</td>
<td>FLNG</td>
<td>N/A</td>
<td>2</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Abadi FLNG</td>
<td>FLNG</td>
<td>N/A</td>
<td>2</td>
<td>1</td>
<td>In progress</td>
</tr>
<tr>
<td>Coral South FLNG</td>
<td>FLNG</td>
<td>N/A</td>
<td>3</td>
<td>1</td>
<td>In progress</td>
</tr>
</tbody>
</table>

It is still common to employ multiple liquefaction process technologies in competition. Since some process technologies such as Optimized Cascade® and Prico® are aligned to a single FEED
contractor, this strategy may create an environment where a competition contains two of three bidders using the same liquefaction technology. This scenario is inevitable while these licensor-contractor alliances are in effect. If the owner evaluation criteria were weighted heavily to technical qualification and differentiation, competing among multiple process technologies would continue to have merit, but could still potentially take fixed resources away from execution planning and/or review of these plans by the owner/operator.

The Pacific NorthWest LNG Project was a recent example of a three way grassroots design competition using more than one liquefaction process technology. Although this competition required considerable time and resources, the owner/operator (Petronas) gained considerable technical and commercial insight from the state of the art plant configurations and current market pricing from three contracting groups. These configurations each included new developments and lessons learned in the areas of process technology, execution planning, train size, driver/compressor selection, etc.

Offshore LNG projects show another interesting trend. Although the first offshore LNG projects (also referred to as floating LNG or FLNG) have yet to be put into service, the design competition has now become the default contractor execution strategy. Interestingly, the first two offshore LNG projects in EPC (Prelude LNG and Petronas PFLNG-1) were not executed in a design competition. Working in a sole-sourced manner allowed those project configurations to fully develop without a contractor fear of "losing" along the journey. In addition, since offshore LNG has still not been placed in operation, the contracting group has the opportunity to conduct a full analysis of the technical and execution risks without the pressure of completing an on-time bid in FEED. Discussion of variations for offshore LNG is presented in a subsequent section.

Looking at grassroots onshore projects in the most challenging locations, there may be a trend to set the competition with only one process licensor. Examples such as Yamal LNG and Mozambique LNG implemented this strategy. Yamal LNG has the execution challenges of working with extreme temperatures in the Arctic while Mozambique LNG facility would be in an isolated sub-Saharan site and represents the largest capital project in the country. Although this trend is not without exception (e.g. Pacific NorthWest LNG), contractor technical competence and execution experience should trump whether or not to stage a competition around process technology.

If not obvious to the reader, brownfield projects (those with existing LNG production) may employ a design competition to optimize cost and schedule, but a change in process technology has never been seriously considered for plant expansions. Brownfield projects executed in design competition are not done so for a single reason. There are examples where the expansion is considerably different from the base project (e.g. Nigeria 7+), quite similar to the previous project phase (e.g. MLNG Train 9), or looked to move away from sole-source contracting to look for improvements in execution or project cost (e.g. Pluto Trains 2 & 3). Another example is Tangguh Train 3, where although the project appears to be a duplicate train, the competition involves implementing many technical and execution lessons learned since the construction of the first trains.

Although every project is unique, there are at least fifteen cases in the last ten years of design competitions for LNG projects. These projects have been both onshore and offshore, using one or more liquefaction process technologies and have been used for both grassroots and expansion phases. The remainder of the paper will review issues that can make competition challenging, issues pertaining to offshore LNG, and a review from a contractor’s perspective.

**CHALLENGING ISSUES FOR CURRENT DESIGN COMPETITIONS**
While the rules for structuring a fair and balanced design competition were discussed in the previous publication, there are new scenarios facing contracting groups that were not foreseen a decade ago. These issues include:

- Competing in the pre-FEED phase
- Contractors and consultants with limited LNG, LSTK, or large project experience
- Owner companies with limited resources for oversight
- Unclear EPC terms and conditions and/or contractor evaluation criteria

Competition in the pre-FEED phase has been considered for both grassroots projects and export conversions from regasification projects. Having contractors compete in the pre-FEED phase has some merit, but those benefits must be evaluated versus the challenges when reviewing the contractors’ work product in order to determine a winner for the subsequent FEED phase. Discussion of this subject is specifically addressed at the end of this section.

Another issue new to today’s design competitions is the participation of companies with limited LNG, LSTK, or large project experience. Whether sourced from stranded gas, a new large gas discovery, or low cost shale or coal seam gas, the number of LNG opportunities is higher than ever. Each opportunity requires support from the contractor and consulting community to move these projects forward. New companies entering the LNG business is a good thing for competition and to support growth, but companies new to executing LNG participating in design competitions could be a challenge both on the designer side and the reviewer side. Lack of experience in LNG design or mega-project execution may result in a misunderstanding of risk and/or an overly optimistic view of the CAPEX and schedule.

In addition to the design part of the equation, the sponsors and advisors for these new projects are not always the traditional owner/operator companies familiar to the LNG industry. The rise of the developer and LNG toller as owner/operator has been a positive influence on the growth of the LNG industry. Consultants and owner’s engineers are the front line support for these new owner/operators and there are many companies ready and willing to support these new projects. In fact, some projects face a certain amount of pride or bias which may result in an understatement of cost/time or an overconfident assessment of risk. A conservative consulting strategy would be to seek advice from companies who have experience in executing LSTK EPC projects; although larger than consultants or owner’s engineers, these companies would have a track record of accountability for executing to their contractual commitments (i.e. their own estimates, schedules, and guarantees).

One other element which makes a design competition challenging is when the FEED does not have clear EPC terms and conditions or has vague contractor evaluation criteria. One of the most important deliverables of the competition is the cost estimate. If the EPC terms are not fully defined prior to FEED, the engineering design may be affected (e.g. performance guarantees) and the technical and commercial risk (e.g. contractor liabilities and liquidated damages [LDs]) would be difficult to factor into the final results. In addition, the contractor evaluation criteria must be clear to all participants so that the final proposal meets both the technical and commercial requirements of the owner. Vagueness in these areas (such as production rate, process efficiency, CAPEX, life cycle cost, availability, etc.) make it difficult for contracting groups to put forth their best efforts. An example of clear evaluation criteria is a specific formula to incorporate these factors into a numerical value. Preparations prior to the competition, such as a clear basis of design, philosophy regarding technology and prototype designs, and the value of exceeding minimum expectations will result in a healthy competitive environment.

ARE DESIGN COMPETITIONS APPROPRIATE FOR CONCEPTUAL OR PRE-FEED WORK?
The original intent of a design competition was to get the best technical and commercial solutions from competing contractors or contracting groups in FEED. In practice, this competition results in improved economics of the project (lowest CAPEX or life cycle cost) while mitigating technical risk (meeting availability, reliability, and operational objectives). In FEED, competitions meet those objectives – the design is at a maturity level to determine technical performance risk and the cost estimate is developed to an accuracy level to instill confidence in the commercial outcome. However, competitions have been conducted and continue to be proposed for conceptual and/or pre-FEED work.

Figure 2. The Conceptual and Pre-FEED Phases Require Strong Collaboration Among Groups

As mentioned in many publications, the level of cost estimate accuracy is proportional to the cumulative number of engineering hours spent on the project\(^3,7,8\). The difference in accuracy of the cost estimate for each phase of development is shown in Table 2. In a pre-FEED (also known as FEL-2), the cost estimates from contractors have an expected accuracy of +/- 25%. As an example, for a potential two train large scale grassroots project CAPEX of US $12 billion, the estimate could be expected to deviate by +/- US $3 billion. While the math is simplistic, the bids from the contractors could be separated by twice this amount, or US $6 billion. When the cost estimates from two contracting groups are separated by US $6 billion, is it perfectly clear who has the most realistic cost estimate? Would you have the highest confidence in the lowest bidder?\(^6\)

<p>| Table 2. Example of Cost Estimate Accuracy for LNG Project Phases(^3) |
|----------------------------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>Conceptual Study Phase (FEL-1)</th>
<th>Pre-FEED or Feasibility (FEL-2)</th>
<th>FEED Definition (FEL-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Estimate Accuracy</td>
<td>+/- 40%</td>
<td>+/- 25%</td>
<td>+/- 10%</td>
</tr>
<tr>
<td>Cumulative Engineering Hours Spent</td>
<td>1 - 5 %</td>
<td>5 - 15 %</td>
<td>15 - 30 %</td>
</tr>
<tr>
<td>Contingency</td>
<td>15 - 20 %</td>
<td>10 - 15 %</td>
<td>8 - 12 %</td>
</tr>
</tbody>
</table>

Design contractors are trying to do the best they can with the resources they are allotted. In conceptual or pre-FEED work, that means they are building these estimates and schedules based on prior EPC experience and the information available at the time; this information is a function
of the time and resources spent on developing engineering data and an execution plan. The engineering data is the simple part of the scope as the activities and deliverables are well known to contractors experienced in LNG projects. The site specific elements of the execution plan go well beyond the engineering data and have a greater impact on the cost and schedule of the project. Judging a design competition at this phase of project development includes a great deal of uncertainty and inaccuracy that may lead to an incorrect decision or false confidence in a poorly developed estimate or execution plan.

Speaking of early phase execution planning, a plan based on the efficiencies of standardization, duplication, or replication is difficult to validate in pre-FEED on site specific modifications. A plan based on modularization is difficult to validate without significant work to develop the module design, fabrication strategy, and logistics of transportation and installation. Schedules in pre-FEED are not detailed at the individual activity level in order to analyze the EPC schedule risk. In sum, competitions in pre-FEED may have value to determine which contractors are the best fit from a relationship standpoint, but it is difficult to measure contractors quantitatively in this phase.

Continuing with the theme of working within the resources allotted, one item often forgotten in the preliminary cost estimates is the cost of the EPC contract terms and conditions. Even if competing in pre-FEED, cost estimates based on preliminary data and high uncertainty are not binding. The accuracies shown in Table 2 are guidelines and are not absolute. Similar to estimates, schedules are not developed to a deep activity level and have not been fully vetted and risked. Any commercial consequences or LDs associated from exceeding the EPC schedule are developed during FEED and are included in the EPC contract terms and conditions. Once the cost and schedule risk is determined, any significant risks that are difficult to control may affect the final LSTK price. Therefore, there is little incentive for a contractor to include high levels of contingency and risk cost in pre-FEED if it will result in losing the design competition.

Initially, the idea behind a design competition in pre-FEED appears to have value. With limited spend on pre-FEED development activities, an owner could make decisions among contracting groups, liquefaction process technologies, or plant configurations. However, this limited spending prior to FEED results in limited technical definition with corresponding lack of accuracy in project data and deliverables, namely the cost estimate and schedule.

As a result, this lack of accuracy makes it difficult to delineate one contractor from another; these early phase competitions are at best a beauty contest and at worst a game of liar’s poker. To create value in a pre-FEED competition, the amount of engineering workhours expended in the pre-FEED must exceed that of industry norms (see Table 2). The Bonaparte FLNG design competition was an example of a successful pre-FEED design competition that significantly extended the scope of pre-FEED in order to have the information necessary to make a proper evaluation of the economics of the project and the competency of the contractor groups.

DESIGN COMPETITIONS FOR OFFSHORE LNG

When developing a contractor execution strategy for a potential offshore LNG project, one should determine the best way to set up the project for technical and commercial success. The key elements of a design competition remain valid for FLNG: to obtain commitments from contracting groups to bid EPC (usually LSTK) and to attempt to optimize CAPEX or life-cycle cost. Key owner decisions include determining how many groups are invited to bid FEED, the number to execute FEED, and the compensation allotted to each FEED contractor.

For a developing industry such as FLNG, it is imperative to have contractor groups with collective experience to not only execute FEED to expectations, but to deliver EPC with high confidence. These groups must have adequate experience in the elements of liquefaction design
and operation, equipment marinization, modularization and layout, topsides and hull fabrication, shipbuilding, and transportation. At times, it may seem that FLNG has opened the gates to a new field of contractors and contracting groups, some of these groups have great strength in certain elements of the list above, but one element may be lacking. It is important to be wary of contracting groups with good FPSO experience but marginal cryogenic or LNG design and operations experience. The reverse of is also true: beware of strong LNG experience with a lack of experience in the offshore aspects of FLNG. One can invite many groups to bid for a FEED competition in order to evaluate their collective experience and experience working together.

Secondly, one must decide how many groups will be allowed to compete in FEED. While two groups are often chosen for competitions, both onshore and offshore projects have engaged three groups in competition during FEED. Regardless of the number of groups chosen, the key is to not simply focus on owner funding available to spend in FEED and simply decide to split the resources among two or three competing groups. This top-down way of thinking will not result in a properly developed project with high confidence estimates and execution plans.

As previously mentioned, limited resources spent in FEED will result in areas of uncertainty and risk. The proper way to determine the FEED costs is to estimate the required time and resources to develop a FEED resulting in a lump sum EPC estimate with high confidence; only after determining that value should one consider the value of conducting multiple FEEDs. An additional owner cost includes the resources required to manage the contractor teams and evaluate the results fairly. Hopefully, these preparations are done in pre-FEED, but there are examples where FLNG design competitions appear to have been launched without a contractor-led conceptual or pre-FEED phase.

One of the reasons that design competitions work for offshore LNG is that the rules of the competition are set with the requirement to submit credible EPC bids at the end of FEED. Without such rules, there is a risk that contractors would participate purely for the FLNG FEED experience or decline the invitation to bid EPC on another company’s FEED. This sentiment is especially true when requiring LSTK bids as a third party FEED would require a rigorous verification and risk assessment in order to assume LSTK risk. This assessment process would add significant time to both conduct the assessment and review the bids from multiple parties.

Lastly, one of the potential traps for FLNG is using onshore LNG rules of thumb for a developing industry like FLNG. FLNG is a natural extension of the experience in LNG onshore and the successful operating history of large FPSOs. However, when jumping from a well-established industry to a one in development, it is best not to lean heavily on the familiar metrics of either previous industry. One example of this concept is the time and effort it takes to develop an FLNG FEED. In onshore LNG, FEEDs are expected to take less than twelve months (sometimes much
less) with other rules of thumb used to estimate the workhours required for FEED. If these metrics are blindly applied to FLNG, the project teams will not have enough time to define their projects and will be scrambling to fulfill their commitments on time. This scenario is likely to result in a high LSTK price.

In sum, one must decide whether the benefits of conducting an FLNG design competition is worth more than working with a single contractor group in a sole-sourced manner. The question is not particularly about the gross economics of the project, but whether the state of FLNG is mature enough to engage groups in competition in the drive to lower cost and shorten schedules for projects that have yet to be commissioned. The competing contracting groups want to win these competitions, but the project must be fully defined and the risk properly analyzed in order to make them technically and commercially successful.

DESIGN COMPETITIONS FROM A CONTRACTORS PERSPECTIVE

HOW ARE WE BEING EVALUATED?

One item that is of prime interest to contractors is how they are to be evaluated. Some projects are determined solely by lowest CAPEX, others by life cycle cost, some by technical differentiation, and others by a unitized formula taking several factors into account. Other projects may prohibit disclosing the evaluation criteria which is the most difficult scenario. While some evaluation criteria were addressed earlier in the paper, there are other interesting scenarios for current projects.

For grassroots projects in new locations, all competitors are on a similar level with regard to site and regional intelligence. In these cases, either lowest CAPEX or highest value (lowest life cycle cost) will win the project. However, what if the competition was for a site with nearby LNG plant infrastructure or a brownfield site?

Design competitions for a brownfield project have a unique set of conditions. Any incumbent contractors (the incumbent contractors may or may not continue to work together) have an advantage with regard to site and regional intelligence, but “knowing too much” can be a liability with regard to the estimate for the new project. Contracting groups must determine if a realistic cost estimate with a high probability of outcome can win the project when the lowest cost is what wins the competition. In addition, the owner/operator must be able to evaluate an estimate on more than simply the bottom line price and consider if all the bidding groups fully understand the site-specific issues of the region.

Similar issues regarding estimates and site knowledge will also affect schedules. Contractors are determined to develop a schedule that accurately reflects the execution plan. The shortest schedules, which are indeed high value offerings, are not often a low risk or high probability schedule. Similar to CAPEX, an underrepresentation of schedule may result in contractor losses and/or the reputation as an unsuccessful project. One may ask if the real winner of a competition is the group with the lowest cost and schedule or the most realistic cost and schedule. There can be scenarios where a contracting group’s site-specific knowledge may make it difficult to win against one or two other bidding groups without the same regional experience.

COMPLIANCE VERSUS OPTIMIZATION

An issue affecting the final bid developed in competition is that of compliance vs. optimization. Although the subject of contractor optimization was discussed in the previous publication\(^1\), in certain countries, non-compliance is cause for disqualification. If optimization and improvements are desired, there should be clear instructions to incentivize contractors to develop alternate solutions. Conversely, if compliance is strictly required, similar instructions should also be clear.
TOP DOWN VERSUS BOTTOM UP

When competing for EPC (and even for pre-FEED and FEED), it is difficult to overcome expectations based on top-down thinking. While metrics and rules of thumb based on proven experience are valuable for feasibility-type work, FEEDs and EPC projects are developed from the bottom up. The slogan for top-down thinking in LNG, which has now become cliché, is declaring CAPEX in terms of $US/tonne of a project at any point prior to FEED. Pre-conceived metrics such as cost per unit capacity have no consideration of the site specifics of a project, especially execution planning. Similar oversimplifications exist for project schedules, when looking from the top down.

Challenging unrealistic expectations is likely to leave either the owner/operator or the contracting group unsatisfied – possibly both. Another challenging scenario is executing FEED, whether in competition or not, with X$/tonne or Y months of EPC schedule as the criteria for every decision. Under this set of expectations, the final deliverables, if they don't meet the $/tonne or schedule targets are deemed to be a failure even if they are realistic and driven from the bottom up.

In a competition where time is of the essence, there is merit to setting the competition on a consistent technical basis of design (e.g. fixing items such as process technology, feed gas flow rates, minimum availability, and other key technical elements) which allows added focus in FEED on developing a realistic cost estimate, schedule, and project execution plan. Who wins when both an owner and contracting group cannot agree to a cost basis and schedule?

ADDITIONAL THOUGHTS FOR OFFSHORE LNG

One difference for offshore design competitions is the participation of the shipyard and module constructor, which may or may not be different companies. For onshore projects, fabrication and construction are directly managed or subcontracted, but for offshore LNG, the shipyard and module fabrication facilities are critical factors in the design, execution, and functionality of the project. In addition, much of the EPC cost runs through the hull and modules which places significant scope in these companies.

Shipyard participation is critical in developing a workable FLNG EPC execution plan. In the thought of limiting spending in FEED, a competition may seek to limit participation to only LNG design and engineering firms. This strategy is not recommended due to the amount of influence the shipyard will have on the cost and schedule for an offshore LNG project. There are many capable shipyards that can assume such a role for FLNG projects.

In regard to evaluation criteria, the competitors should be clear on the value and interplay among production rate, availability and capital cost (often expressed as a formula). There are also many other issues other than economics to consider for FLNG. These issues include safety, accommodation and accessibility, topsides weight and module density, hydrodynamics, etc. Contractors are looking to avoid gamesmanship with calculated results for parameters that have yet to be proven or put into service.

Lastly, contractors will keenly review the commercial elements of the EPC contract to determine the balance of risk and reward. Bidding LSTK for a new and developing industry is certainly a proposition with considerable technical and commercial risk. Teams will review limits of liability and the value of LDs to determine the risk and consequences of not meeting performance expectations. When winning an FLNG project means having the lowest price and committing to LSTK, a design competition with significant penalties and LDs may not result in the best economics for the owner.
WINNING IS ONLY THE FIRST STEP

Contractors are always competing for business, whether or not in an LNG design competition. While the industry continues to demand reductions in plant cost, contractors look for ways to increase the certainty of plant cost. Increasing the certainty of plant cost is intended to support all the stakeholders in the project; if the original cost estimate is unrealistic and the final cost is substantially higher than estimated, the project appears to be unsuccessful regardless of the true economics. The potential liability facing contractors in LSTK projects requires a balance of certainty and risk to assure a successful project at a fair price. As the design competition has evolved, one may consider if the contractor’s perspective of participating in design competition has changed. Expressed another way, is every design competition arranged where all the bidding groups want to win?

The only way to increase the certainty of the project cost and schedule is by properly analyzing risk; without an understanding of risk, the project will either be underestimated (resulting in losses) or overestimated (resulting in a high bid CAPEX and a failed bid). This technical and commercial risk analysis can be achieved in a FEED design competition when the conditions are set for the groups to develop a technically sound configuration and a realistic execution plan.

CONCLUSIONS

Contractors are ready and willing to compete to be a part of new LNG projects which may include participating in a design competition. In addition to “winning”, contractors want to be associated with projects that are deemed technically and commercially successful. Success is often defined as meeting cost and schedule expectations that are set when evaluating the bidders. Design competitions must be arranged so that contractors have the time and resources to put forth their best efforts. These efforts will result in bids with well-defined and manageable risk, a high confidence cost estimate, and a realistic execution plan.

Liquefaction process technology may or may not be used to establish technical competence and encourage different project configurations. This decision will affect how contractors align with each other as well as who may or may not participate in the project. In any execution scenario, competition among process technologies creates added complexity when evaluating the capabilities and final proposals from multiple contractor groups. Owner/operators must assure they have the oversight capability to get the most from these proposals.

Offshore LNG projects present opportunities to use the design competition in new ways. Offshore, a design competition assures contractor engagement in FEED to define risks and develop an execution plan while providing the owner with commitment to receive multiple bids for their projects. Although design competitions for offshore LNG may have become standard practice, care should be taken to fully analyze the technical and commercial proposals for these unique projects to assure the projects can be executed as planned. In addition, offshore LNG project bids with inadequate definition in FEED may result in higher than expected CAPEX due to pricing technical uncertainty and risk.

Lastly, we must consider if the drive to limit pre-FID spending has resulted in projects that cannot be executed as-planned, or even successfully. Constraints on schedule and compensation to the contractor groups in FEED will likely result in a poor assessment of technical and execution risk and a low confidence cost estimate. Competitions are welcome in environments with flexibility to execute the EPC phase (labor sourcing, material sourcing, local content, etc.). Well managed sole-sourced projects may work better in areas of high execution risk or for taking on technical novelties.
Although price is always king, the design competition is evolving from a technical competition to an execution competition. While the full economics of a project are not public knowledge, the perception of a project being successful is heavily influenced on sustainable operations and commercial (cost) certainty. Contractors are eager to engage in competitions when the conditions are well defined and the owner should allow the contracting community, which includes all the technology, service, and equipment providers, to be “the best that they can be”.

REFERENCES


8. CII – The Construction Industry Institute, [https://www.construction-institute.org](https://www.construction-institute.org)