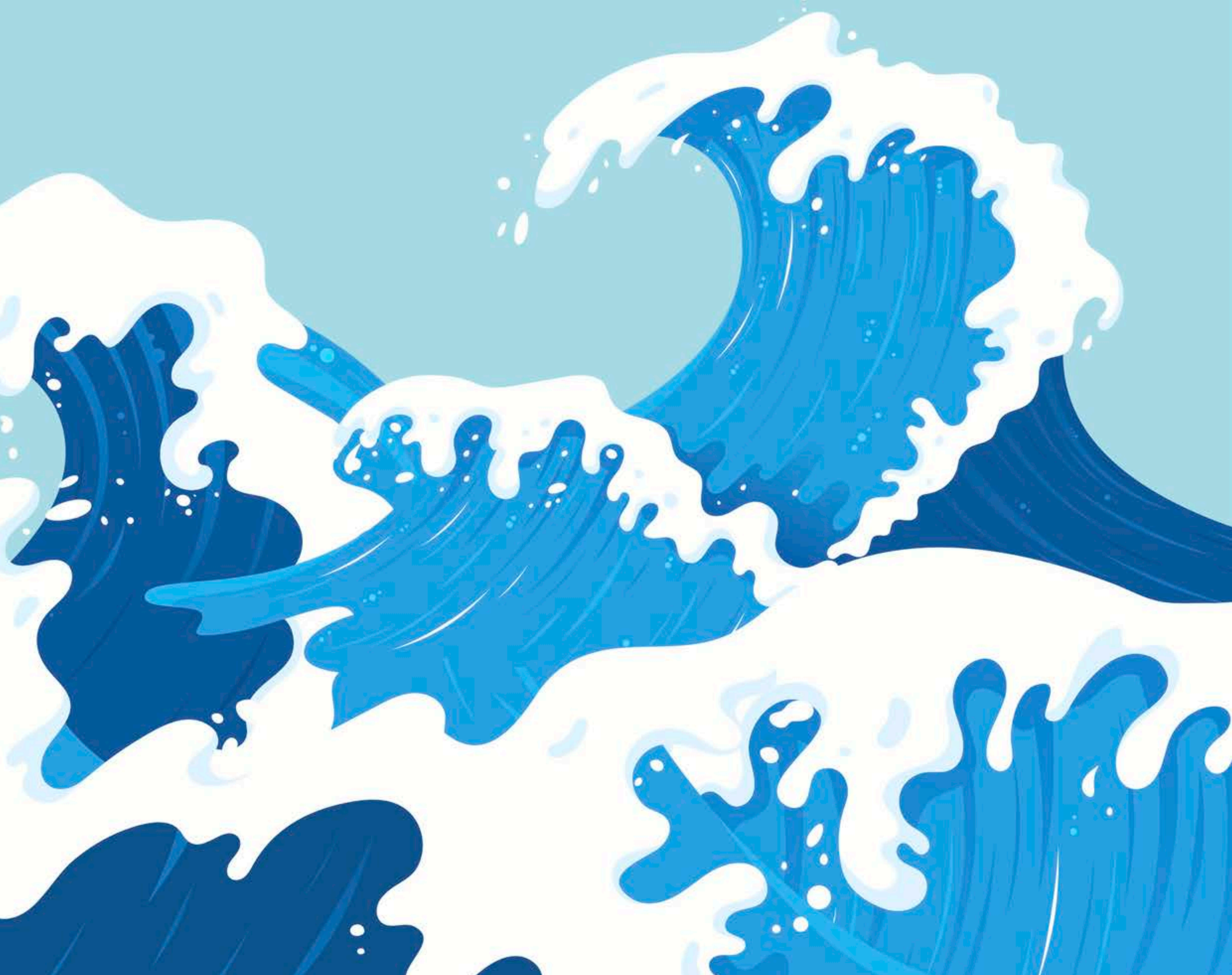
Smarter project delivery

Rob Shaul, McDermott Senior Vice President, Low Carbon Solutions, UK, looks at how large scale modularisation is leading the next wave of LNG projects.

As global energy dynamics evolve and LNG demand continues to grow, project delivery models are being re-evaluated to improve delivery, efficiency, and cost control. Demand projections from the International Energy Agency and Shell point to consumption surpassing 600 million tpy by 2040, driven by Asia's continued industrialisation, Europe's post-Russia energy diversification, and emerging markets in South America and Africa seeking a reliable, lower-emission bridge fuel. That trajectory represents annual growth of 3 – 4% over the next 15 years – a powerful signal for developers and contractors alike.

Yet, the momentum of LNG expansion is meeting significant resistance in the form of escalating capital costs and constrained labour markets. On the US Gulf Coast alone, more than 80 million tpy of LNG capacity is under development, and project CAPEX has inflated by nearly 20% since 2022. While material supply chains have changed substantially in the post-COVID era, a major factor is the dominance of stick-built construction that exposes projects to qualified craft labour shortages, weather-related productivity losses, quality control variability, and heightened community impact. In a region where energy sector and data centre construction activity is already



stretching available labour resources, these headwinds are structural rather than cyclical.

The industry needs a different approach; one that transfers risk from the field to the factory, provides greater certainty with schedules, reduces on-site labour demand, and delivers more LNG output from a smaller physical footprint. Large scale modularisation is that answer, and McDermott and ConocoPhillips have spent a significant amount of time developing and refining a standardised solution to deliver it.

The modular paradigm: From offshore to onshore

The origins of McDermott's onshore modular LNG design lie in an earlier collaboration with ConocoPhillips on a nearshore floating LNG concept. That work forced both organisations to think rigorously about spatial efficiency: how does one pack maximum processing capacity into a constrained envelope while preserving safety, operability, and maintainability? The answers developed for the marine context translated directly – and powerfully – to onshore applications.

The result is a standardised modular LNG plant design built around ConocoPhillips' Optimized Cascade® Process (OCP), a technology with more than 50 years of operating history and over 120 million tpy of licensed global capacity. The OCP's architecture – three multi-staged, cascaded refrigerant circuits using pure refrigerants and brazed aluminium heat exchangers – lends itself naturally to modularisation. Its compact, systemised configuration minimises the number of inter-module connections, supports maximised pre-commissioning in the fabrication yard, and enables the layout densities required to achieve meaningful footprint reduction.

McDermott's role brings a complementary capability: more than 100 years of large scale module design and fabrication, honed through offshore projects where weight, footprint, and structural integrity are existential engineering constraints. By applying an offshore module philosophy to onshore LNG – engineering mega-modules of up to 80 m long, 40 m wide, and 45 m tall, weighing 10 000 t or more – the collaboration targets a performance envelope stick-built projects simply cannot match.

Maximising LNG output per square metre of plot

One of the most commercially compelling metrics in modern LNG development is production per unit of land area. Real estate constraints on prospective US Gulf Coast sites (compounded by permitting complexity, environmental sensitivity, and community considerations) are increasingly shaping project feasibility. The ability to produce more LNG per square metre is not merely a technical achievement; it is a commercial differentiator.

Internal modularisation studies using the OCP design have demonstrated a more than 50% reduction in plot area compared to equivalent stick-built facilities on the US Gulf Coast. By increasing on-module equipment density, the design shortens piping runs, reduces electrical and instrumentation cable lengths, and minimises the earthworks, piling, and concrete foundations that contribute significantly to stick-built costs. The land freed by this compact configuration can accommodate additional LNG trains, laydown areas, or supplementary process units such as carbon capture systems – all critical to project economics and long-term flexibility.

Importantly, higher equipment density is not achieved by simply packing equipment closer together. It requires detailed material handling studies to preserve crane and forklift access for routine maintenance and major overhauls. Reserve maintenance volumes are built into the 3D design model. Monorail capacity, hoist locations, and emergency egress routes are engineered from day one. The result is a facility that is dense but not cramped – optimised for both construction efficiency and operational reliability over a multi-decade lifecycle.

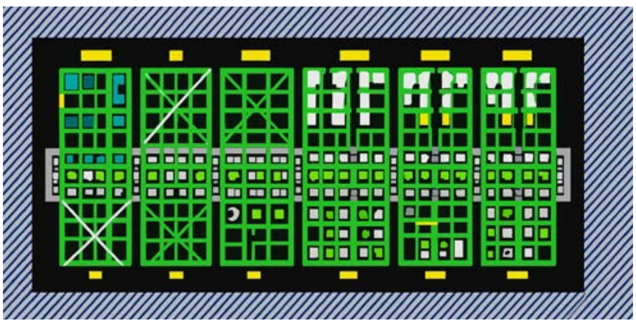


Figure 1. Module Optimized Cascade® Process design overlayed on typical stick-built plot. Source: Google Earth 2025.

Benefits beyond economics

Cost reduction is the headline benefit of modularisation, but it is far from the only one. The advantages span the entire project lifecycle.

On cost, evaluations indicate a 15 – 25% CAPEX reduction potential vs stick-built baselines, contingent on logistics and site-specific conditions. Site workhours can be reduced by 60 – 70%, since the majority of assembly occurs in controlled fabrication yards. In regions with high labour costs or skilled labour scarcity (conditions endemic to the US Gulf Coast), this shift in where the workhours are spent is particularly impactful.

For schedule, modularisation enhances predictability by isolating fabrication from the weather, labour risks, or unique environmental windows that dominate stick-built timelines. Module fabrication proceeds in parallel with site preparation, reducing the compounding delays that can cascade through traditional construction sequences. Fewer site activities mean fewer interfaces where disruptions can propagate.

As for safety and quality, a fabrication yard is a fundamentally different environment from a construction site. Controlled conditions enable improved oversight, better access to specialised equipment, and more thorough quality assurance protocols. Non-destructive testing, pre-commissioning activities, and compliance verification all occur in the yard before modules are shipped, reducing the likelihood and cost of rework during final integration. This approach consistently delivers higher-quality outcomes while reducing lost-time incidents.

Sustainability metrics also improve. McDermott's analysis indicates that modularisation achieves approximately a 20% reduction in carbon footprint during the execution phase relative to stick-built construction. Concentrated fabrication in specialised facilities enables more efficient, less carbon-intensive processes. As module fabrication yards increasingly source sustainable energy, this advantage is expected to improve further.

On community impact, reducing on-site headcount directly reduces the demand for temporary workforce housing, support infrastructure, and local services. A smaller construction footprint means less land disturbance, reduced noise and traffic, and a lighter community footprint throughout the construction phase.

Engineering for modular realities

The benefits of modularisation are not automatic; they require disciplined engineering attention to challenges that do not exist or exist in a fundamentally different form to stick-built projects.

Transport stability is one such challenge. Mega-modules must be designed to withstand the dynamic loads of lifting, sea transport, and on-site transportation, including accelerations, wind forces, and vessel motions. The module envelope must comply with port constraints and road transport limitations that govern maximum width, height, and weight thresholds. McDermott's fabrication yards have recently executed the load-out of multiple modules for a North American LNG project, several of which exceeded 10 000 – 12 000 t – validating the practicality of the mega-module concept at commercial scale.

Safety engineering for compact module layouts requires additional rigour around blast overpressure analysis, jet fire and cryogenic spill scenarios, and pressure vessel survivability. Passive fire protection coatings, blast walls, and strategic equipment positioning are integrated into the design to mitigate consequences from potential loss-of-containment events. Human factors engineering – ensuring accessible control room interfaces, adequate valve access, and clear emergency egress – is embedded from the earliest design phases rather than treated as a downstream check.

Logistics planning is the third discipline that can make or break modular execution. Heavy-haul transport requires co-ordination with specialised vessels, trailers, and port facilities. Route surveys must confirm that roads, bridges, and infrastructure can handle oversized loads. Installation methodology, whether using heavy-lift cranes or self-propelled modular transporter (SPMT) systems, must be defined during front-end engineering, not resolved in the field. McDermott's track record with SPMT load-outs for large modules demonstrates that these logistical challenges are manageable with appropriate planning.

Commissioning: The yard as a pre-operations environment

One of the most underappreciated dimensions of the modular approach is its impact on commissioning. In a well-executed modular project, the fabrication yard functions as a pre-operations environment, not merely a construction facility.

Figure 2. Recent mega-module load-out from McDermott's module yard using a self-propelled modular transporter system.

Pre-commissioning activities performed in the yard before shipment include piping system flushing and air blowing to remove debris, hydrostatic and pneumatic pressure testing to verify integrity, loop testing and calibration of instrumentation, electrical continuity checks, and control valve response verification. Subsystem boundaries – refrigeration loops, power distribution, control systems – are aligned and tested against their design specifications before a module leaves the yard.

This strategy means modules arrive at the project site in near-ready-for-start-up condition. Integration work is reduced to tie-ins between pre-tested subsystems, with clear documentation and tagging to guide the final commissioning sequence. The practical result is fewer site work hours, more certain schedule progression through mechanical completion, and higher confidence in first-gas timing, a critical metric for LNG project economics given the capital deployed.

Realising success

McDermott is using the modular design philosophy described here not just in theoretical terms, but actively shaping the next generation of LNG infrastructure.

McDermott's master services agreement with Monkey Island LNG demonstrates the approach in action. The project involves front-end engineering and planning services for a world scale natural gas liquefaction facility in Cameron Parish, Louisiana. By utilising McDermott's compact modular LNG train design and the ConocoPhillips OCP, the project is targeting delivery of up to 60% more LNG per acre than comparable facilities – a metric that speaks directly to the land-efficiency advantage of the modular paradigm.

The Woodfibre LNG project in British Columbia, Canada, provides another reference point. Leveraging modular construction from McDermott's QMW fabrication yard in Qingdao, China, alongside integrated project delivery, Woodfibre is demonstrating how modularisation can streamline execution and reduce on-site complexity in an environmentally sensitive, geographically constrained setting – precisely the conditions where stick-built construction struggles most.

Shaping the next wave and future outlook

As the LNG industry looks towards its next cycle of investment decisions, the competitive landscape has shifted. Final investment decisions are under pressure from cost escalation and schedule risk. Skilled labour on the US Gulf Coast is a constrained resource that will only become more contested as demand for domestic power generation and associated infrastructure continues to increase. Additionally, the social and environmental license to build large infrastructure is more carefully scrutinised than at any point in the industry's history.

Large scale modularisation addresses each of these pressures directly. It transfers labour from the field to the fabrication yard, secures schedule certainty by enabling parallel workstreams, reduces the community footprint of construction, and lowers the carbon intensity of project execution. It standardises design to reduce engineering variability and improve cost predictability across multiple trains and projects.

The message is clear for the next wave of LNG development: success will be defined not only by scale, but by agility, sustainability, execution excellence, and capital efficiency. Large scale modularisation is not a future option; it is a present imperative. **LNG**