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Understanding Alternative Energy: Wind and Solar Energy Systems on Texas Rangelands

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Introduction

Texas leads the nation in wind, solar, and energy storage capacity with 80,659 MW installed, providing 30.2% of the state's electricity (American Clean Power, 2025). This rapid growth of alternative energy on rangelands offers benefits such as reduced fossil fuel dependence, but it also raises significant concerns about long-term ecological, economic, and social impacts on rural landscapes primarily used for grazing and wildlife habitat. However, this expansion has also delivered substantial economic advantages to rural Texas communities. Wind and solar projects generate significant property tax revenues that fund essential public services, including schools, hospitals, roads, and emergency response in areas often challenged by declining populations and limited tax bases. Additionally, lease payments and royalties provide stable, multigenerational income to landowners, helping preserve family ranches and farms amid fluctuating agricultural markets. While it is clear these financial inflows have enabled upgrades to local infrastructure, supported school districts with new facilities and programs, and bolstered rural hospitals and community services across the state, there are spatial and temporal ecological concerns, costs, and cascading effects that these decisions impact.

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Solar Energy Systems

Solar energy in Texas predominantly uses photovoltaic (PV) panels in ground-mounted arrays, either fixed or tracking, requiring an average of 6.9 acres per megawatt of capacity. While these systems efficiently capture sunlight, their installation and operation can disrupt soil through compaction and erosion, alter vegetation communities via clearing and shading, fragment wildlife habitats, and attract or harm insects and birds (Table 1). At end-of-life after about 30 years, panels contribute to growing waste challenges, with U.S. projections of 0.17 to 1 million tons by 2030 and risks of heavy metal leaching if not properly recycled (Fig. 1) (Hernandez et al., 2013; Heath et al., 2020). Effective management, such as using sheep grazing for vegetation control, can mitigate some issues like wildfire risk while supporting dual rangeland use (Walston, 2024). However, grazing animal selection and uniform grazing with undesirable species present a significant challenge for solar grazing operations. In recent case studies, contracted solar grazing transitions to mowing to meet the uniform vegetative height requirements, and grazing animals are transitioned out (Ramirez, 2025).

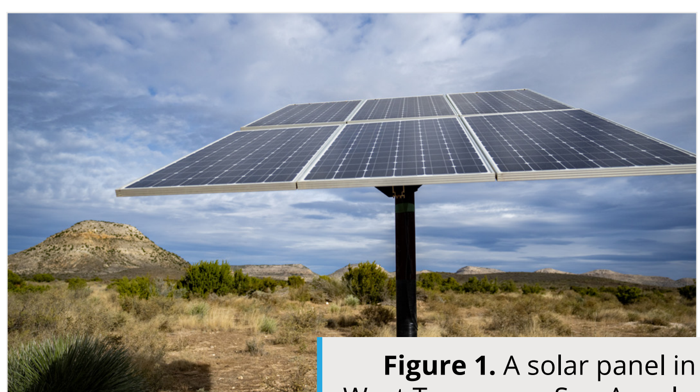

Figure 1. A solar panel in West Texas near San Angelo.

Table 1. Anthropogenic impact of solar alternative energy development.			
Phase	Site Alteration Processes	Environmental Impacts	Long-term Effects
Installation	• Land clearing and vegetation removal • Grading and compacting soil • Road construction • Panel and infrastructure setup	• Loss of native vegetation and habitat • Soil disturbance and compaction • CO_2 emissions from transportation/installation machinery • Increased erosion risk • Dust generation	• Decreased carbon sequestration potential (Chen et al., 2024) • Reduced soil fertility and health (Chen et al., 2024) • Fragmented ecosystems if no wildlife corridors are preserved
Operation	• Panel cleaning (can use water or chemicals) • Mowing, herbicide application, or livestock grazing • Panel shading alters sunlight and precipitation/water retention on the ground	• Changes to plant growth (e.g., shade-tolerant species may dominate) • Soil moisture shifts • Wildlife avoidance or mortality due to fencing, roads, or infrastructure (panels included) • Potential pollution from herbicide application	• Microhabitat alteration and degradation (Webb, 2024) • Species composition shifts • Persistent contaminants in soil (if herbicides or chemicals were used)
Maintenance	• Replacement of damaged panels or batteries • Regular mowing or grazing • Possible road repair or site re-leveling	• Habitat disturbance from regular human presence • Chemical leaks (e.g., cadmium compounds, silicon tetrachloride, hexafluoroethane, and lead) (Karban et al., 2025) • Noise or light pollution • Possible dust, erosion from road/site repair	• Chemical residues/pollution (Karban et al., 2025) • Changed animal behavior patterns or population levels due to long-term disturbance
Decommissioning	• Removal of panels, inverters, fences • Hauling off infrastructure (may involve heavy machinery) • Attempted site restoration or seeding	• Heavy machinery can compact soil again • Improper removal may leave concrete pads, footings, cables (NRCS, 2024) • Dust, erosion • Potential for illegal dumping or abandoned waste	• Remaining debris or contaminants if not fully removed or cleaned (Dhar et al., 2020) • Poor soil structure and health due to disturbance • Weedy or invasive regrowth if not reseeded properly (NRCS, 2024)
Post-Contract Completion	• No required activity unless regulated • Site may be sold, reused, or left abandoned (Foxhall, 2023)	• If unmanaged, may become a weed-dominated or degraded site • Wildlife may not return without targeted habitat recovery efforts • Lost potential for agricultural/pasture reuse (Karban et al., 2025)	• Long-term biodiversity loss • Pollutants in soil • Visual and structural remnants (e.g., fence posts, footings)

Wind Energy Systems

Wind energy relies on large turbines, typically 300 to 415 feet tall, that convert wind into electricity through blade rotation (Fig. 2). These installations cause substantial soil and vegetation disturbance from roads, pads, and infrastructure, leading to compaction, erosion, and slow native grassland restoration that can take over 10 years (Table 2). Wildlife faces major threats, particularly birds contributing to 140,000 to 679,000 annual U.S. deaths (Loss, 2013) and bats through collisions and barotrauma (Fig. 3) (Hayes, 2013). Turbine blades, durable for 20 to 30 years, are difficult to recycle and often end up in landfills, creating long-term disposal issues.

Considerations and Landowner Implications

Large-scale wind and solar projects on Texas rangelands can depress nearby property values by 20 to 30%, increase land rental costs, and shift infrastructure burdens to local communities through tax abatements and road damage (Vyn, 2014). Socially, they transform iconic open vistas, eroding rural cultural heritage and sparking opposition from residents concerned about quality of life and landscape changes.

Leases for wind or solar development can provide valuable, steady income to support ranching operations, but they carry risks including loss of productive grazing land, restrictions on use, potential property devaluation, and environmental liabilities. Landowners are advised to thoroughly review contracts, incorporate restoration and decommissioning requirements, prioritize low-productivity sites, explore compatible uses such as agrivoltaics, and negotiate wildlife protections to safeguard their rangeland's long-term health and legacy.

Figure 3. 30.2% of all electricity produced in Texas comes from wind, solar, and energy storage power plants.

Figure 2. Wind turbines in West Texas near San Angelo.

Table 2. Anthropogenic impact of wind energy development.			
Phase	**Site Alteration Processes**	**Environmental Impacts**	**Long-term Effects**
Installation	• Site selection and road construction • Foundation excavation and cement pouring • Turbine tower and blade delivery/installation (heavy haul/18-wheelers, cranes, etc.) • Grid connection infrastructure (trenching or cabling)	• Vegetation loss, soil degradation and compaction, erosion risks • High carbon emissions from transport and production of steel and concrete • Disturbance to wildlife (especially nesting birds and bats)	• Permanent land-use change due to turbine pads and created access roads • Soil profile degradation (Dhar et al., 2020) • Fragmented landscapes
Operation	• Blade rotation and power generation • Routine maintenance (via access roads) • Remote monitoring systems • Oil/lubricant replacement	• Bird and bat mortality from blade collisions • Low-frequency noise pollution (Texas Comptroller of Public Accounts, 2023) • Habitat fragmentation • Minor fluid/chemical leaks (oils, lubricants, etc.)	• Wildlife population changes (e.g., displacement, loss of nesting sites) • Behavior adaptations (even after turbine removal) • Wildlife mortality to abandoned infrastructure • Contaminated soils (if improper cleanups from spills)
Maintenance	• Regular inspections (by drone or vehicle) • Repairs and replacements (all components) • Vegetation control along access roads and infrastructure	• Disturbance to wildlife • Soil disruption/degradation from equipment (Dhar et al., 2020) • Potential spills of chemicals (lubricants, coolants, etc.)	• Contaminated soils (if improper cleanups from spills) • Encroachment of unwanted species along roads and pads • Wildlife avoidance
Decommissioning	• Turbine dismantling (towers, power units, blades) • Crane and heavy haul equipment use • Potential removal of cables (underground) and pads (transformer and wind units) (Bauman, 2020)	• Blade disposal waste/ pollution (often to landfill due to materials) (Sproul et al., 2023) • Soil compaction from machinery and equipment • Noise pollution and disturbance (Saidur et al., 2011)	• Without legal obligation, concrete foundations are often left buried • Roads may remain • Alteration to habitat corridors and species composition
Post-Contract Completion	• Site may be repurposed (e.g., solar or recreation) • Landowner or utility company may abandon or convert land use • No guaranteed ecological restoration unless specified by policy	• Risk of infrastructure abandonment • Remaining roads (gravel and cement for access to pad) • Weed or woody encroachment • Detriment to visual aesthetics (lowers value of the land/economics) (Saidur et al., 2011)	• Land alteration (soil, water, drainage) • Reduction in ecological efficiency and integrity if minimal to no reclamation • Restoration to pre-disturbance condition is impossible (Bauman, 2020)

Conclusion

The rapid expansion of wind and solar energy on Texas rangelands, while contributing significantly to renewable energy goals and providing economic benefits through leases, comes at a substantial cost to ecological integrity, rural economies, and cultural heritage. Large-scale installations disrupt soils, fragment habitats, cause significant wildlife mortality, particularly to birds and bats, and generate long-term waste challenges from panels and turbine blades. Economically, they can depress property values, inflate land costs, and burden local communities, while socially transforming iconic open landscapes and sparking opposition. At the same time, wind and solar development have brought meaningful economic benefits to many rural communities in Texas. Property tax revenues from these projects have provided critical funding for public schools, hospitals, law enforcement, and infrastructure improvements in underserved areas. Lease agreements and royalties have offered landowners reliable income streams, enabling the continuation of ranching operations and preserving generational land ownership. These contributions have helped stabilize local budgets, enhance community services, and support economic resilience in rural Texas. However, this progress must be balanced and requires responsible siting on marginal lands, robust contract protections, comprehensive ecological restoration plans, and stricter regulations to ensure that alternative energy development preserves the long-term health, productivity, and integrity of Texas' vital rangeland ecosystems, ecosystem services, and all wildlife, livestock, and livelihoods depending on them.

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