Firstgreen Consulting

Energy Efficiency|Renewables|Sustainability

WHEN CHEAP BECOMES TOO CHEAP

The Solar Glut and the Great Manufacturer Shake-Out

When Cheap Becomes Too Cheap: The Solar Glut and the Great Manufacturer Shake-Out

Over the past decade, the solar industry has entered a phase of unparalleled expansion that has fundamentally transformed global energy markets. Module prices have fallen from **USD 0.66/W in 2016 to USD 0.2/W by 2025**, representing a staggering decline that has enabled annual installations exceeding **1.8 TW** worldwide and made solar photovoltaics the most cost-competitive form of electricity generation across most global markets.

However, this rapid and sustained cost decline has also triggered a profound structural imbalance across the manufacturing value chain. Manufacturers' margins have turned deeply negative, several large and historically dominant players have filed for bankruptcy protection, and global supply chains are consolidating around a few dominant geographies—particularly China, which now commands over 92% of global module production capacity.

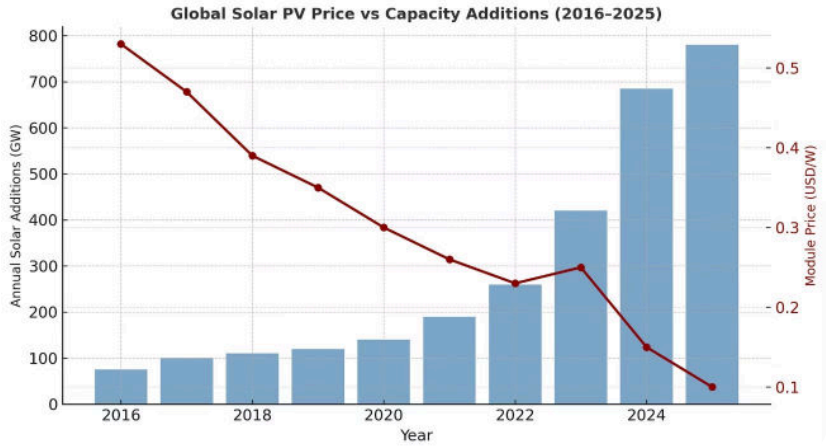
This comprehensive report by **Firstgreen Consulting** provides an in-depth analysis of the **economic, financial, and geographic implications** of the ongoing solar price correction. Drawing on authoritative data from **IEA Renewables 2025**, industry releases, financial disclosures, and Firstgreen's internal market assessments, we examine how abundance has created crisis, why manufacturers are exiting en masse despite record deployment, and what this consolidation means for investors, developers, and policymakers navigating the next phase of the solar transition.

The Paradox of Abundance

Between **2016 and 2025**, the global solar photovoltaic industry has undergone one of the most dramatic and sustained cost transformations in modern industrial history. Average module prices declined precipitously from **USD 0.66/W** to **USD 0.20/W**, representing an extraordinary **70% reduction** in nominal terms—and an even steeper decline when adjusted for improvements in module efficiency, durability, and performance characteristics.

This unprecedented fall in cost unlocked exponential growth in capacity deployment. Global annual installations surged from approximately **75 GW in 2016** to nearly **780 GW in 2025**—more than a tenfold increase—and cumulative installed capacity surpassed **1,800 GW** for the first time in history. Solar PV now represents the single largest source of new electricity generation capacity additions globally, outpacing coal, natural gas, wind, and nuclear combined in many markets.

While this dramatic deflation has made solar electricity the cheapest power source available in most markets—with levelized costs of energy (LCOE) falling below USD 20/MWh in optimal locations—it has simultaneously triggered acute new financial and structural stresses across the manufacturing ecosystem that threaten the industry's long-term sustainability and resilience.



Manufacturer Margins Collapsed

Industry-wide profit margins fell from positive territory to below zero by 2024, with many integrated manufacturers reporting operating losses despite record production volumes and unprecedented deployment growth across all major markets.

Inventory Oversupply

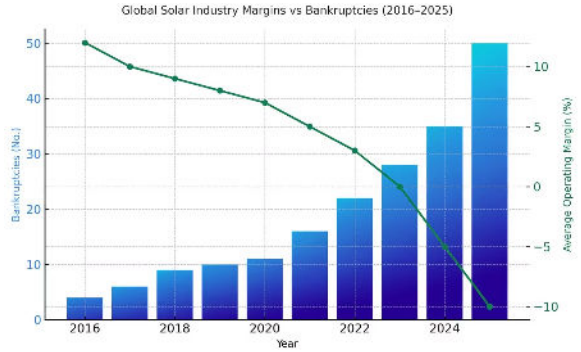
China and Southeast Asian producers flooded global markets with excess capacity, creating persistent inventory buildups at every tier of the value chain and driving spot prices below marginal production costs for extended periods.

Financial Exposure Increased

Module prices became significantly more volatile than project development pipelines, creating severe mismatches between contract commitments and realized revenues, amplifying working capital requirements and credit risk exposures.

Margins in Free Fall: The Economics of Overcapacity

The global solar manufacturing industry is currently experiencing its sharpest and most sustained margin compression in over two decades of modern commercial production. Despite achieving record installation volumes that exceed 780 GW annually, industry-wide profit margins have steadily and relentlessly declined—from a healthy **+12% in 2016** to a deeply negative **–10% by 2025**. This structural deterioration reflects fundamental overcapacity, aggressive price competition, rising input costs for capital and labor, and the commoditization of what was once a differentiated technology product.



By mid-2025, an estimated **50 companies** spanning the entire solar value chain—from polysilicon and wafer production through cell fabrication and module assembly—had either **declared bankruptcy**, entered restructuring proceedings, or been **delisted from public exchanges**. This wave of financial distress represents far more than cyclical downturn; it marks a fundamental structural realignment in which only the most vertically integrated, technologically advanced, and cost-efficient manufacturers with access to patient capital are expected to survive and thrive in the new competitive landscape.

Overcapacity in China

Annual production capacity in China alone now exceeds total global demand by nearly 2×, creating an industry-wide price war as manufacturers compete for volume to maintain factory utilization rates. This structural imbalance has proven persistent despite multiple rounds of capacity shutdowns and consolidation announcements.

Falling Polysilicon Prices

Sharp declines in upstream polysilicon input costs—driven by massive capacity additions and improved production efficiency—triggered aggressive price competition among tier-2 and tier-3 manufacturers seeking to gain market share, thereby eroding margins for all players including cost leaders.

Rising Capital Costs

Elevated global interest rates and extended payment cycles have dramatically increased working capital requirements across the value chain. Many manufacturers face severe liquidity stress as receivables stretch beyond 120 days while input costs must be paid within 30-60 days, creating dangerous cash flow mismatches.

The Shake-Out Begins: Global Bankruptcies and Market Exits

By 2024–25, the global solar manufacturing and installation industry entered a severe consolidation phase following two consecutive years of record deployment combined with deepening and unsustainable financial losses. Over **50 companies** across China, the United States, Europe, and emerging markets either **filed for bankruptcy protection**, **suspended production operations**, or executed distressed asset sales, signaling a profound structural shake-out that is reshaping competitive dynamics and geographic footprints across the entire value chain.

01

SunPower (USA)

Filed for Chapter 11 bankruptcy protection in August 2024 after more than two decades as a pioneering high-efficiency module manufacturer and major residential solar installer. The collapse was driven by mounting debt obligations, deteriorating customer payment performance, and inability to compete with low-cost Asian imports despite premium positioning.

02

Meyer Burger (Switzerland/Germany)

Declared insolvency for its German manufacturing subsidiaries in mid-2025 after burning through hundreds of millions in restructuring capital. Despite advanced heterojunction technology and European manufacturing credentials, the company could not achieve competitive pricing against Chinese TOPCon modules selling below USD 0.13/W.

03

Titan Solar Power and Lumio (USA)

Leading residential installation companies that collapsed in 2024 due to rising customer payment defaults, aggressive dealer fee structures that proved unsustainable, and tightening credit conditions that eliminated access to securitized solar loan facilities that had previously fueled growth.

04

Multiple Chinese Tier-2 Manufacturers

Dozens of second- and third-tier Chinese module assemblers, cell producers, and wafer manufacturers shut down operations as module average selling prices (ASPs) fell catastrophically below USD 0.13/W—a level at which even low-cost producers struggle to cover cash costs including materials, labor, and factory overhead.

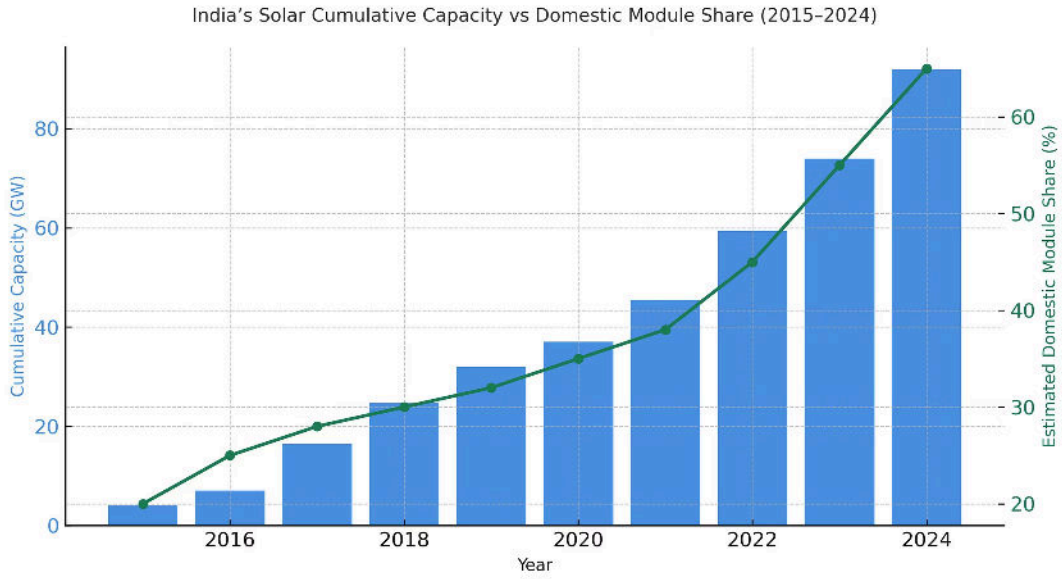
> *"This consolidation phase mirrors the shake-outs seen in other industries reaching maturity stages—semiconductors in the 1980s, LCD panels in the 2000s, LED lighting in the 2010s. The solar industry is transitioning from growth-at-any-cost to survival-of-the-fittest, leaving a smaller but financially stronger and more technologically advanced cohort of globally competitive firms capable of sustained profitability."*

The bankruptcies span the full spectrum of the value chain: from upstream polysilicon and ingot producers facing negative gross margins, to midstream cell and module manufacturers squeezed by pricing pressure, to downstream installers and project developers facing customer credit deterioration and reduced access to low-cost financing. This wave represents the most significant industry restructuring since the 2011-2013 period when overcapacity from Chinese expansion first destabilized global markets.

India's Resilience: The Rise of Domestic Solar Manufacturing

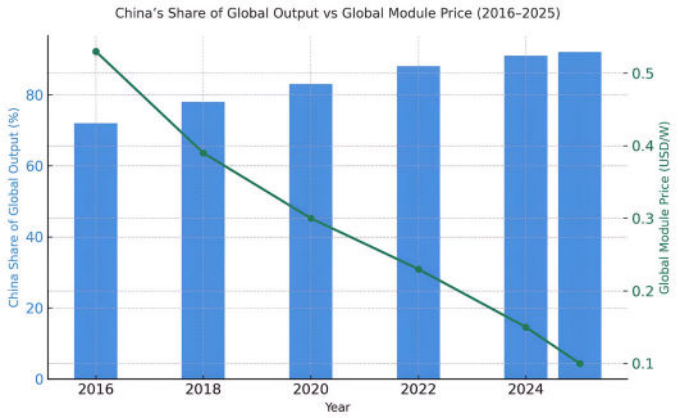
India has emerged as one of the few genuine bright spots and success stories in the ongoing global solar supply chain realignment and restructuring. Supported by a comprehensive suite of strategic policy instruments—including the **Production Linked Incentive (PLI)** schemes providing significant capital subsidies, **Basic Customs Duty (BCD)** of 25-40% on imported modules and cells, and the **Approved List of Models and Manufacturers (ALMM)** quality and compliance framework—Indian manufacturers have successfully expanded domestic production capacity nearly **fourfold** between 2020 and 2025.

Leading domestic manufacturers such as **Adani Solar**, **Waaree Energies**, **Vikram Solar**, and **Premier Energies** have executed aggressive strategies moving toward full vertical integration spanning ingot-to-wafer-to-cell-to-module production. This integration has enabled them to achieve cost competitiveness with Chinese imports even as global module prices collapsed to historically low levels, while simultaneously maintaining positive operating margins through a combination of manufacturing scale, process efficiency, and tariff protection.



China's Price Engine: Global Dominance and Deflationary Impact

Over the period spanning 2016–2025, China's share of global solar module production capacity rose dramatically from approximately **72% to over 92%**, representing one of the most remarkable examples of industrial concentration and manufacturing dominance in any major technology sector. This extraordinary consolidation was enabled by a unique combination of factors including coordinated industrial policy, massive state-backed capital deployment, vertically integrated supply chains, and relentless focus on manufacturing scale and cost reduction.



As China's manufacturing share climbed inexorably toward complete dominance, **global average module prices fell from approximately USD 0.66/W to USD 0.20/W**—a 70% decline that fundamentally transformed solar economics worldwide. This price deflation created a powerful self-reinforcing feedback loop: manufacturing scale drives unit costs lower → lower costs enable aggressive pricing → lower prices stimulate demand growth → demand growth justifies additional capacity investment → additional capacity creates further economies of scale. This cycle benefits project developers and electricity consumers but simultaneously compresses producer margins globally and eliminates viable competition from higher-cost regions.

Key Strategic Implications for Global Solar Markets

- **Price discovery is fundamentally China-anchored** — Global average selling prices (ASPs) now follow Chinese domestic spot market prices and large-scale tender results rather than costs in other regions, eliminating pricing power for non-Chinese manufacturers
- **Non-integrated producers face structural disadvantages** — Module assemblers lacking upstream wafer and cell capacity cannot achieve competitive costs, particularly in high-cost regions with expensive labor, energy, and regulatory compliance burdens
- **Policy shields (ALMM/BCD/PLI) are essential** — India's ability to preserve economically viable domestic margins while achieving manufacturing scale depends critically on maintaining tariff barriers and quality requirements that offset Chinese cost advantages
- **Technology differentiation is narrowing** — Chinese manufacturers have rapidly closed efficiency gaps, mastering advanced technologies like TOPCon, HJT, and back-contact architectures that were once Western competitive advantages

The Investment Paradox: Capital Inflows vs Manufacturer Losses

Global investment in solar energy infrastructure, projects, and supply chains has more than **tripled since 2016**, reaching an estimated **USD 386 billion in 2025**—a level of capital deployment nearly equal to combined global investments in all fossil fuel generation technologies including coal, natural gas, and oil-fired power plants. This extraordinary surge in capital reflects profound investor confidence in long-term solar demand growth, accelerating decarbonization mandates and climate commitments, falling technology costs that improve project economics, and coordinated government-led clean energy transitions across developed and emerging economies.

Top Ten Global Solar Industry Bankruptcies (2016–2025)

No.	Company	Country	Year	Segment	Capacity (GW)	Key Reason
1	SunPower	USA	2024	Module + EPC	2.2	Debt & demand slump
2	Meyer Burger	Germany	2025	Module	1.0	Price undercutting
3	Titan Solar Power	USA	2024	EPC	0.9	Customer defaults
4	Lumio	USA	2024	Installer	0.5	Cash flow issues
5	LDK Solar	China	2015	Wafer	4.0	Over-expansion
6	Isofoton	Spain	2015	Module	0.8	Policy withdrawal
7	CentroSolar AG	Germany	2014	Module	0.6	EU demand contraction
8	HelioSphera	Greece	2017	Thin Film	0.3	High cost per W
9	Systovi	France	2023	Module	0.2	Import competition
10	Hanergy	China	2019	Thin Film	3.0	Governance failure

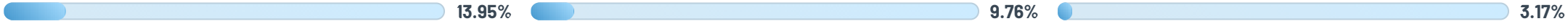
This profound paradox—surging capital inflows coexisting with collapsing manufacturer profitability—defines the new and paradoxical financial landscape of the contemporary solar industry: **unprecedented growth without commensurate profits**, driven primarily by the race for installed capacity and asset ownership rather than manufacturing returns. Investors recognize that value creation in solar has fundamentally shifted downstream from manufacturing to project development, asset management, and integrated energy services—leaving equipment producers in a commoditized, low-margin business characterized by chronic overcapacity and destructive price competition.

Profit Margins of Leading Indian Solar Companies

While global solar manufacturers struggle with negative margins and widespread financial distress, leading Indian solar companies have demonstrated remarkable resilience and maintained positive profitability despite intense competitive pressures. Protected by a combination of tariff barriers (Basic Customs Duty), quality frameworks (ALMM), and production incentives (PLI), Indian manufacturers have successfully carved out a viable competitive position in one of the world's fastest-growing solar markets.

The following table presents the latest audited net profit margins for major Indian solar manufacturers and related companies, demonstrating the range of financial performance across different scales, technology positions, and value chain integration strategies. These margins stand in stark contrast to the negative returns experienced by most global competitors and underscore the effectiveness of India's coordinated industrial policy framework in fostering a sustainable domestic solar manufacturing ecosystem.

Company	Net Profit Margin (%)	Notes / Context
Waaree Energies Ltd	~13.95%	India's largest module manufacturer by capacity; vertically integrated from cells to modules; strong domestic market position with growing exports; data from Moneycontrol for latest fiscal year
Vikram Solar Ltd	~3.17%	Established manufacturer with diversified customer base across utility and C&I segments; lower margins reflect competitive positioning and less vertical integration; data from FY 2023-24 annual report
Saatvik Green Energy	~9.76%	Emerging player focused on high-efficiency modules and integrated solutions; FY24-25 financials show Net ₹213.9 crore on Revenue ₹2,192.5 crore; data from IPO draft disclosures and industry sources
INA Solar (Insolation Energy)	~9.47%	Mid-tier manufacturer with focus on domestic utility-scale projects and government tenders; FY24-25 financials show Net ₹126.19 crore on Revenue ₹1,333.76 crore; competitive in price-sensitive segments



Waaree Energies

Leading integrated manufacturer demonstrating viability of Indian solar production at scale

Saatvik Green Energy

Strong margins for emerging player indicate healthy competitive dynamics in protected market

Vikram Solar

Lower but positive margins reflect pricing pressure even within tariff-protected environment

These profitability metrics—ranging from approximately 3% to 14% net margins—demonstrate that solar manufacturing can remain economically viable under appropriate policy frameworks that balance market competition with strategic protection from predatory pricing by subsidized overseas competitors. The variance in margins across companies reflects differences in vertical integration (with cell manufacturing capability commanding premium margins), customer mix (utility vs. distributed generation), technology positioning (standard vs. high-efficiency), and operational efficiency.

Global Manufacturing Capacity: The Dominant Players

The global solar manufacturing landscape is dominated by a concentrated group of vertically integrated Chinese producers who control the vast majority of capacity across all segments of the value chain—from polysilicon refining through wafer production, cell fabrication, and module assembly. The following table presents the approximate nameplate capacities for the ten largest manufacturers globally, illustrating the extraordinary scale advantages and integration strategies that define competitive positioning in the modern solar industry.

#	Company	Modules (GW)	Cells (GW)	Wafers (GW)	Polysilicon (kt/y)	Strategic Notes
1	**JinkoSolar**	~110–130	~90–100	~0–20	—	Global leader by module shipments; extensive in-house cell capacity; wafers largely procured externally; strong international distribution
2	**LONGi Green Energy**	~80–100	~70–90	~180–220	—	World's largest wafer producer; reported 44.4 GW wafer shipments in H1 2024; vertically integrated mono-Si specialist
3	**Trina Solar**	~110–130	~90–105	~20–40	—	Top-tier module and cell capacity; moderate wafer integration; China-centric manufacturing footprint with selective overseas assembly
4	**JA Solar**	~95–115	~90–105	~80–100	—	Significant vertical integration spanning wafer-cell-module; technology focus on n-type TOPCon architectures
5	**Tongwei**	~60–85	~200–260	~0–20	~500–650	Dominant cell and polysilicon producer; rapidly expanding module assembly; central player in China capacity consolidation

Key Observations on Industry Structure

The capacity data reveals several critical structural features of the global solar manufacturing industry: (1) **Extreme geographic concentration** with Chinese companies controlling 9 of the top 10 positions; (2) **Vertical integration as competitive imperative** with leading firms controlling multiple value chain stages; (3) **Massive scale requirements** with minimum efficient scale now exceeding 20-30 GW for modules; (4) **Upstream consolidation pressure** particularly in polysilicon where overcapacity has triggered coordinated capacity reduction discussions; (5) **Technology standardization** around monocrystalline silicon and TOPCon cell architectures, reducing differentiation opportunities.

The Solar Economy in the Age of Abundance

The global solar industry has definitively entered what we characterize as the **age of abundance**—a new era in which solar electricity has transitioned from a niche, expensive, and technically challenging power source to become the **world's most affordable, scalable, and rapidly deployable form of electricity generation** across the vast majority of global markets. This transformation represents one of the most remarkable industrial and technological success stories of the 21st century, with profound implications for energy systems, economic development, climate policy, and geopolitical dynamics.

Economic Shift: From Scarcity to Surplus

Module prices have fallen an extraordinary **70% over the past decade**, from USD 0.66/W in 2016 to USD 0.20/W in 2025, making solar power universally cost-competitive and often the cheapest electricity source available in most markets with decent solar resources. However, this dramatic cost deflation has simultaneously created a severe **profit compression crisis** across the manufacturing value chain, with over 50 major firms exiting the market through bankruptcy, restructuring, or forced asset sales between 2023–2025. The industry faces a fundamental paradox: unprecedented deployment growth coexisting with unsustainable manufacturer economics.

Geographic Realignment: Asian Dominance

Solar manufacturing has undergone dramatic geographic consolidation, with production now heavily concentrated in Asia where **China commands 92% of global module capacity** and **India represents 8%** of remaining production, leaving minimal viable manufacturing in traditional Western markets. Europe and the United States are pivoting away from commodity module production toward higher-value opportunities in advanced cell technologies (HJT, tandem, perovskite), energy storage integration, power electronics, and digital grid management platforms. This geographic realignment reflects fundamental competitive realities around manufacturing scale, integrated supply chains, labor costs, and industrial policy support.

Technological Inflection: Beyond Panels

Solar's next major growth phase will be defined not by further panel cost reduction—which is approaching practical limits—but rather by integration into **hybrid systems combining PV generation with battery energy storage (BESS)**, green hydrogen production, and advanced **digital platforms leveraging artificial intelligence, blockchain verification, and digital twin modeling** for optimization of distributed energy resources, virtual power plants, and grid services. Value creation is shifting decisively from hardware manufacturing toward software, integration expertise, and energy service delivery models.

Policy Evolution: From Expansion to Circularity

Government incentive frameworks are evolving rapidly from simple capacity expansion subsidies toward more sophisticated policies emphasizing **circular economy principles, lifecycle environmental accountability, supply chain resilience, and integration with carbon trading mechanisms**. Future policy will increasingly focus on end-of-life module recycling, embodied carbon in manufacturing, domestic content and security of supply considerations, and ensuring that solar deployment contributes to broader economic development and industrial strategy objectives beyond pure gigawatt additions.

Together, these four fundamental dynamics—economic abundance with financial stress, geographic consolidation, technological evolution beyond panels, and policy sophistication—define a powerful self-reinforcing cycle that will shape the industry's trajectory over the coming decade. We are entering an era where **solar energy is plentiful, clean, and increasingly intelligent**, but where long-term value creation and financial sustainability depend far less on manufacturing cost reduction and far more on **systems integration, digital optimization, and service delivery capabilities**.

> *"The solar industry's transformation from growth-at-any-cost to sustainable-value-creation marks a fundamental maturation. Winners in the next decade will be those who recognize that abundance has changed the competitive game: success now requires excellence in integration rather than simply excellence in production."*
>
> — Firstgreen Consulting, 2025

About Firstgreen Consulting

Firstgreen Consulting Pvt. Ltd. is a leading renewable energy and sustainability advisory firm headquartered in Gurugram, India. Established in 2010, the company has emerged as a trusted partner to governments, development agencies, and private corporations in advancing clean-energy transitions across Asia, Africa, and the Pacific.

Firstgreen specializes in solar PV engineering, energy efficiency, carbon markets, and green-building certification. Its portfolio includes over 1 GW of solar PV design and project management, and numerous assignments supported by MNRE, the International Solar Alliance (ISA), the World Bank, GIZ, UNDP, and ADB. The firm's services span the entire project cycle—from feasibility assessment and regulatory frameworks to detailed design, EPC management, and sustainability reporting.

A pioneer in net-zero strategy and ESG integration, Firstgreen has delivered landmark projects such as DLF Cyber City's Net Zero Energy roadmap, HCL's Net Zero Water campus, and embassy-grade LEED and IGBC certifications. Internationally, it has contributed to solar policy development and energy-transition planning in countries including Bhutan, Mozambique, Kenya, and Nepal.

Driven by data-centric innovation, Firstgreen combines engineering analytics, digital modeling, and climate finance expertise to create scalable, bankable solutions for the renewable-energy ecosystem. Its interdisciplinary team of engineers, economists, and sustainability experts continues to lead with research, policy insight, and technical excellence—helping clients achieve measurable decarbonization outcomes.

5+

GW Advised

Renewable projects under advisory

$1B

Project Value

Total investment facilitated

100+

Clients Served

Across public and private sectors

14

Years Experience

Leading India's energy transition

Contact Information

Firstgreen Consulting Pvt Ltd; U26/6 DLF PH III Gurgaon 122002

Email: info@firstgreen.co; Phone: +91-12443523904

Website: www.firstgreen.co

Firstgreen Consulting

Energy Efficiency|Renewables|Sustainability