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A Comprehensive Analysis of Solar Energy in Louisiana: Development, Challenges, and Future Prospects

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Abstract

This study provides a comprehensive analysis of solar energy development in Louisiana, examining current capacity, growth trends, technical and economic feasibility, policy influences, and future prospects within the broader U.S. renewable energy context. Although Louisiana possesses moderate solar resources and abundant land, its solar sector remains underdeveloped, contributing only 0.7% to the state's electricity generation. Critical gaps persist in understanding the spatial distribution of solar potential, the local feasibility of photovoltaic systems, and the socio-economic and policy factors shaping adoption. Using GIS-based spatial analysis combined with rooftop and utility-scale system assessments, alongside policy and economic evaluation, the study identifies optimal deployment locations, analyzes installation trends, and evaluates workforce distribution and technical constraints. Results highlight rapid utility-scale growth, limited residential adoption, and climate-related challenges. The study recommends a holistic policy framework that stabilizes incentives, enforces resilient system design, supports recycling, integrates agrivoltaics, and invests in workforce development to ensure a sustainable and equitable solar energy future for Louisiana.

Keywords

Agrivoltaics, Photovoltaic Systems, Renewable Energy, Spatial Analysis, Solar Sector

1. Introduction

According to the National Renewable Energy Laboratory, Louisiana has the technical potential to generate solar energy equivalent to 48 times its electricity demand and wind energy equivalent to 7 times its annual electricity needs. Even with rapid electrification of buildings and transportation, the state could still produce enough solar and wind energy to meet approximately 36 times its projected electricity demand by 2050 [1]. The state ranks among the highest in energy consumption in the United States, largely driven by the chemical, petroleum, and natural gas sectors, which together account for approximately 70% of total usage. Other sectors such as transportation, residential, and commercial contribute smaller shares, influenced by high summer cooling demand and relatively low heating needs in winter. Solar energy has a long history, evolving over millennia from basic sunlight utilization to sophisticated modern technologies capable of efficiently capturing energy for diverse applications [2]. As a renewable source, solar power holds significant promise as a supplemental or alternative energy source to fossil fuels, particularly in the United States and developing nations [3]. It can be harnessed for electricity generation, water heating, and space heating, offering a clean, sustainable alternative to conventional energy sources [3]. Solar panels are primarily classified into photovoltaic (PV) systems, which directly convert sunlight into electricity, and solar thermal systems, which produce heat often less efficiently but at lower cost [4]. Despite their benefits, PV systems have an operational lifespan of roughly 30 years, raising concerns about end-of-life disposal and decommissioning [5]. Louisiana, in particular, faces a need for regulations that ensure proper recycling and environmental management of solar panels. Solar thermal power relies heavily on direct sunlight and is most effective in regions with high solar radiation. Areas receiving at least 2000 kWh/m^2 annually are ideal, while top-yield sites exceed 2500 kWh/m^2 [3]. For example, Louisiana receives an average direct normal irradiance (DNI) of 4 - 5 $kWh/m^2/day$, with Lafayette recording a median peak DNI of 688 W/m^2 from April onward. However, most assessments rely on modeled estimates, highlighting the need for ground-based measurements to validate predictions under Louisiana's humid and storm-prone climate [6]. This paper provides a comprehensive assessment of solar energy development in Louisiana, examining current capacity, growth trends, and future potential within the broader U.S. renewable energy landscape. It analyzes geographic distribution, technical and economic constraints, policy impacts, and emerging opportunities such as investment expansion, technological adoption, and supportive regulations.

Despite the growth of Louisiana's solar industry, notable knowledge gaps remain that hinder effective planning and implementation. Limited ground-based measurements make it difficult to accurately assess local solar potential, especially given the state's humid climate and frequent storms. Research on the technical and economic viability of large-scale photovoltaic systems is scarce, particularly regarding their efficiency, durability, and cost-effectiveness in Louisiana's conditions. Additionally, there is an inadequate analysis of how policies, incentives, and regulations influence adoption, investment, and long-term development, as well as a limited understanding of the socio-economic impacts on rural communities, agricultural land use, and equitable access to solar benefits. Advanced modeling and simulation tools for optimizing solar deployment are also underused, leaving potential for resilient and economically feasible expansion largely untapped. This study addresses these gaps by integrating GIS-based spatial analysis, assessments of rooftop and utility-scale solar capacities, and a review of policy and economic factors to provide a comprehensive evaluation of solar potential, deployment trends, and barriers, offering actionable insights for informed decision-making and strategic growth in Louisiana's solar sector.

2. Development of Solar Energy in Louisiana

While the United States has seen rapid growth in solar photovoltaic (PV) capacity, Louisiana has lagged, with only 177.56 MW installed as of recent reports [7]. The state receives lower solar radiation compared to the U.S. Southwest, averaging 4 - 5 kWh/m^2/day. Data from the National Renewable Energy Laboratory (NREL) indicate that Lafayette experiences a median peak direct normal irradiance (DNI) of 688 W/m^2 from April, with a 15% margin of error. Despite being lower than the Southwest, Louisiana's solar resources remain significant [8]. Investment in Louisiana's solar energy sector has been rising, driven in part by increasing electricity demand from manufacturing and data centers, with total cumulative investment surpassing $2 billion by the end of 2024 [9].

The state benefits from approximately 216 sunny days annually, slightly above the national average of 205 days, which supports the viability of solar projects [10]. By October 2025, Louisiana hosted 15 utility-scale solar farms totaling 1243 MW. Solar potential is influenced by atmospheric conditions affecting incoming radiation [11]. To encourage adoption, state-level incentives such as property tax exemptions and net metering programs enable homeowners to offset energy costs or sell surplus electricity to utilities [12]. Louisiana's solar sector is at a critical juncture. Changes in state tax credits and net metering policies present opportunities to establish regulatory frameworks balancing the interests of utilities, taxpayers, and solar adopters [13]. Historically, programs like the Solar Energy Income Tax Credit significantly accelerated adoption, exceeding initial projections and serving as a key growth driver [12].

2.1. Challenges in Solar Energy Development in Louisiana

Possessing diverse energy resources, including fossil fuels, nuclear, and renewables such as solar, wind, and biomass, Louisiana remains heavily dependent on non-renewables, with renewables contributing only a small fraction of total energy production [14]. Although solar potential is considerable, historical reliance on fossil fuels has hindered large-scale adoption. Incentives and decreasing costs are gradually encouraging growth across residential, utility-scale, and floating solar projects. Ground-mounted systems encounter structural and environmental challenges, while floating PV installations offer benefits such as improved efficiency and land conservation. Advanced modeling tools, including computational fluid dynamics (CFD) and digital twin simulations, are increasingly applied to optimize solar design, improve system resilience, and support sustainable expansion in the state [15].

[5] observes that, despite economic opportunities, local communities, officials, and policymakers often hesitate due to concerns about visual impacts, farmland use, and taxation. Conversely, rural economic development officials see solar projects as potential revenue sources, while developers continue to explore the state's solar resources. [16] highlights that agrivoltaics, which allows simultaneous farming and solar energy production, provides farmers with dual income, crop protection, and soil benefits, addressing concerns over land conversion. Extreme weather events, including hurricanes, hail, and flying debris, pose risks to solar panels, potentially causing damage, costly repairs, and reduced economic returns. Systems that fail before achieving financial payback are not viable [17]. Additionally, energy system sustainability depends on lifetime output relative to construction energy costs. Environmental exposure and weather can shorten effective lifespan, complicating estimates of long-term economic and energy benefits [17].

2.2. Future Prospects of Solar Energy in Louisiana

Louisiana's renewable energy potential, particularly solar and wind, remains largely untapped across the state [18]. Solar energy growth in Louisiana is outpacing national averages, driven by abundant sunlight, available land, private investment, a skilled workforce, and higher education support [11]. The state's historical reliance on energy industries for economic growth provides a foundation for renewable expansion through job creation and tax revenue [18]. Despite sufficient sunlight to meet electricity demand, installed solar capacity remains relatively low. However, plans for expansion are underway, with rising investment from manufacturing facilities and data centers, totaling over $2 billion by 2024 [9]. Financial incentives such as property tax relief and the Industrial Tax Exemption Program (ITEP) further stimulate investment and economic growth [5]. Louisiana's solar industry could expand by an estimated 4600 MW over the next five years, ranking 14th nationally in growth potential. It has a warm, sunny climate, with 216 sunny days per year, and flat terrain supports utility-scale development [11].

Notable projects include the 127 MWdc Bayou Galion Solar Project in Northeast Louisiana by Recurrent Energy [11]. By 2024, total solar production, combining utility-scale (≥1 MW) and smaller customer-sited systems, surpassed hydropower for the first time, contributing 37% of the state's renewable generation. Utility-scale generation quadrupled compared to 2023 with five new solar farms totaling 708 MW. Louisiana currently hosts 13 major solar farms, primarily in the south, including the 300 MW Oxbow Solar Farm. Eleven additional projects are expected by 2026, adding nearly 700 MW. Residential solar adoption remains slow, ranking 39th nationwide, due largely to low electricity rates of 11.23 cents/kWh compared to the national average of 16.79 cents/kWh, leading residents to question economic feasibility [10]. Developers are encouraged to demonstrate financial security to ensure decommissioning and land rehabilitation obligations are met, mitigating future risks [5].

3. Methodology

3.1. Data Sources

This study draws on a diverse set of sources to evaluate solar energy development in Louisiana, including academic publications, industry reports, government datasets, and online platforms. Key references comprise peer-reviewed articles and theses addressing solar technologies and pilot projects, media and industry reports documenting existing installations, official energy generation data, and analyses of policies and incentive programs. Information on rooftop solar systems such as system size, roof orientation, and estimated energy output was collected from Google Project Sunroof, AES, and the U.S. Energy Information Administration. Data on annual trends and cumulative solar installations were sourced from the Public Interest Research Group and the LSU Center for Energy Studies. Spatial data for mapping were obtained from Table F53, published by the U.S. Energy Information Administration [19].

3.2. Data Analysis and GIS Mapping

The study employed quantitative analyses of both rooftop and utility-scale solar systems, considering factors such as system size, roof orientation, and projected energy production. A GIS-based approach was implemented using ArcGIS Pro to map parish- and state-level photovoltaic (PV) capacity and usage factors across the United States in 2023. Solar generation data, including installed capacity (MW) and operational usage factors, were compiled into an attribute table and linked to geographic boundaries via shapefiles. The map (**Figure 1**) visualized a graduated color scheme, highlighting the spatial distribution of solar generation potential and actual utilization across states and regions.

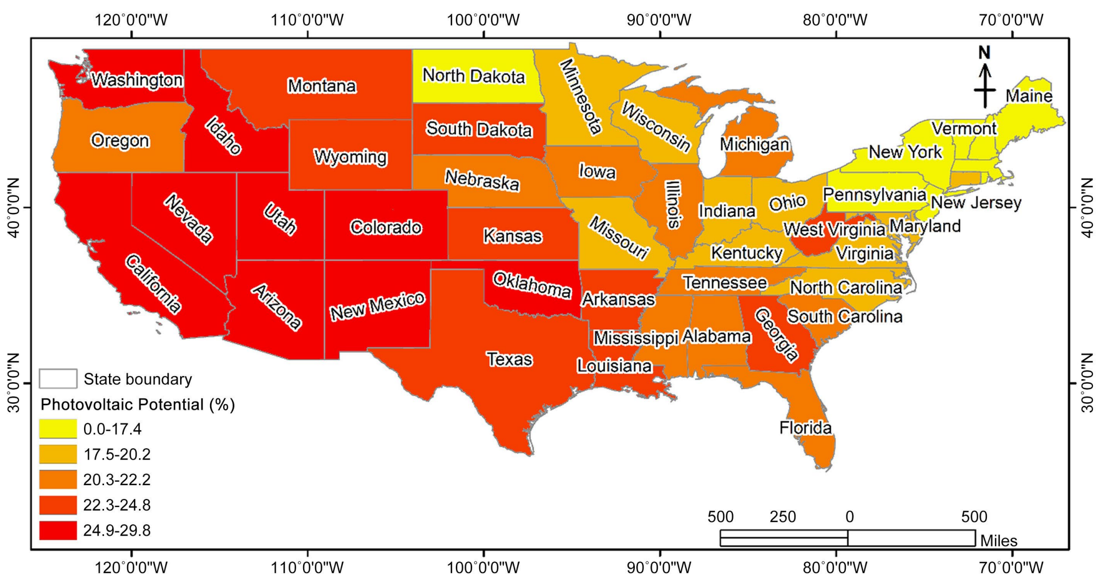
Capacity and usage factors were categorized using the natural breaks (Jenks) method, which minimizes intra-class variation while maximizing inter-class differences, allowing meaningful spatial patterns to emerge. This ensured that observed variations in PV capacity and performance reflected genuine regional differences rather than arbitrary classifications. The data was processed and linked to Louisiana's geographic boundaries in ArcGIS Pro to visualize trends in solar deployment and identify general areas with favorable conditions for solar energy development.

While this analysis focused on existing generation and capacity factors rather than detailed topographic or infrastructure layers, it provided a spatial overview that supported the identification of regions suitable for future solar deployment. Temporal trends in solar adaptation, especially for behind-the-meter systems, were analyzed to identify annual and cumulative growth patterns. A comprehensive literature review provided additional context on technical, economic, and policy factors shaping solar deployment. Multiple datasets were cross-validated to ensure accuracy, and modeled estimates were used to project potential generation where direct measurements were unavailable.

4. Results

4.1. Solar (Photovoltaic) Generation in the United States

Figure 1 is a thematic map of the United States showing photovoltaic (solar energy) potential by state. States are color-coded using a yellow-to-dark-red gradient, where darker shades represent higher solar potential and lighter shades indicate lower potential. Western and southwestern states, including California, Nevada, Arizona, New Mexico, Texas, and Colorado, are shaded in darker red, reflecting the highest levels of solar photovoltaic potential due to stronger and more consistent solar irradiance. In contrast, northeastern states such as Maine, Vermont, and New York appear in lighter yellow tones, indicating comparatively lower solar potential driven by reduced solar intensity and shorter periods of peak sunlight availability. The map also highlights a clear regional pattern, where solar resources are generally more abundant in the southern and western parts of the country compared to the northern and eastern regions. This spatial variation suggests that large-scale solar development is likely to be more efficient and economically viable in high-irradiance states, while lower-potential regions may require complementary renewable energy strategies such as wind or grid integration from other regions.



Source: [19].

Figure 1. Capacity and usage factors for solar (photovoltaic) generation in the United States in 2023 [19].

4.1.1. Estimated Solar Installation Potential in the United States

Table 1 shows the estimated solar installation potential across different roof types in the United States, revealing that flat roofs hold the greatest capacity, with a potential of about 22,700 MW (DC). This is followed by south-facing roofs, which can support approximately 15,200 MW, owing to their favorable orientation for capturing sunlight throughout the day. East- and west-facing roofs have similar potentials, 11,900 MW and 11,500 MW, respectively, reflecting balanced exposure to morning and afternoon sunlight. North-facing roofs contribute the least, with an estimated potential of 5900 MW, due to limited solar radiation. Overall, the distribution highlights that while flat and south-facing rooftops offer the most significant opportunities for solar expansion, all roof orientations together represent a substantial untapped resource for photovoltaic development in the United States [20].

Table 1. Projected solar installation potential in the United States.

Type	Total installation size (MW DC)
Flat Roof	22.7 K MW
South-facing	15.2 K MW
West-facing	11.5 K MW
East-facing	11.9 K MW
North-facing	5.9 K MW

Source: [20].

4.1.2. Energy Generation Potential

Table 2 shows the total yearly energy generation potential of rooftop solar systems in the United States varies significantly by roof orientation. Flat roofs offer the highest potential, generating approximately 30 million MWh (AC) annually, reflecting their suitability for optimal solar panel placement and tilt adjustment. South-facing roofs follow with 20.3 million MWh, benefiting from maximum sunlight exposure throughout the day. East- and west-facing roofs provide comparable outputs of 14.6 million MWh and 14.1 million MWh, respectively, capturing morning and afternoon sunlight. In contrast, north-facing roofs contribute the least, with about 6.8 million MWh, due to limited direct solar exposure. Overall, the data indicates that while flat and south-facing roofs dominate solar energy potential, all orientations contribute meaningfully to the nation's total rooftop solar generation capacity.

Table 2. Total yearly energy generation potential (MWh AC).

Type	Energy generation (MWh AC)
Flat Roof	30 M MWh
South-facing	20.3 M MWh
West-facing	14.1 M MWh
East-facing	14.6 M MWh
North-facing	6.8 M MWh

Source: [20].

4.1.3. Rooftop Solar Capacity Distribution below 50 KW

Rooftop solar installations below 50 kW in the United States are predominantly small-scale systems, with the highest concentration found in the lower capacity ranges. Table 3 shows that installations between 5 - 10 kW are most common, representing about 361,700 roofs, followed closely by the 0 - 5 kW and 10 - 15 kW categories with 347,300 and 343,900 roofs, respectively. The number of systems declines gradually with increasing capacity, dropping from 297,500 roofs in the 15 - 20 kW range to just 48,200 roofs in the 45 - 50 kW category. This pattern indicates that most rooftop solar adopters in the U.S. favor smaller residential-scale systems, which are typically more affordable, easier to install, and well-suited to household electricity demand. Overall, the distribution reflects a strong preference for low-capacity solar systems, underscoring the dominance of residential installations in the nation's rooftop solar landscape [20].

Table 3. Rooftop solar capacity distribution (number of roofs, <50 kW).

Distribution	Installation size (KW DC)
0 - 5	347.3 K roofs
5 - 10	361.7 K roofs
10 - 15	343.9 K roofs
15 - 20	297.5 K roofs
20 - 25	284.7 K roofs
25 - 30	217.5 K roofs
30 - 35	179.5 K roofs
35 - 40	118.6 K roofs
40 - 45	82.7 K roofs
45 - 50	48.2 K roofs

Source: [20].

4.1.4. Rooftop Solar Capacity Distribution above 50 KW

Rooftop solar installations above 50 kW in the United States are heavily concentrated in smaller-capacity systems, with the number of installations dropping sharply as system size increases. From Table 4, most systems fall within the 50 - 100 kW range, totaling about 124,600 roofs, reflecting the preference of commercial and large residential users for more affordable and easily integrated setups. Installations decline steadily with size, from 25,900 roofs at 100 - 150 kW to 12,200 at 150 - 200 kW, and become uncommon beyond 250 kW due to higher costs, permitting complexities, and grid connection barriers. Very few systems exceed 950 kW (around 2400 roofs), and the lack of systems between 650 and 900 kW suggests technical or economic limitations in that range. Overall, the pattern underscores the predominance of small to mid-sized rooftop systems in driving distributed solar generation across the U.S.

Table 4. Rooftop solar capacity distribution (number of roofs, >50 kW).

Distribution	Installation size (KW DC)
50 - 100	124.6 K roofs
100 - 150	25.9 K roofs
150 - 200	12.2 K roofs
200 - 250	6.5 K roofs
250 - 300	3.8 K roofs
300 - 350	2.5 K roofs
350 - 400	1.8 K roofs
400 - 450	1.3 K roofs
450 - 500	965 K roofs
500 - 550	731 K roofs
550 - 600	500 K roofs
600 - 650	300 K roofs
650 - 700	-
700 - 750	-
750 - 800	-
800 - 850	-
850 - 900	-
900 - 950	-
950+	2.4K

Source: [20].

4.1.5. Annual Solar Installations in Louisiana

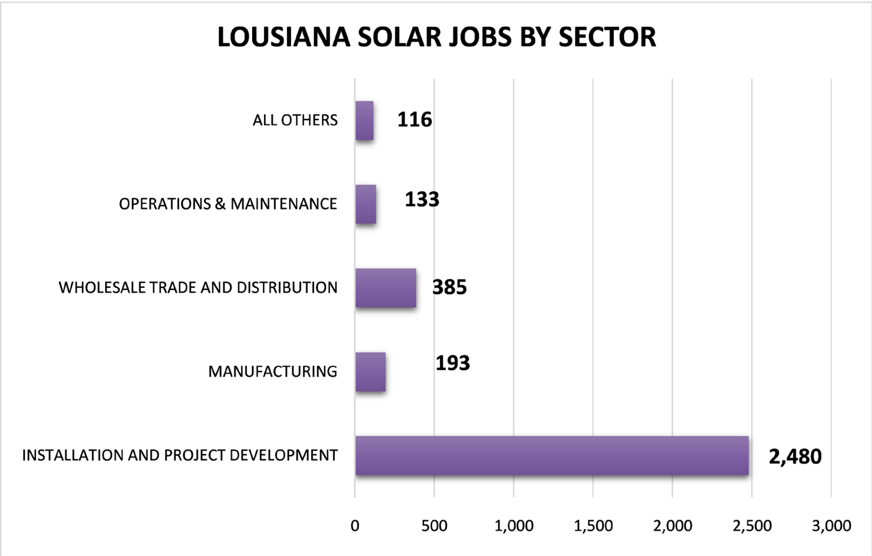
Solar installation capacity in Louisiana has increased significantly since 2020, driven primarily by the rapid expansion of utility-scale solar projects [11]. Between 2016 and 2019, growth in solar development was relatively modest and was mostly limited to residential installations. From 2020 onward, however, the state experienced a substantial acceleration in capacity additions as several large-scale utility projects came online. This expansion produced a sharp upward trend, with the most notable growth occurring in 2023 and reaching its highest point in 2024, when installed capacity exceeded 900 MW, representing the peak level of solar development in Louisiana to date. Although a minor decrease is recorded in 2025, overall capacity remains significantly higher than pre-2020 levels. Overall, this pattern highlights Louisiana's transition from slow, residential-scale solar adoption to a rapidly growing, utility-driven solar energy sector [11].

4.2. Louisiana Solar Employment Growth

Solar energy employment in Louisiana experienced gradual but steady growth between 2018 and 2023, reflecting the state's ongoing transition toward renewable energy. The solar workforce increased from approximately 2950 workers in 2018 to 3352 in 2019, representing a 13.6% rise likely driven by increased investment and the expansion of solar development projects. However, employment levels saw slight declines in 2020 and again in 2022, which may be associated with project delays and the broader economic disruptions caused by the COVID-19 pandemic. Despite these fluctuations, the sector demonstrated resilience and began recovering in subsequent years, reaching about 3,308 workers in 2023. Overall, solar employment in Louisiana grew by roughly 12% over the five-year period, highlighting a stable upward trend in clean energy job creation supported by expanding solar infrastructure, increased investment, and supportive policy initiatives [21].

4.2.1. Louisiana Solar Energy Jobs

Louisiana's solar workforce is primarily concentrated in installation and project development in **Figure 2**, which employs about 2,480 workers, underscoring the state's strong emphasis on expanding residential, commercial, and utility-scale solar infrastructure. The manufacturing sector, with roughly 193 workers, represents a smaller share, reflecting limited in-state production capacity and reliance on imported equipment. Wholesale trade and distribution support around 385 jobs, facilitating the supply and logistics essential for timely solar project delivery. Meanwhile, operations and maintenance (O&M) employ approximately 133 workers, ensuring the continued efficiency and reliability of installed systems, an area poised for growth as capacity expands. The remaining 116 workers fall under the "all others" category, covering roles in research, finance, administration, and policy support. Collectively, this distribution reveals a project-driven industry dominated by installation work but with potential for diversification as Louisiana's solar sector matures and investments in manufacturing and maintenance increase.



Source: [21].

Figure 2. Solar jobs in Louisiana by sector.

4.2.2. The Solar Industry in Louisiana

Louisiana's solar sector is still in its early stages of development but continues to make gradual progress in renewable energy adoption. By 2025, **Table 5** shows the state had achieved a total installed solar capacity of 617 megawatts (MW), placing it 36th in the nation. This capacity can supply electricity to roughly 61,098 homes and contributes about 0.7% of the state's overall power generation. With 71 solar companies operating across installation, project development, manufacturing, and related fields, Louisiana's solar industry demonstrates growing diversification. Although the state remains behind national frontrunners, rising private investments, favorable policies, and expanding infrastructure indicate a strengthening commitment to renewable energy and a gradual shift away from fossil fuel dependence [21].

Table 5. Louisiana solar industry context.

Solar Industry	Results
Cumulative Installed Solar Capacity	617
State Ranking for Installed Solar Capacity	36
Equivalent Number of Homes Powered by Solar	61,098
% of State's Electricity from Solar	0.7%
Number of Solar Companies	71

Source: [21].

5. Discussions and Conclusions

This study provides a comprehensive assessment of solar energy development in Louisiana, addressing current capacity, growth trends, technical and economic feasibility, policy impacts, and future prospects within the broader U.S. renewable energy context. Based on renewable energy consumption, the state only consumes 3% of renewable energy which comprises Solar Energy, Hydropower, Geothermal, Biodiesel, Fuel Ethanol, Wood and waste as well as Biofuels [22]. The findings reveal that while the state's solar sector is expanding, driven primarily by utility-scale projects, its contribution to overall electricity generation remains modest at approximately 0.7%. This highlights a substantial gap between potential and realized capacity and underscores the importance of filling key knowledge gaps, including empirical data on local solar resource distribution, the feasibility of PV systems under Louisiana's humid and storm-prone conditions, and the socio-economic and policy factors shaping adoption. Spatial analysis using GIS identified southern and central parishes as most suitable for utility-scale solar development due to favorable solar irradiance, flat topography, and available land, whereas northern regions face moderate limitations from lower insolation and seasonal cloud cover. These findings not only validate prior model-based predictions but also provide localized, ground-validated insights that address the scarcity of empirical resource assessments.

Rooftop solar potential is highest on flat and south-facing roofs, emphasizing the value of targeted residential and commercial deployment programs that optimize orientation and maximize energy yield. Integrating GIS mapping with rooftop assessments offers actionable guidance for strategic planning, enabling utilities, developers, and policymakers to prioritize high-yield locations and optimize energy output. Analysis of installation trends shows a pronounced acceleration in solar capacity since 2020, reflecting increased private investment and the effectiveness of incentive programs. However, residential adoption remains limited due to modest electricity prices, high upfront costs, and low awareness of incentives such as net metering and property tax exemptions. These findings indicate that while Louisiana has made substantial progress in building large-scale capacity, broader strategies, public awareness campaigns, financing mechanisms, and stable incentives are needed to stimulate distributed solar deployment. Employment data further illuminate the sector's dynamics. Solar jobs are concentrated in installation and project development, while manufacturing, operations, and maintenance remain underdeveloped. Expanding workforce opportunities in these sectors will enhance economic resilience, skill development, and long-term sustainability, addressing knowledge gaps regarding the socio-economic effects of solar deployment and guiding policy interventions for inclusive growth.

Solar energy adoption across Louisiana reveals notable socio-economic and geographic inequalities linked to variations in income levels, location, and policy access. Thus, it pays to recognize the fiscal and ecological advantages that are associated with renewable energy manifested by the anticipated socio-economic, technological and environmental turnarounds based on employment generation and amenity development [23]. Installations are largely concentrated in urban and suburban parishes such as East Baton Rouge, Orleans, and Lafayette, areas characterized by higher household incomes, better financing opportunities, and stronger grid connections. Conversely, rural and low-income regions, despite their significant solar potential, experience slower adoption due to high upfront costs, insufficient local incentives, and limited awareness of available funding options. Existing policies, including the federal Investment Tax Credit and Louisiana's property tax exemptions, tend to favor wealthier homeowners who can afford the initial expenses, thereby excluding renters and low-income groups. Additionally, the state's minimal investment in community solar initiatives restricts access for residents lacking suitable rooftops or capital for individual systems.

Inadequate and unreliable power supply remains a major constraint to future economic growth [24]. While Louisiana's solar sector continues to expand, the benefits remain unevenly distributed, deepening existing socio-economic and spatial divides. Promoting equitable participation will require more inclusive measures such as income-based support, rural solar cooperatives, and expanded community solar programs that extend opportunities to all population segments. Technical and environmental factors, including Louisiana's humid climate, frequent storms, and hurricanes, pose risks to system durability and efficiency. Sustainability concerns such as decommissioning and recycling of solar panels also require attention. These findings highlight the need for robust system design, resilience planning, and supportive regulations to enhance the technical and economic feasibility of PV systems in the state. Policy frameworks significantly influence adoption and investment. While incentives such as net metering, tax exemptions, and the Industrial Tax Exemption Program have spurred growth, their limited scope and duration may constrain future expansion.

Agrivoltaics emerges as a promising approach to balance solar development with farmland preservation, ensuring socially equitable and environmentally sustainable growth. Agrivoltaics offers a valuable opportunity to expand solar energy while supporting Louisiana's farming sector. By combining solar panels with crops such as sugarcane, soybeans, and rice, farmers can earn extra income from electricity generation without reducing crop production. This dual-use system can help conserve soil moisture, optimize land use, and strengthen the economic resilience of rural communities, making solar adoption more practical and equitable in the state [25]. Louisiana's solar sector possesses substantial potential. With moderate solar irradiance, abundant land, increasing investment, and a skilled workforce, the state could expand capacity by several thousand megawatts over the next decade. By combining spatial analysis, rooftop and utility-scale assessments, and policy and economic evaluation, this study addresses critical knowledge gaps and provides actionable insights for strategic solar energy deployment, highlighting optimal investment areas, deployment strategies, and the technical, economic, and social considerations necessary to achieve a resilient, diversified, and sustainable energy future in Louisiana.

To unlock the full potential of solar energy in Louisiana, state policymakers should adopt a holistic, long-term approach that addresses technical, economic, and social considerations. This approach should expand and stabilize financial incentives, such as tax credits, net metering, and grants for both utility-scale and distributed solar projects to stimulate private investment and residential participation. Regulatory measures should emphasize system resilience and sustainability, ensuring installations can withstand hurricanes and storms, while also providing clear standards for panel decommissioning and recycling to reduce environmental impacts. Incorporating agrivoltaics and strategic land-use planning can harmonize solar development with agricultural preservation, ensuring equitable energy access for rural communities. Additionally, supporting workforce training, local manufacturing, and operations and maintenance capacity will strengthen the sector's economic and social foundation, enabling solar growth to advance energy security and inclusive economic development.

Louisiana's frequent hurricanes, hail, and high winds create considerable risks for solar panel performance and longevity. To improve resilience, systems can incorporate elevated mounting to reduce flood exposure, wind-resistant panels, reinforced racking, and secure anchoring to withstand strong storms. These measures, combined with regular maintenance and adequate insurance, help minimize damage, ensure consistent energy production, and support the long-term viability of solar installations in the state [26]. Together, these policies will position Louisiana for a resilient, diversified, and sustainable solar energy future. The absence of ground-based solar measurements in Louisiana introduces uncertainty into the estimated solar potential presented in this study. Reliance on modeled or secondary data may overestimate or underestimate actual generation capacity due to local variations in cloud cover, humidity, and storm impacts. This limitation underscores the need for empirical validation through on-site solar monitoring to improve the accuracy of capacity assessments and inform more reliable planning for both utility-scale and rooftop solar deployment.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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