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Title: Evaluation of environmental impact manifestations of electric power transmission projects

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Introduction

Achieving deep decarbonization of electricity systems requires significant expansion and modernization of transmission networks to connect resource-rich areas to load centers, balance energy variability, and improve system resilience. The deployment of high-voltage transmission lines presents complex environmental and socio-environmental effects, which must be evaluated across the entire project lifecycle, from planning to decommissioning. A robust environmental assessment should address cumulative and synergistic effects of linear infrastructures.

Methodology

This article is based on a narrative review of indexed literature and reference texts on Environmental Impact Assessment (EIA), mitigation measures, life cycle studies, and risk assessment. EIA manuals, peer-reviewed articles on impacts from linear infrastructure, and life cycle studies of electricity networks were prioritized. Impact manifestations were coded by life cycle phase, extracting assessment criteria, measures, and monitoring metrics.

Results

1. **Avoiding impacts**: The most effective measure is to avoid corridors through critical habitats and flight paths, utilizing a multi-criteria analysis considering environmental and social variables from the outset of the project.

2. **Minimizing impacts**: When avoidance is not feasible, measures like cable marking and optimized conductor configurations are used to minimize risks, especially in sensitive areas.

3. **Restoring and compensating**: Native plant revegetation and post-construction drainage restoration are recommended to reduce long-term residual effects.

4. **Assessment of externalities**: Externality assessments help compare technological alternatives under uncertainty, supporting more informed decision-making.

Conclusions

The EIA for electricity transmission projects must go beyond formal compliance, adopting a preventive and adaptive approach. This includes avoiding corridors over sensitive habitats, minimizing impacts with proven measures, and restoring and compensating for significant impacts. The assessment of externalities provides economic rationality when selecting measures under uncertainty, particularly in energy transition contexts. The life cycle perspective reveals that, while transmission and distribution emissions are low compared to generation, they are crucial for design decisions, such as material use and selective burial. Informed participation and transparent governance promote social acceptance and long-term project viability.

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