ZE Gen Country Prioritisation: APAC

Market Report, 24 July 2024

intellecap
AAVISHKAAR GROUP

Executive Summary

- The Top 5 countries prioritised as recommended focus areas are **India, Nepal, Bangladesh, Maldives, and Fiji**. Intellecap and the ZE Gen team aligned on these countries after factoring the quantitative framework scores, simulations, qualitative analysis, archetypes, and our institutional experience.
- The Top 3 recommendations:
  - **India**
    - **Largest genset fleet size (15x the LMIC average)** and the **greatest delta of GHG emission reduction**
    - Ranked as the **clear top performer** in the simulations as it ranked as the Top 1 LMIC in 83.5% of the 100 K simulations
    - **Desirable archetype** for: heavy-use, affordability potential, market maturity, and policy provisions
    - Deemed a country with **high multidimensional readiness** for intervention
  - **Bangladesh**
    - Genset fleet size is approximately **1.7x the LMIC average**
    - LMIC with **highest co-benefits from intervention** and with **high multidimensional readiness** for intervention
    - As the **4th fastest growing economy in Asia**, driven by its **textile sector**, it is a prime candidate for immediate intervention
  - **Maldives**
    - **95% of the fleet capacity** is dedicated for Commercial & Industrial (C&I) applications driven largely by its tourism sector
    - **Strong demand drivers** for adopting renewable alternatives, supported by its profiling as a country with **high affordability potential**
    - Among the studied island nations, the Maldives has a **higher multidimensional readiness for intervention**
- The reasons for relegating Nepal and Fiji to Top 4 & 5 LMIC:
  - **Nepal: Lower delta of GHG emissions reduction**, and greater implementation challenges related to affordability potential and policy provisions when compared to India, Bangladesh, and Nepal
  - **Fiji:** Lower **overall impact potential** and **lower delta of GHG emissions reduction potential**

Comparison of quantitative scores Top 5 LMICs with key insights

Country	Framework Scoring		
	Market Assessment	Demand Drivers	Impact Quantification
India	16.38	16.44	17.96
Bangladesh	1.94	12.61	14.12
Maldives	0.99	22.39	10.87
Nepal	1.24	18.52	14.44
Fiji	1.18	21.00	8.41

Insights

- India's Market Assessment score is significantly better than the other Top 5 driven by its large population
- Maldives and Fiji have high "Demand Drivers" score due to higher GNI per capita & stronger currencies
- Fiji has a lower "Impact Quantification" score due to lower Carbon Intensity of Electricity & lower PM2.5 pollution

Legend

High – Top 9 LMICs

Med – Middle 9 LMICs

Low – Bottom 9 LMICs

Comparison of archetypes for the Top 5 LMICs with key insights

	Archetype Analysis			
Country	**Heavy-use**	**Affordability Potential**	**Market Maturity**	**Policy Provisions**
India	Heavy-user	High affordability	Mature market	Supportive
Bangladesh	Med-user	High affordability	Frontier market	Challenging
Maldives	Heavy-user	High affordability	Frontier market	Neutral
Nepal	Low-user	Low affordability	Mature market	Challenging
Fiji	Heavy-user	High affordability	Mature market	Supportive

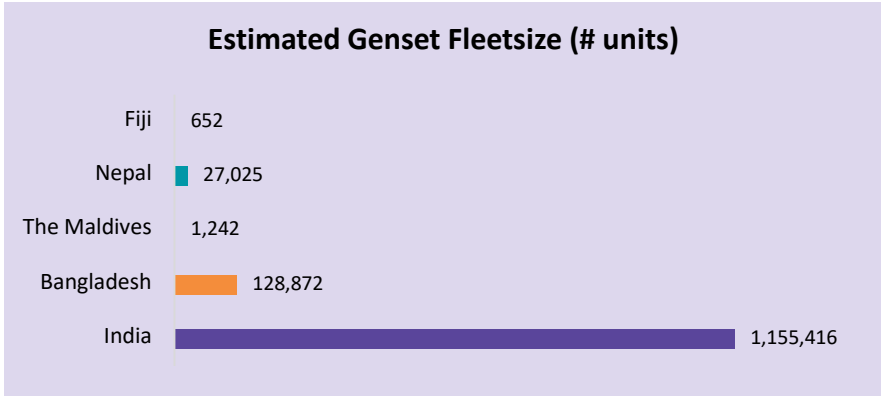
Insights

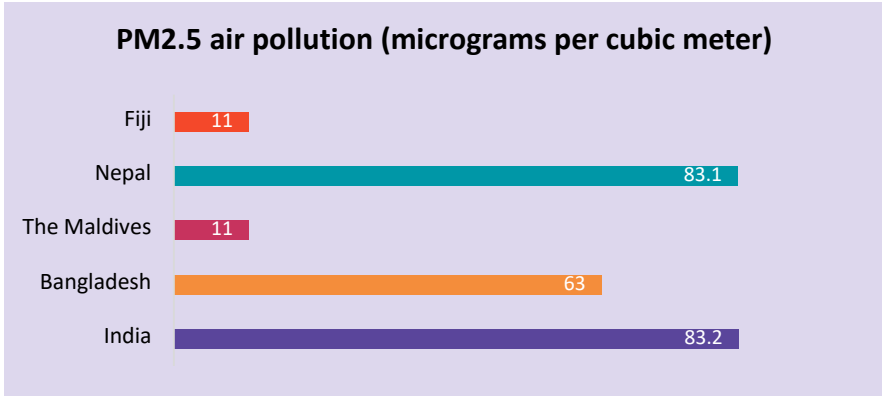
- India is the ideal archetype along all 4 dimensions
- Bangladesh is classified as a “Challenging” and “Frontier Market” largely due its lower levels of “Public Investments in RE” and lower “% Current Installed Capacity of RE” respectively
- Maldives is classified as a “Frontier Market” largely due to its lower levels of “Public Investments in RE” and lower “Manufacturing Value Added”

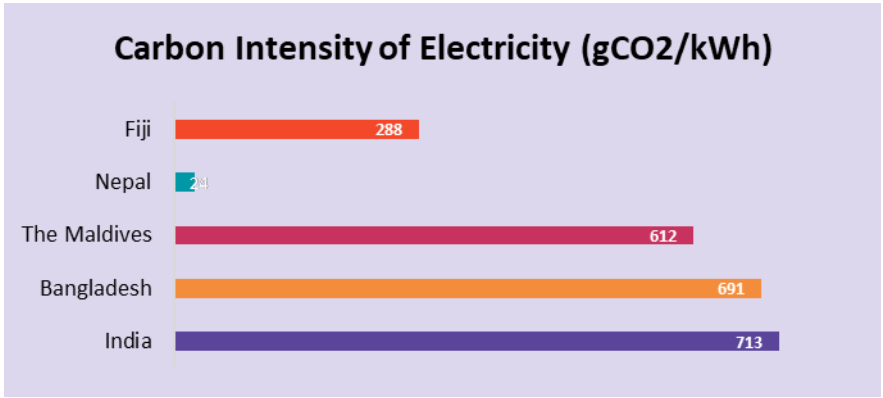
Legend

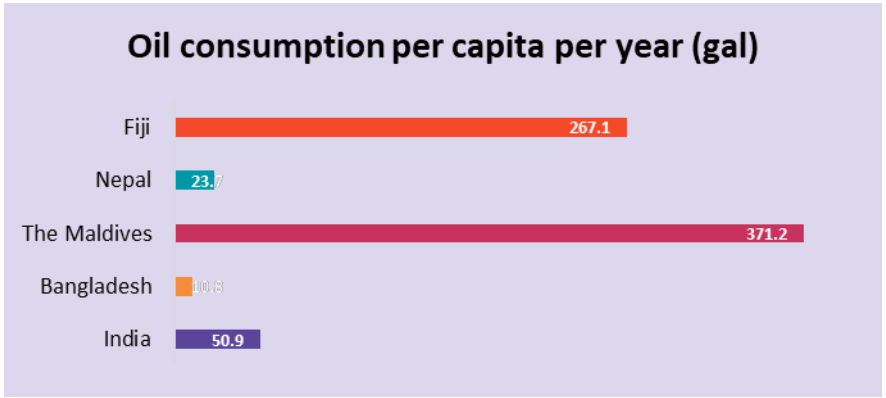
- High – Top 9 LMICs
- Med – Middle 9 LMICs
- Low – Bottom 9 LMICs

Comparison of impact metrics that were key for decision-making to determine the Top 5 LMICs



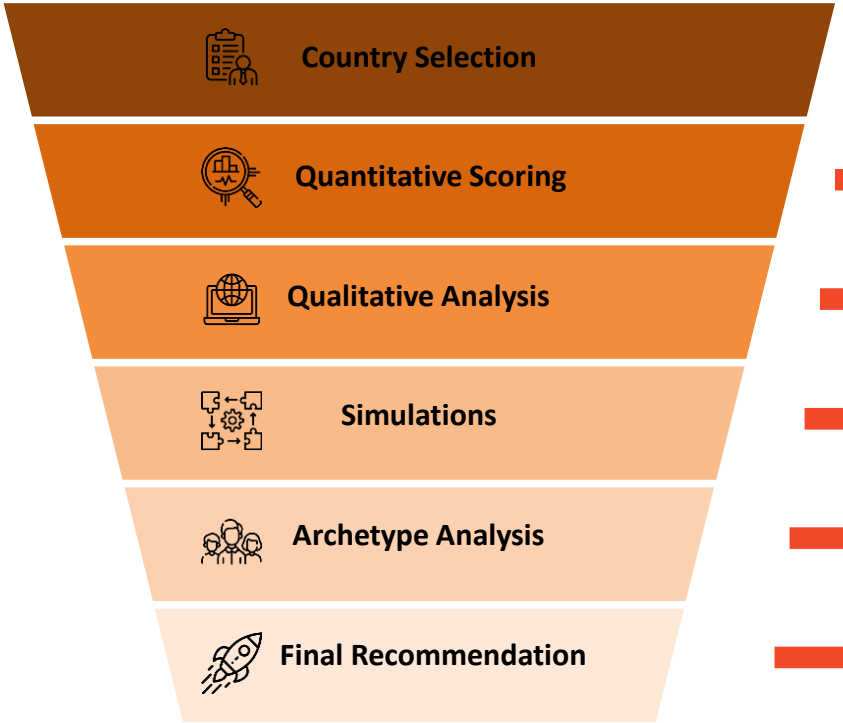






Methodology to arrive at the Top 5 LMICs

A birdseye view of the methodology that led to the final Top 5 LMIC recommendation



- Identified a list of 27 LMICs in the APAC region for the initial study
- Scored the LMICs along 25 metrics that captured the market potential, demand drivers, and impact
- Qualitatively analyzed each LMIC to build on the objective analysis and add context to the numbers
- Ran 100k simulations of the quantitative framework with randomly-assigned weights to identify the consistent top scorers
- Bucketed countries into archetypes such as heavy-users or mature markets to profile needs, possible interventions, and challenges
- The top 5 LMICs were selected based on strong scores supported by qualitative research, country archetype analysis, and Intellecap's extensive experience with each country

1. 27 LMICs were selected for initial research from a list of all APAC countries using a three-step process

We selected World Bank GDP database and selected low- and middle-income countries

Country Name	Region	Classification	Indicator Name	2018	2019	2020	2021	2022	Average GDP
Afghanistan	South Asia	Low income	GDP (current US$ Mn)	18,053	18,799	19,956	14,266	0	14,215
Bangladesh	South Asia	Lower middle income	GDP (current US$ Mn)	3,21,379	3,51,238	3,73,902	4,16,265	4,60,201	3,84,597
Bhutan	South Asia	Lower middle income	GDP (current US$ Mn)	2,583	2,736	2,458	2,768	0	2,109
Fiji	East Asia & Pacific	Upper middle income	GDP (current US$ Mn)	5,581	5,444	4,432	4,305	4,980	4,949
Micronesia, Fed. Sts.	East Asia & Pacific	Lower middle income	GDP (current US$ Mn)	402	416	408	406	424	411
Indonesia	East Asia & Pacific	Upper middle income	GDP (current US$ Mn)	10,42,272	11,19,100	10,59,055	11,86,505	13,19,100	11,45,206
India	South Asia	Lower middle income	GDP (current US$ Mn)	27,02,930	28,35,606	26,71,595	31,50,307	34,16,646	29,55,417

LMIC's identified and shortlist was refined further, as relevant

Country Name	Region	Classification	Indicator Name	2018	2019	2020	2021	2022	Average GDP
Afghanistan	South Asia	Low income	GDP (current US$ Mn)	18,053	18,799	19,956	14,266	0	14,215
Korea, Dem. People's Rep.	Southeast Asia	Low income	GDP (current US$ Mn)	0	0	0	0	0	0
India	South Asia	Lower middle income	GDP (current US$ Mn)	27,02,930	28,35,606	26,71,595	31,50,307	34,16,646	29,55,417
Bangladesh	South Asia	Lower middle income	GDP (current US$ Mn)	3,21,379	3,51,238	3,73,902	4,16,265	4,60,201	3,84,597
Philippines	Southeast Asia	Lower middle income	GDP (current US$ Mn)	3,46,842	3,76,823	3,61,751	3,94,087	4,04,284	3,76,758
Viet Nam	Southeast Asia	Lower middle income	GDP (current US$ Mn)	3,10,106	3,34,365	3,46,616	3,66,138	4,08,802	3,53,205
Pakistan	South Asia	Lower middle income	GDP (current US$ Mn)	3,56,128	3,20,909	3,00,426	3,48,517	3,74,697	3,40,135

List of countries identified for the study

Pacific Islands	South Asia	Southeast Asia
Papua New Guinea	India	Indonesia
Fiji	Bangladesh	Thailand
Solomon Islands	Pakistan	Philippines
Vanuatu	Sri Lanka	Malaysia
Samoa	Nepal	Viet Nam
Micronesia, Fed. Sts.	Maldives	Myanmar
Tonga	Bhutan	Cambodia
Marshall Islands		Lao PDR
Palau		Timor-Leste
Kiribati		
Tuvalu		

2. The 27 LMICs were then quantitatively asssesed on three broad factors to build the prioritization framework

Market Assessment

- Assess the **current market size of fossil fuel gensets** by usage, product penetration, market share & competition
- Establish an **as-is understanding of existing energy access & use** by quality, cost, reliability, affordability, etc
- **Evaluate potential** for RE gensets as a replacement to fossil fuel gensets

Demand Driven Analysis

- **Understand consumer demand / preference f**or fossil fuel gensets by cost, access and ease of use
- **Identify potential for RE based gensets / alternatives** by consumer preference
- **Identify scalable solutions** by evaluating policy, regulatory and market landscape

Impact Quantification

- **Evaluate economic impact** as measured overall cost savings, livelihood creation
- **Assess social impact** such as improved well-being, improved health, and improved electricity access
- **Quantify environmental impact** basis reduction in emissions

2. The framework uses key metrics that account for each assessment factor

Criteria Bucket	Scoring Criteria	
Market assessment	Total population (Mn)	Market size
	Electricity capacity per capita (W)	
	Number of fossil fuel gensets (# units)	
	Total installed capacity of fossil fuel gensets (GW)	
	Rural access to electriciy (%)	Quality of electricity supply
	Urban access to electriciy (%)	
	Population with no/limited electricity access (Mn)	
	System average interruption frequency index	
	System average interruption duration index (hrs)	
Demand driver analysis	GNI per capita ($)	Impact of fuel price
	Diesel CAGR (%)	
	Currency depreciation (%)	Regulatory and policy landscape
	Photovoltaic power output (kWh/kWp) per day	
	Renewable energy capacity (% of total power capacity)	
	Does the country have a emission reduction target	Affordability of alternatives
	Population share using the Internet (%)	
	Population share with access to financial services (%)	
Impact quantification	Oil consumption per capita (gallons/year)	Economic impact
	Diesel price ($/l)	
	Jobs created in the clean energy sector due to new capacity added (jobs/GW)	
	Potential new RE capacity required for household electrification (GW)	Social impact
	Unemployment, female (% of female labor force)	
	Number of respiratory deaths in the country (per 100,000)	
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	Environmental impact
	Carbon intensity of electricity (gCO2/kWh)	

2. Comparison of the quantitative data points across 25 metrics of all 27 LMICs (1/4)

Criteria Bucket	Scoring Criteria	India	Philippines	Papua New Guinea	Fiji	Viet Nam	Indonesia	Thailand
Market assessment	Total population (Mn)	1,428.63	113.88	10.49	0.93	98.19	279.71	71.88
	Electricity capacity per capita (W)	117	98	53	123	268	117	323
	Number of fossil fuel gensets (# units)	1,155,416	82,811	8,078	652	91,760	211,836	62,273
	Total installed capacity of fossil fuel gensets (GW)	105.20	8.11	0.21	0.08	12.84	29.52	9.87
	Rural access to electriciy (%)	97.0%	98.6%	14.2%	86.8%	100.0%	98.2%	100.0%
	Urban access to electriciy (%)	100.0%	96.5%	65.1%	97.6%	100.0%	100.0%	100.0%
	Population with no/limited electricity access (Mn)	304.00	11.00	8.29	0.04	1.22	4.20	0.10
	System average interruption frequency index	2.38	2.23	500.00	4.74	1.57	2.18	0.72
	System average interruption duration index (hrs)	3.72	3.57	940.00	5.00	2.07	2.82	0.38
Demand driver analysis	GNI per capita ($)	2,540	4,230	2,840	5,580	4,180	4,870	7,180
	Diesel CAGR (%)	3.75%	7.65%	6.20%	4.59%	2.48%	1.29%	2.01%
	Currency depreciation (%)	21.63%	14.92%	13.70%	4.35%	8.72%	15.81%	19.26%
	Photovoltaic power output (kWh/kWp) per day	4.31	3.80	3.59	4.02	4.22	3.67	4.02
	Renewable energy capacity (% of total power capacity)	19.2%	22.0%	40.0%	60.1%	42.8%	13.0%	17.2%
	Does the country have a emission reduction target	Yes	No	Yes	Yes	Yes	Yes	Yes
	Population share using the Internet (%)	46.31%	52.68%	32.05%	87.66%	78.60%	66.48%	88.00%
	Population share with access to financial services (%)	77.53%	51.37%	37.00%	74.86%	56.27%	51.76%	95.58%
Impact quantification	Oil consumption per capita (gallons/year)	50.9	62.7	63.7	267.1	78.7	95.0	282.7
	Diesel price ($/l)	1.18	1.01	1.68	1.11	0.78	0.94	0.90
	Jobs created in the clean energy sector due to new capacity added (jobs/GW)	8,172	9,989	No data available	No data available	7,685	9,560	11,660
	Potential new RE capacity required for household electrification (GW)	35.57	1.08	0.44	0.00	0.33	0.49	0.03
	Unemployment, female (% of female labor force)	3.9%	2.5%	2.2%	5.5%	4.3%	3.2%	1.1%
	Number of respiratory deaths in the country (per 100,000)	87.90	51.31	122.46	24.76	34.16	64.30	24.60
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	83.2	18.8	16.2	11.0	20.4	19.4	27.4
	Carbon intensity of electricity (gCO2/kWh)	713	611	507	288	475	676	550

2. Comparison of the quantitative data points across 25 metrics of all 27 LMICs (2/4)

Criteria Bucket	Scoring Criteria	Tonga	Marshall Islands	Palau	Kiribati	Tuvalu	Sri Lanka	Pakistan
Market assessment	Total population (Mn)	0.11	0.04	0.02	0.13	0.01	22.04	240.49
	Electricity capacity per capita (W)	56	728	1,909	27	224	79	65
	Number of fossil fuel gensets (# units)	114	30	15	86	8	19,629	186,159
	Total installed capacity of fossil fuel gensets (GW)	0.02	0.01	0.00	0.01	0.00	1.47	15.45
	Rural access to electriciy (%)	100.0%	100.0%	100.0%	94.3%	99.1%	100.0%	93.0%
	Urban access to electriciy (%)	100.0%	96.1%	99.9%	86.0%	100.0%	100.0%	100.0%
	Population with no/limited electricity access (Mn)	0.00	0.00	0.00	0.01	0.00	0.00	12.00
	System average interruption frequency index	9.20	48.00	8.90	No data available	No data available	2.98	81.65
	System average interruption duration index (hrs)	12.31	120.00	615.00	No data available	No data available	4	89.60
Demand driver analysis	GNI per capita ($)	5,000	7,570	14,250	3,730	7,550	3,540	1,500
	Diesel CAGR (%)	4.07%	No data available	No data available	10.76%	3.46%	12.78%	1.90%
	Currency depreciation (%)	0.56%	0.00%	0.00%	3.83%	5.54%	72.48%	75.73%
	Photovoltaic power output (kWh/kWp) per day	4.50	4.50	5.20	3.80	4.70	4.17	4.67
	Renewable energy capacity (% of total power capacity)	14.2%	2.4%	4.6%	16.4%	15.8%	51%	29.8%
	Does the country have a emission reduction target	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Population share using the Internet (%)	71.60%	38.70%	37.20%	53.63%	71.59%	44.45%	21.04%
	Population share with access to financial services (%)	52.00%	No data available	26.00%	No data available	No data available	89.27%	20.98%
Impact quantification	Oil consumption per capita (gallons/year)	130.4	No data available	No data available	51.7	No data available	90.9	39.9
	Diesel price ($/l)	1.05	1.20	1.10	1.30	1.15	1.04	1.00
	Jobs created in the clean energy sector due to new capacity added (jobs/GW)	No data available	No data available	No data available	No data available	No data available	1,172	8,298
	Potential new RE capacity required for household electrification (GW)	0.00	0.00	0.00	0.00	0.00	0.00	0.78
	Unemployment, female (% of female labor force)	3.0%	No data available	No data available	No data available	No data available	8.2%	7.6%
	Number of respiratory deaths in the country (per 100,000)	No data available	No data available	No data available	51.07	No data available	36.99	77.79
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	10.6	10.0	8.5	12.0	9.8	20.0	62.6
	Carbon intensity of electricity (gCO2/kWh)	625	No data available	No data available	667	625	510	441

2. Comparison of the quantitative data points across 25 metrics of all 27 LMICs (3/4)

Criteria Bucket	Scoring Criteria	Nepal	Myanmar	Cambodia	Samoa	Micronesia, Fed. Sts.	Bangladesh	Maldives
Market assessment	Total population (Mn)	30.90	54.58	16.94	0.23	0.12	172.95	0.52
	Electricity capacity per capita (W)	27	36	76	72	126	53	131
	Number of fossil fuel gensets (# units)	27,025	43,617	16,378	219	113	128,872	1,242
	Total installed capacity of fossil fuel gensets (GW)	2.06	3.35	1.91	0.02	0.01	10.04	0.38
	Rural access to electriciy (%)	93.7%	62.8%	88.0%	97.9%	79.4%	99.3%	100.0%
	Urban access to electriciy (%)	97.7%	93.9%	99.0%	100.0%	98.6%	100.0%	100.0%
	Population with no/limited electricity access (Mn)	1.85	17.60	0.34	0.00	0.02	11.00	0.00
	System average interruption frequency index	No data available	26.42	15.35	15.80	No data available	No data available	2.52
	System average interruption duration index (hrs)	No data available	30.28	20.78	35.90	No data available	No data available	168.02
Demand driver analysis	GNI per capita ($)	1,370	1,210	1,810	4,020	4,150	2,860	11,030
	Diesel CAGR (%)	6.30%	6.18%	5.30%	No data available	No data available	3.56%	6.85%
	Currency depreciation (%)	20.66%	39.42%	0.91%	2.95%	0.00%	38.90%	-1.79%
	Photovoltaic power output (kWh/kWp) per day	4.10	4.01	4.09	3.93	3.80	3.89	4.44
	Renewable energy capacity (% of total power capacity)	100.0%	46.4%	58.9%	49.1%	4.9%	1.6%	5.8%
	Does the country have a emission reduction target	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Population share using the Internet (%)	51.63%	44.02%	60.15%	78.20%	40.40%	38.92%	85.76%
	Population share with access to financial services (%)	54.00%	47.79%	33.39%	39.00%	23.55%	52.81%	79.55%
Impact quantification	Oil consumption per capita (gallons/year)	23.7	36.3	47.1	179.0	No data available	10.8	371.2
	Diesel price ($/l)	1.15	0.78	1.01	1.26	1.18	0.92	0.90
	Jobs created in the clean energy sector due to new capacity added (jobs/GW)	No data available	5,652	6,429	No data available	No data available	36,482	No data available
	Potential new RE capacity required for household electrification (GW)	0.05	0.63	0.03	0.00	0.00	0.58	0.00
	Unemployment, female (% of female labor force)	12.5%	3.5%	0.2%	15.0%	No data available	7.5%	3.6%
	Number of respiratory deaths in the country (per 100,000)	149.01	73.61	35.56	47.54	67.93	41.72	34.69
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	83.1	29.4	22.1	11.0	10.0	63.0	11.0
	Carbon intensity of electricity (gCO2/kWh)	24	399	418	474	No data available	691	612

2. Comparison of the quantitative data points across 25 metrics of all 27 LMICs (4/4)

Criteria Bucket	Scoring Criteria	Bhutan	Malaysia	Solomon Islands	Vanuatu	Lao PDR	Timor-Leste
Market assessment	Total population (Mn)	0.79	34.31	0.74	0.33	7.63	1.36
	Electricity capacity per capita (W)	484	513	17	25	94	35
	Number of fossil fuel gensets (# units)	622	27,347	634	296	6,715	1,110
	Total installed capacity of fossil fuel gensets (GW)	0.07	8.15	0.05	0.03	0.81	0.09
	Rural access to electriciy (%)	100.0%	100.0%	75.4%	60.7%	100.0%	100.0%
	Urban access to electriciy (%)	100.0%	100.0%	79.0%	97.0%	100.0%	100.0%
	Population with no/limited electricity access (Mn)	0.00	0.00	0.18	0.10	0.00	0.00
	System average interruption frequency index	2.88	0.49	1.50	5.10	22.70	No data available
	System average interruption duration index (hrs)	7.08	0.48	3.10	7.30	4.00	No data available
Demand driver analysis	GNI per capita ($)	3,590	11,970	2,270	3,660	2,120	2,140
	Diesel CAGR (%)	-2.67%	6.05%	3.58%	No data available	No data available	8.21%
	Currency depreciation (%)	21.95%	13.86%	3.44%	3.54%	154.55%	0.00%
	Photovoltaic power output (kWh/kWp) per day	3.62	3.71	3.54	3.54	3.73	4.27
	Renewable energy capacity (% of total power capacity)	100.0%	17.8%	6.6%	25.2%	69.3%	0.4%
	Does the country have a emission reduction target	Yes	Yes	Yes	Yes	Yes	Yes
	Population share using the Internet (%)	85.64%	97.40%	36.13%	66.30%	62.00%	39.50%
	Population share with access to financial services (%)	33.67%	88.37%	No data available	37.00%	37.32%	64.00%
Impact quantification	Oil consumption per capita (gallons/year)	61.4	344.3	39.1	59.5	40.0	43.8
	Diesel price ($/l)	0.79	0.71	1.24	1.82	0.97	1.35
	Jobs created in the clean energy sector due to new capacity added (jobs/GW)	No data available	14,381	No data available	No data available	No data available	No data available
	Potential new RE capacity required for household electrification (GW)	0.00	0.00	0.00	0.00	0.00	0.00
	Unemployment, female (% of female labor force)	7.6%	4.0%	1.6%	6.4%	0.9%	1.5%
	Number of respiratory deaths in the country (per 100,000)	87.76	25.89	67.86	78.03	46.19	44.62
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	40.0	17.0	13.0	13.0	21.0	16.0
	Carbon intensity of electricity (gCO2/kWh)	23	606	700	571	266	667

3. The quantitative methodology is supplemented with a qualitative analysis to add context to the data

- **Market size:** What is the market size of diesel gensets in the country?
- **Application and use cases:** What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?
- **Electricity supply quality:** What is the quality of electricity supplied in the country? What are the key gaps and limitations of the grid supply which are difficult to mitigate?
- **Policy and regulatory landscape:** What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?
- **Market maturity of RE alternatives:** What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?
- **Supply chain of RE alternatives:** How do existing and potential supply chains for cleaner energy solutions, including renewable energy components, hybrid systems, and related services, impact the availability, accessibility, and affordability of these solutions in target markets?
- **Access to financing options:** How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?
- **Market segmentation:** What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?
- Any other research insights unique to an LMIC.

An example of some of the qualitative analysis conducted for Fiji showcasing the observations and sources reviewed

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	Fiji, like many island nations, relies heavily on diesel gensets for backup power and primary power in remote areas. This is driven by the need for reliable power supply amidst frequent power outages and limited grid infrastructure. The diesel genset market in the Asia-Pacific region, which includes Fiji, is expected to see substantial growth due to increasing demand for reliable power solutions in the face of infrastructure challenges and natural disaster. Key Insights: Reliability and Demand: Diesel gensets are favored in Fiji for their reliability and ability to provide immediate power during outages, which are common in the region. Market Growth: The genset market in the Asia-Pacific region is poised for growth due to rapid urbanization, industrialization, and the increasing need for reliable power in both residential and commercial applications. Application: In Fiji, gensets are critical for various sectors, including healthcare, telecommunications, and industrial operations, ensuring continuous operations during power disruptions. While specific figures for Fiji are not readily available, these insights suggest a robust market for fossil fuel gensets, driven by the country's need for dependable power solutions.	https://www.adb.org/sites/default/files/linked-documents/cps-fij-2014-2018-ssa-03.pdf
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	Commercial Sector Applications: Backup power for retail businesses, hotels, hospitals. Needs: Continuous operations during outages. Segments: Hospitality, healthcare, retail. Value: Ensures reliability and operational continuity Industrial Sector Applications: Power for construction sites, manufacturing plants, telecom infrastructure. Needs: Continuous power for critical operations. Segments: Construction, manufacturing, telecom. Value: Enhances productivity and efficiency Residential Sector Applications: Backup power for homes in remote areas. Needs: Reliable power during outages. Segments: Homeowners in rural areas. Value: Ensures basic amenities and safety	1. https://www.trade.gov/country-commercial-guides/fiji-renewable-energy 2. https://www.fijivillage.com/news/FEA-brings-in-4-new-diesel-generators-s5r2k9/

Note: Qualitative analysis for the Top 5 countries is in the Annexure

4. The quantitative data was simulated 100 K times using the below methodology to arrive at the consistently high-ranking LMICs

Data Preparation

- **Missing data points** replaced with the mean of values from other countries within the same region (e.g., South Asia, Pacific Islands, Southeast Asia)
- **Data normalized** on a scale of 0 to 1
- **Negative impact variables** like rural access to electricity, urban access to electricity, and currency depreciation, have a declining impact on the score. These values are normalized by using the formula (1 - value) to invert their scale.

Weight Assignment & Ranking

- **Range of values** for any 1 weight is between **4 – 76**
- Each metric is assigned **random weights**, ensuring the **sum of all weights is 100; randomization discounts any bias in assigning weights**
- Each value is multiplied by its weight to derive a score. A country's score across all metrics gives its final score

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- **Highest scoring country** is ranked 1st, and so on.

Iteration & Sensitivity

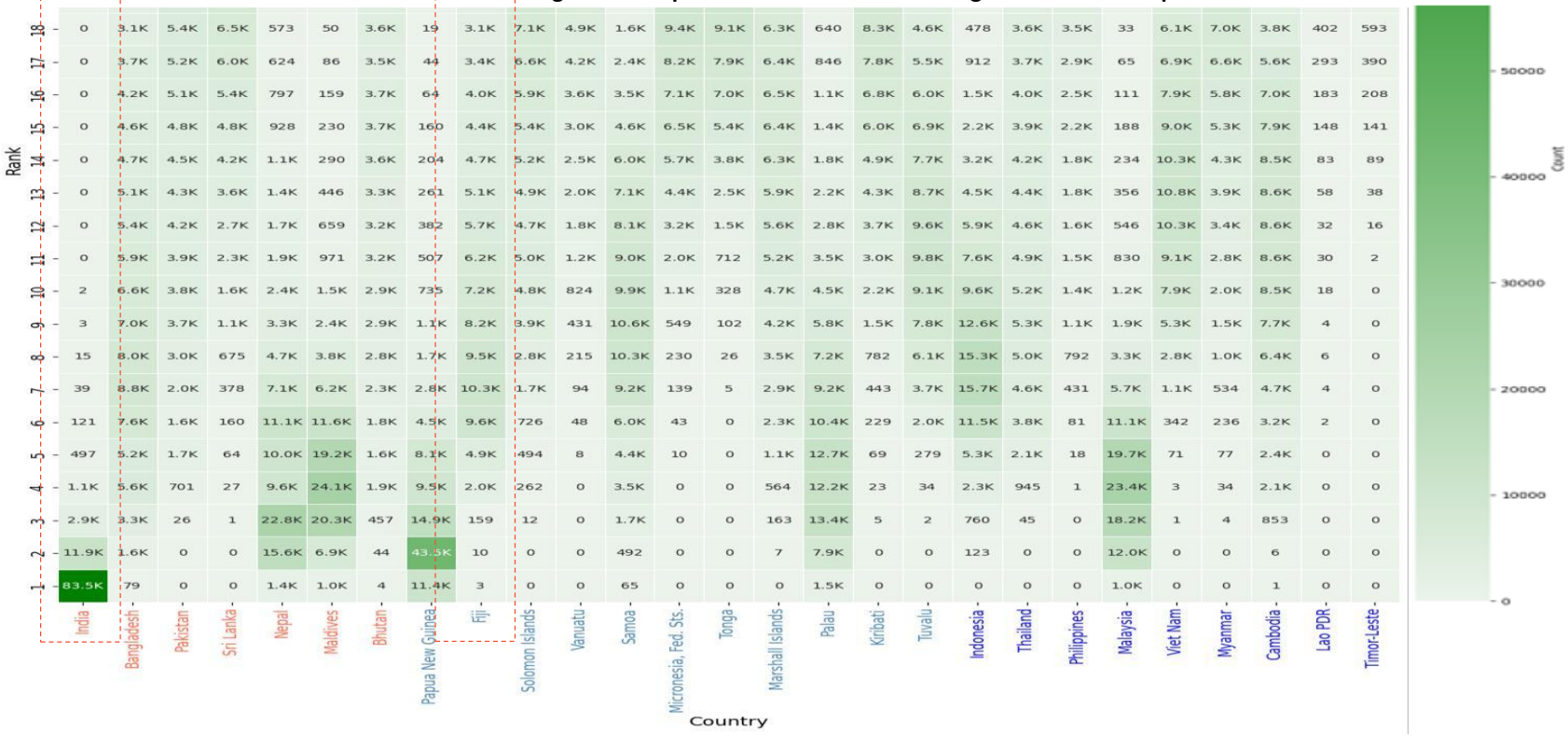
- The weight assignment, scoring, and ranking was repeated multiple times to generate iterations with different weight distributions
- **100 K simulations** were executed using **Python** which involved **different combinations of weights** across variables for the different countries
- Results were analyzed across different 100 K iterations to see how many times a particular country ranked high which helped identify the Top 5 countries

The results of 100 K simulations showcase the consistent top performers that ranked high with randomized weights

It can be observed that India ranked 1st in 83.5k simulations

It can be observed that Fiji also consistently ranks high in the Top 10

Countries like PNG and Pakistan score well but our qualitative analysis insights led to their relegation from the Top 5



Note: The full plot is available on the 'Plot' section of the ZE Gen Prioritization Framework Excel

5. LMICs were categorzied into three Archetypes to understand the scope of interventions and potential challenges in each LMIC

Affordability Potential

- GDP/income indicators eg. per capita income, inflation, etc
- Fuel price fluctuations/favorable subsidy structure
- Availability of financing options

Market Maturity

- Existing infrastructure & supply chains for alternatives
- Technology readiness, and potential for scalability
- Support and collaborations

Policy Provisions

- Government priority, policy frameworks & support
- Implementation and adoption challenges due to external factors and exigencies

	Metrics	Source	
Affordability Potential	GNI per capita	WB	→ High is desirable
	FF subsidies per capita	OECD	→ High is desirable
	Sovereign credit ratings	S&P	→ High is desirable
	%access to financing	WB	→ High is desirable
	Depreciation	Xe.com	→ Low is desirable
	Country risk premium	NYU	→ Low is desirable

	Metrics	Source	
Market Maturity	Manufacturing, value added (2022)	WB	→ High is desirable
	RE current mix in installed power (%)	Individual country source	→ High is desirable
	RE planned mix in installed power (%) (2030)	Individual country source	→ High is desirable
	Off-grid and on-grid solar installation (2022) (MW)	IRENASTAT	→ High is desirable

	Metrics	Source	
Policy Provisions	Govt. effectivness	WB	→ High is desirable
	Public investement in RE (2020-22)	IRENASTAT	→ High is desirable
	Regulatory quality	WB	→ High is desirable
	Control of corruption	WB	→ High is desirable
	Rule of Law	WB	→ High is desirable
	Political Stability and Absence of Violence/Terrorism	WB	→ High is desirable

Showcasing the metrics that were used to create the archetypes with data for the Top 5 LMICs

	Metrics	India	Fiji	Nepal	Bangladesh	Maldives
Affordability Potential	GNI per capita	2,540	5,580	1,370	2,860	11,030
	FF subsidies per capita	45	18	0	150	259
	Sovereign credit ratings	BBB-	B+	No rating assigned	BB-	B-
	%access to financing	77.53%	74.86%	54.00%	52.81%	79.55%
	Depreciation	21.63%	4.35%	20.66%	38.90%	-1.79%
	Country risk premium	3.21%	6.58%	#N/A	6.58%	10.97%

	Metrics	India	Fiji	Nepal	Bangladesh	Maldives
Market Maturity	Manufacturing, value added (2022)	440,058,417,141	498,250,619	1,989,989,258	100,146,830,915	123,530,482
	RE current mix in installed power (%)	19.2%	60.1%	100.0%	1.6%	5.8%
	RE planned mix in installed power (%) (2030)	40%	99%	100%	15%	70%
	Off-grid and on-grid solar installation (2022) (MW)	63047.9	9.5	109.6	524.0	35.8

	Metrics	India	Fiji	Nepal	Bangladesh	Maldives
Policy Provisions	Govt. effectivness	0.37	0.59	-0.92	-0.76	-0.13
	Public investement in RE (2020-22)	1917.8	4.2	39.3	345.1	42.9
	Regulatory quality	-0.05	-0.06	-0.65	-0.93	-0.66
	Control of corruption	-0.32	0.39	-0.53	-1.08	-0.40
	Rule of Law	0.11	0.32	-0.45	-0.60	-0.03
	Political Stability and Absence of Violence/Terrorism	-0.57	0.76	-0.25	-1.09	0.67

6. The selection criteria that helped us distinguish between other top scorers and curate the final Top 5 recommendation

Criteria for selection

Highest co-benefits: We considered countries with impactful stories at the intersection of gender, climate, and economics, where interventions can create a ripple effect.
Example: **Bangladesh**

Geographical diversity: In our overall recommendation, we wanted to ensure diversity of geographies (islands/hilly) and use-cases, so that learnings can be cross-applied later for other LMICs.
Example: **Fiji, Maldives, and Nepal**

Multi-dimensional readiness: We wanted to prioritize countries where likelihood of delivering impact would be high driven by a strong ecosystem and Intellecap's presence and connects
Example: **India and Bangladesh**

Criteria for rejection

Political scenario: We disregarded countries that scored well but were not feasible due to safety-reasons such as a political instability or threat of violence.

Example: **Papua New Guinea and Myanmar**

Macro-economic conditions: We disregarded countries with a poor macro-economic outlook driven by factors such as high inflation or a weak currency

Example: **Sri Lanka**

Low impact: We did not recommend countries that, despite scoring well and having strong archetypes, had a judged poor overall impact footprint due to low population or difficulty in executing interventions
Example: **Palau**

Individual Country Analysis

Rank 1: India

Selected for WP2 due to its significant impact potential by both displacing fossil fuel gensets and by electrifying the unserved populace

Summary of Impact Potential

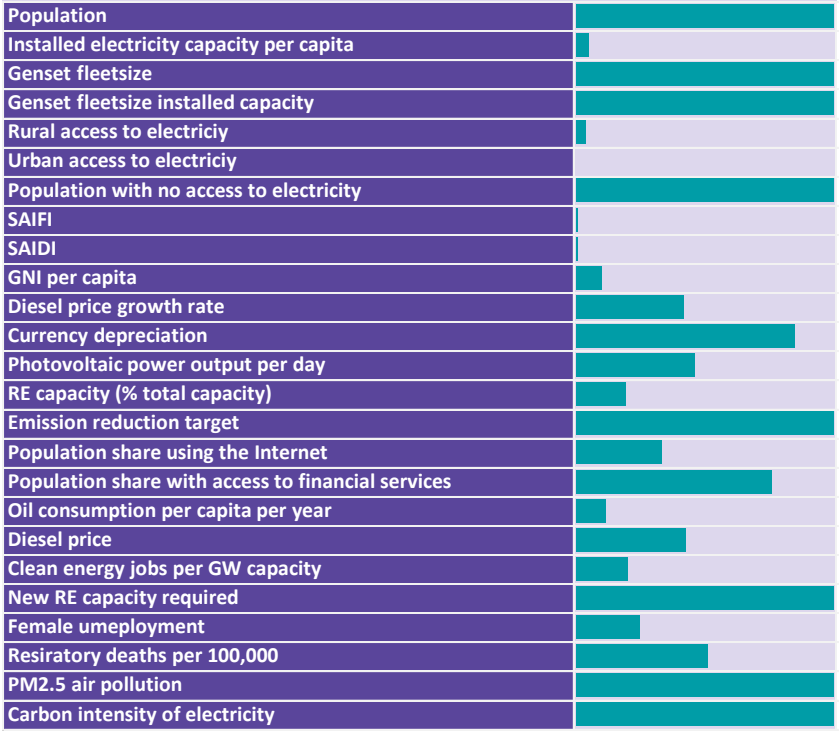
- India has the largest genset fleet at over 1 million units, which is 15x greater than the average LMIC fleet size
- The 2030 renewable energy (RE) target is 40%, lower than the LMIC average, but given India's population size and economic growth, this represents a significant amount of RE capacity
- India's large manufacturing base (5th largest globally) and 63 GW of RE capacity (vs 3 GW average) suggest strong RE supply chains
- India has the highest carbon intensity of electricity and the highest air pollution of all countries, indicating a strong need for intervention

Heavy-user	High affordability	Mature market	Supportive policies

Impact Story

Implementing an intervention in India offers the greatest reduction in GHG emissions through genset displacement and the most significant socio-economic benefits through RE alternatives market creation.

Analysis of Normalized Scores across 27 LMICs – Longer the teal bar, the better performance across that parameter



Legend High Med Low

Rank 1: India

	Insights	Relevance for ZE Gen
Market assessment	• India has the largest estimated genset fleet at over **1 Mn units**, which is **15x the LMIC average** • Approximately **304 million people**, or 25% of the total population, **lack access to electricity** • Classified as a **"heavy-user," 87%** of India's installed fossil fuel genset capacity is used in **commercial and industrial (C&I)** sectors	• India presents the **largest "displacement market"** among all studied LMICs, making it the prime location for replacing fossil fuel gensets with RE alternative solutions • India also represents the **largest "creation market,"** meeting the needs of customers who do not have electricity through alternative gensets. This underserved population could significantly benefit from affordable renewable energy solutions • As one of the 5 largest and fastest-growing economies in Asia, India's need for backup power is likely to increase
Demand drivers	• While GNI per capita is **0.5x LMIC average**, the affordability potential is strong driven by **low country risk premium** • The country has an installed RE capacity of 19.2% (of total capacity) with **2030 commitment of 40% (of total capacity)** • The **5th largest manufacturing sector** in the world and the highest **solar installations at 63 GW** (vs. 3 GW LMIC average)	• Given the low GNI per capita and the “heavy-user” archetype, the ideal intervention for India could target the C&I use case • While a 40% target is 0.7x LMIC average, **the country’s installed capacity is large and growing**, ensuring a strong demand • Strong supply chains for RE components exist in the country and will increase as the RE penetration further increases
Impact quantification	• **Highest carbon intensity of electricity** at 713 gCO2/kWh • **Highest PM2.5 air pollution** at 83.2 micrograms/m3 • Potential **36 GW of electricity capacity** needed to electrify the unserved populace which can lead to jobs creating an estimated **8,172 jobs/GW in the process**	• **Highest delta of GHG** emission reduction due to population size 14x LMIC average • A transition to RE away from fossil fuel gensets represents deep impact for the environment and general well-being • High socio-economic benefits of electrification starting with livelihood creation which bleed into gender equality, health, and education

Rank 2: Bangladesh

Selected for WP2 due to anticipated green energy needs and immediate high co-benefits from the RE transition

Summary of Impact Potential

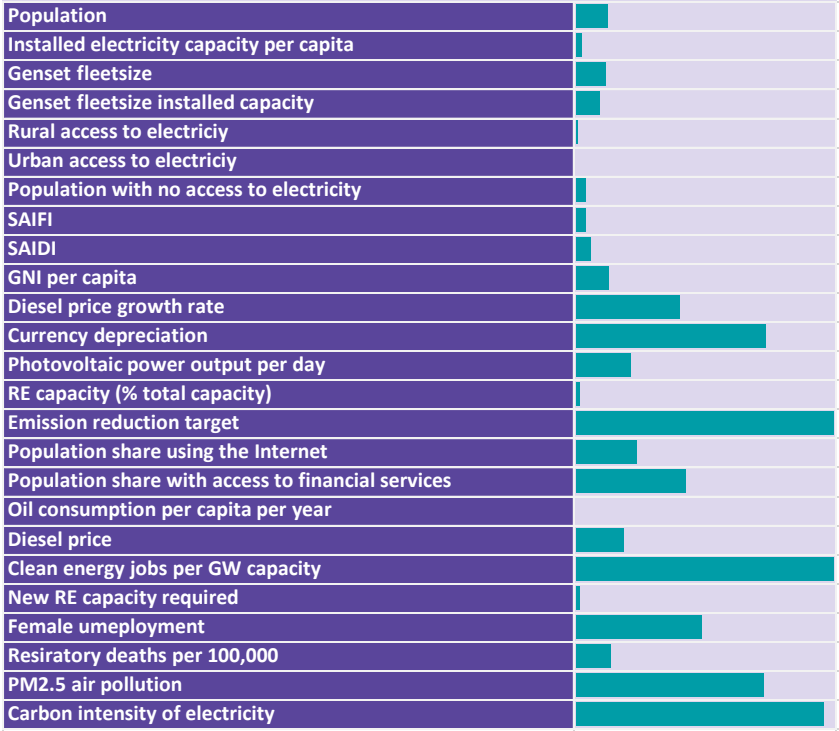
- Bangladesh has a estimated fleet of 100 – 150K units, which is 1.7x the LMIC average
- Around 11 Mn people in Bangladesh lack access to electricity, and there is precedence of solar home systems (SHS) being used by policy channels to electrify the population
- Carbon intensity of electricity (1.4x average) & PM2.5 air pollution (2.3x average) are high indicating a need for transition
- Bangladesh's rapidly expanding manufacturing sector, particularly the textile industry, requires reliable and clean backup power to support its growth

Med-user	High affordability	Frontier market	Challenging policies

Impact Story

Bangladesh offers the highest co-benefits among all studied countries, including improvements in gender equality, health, and well-being. Replacing gensets in the textile sector has the potential to significantly impact lives across multiple dimensions

Analysis of Normalized Scores across 27 LMICs – Longer the teal bar, the better performance across that parameter



Legend: High, Med, Low

Rank 2: Bangladesh

	Insights	Relevance for ZE Gen
Market assessment	• Bangladesh has a large estimated genset fleet, ranging between **100 – 150 K units**, which is **1.7x LMIC** average • Approximately **11 million people in Bangladesh**, or nearly 6% of the total population, lack access to electricity • Classified as a "medium user," **84% of Bangladesh's installed fossil fuel genset** capacity is utilized in C&I sectors	• Bangladesh has the **4th largest "displacement market"** among all studied regions • It represents one of the **largest "creation markets,"** with a precedent for electrifying unserved populations with renewable energy alternatives through the **Grameen Shakti Program** • As one of the five largest and fastest-growing economies in Asia, Bangladesh's **need for reliable backup power will continue to grow**
Demand drivers	• Although the GNI per capita is 0.6 times the LMIC average and 53% of the population has access to financial services (vs. 52% average), Bangladesh shows strong affordability potential driven by a **low country risk premium** • The country has an installed renewable energy capacity of 1.6% (of total capacity) with **a commitment to reach 15% by 2030** • Bangladesh has the **5th largest manufacturing sector** among the studied countries, with 0.5 GW of solar installations (vs. 3 GW average). The Grameen Shakti Program has **installed 1.8 million SHS units to electrify villages**	• Given the low average level of the banked population, the ideal customer segment for intervention in Bangladesh might be the **Commercial and Industrial (C&I) sector** • Although the 15% renewable energy target is 0.25 times the LMIC average, the country's demand will be driven by the **C&I sector with its export obligations pertaining to green supply chains** • While the current supply chains are developing, the size and complexity of Bangladesh's manufacturing sector will ensure captive growth
Impact quantification	• Bangladesh has a **high carbon intensity of electricity** at 691 gCO2/kWh, which is **1.4x LMIC average** • It has **high PM2.5 air pollution** at 63 micrograms/m^3, which is **2.3x LMIC average** • There is a potential need for **0.6 GW of electricity capa**city to electrify the unserved populace, which could create **36,482 jobs per GW**, the highest of all studied countries	• Bangladesh has a **high potential for GHG emission reduction** due to its **population, 2x LMIC average**, and its rapidly growing economy • Transitioning to renewable energy from fossil fuel gensets will have a significant positive impact on the environment and well-being • The country offers the highest co-benefits of intervention, including **clean job creation and women empowerment** through the electrification of the economy

Impact Quantification

Rank 3: Maldives

Selected for WP2 due to urgent transition needs, an intervention in the Maldives will offer learning opportunities for similar contexts

Summary of Impact Potential

- A large genset fleet size which is nearly 3x the size for LMICs with less than 1 Mn population with nearly 95% of the fleet capacity dedicated to C&I sector
- A high GNI and strong currency to support debt-based financial interventions targeting residential users or C&I users as end customers
- Ambitious target to increase RE installed capacity by 64 percentage points by 2030
- Selected for WP2 high impact potential to reduce GHG emissions and its climate vulnerability as an island nation

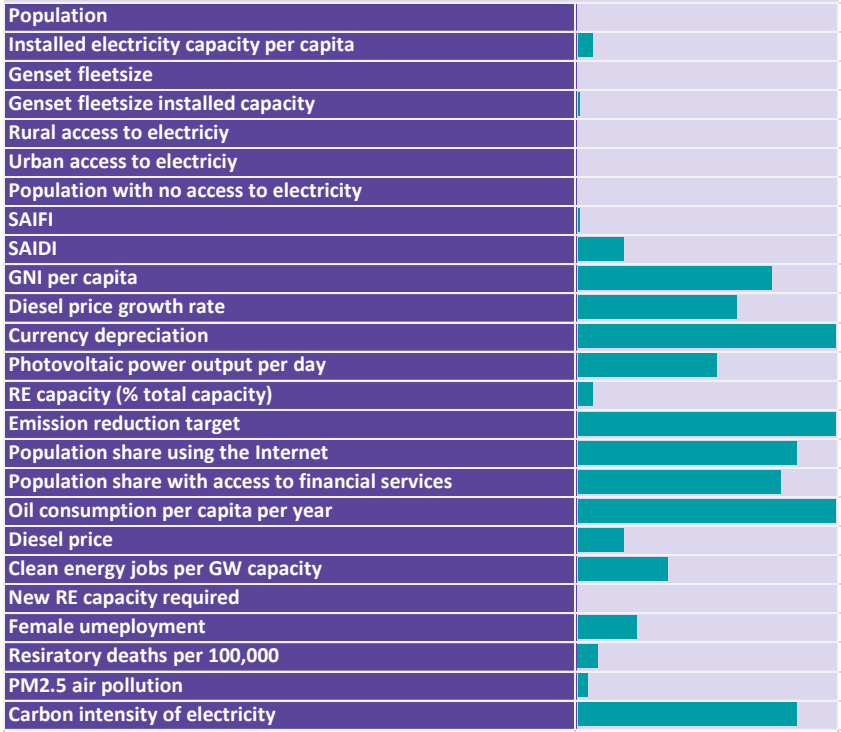
Heavy-user	High affordability	Frontier market	Neutral policies

Impact Story

The Maldives has the highest installed genset capacity among small island nations. An intervention here could significantly reduce GHG emissions while addressing the climate risks of this highly vulnerable country

Legend: High Med Low

Analysis of Normalized Scores across 27 LMICs – Longer the teal bar, the better performance across that parameter



Rank 3: Maldives

	Insights	Relevance for ZE Gen
Market assessment	• The Maldives has the largest estimated genset fleet among LMICs with populations <1 Mn, **ranging from 1,000 – 1,500 units**, which is **3x the average for such LMICs** • Despite a reported 100% electrification rate, the Maldives suffers from poor electricity quality with a **SAIDI of 168 hrs, 1.6x the average of all nations** • Classified as a "heavy user," over **95% of installed genset capacity** is used in the C&I sectors, particularly in tourism	• The Maldives has the **largest "displacement market" among all small island nations**; successful interventions here can be applied to similar geographies in APAC • Although data does not suggest a creation market, the geography offers opportunities to electrify areas beyond grid reach • As an island nation, the Maldives faces significant climate vulnerability; replacing fossil fuel gensets can mitigate climate risk and reduce reliance on fuel imports
Demand drivers	• The Maldives has a **high GNI, 2.25x the LMIC average**, 80% of the population having access to financial services and a **currency that has appreciated 2% against the dollar** in the last five years • The country has an installed renewable energy capacity of 5.8% (of total capacity) and a **commitment to reach 70% by 2030** • The Maldives has the **3rd largest manufacturing sector** among similarly sized LMICs, with 35 MW of solar installations (vs. 8 MW average for similar countries)	• Given the excellent affordability factors, both **C&I and residential interventions can succeed** in the Maldives • The 70% renewable energy target is 1.1 times the LMIC average, with a target delta of 64%, indicating **strong policy intent and likely demand in the coming years** • While the **RE supply chains are import-dependent**, the Maldives, has the choice between RE component imports and fuel imports, with **policy support favoring the former**
Impact quantification	• The Maldives has **a high carbon intensity of electricity at 612 gCO2/kWh,** which is **1.2x** the LMIC average • It has **low PM2.5 air pollution at 11 micrograms/m³**, which is 0.44 times the LMIC average • While there is limited potential to electrify unserved populations, there is significant potential to create green jobs, reduce fuel import dependency, and increase well-being by improving power reliability in a challenging geography	• The Maldives has a **significantly high GHG emission delta** for an island nation • While the environmental impacts of transitioning to RE may not be immediately obvious, the Maldives' geography makes it a climate-endangered region • The biggest co-benefit of transitioning to renewable energy comes from the economic perspective, as it reduces the recurring import costs of fuel while offering health benefits to workers

Rank 4: Nepal

Not selected for WP2 due to lower impact potential, despite hilly terrain and climate vulnerability indicating a need for energy reliability

Summary of Impact Potential

- As a hilly region, Nepal faces limited grid expansion, increasing the demand for reliable power backups
- Nepal has 100% installed electricity capacity from renewable sources, with 98.7% from hydro and 100 MW from on-grid and off-grid solar installations
- Nepal has one of the lowest carbon intensities of electricity at 0.05 times the LMIC average
- Nepal was not selected as a Top 3 candidate due to low usage, poor affordability factors, and low direct impact via GHG emissions reduction

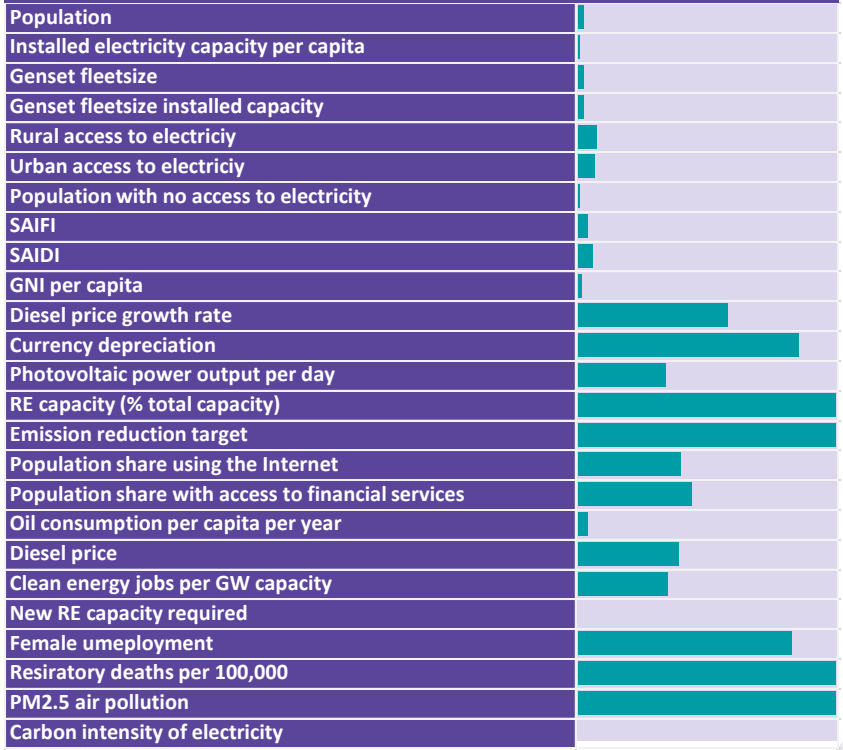
Low-user	Low affordability	Mature market	Challenging policies

Impact Story

An intervention in Nepal would help the transition for a hilly region that is uniquely disadvantaged by its geography that limits electricity access and increases climate risk

Legend: High Med Low

Analysis of Normalized Scores across 27 LMICs – Longer the teal bar, the better performance across that parameter



Rank 4: Nepal

	Insights	Relevance for ZE Gen
Market assessment	• Nepal has an estimated genset fleet of **22,000 – 32,000 units, which is 0.35x the LMIC average** • Approximately **2 million people in Nepal**, or nearly 6% of the total population, lack access to electricity. There are further complications in electricity quality due to Nepal's hilly terrain. • Classified as a **"low user," over 83%** of Nepal's installed genset capacity is used in the C&I sector	• Nepal **has low "displacement market"** compared to other countries even if the overall usage profile is likely high given its terrain • Nepal has a sizeable market for serving un-electrified populations and customers relying on gensets for power backups • As a hilly region, Nepal faces grid reliability issues; reliable and clean backup power can boost its C&I sector
Demand drivers	• Nepal has a low GNI, 0.29x the LMIC average, with a **high country risk premium** further worsening its affordability potential • The country has an installed renewable energy capacity of **100% (of total capacity)** with **98.7% of this capacity being hydropower** • Nepal has the **12th largest manufacturing of all LMICs**, with **100 MW of solar installations** (vs. 3 GW LMIC average)	• Given poor affordability factors, the likelihood of the **success of financial interventions is limited** • Nepal is entirely reliant on RE alternatives for its energy needs which does signal policy intent, however, **market maturity of non-hydro sources is limited**
Impact quantification	• Nepal has one of the **lowest carbon intensity of electricity** at 24 gCO2/kWh, which **is 0.05x the LMIC average** • It has **the highest PM2.5 air pollution** at 83 micrograms/m^3, which is 3x the LMIC average • As an hilly region, Nepal faces **limitations in grid reliability and reach** which has impact on gender equality, education, and health	• Nepal's GHG emissions reduction potential is **low-to-medium** due to the **likely high usage of gensets** in its terrain • Transitioning to renewable energy for backup power has **significant environmental benefits due to high air pollution levels** • The primary impact of intervention in Nepal will be **providing reliable backup power**

Rank 5: Fiji

Not selected for WP2 due to lower impact potential, despite profiling as a nation with a high likelihood of a successful transition

Summary of Impact Potential

- As an island nation, Fiji faces limitations in improving grid reliability and reach, compounded by climate change vulnerability, which reduces further electricity reliability
- Fiji heavily depends on gensets for backup power, especially in the tourism sector, which accounts for 40% of GDP
- Fiji has a **low carbon intensity of electricity**, at 0.6x the LMIC average
- Fiji was not selected for WP2 because the desired impact of the transition is lower compared to the Maldives

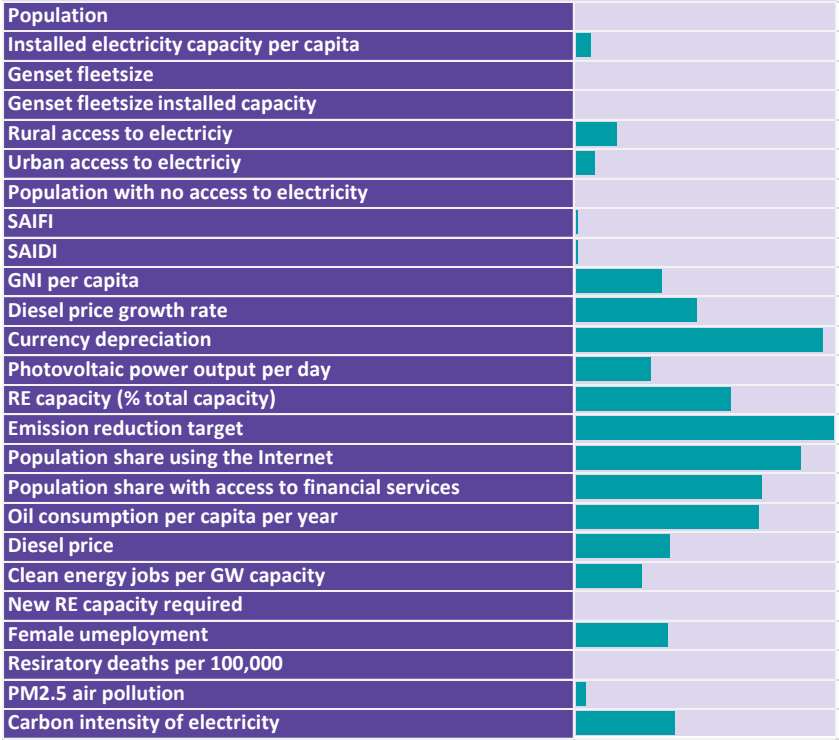
Heavy-user	High affordability	Mature market	Supportive policies

Impact Story

An intervention in Fiji would enhance electricity reliability in a nation struggling with grid reach and reliability, the main GDP contributor (tourism) heavily relies on gensets

Legend: High, Med, Low

Analysis of Normalized Scores across 27 LMICs – Longer the teal bar, the better performance across that parameter



Rank 5: Fiji

	Insights	Relevance for ZE Gen
Market assessment	• Fiji has an estimated fleet size ranging **from 500 – 1,000 units**, which is **2x the average for LMICs** with less than 1 Mn in population • Fiji has a reported **37 K people without access to electricity** which corresponds to about 4% of its population • Classified as a **"heavy user," over 90%** of the installed genset capacity is used in the C&I sectors, particularly in tourism	• Fiji has the **second largest "displacement market"** among all small island nations • A low “creation market” exists with for Fiji to electrify unserved populations • As an island nation, the Fiji faces significant climate vulnerability; and its C&I sector has **heavy dependence on back-up power with its tourism sector contributing 40% to GDP**
Demand drivers	• Fiji has a **high GNI, 1.2x the LMIC average,** 75% of the population having access to financial services and a currency that has only depreciated 4% in the last 5 years against the USD • The country has an installed renewable energy capacity of 60.1% (of total capacity) and a **commitment to reach 99% by 2030** • Fiji has the largest manufacturing sector among similarly sized LMICs, with **9 MW of solar installations** (vs. 8 MW average for similar countries)	• Given the excellent affordability factors, both C&I and residential interventions can succeed in Fiji • The 99% renewable energy target is 1.56x the LMIC average, which indicates a strong historical policy intent and future demand • Like island nations, Fiji’s demand for RE component will likely have to be met by import. It’s current RE supply chains are dominated by hydro and biogas components and services.
Impact quantification	• Fiji has **a low carbon intensity of electricity** at 288 gCO2/kWh, which is 0.6x the LMIC average • It has **low PM2.5 air pollution at 11 micrograms/m³**, which is 0.44x the LMIC average • **5 MW of installed capacity** is needed to electrify the unserved populace, and further impact can be generated by reducing fossil fuel consumption	• Fiji has a **low delta for GHG emissions reduction**, even for an island nation • As an island nation, it does face climate vulnerability, however, direct benefits **from reducing fossil fuel emissions seem lower** • The biggest co-benefit from an intervention would be **enhanced electricity reliability and reduced fuel consumption**

Research Sources that were reviewed to analyze the 27 LMICS

The sources that were reviewed to research the 27 LMICs qualitatively and quantitatively

WP1 Methodology Steps

Quantitative analysis & archetype analysis

Open-source databases	Country-wise reports form DFIs and development organizations	Other sources
• World Bank Group • International Renewable Energy Agency • International Labour Organization • Xe.com • Worldometer	• Asian Development Bank Country Reports • International Energy Agency Country Profiles	• Researchgate • Elsevier • Reputed newspapers & journals • White paper and leadership thought pieces

Qualitative analysis

Country-wise reports form DFIs and development organizations	Government Reports	Other sources
• Asian Development Bank Country Reports • International Energy Agency Country Profiles • World Bank Group Country Profiles	• Reports from governments from the LMICs that focus on energy policy, sustainability targets, and industrial incentives	• Researchgate • Elsevier • Reputed newspapers & journals • White paper and leadership thought pieces

Note: All sources have been linked in the submitted Excels

Annex 1. Legend

Explanation for the terms used for describing Archetypes

Archetype	Description	High	Medium	Low
Genset usage	Genset usage is driven by C&I use where there is higher run-time, higher WTP to pay for the costs of diesel, and larger share of installed capacity	Heavy-user - Higher capacity C&I gensets and poorer electricity quality	Med-user – Higher capacity of C&I genset or poorer electricity quality	Low-user – Lower capacity of C&I gensets and better electricity quality
Affordability potential	Countries that are likely to have higher affordability potential for RE alternatives, less expensive implementation of financing interventions	High affordability – Higher GNI and lower barriers to implementing financial interventions	Med affordability – Higher GNI or higher barriers to implementing financial interventions	Low affordability – Lower GNI and higher barriers to implementing financial interventions
Market maturity	Countries that have a mature market for RE alternatives driven by a strong manufacturing base, installed RE capacity, and planned RE capacity	Mature market – Higher maturity of RE solution and prominent manufacturing sector	Developing market – Higher maturity of RE solutions or less developed manufacturing sector	Frontier market – Low ermaturity of RE solution and less developed manufacturing sector
Policy provisions	Countries that have a supportive policy environment for RE alternatives and strong governance for ease of implementation	Supportive – Stronger RE policy support and effective governance	Neutral – Stronger RE policy support or effective governance	Challenging – Poorer RE policy support and poor ergovernance

Annex 2. Qualitative Analysis

India Qualitative Analysis (1/3)

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	As of 2023, the market size of fossil fuel gensets in India is significant and growing. The Indian gensets market was valued at $554.5 million in 2019 and is projected to grow at a compound annual growth rate (CAGR) of 6.8% during the forecast period from 2020 to 2030. The demand for gensets in India is driven by various factors, including the need for reliable power supply in residential, commercial, and industrial applications, as well as in the telecom sector. Diesel gensets continue to dominate the market due to their efficiency and cost-effectiveness.	1. https://www.psmarketresearch.com/market-analysis/india-gensets-market-outlook 2. https://www.businessresearchinsights.com/market-reports/gensets-market-110880
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	1. Commercial Sector: Diesel gensets are widely used in commercial establishments such as hospitals, hotels, and office complexes to provide backup power during grid outages. These sectors require uninterrupted power for critical operations like lighting, HVAC systems, and IT infrastructure. 2. Industrial Sector: Industries use diesel generators for continuous power supply to avoid production losses during power cuts. Key industries include manufacturing, construction, and telecommunications. 3. Residential Sector: In areas with unreliable grid supply, residential users rely on diesel gensets for essential home appliances and comfort during outages. 4. Rural and Remote Areas: Diesel gensets are vital for powering rural and remote areas where grid connectivity is poor or non-existent, supporting agricultural activities, small businesses, and community services.	1. https://www.researchandmarkets.com/reports/5758520/india-diesel-genset-market-size-forecast 2. https://www.marknteladvisors.com/research-library/india-diesel-generators-market.html
Electricity supply quality: What is the quality of electricity supplied in the country? What are the key gaps and limitations of the grid supply which are difficult to mitigate?	Quality of Electricity Supplied: India's electricity supply has faced significant challenges, primarily due to the deteriorating condition of the infrastructure managed by state electricity boards. This has impacted the country's economic growth and necessitates substantial investment to meet the growing demand from over a billion citizens. While urban areas generally experience better quality supply with fewer outages, rural areas suffer from erratic electricity with frequent voltage fluctuations and extended outages. Key Gaps and Limitations: Reliability: Despite achieving near-universal household electrification, the reliability of supply remains a major issue. Rural areas particularly experience prolonged outages compared to urban regions. Transmission and Distribution Losses: Technical losses in India's power sector are significantly higher than in more efficient systems, with transmission and distribution losses around 15.8% in 2022-23. Financial Health of Discoms: The distribution companies (discoms) are often debt-ridden, affecting their ability to maintain and upgrade infrastructure. This financial strain results in subsidized but unreliable supply, especially in rural areas. Political Constraints: Efforts to raise electricity prices to improve discoms' financial positions are often hindered by political constraints, perpetuating the cycle of poor quality supply in financially weaker ares. Rural Electrification: Although the government has made significant strides in electrifying rural areas, many villages receive a subpar quality of electricity. The distance from transmission grids to remote villages increases the cost and reduces the reliability of supply. Overall, while India has made considerable progress in expanding electricity access, improving the quality and reliability of the supply remains a critical challenge that needs to be addressed through better infrastructure, financial reforms, and	1. https://www.downtoearth.org.in/governance/indian-villages-are-100-electrified-but-what-s-next--94273 2. https://www.ibef.org/industry/power-sector-india
Policy and regulatory landscape: What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?	India's regulatory landscape for diesel generators includes stringent emission standards, particularly the CPCB IV+ standards, which mandate a 90% reduction in particulate matter (PM) and nitrogen oxides (NOx) emissions. These regulations align with European and American standards and require advanced technologies for compliance. To promote cleaner energy alternatives, the government offers subsidies, tax benefits, and grants for adopting solar, wind, and natural gas-based technologies. National policies, including India's NDCs under the Paris Agreement, set ambitious targets for renewable energy capacity and emission reductions, supported by initiatives like the National Solar Mission and the National Green Hydrogen Mission. Compliance varies, with larger businesses more likely to adhere due to stricter enforcement, while smaller entities face	1. https://www.jakson.com/blog/how-cpcb-iv-emission-standards-will-overhaul-the-genset-industry-once-and-for-all/ 2. https://dgset.net/diesel-generator/diesel-generator-rules-in-india-maharashtra/

Note: Qualitative analysis for the Top 5 countries in the Annexure.

India Qualitative Analysis (2/3)

Questions	Comments	Source
Market maturity of RE alternatives: What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?	Available RE/Alternate Energy Genset Solutions: India has a diverse array of renewable energy solutions, prominently featuring solar photovoltaic (PV) and wind power. As of mid-2023, India had over 126 GW of installed renewable capacity, with solar PV and onshore wind accounting for the majority of this capacity. Major renewable developers like Adani Green Energy and ReNew dominate the market, holding a significant portion of the total operational assets. Market Maturity: India's renewable energy market is rapidly maturing, driven by ambitious government targets and supportive policies. The country aims to reach 500 GW of non-fossil fuel energy capacity by 2030 and achieve net-zero emissions by 2070. The renewable energy mix is set to expand significantly, with targets for solar power at 280 GW and wind power at 140 GW by 2030. India's progress is also supported by substantial investments in advanced energy solutions, including energy storage and green hydrogen. The government has implemented various incentives, such as production-linked incentive schemes and viability gap funding, to attract investment and promote domestic manufacturing of renewable energy technologies. Additionally, competitive tenders have played a crucial role in consolidating the renewable energy market, with local companies winning a significant share of tenders despite the availability of 100% foreign direct investment in the sector. This competitive environment has led to the emergence of large portfolio owners, contributing to the overall maturity of the market. Conclusion: India's renewable energy market is on a strong growth trajectory, supported by robust government policies, significant investments, and competitive market dynamics. The focus on solar PV, wind power, and emerging technologies like energy storage and green hydrogen indicates a promising future for renewable energy solutions in India .	1. https://www.spglobal.com/commodityinsights/en/ci/research-analysis/indias-leading-renewable-companies-in-2023.html 2. https://www.trade.gov/country-commercial-guides/india-renewable-energy 3. https://www.weforum.org/agenda/2024/05/india-emerging-advanced-energy-superpower/ 4. https://www.iea.org/reports/world-energy-investment-2024/india
Supply chain of RE alternatives: How do existing and potential supply chains for cleaner energy solutions, including renewable energy components, hybrid systems, and related services, impact the availability, accessibility, and affordability of these solutions in target markets?	India's supply chain for renewable energy faces challenges and opportunities. The government is promoting local manufacturing of solar panels and batteries to reduce dependence on imports and improve supply chain security. Financial incentives and tax reductions are being considered to make renewable projects more affordable. However, supply chain bottlenecks, such as regulatory delays and logistical issues, still pose significant challenges. Public-private partnerships are essential for infrastructure development and integrating renewable energy sources into the grid	1. https://www.spglobal.com/commodityinsights/en/ci/research-analysis/top-trends-in-2024-for-indias-power-and-renewables-markets.html 2. https://www.iea.org/reports/renewables-integration-in-india 3. https://ieefa.org/sites/default/files/2023-01/Emerging%20Investment%20Opportunities%20in%20India%27s%20Clean%20Energy%20Sector_Jan23.pdf#:~:text=URL%3A%20https%3A%2F%2Fieefa.org%2Fsites%2Fdefault%2Ffiles%2F2023 4. https://oilprice.com/Energy/Energy-General/Renewable-Energy-Faces-Supply-Chain-Bottlenecks.html
Access to financing options: How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?	Renewable energy solutions, such as solar power, are more cost-effective over time compared to diesel generators. The levelized cost of electricity (LCOE) for solar power ranges from Rs. 7-8.50/kWh, whereas diesel power costs about Rs. 16/kWh, potentially rising to Rs. 20/kWh with fuel price increases. The Indian government supports this transition through subsidies, tax benefits, and grants for renewable energy projects. Financing options include grants, loans, and carbon credits, enhancing accessibility for various market segments.	1. https://peterheinzl.com/solar-generators-vs-diesel-generators 2. https://www.eai.in/ref/ae/sol/rooftop/solar-vs-diesel 3. https://www.pv-magazine-india.com/2022/09/14/battery-energy-storage-systems-as-an-alternative-to-diesel-generators/ 4. https://www.datacenterdynamics.com/en/analysis/plant-powered-generators-switching-data-centers-from-diesel-to-hvo/

India Qualitative Analysis (3/3)

Questions	Comments	Source
Market segmentation: What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?	General Awareness: Awareness about renewable energy, particularly solar and wind power, is increasing due to government campaigns and visible project deployments. Approximately 59% of commercial consumers and 52% of residential consumers recognize the benefits of solar power for addressing energy shortages. Urban Consumers: Higher awareness due to better access to information and exposure to urban renewable projects Rural Consumers: Growing awareness, especially where decentralized solutions like solar home systems are implemented General Willingness: Moderate WTP for renewable energy, influenced by environmental concerns and economic constraints Government offers schemes 40% of installation cost savings for residential installments. Other incentives include: accelerated depreciation,	1. https://www.frontiersin.org/articles/10.3389/fenrg.2023.1088297/full 2. https://smartenergycc.org/renewables-engaging-consumers-in-the-clean-energy-transition-report/ 3. https://www.orfonline.org/research/evaluating-readiness-for-renewable-energy-adoption-in-india-a-multi-state-survey-of-industrial-and-residential-power-consumers#:~:text=Perception%20of%20Green%20Energy,to%20promote%20green%20energy%20adoption.
Any other research insights unique to an LMIC.	Renewable energy solutions, such as solar power, are more cost-effective over time compared to diesel generators. The levelized cost of electricity (LCOE) for solar power ranges from Rs. 7-8.50/kWh, whereas diesel power costs about Rs. 16/kWh, potentially rising to Rs. 20/kWh with fuel price increases. The Indian government supports this transition through subsidies, tax benefits, and grants for renewable energy projects. Financing options include grants, loans, and carbon credits, enhancing accessibility for various market segments. Mini-grids, solar home systems (SHS), and commercial & industrial (C&I) applications hold significant potential for broadening clean energy adoption in India. Mini-grids can reduce power costs by up to 30% for rural MSMEs and are expanding rapidly, although they face challenges with high initial costs and complex infrastructure needs . SHS provides decentralized, autonomous power for individual households, with innovations like smart meters and PAYGo systems improving affordability and payment management. The C&I sector benefits from lower costs for solar power (Rs. 3.5 per kWh) compared to grid power (Rs. 6-10 per kWh), despite facing module price volatility and capital investment challenges. Financing options like grants, loans, and risk-mitigation instruments, along with government support, are crucial for scaling these clean energy solutions.	1. https://peterheinzl.com/solar-generators-vs-diesel-generators 2. https://www.eai.in/ref/ae/sol/rooftop/solar-vs-diesel 3. https://www.pv-magazine-india.com/2022/09/14/battery-energy-storage-systems-as-an-alternative-to-diesel-generators/ 4. https://www.datacenterdynamics.com/en/analysis/plant-powered-generators-switching-data-centers-from-diesel-to-hvo/ 5. https://www.saurenergy.com/solar-energy-conversation/husk-power-plans-to-commission-more-mini-grids-in-india-william-brent-cmo 6. https://cleantechnica.com/2019/09/04/solar-home-systems-mini-grids-same-same-but-different/

Bangladesh Qualitative Analysis (1/2)

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	The Bangladesh Diesel Genset Market is projected to grow at a CAGR of 9.9% during 2021-2027. In terms of market size, Bangladesh occupies the 14th position in the Asia Pacific Diesel Genset market. Additionally, the annual sales of diesel generators in Bangladesh are estimated to be around Tk3,000 crore, and if smaller generators are considered, this figure might reach Tk4,000 crore. Government projects account for at least 15% of large generator purchases.	1.https://www.6wresearch.com/industry-report/bangladesh-diesel-genset-generator-market-2021-2027 2.https://www.tbsnews.net/companies/energypac-plans-go-global-large-diesel-generators-167701
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	1.Backup Power for Homes and Businesses. 2.Construction and Engineering Projects 3.Agriculture and Farming 4.Telecom and Internet Services 5.Emergency Response and Disaster Relief	1.https://www.6wresearch.com/industry-report/bangladesh-diesel-genset-market-2021-2027 2.https://www.abpowerbd.com/products/generator 3.https://www.globenewswire.com/en/news-release/2021/05/04/2222087/28124/en/Bangladesh-Diesel-Genset-Market-Report-2021-Focus-on-Residential-Commercial-Industrial-Healthcare-Hospitality-Public-Infrastructure.html
Electricity supply quality: What is the quality of electricity supplied in the country? What are the key gaps and limitations of the grid supply which are difficult to mitigate?	1.The government is working to ensure uninterrupted, quality, and affordable electricity nationwide. State Minister Nasrul Hamid highlighted efforts to enhance power capacity and transmission, with plans for underground power cables and substations. Power companies, including DPDC, are implementing various projects, resulting in significant progress. Since taking office, the government has built 111 new power plants, increasing generation capacity to 23,548 MW and expanding coverage to 98% of the population. Aiming for 60,000 MW by 2041, the government is also focusing on solar energy to boost renewable contributions. 2.Demand-Supply Gap: Bangladesh experiences a substantial gap between electricity demand and supply. Despite improvements, power plants are often unable to meet peak demands, especially during hot weather, leading to frequent power outages	1.https://www.tbsnews.net/bangladesh/energy/efforts-underway-uninterrupted-quality-power-supply-affordable-price-160846 2.https://energytracker.asia/bangladesh-energy-scenario/
Policy and regulatory landscape: What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?	1. **Net Metering Policy:**The policy allows individuals and businesses with rooftop solar panels to sell excess electricity back to the grid, encouraging investment in solar power. 2.Offering tax exemptions and incentive tariffs to incentivize renewable energy investments. 3.**Environmental Regulations:** Bangladesh follows global trends in reducing emissions from diesel engines. The implementation of Tier 4 Final standards by the Environmental Protection Agency (EPA) in many countries influences policies in Bangladesh as well. These standards mandate significant reductions in particulate matter (PM) and nitrogen oxides (NOx) emissions from diesel engines, which increases the cost and complexity of using diesel gensets.	1.http://bd.bpdb.gov.bd/bpdb/index.php/site/page/5a3f-2fdb-e75f-3cab-e66b-f70d-5408-cbc9-f489-c31c 2.https://www.sciencedirect.com/science/article/pii/S2211467X24000439 3.https://woodstockpower.com/blog/epa-tier-4-final-regulation-impacts-diesel-generators/
Market maturity of RE alternatives: What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?	1.**solar Home Systems (SHS)**: Grameen Shakti has installed around 1.8 million SHS, providing clean energy to more than 9 million people in rural areas. These systems have significantly improved access to electricity in off-grid areas, promoting better health, education, and productivity. 2.**Wind Power:** Wind energy is being explored, with 149 MW of wind power capacity installed. However, the development of wind energy faces challenges due to the need for detailed resource mapping and zoning. 3.In Bangladesh, solar power is the most mature renewable energy source, with wind, biomass, biogas, hydropower, and ocean energy still developing. These technologies face investment and integration challenges.	1.https://www.dhakatribune.com/science-technology-environment/climate-change/256374/how-grameen-shakti-is-providing-a-sustainable 2.https://bangladesh.un.org/en/260959-bangladesh%E2%80%99s-energy-transition-journey-so-far 3.https://www.tbsnews.net/supplement/renewable-energy-nature-based-sustainable-solution-smart-bangladesh-783198

Bangladesh Qualitative Analysis (2/2)

Questions	Comments	Source
Supply chain of RE alternatives: How do existing and potential supply chains for cleaner energy solutions, including renewable energy components, hybrid systems, and related services, impact the availability, accessibility, and affordability of these solutions in target markets?	1.In Bangladesh, the supply chains for cleaner energy solutions, including renewable energy components and hybrid systems, significantly impact their availability, accessibility, and affordability. Reliance on imports, the need for local manufacturing, and improved infrastructure are crucial for consistent availability. Strengthening distribution networks, implementing supportive government policies, and raising public awareness can enhance accessibility. Affordability hinges on economies of scale, financing options, and reducing component costs. Integration of hybrid systems and robust maintenance services further supports sustainability. Successful initiatives like solar home systems, mini-grids, and biogas projects illustrate these principles in action, promoting broader adoption of renewable energy in the country.	1.https://www.adb.org/sites/default/files/publication/177814/ban-making-renewable-energy-success.pdf 2.https://www.researchgate.net/publication/331695113_Renewable_energy_in_Bangladesh_Status_and_prospects
Access to financing options: How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?	1.Grameen Shakti focuses on promoting renewable energy technologies, particularly solar home systems, in rural Bangladesh through microfinancing and grant programs. 2.IDCOL offers financing and implementation support for sustainable infrastructure projects, including renewable energy initiatives.	1.https://www.gshakti.org/about-us/missionvision 2.https://idcol.org/home/about
Market segmentation: What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?	Compared to rural areas, urban areas have a six fold increase in the adoption of clean energy. The Government of Bangladesh should be cautious in promoting the adoption of clean energy, particularly in rural areas. Additionally, efforts to increase education and reduce poverty in rural Bangladesh can contribute greatly to the successful adoption of clean energy options for rural people.	1.https://www.nature.com/articles/s41598-024-52798-7
Any other research insights unique to an LMIC.		

Maldives Qualitative Analysis (1/3)

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	The Maldives relies significantly on imported refined petroleum products, with around 290 megawatts (MW) of diesel generation capacity installed across inhabited islands. Additionally, resort islands have an extra 144 MW, and industrial islands contribute about 20 MW	1.https://www.adb.org/sites/default/files/linked-documents/mld-46122-005-ssa.pdf
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	Island Electrification: The Maldives consists of numerous islands, and diesel gensets play a crucial role in providing electricity to these remote locations. They serve as the primary power source for inhabited islands, resorts, and industrial facilities. Backup Power: Diesel gensets act as backup power sources during grid outages. When the main power grid fails, these generators automatically kick in, ensuring critical appliances and systems remain operational. Hybrid Systems: The Maldives is actively transitioning to renewable energy sources. However, diesel generators are still essential in hybrid systems that combine solar or wind power with diesel generation. These systems provide reliable electricity while reducing reliance on fossil fuels. Marine Applications: Cummins, a global entity, offers diesel engines and generating sets in the Maldives. These are used in marine applications, including power transmission equipment for marine engines	1.https://sempraelectric.com/2024/05/09/exporter-of-diesel-generator-in-maldives/ 2.https://www.energy-storage.news/solar-and-battery-microgrids-reduce-diesel-reliance-for-26-islands-in-maldives/ 3.https://electrifymv.com/
Electricity supply quality: What is the quality of electricity supplied in the country? What are the key gaps and limitations of the grid supply which are difficult to mitigate?	Maldivians have enjoyed universal access to electricity since 2008, but the heavy reliance on imported diesel and isolated island-based grids has driven up the costs of electricity generation. Even with subsidies, which add to the government's fiscal burden, electricity tariffs are among the highest in the South Asia region. Some gaps are Inadequate Capacity, Dependency on Diesel Generators, High Costs and Financial Risks:	1.https://www.worldbank.org/en/news/feature/2020/12/11/maldives-building-back-better-through-clean-energy

Maldives Qualitative Analysis (2/3)

Questions	Comments	Source
Policy and regulatory landscape: What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?	Promoting Alternate Sources of Gensets: Net Zero Goals: Regulatory changes and public pressure are driving the transition toward cleaner energy sources. Private sector investments play a crucial role in filling the funding gap for decarbonization efforts. Renewable Energy Emphasis: The recently gazetted Maldives Energy Act places emphasis on renewable energy usage. It introduces a new licensing regime to regulate the energy sector and encourages the adoption of cleaner alternatives. Resource Efficiency: Studies highlight the influence of solar photovoltaic (PV) use on improving efficiency levels in power generation. Privately owned power plants in resort islands tend to be more efficient, emphasizing the importance of renewable energy adoption. Discouraging Diesel Gensets: Cost and Reliability: While diesel gensets have been essential for electrification in the Maldives, their reliance on imported fuel drives up costs. Additionally, intermittent supply remains a challenge due to inadequate planning and technical know-how. Transition to Clean Energy: The government aims for long-term sustainability and independence from diesel-based power generation. Scaling up renewable energy can provide budgetary relief and reduce reliance on fossil fuels.	1.https://impact-investor.com/net-zero-funds-regulatory-and-societal-tailwinds-lift-net-zero-strategies/ 2.https://policy.asiapacificenergy.org/sites/default/files/Maldives%20Energy%20Act%20%28Law%20No.%2018-2021%20of%202021%29%20%28Overview%29.pdf 3.https://oak.go.kr/repository/journal/23389/jafeb_2020_07_01_111.pdf 4.https://www.worldbank.org/en/news/feature/2020/12/11/maldives-building-back-better-through-clean-energy
Market maturity of RE alternatives: What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?	Different alternatives are Solar, Magnetic generator, Wind turbine, Modular energy storage. The market maturity varies, but the Maldives is actively adopting RE solutions to reduce dependence on imported fossil fuels. Considering factors like power output, energy source, portability, cost, and reliability when choosing a solution is always useful.	1.https://renewablewatch.in/2023/10/05/greening-the-maldives-uptake-of-clean-energy-in-the-island-nation/#:~:text=Maldives%20has%20been%20naturally%20endowed,including%20solar%2C%20wind%20and%20ocean.
Supply chain of RE alternatives: How do existing and potential supply chains for cleaner energy solutions, including renewable energy components, hybrid systems, and related services, impact the availability, accessibility, and affordability of these solutions in target markets?	Supply Chain Resilience: Too much reliance on imports can make the industry vulnerable to production shortages, trade disruptions, and natural disasters. Affordability: Supply chain disruptions can lead to cost fluctuations. For instance, price shocks in mineral markets impact clean energy affordability. Renewable energy delivery: Solar accounts to 95% of renewable energy. Energy storage through BESS (Poised project) has been active and impacting the renewable energy lanscape through easy availability.	https://renewablewatch.in/2023/10/05/greening-the-maldives-uptake-of-clean-energy-in-the-island-nation/#:~:text=Maldives%20has%20been%20naturally%20endowed,including%20solar%2C%20wind%20and%20ocean.

Maldives Qualitative Analysis (3/3)

Questions	Comments	Source
Access to financing options: How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?	World Bank-Financed Projects: The ASPIRE and ARISE projects, supported by the World Bank, have installed over 53.5 megawatts of solar capacity and 50 megawatt-hours of battery storage in the Maldives. These projects reduce the country's annual import bill by approximately $30 million and provide quasi-budgetary support. The Greater Male Waste-to-Energy Project is financed through loans, grants, and counterpart funds,Enhancing sustainability and reducing waste-related environmental challenges. De-risking Investments:The World Bank's approach focuses on risk mitigation to attract private investment	1.https://www.worldbank.org/en/results/2023/03/14/powered-by-the-sunshine-achieving-cheaper-cleaner-and-sustainable-energy-in-the-maldives 2.https://www.aiib.org/en/projects/details/2020/approved/_download/project-implementation-monitoring-report/February-2022/Maldives_P000278_Greater-Male-Waste-to-Energy-Project_No.3_February_2022_Public-Version.pdf 3.https://www.worldbank.org/en/news/feature/2022/04/20/derisking-investments-to-build-a-green-maldives
Market segmentation: What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?	The projection of adaptation of solar is evident from the national target of renewable energy and decrease of fossil fuel usage.	1.https://www.adb.org/sites/default/files/publication/654021/renewables-roadmap-energy-sector-maldives.pdf
Any other research insights unique to an LMIC.		

Nepal Qualitative Analysis (1/4)

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	Market Overview: Nepal relies significantly on diesel gensets for backup power due to an underdeveloped grid infrastructure and frequent power cuts. The country imports a considerable number of gensets to meet its energy needs, particularly in sectors such as healthcare, manufacturing, and hospitality. Installed Capacity: According to the Asian Development Bank (ADB), the total installed capacity of diesel generators in Nepal is substantial, although exact figures vary. The reliance on diesel gensets is more pronounced in remote and rural areas where grid connectivity is either limited or non-existent.	1. https://documents1.worldbank.org/curated/en/592481554093658883/pdf/Nepal-Energy-Infrastructure-Sector-Assessment.pdf
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	The primary drivers for the genset market in Nepal include: Frequent Power Outages: Nepal experiences significant power shortages, prompting businesses and households to invest in backup power solutions. Remote and Rural Electrification: Many remote areas depend entirely on gensets for electricity, especially in the absence of grid connectivity. Industrial and Commercial Use: Industries and commercial establishments use gensets to ensure uninterrupted operations, critical for sectors such as manufacturing and hospitality. Commercial Sector Applications: Backup power for retail businesses, hotels, and office buildings. User Needs: Continuous operations during power outages, ensuring customer satisfaction and operational efficiency. Customer Segments: Hospitality industry, retail stores, and office complexes. Value Addition: Provides reliability and operational continuity, essential for maintaining business operations and customer service during outages. Industrial Sector Applications: Primary and backup power for manufacturing plants, construction sites, and telecom infrastructure. User Needs: Uninterrupted power supply to support critical operations and heavy machinery, ensuring project timelines are met and operations remain smooth. Customer Segments: Manufacturing units, construction companies, and telecom operators. Value Addition: Enhances productivity and operational efficiency, reducing downtime and ensuring consistent workflow. Healthcare Sector Applications: Backup power for hospitals, clinics, and medical facilities. User Needs: Maintaining power for life-saving equipment and medical operations, ensuring patient safety and continuous healthcare services. Customer Segments: Hospitals, clinics, emergency medical facilities. Value Addition: Ensures the functionality of critical medical devices and systems, crucial for patient care during power outages.	

Nepal Qualitative Analysis (2/4)

Electricity supply quality: What is the quality of electricity supplied in the country? What are the key gaps and limitations of the grid supply which are difficult to mitigate?	Quality of Electricity Supplied: Nepal's electricity supply quality is often characterized by frequent outages and voltage fluctuations. Despite efforts to improve the infrastructure, the country continues to face challenges in providing consistent and reliable electricity, particularly in rural areas. Urban centers generally experience better quality, but even these areas are not immune to disruptions. Key Gaps and Limitations of the Grid Supply: Frequent Power Outages: Nepal suffers from regular power outages due to various factors including infrastructure inadequacies and seasonal variations in hydropower generation. Underdeveloped Infrastructure: The grid infrastructure, especially in rural areas, is underdeveloped, leading to significant transmission and distribution losses. Dependency on Hydropower: Nepal's reliance on hydropower makes it vulnerable to seasonal variations and climate change impacts, affecting the consistency of power supply. Financial Constraints: The financial health of the Nepal Electricity Authority (NEA) and other power sector entities limits their ability to invest in necessary upgrades and maintenance of the grid. Geographical Challenges: Nepal's challenging topography makes the extension and maintenance of grid infrastructure difficult and costly.	1. https://documents1.worldbank.org/curated/en/592481554093658883/pdf/Nepal-Energy-Infrastructure-Sector-Assessment.pdf
Policy and regulatory landscape: What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?	Promoting Alternate Sources of Gensets: Government Initiatives: The Government of Nepal has been actively promoting renewable energy sources through various initiatives and subsidies aimed at reducing reliance on diesel gensets. Projects like the Alternative Energy Promotion Centre (AEPC) support the development and adoption of renewable energy technologies, including solar and wind power. The AEPC provides financial incentives and technical assistance to encourage the use of clean energy solutions. Financial Support and Grants: International organizations such as the Asian Development Bank (ADB) and the World Bank have been providing grants and loans to support Nepal's transition to renewable energy. These funds are used to develop infrastructure and promote the adoption of renewable energy technologies, thereby reducing dependence on fossil fuel-based gensets. Discouraging the Use of Diesel Gensets: Emission Standards: Nepal is aligning with stricter emission standards similar to the CPCB IV+ norms in India, which aim to significantly reduce particulate matter (PM) and nitrogen oxides (NOx) emissions from diesel generators. These regulations require genset manufacturers to invest in advanced emission control technologies, thereby discouraging the use of older, polluting diesel gensets (Jakson). Regulatory Measures: The government has implemented policies to phase out older, high-emission gensets and promote cleaner alternatives. This includes higher tariffs on diesel fuel and incentives for the adoption of cleaner technologies. Environmental Policies: Nepal's commitment to reducing its carbon footprint and addressing climate change has led to the implementation of policies that favor renewable energy over fossil fuels. These policies are part of Nepal's broader strategy to meet its sustainable development goals and reduce greenhouse gas emissions.	

Nepal Qualitative Analysis (3/4)

Market maturity of RE alternatives: What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?	Available RE/Alternate Energy Genset Solutions: Solar Power: Nepal has been progressively increasing its solar capacity. By the end of 2021, the country had installed 93 MW of cumulative solar capacity, and projects are underway to expand this further with the help of international consultants and funding from bodies like the Asian Development Bank (ADB). Solar home systems (SHS) and solar mini-grids are particularly prominent in remote and rural areas, addressing energy access where the national grid is unavailable Hydropower: Hydropower remains the backbone of Nepal's renewable energy strategy. Projects like the Upper Trishuli-1 Hydropower Project, with a capacity of 216 MW, highlight significant investments in this sector. This project is co-financed by a consortium of multilateral development banks, led by the International Finance Corporation (IFC), and employs innovative financing methods such as parametric insurance to mitigate risks Hybrid Systems: There is a growing interest in hybrid systems that combine solar and wind energy. For instance, Nepal is seeking to expand its power system through projects that include solar-wind hybrid energy systems, particularly aimed at remote areas. These projects are part of broader efforts to enhance energy security and reduce reliance on fossil fuels Market Maturity: The renewable energy market in Nepal is in a rapid development phase, supported by both government initiatives and international aid: Government Support and Policies: The government of Nepal has introduced various policies to promote renewable energy. This includes financial incentives for renewable energy projects and efforts to streamline regulatory frameworks to facilitate investment in clean energy technologies International Collaboration: Partnerships with international companies and financial institutions are crucial. For example, Tata Power Renewable Energy Limited's (TPREL) collaboration with Dugar Power Private Limited aims to deploy transformative solar technologies in Nepal, providing both on-grid and off-grid solutions	1. https://www.adb.org/publications/nepal-energy-strategy-roadmap 2. https://corporatesolutions.swissre.com/insights/knowledge/parametric-renewable-energy-nepal.html 3. https://www.tatapowersolar.com/press-release/tata-power-renewable-energy-limited-and-dugar-power-forge-tie-up-to-accelerate-nepals-renewable-energy-initiatives
Supply chain of RE alternatives: How do existing and potential supply chains for cleaner energy solutions, including renewable energy components, hybrid systems, and related services, impact the availability, accessibility, and affordability of these solutions in target markets?	Renewable Energy Components: Solar Power: Nepal relies on both domestic manufacturing and imports for solar components. Projects like the Rural Electrification Support Project funded by international bodies ensure a steady supply of solar panels and inverters Hydropower: Hydropower projects like Upper Trishuli-1 involve international collaboration for technology and investment, enhancing the local supply chain for turbines and other hydropower equipment (Swiss Re). Solar-Hydropower Hybrids: Interest in hybrid systems is growing, combining solar and hydropower to utilize seasonal water flow efficiently. These systems require integrated technology solutions, often sourced through international partnerships Impact on Availability, Accessibility, and Affordability: Availability: International collaborations, such as the partnership between Tata Power and Dugar Power, improve the availability of renewable energy components by bringing in advanced technology and expertise Accessibility: Government initiatives and international funding, like those from the Asian Development Bank, improve accessibility, particularly in remote areas Affordability: Subsidies, grants, and low-interest loans from international bodies help reduce costs for consumers and businesses, making renewable energy solutions more affordable	1. https://www.adb.org/publications/nepal-energy-strategy-roadmap 2. https://corporatesolutions.swissre.com/insights/knowledge/parametric-renewable-energy-nepal.html 3. https://www.tatapowersolar.com/press-release/tata-

Nepal Qualitative Analysis (4/4)

Access to financing options: How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?	Grants and Loans: The OPEC Fund provided a US$15 million loan to NMB Bank for renewable energy projects and MSMEs, addressing financial gaps and supporting local hydro projects Innovative Financing Models: The Upper Trishuli-1 Hydropower Project uses parametric insurance to mitigate risks from natural disasters, ensuring financial viability Impact on Market Segments: Rural and Remote Communities: Accessibility: Grants and low-interest loans from organizations like the ADB and World Bank improve energy access in remote areas. Suitability: Tailored financial support for small-scale projects meets decentralized energy needs. Commercial and Industrial Sectors: Accessibility: Loans and grants facilitate large-scale renewable projects, reducing costs. Suitability: Innovative financing like carbon credits helps industries adopt cleaner technologies. Government and Public Services: Accessibility: Government and international funding enhance renewable energy access for public services. Suitability: Projects align with national development and climate goals.	1. https://opecfund.org/media-center/press-releases/2021/the-opec-fund-boosts-renewable-energy-and-access-to-finance-in-nepal 2. https://www.energyglobal.com/special-reports/10052021/the-opec-fund-to-support-renewable-energy-projects-in-nepal/
Market segmentation: What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?	Consumer Awareness: Awareness of renewable energy (RE) alternatives is rising due to government and international initiatives like those from the ADB and World Bank (Frontiers) (DSpace MIT). Willingness-to-Pay (WTP): Urban Households: Higher WTP due to better economic conditions and environmental awareness, particularly in cities like Kathmandu. Rural Communities: Lower WTP, but government subsidies and grants improve access to solar home systems and mini-grids. Commercial Sector: Businesses, especially in hospitality and manufacturing, invest in RE to reduce costs and enhance sustainability. Government and Public Services: Increasing adoption of RE to improve energy reliability and reduce fossil fuel dependency. Summary Consumer awareness and WTP for renewable energy in Nepal are increasing, especially in urban areas and among higher-income groups. Government and international support are crucial for making RE more accessible and affordable.	
Any other research insights unique to an LMIC.		

Fiji Qualitative Analysis (1/3)

Questions	Comments	Source
Market size: What is the market size of fossil fuel gensets in the country?	Fiji, like many island nations, relies heavily on diesel gensets for backup power and primary power in remote areas. This is driven by the need for reliable power supply amidst frequent power outages and limited grid infrastructure. The diesel genset market in the Asia-Pacific region, which includes Fiji, is expected to see substantial growth due to increasing demand for reliable power solutions in the face of infrastructure challenges and natural disaster. Key Insights: Reliability and Demand: Diesel gensets are favored in Fiji for their reliability and ability to provide immediate power during outages, which are common in the region. Market Growth: The genset market in the Asia-Pacific region is poised for growth due to rapid urbanization, industrialization, and the increasing need for reliable power in both residential and commercial applications. Application: In Fiji, gensets are critical for various sectors, including healthcare, telecommunications, and industrial operations, ensuring continuous operations during power disruptions. While specific figures for Fiji are not readily available, these insights suggest a robust market for fossil fuel gensets, driven by the country's need for dependable power solutions.	https://www.adb.org/sites/default/files/linked-documents/cps-fij-2014-2018-ssa-03.pdf
Application and use cases: What are the key use cases of diesel gensets in the country, disaggregated by key sectors, user needs, customer segments and value addition?	Commercial Sector Applications: Backup power for retail businesses, hotels, hospitals. Needs: Continuous operations during outages. Segments: Hospitality, healthcare, retail. Value: Ensures reliability and operational continuity Industrial Sector Applications: Power for construction sites, manufacturing plants, telecom infrastructure. Needs: Continuous power for critical operations. Segments: Construction, manufacturing, telecom. Value: Enhances productivity and efficiency Residential Sector Applications: Backup power for homes in remote areas. Needs: Reliable power during outages. Segments: Homeowners in rural areas. Value: Ensures basic amenities and safety	1. https://www.trade.gov/country-commercial-guides/fiji-renewable-energy 2. https://www.fijivillage.com/news/FEA-brings-in-4-new-diesel-generators-s5r2k9/

Fiji Qualitative Analysis (2/3)

Questions	Comments	Source
Policy and regulatory landscape: What are the policy/regulatory tailwinds of promoting alternate sources of gensets? Conversely, are there any policy/regulations discouraging the use of diesel gensets?	Renewable Energy Policy: The Fiji Government has implemented the National Energy Policy (NEP) which aims to increase the share of renewable energy in the national energy mix. The policy includes incentives for the adoption of renewable energy sources such as solar, wind, and biomass. Investment Incentives: Tax incentives, subsidies, and grants are provided for renewable energy projects. This includes reduced import duties on renewable energy equipment and tax holidays for companies investing in renewable energy infrastructure. International Support: Fiji receives significant support from international organizations such as the World Bank, Asian Development Bank (ADB), and various UN agencies for renewable energy projects. These organizations provide funding, technical expertise, and policy advice. Feed-in Tariffs (FiTs): Feed-in Tariffs are offered to encourage the development of renewable energy projects by guaranteeing a fixed payment for the electricity generated from renewable sources. Discouraging the Use of Diesel Gensets: Environmental Regulations: The Environmental Management Act and other related policies impose strict regulations on emissions from diesel gensets. Operators are required to comply with these regulations, which can increase operational costs. Fuel Subsidy Reductions: The government is gradually reducing subsidies for diesel fuel, making diesel gensets less economically attractive compared to renewable alternatives. Carbon Tax: The introduction of carbon pricing mechanisms, such as a carbon tax, makes the use of diesel gensets more expensive. This incentivizes the shift towards cleaner energy sources. Public Awareness Campaigns: Government and non-government organizations conduct awareness campaigns highlighting the environmental and	
Market maturity of RE alternatives: What are the available RE/alternate energy genset solutions available? What is the market maturity of these solutions?	Solar Power Gensets: Description: Solar gensets use photovoltaic panels to generate electricity, often paired with battery storage systems for consistent power supply. Market Maturity: High. Solar power is well-established in Fiji, supported by various government initiatives and international aid programs aimed at increasing renewable energy adoption. The installation of solar panels in both urban and rural areas has been steadily growing. Wind Power Gensets: Description: Wind gensets generate power using wind turbines. These are typically deployed in areas with high wind potential. Market Maturity: Medium. While Fiji has a suitable environment for wind energy, the deployment of wind power gensets is still in its early stages compared to solar. There are ongoing projects and studies to expand wind energy capacity. Market Maturity: Supportive Policies: Fiji's government has been proactive in promoting renewable energy through supportive policies, subsidies, and tax incentives. International Aid and Investment: Various international organizations and countries have invested in Fiji's renewable energy sector, providing funding and technological support. Public Awareness: Increasing awareness of the benefits of renewable energy among the public and businesses has accelerated the adoption of these technologies.	

Fiji Qualitative Analysis (3/3)

Questions	Comments	Source
Access to financing options: How do various financing options for cleaner energy projects, including grants, loans, and innovative financing models like carbon credits, impact the accessibility and suitability of these options for different market segments?	Grants and Loans: Fiji has access to various grants and loans to support its clean energy projects. Notably, the Asian Development Bank (ADB) and the Government of Fiji signed a grant agreement totaling $3 million to improve access to renewable energy through the Rural Electrification Support Project. This project aims to provide renewable energy to remote locations, directly benefiting around 190 household. Additionally, the Fiji Rural Electrification Fund (FREF) is a significant initiative that uses a revolving fund structure combining affordable tariff payments with grant financing to electrify rural communitie. Innovative Financing Models: Fiji also leverages innovative financing models like carbon credits. The Fiji Climate Finance Strategy is designed to secure funding from various sources, including the Green Climate Fund. This strategy helps Fiji to align its climate goals with international funding opportunities, ensuring that projects are well-funded and sustainable. Impact on Market Segments: Rural and Remote Communities: The availability of grants and innovative financing models significantly enhances the accessibility of clean energy solutions for rural and remote communities. For instance, projects funded through FREF have already started to electrify these areas, providing them with reliable and sustainable energy. Commercial and Industrial Sectors: Loans and grant programs support the deployment of larger scale renewable energy projects, making it feasible for commercial and industrial sectors to transition to cleaner energy sources. This is crucial for reducing operational costs and enhancing sustainability in these sectors. Government and Public Services: The integration of climate finance strategies into national policies ensures that public services can access the necessary funds to implement renewable energy projects. This not only improves energy security but also aligns with Fiji's broader climate resilience goals.	1. https://fijiclimatechangeportal.gov.fj/publication/climate-finance-infographic/ 2. https://www.adb.org/news/adb-fiji-sign-grant-improved-access-renewable-energy-generated-electricity 3. https://www.weforum.org/agenda/2022/09/world-can-learn-from-fijis-national-climate-finance-strategy/ 4. https://www.fbcnews.com.fj/news/accelerating-solar-mini-grid-deployment-in-fiji/
Market segmentation: What is the consumer awareness and willingness-to-pay (WTP) for RE alternatives among key market segments?	Fiji's strategic focus on renewable energy and the availability of financing options like grants, loans, and carbon credits significantly enhance the accessibility and attractiveness of RE alternatives for various market segments	
Any other research insights unique to an LMIC.		

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