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From Scarcity to Scale: The New Economics of Energy

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Abstract

The global energy landscape is undergoing a major transformation, upending decades of economic thinking built around resource scarcity. Unlike fossil fuels—continuously extracted from finite, geographically fixed deposits—renewable energy revolves around manufacturing technology that harvests essentially free and limitless resources. This shifts our economic framework from Hotelling's Rule, where scarcity drives rising costs, to a learning curve model where costs fall with cumulative production—creating a deflationary trajectory contradicting traditional energy economics. While natural endowments of solar irradiation and wind resources vary globally, geographic accident no longer fundamentally determines energy wealth; instead, technological innovation, manufacturing scale, and early-mover advantages determine market leaders, creating a 'winner-takes-most' dynamic exemplified by China's dominance in solar PV and battery manufacturing. The concept of energy security transforms from dependence on fuel imports to reliance on imported equipment, making domestic production capacity and resilient supply chains critical to national interests and driving a global resurgence of industrial policy. The nature of risk undergoes fundamental transformation in this paradigm, shifting from volatile commodity prices, concentrated resource control, and environmental impacts of fossil fuel systems to new considerations including critical minerals access, grid flexibility requirements, storage solutions, and land-use planning for renewable infrastructure. Market design experiences philosophical inversion as fossil fuel markets designed to price extracted commodities give way to clean-energy markets that must accommodate near zero-marginal cost resources, reward flexibility, and prioritise integration. Renewable energy blurs traditional boundaries between production and consumption through 'prosumers', while simultaneously integrating previously separate sectors through electrification and digitalisation. These evolving system boundaries produce novel emergent behaviours that necessitate new approaches to market design and regulation—marking a decisive shift from an energy paradigm rooted in scarcity towards one characterised by scale and abundance.

Keywords: industrial economics, energy economics, economics of renewable energy, Hotelling model, learning curve