PETROCHEMICAL UPDATE

Define Your Petrochemical Project Execution Plan

Secure a project execution strategy that can ensure your petrochemical project is delivered on time & within budget

Industry Whitepaper

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Introduction

With the oil and natural gas prices at their lowest in years, a growing number of petrochemical owners on the US Gulf Coast are shifting their priorities from speed-focused to cost-focused construction strategies. EPC companies in the region are also beginning to see a move from cost-reimbursable contracts back to lump-sum ontracts

This cost-driven project approach is likely to persist at least until oil prices stabilize back to a minimum of $85/barrel, according to Milt Cousins, Director of Fabrication Sales at Turner Industries.

In the meantime, the delays in capital spending are freeing up resources for ongoing projects, allowing petrochemical owners to take more time to evaluate their contracting strategies and available contractors, and to determine their building approaches moving forward.

To assist petrochemical producers and EPC companies to choose the best construction strategies for their current and planned projects, Petrochemical Update has conducted in-depth interviews with industry experts to bring you the present thinking into:

- Key analysis and data comparing the modularization and stick build approaches
- The best project approaches based on the complexity and size of the project, the availability of contractors, and the ability of petrochemical owners to manage costs and risk
- The advantages and disadvantages of bidding out packaged sections to individual contractors compared to working with a dedicated EPC throughout the project lifecycle

Announced ethane-based plants and expansions

OPERATORS	PROJECT	ETHYLENE CAPACITY	STATE	STARTUP YEAR
Sasol	Lake Charles Ethane Cracker and Derivatives	1.5 mtpa	Louisiana	2017
Formosa Plastics	Louisiana Ethylene Plant	1.2 mtpa	Louisiana	2018
Formosa Plastics	Point Comfort Plastics & Petrochemical Plant Expansion	1.15mtpa	Texas	2017
Axiall Corp & Lotte Chemical	Louisiana Ethylene Cracker	1.0 mtpa	Louisiana	2018
Shell	Monaca Ethane Cracker	1.5 mtpa	Pennsylvania	2019
Chevron Phillips Chemical Co	Cedar Bayou Ethylene Plant	1.5 mtpa	Texas	2017
ExxonMobil	Baytown Olefins Plant Expansion: New Ethane Cracker & Two PE Plants	1.5 mtpa	Texas	2017

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OPERATORS	PROJECT	ETHYLENE CAPACITY	STATE	STARTUP YEAR
Dow Chemical	Freeport Ethylene Plant	1.5 mtpa	Texas	2017
Ingleside Ethylene LLC (Mexichem;	Ingleside Ethane Cracker	545,000 tpa	Texas	2017
Odebrecht Group-Braskem*	Wood County Ethane Cracker and Polyethylene Plants (Project ASCENT)	Not yet decided	West Virginia	2018
Badlands-Vinmar-TR	North Dakota Polyethylene Plant (proposed)	1.5 mtpa (PE)	North Dakota	2019***
Ineos (JV with Sasol)	LaPorte HDPE Plant	470,000 tpa (HDPE)	Texas	2016
LyondellBasell	Corpus Christi Expansion	360,00 tpa	Texas	2016
LyondellBasell	Channelview Expansion	113,000 tpa	Texas	2015
LyondellBasell	La Porte Polyethylene Plant	454,000 tpa	Texas	2017
ShinEtsu	Ethylene Plant (proposed)	500,000 tpa	Louisiana	2018
Williams	Geismar Olefins Plant Expansion	295,000 tpa	Louisiana	2015**

Source: Petrochemical Update
*Pending internal decision
**Operational
***Estimated start up

Tailoring your strategy: Modularization vs. Stick Build

While about 80% of production expenditures in the petrochemical industry depend on the cost of the feedstock, companies can save millions of dollars in capital expenditure or gain a competitive advantage by ensuring that projects are completed on schedule and within budget.

The size and complexity of petrochemical projects, the pressing shortages of skilled craft labor in the US Gulf Coast, and the race to bring production on stream early on are prompting more and more petrochemical producers to carefully reconsider their construction methods – modularization or the conventional stick-built (onsite) approaches – on a case-by-case basis.

Logistics and schedule is everything in analyzing the construction strategy, either module or stick-built, of a greenfield or brownfield project, according to Cousins. The bottom line is that no matter how attractive either construction approach may appear, it must provide a clear economic advantage over alternative methods, based on a detailed assessment of the labor costs and productivity, equipment expenditure, ability to meet the project timeline, space requirements, safety and other risks.

Equipment costs

Equipment and service costs in petrochemical projects in North America have increased by as much as 50% since 2009, making this a key consideration when comparing modular and stick-built construction methods.

Besides the cost of manufacturing, equipment costs also comprise transportation and crane expenditures.

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Before choosing the best construction method for their project, EPC contractors and owners have to determine whether the size and physical location of the plant allows for modularization, whether there is sufficient fabrication capacity available, whether the equipment spacing requirements are reasonable for modularization, whether the crane capacity is available and economical, and whether overland shipping and vessel/barge/tug limits allow for module transportation.

Modularization, in particular, further requires a more careful preliminary screening of a complex set of factors, including choosing a process engineering method backed by a thorough knowledge of the available equipment, equipment selection and layout, piping and instrumentation needs, the size of the modules, insulation, equipment elevation and refractory.

Transporting modules across the country also requires setting up a dedicated multi-disciplinary team with strong modular skill sets, including experienced shipping and traffic coordinator. Even though some shipping restrictions are easy to define, US states have different rules about the weight, length and width of truck loads that can vary throughout the year

With proper work scheduling and sequencing, modules can decrease the number and durations of large cranes and other equipment in the field. Procurement is also often simplified, especially when the installation site is located in remote areas, where raw materials and equipment are expensive or difficult to obtain.
Moreover, modularization results in fewer fitting errors and re-work because developers can pre-fit components prior to shipment. The requirement for construction cranes can also be reduced on modular projects when roll-in jack down methods are used.

Yet, according to a senior consulting mechanical engineer at a major petrochemical company operating in the US Gulf Coast, outsourcing a lot of the pre-fabrication reduces the owner's ability to oversee the quality of the whole process compared to traditional stick-built methods.

"I believe that the prevailing thought is: we don't usually build modules downstream," he says. "If someone else is doing the work for us, how are we going to be responsible for the quality that comes out of it? "

According to James G. Slaughter, Jr., President of S&B, modularized projects have more sophisticated engineering and design requirements, which increases design costs compared to stick-built construction. Engineering costs for modular units are generally 10%-15% higher than field constructed units, according to estimates by the Pro-Quip Corporation. Modularization also increases structural steel quantities substantially, forcing developers to offset costs elsewhere – for example, by minimizing downstream equipment erection or optimizing labor use, which are more costly than shop fabrication work – to make the numbers work.

Case study: The Gemini HDPE project at Ineos's Battleground Manufacturing Complex in Texas

Ineos Olefins & Polymers USA and Sasol have created a joint venture to build a high-density polyethylene (HDPE) facility at Ineos's Battleground Manufacturing Complex in LaPorte, Texas. The facility will feature the Innovene S process technology licenced from Ineos Technologies and will produce 470,000 tons of bimodal HDPE each year.

The scope of the project includes the addition of new polymerisation, pelletisation, and railcar load-out units, and upgrades to existing utilities and infrastructure.
KBR was appointed to provide engineering, procurement, and construction (EPC) services for the project, which uses a cost-reimbursable contract.

KBR's Houston Operating Center and KBR's Monterrey Engineering Center will manage the engineering and procurement services. The engineering firm plans to provide direct-hire construction with selected subcontracts to build the facility.

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the skilled labor in the area is not presently organised to provide modular construction services for components that we need for the facility," says Peter Subtelny, senior consulting mechanical engineer at Ineos in Houston and lead engineer at the Gemini HDPE project.

Workers will not be located onsite because the facility is surrounded by plants. The facility next door is Total's polypropylene (PP) plant, the largest of its kind in the world. Instead, workers will live offsite and be transported into the construction site during working hours.

"The mindset the industry has is that modular construction will be inferior to stick build, and that is not the case," Subtelny says. "It's a psychological block that the industry has, particularly in the downstream industry, and I think will shift slowly, it takes time to change the minds of an industry that has done stick build for decades."

Labor costs

The availability of crafts and equipment are the two key drivers for both modular and stick-built methods. Remote locations with minimum crafts and resources lend themselves to pre-assembly, while projects with a strong labor force, such as the Mississippi Gulf Coast, can be more easily stick-built, according to Cousins.
While it is obvious that modularization transfers work hours from a field environment to a shop environment, it is important to determine whether that shift saves money compared to the traditional stick-built approach.

Labor costs typically include a detailed assessment of the direct and indirect costs in the shop or on the field, labor productivity on site and in the shop, the cost of structural design, fabrication and installation work, the shop versus field assembly hours, the insulation and fireproofing (sub)contract cost, the potential effects of schedule overruns.

Before opting for a construction method, project engineers should also determine whether field labor requirements put restrictions on where and who can fabricate modules, and whether there are local labor market restrictions for particular jobs or crafts.

In modularization, the requirements for highly skilled labor onsite are often minimal, a particular advantage in the US Gulf Coast, where fully trained skilled labor is either costly or highly restricted.

As a rule, modularization will likely benefit the bottom line if shop costs are less than the field labor cost. This is often the case, especially when taking into consideration the cost of the infrastructure required to support crews in the field.
The cost of tools, work and living facilities, supervision, training, safety measures, and recruitment, among others, are usually higher for onsite construction rather than in a more controlled shop environment.

"The numbers of workers in the field or shop are determined by the size of a project. Module assembly labor is approximately 30% cheaper than field installation. It also reduces costs associated with having crafts on site, such as safety, PPE, lunch areas, orientation, laydown area, parking, and others," Cousins says.
Moreover, according to Don Lieske, retired Director II and Manager of Modularization at Fluor, various project locations in the US Gulf Coast tend to have higher labor rates than many local and overseas pre-fabrication shops, which could be located in a more economical labor environment, especially when all-in at site labor rates include per diem.

"With modularisation, there are reductions in onsite construction support cost," he says. "And with companies facing extra cuts right now, they can ship the components in from the US or other locations where labor costs are reduced and equipment costs have been demonstrated."

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Modular construction can therefore work very well in North America, where the shortage of craft workforce is a serious issue, according to Paul Dainora, Director Business Development - Petrochemical Plants at The Linde Group.

That shortage is often aggravated by the need to manage and segment the whole project. Engineering firms are often working with multiple processes and need to foster communication among engineers on the different phases of the build.

"Modularization takes more thought and engineering, and companies have to make a detailed evaluation. It's a well-thought out process whereas with stick-built, you hand the project over, but costs can escalate because of the need to assemble and manage large labor forces and onsite issues, and work around local weather conditions, etc. When everything is stick built, the client can experience more complex issues both for the site and for communities nearby," Lieske says.

Case study: BASF

BASF, the world's biggest chemical manufacturer, is considering adopting a modularization approach in its US projects to deal with a potential shortage of craft workers.

Stick-built has been the historical standard for BASF projects as they do not operate in remote locations that necessitate modularization. However, due to the heated Gulf Coast labor market, the company is now considering modularization for larger projects, as a way to mitigate construction labor market risks.

The German-based company is building an on-purpose methane-to-propylene plant on the US Gulf Coast, and has expanded a Texas ethylene facility it owns with France's Total. It is also building a 750,000 tpa ammonia plant in Freeport, Texas, with Oslo-based Yara International. BASF will have a 32% interest in the plant, and Yara will have a 68% interest.

Total capital investment for the plant is estimated at $600 million. Yara will also construct an ammonia tank at BASF's Freeport terminal bringing Yara's total investment to $490 million. BASF will in addition upgrade its current terminal and pipeline assets at the site. KBR will be undertaking the EPC work for the plant under a fixed-price turnkey contract. The plant is expected to be completed by the end of 2017. The company also used an EPC approach to build an additional ethane cracking furnace at its facility in Port Arthur, Texas in 2014 to improve feedstock flexibility, enhance plant reliability, and increase annual production capacity of ethylene to more than 1 million metric tons.

The Port Arthur site produces ethylene, used for anti-freeze, polyester, plastics and pharmaceuticals; propylene, used for plastics, diapers and adhesives; and butadiene, used in the production of rubber and plastics.

The Port Arthur cracker is one of the world's largest steam crackers, representing a $1.5 billion investment by BASF Corporation and Total Petrochemicals & Refining USA, Inc.

The cracker turns a wide range of feedstocks such as ethane, propane, butane and naphtha into ethylene, propylene, butadiene and other chemical raw materials.

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"It's a more complex project when you modularise but the upside is that with modularisation you meet your targets because you outsource work when labor is tight and reduce the uncertainty of having the workforce on the ground to do the job," says Matthew Czuba vice president, manager of projects – North America Gulf Coast Downstream & Chemicals at Worley Parsons.

There are about 100,000 skilled craft professionals in the US Gulf Coast, but the petrochemical industry needs about 140,000, according to Czuba.

A shortage of key talent, for example, can increase project costs by 20% to 40%, while delays can mean lost opportunities to take advantage of peaks in business cycles, according to management consultancy Accenture.

An assessment of a North American ethylene cracker project estimated that delays due to workforce challenges can equate to a daily loss of cash flow of at least $1 million a day.

Productivity

Besides per hour work rates, productivity levels can also make a difference to the balance sheets of modularized and stick-built projects.

Shops, for example, tend to maintain standard procedures, QA and assembly-line techniques that add to the overall efficiency of the shop environment. In addition, unlike onsite construction, many shops work in a covered and/or environmentally controlled environment, which reduces productivity losses due to flooding, hurricanes, wind, rain or other adverse weather conditions.

This makes modularization a suitable option in places such as Northern Alberta, Siberia and even the US Gulf Coast, where weather conditions are typically unpredictable. The productivity of skilled shop craftsmen is 30% to 50% higher than field craftsmen, resulting in a considerable savings in the total project man-hours, according to Pro-Quip Corporation.

Schedule

Assessing how a project's construction method will affect its schedule is a key criteria in choosing a construction method.

Modularization involves the construction of pre-fabricated plant modules that can be assembled on-site after the receipt of construction permits.

Modularization can effectively allow construction to begin months earlier in a shop environment. Once the permit is acquired, modules can be set much quicker than the time required for onsite fabrication and assembly.

"Modularization requires complete engineering design and project scope to be frozen. Project completion schedule drives the decision, " Cousins says. This could make schedules more difficult to meet and adjust since everything must be complete and tested in the shop prior to shipping. Shipping late or incomplete modules can doom a construction project to missed schedules and cost overruns.

By contrast, stick-built plants can be started after a minimum of engineering is complete. Work-arounds are common in stick-built construction, and can be planned and executed well.

Modularization could also be less desirable when owners are faced with a very tight schedule because the modular approach typically increases the overall project timeline by 4-6 months – or the duration of the bidding cycle for an EPC contract. Modularization can also entail substantial shipping costs and additional material costs, which requires high upfront investment.

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"Properly planned and executed modularization concepts can be very successful and offer significant advantages, but they can likewise increase cost and schedule risk – the very things they were designed to minimize," Slaughter says.

Space requirements and risk factors

`Modularization typically requires less space on site compared to conventional stick-built approaches because most of the build is done off site. Onsite laydown areas, warehousing and material storage, and staging are substantially less, according to Lieske.

By reducing fieldwork, this approach also minimizes the project's impact on the customer site, a significant advantage when the installation site is an operating plant. Modular construction also minimizes lay-down space, an important benefit when the field site is small or congested, and reduces delays due to unpredictable weather. Moreover, shifting work into a controlled shop environment generally decreases the overall safety risks of a project. In particular, large vertical structures can be constructed in the horizontal by use of modularization, thus limiting the amount of vertical work at elevation. This can decongest areas that, by their nature, possess a riskier work environment.

The race to build your plant on time could become so crucial that spending more capital on adopting a construction model such as modularisation might mean the difference becoming a key market player on the Gulf Coast and having a plant start up late in a market that already has a surplus of product.

However the upside to a conventional stick build, according to senior executive at a major chemicals company, is the method requires fewer of the owner's resources and moves the risk of interface management between the "E", the "P", and the "C", to the EPC contractor

Choosing the best EPC contracts: Lump-sum vs cost-reimbursable contracts
Before the petrochemical boom in the US Gulf Coast, owners preferred to procure major construction projects via a fixed-price, lump-sum route – the so-called engineering, procurement and construction (EPC) contract. The EPC contracts gave owners and financers more certainty about the time and costs it would take to execute a project

Then, in 2013, when the surge in petrochemical projects announcements took place and the wave of bids started, there were simply not enough contractors with the experience or balance sheets to take on the demand.

As a result, contractors gained more bargaining power as owners were in a hurry to complete projects quickly. Hence, more cost-reimbursable contracts were inked to start the projects off quickly.

Most of the EPC contracts at the US Gulf Coast at the moment are still cost-reimbursable. In the fourth quarter of 2014, approximately 81% of Fluor's backlog was cost-reimbursable and 19% was for fixed-price or lump-sum contracts, a Fluor spokesperson said. The breakdown was very similar to the same quarter in 2013

But with oil prices in volatile swings and the outlook for some projects uncertain, EPC firms are beginning to see more lump-sum contracts.

In its February 2015 earnings statement, Fluor reported continued demand for new capacity, but a change in demand for the types of contracts. The company said that given the current price conditions, it expects to see more lump-sum contracts.

"Depending on schedule and service offerings of that EPC, single source [contracting] is the most efficient,'' Cousins says. "Owners are usually looking for budget assurance and prefer lump-sum [contracts].'' That provides cost certainty to the owner, and the efficiencies gained from the EPC approach vs EP-bid-C or EPCM-at-risk will also reduce overall costs.

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Contractors, on the other hand, might prefer cost-reimbursable contracts to shield themselves from the burden of escalating costs.

In order to take advantage of the modular construction, the purchasing group and the engineering group need to ensure the quality and inspection of the different modules. This means deciding between bidding out packaged sections to individual contractors or working with an integrated EPC throughout the project lifecycle.

The biggest advantage of an EPC approach is single-point responsibility as multiple contracts add a level of interfaces that must be managed, according to James G. Slaughter, Jr., President of S&B.

However, Slaughter says, to maximize cost efficiency, the ISBL portion of the project should be executed EPC by a major contractor and the OSBL should be executed EPC by one or more smaller contractors.

"Business is absolutely good right now," says David Taylor, vice president of field operations at S&B Engineers & Constructors Ltd. "Larger companies prefer [to contract an] EPC that does it all. It depends on the complexity of the project. Most companies like more of the one-stop shopping. That has helped us."

"In general for larger investments (> $500 Mil) we typically prefer an EPC approach, regardless of market conditions. This is driven by construction management resource availability," a senior executive at a major chemicals company said.

Slaughter is seeing more demand for EPCs, including joint venture EPCs. According to him, fixed-price contracts are only practical with a true EPC or joint-venture EPC companies.

Moreover, as owners' internal resources to manage projects are stretched, they prefer to manage a single-point EPC than multiple contractors.

"Owners are steering away from the program management concept where a major contractor manages other major contractors due to past project failures," Slaughter says.

Lump-sum contracts can be a cost-containment approach, as long as the scope of the project is frozen. In a cost-reimbursable cost project managed by the owner, cost saving can be realized if the project is run efficiently and effectively, but the owner has to staff their team with highly experienced project resources.

Conclusion

While it is still too early to draw hard-and-fast conclusions about the direction of the US Gulf Coast construction market, petrochemical producers that are considering investing in new or revamping existing facilities have to make up their mind "now" if they want to have their projects up and running before the regional and global markets become overcrowded.

Although the future of chemical plant construction projects on the US Gulf Coast depends on the length and duration of the oil price drop, most industry players do not expect companies that have started building to pull back. The maths prove that the US will continue to be a major player in the global petrochemical scene.

America's shale gas revolution could lead to a dramatic growth in US chemical exports over the next 15 years, according to a new report from Nexant, Inc., and sponsored by the American Chemistry Council (ACC).
Gross exports of chemical products, including plastics, linked to plentiful and affordable natural gas are projected to double, from $60 billion in 2014 to $123 billion by 2030.