ZE-Gen Market Deep Dive: India

Market report, 23 August 2024

intellecap
AAVISHKAAR GROUP

Executive Summary – India

India current energy profile:

- **Growing RE market:** 17.9 GW of new RE power capacity (2024), ~80% ↑
- **Systemic power deficits with need for power back up:**
  - Power deficit of 0.5% (2022-23); 20.6 hours of electricity per day per household + regional variation
  - Diesel gensets promising solution - **reliability, energy density, and accessible after-sales service**
- **Estimated diesel genset fleet size**: 100+ GW (85% as back-up)

Key segments for alternate solutions:

- Considerations for selection: large fleet size, use gensets as primary power source, higher feasibility to switch, high co-benefits

	Type of use	Genset fleet size (# units)	Genset capacity (kVA)	Daily use (hr)	GHG emissions share (%)	Solution pathways
Infrastructure	Primary	14,000	75-375	8-12	8.1	Solar generator
Rural commercial	Quasi-primary	225,000	5-30	6-8	1.3	Solar productive-use equipment
Hospitality	Back-up	162,000	15-750	1-3	1.5	Storage, Solar + storage
Agriculture	Quasi-primary	10,000,000	<10	2-3	1.7	Solar pumps
Industrial	Back-up	192,000	15-750+	1-3	24.2	Storage, solar + storage

India has huge potential for RE solution deployment

India offers the potential to create impact at scale by replacing 94+ GW of fossil fuel generator capacity and electrifying 304 Mn people

94-110 GW
Current genset installed capacity

46 Mn Mt-CO2e
GHG emission reduction potential

17 Bn liters
Fuel savings annually

304 Mn
Fuel savings annually

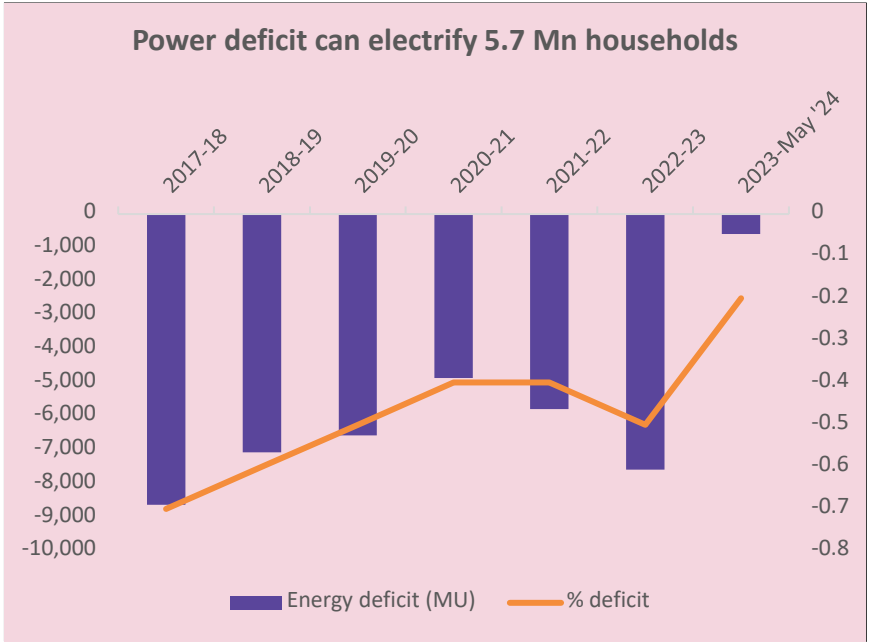
Why is India a promising market for deep-dive and further intervention?

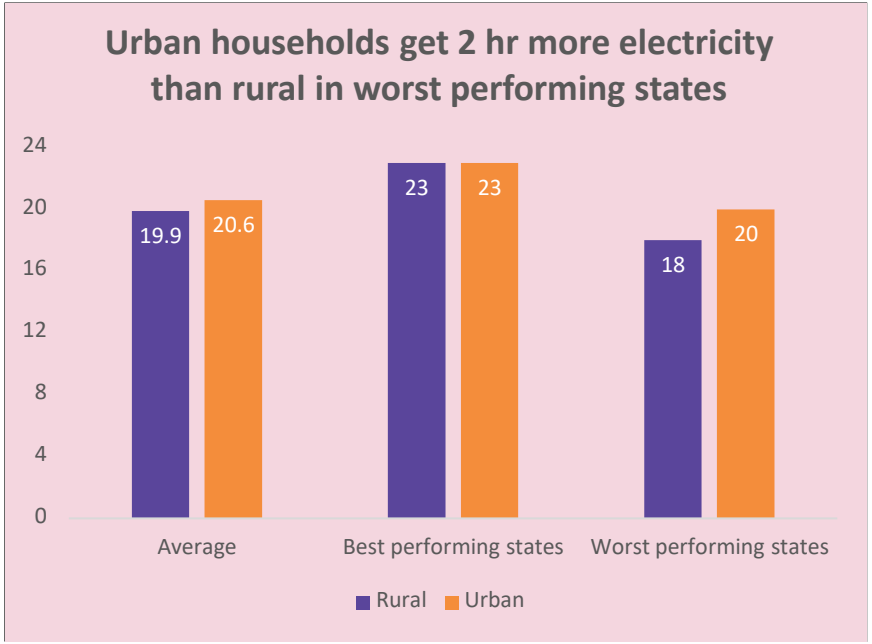
1. **High market potential:** India's energy plan for 2030, suggests installed capacities for solar (448 GW), 112 GW wind, and battery-energy storage capacity of 208 GW
2. **Broad RE acceptance across segments:** C&I segment account for 70-80% of the roof-top-solar installations, SHS (solar home systems) is mature market in the rural segment, and BESS is highly anticipated technology across segments.
3. **High diesel genset penetration:** DGs solve a market need for back-up power, however, the economic case for replacement is strong when considering LCOEs (2x RE alternative). The case will get only stronger as battery prices drop lower
4. **Robust RE supply chains:** Solar demand projected to be fully captively captured by 2030, and battery manufacturing supply chain will also increase by 8x (to 150 GWh) overcoming a key hurdle of import dependence
5. **High impact potential:** Reduce GHG emissions by **46 Mn Mt-CO2e** annually by **saving 17 Bn liters of fuel**. Despite a claimed 100% electrification, providing an alternative to DG can create a host of co-benefits by electrifying the nearly **304 Mn un-electrified**.

Although India quotes 100% electrification, the system is riddled with grid reliability issues (frequency, stability)

Fossil fuel gensets bridge the power supply gap as a reliable, source of back-up power

On an average, Indian households don't have electricity for 4 hours

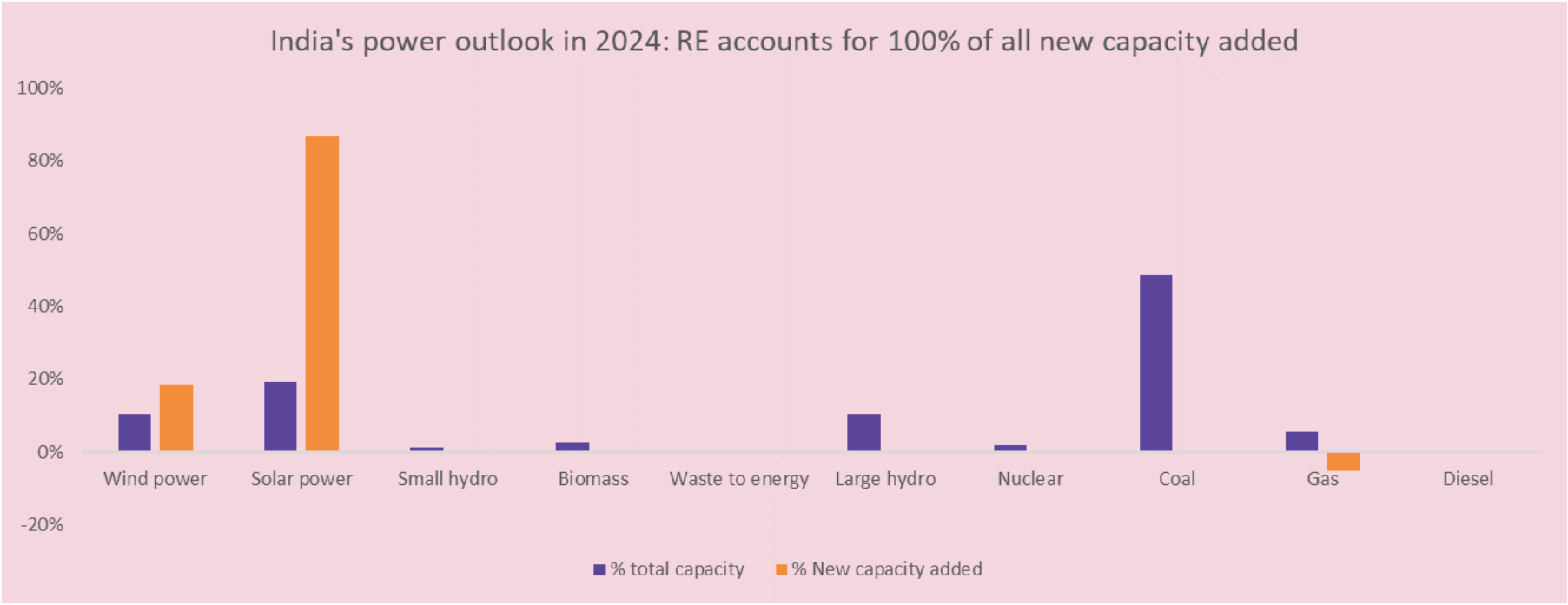




Source: Central Electricity Authority, GoI; CEEW.

Indian government has favored green energy addition over fossil fuel led energy upgradation

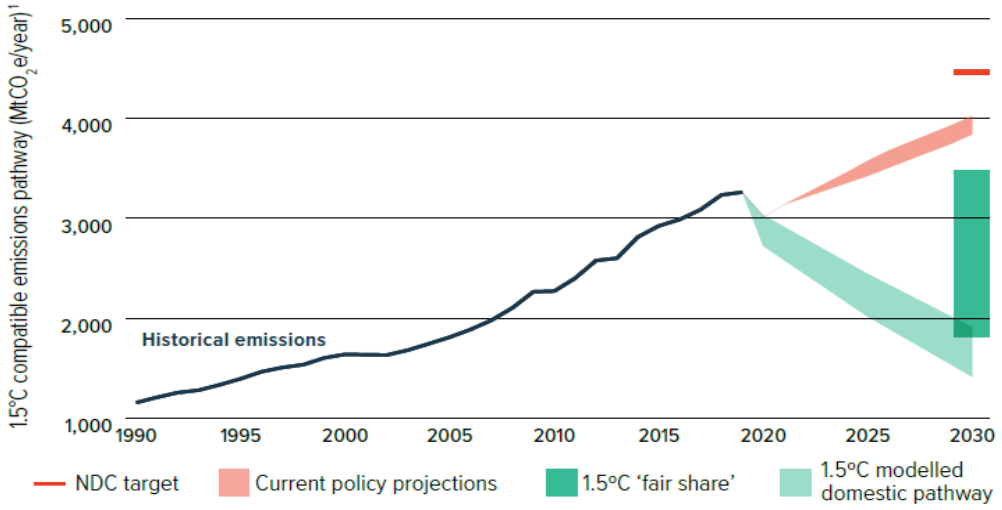
RE accounted for 100% of all new capacity added in the 2nd quarter of 2024



Source: Central Electricity Authority, GoI;

Despite the ambitious growth targets of RE, India has a long way to go to meet its 2030 NDC “1.5C fair share” target

NDC target unambitious & policies “insufficient” against fair share



2030 unconditional NDC (without climate finance aid)

1. **Emissions intensity:** 45% below 2005 levels; Emission target: 4,443 MtCO2e; Ideal target: 1,650 MtCO2e
2. **RE capacity:** 50% RE capacity

Regulatory landscape | Customer segmentation

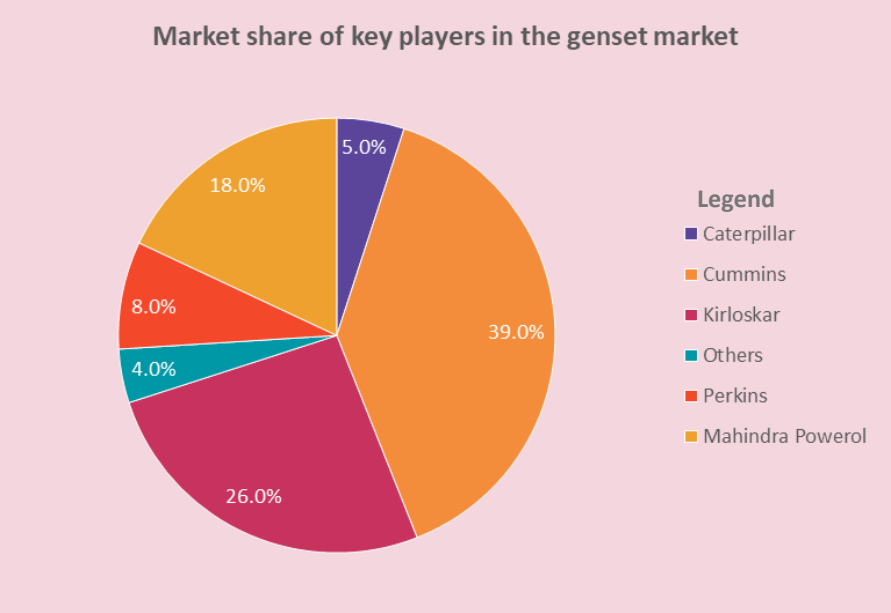
Relevance for ZE GEN

POLICY changes to watch out:

- India could soon issue a mandate for **minimum share of “non-fossil-fuel” energy for heavy industries** (mining, steel, cement, textile, chemicals, paper and pulp, and petrochemicals)
- Pilot **carbon market likely include to four heavy industries** petrochemicals, iron and steel, cement and pulp and paper

Any RE alternate solutions to the fossil fuel gensets will have to compete with the 3 largest players (who claim 80% market)

Cummins, KOEL & Mahindra account for ~80% of market share



Market seeks reliability offered by genset players

- Annual demand 140,000 gensets
- Cummins market leader (39% market share)
- Caterpillar has highest brand equity: 1st preference with critical usage
- **Genset pricing** drives market share in the low-capacity segment
- Brand perception of **reliability, performance, and after-sales network** key in medium-high-capacity segment

Indian RE alternatives should match/beat reliability in performance & after-sales of incumbent fossil fuel players

Source: Motilal Oswal

Cummins dominates due to perception of higher reliability and R&D that allows it to meet new emission standards

	Cummins	Kirloskar Oil Engines	Powerol by Mahindra
Market share	39%	26%	18%
Key segment (kVA)	75 – 375, 750+	75 – 375	15 – 75
Product modes	44	27	12
Product range (kVA)	7.5 – 3,350	3 – 1,500	5 - 625
Price comparison	62.5 kVA – USD 6,700 400 kVA – USD 46,000 750 kVA – USD 77,000	75 kVA – USD 5,900 400 kVA – USD 40,000 750 kVA – USD 81,000	75 kVA – USD 6,400 400 kVA – USD 38,000
Sales model	OEM driven, service is Cummins	OEM driven, service is KOEL	OEM/dealer driven, service is Mahindra
OEMs	3	11	13
Service network	180+	400+	270+

The Big 3's extensive sales/service network lends a perception of reliability

Source: Motilal Oswal

The annual OPEX for a fossil fuel genset overshoots the initial outlay when use exceeds 3 hr/day

Genset users spend 6x – 14x of the initial outlay as fuel costs of the lifetime of a genset

Capacity (kW)	Initial outlay (USD)	Area (sqm)	Diesel use @ 25% load (l/hr)	Run-time range (hr)	Annual OPEX range (USD)
20	5,600	0.42	2.3	200 – 1500	490 – 3,700
80	15,000	0.77	9.1	200 – 1500	1,900 – 14,600
400	53,000	12.00	33.7	200 – 1500	7,200 – 54,000

Market seeks reliability offered by fossil fuel genset players

- Estimated run-time of an average genset in India is anywhere between **200 – 1500 hr**; as per an expert there has been a steep decline **(500 hr to 100 hr)** in run-time in the past few years
- Over the life of a genset, a user can spend anywhere between **6 – 10x** of the initial outlay on just fuel costs
- Gensets have a capacity per area of **61 kW/sqm** compared to **0.14 kW/sqm** for a solar plant; space constraints are a factor in urban settings

RE alternatives have an opportunity significantly lower OPEX for genset users; the ideal target can be greenfield projects

Lessons from the incumbents: Improve reliability perception by increasing trained service men & expanding distribution networks

Cummins service network spans 200-300 providers indicating areas with higher concentration of DGs

DGs are perceived as reliable solution providers due to ease of maintenance and active network of dealers

1. **Distributor network:** DG manufacturers have on average 150 sales dealers, 300+ service providers, and 2-13 OEMs which **increases accessibility and top-of-mind awareness**

2. **Reliability:** Maintenance more accessible for DG due to **trained service men**, **expansive service network**, and **availability of parts**. Service lead times are higher for RE which contributes to perception of unreliability

3. **Lack of understanding for RE:** In the rural segment, awareness of RE products is high (95%) but understanding of benefits (10%) and awareness of financing is low (78%); which affects perceived affordability of these products

Relevance for ZE-Gen: Jakson (OEM Cummin) also deals in solar products so there is an opportunity to tap into the sales and distributor network of DG players to promote low-ticket solar products as this aligns with the vision of the C-suite executives of these firms

25%+ fossil fuel genset market in India is unregulated; regulations anyway do not target GHG emissions (only pollution focused)

What is CPCB IV+

- The Central Pollution Control Board (CPCB), July 2023 **sets emission standards for diesel generators,** mandating reduction of pollutants like NOx, SO2, PM, and CO by 90% for diesel gensets up to 800 kW
- There is an additional cost for diesel genset manufacturers to obtain **Type Approval** and annual **Conformity of Production (COP)** for their products

Impact of CPCP IV+

- Cummins and Kirloskar, announced CPCB IV+ compliant models at **30-40% price premium**
- New product essentials: Premium offsets cost of **electronic fuel systems, advanced after-treatment systems (ATS), and exhaust gas recirculation (EGR) systems** in new models
- **Retrofit Emission Control Devices (RECDs)** advanced technologies installed on existing DG to reduce harmful emissions gaining market acceptance

Policy gaps

- **1/4th of fleet unregulated:** No regulations for gensets sold in the unorganized market
- **No mention of replacement:** No focus on replacing fossil fuel gensets with clean alternatives
- **Limited scope:** Scope limited to approval of new gensets; little focus on their increasing the efficiency or phasing out older gensets
- **Poor implementation:** CPCB IV+ is not stringently implemented

ZE Gen Relevance

- **There is no fossil fuel policy incentive** to reduce/replace fossil fuel genset usage
- **Enablers:** RE solutions uptake relies on either the operational difficulty of diesel genset usage or price parity with diesel
- **Barriers:** Poor implementation & awareness among users renders the policy toothless

Source: Sudhir Power. Bangalore Mirror. Intellecap expert interview.

Upcoming storage policies are promising for providing incentives to transition away from fossil fuel gensets

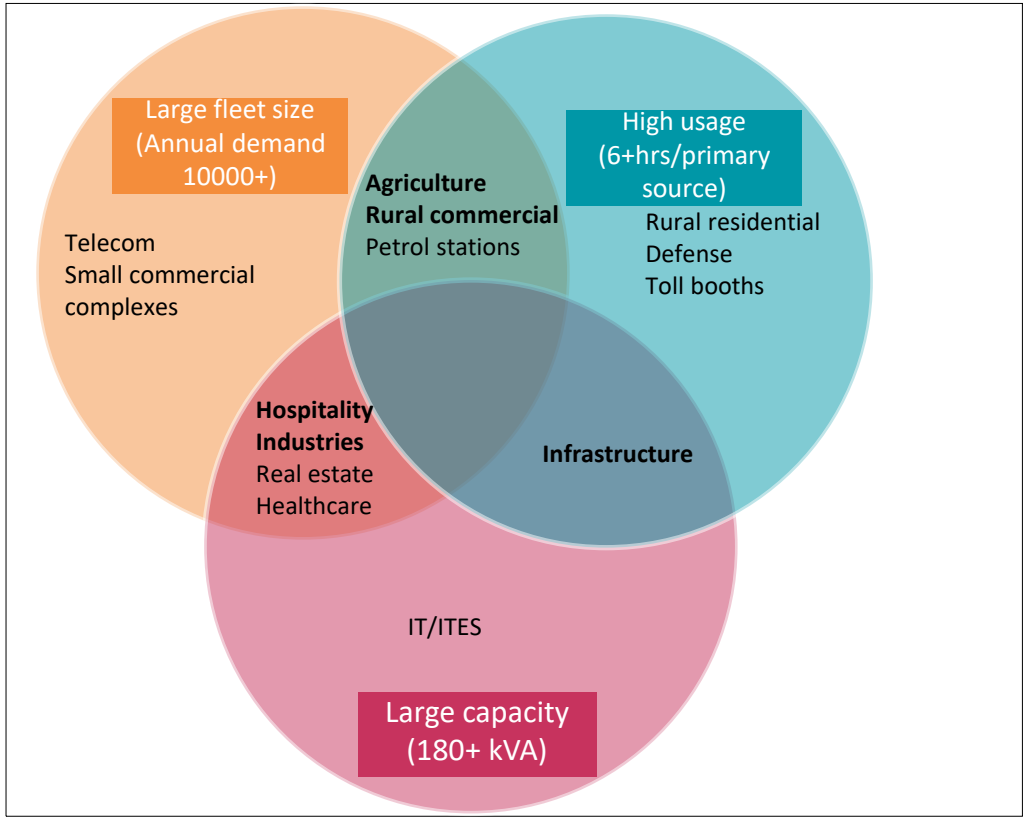
	Net-metering	PM-KUSUM	Viability Gap Fund for BESS
Details	• Allowable range of installation (1 kW – 1 MW) varies by state with Maharashtra having the highest at (1 kW – 5MW)	• Support RE power plants in rural areas by farmers/FPOs/cooperatives • Install 1.8 Mn solar pumps (<7.5 HP) • Solarize 1 Mn grid connected pumps	• Cover the capital costs of BESS installations up to 40% • Initial outlay of USD 1.1 Bn including budgetary support of USD 450 Mn
Segments	On-grid C&I (chiefly) and other on-grid consumers	Rural communities, farmers	DISCOMs, ecosystem strengthening measure
Relevance	• Offsets 40-50% of grid consumption charges • Reduces the battery size needed	• Incentivizes DISCOMs to purchase solar power from farmers • Reduces farmer's installation cost of pumps to 20-40%	• Aims to install 4000 MWh/year of BESS capacity by 2030 • Reduce LCOS of BESS to INR 5.5-6.0 per kWh

Upcoming storage policies are promising for providing incentives to transition away from fossil fuel gensets

	Grid-connected Solar Rooftop Programme	Renewable Energy Certificate (REC) mechanism	National Framework For Promoting Energy Storage Systems
Details	• Target is to achieve 40 GW of RTS • Covers 12-15% CAPEX for 10 kW RTS system • Offers CAPEX assistance for large residential installations	• Renewable Energy Certificate (REC) mechanism is a market-based instrument to facilitate compliance of renewable purchase obligations (RPO)	• Planned framework to promote ESS with financial incentives and mandating replacement of DG with ESS options • Incentives could include carbon credits and tax breaks
Segments	Residential users, DISCOMs	C&I on-grid users	ESS users specifically C&I and construction
Relevance	• Policy support and incentives for installation of residential RTS for urban and rural users	• Users that install captive generation plants can exchange RECs for to other entities that have RPOs	• Implementation of this framework would be one of the first mandates of replacing DG with alternatives in India

Which segments should be targeted?

Ideal segment has large fleet size, high usage, and large capacity



Segmenting the genset market

High usage – Gensets are **prime source of power; off-grid users**
Segments – Agriculture, rural commercial, construction

Large capacity – Segments with high reduction **GHG emission reduction** potential and **higher WTP**
Segments – Hospitality, construction, industries

Large fleet size – Segments with **high market potential**
Segments: Agriculture, rural commercial, industrial, hospitality

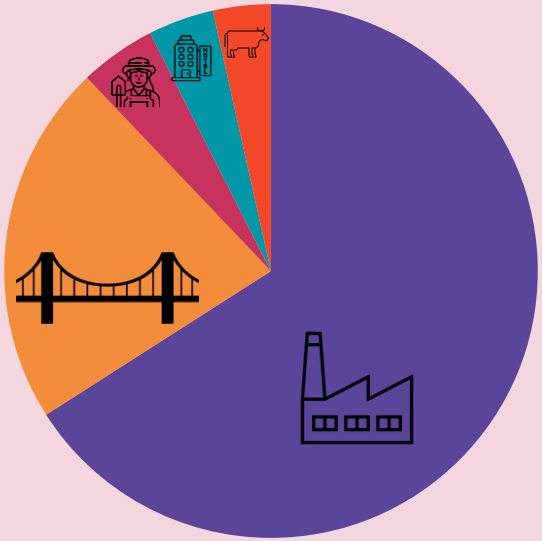
We de-prioritized some segments given tech immaturity, relatively lower impact potential, and high switching costs

	Defense	Petrol pumps	Real estate	Healthcare
Power needs	Off-grid Portable source Critical power	On-grid/Off-grid Portable source	On-grid (primarily)	On-grid (primarily) Critical power use
Reason for de-prioritizing	**Criticality:** Unlikely to switch given critical nature of use; would need a mature replacement technology to **avoid risks of failure**	**Impact potential:** Although replacing DGs with solar power is a strong demonstrable business case, the impact potential is lower **(20 kWh power consumption per station)** and **no co-benefits**	**Impact potential:** While the number and capacity of installed gensets in real estate segment is high, the **impact potential is low** given **fewer power cuts in urban** settings and **few co-benefits**	**Criticality:** Large, urban hospitals are unlikely to switch given **critical nature of use-case** **Feasibility:** Rural hospitals have large impact potential, but **timely debt re-payments** are unlikely

Target market

The 5 prioritised segments have high GHG emission reduction potential & co-benefits

Target segments: 37% of all GHG emissions



Fund nascent (segment: construction, hospitality, industry) and mature technologies (Segment: agriculture & rural commercial)

Industry: Foot-in-the-door

Why target? C&I sector has highest emissions; market ready for BESS uptake with demonstrated viability

Construction: High capacity, mobile RE

Why target? High-capacity, mobile RE solutions have wide use-cases

Solar pumps: High impact & feasible segment

Why target? High impact potential impacting 94 Mn households; feasible due to policy support

Hospitality: Highly feasible due to ESG goals

Why target? Hospitality sector has likeliness to adopt due to ESG goals

Rural commercial: High co-benefits

Why target? Demonstrated use-case with high livelihood creation potential

Target market

Infrastructure: Opportunity to replace 14,000 primary–use gensets by investing in a technology with multiple off-grid use-cases

What do they use DG for

- Lighting systems
- Field office gadgets & appliances
- Portable electric tools
- Batching plants

How do they use gensets

Type of power	Primary source
Location	Remote/off-grid
Capacity	75 – 375 kVA
Business model	Rental & CAPEX
Estimated fleet size	14,000
Average runtime	8 hours/day
CO2 emissions	469 kgCO2e/day
NOx emissions	6.15 kg/day
SO2 emissions	0.18 kg/day

Infrastructure

Solution pathway

- **Solar generator:** Modular solar solution with panels, battery pack, and sundry packed in a container
- **Cost:** USD 83,000 for a 90 kW container

Power needs

- Primary power source
- Portable solution
- Continuous source of power

Impact of switching

- **GHG reduction potential:** 1.64 Mn Mt CO2e
- **Fuel saved:** 615 Mn liters/yr
- **Fuel cost savings:** USD 660 Mn/yr
- **Gensets displaced:** 14,000

Reasons for switching

Cost savings – RE LCOE USD/kWh 0.24 (vs fossil fuel genset USD 0.44), 0.55x lower

Hospitality: Opportunity to replace 162,000 high-capacity fossil fuel gensets with storage solutions

What do they use DG for

- Lighting systems
- HVAC system
- Appliances

How do they use gensets

Type of power	Back-up source
Location	On-grid
Capacity	15 – 750 kVA
Business model	CAPEX
Estimated fleet size	162,000
Average runtime	3.6 hours/day
CO2 emissions	130 kgCO2e/day
NOx emissions	1.89 kg/day
SO2 emissions	0.05 kg/day

Solution pathway

- **Storage:** Li-powered battery solution deployed. Hybrid solutions are viable in areas with worse electricity supply
- **Cost:** USD 90,000 for 225 kW BESS (2 hr backup)

Power needs

- Back-up power source
- Continuous source of power

Impact of switching

- **GHG reduction potential:** 5.5 Mn Mt CO2e
- **Fuel saved:** 2.1 Bn liters
- **Fuel cost savings:** USD 2.2 Bn
- **Gensets displaced:** 162,000

Reasons for switching

- **Cost savings –** LCOS USD 0.40 (vs fossil fuel genset USD 0.50)
- **Non-economic reasons:** Company level net zero targets like ITC hotels and Chalet Hotels

Rural commercial: Opportunity to replace and serve unmet needs by installing 225,000 milk chillers

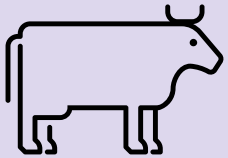
What do they use DG for

- Lighting systems
- Productive-use equipment – cold storage, refrigerators

How do they use gensets

Type of power	Quasi-prime
Location	On-grid/off-grid
Capacity	<30 kVA
Business model	CAPEX
Estimated fleet size	NA
Average runtime	6 hours/day
CO2 emissions	36 kgCO2e/day
NOx emissions	1.4 kg/day
SO2 emissions	0.03 kg/day

Rural commercial



Solution pathway

- **Solar-powered milk chiller:** 5 kWp solar-powered milk chiller with 1 day battery back-up
- **Cost:** USD 5,000 – 7,000 for panels, chiller, and battery pack

Power needs

- Affordable power

Impact of switching

- **GHG reduction potential:** 2.47 Mn Mt CO2e
- **Fuel saved:** 0.9 Bn liters
- **Co-benefits:** Secure livelihood of 80 Mn including 24 Mn women

Reasons for switching

Reliability: The RE solution provides reliable power which is crucial for operations

Cost savings: RE solution has a 6-10x lower OPEX

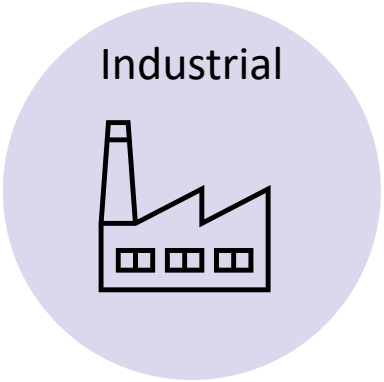
Industrial: Opportunity to replace 192,000 fossil fuel gensets in the most GHG emitting sector

What do they use DG for

Industrial machinery
Lighting systems
HVAC units
Office gadgets and appliances

How do they use gensets

Type of power	Back-up
Location	On-grid
Capacity	15-750+ kVA
Business model	CAPEX
Estimated fleet size	192,000
Average runtime	3 hours/day
CO2 emissions	130 kgCO2e/day
NOx emissions	1.97 kg/day
SO2 emissions	0.06 kg/day



Solution pathway

- **Solar and storage:** 250 kWp solar PV installation with 2 hours battery back-up
- **Cost:** USD 220,000 for 250 kW installation

Power needs

- Back-up power
- Reliable power
- Heavy capacity

Impact of switching

- **GHG reduction potential:** 4.9 Mn Mt CO2e
- **Fuel saved:** 1.8 Bn liters
- **Fuel cost savings:** USD 1.95 Bn
- **Gensets displaced:** 192,000

Reasons for switching

- **Non-economic reason:** Industries with emissions targets or supply chain greening mandates
- **Cost savings:** RE solution has a 1.22x lower LCOE

Opportunity to replace 10,000,000 diesel pumps while serving unmet needs of farmers for whom fossil fuels are expensive and inconvenient

What do they use DG for

- Irrigation use
- Water pumps

How do they use gensets

Type of power	Primary
Location	Off-grid/on-grid
Capacity	<30 kVA
Business model	PAYG
Estimated fleet size	10,000,000
Average runtime	3 hours/day
CO2 emissions	5.3 kgCO2e/day
NOx emissions	0.05 kg/day
SO2 emissions	0.001 kg/day

Solar-pumps

Solution pathway

- **Solar-powered pump:** 0.8 - 5.5kWp solar-powered pump
- **Cost:** USD 1,100 for the pump (20-40% cost borne by farmer)

Power needs

- Mobile power
- Flexible power
- Seasonal

Impact of switching

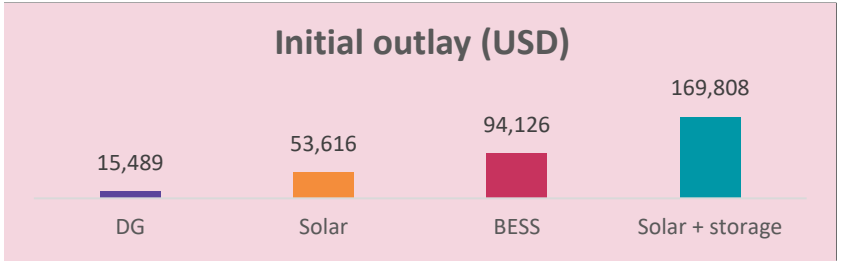
- **GHG reduction potential:** 4 Mn Mt CO2e
- **Fuel saved:** 1.5 Bn liters
- **Gensets displaced:** 10,000,000

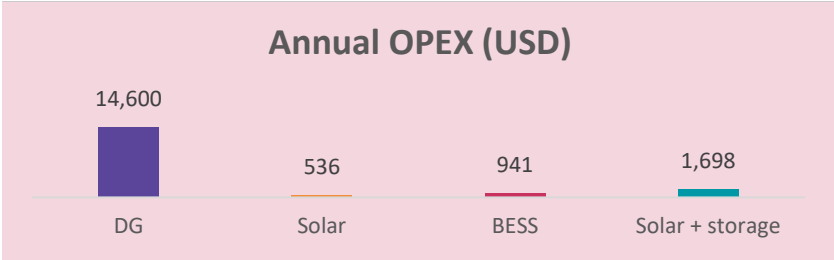
Reasons for switching

- **Reliability:** The RE solution provides reliable power during crucial agricultural season
- **Subsidized purchase:** Although solution cost 2x more out pocket, operational costs are 0

Target market

DG are 10x less expensive than RE alternatives – new players need to create a business case around this major fact (among others)





	DG	Solar	BESS	Solar + storage
LCOE ($/kWh)	0.59 – 0.69	0.06 – 0.07	0.42 – 0.46	0.24 – 0.29
Payback period (yrs)	2.1 – 2.5	3 – 6	5 – 6	4 – 5

- **High outlay:** RE initial outlay 7-10x higher than diesel yet; LCOE of RE is 2-10x lower than DG sets
- **Target business models:**
  - **Large industries:** CAPEX model preferred
  - **Small industries:** OPEX model preferred; avoid CAPEX
  - **Rural segment:** PAYG effective model
- **The direct subsidy structure is not enough:** End-consumers get a subsidy of **USD 930** which is negligible for higher capacity applications
- **Space requirement: 1000 sq ft. area** for panels **36x higher** (vs. 28.4 sq ft.) than genset

Source: Expert interview. CSE India. Auroville Consulting.

What does it take to conquer C&I segment - educate on the long-term gains (awareness campaigns) and financing schemes

Facilitative Factors

- **Conglomerates can influence SME players in the value chain to adopt RE solutions:** ~20% of RE adopters are mandated by business partners to switch
- **While big players want CAPEX support, small players need working capital support:** CAPEX for corporates, OPEX for SMEs to ease reliability worries
- **Large scale value demonstration needed:** RE + storage promising tech for remote commercial users (10%), however, need proof of concept, system maintenance, and equipment warranties. BESS is promising as it offers a pathway to energy independence
- **Social proof is the biggest motivator:** 35% of adopters switch to RE after seeing peer's switch. SMEs rely on personal networks/word-of-mouth to make switch

Barriers

- **Subsidy delays and lack of supportive policies hinder adoption :** Delayed approvals and subsidy payments (28% for SMEs) slowdown adoption and benefit realization. Lack of policies on BESS specifically on buyback and recycling make adoption challenging.
- **Space availability and panel quality is a major issue for consumers:** Space constraints and solar panel degradation major issue for adoption
- **Externalities like aesthetics also affect adoption:** Perceived poor aesthetics of solar (more relevant for hospitality)
- **Funding enterprises to provide deploy OPEX RE models:** 27-35% of non-adopters concerned about high initial capital costs
- **Drastic improvement in distribution reach needed:** 50% of C&I consumers were not approached by developers for utilizing solar
- **Targeted awareness campaigns to add nuance of OPEX savings to counter high capex costs:** 60% of C&I consumers are unaware or need information surrounding RE projects such as costs, benefits, payback period, adoption models

Relevance for ZE Gen

Gaps to overcome:

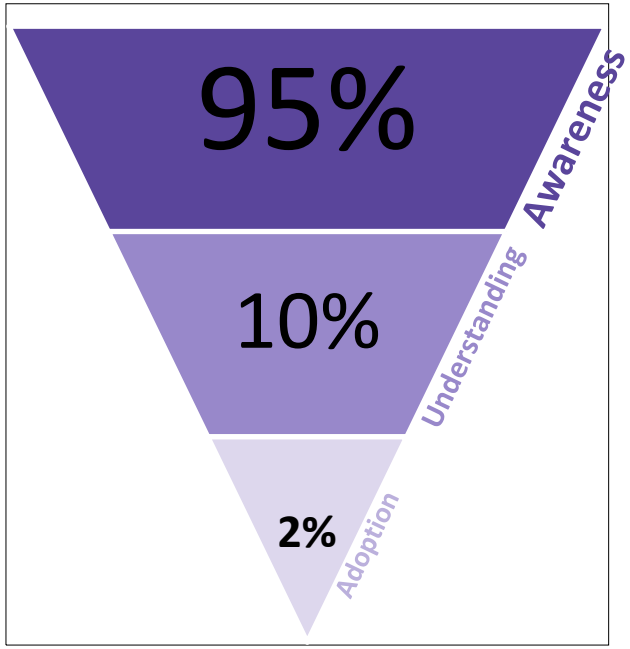
- Awareness gaps on the economic benefits of RE solutions
- Proof-of-concept for BESS to showcase potential
- Improved distribution network of RE service providers to overcome awareness and reliability gap

Opportunities:

- **SME-focused financing:** Potential uptake for financing models like invoice-based financing to increase adoption of RE
- **Awareness creation:** Working with nodal agencies and private organizations to accelerate RE awareness
- **Capacity building for regulators to better formulate storage policies:** Improving the policy framework for BESS/storage solutions by training regulators
- **Prioritize BESS/ESS enterprises to increase uptake:** Strengthening the BESS ecosystem in India by funding RE solution providers to increase adoption, publicize proof-of-concept, and ultimately lower costs

Rural segment (agriculture & rural commercial) has incomplete understanding of RE – Aware of products but not how to access or deploy

Poor product understanding and high upfront costs lead to low adoption



Mechanisms that create awareness are not delivering the full picture

High awareness generated through:
- Local agricultural institutions
- Newspapers
- Word-of-mouth

Benefits not clearly communicated:
- High upfront cost negates perception of benefits
- Adopters do not utilize pumps fully to realize benefits

High cost & unavailability of financing:
- No WTP above status quo
- 78% surveyed unaware of financing options
- 30% surveyed want more benefits

Relevance for ZE Gen

Target the segment with unmet needs: Ideal target are marginal farmers (~80% of all farmers) for maximum impact

Aggregate demand and get community buy-in: Demo & awareness building using (FPO/farm cooperatives) to increase adoption rate

Explore innovative models: Financing schemes like PAYG or joint-ownership models key to reach marginal farmers (e.g. Claro Energy)

Access to financing, availability of servicemen, and stakeholder engagement are consistent issues from solar case studies in India

Mini-grids

Performance

- **Wide acceptance:** Mini-grids have seen gradual growth, with over 14,000 deployed
- **PPP is the relevant model:** 80% of Indian mini-grids are govt. financed and owned

Challenges

- **Policy differences across states makes deployment challenging**
- **Rural-focus makes financing challenging:** High initial CAPEX and revenue uncertainty
- **Performance of the system dips over time:** In remote areas, technical challenges, such as maintenance and grid reliability

Lessons learned

- **Community Engagement:** Involving local community in planning and operation enhances the sustainability & acceptability
- **Innovative Financing:** Innovative financing like concessional debt with risk-mitigating instruments like minimum feed-in-tariffs

Solar-home systems

Performance

- **Mature market:** SHS peaked, driven by government programs like Saubhagya
- **High-consumer acceptance:** Affordable solution to alternatives like kerosene

Challenges

- **Affordability:** Affordability concern with low prevalence of PAYG models
- **Quality and After-Sales Service:** Glut of low-quality products and lack of service reduces consumer confidence

Lessons learned

- **Quality assurance:** Establishing quality standards and certifications key to driving adoption

C&I solar installations

Performance

- **High adoptions:** ~80% of rooftop solar deployed by C&I consumers; 15% through OPEX model
- **Fixed prices:** C&I customers attracted by lower and fixed tariffs

Challenges

- **Regulatory Hurdles:** Complex regulatory processes, such as approval for net metering are barriers
- **Financing:** Comparatively better access to finance, long-term financing is difficult for smaller players

Lessons learned

- **Energy storage is anticipated:** Demand rising to account for space constraints and supply stability
- **Innovative financing:** Solar-asset backed financing could accelerate adoption
- **Supportive state policies key:** Given the scale of investment, adoption driven by supportive policies that impact solution provider and user

The current RE ecosystem

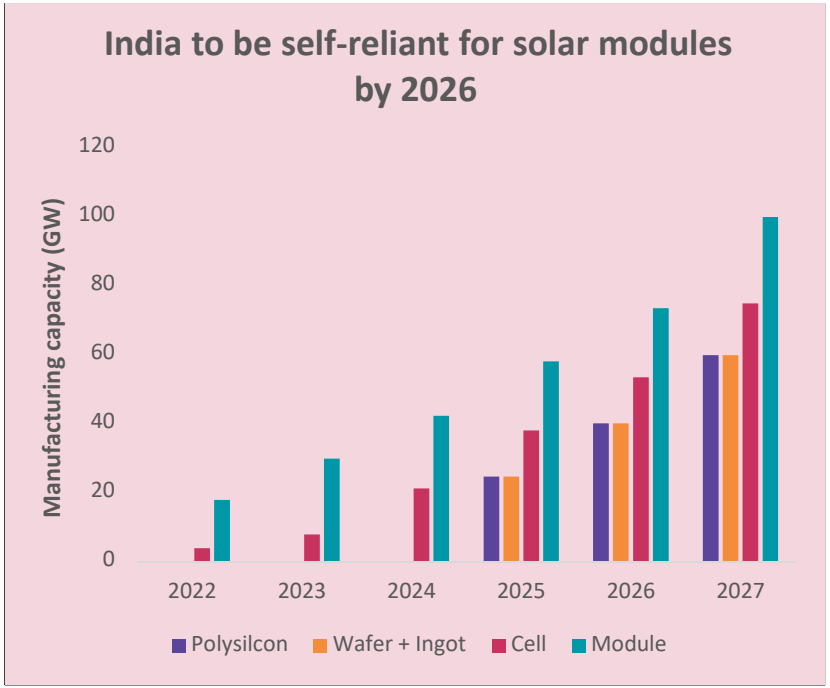
Solar panels & battery account for 75% costs of alternative solution; supply chain is import dependent and accessibility is challenge

	Solar panel	Solar inverter	Battery (1 hr back-up)	Cables and junction boxes	Earthing & accessories
% initial outlay	47%	10%	28%	5%	10%
Import dependence	Medium	Nil	High	Nil	Nil
Accessibility challenges	Significant in rural and remote areas	Significant in rural and remote areas	Significant in rural and remote areas	Not a significant challenge	Not a significant challenge

Solar panel and battery supply chains are major bottlenecks due to **inadequate existing domestic supply chains** and have **low accessibility in remote areas**. While supply chains evolve, ideal geographical targets are **locations within 100 km of an urban centers**

Economic case for solar will become stronger as solar LCOE likely reduce 20% by 2030 driven by manufacturing capacity

Fully-integrated solar manufacturing by 2025



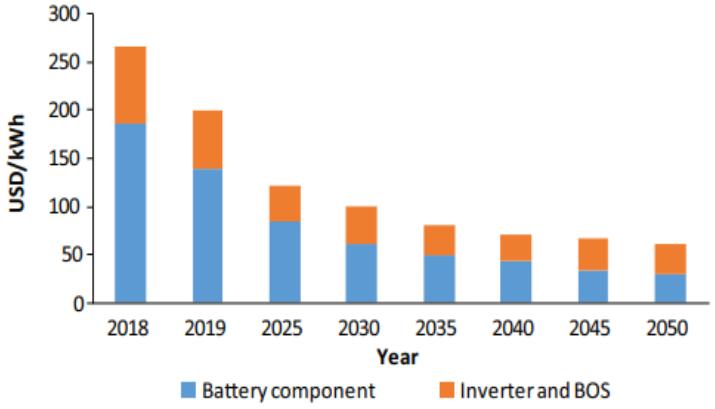
Source: IEA. IEEFA.

Solar PV module cost to trend lower

- **Self-reliance:** India to be self-reliant for solar modules by 2026
- **Price-competition:** Unlikely to be price-competitive due to reliance on import upstream raw materials and Chinese imports
- **Production-linked incentives:** USD 2 Bn outlay to incentivize solar PV production with price benefits flowing to end-consumer
- **Lowering taxes on imports:** Lowering GST (40% to 20%) on solar modules to drive prices lower

Battery supply chains are projected to grow 8x which will make BESS systems much more accessible

Li-ion battery prices are expected to drop by 30-40% by 2030



Source: CEEW. JMK Research.

India's battery manufacturing capacity will increase by 8x, raw material procurement will persist as an issue

- **Manufacturing capacity:** Current production capacity of Li-ion batteries is **18 GWh** with the projected capacity in **2030 to be 145-180 GWh**
- **Import dependence:** Bottlenecks will remain import of key raw materials (**77% of all costs**)
- **Falling costs:** Battery costs are projected to fall by 30-40% by 2030, making BESS much more accessible and affordable as an alternative to DGs
- **Challenges:** Lack of recycling framework and shortage of trained servicemen

Distribution strategies

Key BESS technology players in India; technology is gaining more traction and will become much accessible as new manufacturing plants come online

AmpereHour Energy

- Founded in 2017, AmpereHour Energy is renewable energy provider in the renewable + storage space
- Getting more recently inquiries from C&I customers for greenfield BESS projects
- Key clients: Sula Vineyards (220 kWh), Coca-Cola

Log9 Materials

- Bangalore-based nanotechnology firm that is building storage solutions for EPC projects and large C&I uses
- ZappUp micro is a key product that solves for residential and C&I storage solutions

Good Enough Energy

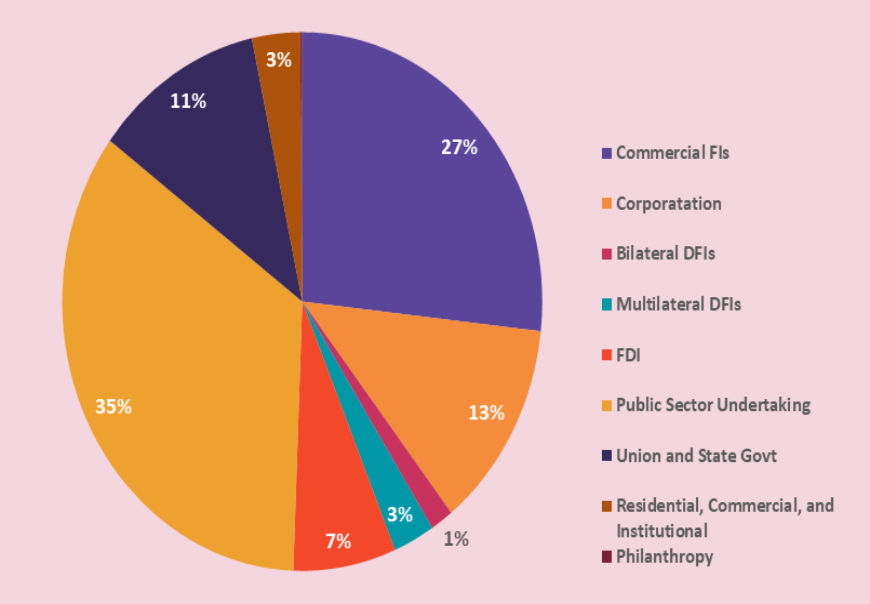
- Noida-based energy storage provider working on battery storage and UPS solutions
- Setting up a 20 GWh storage equipment factory in Jammu & Kashmir that will come online by 2026; factory will develop LFP based solutions

Reliance Industries

- Setting up a battery giga factory by 2026 for manufacturing battery chemicals, cells and packs, as well as containerized energy storage solutions and a battery recycling facility.
- Aim to produce Lithium Iron Phosphate (LFP) based solutions

Targeting energy storage solution providers with debt capital will accelerate the transition from fossil fuel generators

Domestic sector players account for 82% of clean energy finance



Solar received the majority of clean energy finance

- Between 2019-21, **INR 1,290 Bn (USD 15.5 Bn)** was deployed as green energy finance
- Solar sector received about a **1/3rd of funds** with energy storage receiving **<3% of funds**
- Debt is the preferred instrument making up 56% of all flows
- **Green bonds:** Chiefly used by larger corporates (Adani/ReNew) to refinance projects. Issuances worth USD 21 Bn till 2023 (3.8% of domestic bonds market)
- **Carbon credits:** Avoidance offsets can be used to finance RE projects but due to complexity of the market ideal tool for larger end-users and developers

ZE Gen relevance: Given the current funding flows**, grant-based funding** for energy storage enterprises is a crucial gap to fill; relatively low-risk given policy landscape and supply chains will likely mature in the coming 5 years.

Key players that are providing debt-based clean energy finance in India

DFIs

AIIB, KFW, ADB, THE WORLD BANK, DFC

Government banks

Bank of India, SBI, Bank of Maharashtra, Union Bank of India, Indian Overseas Bank, pnb, sidbi

Private banks

AXIS BANK, HDFC BANK, ICICI Bank, IndusInd Bank, kotak Kotak Mahindra Bank, YES BANK

International banks

BARCLAYS, BNP PARIBAS, DBS, MUFG, standard chartered, SMBC

NBFCs

IIFCL, IREDA, L&T Financial Services, PFC, TATA CAPITAL Cleantech Finance, NABARD, cKers finance, AEREM Aapka Solar Saathi, Ashv Aavishkaar Group, efl ...by your side, clime finance

Key financing programs in the clean energy sector in India and the relevance for ZE Gen (1/2)

	sidbi	SBI	THE WORLD BANK
Instrument	Term loan	Term loan	Concessional credit
End segment	• Construction • Rural commercial • Hospitality • Industrial	• Construction • Rural commercial • Hospitality • Industrial	• Construction • Rural commercial • Hospitality • Industrial
Details	**SIDBI MSME loans for Solar PV Projects** • Loan: <USD 6 Mn • Project size: 25 kW-10 MW • Tenor: < 10 yrs • Up to 100% financing • Rate: 8%-10%	**SBI Surya Shakti** • CIBIL/credit score > 649 • Minimum DSCR: 1.2 • Loan: <USD 480 K • Project size: <1MW • Tenor: <10 yrs • Collateral: Not required • Rate: ~10-11%	**World Bank-SBI Credit Line** • Outlay: USD 648 Mn • Avg. Loan: USD 820 K • DSCR: >= 1.20x • Repayment period: < 15 yrs • Rate: 8%-8.5% • OPEX loan accounts were (27%) of all loan accounts but were 77% of the total amount disperse
ZE Gen Relevance	**Loan tenor:** Loan tenors that match the lifecycle of a RE project 20-25 years are more viable for SME C&I segment	**Interest rate & credit score:** Although the loan is intended for MSMEs, the credit requirements can exclude MSMEs from participating	**OPEX funding:** Funding smaller ticket OPEX loans for smaller developers is critical for increasing uptake

Key financing programs in the clean energy sector in India and the relevance for ZE Gen (2/2)

Instrument	Term loan	Philanthropy	End-to-end solution: Financing, EPC, and maintenance
End segment	• Rural agriculture	• Rural commercial	• Rural commercial • Hospitality • Industrial
Details	**Financing Solar Energy Based Pumpsets** • Land eligibility: Min 10 acres (large-scale farmer) • Collateral: Hypothecation of pump & third-party guarantee/mortgage land • Tenor: 5-7 yrs • Up to 75% financing • Rate: ~11.5-12.5%	**Solarize Dairy Cold Chain Initiative** • Target: Install 1000 kW of solar milk chillers (200 – 300 units) • Estimated philanthropic funding: USD 860 K – 1.4 Mn • Execution partners: Dairy cooperatives and solar-based milk chiller enterprises	• Avg loan: USD 90 K • Collateral: No collateral • Down payment: 0-25% • Rate: 12% • Tenor: 2-5 years
ZE Gen Relevance	**High impact potential:** The land requirement excludes marginal and small farmers (70-80%) that are underserved.	**Grant-based funding:** Providing grant-based funding to solar milk-chiller enterprises can create an impact solar-milk chain	**Funding opportunity:** Fund similar end-to-end solution providers with concessional finance to lower borrowing costs

Rural agriculture and rural commercial segment would benefit PAYG business models to bridge the financing gap

Segment	Financing challenges	Creditworthiness	Existing financing mechanisms	Potential financing mechanisms
Rural	**High cost of capital:** Limited collateral and variability income leads to high rates	**Risky:** Income seasonality, lack of credit history	• Microfinance-driven loans (18 – 25% p.a.) • Philanthropy (grants and CSR initiatives)	• **IAAS:** Irrigation-as-a-service model that use IoT • **Concessional finance:** At concessional rates (<10-14%) to promote adoption • **Financing SHGs/FPOs:** Servicing a group of individuals who then extend loans
Rural commercial	**High cost of capital:** Limited collateral and variability income leads to high rates	**Risky:** Lack of credit history, unsuitable for current credit assessment mechanisms	• Microfinance-driven loans (18 – 25% p.a.) • Philanthropy (grants and CSR initiatives) (e.g WWF solar milk-chiller programme)	• **PAYG:** Pay-per-use community model (e.g. Ecozen) where users can pay for a certain amount of space • **Concessional finance:** At concessional rates (<10-14%) to promote adoption • **Financing Milk Cooperatives:** Milk cooperatives have a greater capacity to service debt

SMEs (hospitality, construction, and industrial) require concessional finance to promote RE adoption

Segment	Financing challenges	Creditworthiness	Existing financing mechanisms	Potential financing mechanisms
SME (Hospitality, construction, and industrial)	• **Access to capital:** 40% of SMEs lack access to capital to install RE solutions • **High cost of capital: L**ack of collateral, and short payment periods	**Mixed but perceived as risky:** Considered high-risk clients because current credit assessment methods are inadequate for accurately determining their creditworthiness	• **Commercial loans** at market rates (10-12%) • **Concessional finance** from credit facilities like WB-SBI (8 – 8.5%)	• **Innovative financing:** Invoice-based financing with 20-30% downpayment • **Lower collateral requirements:** Collateral-free loans or loans that consider the RE asset as collateral (e.g. Orb Energy) • **Blended finance:** Concessional finance instruments at interest rates <9%.
Large C&I (Hospitality and industrial)	**No significant challenges:** Sunk cost associated with high-capacity DG sets is a challenge; can afford to pay for funded-CAPEX projects	**Low-risk:** Considered lower-risk due to detailed financial records, operational record, and stronger balance sheets	• **Self-financed** • **Commercial loans at market rates**; better terms due to banking relationships • **Green bonds:** Accessible to the larger firms (e.g ReNew)	• **Longer tenure loans:** Longer-term loans that match the maturity of RE projects • **Accelerated depreciation:** 100% accelerated depreciation rates (vs. 40% current) for RE projects

We looked at possible solution providers of technologies of interest to ZE Gen and their uptake in our target segments (1/3)

Construction, industrial, hospitality	Solar-powered batteries	WAAREE One with the Sun; EXIDE INDUSTRIES LIMITED; OKAYA NEVER STOP INDIA; RELICELL Reliable Energy Storage; AMARA RAJA Gotta be a better way; HBL HBL Power Systems Limited.; Eastman ENERGY. UNLIMITED.; V-GUARD Bring home a better tomorrow; LOOM SOLAR; LIMRA BATTERIES; AMARON LASTS LONG, REALLY LONG.; SERVOTEC smart power solutions; MICROTEK TECHNOLOGY WE LIVE; TATA TATA POWER; vikramsolar CREATING CLIMATE FOR CHANGE; Livguard energy unlimited; PILOT INDUSTRIES LIMITED
Construction, industrial, agriculture	Solar generator	KNV SOLAR; IYSERT >>Delivers Future Energy; FCHOICE The Bright Way; Ramasis Energy Expertise Worldwide; Raema SOLAR; SYNERGY WAVE SYSTEM; GLOBE POWER ENGINEERING; agniSOLAR SUN FOR EVERYONE
No direct use cases	Air battery	IOP IOC PHINERGY; LOGO PIONEERING RESPONSIBLE ENERGY

We looked at possible solution providers of technologies of interest to Ze Gen and their applicability to our segments (2/3)

Rural commercial, agriculture, hospitality	Solar mini-grid	CEL, Hamara Grid, Minda, vikramsolar, EMMVEE, SELCO Foundation, Azure Power, GTPL Lucent Solar
Rural commercial, agriculture	Community microgrid	TATA Power, Schneider Electric, GE, ABB, Gram Oorja, Nergy solar
Hospitality, industrial, construction	ESS	Newen, TATA Power, Luminous, Powergrid, Exide Industries Limited, Amara Raja, aes, Toshiba, Rays Power Infra, Good Enough, Urja Solutions, Statcon Energiaa, Fluence, Delta

We looked at possible solution providers of technologies of interest to Ze Gen and their applicability to our segments (3/3)

Industrial, hospitality, construction	Hybrid wind and solar
Primarily for EVs	Battery Swap Station
Industrial	Green hydrogen

Solar Energy Corporation of India Limited (A Government of India Enterprise)
HERO FUTURE ENERGIES planet positive power
Great Place To Work. Certified
TATA TATA POWER
ReNew
adani | Renewables
VENA ENERGY
greenko
SUZLON
BatteryPool
esmito
CHARGEUP
RACE energy
VOLT UP SMART SWAPPING
SUN MOBILITY
BatterySmart
gogoro
LITHION
Reliance
GAIL (India) Limited
LARSEN & TOUBRO
Bharat Petroleum energising lives
JSW Energy
IndianOil
NTPC
adani | Renewables

The way forward

Our timeline of ZE Gen recommendations

Regional prioritization
Target locations within **100 km radius of Tier 1/2** cities, to leverage the better access to parts and servicemen that these cities have

Funding recommendation
Fund industrial-targeted solutions first, as they have incentives to switch for storage solutions due to time-of-day pricing

Funding recommendation
Co-fund CSR initiatives of enterprises and firms to install **solar pumps or milk chillers.** Funding given to mature ventures (Agni Solar/Ecozen) at <9%

Awareness creating
Fund ventures (e.g. Ampere Hour) that can immediately deploy **solar + storage solutions** in **industrial clusters** to demo proof-of-concept

Funding recommendation
Fund enterprises that have SHGs/FPOs as a part of the business model to **build awareness and as a possible financing mechanism**

Capacity building
Fund educational institutes to train financiers on alternative, data-driven lending model

Capacity building
Fund educational institutes to train policy-makers to add nuances to India's storage policies
Focus on subsidies, recycling, and battery end-of-life

Capacity building
Fund technical training institutes (e.g. National Power Training Institute) to train RE deployers and engineers

Funding recommendation
For RE + storage solutions, fund ventures that offer **regional diversity** at portfolio level to increase word-of-mouth effect

Funding recommendation
Fund the working capital needs of ventures using PAYG/OPEX models to target rural & SME segments (industrial, hospitality, construction)

Regional prioritization
Target states with **high industrial electricity tariffs** with **RE + storage solutions**. Recommended states: Tamil Nadu, Maharashtra, Haryana, and Andhra Pradesh/Telangana

Regional prioritization
Target states that **subsidize or regulate a ban on gensets** under the upcoming **National Energy Storage Framework**

Short-term **Medium-term** **Long-term**

Nuances in state level policies and electricity tariff structures determine ideal RE solution and target states

	Insights	Recommendations
Time-of-day tariffs	• Time-of-day tariffs will be effective by April ’25 which lead to C&I customers seeking solutions to manage back-up power and peak load demand • Storage solutions will have a stronger economic case in this with LCOE being lower than DG sets	**Solution prioritization for ZE Gen:** Begin by funding solutions in the industrial since it has policy incentives
Net-metering provisions	• Variances in net-metering provisions across states, can affect project economics across states and are projected to lead to lower demand for BESS	**Regional prioritization for ZE Gen** Haryana, Maharashtra (high tariff) are for states for BESS
National Energy Storage Framework	• Implementation of this framework will grow the ESS (energy storage solutions) sector in India while suggesting deployment of ESS to replace DG	**Regional prioritization for ZE Gen** Target ventures in states that enforce the DG replacement with ESS solutions

Awareness building is critical to establish RE as a reliable solution among the rural and SME segments

	Insights	Recommendations
WHAT'S MISSING: Awareness building through SHGs/FPOs in rural areas	• RE solution uptake in rural areas held back by lack of awareness (RE solution/subsidies/optimizing use) • Utilizing SHGs/FPOs is an effective way to build awareness, get community buy-in, and have an alternative means of financing	Prioritize enterprises that have rural collectives as part of the business model (Eg: Agni Solar)
WHAT CAN BE DONE? Capacity building: Technical training for servicemen	• Due to shortage of trained servicemen outside Tier 1/2 cities, RE solutions perceived as less reliable by consumers • **REASON FOR ZE GEN TO INTERVENE:** Government schemes do cover training as a part of the plan with goal to add 1.7 Mn jobs across the supply chain	Target regions for solutions should be Tier 1/2 cities or 100 KM around these cities where parts/service men are accessible
WHAT CAN BE DONE? Expand proven solutions: Installing RE solutions in industrial clusters	• C&I customers prefer to witness tech demonstration and peer recommendations to adopt RE solutions themselves • Targeting industrial clusters is an effective way to create word-of-mouth awareness	Prioritize enterprises that have a regional presence to leverage brand and build awareness
HOW DOES FINANCING NEED TO CHANGE? Data-driven lending: Using different models to establish credit-worthiness	• Data-driven lending using metrics such as tax returns and business revenues can be establishing credit-worthiness • **REASON FOR ZE GEN TO INTERVENE**: Invest in ventures promoting alternative financing methods (e.g. Metafin)	Capacity building initiatives for financiers and enterprises to utilize alternative credit-worthiness models

Access to finance for ventures is key hurdle to increasing adoption in the rural and SME sector

	Insights	Recommendations
WHAT CAN BE DONE? Business model innovation: Pay-as-you-go models	• PAYG models are critical for success in the rural segment with models such as a irrigation-as-a-service or storage-as-a-service • PAYG would leverage India's high penetration of mobile internet (95% of all villages)	**Funding recommendation:** Prioritize enterprises with viable PAYG/energy-as-a-service models (e.g. Claro Energy)
FUNDING STRATEGY: Working capital funding for C&I-focused enterprises	• Access to finance is key hurdle for smaller C&I players to move to RE solutions • Funding enterprises' working capital needs to enable OPEX-based models for smaller C&I (industrial, construction, hospitality) customers	**Funding recommendation:** Venture debt at below market rate (<14%) ideal for cash-positive firms that need capital to build inventory (e.g. Metafin)
FUNDING STRATEGY: Project-based funding	• Ventures like Agni Solar (that typically target C&I use cases) also have rural projects like installing milk chillers or distributing SHS • Funding rural projects at concessionary rates (<9%) could create impact	**Funding recommendation:** Explore project-level funding to reach rural customers (e.g. Agni Solar/Inficold)
FUNDING STRATEGY: Longer-term financing	• Market loans for RE projects are shorter (7-10 years) than the typical life of a RE project (20+ years) • Extending the loan tenure can significantly impact the willingness-to-pay of entrepreneurs and end-users (rural & C&I)	**Funding recommendation** Explore increasing the tenure of loans as part of the funding mechanism

We are looking at prospective ZE Gen funding recipients to understand their business models and funding needs

Founded: 1994 | **PoC:** Ravi Pittie, Founding Director | **E:** ravi.pittie@agnisolar.com

Company Overview

- Market leader with over 30 years of operations in providing solar solutions in India. They started as RE R&D outfit with R&D continuing to be a key focus.
- Main business verticals:
  - RTS (installed capacity >10 MW)
  - Water heating solutions for industries (installed capacity >1M litres / day)
  - Off-grid solar primarily SHS (100K+ sold)
  - O&M of solar plants + open access power generation in solar parks
- Strong presence in Maharashtra and NCR (Delhi)
- Sister concern **KPAY, a proprietary PAYG platform**, handles customer on-boarding, payments, and O&M. They have demonstrated use-cases for **SHS, solar refrigeration, and off-grid solar.**

Why do they need funding?

Agni Solar is expanding their existing business lines and venturing into new segments, for which they need financing:

- **Rooftop solar** – Business expansion – Call for investors for OPEX financing
- **Solar parks** – New business line – Solar power generation for industrial customers, plans of 100 MW in 3 years
- **ZE GEN relevant** – **Solar Generators** – New business line – Deployment for off-site construction (using a rental), to replace diesel generator use. Require **funding to build inventory of generators to deploy.**
- **ZE GEN relevant** – **Solar powered milk chillers** – New business line – Early-stage deployment, working with women's groups in villages to deploy the solution in Maharashtra villages

How will the funds be used?

- **Business maturity –** The company has over three decades of operations, with demonstrated R&D & innovation capabilities
- **Business model**
  - New business lines depend on an **OPEX/PAYG model** where revenue generation happens after deployment
  - **CAPEX needed to fund inventory** that can be deployed at the end-user site
  - Looking for debt-financing
- **Growth & Expansion –**
  - **Lack of financing limits the business to expand and deploy more units**
  - Financing also covers costs while the unit is not generating rent from use such as when the unit is being re-deployed to a new site

Vikalp Tech is an ideal target for grant funding which will be used to accelerate their impact footprint

Founded: 2017| **PoC:** Anant Chaturvdei, Co-founder & CEO | **E:** anant.chaturvedi@vikalp.tech

Company Overview

- Organic and zero-emission farming solution; the target is marginal/small farmers who are underserved by traditional solutions.
- Main business verticals:
  - **Organic farming:** Eliminates fertilizer and weedicide use through organic inputs and better cultivation/harvesting techniques
  - **Solar farm station:** Container solar solution that has multiple solar products like solar sprinkler, solar thresher, small processing machines, solar scythe. While a solar pump is utilized for 80-100 days, solar station utilized for 330 days which lowers LCOE.
- Strong presence Kanpur (Uttar Pradesh) and targeting Chhattisgarh with pilot programs

Why do they need funding?

Vikalp Tech is primarily looking for grant funding (less than USD 1 Mn):

- **Solar farm penetration:** Accelerate their impact from 10,000 farmers to 20,000 farmers in the coming 2-3 years by launching pilots**.** Will self-fund 25% of the project themselves.
- **New product development:** Need funding to hire talent to commercialize new products like Bull Pump, bio-gas engine, and solar mills

How will the funds be used?

- **Business maturity :** The company has 7 years of operational experience with the founding team having core farming and research experience.
- **Growth & Expansion:**
  - **Financing needed to deploy solar farm stations in new locations to reach more farmers (each costs USD 36,000)**
  - Financing will also enable team expansion to commercialize more products and work with operational partners that can deploy products via OPEX model

We mapped relevant enterprises that service the 5 ZE Gen India target segments (1/10)

Enterprises	Technologies	Segments	Maturity
Su-vastika	Solar inverters, energy storage systems, solar panels	Industrial, construction, hospitality	High
agni SOLAR SUN FOR EVERYONE	Solar rooftop systems, solar water heating, Solar Inverter	Industrial, hospitality, construction, rural commercial	High
KNV SOLAR	Solar generators and power systems	Construction, industrial	Moderate to High
NEWEN NEW ENERGY SOLUTIONS	Battery energy storage systems (BESS), Microgrid, RE + Storage, Green Hydrogen	Industrial, hospitality	Moderate to High
LIMRA BATTERIES	Tubular Batteries, VRLA Batteries	Industrial, rural commercial	High
BatteryPool	Battery Swapping Technology for EVs	No direct use-cases	Moderate

We mapped relevant enterprises that service the 5 ZE Gen India target segments (2/10)

Enterprises	Technologies	Segments	Maturity
HAMARA GRID	Solar mini-grid	Rural commercial, agriculture, construction	Moderate
Racma SOLAR	Lithium-Ion Solar Off-Grid Plants, Rooftop Solar Systems	Agriculture, rural commercial, construction	Moderate
GLOBE POWER ENGINEERING	Solar Panels, Solar Street Lights, Solar Power Systems	Construction, hospitality	High
Inficold	Solar Cold Storage, Solar Energy Technologies	Rural commercial, agriculture	Moderate
SYNERGY WAVE SYSTEM	Solar PV Modules, Solar Inverters, Solar Lights	Construction, hospitality, rural commercial	Moderate
SELCO Foundation	Decentralized Renewable Energy (DRE) Technologies	Agriculture, rural commercial, hospitality	High

We mapped relevant enterprises that service the 5 ZE Gen India target segments (3/10)

Enterprises	Technologies	Segments	Maturity
IYSERT	Solar Energy Technologies, Micro Wind Systems	Agriculture, rural commercial	Moderate
Gram Oorja	Solar Power, Biogas, Hybrid and Community Microgrids	Agriculture, rural commercial	High
LITHION	Lithium-Ion Battery Technologies	Industrial	High
CHARGEUP	EV Charging Solutions, Battery Swapping Technology	No direct use cases	High
FCHOICE The Bright Way	Solar Energy Solutions	Agriculture, industrial, rural commercial	High
Urja Solutions	Solar PV, Wind Energy, Hybrid Systems, Energy Storage	Construction, hospitality, rural commercial	High

We mapped relevant enterprises that service the 5 ZE Gen India target segments (4/10)

Enterprises	Technologies	Segments	Maturity
surja ENERGY	Solar Power Plants, Solar Panels, Solar Hybrid Systems	Construction, hospitality, agriculture	Moderate
BatterySmart	Battery Swapping Networks	Rural commercial, industrial	High
LOG 9 PIONEERING RESPONSIBLE ENERGY	Lithium-Titanium-Oxide Batteries, Aluminium-Air Batteries	Industrial	High
STATCON ENERGIAA Inspire • Innovate • Implement	Solar Inverters, Energy Storage Systems	Construction, hospitality, rural commercial, industrial	High
LOOM SOLAR	Wind Farms, Renewable Energy Technologies	Industrial	High
INDOWIND Green Power For You, Forever	Wind Farms, Renewable Energy Technologies	Industrial	High

We mapped relevant enterprises that service the 5 ZE Gen India target segments (5/10)

Enterprises	Technologies	Segments	Maturity
ReGen POWERTECH	Wind Energy, Solar Inverters	Agriculture, Industrial, Construction	High
Karma Energy A Weizmann Group Company	Wind Farms, Hydro Power	Industrial, Agriculture	Moderate
RAYS POWER INFRA Think Green Think Better	Solar Energy Technologies, Battery Energy Storage Systems	Construction, agriculture, industrial	High
SERVOTEC smart power solutions	Decentralized Solar Solutions, Solar Rooftop Power Plants	Agriculture, rural commercial, residential	High
Nergy solar	Solar Products, EV Chargers, Energy Backup Solutions	Construction, hospitality, rural commercial, industrial	High
ecozen	Solar-Powered Solutions, Energy Storage Systems	Agriculture, rural commercial	Moderate

We mapped relevant enterprises that service the 5 ZE Gen India target segments (6/10)

Enterprises	Technologies	Segments	Maturity
JAKSON	Hybrid Renewable Energy Systems	Industrial, Agriculture	High
HUSK.	Solar Mini-Grids, Community Micro-Grids	Rural Commercial, Industrial	Moderate
Amptek Keeps it on	Solar Powered Batteries	Industrial, Agriculture	Low
EFFICIENCY FIRST smartjoules	Energy Management Systems	Hospitality, Construction	High
VNOVA ENERGY	Solar Generators	Hospitality	Low
cygni	Battery Storage Solutions	Industrial, Rural Commercial	Moderate

We mapped relevant enterprises that service the 5 ZE Gen India target segments (7/10)

Enterprises	Technologies	Segments	Maturity
MINI MINES	Waste-to-Energy Technologies	Rural Commercial	Low
A2Z GROUP ...on POWERing the nation	Waste-to-Energy Technologies	Construction, Industrial	Moderate
GREENTECH -RENEWABLES-	Waste-to-Energy Technologies	Construction	Low
SunSource ENERGY An SHV Energy Company	Solar Power Solutions	Industrial	Moderate
sun king	Solar Power Solutions	Industrial, Agriculture	High
ZTRIC	Solar Power Solutions	Rural Commercial	Low

We mapped relevant enterprises that service the 5 ZE Gen India target segments (8/10)

Enterprises	Technologies	Segments	Maturity
FOURTH PARTNER ENERGY Partnering for Sustainable Change	Energy Management Systems	Industrial, Agriculture	High
ReNew	Hybrid Solutions, Energy Storage Systems	Industrial Agriculture	High
SOLIS Technology	Solar Power Solutions	Construction	Moderate
PowerMAX Energy Solutions Limited	Solar Power Solutions	Industrial, Agriculture	Moderate
ECO SOCH Sunny Living	Sustainable Energy Solutions	Construction	Moderate
zunroof India's #1 Choice	Solar Rooftop Solutions	Residential. Rural Commercial	Low

We mapped relevant enterprises that service the 5 ZE Gen India target segments (9/10)

Enterprises	Technologies	Segments	Maturity
AEON RENEWABLES	Solar, biomass, and energy efficiency solutions	Industrial	Moderate
RADIANT SOLAR	Solar-Wind Hybrid Systems	Industrial, Agriculture	Low
Power Nucleus	Micropower and Solar Solutions	Industrial	Moderate
CLEANTECH SOLAR®	Energy Efficiency Solutions	Urban commercials , Indistrial	High
EnerMech Safer • Smarter • Solutions	Renewable Energy Projects	Industrial	High
ECOGEN technologies	Integrated Renewable Energy Solutions	NA	Moderate

We mapped relevant enterprises that service the 5 ZE Gen India target segments (10/10)

Enterprises	Technologies	Segments	Maturity
urbansolar	Urban Smart Solar Solutions	Hospitality, Construction	Moderate
MYSUN	Rooftop Solar Solutions	Residential, Commercial , Industrial	Moderate
SHIZEN ENERGY Pioneering India's Lithium Battery Solutions	Solar PV and Energy Storage Solutions	Industrial, Construction	Low
AKRUTI GROUP ENGINEERING WORKS & CONSTRUCTION	Solar Power Solutions	Construction, Urban Commercial	High
DAKSHIN SOLAR POWER	Rural Solar Solutions	Industrial, Construction , Commercial	Low
ARKA Renewables	Solar Energy Solutions	Residential, Agriculture	Moderate

For the most relevant 10-15 enterprises we will provide a brief on their activities

Business: Cooling solutions (cold storage, bulk milk chiller) using solar, batteries, and PCM
Founded: 2015
E: info@inficold.com

Key business activities:
- Manufacture and provide cooling solutions from cold storage, bulk milk chillers, instant pre-milk coolers, and PCM pack
- Incorporates solar panels with thermal energy storage to chill milk and requires 10 hrs of grid connectivity to charge. The solution has 1 day of power back-up
- Ideal customer segment: Rural dairy farmers with poor grid reliability

Relevance for ZE Gen
- Inficold has product installation in India and Africa across cooling solutions

Business: Solar-powered pumping and cooling solutions that remote-controlled
Founded: 2010
E: pramod@ecozensolutions.com

Key business activities:
- Ecotron a solar-powered, water pumping solution that is remotely controlled and has predictive maintenance capabilities
- Ecofrost a solar-powered cold-storage solution that has 30+ hr of battery-less back-up. Ecofrost solution is deployed using two innovative models: rental and community model.
- Ideal customer segment: Rural agriculture and rural dairy farmers

Relevance for ZE Gen
- Target two high-impact use cases using IoT tech that enable innovative business model

For the most relevant 10-15 enterprises we will provide a brief on their activities

Business: R&D, residential & C&I solar, off-grid solar, O&M
Founded: 1994
PoC: Ravi Pittie, Founding Director
E: ravi.pittie@agnisolar.com

Key business activities:

- Developing a mobile solar generator that is 40 ft long with 90 kW of solar panels with storage and sundry equipment included in the container.
- Container cost USD 83,000 and the preferred business model is pay-as-you-go per unit electricity generated
- Ideal customer segment: off-grid commercial activities like construction

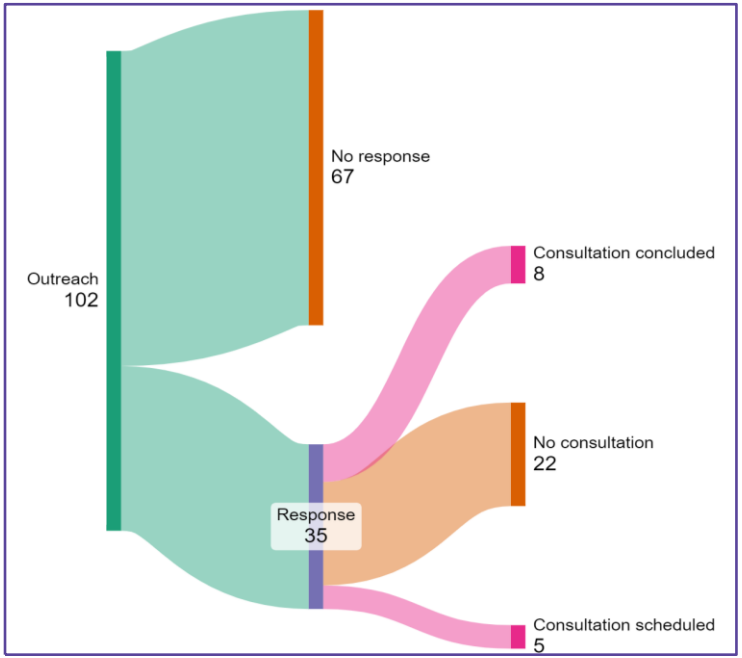
Relevance for ZE Gen

- Agni Solar is looking to raise debt to the tune of USD 476 – 600 K to develop and deploy solar generators

Insights from our primary research

Outreach targeted diverse stakeholders with the view to validate our secondary research and to identify promising ventures

India consultations are 80% completed



India's battery manufacturing capacity will increase by 8x, raw material procurement will persist as an issue

- **Diverse archetypes:** Outreach targeted a diverse set of archetypes to develop a complete picture of the as-is scenario and the way forward
- **Consultation status:** Consultations for India are 80% done and will be concluded when scheduled calls are concluded
- **Lines of enquiry:** Consultations are geared to enhance secondary research while exploring ventures/enterprises that could be funding recipients

Our consultations with experts added nuances from their sectoral expertise

Alexander Hogeveen Rutter

Bio: Manager at Third Derivative; RE and Indian power sector expert **Archetype:** Financier
Key insights:

- RE spares and servicemen coverage is much worse outside Tier 1/2 cities; regions with 100 km of these cities are prime regions due to unreliable electricity
- Venture debt available at 14-16% but concessional financing at 8% would impact solution providers
- Storage absent from India's policies and regulator lack understanding to regulate storage

Debmalya Sen

Bio: India Lead – Energy at WEF; RE technology, policy, and energy sector expert **Archetype:** Policy
Key insights:

- RE + storage not viable for use cases with constant load profiles like data centers
- Rural sectors have low WTP; unlikely to pay anything above normal cost of electricity
- Commercial outfits can pay INR 1 premium for RE due to sustainability goal and expectations of RE costs falling

Abhishek Jain

Bio: Director - CEEW; Rural sector and livelihoods expert **Archetype:** Policy
Key insights:

- SME in the rural sectors are ideal targets as they use DG to run their businesses
- Maharashtra and Haryana (other regions with high electricity penetration) ideal areas to target
- Primary health (and other government-related use cases) non-ideal segments due to poor payment cycles

Our experts added nuances that validated our solutions

Vibhuti Garg

Bio: Director at IEEFA; RE and policy expert **Archetype:** Policy
Key insights:
- Issues with RE schemes is time requirements for disbursal of subsidies and funds
- Financing individuals is much less viable and impactful than funding ventures
- Ventures are well-aware of schemes, however, awareness among end-users is low

Ravi Pittie

Bio: Founder at Agni Solar; RE industry veteran and R&D expert **Archetype:** RE supplier
Key insights:
- NGOs and CSOs key to unlocking rural markets as they communicate co-benefits better
- Significant regulatory hurdles for mini-grids (regional variations) that reduce viability
- BESS is the ideal solution for urban use-cases as space is an issue in urban spaces

Aakash Singh

Bio: Strategy at Sun Sure **Archetype:** RE supplier
Key insights:
- Ideal C&I target segments are RE 100 firms and MNCs that have defined sustainability goals
- Regions with high grid tariffs (like Maharashtra) ideal off-takers for BESS when the technology is more accessible
- Mining use-case has low-viability due to dust which ruins efficiency of solar solutions

Our experts added nuances that validated our solutions

Piyush Dogra

Bio: Senior Environmental Specialist at The World Bank; Environment and clean energy specialist **Archetype:** DFI
Key insights:

- Hindukush belt (UP and Punjab) ideal areas for intervention due to impact potential of reducing air pollution
- DG regulations do not focus on efficiency or replacing DG sets
- Regulations not implemented well and poor implementation among MSME

Ravi Pittie

Bio: Lead at SAREP; International energy and policy expert **Archetype:** DFI
Key insights:

- Engaging with NGOs/universities crucial to raise stakeholder awareness
- Investment in transmission infrastructure has been key to driving India's RE growth
- High income states on the West coast, ideal target regions due to viability of solar and robust cashflows of end-users

Our interviews with varied experts brings out nuances that highlight ideal customer segments, challenges to adoption, financing needs, and policy barriers (1/2)

RE supplier

Key line of enquiry: What are the DG displacement use-cases that their solution can replace?

Other questions:

- **Customer and target market analysis:** What other segments/regions in the market are promising for them? How can they service these markets?
- **Distribution Channels and Sales Strategies:** What are the supply chain challenges that they face?
- **Distribution Channels and Sales Strategies:** What are the impactful business models that drive adoption in their target segments?
- **Consumer preferences and market challenges:** How do they assess credit-worthiness of their target customers in renting/leasing models?

Financier

Key line of enquiry: What financing intervention would be most impactful? Financing the RE suppliers or financing the adopters?

Other questions:

- **Customer Segmentation and Target Market Analysis:**What other segments/regions in the market are promising for them? What is preventing them from servicing these segments?
- **Case Studies and Success Stories:** What ventures have deployed innovative technologies or models that have led to high adoption?
- **Distribution Channels and Sales Strategies:** What are the financing needs of the RE ecosystem? How to identify which financing option is suitable for which clean energy option?

Think Tanks

Key line of enquiry: What policy levers can be pulled to increase RE uptake?

Other questions:

- **Regulatory Landscape and Policy Analysis:** How effective are the policies that control diesel genset use? What are the challenges with the implementation of these policies?
- **Consumer preferences and market challenges:** What is the WTP among market segments? How can awareness be increased among segments?
- **Economic and Financial Analysis: :** What is the political commitment to RE adoption in the country?

Our interviews with varied experts brings out nuances that highlight ideal customer segments, challenges to adoption, financing needs, and policy barriers (2/2)

Genset manufacturer

Key line of enquiry: What are the usage of their target segments?

Other questions:

- **Sustainability and Environmental Impact Assessment:** How are the traditional genset players anticipating demand for RE alternatives?
- **Consumer preferences and market challenges:** What are the key decision-making points for their various customer segments?
- **Customer Segmentation and Target Market Analysis:** What are their key regional segments and their target regions?
- **Competitive Landscape and Market Share Analysis:** What are the drivers of sustained competitive advantage?

DFI

Key line of enquiry: What are the financing needs of the RE value chain and how do financial solutions map to different stakeholders?

Other questions:

- **Regulatory Landscape and Policy Analysis:** What policy levers will drive higher uptake of RE solutions?
- **Customer Segmentation and Target Market Analysis:** Which market segments are in need of a transitions or are underserved?
- **Case Studies and Success Stories:** What are their learnings from various case studies they are involved in?

Academician

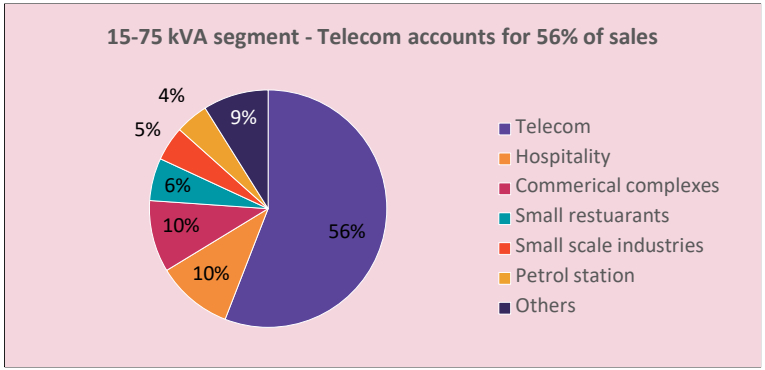
Key line of enquiry: What are novel technologies that address segments without a viable market solution?

Other questions:

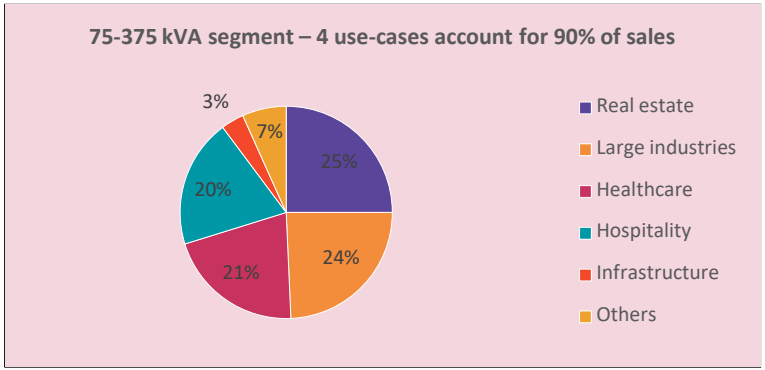
- **Economic and Financial Analysis:** What is the LCOE and LCOS of various solutions? What innovations can drive down the cost of RE solutions?
- **Customer Segmentation and Target Market Analysis:** What are the key decision-making points for their various customer segments?
- **Customer Segmentation and Target Market Analysis:** What are regions and co-factors would lead higher success of an RE solution?

Annexure

Annex 1. Break-up of sub-segments of the genset market along genset sizes (1/2)



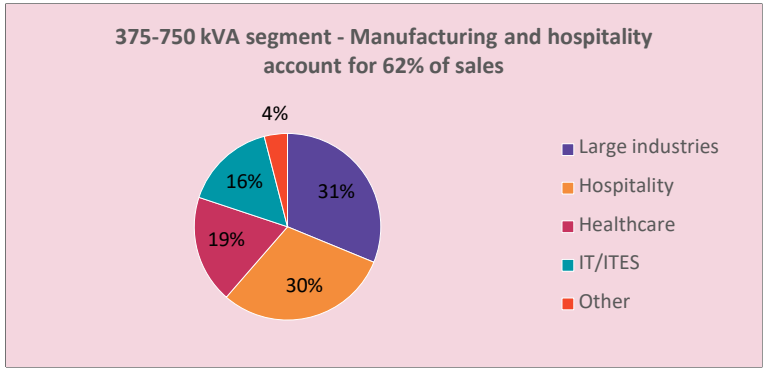
- Estimated annual demand – 53,000 units
- Price range – INR 350 K – 680 K
- Genset size – 3,850 mm x 1,100 mm x 1,700 mm
- Differentiator – Competitors compete mainly on price and then service quality



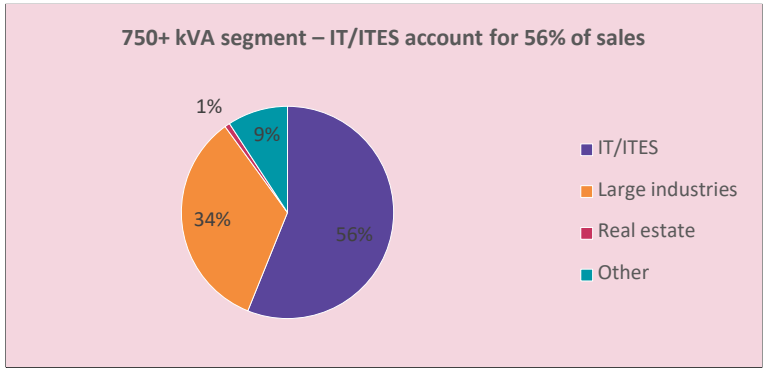
- Estimated annual demand – 60,000 units
- Price range – INR 680 K – 2.5 Mn
- Genset size – 4,200 mm x 1,350 mm x 1,850 mm
- Differentiator – Service quality and product reliability are more important than price

Source: Motilal Oswal

Annex 1. Break-up of sub-segments of the genset market along genset sizes (2/2)



- Estimated annual demand – 7,000 units
- Price range – INR 2.5 Mn – 4.95 Mn
- Genset size – 6,000 mm x 2,000 mm x 2,250 mm
- Differentiator – Competition is mainly on reliability and service quality



- Estimated annual demand – 5,000 units
- Price range – INR 4.95+ Mn
- Genset size – 8,500 mm x 2,500 mm x 2,975 mm
- Differentiator – Competition is only on reliability and service quality
- Demand driven by growth of data centers attracting USD 2.6 Bn in investments by 2026 to add 791 MW of capacity

Source: Motilal Oswal. The Hindu Business Line.

Annex 2. Institutes that can be partner with capacity building initiatives

State	University/Institute
Tamil Nadu	Anna University
	University of Madras
	Chennai Institute of Technology
Andhra Pradesh	R.V.R. & J.C. College of Engineering
	Andhra University
Maharashtra	Symbiosis Skills and Professional University
	Indian Institute of Technology Bombay
	National Power Training Institute
Haryana	NIILM University
	Haryana Renewable Energy Development Agency (HAREDA)
	College of Agricultural Engineering and Technology, Hisar
Gujarat	Sardar Vallabhbhai National Institute of Technology
	Pandit Deendayal Energy University
	Rai University
	Gujarat Institute of Solar Energy
	Gujarat Energy Research & Management Institute
Delhi	ReNew IIT Delhi Centre of Excellence
	Vivekananda College
Karnataka	Basudev Somani College
	National Institute of Technology, Karnataka
Odisha	Odisha Renewable Energy Development Agency (OREDA)
	Odisha Renewable Energy Research Institute (ORERI)
	CV Raman Global University

Institute/Organization
National Institute of Solar Energy (NISE)
Indian Institute of Solar Energy (IISE)
Gujarat Institute of Solar Engineering & Technology (GISET)
National Power Training Institute (NPTI)
Sofcon India Pvt. Ltd.
Solar Energy Research Institute for India and the United States (SERIIUS)
National Institute of Electronics & Information Technology (NIELIT)
National Renewable Energy Laboratory (NREL)

THANK YOU

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