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Climate Change Adaptation Strategies for Energy Infrastructure in Coastal Regions

In recent years, the intensification of global climate change has led to a surge in extreme weather events. Phenomena such as sea level rise, storm surges, and heavy rainfall pose severe threats to energy infrastructure in coastal regions. As critical nodes in energy production and transmission, coastal facilities—including power plants, transmission lines, LNG terminals, and port infrastructure—are increasingly vulnerable to climate-related disasters. Disruptions to these systems could lead to large-scale energy outages, affecting urban operations and national energy security. Therefore, developing effective climate change adaptation strategies for coastal energy infrastructure has become a vital interdisciplinary research area linking energy and climate policy.

Energy infrastructure is characterized by high investment costs, long life cycles, and limited flexibility for post-construction modifications. As such, it is essential to incorporate climate risk considerations into early-stage planning and design. Traditional disaster-resilience standards are no longer sufficient in the face of escalating climate threats. A shift is needed from purely defensive approaches to adaptive and resilience-based strategies. These may include technical measures such as facility reinforcement, relocation, and the development of flexible grid systems, as well as policy and management approaches such as risk assessment frameworks, financial incentives, and regional coordination mechanisms.

This study aims to identify and evaluate the major climate risks facing coastal energy infrastructure, review international and domestic adaptation practices, and propose a regionally differentiated adaptation strategy framework tailored to China’s coastal zones. Utilizing methods such as climate risk modeling, vulnerability analysis, and multi-scenario simulation, the research seeks to provide theoretical insights and policy recommendations for enhancing the resilience and reliability of energy systems under changing climatic conditions.