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Review

Potential, Current Status, and Renewable Energy in Energy Sector of Palestine: A Review

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Abstract
Palestine faces a critical energy challenge marked by over 94% dependence on imported electricity and fuels alongside rapid demand growth and territorial restrictions. This review synthesizes 50 academic, policy, and institutional sources (2015–2025) on renewable energy (RE) in Palestine, with focus on solar, wind, and biogas. Despite policy frameworks such as Law No. 14/2015, installed PV capacity reached only ~199 MW by 2023, contributing less than 2% of total primary energy, while grid losses remain ~22–24%. A structured synthesis links technical, regulatory, financial, and land-use constraints into an integrated policy map. Comparative benchmarking with Jordan and Morocco highlights transferable mechanisms (open grid access, competitive tenders, PPAs) that could accelerate adoption. The study concludes with policy-ready recommendations: grid modernization, concessional financing, streamlined permitting, and public engagement to support a coherent RE transition toward 2030 and beyond.

1. Introduction

Energy is a cornerstone of modern economies, directly influencing social welfare, industrial growth, and environmental sustainability. In recent years, renewable energy has become the fastest-growing source of electricity worldwide, accounting for nearly 30% of global power generation in 2023 [1]. Despite this progress, global demand for energy continues to rise, with the International Energy Agency projecting steady growth toward 2030 [2].

In Palestine, the energy sector is characterized by extreme vulnerability. More than 94% of electricity and 100% of petroleum products are imported, primarily from Israel, with marginal contributions from Jordan and Egypt [3]. This dependence limits energy sovereignty, increases exposure to price volatility, and undermines long-term planning. According to the Palestinian Central Bureau of Statistics, energy demand has increased consistently over the past decade, reflecting rapid population growth, urban expansion, and greater reliance on electrical appliances [4].

The strategy envisioned local sources covering ~50% of total electricity consumption by 2020, with renewables contributing at least 10% of locally produced electricity (≈240 GWh). These targets were only partially met due to infrastructure and regulatory constraints. The framework also details PSI/net-metering/competitive bidding and early utility-scale initiatives (e.g., PIF's Noor Palestine). These targets were only partially met due to infrastructure and regulatory constraints [5]. Yet, by 2023, only around 199 MW of capacity had been installed, leaving a significant gap between policy ambitions and actual deployment [6].

This review advances the literature in four ways:

1. It applies a mini-PRISMA screening of 2015–2025 sources (N=50) across academic, institutional, and grey literature to build a reproducible evidence base.
2. It integrates technical, financial, regulatory, and land-use strands into a single policy-diagnostic map, moving beyond narrative summaries.
3. It benchmarks Palestine's framework against Jordan (Law 13/2012) and Morocco (Law 13-09, amended 2015), linking policies to observed outcomes (e.g., >2 GW RE in Jordan, >4.5 GW in Morocco, versus ~199 MW in Palestine).
4. It consolidates the most recent quantitative status (PV ~199 MW in 2023; grid losses ~22–24%) and translates findings into policy-ready recommendations. Collectively, these contributions provide an auditable evidence base and outcome-linked regional benchmarking that clarify feasible acceleration paths for Palestine.

Fig. 1 illustrates the geographic division of the West Bank according to the Oslo II agreement (Areas A, B, and C), which constrains land access and renewable-energy project siting.

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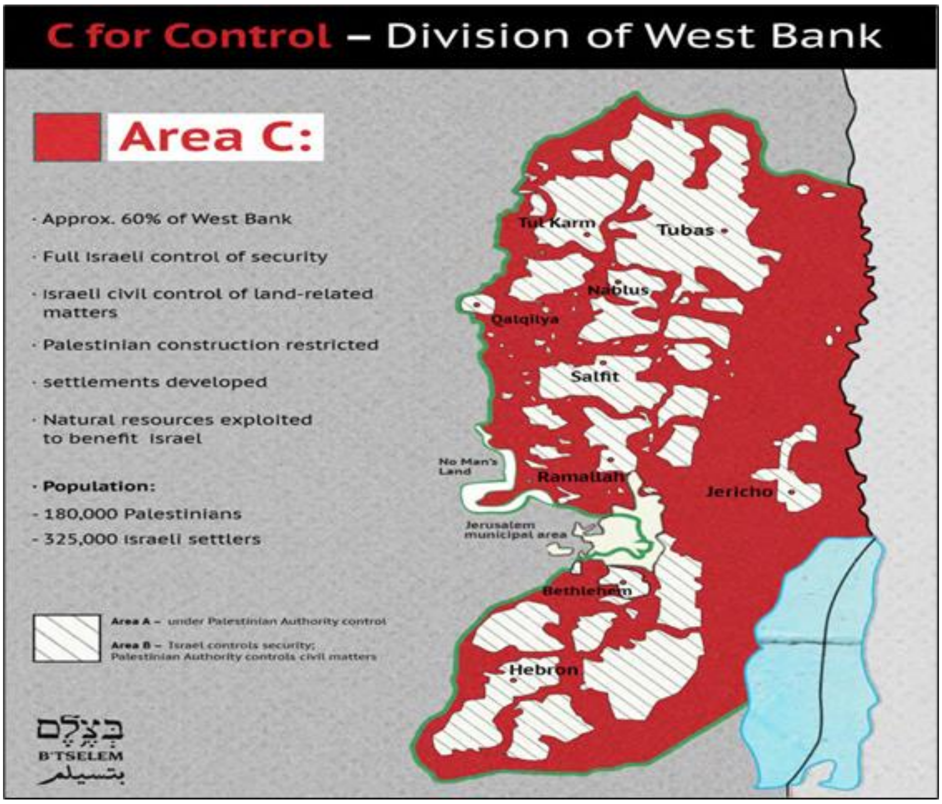

Figure 1. Administrative Division of the West Bank into Areas A, B, and C under Oslo II, Which Continues to Shape Infrastructure Development and Land Access [7,8]

2. Materials and Methods

This study adopts a narrative review approach rather than a bibliometric analysis. The rationale is twofold:

1. Policy and technical focus: The primary aim is to integrate technical, institutional, and policy dimensions of renewable energy in Palestine into a single framework. Bibliometric tools, while useful for mapping publication trends, do not adequately capture regulatory frameworks, official reports, or grey literature that are central to the Palestinian context.
2. Scope and time frame: The review covers peer-reviewed articles, reports, and policy documents published between 2015 and 2025. Sources include international databases (Scopus, ScienceDirect, IEEE Xplore), institutional reports (World Bank, IEA, IRENA, UNDP, OECD), and national sources (Palestinian Central Bureau of Statistics (PCBS), Palestinian Energy & Natural Resources Authority (PENRA), Palestinian Electricity Regulatory Council (PERC)). This broad scope ensures a comprehensive understanding of both the academic and practical developments in the field.
3. A total of 50 references were reviewed, encompassing journal articles, international reports, and official Palestinian statistics. The narrative approach enables the synthesis of diverse perspectives—technical, financial, and regulatory—necessary for contextualizing renewable energy development in Palestine.

3. Palestine's Energy Situation

Imports dominate the energy balance. (PCBS) time-series show that overall electricity consumption rose steadily over the last decade, with local generation covering only a small fraction of demand [9]. Monthly consumption profiles for 2022 also reflect higher summer and winter peaks and confirm the persistence of the import gap [10]. PCBS's latest consolidated release for 2023 provides updated national indicators and confirms the upward trend in demand and grid stress [11].

Despite growing demand, the supply side remains fragile. The Palestinian Electricity Transmission Company Ltd. (PETL) purchases bulk power and distributes it to regional distribution companies, but technical and non-technical losses remain among the highest in the region (≈22–24%) [12]. The heavy reliance on external supply also ties domestic tariffs to external regulatory decisions, limiting policy room for maneuver [13]. Table 1 summarizes the main electricity consumption statistics and energy balance in Palestine between 2010 and 2022, illustrating the overall growth trend in demand and imports.

Table 1. Electricity Supply and Demand Trends in Palestine (2010–2022)

Year[a]	Consumption (GWh)	Peak Load (MW)	Imports (%)	Local Generation (%)	Losses (%)
2010	~5,200	~1,050	98	2	20
2015	~6,400	~1,300	96	4	21
2018	~7,100	~1,450	95	5	23
2020	~7,600	~1,600	95	5	23
2022	>8,000	~1,700	94	6	22–24

[a]Data compiled from PCBS [9–11], and PERC [12]. Values are rounded to highlight trends; exact figures vary slightly across sources.

4. Electric Power Sector

The Palestinian power sector operates without a unified national generation base. Instead, electricity is purchased through bulk supply agreements, mainly from Israel, and transmitted via the PETL. Local generation remains limited and largely consists of small diesel-based facilities and distributed solar PV. PETL has faced technical challenges, particularly in balancing flows across fragmented networks and reducing dependence on imports [14].

The scalability of solar power in Palestine has been widely emphasized, particularly in the West Bank, where solar PV is regarded as the most feasible renewable option due to abundant irradiation, declining installation costs, and increasing consumer demand [15]. However, scaling up requires addressing structural barriers such as limited grid absorption capacity, fragmented permitting processes, and restrictions in Area C. According to GIZ, renewable energy projects implemented over the past years have shown promising results, with cumulative PV capacity surpassing 190 MW by 2023, yet further institutional support and investment incentives remain essential to unlock the full potential of the sector [16].

4.1. Electricity Consumption and Demand

Electricity in Palestine accounts for approximately 31% of total final energy consumption, reflecting the growing electrification of households and services [17]. According to the PCBS energy balance (2020), electricity consumption was distributed as follows: households 68.75%, commercial and services 22.33%, industry 8.42%, and agriculture 0.50% [18]. Total gross electricity consumption reached about 7,553 GWh in 2020, with sustained growth driven by demographic change and rising living standards [19].

Seasonality is pronounced. Peak demand typically occurs in winter due to space heating, with a secondary peak in summer for air conditioning. Model-based projections suggest the electrical peak could reach ~2,719 MW by 2030 and ~4,620 MW by 2050 (assuming ~6–7% annual demand growth), underscoring the need for timely grid and supply-side investments [6, 20]. Table 2 presents the installed generation capacity by energy source from 2010 to 2023, highlighting the gradual penetration of renewable resources compared with conventional imports.

Table 2. Installed Electricity Generation Capacity in Palestine by Source (2010–2023)

Year[a]	Solar PV (MW)	Diesel/Conventional (MW)	Total Installed (MW)	Share of Solar (%)
2010	~5	~120	~125	4
2015	~20	~150	~170	12
2018	~60	~160	~220	27
2020	~120	~140	~260	46
2023	~199	~51	~250	80

[a]Data compiled from PCBS [18,19], PENRA [21], and PENGON [14]; values are rounded to highlight trends.

The table presents the evolution of electricity demand in Palestine during the period 2019–2021. Annual gross consumption increased from 7,060 GWh in 2019 to 7,726 GWh in 2021, reflecting a growth of approximately 9%. Peak demand rose from 1,480 MW to 1,600 MW in the same period, representing an increase of around 8%. These figures demonstrate the steady rise in energy needs, underlining the urgency of expanding local generation capacity and integrating more renewable energy resources into the grid.

Fig. 2 presents the monthly variation of electricity consumption during 2021, showing clear dual peaks in winter and summer.

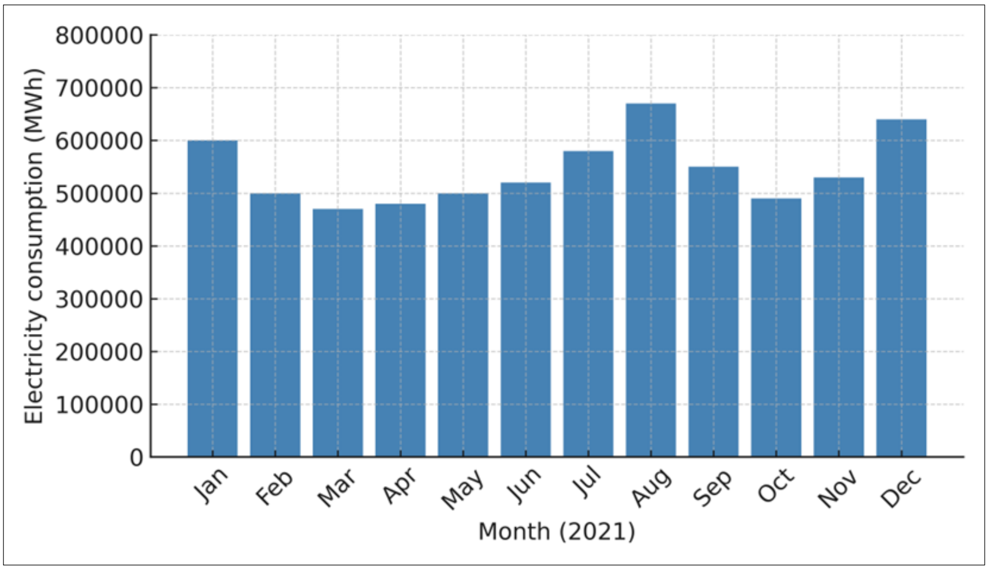

Figure 2. Monthly Electricity Consumption (MWh) in Palestine during 2021

4.2. Transmission and Grid Infrastructure

The Israeli Electricity Company (IEC) supplies power to the West Bank through approximately 237 connection points on medium- and low-voltage networks. Recent reforms have concentrated high-voltage interconnections in PETL-operated substations to improve reliability and reduce fragmentation. The ALJALAMEH substation (managed by PETL) currently operates at ~80 MW out of an installed 135 MW (expandable to 180 MW), supplying Jenin and surrounding areas; three additional substations are under construction or commissioning: SARRA (135 MW, Nablus area), BEIT ULA (90 MW expandable to 180 MW), and RAMALLAH/QALANDYA (180 MW, the largest) [21, 22].

The combined capacity of West Bank connection points (including PETL substations) was reported at ~1,500 MW in 2021 [19]. While these upgrades mark progress, additional transmission capacity and coordinated planning are needed to integrate new renewable capacity and maintain power quality. Fig. 3 displays the projected increase in electricity demand up to 2050, emphasizing the need for long-term capacity planning.

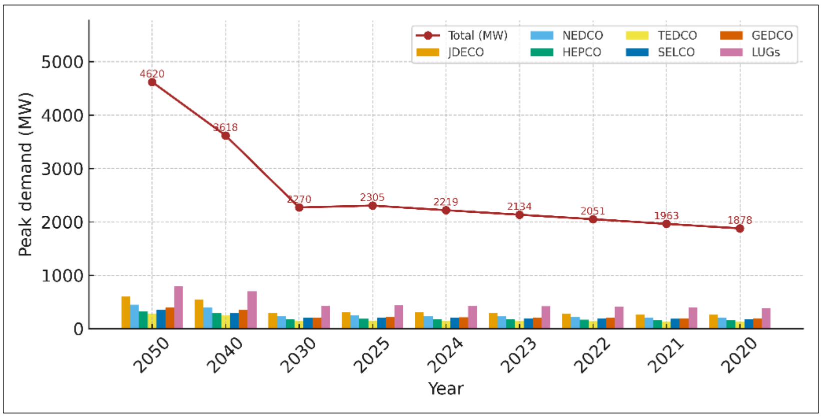

Figure 3. Modelled Cumulative Peak Demand Projections to 2050 (based on Brik. [6])

5. Electrical Grid System in the WB

The electrical energy sector in Palestine has undergone several institutional reforms, though further consolidation is still required. In 1995, the sector was reorganized to cluster most of the former municipal electricity providers into local distribution utilities. The Electricity Law of 2009 established the Palestinian Electricity Regulatory Council (PERC), responsible for tariff setting and monitoring, as well as the PETL, a new transmission operator and single wholesale buyer. While a dedicated Palestinian transmission infrastructure is still emerging, PETL has assumed responsibility for four high-voltage substations to manage flows of high-voltage electricity imported into the West Bank—previously handled through numerous low-voltage connection points [23].

To integrate new renewable capacities and ensure supply quality, upgrades to both transmission and distribution grids are needed, alongside selective storage. At the distribution level, Palestinian Electricity Distribution Companies (DISCOs) and some municipalities/village councils purchase power and deliver it to end users via roughly 189 medium-voltage connection points (22 kV and 33 kV) [12, 22].

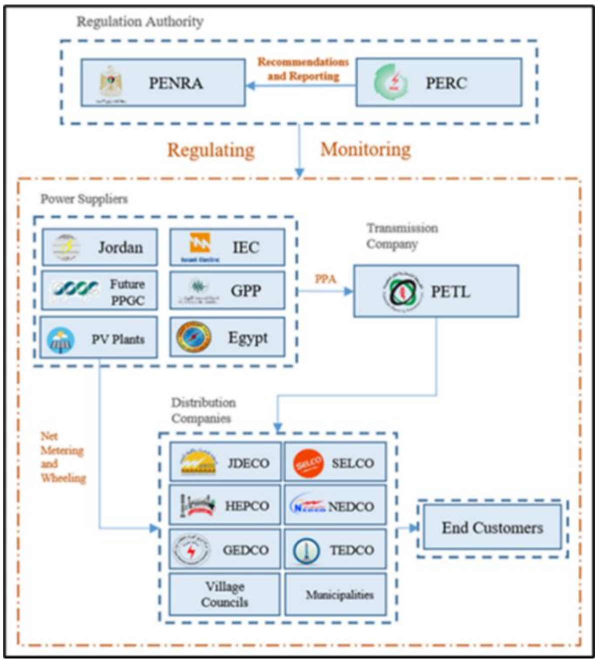

Figure 4. Palestinian Energy Sector Institutional Framework [23]

Fig. 4 illustrates the institutional and operational framework of the Palestinian electricity sector. Regulatory Authorities; The Palestinian Energy and Natural Resources Authority (PENRA) is responsible for setting national energy strategies, issuing policies, and overseeing implementation The Palestinian Electricity Regulatory Council (PERC) monitors, regulates, and ensures compliance with technical and financial standards. Power Suppliers**;** Imports from Israel (IEC)**,** Jordan**,** and Egypt**,** in addition to local producers such as the Gaza Power Plant (GPP)**,** the Future Power Generation Company (PPGC)**,** and solar PV plants. Transmission Company; The PETL acts as the single buyer, signing power purchase agreements Power Purchase Agreements (PPAs) with suppliers and transmitting electricity to distribution companies. Distribution Companies; Include Jerusalem District Electricity Company (JDECO)**,** Southern Electricity Company (SELCO)**,** HEPCO**,** NEDCO**,** GEDCO, and TEDCO**,** along with village councils and municipalities. These entities deliver electricity to end-users and facilitate net metering and wheeling services for distributed renewable energy systems. End Customers**;** Ultimately receive electricity through distribution companies, which aggregate power from imported and local sources. This framework highlights the flow of electricity from generation and imports through transmission and distribution, under the oversight of PENRA and PERC. Table 3 details the shares of electricity sales by customer class. As detailed in Table 3, electricity sales across distribution companies vary widely by customer class, reflecting different consumption patterns among residential, commercial, and industrial sectors.

Table 3. Electric Power Sales by Distribution Companies According to Tariff Classifications (GWh)

Type of Consumers [a]	JDECO	SELCO	TDECO	HEPCO	NEDCO
Residential	1755	122	47	180	280
Commercial	798	40	14	113	136
Industrial	576	17	27	123	78
Others	286	12	55	15	94

[a]DISCOs purchase through medium-voltage interconnections; figures are rounded estimates. Source: sectoral summaries aligned with [12, 22].

Table 4. Palestinian Electricity Distribution Companies DISCOs and Concession Areas

DISCO Name	Concession Area (Cities)
NEDCO (Northern Energy Distribution Company)	Nablus and Jenin
HEPCO (Hebron Electricity Company)	Hebron
SELCO (Southern Electricity Company)	South of Palestine except Hebron
JDECO (Jerusalem District Electricity Company)	Ramallah, Bethlehem, Jericho and Jerusalem
TDECO (Tubas District Electricity Company)	Tubas and Al-Zababdeh
GEDCO (Gaza Electricity Distribution Company)	Gaza Strip
LGUs (Local Government Units)	Municipalities

Table 4 presents the concession areas and coverage of DISCOs.DISCOs in Palestine are covering approximately 75% of the end-consumers, while the rest is covered by municipalities, local councils and small PV generation systems. These

DISCOs have a unified regulation, are non-interconnected, and there is no single buyer model still on the ground, so their concession areas are mentioned in Table IV. They differ among themselves in the concession area, the number of consumers, the geographical nature, the number of connection points from the generation sources, and the nature of loads (household, residential, commercial, industrial, agricultural...etc.), as can be observed in Fig. 5.

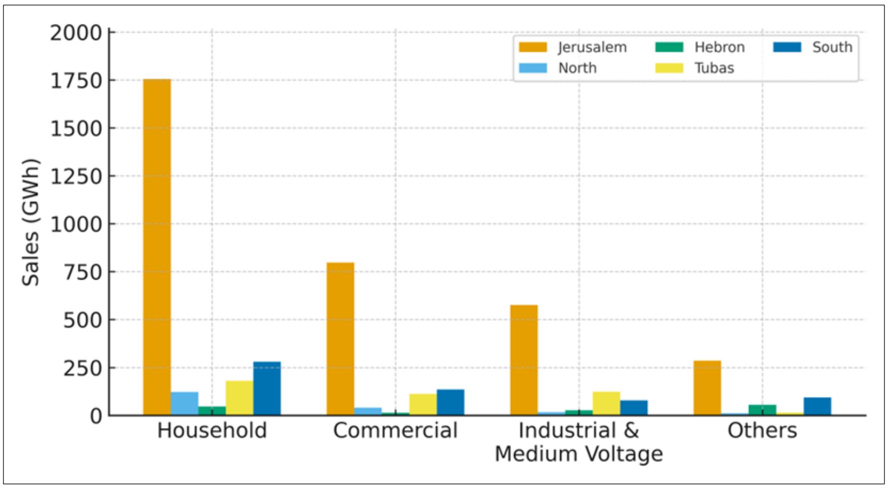

Figure 5. Sales of Distribution Companies According to Tariff (GWh)

6. Renewable Energy Sources

Renewable energy constitutes one of the strongest alternatives for Palestine, given the absence of fossil fuel reserves. Solar energy remains the most abundant resource and is widely applied in photovoltaic (PV) projects and solar-thermal water heating; studies analyze solar-radiation variability and design implications for PV systems [24], while other reviews emphasize Solar's role in alleviating energy poverty and advancing sustainable development [25, 26]. Solar-driven desalination remains under investigation, and rooftop PV continues to expand gradually. Biomass retains a traditional role in rural areas (wood and agricultural residues), and biogas initiatives indicate a technical potential exceeding 33 million m³ per year, supported by pilot projects and cooperation programs [27]. Wind energy assessments identify measurable potential in elevated zones (~1000 m); early mapping and subsequent analyses point to opportunities for hybrid, small-scale applications, though no utility-scale wind farms have been commissioned to date [28, 29]. Geothermal options are in exploratory phases for space heating/cooling; recent practical applications demonstrate feasibility using low-temperature resources in buildings [30]. Despite these options, renewables have supplied only ~1.9% of total primary energy in recent years—mainly for water heating—while around 66% of households use solar/biomass for domestic water heating [31]. Unlocking larger-scale deployment requires R&D, accredited testing laboratories, and strengthening technical training; integrated assessments propose hybrid portfolios tailored to Palestine’s constraints and opportunities [32].

6.1. Solar Energy

Solar energy can be a major contributor to Palestine’s future energy supply given its high resource potential. The country receives about **≈3,000 hours of sunshine per year** and an average global horizontal irradiation of **≈5.4 kWh/m²/day** [24].

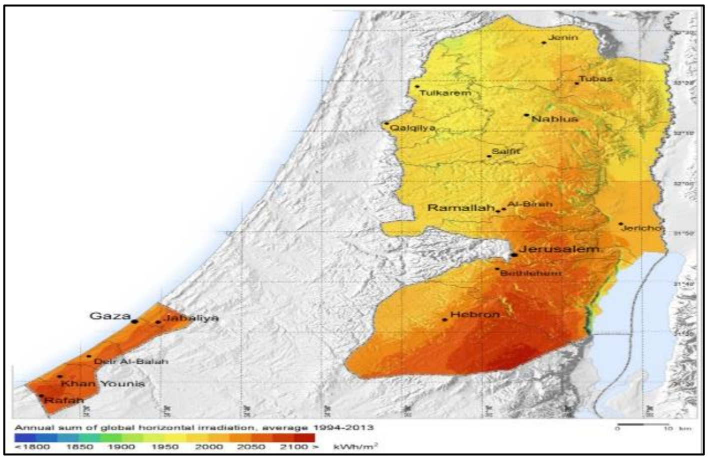

Figure 6. Solar Resource Potential in Palestine Based on Average Global Horizontal Irradiation [33]

6.2 Solar Irradiance Data

The solar resource map in Fig. 6 confirms high GHI in most areas, the use of solar energy depends largely on accurate and reliable irradiance data. Solar resource assessment is the cornerstone of project feasibility, as investment planning requires robust datasets to forecast yield and financial viability. For PV deployment, global horizontal irradiance (GHI) at the optimum tilt is the key parameter [24], while direct normal irradiance (DNI) becomes critical for concentrating solar technologies [34]. Recent assessments of solar radiation variability in Palestine confirm substantial regional differences, reinforcing the need for high-resolution datasets to guide PV system design [33].

Based on GHI values, Palestine can be classified into three zones;
1. High irradiance: >2300 kWh/m²/year [34].
2. Medium irradiance: 2200–2300 kWh/m²/year.
3. Low irradiance: <2200 kWh/m²/year.

Overall, Palestine benefits from annual GHI exceeding 2000 kWh/m² and mean daily radiation levels between 5.4–6.0 kWh/m²/day [35].

6.3. Solar Energy Applications in Palestine

According to PCBS, nearly 67% of Palestinian households use solar water heating systems [11]. PV adoption has accelerated due to falling module prices, coupled with government incentives and awareness programs. Several studies highlight the role of distributed PV in reducing electricity costs and strengthening supply resilience [33]. National policy frameworks have set targets to reach 200 MW of renewable capacity in the near future [35, 36]. Fig. 7 summarizes the installed renewable-energy capacities by governorate and project type, including large-scale and distributed PV systems.

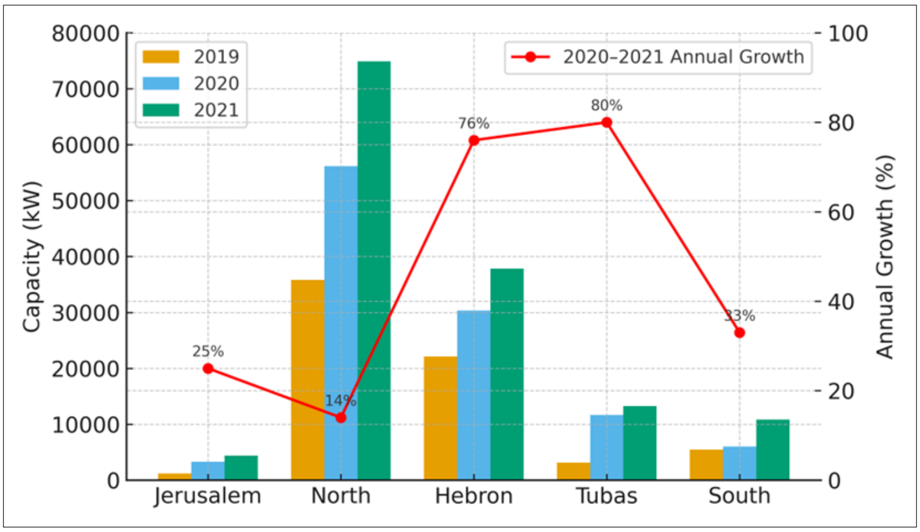

Figure 7. Renewable Energy Project Capacities by Governorate (2019–2021) and Annual Growth in 2020–2021 [12, 36]

Table 5 lists the allocated renewable-energy capacities under national initiatives, including PSI and rooftop net-metering projects.

Table 5. Renewable Energy Project Capacities and Growth by Governorate (2019–2021) [12, 36]

Capacity Type	Year	Capacity (kW)	Jerusalem	North	Hebron	Tubas	The South
Capacity of Palestinian Solar Energy Initiative Projects	2021	80	2,501	313	380	933	795
Capacity of net metering projects	2021	2,291	43,260	28,440	5,417	5,355	1,757
Enterprise production capacity	2021	2,018	29,154	9,070	7,990	2,272	8,295
Total aggregate capacity of renewable energy projects	2021	4,389	74,915	37,823	13,269	8,560	10,847
Total aggregate capacity of renewable energy projects	2020	3,307	56,155	30,325	11,647	4,853	6,023
Total aggregate capacity of renewable energy projects	2019	1,194	35,825	22,116	3,162	3,860	5,493
Capacity growth of renewable energy projects (%)	2020-2021	33%	33%	25%	14%	76%	80%

Table 6 presents the main on-grid renewable-energy programs implemented in Palestine, including the Palestinian Solar Initiative and the Net-Metering scheme, which support distributed generation under the supervision of the distribution companies.

Table 6. Renewable Energy Projects and Ways to Invest [12, 36]

The Program	Program Beneficiary	Capacity	The Buyer	Tariff	Expected Capital Recovery
Palestinian Solar Energy Initiative	Domestic sector	A maximum of 5 kilowatts per subscriber	Distribution companies	0.54 shekel each kilowatt	Year
Net Metering	All consumer segments	A maximum of 1000 kilowatts	Distribution companies or local authorities	Offsetting energy between the consumed and exported to the network	Year
Average electrical capacity	-	A maximum of 999 kilowatts	Distribution companies or local authorities	A maximum of 85% of the energy purchase price from conventional sources	Year

7. Wind Energy

No utility-scale wind projects have been commissioned in Palestine to date, yet multiple assessments point to site-specific potential. Overall, wind regimes are modest at national scale, but ridge-top and mountainous areas (e.g., Hebron and northern Ramallah) exhibit measurably higher resources suitable for small wind and hybrid off-grid uses [36]. Global evidence on wind integration and costs suggests that, in mid-wind contexts, targeted deployment (micro/mini-grids, water-pumping, critical-load backup) can be viable when paired with storage and demand management [37].

Wind resource mapping. Mesoscale layers from the Global Wind Atlas (v3.3) indicate that most of the West Bank falls in a mid-wind regime, with typical mean wind speeds of roughly 4–6 m/s at 100 m hub height; ridge-top corridors—notably along parts of Hebron highlands and northern Ramallah—exhibit comparatively higher values and improved shear profiles suitable for small turbines or hybrid PV–wind configurations [36]. These atlas-based signals align with techno-economic site measurements in the West Bank showing mid-single-digit m/s averages at selected hilltops and substantially lower values in valley settings, underscoring the need for micro-siting and careful hub-height selection to reach bankable capacity factors [38]. From a system perspective, IEA evidence suggests that in mid-wind contexts targeted applications (e.g., water-pumping, agro-processing, or critical-load backup paired with storage) are more viable than utility-scale deployments, given cost curves and integration constraints [37].

Instrumented measurements in the West Bank confirm the localized nature of the resource: techno-economic evaluations based on real site data report average speeds around the mid-single-digit m/s at selected hilltop locations, with substantially lower values in valley settings—underscoring why micro-siting is decisive for bankable projects [38]. In contrast, Gaza generally records low average speeds (≈2.5–3.5 m/s), which limits grid-scale prospects and reinforces the case for only small, application-specific turbines where justified [36].

Beyond resource quality, structural barriers—notably restrictions in Area C, equipment import constraints, and transaction costs—continue to raise capex/opex and slow project development; addressing this governance and permitting frictions is as critical as improving the wind data itself [8].

The lack of technical and human capabilities and the absence of professional training on modern applications and designs. The high investment in Palestine, and the low income of the Palestinian people. The lack of awareness of the importance of energy conservation and green technology the political situation in Palestine, and the Israeli control do not allow any foreign investment.

8. Biogas

Biogas adoption in Palestine remains small-scale and pilot-oriented, with most digesters serving cooking fuel needs rather than grid electricity. Notable initiatives include the Bio-Clean project, which converts potato-starch waste and cow manure into biogas and bio-fertilizer for off-grid communities—demonstrating practical circular-economy benefits at village scale [39]. In parallel, farm-level feasibility work shows that anaerobic digestion can be financially viable under local price structures (e.g., poultry farms), with short payback horizons when systems displace diesel or LPG [40].

9. Investment in Renewable Energy Projects in Palestine

Palestine is increasingly regarded as one of the most promising environments for renewable energy (RE) investment, particularly in solar PV. Geographical advantages—such as high solar irradiation in Jericho and the Jordan Valley (≈340 sunny days annually)—make these areas attractive for large-scale deployment [24, 33]. In addition to resource availability, agricultural residues and organic waste provide opportunities for biomass-based energy production, diversifying the energy mix beyond solar [25].

To support investment, the Renewable Energy and Energy Efficiency Decree-Law of 2015 and subsequent regulations have provided tax exemptions and a framework for power purchase agreements (PPAs). More recently, the Palestinian Council of Ministers introduced a dedicated incentive package under the Investment Encouragement Law, offering staged corporate tax reductions for utility-scale RE projects (e.g., 0% for seven years, then 5% and 10% for subsequent stages). Smaller-scale feed-in and net-metering projects also benefit from extensions of incentive periods based on installed capacity, while loans for RE projects receive treatment similar to Small and Medium-sized Enterprises (SMEs) in the tax code [36, 37].

According to the Palestinian Investment Promotion Agency (PIPA), investment incentives further include accelerated licensing, duty-free equipment imports, and access to public land for utility-scale PV projects [38]. International assessments confirm these efforts: the U.S. State Department Investment Climate Statement (2022) highlights regulatory clarity but points to risks around land access and political stability [41]; the World Bank's Aspire Phase-2 grant (2022) committed US$23.5 million to improve grid integration and solar deployment, signaling donor confidence in the sector's viability [42].

Despite these measures, barriers remain. Academic and policy studies identify economic and financial challenges, including limited availability of concessional finance, absence of sovereign guarantees, and fragmented tariff-setting across municipalities [39, 43]. These constraints lengthen project payback periods and deter larger investors, even as payback times for PV plants remain moderate (≈5–6 years). Still, the combination of resource potential, evolving policy incentives, and donor-backed risk mitigation continues to strengthen the investment case for renewable energy in Palestine.

9.1. Barriers to Investment in RES and EE

The barriers to investment in Renewable Energy Sources (RES) and Energy Efficiency (EE) in Palestine can be grouped into three main categories: economic and financial, technological and infrastructural, and public awareness and institutional.

PIPA is already in effect, whereas Palestine is still in the early stages of renewable adoption. Obstacles include the absence of guarantees of sovereignty, non-uniform tariffs across municipalities, and lack of externality modeling. In addition, limited availability of subsidized loans for both large- and small-scale facilities extends payback periods, lowering feasibility for investors. While PV power stations have a reasonable payback (5–6 years), the uncertainty of market design, Power Purchase Agreements (PPAs), and access to funding remain major risks. Fig. 8 compares technical barriers to renewable expansion.

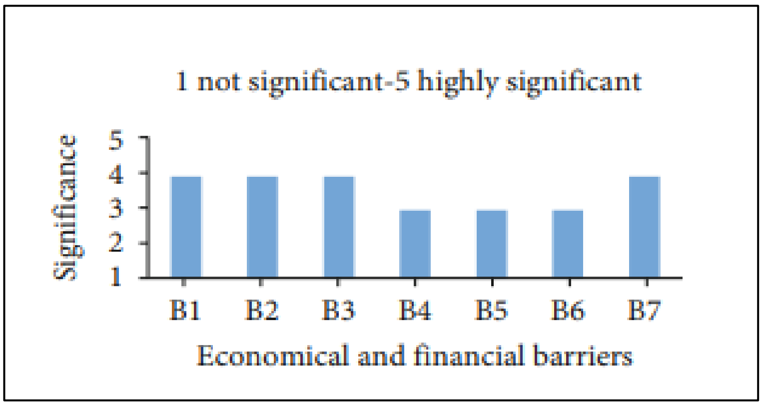

Figure 8. Significance of Financial and Economic Barriers to the Promotion of RE in Palestine [44]

Most governorates' current grids need upgrading to absorb additional PV capacity. Grid connection constraints are a major deterrent, with investors required to fund grid impact studies (costing \$5,000–\$20,000 depending on scale). Limited cooperation among PENRA, PETL, PERC, municipalities, and village councils adds complexity. Processing times for permits are moderate but still hinder investor confidence. Fig. 9 outlines the main financial barriers to renewable-energy investment, such as limited access to credit and high upfront costs.

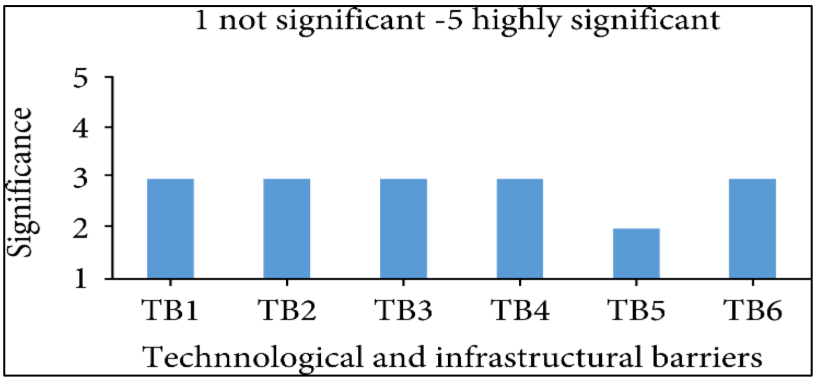

Figure 9. Significance of Technological and Infrastructural Barriers to the Promotion of RE in Palestine [44]

Many governorates experience frequent outages, increasing public interest in distributed PV systems. However, the absence of long-term political strategies, limited coordination between institutions, and the lack of a competitive regulatory framework impede progress. Public information campaigns remain insufficient to build consumer and investor trust. Fig. 10 highlights the institutional and administrative challenges affecting the renewable-energy sector, including permitting and regulatory delays.

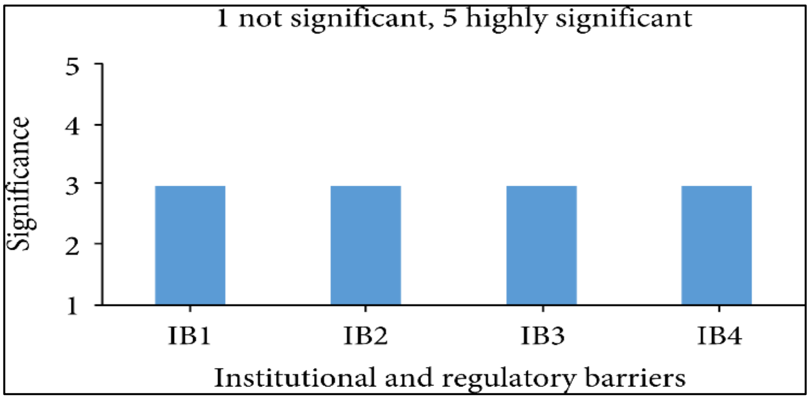

Figure 10. Significance of Institutional and Awareness Barriers to the Promotion of RE in Palestine [44]

10. Renewable Energy Regulations and Laws in WB

Beyond sector statistics, sustainable development indicators help relate energy to broader socio-economic and environmental pressures in Palestine. Plan Bleu/UNEP-MAP highlights structural constraints in resources, environmental stress, and demographic growth—factors that reinforce the urgency of a renewables-led pathway linking energy security with environmental and economic resilience [17]. Renewable energy regulations in Palestine are issued either through laws or decisions by the Council of Ministers, or through legislation by the Palestinian Energy and Natural Resources Authority (PENRA) or the Palestinian Electricity Regulatory Council (PERC). Among these, Law No. 14 of 2015 on Renewable Energy and Energy Efficiency is the primary legislative reference. This law comprises 23 articles and aims to:

1. Promote the use and development of renewable energy sources and expand their share in the national energy mix, in alignment with the Renewable Energy Strategic Plan.
2. Support energy conservation by optimizing energy use across various sectors, contributing to sustainable development and environmental protection.
3. Encourage local production and the integration of energy-efficient and renewable energy technologies [45].

According to Law No. 14, the following mechanisms are established for implementing renewable energy projects

1. The Palestinian Solar Energy Initiative: Targets the household sector for systems with a capacity of 5 kW or less. These systems are subject to a preferential tariff recommended and periodically reviewed by PERC.
2. Net Metering Systems: Designed for projects exceeding 5 kW in capacity across all sectors, with percentage limits defined by the national renewable energy strategy.
3. Competitive Bidding: Involves offering or inviting bids under applicable laws to establish renewable power plants for electricity sale [46, 47].
4. Net Metering Rules: Monthly billing compares exported vs. consumed energy, with a 10% deduction applied to exported amounts. Surpluses can roll over within the same year, while systems serving [46]

proposals and PPAs with clear tariff mechanisms that catalyzed PV and wind IPPs [47, 48]; recent statistics and integration reports indicate ~2.58 GW RE by 2022 and ~30% electricity from RE, supported by MEMR and NEPCO reforms [49, 50]. Morocco's Law 13-09 liberalized renewable generation and opened grid access for private developers; subsequent regulatory work and MASEN/ONEE programs enabled large-scale RE via competitive tenders [51-53]. Compared with these peers, Palestine's framework (Law 14/2015 and PERC net-metering regulations) is newer and more centralized and operates under unique territorial constraints, yet it converges toward the same investment-enabling model (net-metering, competitive bidding, targeted incentives) [45, 46]. Egypt combines a statutory base (RE Law 203/2014 and Electricity Law 87/2015) with a mixed toolkit—early feed-in tariffs, then auctions/IPP schemes and rooftop net-metering—culminating in Benban as a flagship PV cluster while the rooftop regime continues to evolve [51, 54].

11. Results and Discussion

11.1. Energy Demand and Import Dependence

Electricity consumption in Palestine has trended upward over the past decade, with clear seasonal peaks in summer and winter [9–11, 18, 19]. The power system remains predominantly import-dependent, and imports constitute the bulk of supply according to PCBS and World Bank diagnostics [3, 11, 19]. This exposure, combined with technical losses, continues to affect system resilience and cost pass-throughs [9–11, 19]. Table 7 compares regional policy instruments, incentives, and regulatory frameworks that influence renewable-energy deployment in Palestine.

Table 7. Regional Renewable Energy Policy Snapshot (Palestine, Jordan, Morocco, Egypt)

Country	Primary Law / Framework	Core Targets (illustrative)	Key Instruments	Notes / Implementation	Outcomes (2019–2023)
Palestine (West Bank)	Law No. 14/2015 (RE&EE); PERC Net-Metering (2016)	100 MW by 2020; up to 500 MW by 2030 (expanded-access scenario)[55]	PSI (≤5 kW), Net-Metering (>5 kW), Competitive Bidding, Targeted Incentives	Territorial constraints (Area C); HV consolidation via PETL; evolving quotas. [47, 48]	~199 MW PV by 2023; RE share <2%; grid losses ≈22–24%. [11, 21]
Jordan	RE&EE Law No. 13 (2012) + regulations	RE share ≈20% by mid-2020s; large PV/Wind IPP pipeline	Direct Proposals, PPAs, Wheeling; standardized contracts; auctions	Catalyzed private IPPs in PV & wind; mature bankable framework. [48, 49]	~2.58 GW RE installed by 2022 (~30% electricity). [49, 50]
Morocco	Law 13-09 (2009; amended 2015) + MASEN/ONEE programs	≈52% installed capacity from RE by 2030	Open grid access for eligible RE; competitive tenders; corporate/utility PPAs	Large utility-scale pipeline (Noor CSP/PV, wind clusters). [53, 56, 57]	>4.5 GW RE capacity by 2023 (≈37% electricity). [51]
Egypt	RE Law 203/2014; Electricity Law 87/2015; NREA/ERA regs	RE share ≈42% in electricity by 2035 (strategy)	FiTs (early), Competitive Tenders/Auctions, BOO/IPPs, Net-Metering (rooftop)	Benban PV complex; evolving rooftop/net-metering regime. [51, 54]	~6.5 GW RE capacity by 2023; ~4.6 GW solar+wind + 2.8 GW hydro. [58, 59]

11.2. Solar Resource and Current Deployment

Multiple assessments confirm strong solar suitability across the West Bank and Gaza [24–26, 33, 34]. Deployment—especially rooftop PV—has expanded in recent years but still lags technical potential, reflecting constraints in siting, interconnection, and financing [8, 21, 25, 26, 33, 43]. Where net-metering and supportive procurement are available, adoption improves, underscoring the role of stable rules and standardized procedures [21, 23, 46, 50].

11.3. Wind Resource and Prospects

Mesoscale mapping identifies promising wind corridors/sites in the West Bank and Gaza [28, 29, 36], while ground measurements support the bankability of selected locations [38]. From a system perspective, wind contributes to flexibility and decarbonization, complementing daytime-peaking solar [35, 37]. Near-term development requires met-masts, environmental screening, and grid-integration studies aligned with hosting capacity [36, 38].

11.4. Bioenergy and Waste to Energy

Local pilots and feasibility studies—e.g., farm digesters and agro-industrial residues—indicate viable small-scale bioenergy opportunities [39, 40]. Scaling these models calls for programmatic CAPEX support, transparent interconnection procedures, and purchase mechanisms that reflect dispatchability and environmental benefits [39, 40].

11.5. Institutional and Regulatory Context

Since 2015, Law No. 14/2015 and PERC's net-metering instructions have established a nascent but important framework for RE deployment [45, 46, 50]. Institutional roles for PENRA/PERC and distribution companies are defined, yet procedural clarity and hosting-capacity transparency remain critical to reduce developer risk [21, 23]. Sector performance and reform needs are documented in recent diagnostics [42, 49]. Benchmarks from Jordan and Morocco—including clear interconnection standards, auctioning, and structured incentives—offer relevant design choices for Palestine [47, 48, 52–57], while Egypt's utility-scale experience (e.g., Benban) illustrates bankable procurement and grid preparation [51, 54, 58, 59].

11.6. Investment and Financing Signals

Recent programs (e.g., grants and concessional facilities) have supported sector sustainability [42], but bankability still hinges on policy consistency, standardized PPAs/net-metering, credit-risk mitigation, and predictable interconnection costs [41, 44, 49, 50]. Public-sector rooftops and municipal portfolios can lower transaction costs via aggregated procurement [21, 23].

11.7. Synthesis—Advantages and Takeaways

Palestine combines high solar irradiance, discrete wind pockets, and an emerging legal framework [24–26, 28, 29, 33, 36, 38, 45, 46, 50]. The main binding constraints are permitting timelines, interconnection procedures/hosting capacity, and financing risk [21, 23, 41, 46, 49 ,50]. Addressing these frictions aligns technical potential with implementable projects and underpins energy security, affordability, and environmental goals.

12. Policy and Practice Recommendations

To accelerate renewable-energy deployment while safeguarding reliability and consumers, we recommend:

1. Streamlined permitting & standard PPAs for ≤100 kW and C&I projects.
2. Transparent interconnection (clear procedures, fees, timelines) and hosting-capacity maps by DISCO.
3. De-risked finance (credit guarantees, concessional lines, results-based grants).
4. Targeted grid upgrades & smart-inverter settings; pilot storage and demand-response where curtailment is high.
5. Quality & consumer protection (accredit installers, testing labs, enforce IEC standards; require yield/O&M disclosure).
6. Human capital (embed RE in TVET/university curricula; certify inspectors & interconnection engineers; continuous DISCO training).

13. Conclusion

The Palestinian power system remains highly import-dependent and exposed to technical losses and structural barriers that weaken resilience. Yet the country has considerable renewable-energy potential, especially solar, which—if effectively mobilized—can support energy security and sustainable development. Since 2015, Law No. 14/2015 and subsequent PERC regulations have created a nascent but important framework for deployment; however, grid constraints, financing barriers, and political restrictions continue to limit investment and integration. Compared with regional peers (Jordan, Morocco), Palestine's regulatory environment is earlier-stage but gradually converging toward international mechanisms (net metering, competitive bidding, incentive schemes) [47, 48, 51–59]. A focused, credible policy bundle can translate technical potential into bankable projects while safeguarding reliability and consumers.

Policy-relevant recommendations:

1. Grid modernization: prioritize T&D upgrades to raise RE hosting capacity and reduce losses .
2. Diversified financing tools: expand concessional loans and risk-mitigation for utility- and small-scale projects].
3. Institutional strengthening: enhance coordination among PENRA, PETL, PERC, municipalities, DISCOs to streamline permitting/interconnection
4. Public engagement: invest in awareness programs and curricula to build social acceptance and professional capacity.
5. Regional alignment: adapt lessons from Jordan/Morocco to liberalize the market and crowd-in private capital

By addressing these areas, Palestine can move from fragmented initiatives to a coherent RE transition strategy that enhances security, reduces dependency, and supports long-term socio-economic resilience.

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