WAVE International

Whitepaper

Regional Approaches and Risk of the Selection of Engineers

CRM PROJECT LESSONS LEARNED

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Abstract

This whitepaper focuses on the implications of engineering partnership selection for European Critical Raw Material projects. The paper discusses the inherently different engineering and partnering approaches of the small, medium and large engineering houses, and the implication of contracting strategies for each. This is provided in the context of complex processing and technically challenging greenfield project development in a region that has very little recent experience in new mineral exploitation and involves clients and engineers with varying technical capability and capacity.

About the Author

Tony Dopheide has over 25 years project delivery, senior management and consulting experience in Mining & Metals, Construction and Engineering sectors.

His noteworthy contributions have played a pivotal role in shaping and advancing the Australian and European lithium processing and chemical conversion industry, where he has assumed senior portfolio development and management positions in leading tier-1 lithium companies.

Tony's rich industry background encompasses project delivery and departmental management across a wide spectrum of mining and mineral categories, as well as major infrastructure sectors. Additionally, he has provided expert consultancy services on an international scale, collaborating with prominent lithium companies in Europe and the Americas.

Currently, Tony serves as the **'General Manager – Europe'** for Wave International's Advisory function. In this role, he specialises in overseeing lithium, high purity alumina, vanadium, and other battery minerals projects.

Introduction

I have received several enquiries during my panel discussion at the Fastmarkets European Battery Raw Materials Conference this year in Amsterdam. Participants were particularly interested in project performance, engineer selection, and the appropriate level of project risk appetite.

For full disclosure, last year I elected to work for a tier-2 engineering consultant (Wave International) because of its focus on technical excellence and innovation in Critical Minerals and Metals. I also manage Wave International's European function and have a strong interest in supporting European Critical Raw Materials (CRM) businesses.

My experience is embedded in CRM material refining in all segments of the mine to metal value chain, and my 20+ years investment in large capital, client-side management (including 13 years with the pain and pleasure of lithium project involvement) has provided me with unique and intimate insights into what works, and what doesn't.

The drivers for the various tiers of engineering have been broadly defined below (and yes, I do expect a whole lot of commentary around my categorisations).

Table 1 – Drivers per Tier of Engineering

	Tier – 1	Tier – 2	Tier – 3
Project Focus	Standardised and repeatable approach.	Client focus. Process optimisation. Technical excellence.	Equipment or process level.
Primary Revenue Driver	Engineer which frequently may self-perform construction under EPC contracts or deliver EPCM contracts.	Engineering Studies and some may undertake EPCM contracts.	Consulting billable hours.
Project Team	Decentralised structure and assembled from available disciplines.	Generally centralised structure and assembled based on technical knowledge.	Small consultant team.

The selection of Engineers for Critical Raw Material Projects varies in approach by continent, but lessons learned from major lithium projects show just how critical engineer selection is to project delivery success and a least-risk approach. CRM refining requires a scalpel, not a knife.

My Assessed Position in a Broad Context

1. There is a perception that European projects are 'bankable' if they contract with a tier-1 engineering company. The requirement of funders is that the Engineer is capable of self-performing construction under an EPC contract, and this necessarily requires an entity of significant size – not necessarily technical capability as has been proven on many projects. This perception is not correct but persists at board level particularly within new market entrants.

2. Australian projects tend to contract with tier-2 contractors with technical capability and deep experience with the relevant mineral / chemical. Often these engineers may contribute to the delivery of the project under an EPCM contract, Integrated Project Management Team, or Client Representative. The focus for Australian project success is 'technical capability' usually evidenced from previous successful project delivery. The engineer usually remains involved in the oversight of construction which is by separate construction delivery.

3. Projects in the Americas and Canada vary depending on Study Phase, TRL and experience of the client with similar projects.

The success or failure of previous projects, particularly lithium projects, have significant implications for the different approaches to project delivery. A well-considered risk profile and appetite are required. However, memories are often short, contract selection criteria may be incorrectly weighted, and funders' conservative risk evaluation may be misaligned with the complexities of innovative chemical projects.

For the purposes of this discussion, the approaches have been differentiated into two very broad categories: Engineering Capacity and Technical Capability.

Engineering Capacity Approach

The 'capacity' approach is frequently associated with European projects to achieve project bankability and funding based on the engineer's:

1. **Physical capacity** to take the project through construction.
2. **Broad industry applications**.
   Note: the importance of technical depth and experience with the specific material is very often overlooked or significantly undervalued to the detriment of the project.
3. **Brand recognition and lobbying capacity.**

For this approach to be successful, the following are mandatory:

1. **The client must be very well-informed, have appropriate internal technical capacity, and must understand what the project should look like in the end.**

   Lessons learned - If you haven't delivered one of these projects you will not fall into this category, no matter what you think now!

2. **Always budget for a Client Representative or Owners Engineer with relevant mineral experience and a solid history providing this type of service.**

   Lessons learned - Project knowledge is highly valuable but easily lost with attrition of key people within organisations. Project resources are transient; CRM expertise is in high demand; and both client and contractor resource demand/turnover will remain high in the foreseeable future. An engineer with relevant expertise and an embedded knowledge base will help you last the distance.

3. **The client must also be capable of resisting 'bulldozing' tactics frequently adopted by tier-1 engineers:**

   Lessons learned – Avoid contracts that prevent 3rd party or independent reviews. There is tendency for some well-known engineers to write this in contracts to avoid external audits. Avoid this at all costs! Do not be prevented from conducting independent reviews on your own projects.

4. **The engineer has successfully delivered similar projects with the same mineral / chemical:**

   Lessons learned - If you haven't done this, you cannot presume that you can base the design and project delivery on 'similar' processes.

   The failure of large engineers to deliver these projects is reflected in the frequent midstream termination of contracts. For some reason, this seems to be particularly common in lithium projects.

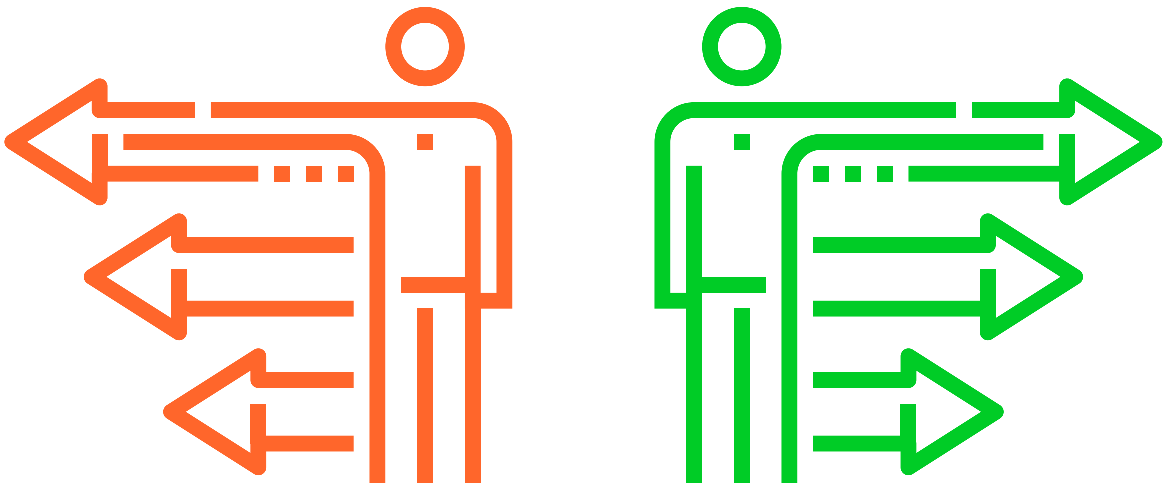
5. **The TRL must be mature (6 and above):**

   Lessons learned – The greenfield development of mineral processing projects is pretty close to zero for European engineers in the last 30 years. Even if the TRL is mature, minerals and chemicals require very bespoke approaches, and the engineer will / must rely on equipment vendors to provide design and performance parameters - which presents obvious risks.

6. **Technical expertise may be present in the engineering organisation but if you are not in the primary location of the mineral processing hot-spot (e.g., Lithium in Australia) you are unlikely to see the expertise beyond the proposal stage, i.e., the engineer's A-Team will be spread very thinly across the globe on multiple projects:**

   Lesson learned – Expertise in CRM is rare. Do not believe anyone who claims to have exclusive dominance, especially tier-1 organisations, as that is not true!

   In larger engineering organisations, technical expertise is the small fish in the large pond. Tier-2 engineers have a higher percentage of expertise across fewer projects, so you are likely to get more technical design capability and know-how dedicated to your project.



Technical Capability Approach

The technical approach is most frequently associated with Australia projects and probably has been learned by the high-cost and schedule impacts endured by the Australian mining giants using tier-1 engineers and the novel processing demands.

The advantages and disadvantages of using this approach are:

1. **As noted above, you will typically get a better level of engineering service from the tier-2 (and sometimes combined with tier-3 engineers), and they will always be less expensive in the end. The downside is that very few will be able to transition into construction management. Therefore, you will probably need to build internal capacity to implement a separate construction contract:**

   Lessons learned – If EPCM is not possible with the tier-2, agree to retain the engineering knowledge as a component of an integrated management team through construction. The intimate knowledge gained during design phase is a valuable accessory to assisting and optimising construction activities and avoiding pitfalls.

2. **The smaller engineers are generally interested in improving the processes, and proactively assist in developing the project and optimising the process in the client's interest. Revenue by this tier of engineering is typically made on engineering hours rather than construction:**

   Lessons learned – This 'flexibility' will typically have cost and change implications (so allow for this in the budget and schedule). The offset is that this usually results in optimisation which pays big dividends at the end.

   Tier-1 engineers will orientate to quick and dirty solutions to commence construction asap. Experience in major lithium projects shows that a fast-track construction commencement does not actually mean earlier production (in fact, no projects in China or Australia have achieved their production timelines through fast-track programs) due to complications in construction and commissioning and ramp-up from insufficient design.

3. **The engineer is part of the ultimate contracting solution and there are many more options available to the Client for integration.**

Implications Of Getting It Wrong

1. Failed projects (there are several high-profile projects associated with well-known tier-1 engineers).
2. Very significant production delay (prolonged engineering – usually requiring a fast-tracked recovery program –).
3. Extended commissioning and ramp-up phases (these projects rarely achieve the McNulty curve).

What Should Be Considered

Confirm where the risk lies for the project. Is it technical (will the plant function when and as expected) or is construction the major risk (for projects that have a high TRL)?

Understand that 90 - 95% of the engineering is easy and is replicable by most competent engineers. It's the 5 - 10% of design that makes or breaks a project, and you won't know it's wrong until too late in the design phase, during construction, or (even worse) in commissioning and ramp-up.

Take a wide-eyes-open approach to selection of an engineer and don't fall for the BS. Most engineers do not have both technical capability and capacity to deliver complex chemical plants from study to operation stages. Look very carefully at the engineer's success with previous project delivery (talk to the engineer's past PM team leadership and don't rely solely on promotional material in the capability study or the presentation) and its experience with processing of similar minerals.

Look at the relevant experience of individuals in the engineering company and contractually agree their commitment to your project.

Ensure that you have the option available to have a 3rd-party review should you need it.

Some Words Around 'Bankability'

Bankability is largely misunderstood by clients. Lenders are looking for:

- De-risked processes and competent testwork. This is even more critical now given that many projects aspire to commence without a clear raw material supply chain or with materials from varied sources.
- Customer acceptance and product validation. Correct engineer selection plays an increasingly important part in assuring off-takers that projects can be constructed, and product will be delivered to an agreed specification.
- Access to experienced teams, with individuals being the key. Funders are increasingly favouring 'A-Teams' featuring industry recognised experts as a de-risking strategy.

- Transparent contracting with a de-risked contract approach: Funders are looking to 'lift the bedsheets' for visibility of risk and are increasingly likely to avoid less transparent investments.
- Security of feedstock: The current reluctance to agree feedstock (both raw material and intermediate) off-takes has resulted in a tighter investment climate. (I'll talk more about this in future papers)

Many of these extend beyond just the selection of an engineer, but it's also evident that support from a suitably technically credentialled engineer and an experienced due diligence process will contribute considerable weight to what constitutes 'bankability' for development, offtake, and project integrity.

Is Europe Getting This Wrong?

There are merits to both the 'Technical' and 'Capacity' approaches, and it's clear that selection reflects a corporate risk appetite, and project delivery success under each of these approaches is significantly related to a client's internal capability.

The question is 'where does Europe find best value"?

Tier-1 engineering houses have contracted on several significant CRM projects in Europe. Some of these appear to be a good client / contractor fit but it's clear that others will take the more difficult (but well-worn) path of extended studies, reworked process design and delayed production.

History tells us that success in delivery of CRM projects is dependent on a client's recognition and acceptance of its technical capability; the applicable experience and capacity of its internal project team to manage technical and engineering risk to achieve best-for-project outcomes; and selection of an engineer that addresses the technical capability and capacity needs of the organisation.

European project developers would be wise to consider lessons learned by the early adopters in other regions and recognise the risks of erring towards 'capacity' approaches at the expense of 'technical' capability. This is particularly relevant for the region that has limited experience with these technologies; has not implemented any significant greenfield developments of similar complexity and value and is dominated by major regional engineering houses that are likely to be currently transitioning out of O&G into renewables and minerals processing.

Many of the European project developers are in early stages on that experience curve and will significantly benefit from the technical capability that a suitably experienced tier-2 engineer will provide. Its up to each developer to understand just what that assistance package might look like.

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