

POWER GENERATION EFFICIENCY IMPROVEMENT: THE OVERLOOKED PATHWAY TO CREDIBLE ENERGY TRANSITION

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Extended Abstract

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Abstract Summary

Power generation efficiency is a critical yet often underemphasized determinant of fuel consumption, emissions intensity, generation cost, and electricity affordability. Despite significant technological advancements, the thermal efficiency of fossil fuel-based power stations remains relatively low, with more than half of primary energy input lost as waste heat. This structural inefficiency continues to shape both the environmental and economic performance of global power systems.

This study evaluates thermal efficiency as an underutilized lever for achieving a credible energy transition. Using International Energy Agency (IEA) data, it presents a longitudinal assessment of power generation efficiency trends across selected global economies over the period 2005–2022. The analysis examines whether improvements in power demand and available technologies have translated into system-level efficiency gains. It further quantifies missed emissions reduction opportunities arising from limited adoption of higher-efficiency technologies and compares these with observed gains from renewable energy expansion.

Results show that although demand for electricity and heat has increased substantially, particularly in emerging economies, realized improvements in thermal efficiency remain marginal across most cases. This indicates limited diffusion of best available technologies and insufficient upgrading of existing assets. While renewable energy deployment has expanded, significant emissions reduction potential remains unrealized due to persistent inefficiencies in thermal generation. Importantly, efficiency improvements also reduce fuel consumption per unit of electricity, lowering generation costs and improving energy affordability. The findings highlight that power generation efficiency improvement is a practical, scalable, and immediately deployable pathway that complements renewable energy expansion. Integrating explicit efficiency benchmarks into regulatory and planning frameworks can strengthen emissions outcomes while improving the economic and social credibility of the energy transition.

Presenting Author Biography

Saqib is a global visionary in industrial energy efficiency and decarbonization with over 25 years of impact across the energy sector. As energy transition expert, he has delivered large-scale decarbonization initiatives driving sustained efficiency and emissions abatement. His work has realized over 10% energy efficiency improvement at a major industrial complex in the Middle East, with continued gains.

He has pioneered integrated energy optimization in capital projects, advanced unit-level energy benchmarking, and promoted renewables integration in energy sector.

A Fellow of the Energy Institute (UK) and Association of Energy Engineers (USA), he has ~50 publications and won multiple international awards.