The role of design-build delivery in rapid US solar market growth

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Abstract
In an emerging US solar market with an influx of foreign direct investment (FDI) and rapidly evolving technology, PV manufacturers who are looking to establish or expand a base of US operations may benefit from choosing a firm specialising in the design-build project delivery method. With faster speed to market and greater flexibility, design-build offers numerous advantages for solar companies seeking an immediate edge over the competition. Design-build’s shorter project timelines help manufacturers meet aggressive production targets, while its streamlined structure offers the adaptability to support manufacturers’ ongoing initiatives to improve products and processes.

Introduction
The US solar market is in a state of intense activity. Driven by rising demand, supportive public policy, and a favourable climate for tax credits and incentives, private companies have determined that now is the time to act. Infused with foreign direct investment (FDI) from Europe, Asia, and North America, US solar production capacity is rapidly expanding, and current projects promise to propel the US to a leading role in the global industry. With many players simultaneously looking to establish or expand US operations, speed to market is the single most vital factor in gaining market share. Early engagement with an industry expert on design-build delivery can be key to meeting critical project milestones and going to market ahead of competitors.

First, we will examine the state of the US solar industry and the factors driving its growth. With this context, we will then explore the advantages that design-build can offer businesses entering this developing market.

FDI and US solar industry growth
The solar industry’s explosive growth is a primary driver for PV manufacturers’ imperative to employ the design-build method. At the federal level, legislation such as 2022’s Inflation Reduction Act has catalysed foreign investment in the solar market. According to figures from Kearney’s Foreign Direct Investment Confidence Index [1] as well as the United Nations’ World Investment Report [2], the US was the No. 1 destination for FDI in 2022. By industry, the 2022 report from the US Bureau of Economic Analysis [3] shows that the manufacturing sector accounted for 50.1% of investment, up from 42.4% in 2021. The list of top 20 countries investing in the US was dominated by Europe (14 countries), Asia (3), and Canada. This trend is reflected in recently announced solar projects, with Canadian Solar and Silfab Solar (Canada), JA Solar and Longi (China), Qcells (South Korea), and Meyer Burger (Switzerland) all commencing projects in 2023.

Stakeholders at all points of contact with the market are seizeing the opportunity to gain an advantage by establishing new US manufacturing operations. Foreign businesses see a fertile market with growing demand, skilled labour, good infrastructure, and vast material resources. Local leaders see opportunities to create jobs that can revitalise their communities and attract more businesses to the area. Federal and state officials are keen to tout policy wins that entice businesses to invest domestically, buoy the economy, and catch up to countries in Asia and Europe that have invested earlier and more aggressively in solar technology. Sustainability and clean energy advocates see the chance to significantly scale production capacity to reduce the country’s reliance on fossil fuels. Design, construction and engineering firms see sustained demand for their services in continuing trends of strong FDI and onshoring for manufacturing.

Qcells’ new facility in Cartersville, GA, will execute the complete production of its solar modules—including ingots, cells, wafers, and modules—beginning in 2024. Concurrently, Qcells is adding an 800,000sqf expansion to its solar module assembly campus in Dalton, GA, which will increase its total capacity in the state to 8.4GW.

In March 2023, Canadian PV manufacturer Silfab Solar unveiled plans to work with ARC Financial Corp. to build a US facility to produce solar cells totaling 1 GW of capacity, with an additional 1.2 GW of PV module assembly. In June, Canadian Solar announced the establishment of a solar PV module production facility in Mesquite, TX, that will boast an annual output of 5GW.

One week later, VSK Energy, a new joint venture backed by Indian solar panel manufacturer Vikram Solar Ltd., announced that it would build a 2 GW facility in Colorado, with plans to expand capacity to 4 GW—an illustration that inbound FDI in US solar production is a global movement.
Impact of the IRA
The passing of the IRA in August 2022 in many ways set the stage for the boom the industry is currently experiencing. A primary feature of the sweeping legislation is investment in clean and renewable energy in the form of available tax provisions, grants, loans, credits, and other incentives.

Among these is a new Advanced Manufacturing Production Credit for domestic manufacturing of components along the supply chain for solar modules. The credit is eligible for transferability and direct pay to PV manufacturers.

In May 2023, in partnership with the Department of Energy and Department of Transportation, the US Department of the Treasury released guidance that detailed requirements for applicable projects and components which solar manufacturers must follow to receive the domestic content bonus credit.

Following suit, Canada and Australia have recently enacted laws similar to the IRA in the scale of funding and policy support for solar and other clean energy initiatives.

US solar capacity and generation
A summary of findings from the National Renewable Energy Laboratory (NREL)’s Spring 2023 Solar Industry Update [4] provides historical context as well as projections for the industry’s growth through the rest of the decade. Figures from the update reflect a domestic solar industry that lags leading global markets but is experiencing rapid growth that promises to lead the energy market in generation and investment. The findings cover industry developments across the following key areas:

Solar versus total generation
• The US is below the global average and other leading markets in PV generation as a percentage of the country’s total electricity generation, with 5%
• In the top 10 US states for solar-generated electricity, solar power accounted for an average of 15.3% of each state’s total generation
• If California were a country, its PV contribution (28%) would be the highest
• In 2022, renewable energy facilities continued to produce more electricity than both nuclear and coal sources
• In 2012, solar produced approximately 0.3% of total US electricity generation; by 2022, solar had grown to 4.7% of electric generation – this increase came from:
  • 3.3% from utility-scale PV (UPV), nearly a 40-fold increase
  • 1.4% from distributed PV (DPV), a nine-fold increase
• 0.1% from concentrating solar power (CSP), a three-fold increase

Production capacity
• PV represented approximately 46% of new US electricity generation capacity (17 GWac) in 2022, compared to 4% in 2010
• The US Energy Information Administration (EIA) projects the percentage of US electricity capacity additions from solar will grow to 58% in 2023 (37 GWac) and 68% (47GWac) in 2024
• The average module’s efficiency has improved, while prices have declined steadily since fall 2022—indicators that contribute to an increasing production capacity
• In 2022, the United States domestically produced roughly 5 GW of PV modules

Solar installations
• The US installed 17.0GWac (20.2GWdc) of PV in 2022, ending the year with 101GWac (140.6GWdc) of cumulative PV installations
• The United States installed approximately 14.1GWh, 4.8GWac of energy storage onto the electric grid in 2022, up 34% year over year
• By the end of 2022, 20 states had more than 1GWac of cumulative PV installations, and 29 states installed more than 100MWac

Public policy
• In 2022, US state and federal governments enacted a record number of policy decisions regarding solar, including corporate incentives for establishing new operations, DG compensation for customers connecting solar systems to the grid, community solar programmes, the acceleration of zero-carbon target dates, incentives for PV-plus-storage systems, and an increase for Investment or Production Tax Credits (ITC/PTC) for specified communities of need
• 21 US states took more than five solar policy and rate design actions in 2022; only four US states took no such actions in 2022
• Projections show that clean electricity could grow to 71–90% of total generation by 2030, without the IRA (August 2022) and Bipartisan Infrastructure Law (November 2021), clean electricity would only be projected to account for 46-52% of the grid

US solar market insight
According to the June 2023 update of the US Solar Market Insight [5] published by the Solar Energy Industries Association (SEIA) and global energy researcher Wood Mackenzie, “the US solar industry installed 6.1GWdc of capacity in the first quarter of 2023, a 47% increase from Q1 2022 [and] the best first quarter in the industry’s history.” Segmented by type of installation, utility-scale projects saw a 66% increase compared to Q1 2022.
The research also noted that the loosening of certain supply chain constraints also led to an uptick in module imports destined for utility-scale projects in the US. According to the report, "12 GW of modules passed through US customs in the first quarter of 2023, compared with 29 GW across the whole of 2022."

SEIA's Major Solar Projects List, updated in July 2023, contains more than 6,300 major projects (those with capacity of 1MW and above) in the database, representing nearly 205GWdc of capacity. Nearly 100GW of this capacity derives from completed projects, with the remaining 105GW attributed to projects currently under construction or development.

The pair of figures from SEIA, taken from the Major Projects List, illustrates the quickening pace of project installation over the past five years as well as the increase in pipeline capacity, with some utility-scale projects planned as far as 2030.

Further SEIA models predict the total installed solar capacity for the US to quadruple by 2030. The consensus among industry stakeholders regarding solar’s unprecedented growth demonstrates the need for a project delivery method that maximises quality, efficiency, and flexibility while minimising challenges surrounding cost, speed and risk. Just as solar is on track to become the world’s predominant energy source, so too has design-build become the most preferred project delivery method.

In this regard, design-build closely resembles one of the oldest concepts in construction delivery—that of the “master builder”—a single, highly experienced person or enterprise that manages all aspects of a project, from concept and design to trades and construction. Though modern design-build incorporates a wider array of services, it performs the same function as the master builder, providing sole responsibility through a singular contract between Design-Builder and Owner.

By contrast, design-bid-build (also known as design-tender) is often described as a “traditional” delivery method, though its origins in the US extend roughly only 150 years back to a period of US history known as the Gilded Age. This period saw rampant political corruption through graft and bribery, as officials awarded inflated contract sums on vast infrastructure projects to friends and political supporters. The US construction market was far less mature than it is today, controlled by a handful of millionaire magnates and plagued by unqualified
contractors. The emergence of design-bid-build project delivery and its subsequent codification can be characterised in part as state and federal governments’ attempts to combat corruption through public contract law. The aim was to secure qualified contractors at a low price as government bodies sought to complete critical infrastructure projects.

Today, the construction industry has far more guardrails against these problems: a larger field of qualified contractors, greater regulatory oversight, rigorous certification programs, merit-based membership in professional associations, etc. Consequently, design-build is regarded by many to be more relevant to the modern industry and its customers’ needs.

Due to its expediency, flexibility and ability to reduce project cost and Owner risk, design-build has quickly evolved from an alternative delivery method to a primary option for projects of all sizes and across all markets. According to DBIA, design-build encompasses the largest share of all new design and construction projects (nearly 50%).

In recent years, DBIA has worked to promote design-build for government infrastructure and critical services projects. As design-build has grown its share of across all construction spending, it has earned its place as an established delivery method with an abundance of evidence that points to its advantages. This growth has led to further studies and rulings on the use of design-build for government projects. Increasingly, departments and agencies that once propelled the emergence of design-build are utilising design-build for its more efficient project delivery. For example, an overview of design-build practices by the Federal Highway Administration highlights 98 FHA projects across the US that were completed using design-build.

**Advantages of design-build**

The general benefits offered by design-build centre on the relationship between Owner and Design-Builder and the integration of design and construction personnel. Without tender separating these project phases, construction teams are free to overlap with the design process, procuring construction materials and equipment based on Owner-provided specs and seeking bids from subcontractors simultaneously.

The elimination of the contractor bidding process facilitates not only an earlier start but also innovation resulting from the contractor’s ability to provide input earlier in the project—an especially salient point for contractors who have prior experience delivering PV manufacturing projects.

Design-build also provides a collaborative advantage, as design managers, project managers, and site managers share common goals and contribute equally to the Design-Builder’s success. This alignment provides each leader with greater visibility and holistic insight into the project’s execution, enabling greater understanding, trust, and cross-team coordination.

Key areas of focus for design-build’s advantages include the following:

**Improved quality** The team structure of a design-build project encourages quality from all sides and naturally discourages corner-cutting, which would undermine the team’s collective effort.
Greater cross-team collaboration Without the segregation of design and construction, cross-team collaboration is incentivised. Shared resources and personnel facilitate problem solving without cost and schedule overruns.

Faster delivery The integration of design and construction enables services to overlap, allowing elements such as procurement, mass grading, and foundations to begin before design is complete. This integration also allows designers to react quickly to change requests from Owners and construction teams.

Greater project flexibility By eliminating lengthy bid and rebidding processes, design and construction teams can quickly anticipate and respond to shifting needs with subcontractors and trade partners.

Deeper project understanding Design-build’s single-team approach offers team members a greater degree of insight into the needs and challenges over the complete life of the project.

Greater transparency With an integrated team and no contractual distinctions between Designer and Builder, design-build project delivery promotes greater financial transparency.

A fully integrated service provider can extend these advantages with end-to-end project services, from front-end services, master planning, and pre-construction to specialty engineering, production-first IT, and advanced automation and material handling.

Effective use of design-build allows teams to minimise or eliminate many problems inherent to traditional project delivery:

- disconnects between design and construction teams regarding cost, documentation and schedule;
- degradation of project quality through a contractual obligation to accept the lowest bid;
- delays resulting from the inability to procure materials and equipment early in the project;
- competing interests between design and construction teams regarding quality and cost;
- the inability of the general contractor to provide experience-based input to the design team;
- lost time from checks on communications and decision-making;
- an adversarial “Owner and Designer versus General Contractor” mentality.

Mid-Cycle Update of Design-Build Utilisation Study
In the March 2023 Mid-Cycle Update [6] of their 2021 Design-Build Utilisation Study, DBIA and FMI Consulting collected information from more than 350 survey respondents on the use of design-build. Sources included firms, owners, specialty trade contractors, industry associations and more.

The following summary of their findings presents a very positive outlook for design-build project delivery for the future:

- Design-build construction spending in the assessed segments and geographies is anticipated to yield a compound annual growth rate of 5.2% over the 2022–2026 forecast period and reach over US$405 billion in 2026.
- 55% of GC/CM respondents, design-build firms, A/E, specialty trade contractors, and owner’s advisor firm respondents believe that design-build assists in addressing talent retention challenges.
- Over three-quarters of survey respondents believe that design-build facilitates greater utilisation of prefabrication on projects.
- 83% of respondents indicated design-build can help them with supply chain issues more than other delivery methods. Furthermore, the majority of respondents indicated that design-build allows earlier procurement of goods and services to alleviate long lead times and collaborate with trades and their fabricators. Earlier procurement and a dynamic and fluid schedule align with overall industry strategies to combat supply chain constraints.
- With a share increase across all construction spending from 42% (2017–2021) to 46% (2022–2026), design-build is on pace to gain further ground as the largest project delivery method, measured by estimated utilisation.
- Total growth in design-build construction spending is anticipated to be 22.5% from 2022 to 2026.
- 78% of respondents did not indicate that the recent market environments have required changes to bonding/insurance on large-scale design-build projects.

CII/Pankow study
In 1998, the Construction Industry Institute (CII) published a landmark study titled A Comparison of US Project Delivery Systems that compared design-build (DB), design-bid-build (DBB), and construction management-at-risk (CMR) delivery methods. According to CII, “the report examined data from over 350 projects of varying size, sector, complexity, and location that were completed in the mid-1990s. The analysis revealed that DB projects outperformed CMR and DBB in terms of unit cost, cost and schedule growth, and all metrics relating to the speed of delivery.

In 2018, 20 years after the release of the initial report, CII and the Charles Pankow Foundation
conducted a new study to update and compare median performance benchmarks and re-evaluate the performance of the three delivery methods. The report, Revisiting Project Delivery Performance 1998–2018, [7] gathered data for a range of cost and schedule metrics from 212 projects of varying size and scope. Among others, the projects’ market categories included Light Industrial, Heavy Industrial, and High Technology.

Together with researchers from the University of Colorado Boulder and the University of Florida, the CII/Pankow study released conclusive findings: after 20 years, DB projects are still delivered faster and with greater reliability in cost and schedule performance.

The leading factors that the CII/Pankow study identifies as resulting in lower unit costs (per square foot), faster delivery and lower cost and schedule growth are all inherent advantages of the design-build delivery method: greater team chemistry between Owner, Designer, and Builder; more equal participation from all project stakeholders in goal-setting; open-book contracting terms with greater transparency; and early involvement of the Builder in project decisions.

The importance of developing partner relationships

In nine case studies of the best performing projects, the CII/Pankow researchers noted two recurring elements:

- The Owner prioritised the development of a relational project culture
- The Owner had previously worked with the design and construction firm(s)

The advantages that stem from a positive, productive relationship between Owner and Design-Build underscore the importance of Owners finding a suitable long-term partner. As many PV manufacturers establish their first US operations, each has an opportunity to not only complete a quality project with superior speed and cost, but also begin a relationship that delivers a continued return on investment with regard to the Owner’s long-term growth strategy. A partnership developed over the course of multiple projects will foster trust, greater familiarity between corporate cultures, and lessons learned through mutual experience, all of which favor faster delivery times and fewer issues related to cost and risk.

The benefits of a lasting design-build partnership can be further enhanced by a Design-Build’s ability to self-perform trades such as steel and concrete. In most DB, DBB, and CMR projects, the general contractor serves primarily as management, while construction and specialty trades are executed by subcontractors. With an effective self-perform arm, the Design-Builder can coordinate and execute every aspect of the project, from coordinating personnel and materials, to instituting best practices for quality and safety to exercising greater control over schedule and trade work.

Using Design-Build to solve challenges common to solar projects

Any manufacturer undertaking a design and construction project faces a broad set of challenges, but this is especially true for the emerging US solar market for a number of reasons:

- Foreign investors often lack connections to a network of domestic vendors, suppliers, and contractors.
- Foreign businesses can encounter delays in dealing with an unfamiliar regulatory climate.
- Local utilities may struggle to meet owners’ daily power, water, and wastewater needs.
- PV manufacturers can encounter project delays for critical long-lead items such as electrical switchgear, sophisticated process equipment, and materials not widely manufactured in the US.
- PV manufacturing operations involve hazardous materials that require extensive safeguards.
- PV production uses extremely sensitive materials that demand precise environmental conditions.
- Rapid advances in solar equipment, processes, and product design can result in ongoing changes mid-project.

Role of design-build in critical path items

For PV manufacturers looking to claim or expand US solar market share, finding a design-build partner who is familiar with the industry’s processes and needs provides a significant edge. Of the PV manufacturing projects that have been completed or begun by July 2023, most have adhered to design-build delivery for its unique advantages for solar manufacturers looking to locate to the US and quickly begin operations.

1 - Site consultation and utilities

The importance of partnering with a design-build expert begins long before the first shovel breaks...
ground. Site selection consultation can help to ensure that an Owner’s preferred site is viable for operations. The most critical factors used to determine this viability are access to sufficient power, water, and wastewater treatment.

A knowledgeable design-build partner can help Owners conduct site due diligence to determine that these utilities meet the standards necessary for plant operation:

**Access**—utilities are site-ready and do not require extensive redirection or additional scope; wastewater infrastructure is maintained by local and state municipalities in a safe condition ready for long-term, continuous, high-volume use

**Volume**—utilities can consistently supply a sufficient daily volume of electricity and water and process the operation’s daily volume of wastewater

**Quality**—utilities supplied maintain high standards of quality; electricity supplied is consistent in frequency and voltage and free from surges and other abnormalities; process water supply is suitable for use

Many businesses in the process of site selection have chosen an integrated design-build approach for its advantages in acquiring a location with suitable power, water, and wastewater capabilities for large-scale operations.

In an article on advanced manufacturing facilities, design and engineering consulting firm Stantec describes the advantages that an integrated team can offer in securing utilities and keeping a project on schedule:

“Advanced manufacturing facilities demand a lot of water, electricity, [and] wastewater treatment ... Wastewater recycling at the industrial scale requires advanced equipment [to] deliver ultra-pure water. The scarcity and long lead times for this specialised equipment can delay a project.

“An integrated wastewater team can provide more than standard services. It can draw on insights and formulate innovative solutions. At the core, the job of an integrated design team is to source alternative arrangements that will allow for procurement. At times, we can source alternative equipment in place of the hard-to-get pieces to stay on track.”

2 - **Procurement and supply chain management**

Given the large scale of the industry’s ongoing projects, securing long lead-time items early can make or break Owners’ production start targets. Prior contractor experience delivering PV manufacturing facilities and a robust procurement team can help identify critical path items and begin procurement in the project’s earliest stages to maintain the Owner’s schedule.

In KPMG’s November 2022 global supply chains trends survey, 71% of global companies identified escalating raw material costs as their chief supply chain concern for 2023. In its analysis, KPMG states that “Building resilient supply chains to combat future disruptions and adapt to new changes quickly will be key to help navigate these risks.”

The fast pace of design-build projects provides better market accuracy in terms of pricing and real-time validation of cost. A faster delivery will allow PV manufacturers to meet schedule and production output targets for investors and government contracts as well as to secure a skilled workforce before competitors can mine regional talent.

A fully integrated design-build firm can provide projects with the range of expertise needed to efficiently procure materials and equipment and respond to changing needs. Delivering services as a single cohesive team empowers decision makers and streamlines the process of ordering items such as electrical switchgear or redesigning to account for change orders or environmental complications.

**Grid incentives**

PV manufacturers’ unique role as energy providers has created opportunities to partner with local and national electrical utility companies looking to backfill their grid with clean-energy capacity. In exchange for the solar modules necessary to complete these grid upgrades, utility providers have been willing to fund plant construction and offer long-term electrical service contracts with favorable pricing.

Such a trend provides even more incentive for PV manufacturers to go to market quickly, as an inflow of competitors vies for a finite number of such utility contracts. Design-build facilitates manufacturers’ ability to begin production quickly to meet targets and secure these grid incentives.

**Relationship between Design-Build and PV innovation**

In a relatively young industry with a crowded but fertile market, securing an early advantage has a decisive and compounding effect on business. One way that manufacturers can gain this advantage is by continuously improving their products and processes. Solar companies’ research and development teams go to great lengths to improve product performance, lifespan, and efficiency and reduce production and assembly costs.

The flexibility of the design-build method makes it easier to support this rate of innovation. With a single, integrated team managing change orders and
RFIs, it is easier to update design once construction has begun. This can ensure that Owners receive a finished facility that reflects current and next-generation capabilities rather than those from 12, 18, or 24 months prior.

Conclusions
As the US solar industry experiences an influx of foreign businesses seeking to outrun the competition to an unpenetrated market with a high growth forecast, the need for a delivery method that enables project Owners to quickly reach critical milestones is of paramount importance. Design-build’s greatest advantage for the PV industry is its proven ability to deliver projects with shorter timelines than those of other delivery methods. These shorter timelines stem from the contractual joining of design and construction, making it easier for Owner and Design-Builder to negotiate terms, manage communications, and execute design and construction services simultaneously. In a young industry, the opportunity to develop a relationship with an experienced design-build partner can offer immediate benefits that also serve Owners’ long-term interests.

References
[1] “Optimism Dashed,” Kearney 2022 FDI Confidence Index, Fig. 3.

About Gray
Founded in 1960, Gray is consistently ranked among the top industrial contractors in the US and internationally, maintaining offices across North America, Europe, and Asia. Gray’s dedicated team operates cohesively to deliver fully integrated, scalable solutions from process improvement to plant design and construction. Our experienced teams offer unique service platforms to implement smart manufacturing initiatives, maximise ROI through process improvement, provide a streamlined source for system design and integration, and deliver top-tier custom contract-manufacturing and fabrication, all while delivering unmatched precision and partnership to some of the world’s most sophisticated organisations.

Gray has served as a premier design-build partner for the solar manufacturing industry since 2018, when it delivered the largest-capacity solar production facility in the US. In January 2023, Gray began a major solar project that the White House described as “the largest solar investment in US history.” Gray has completed or is currently executing solar projects with a total production capacity of 16.4 gigawatts.

For more information on Gray, visit gray.com and follow us @Gray.

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