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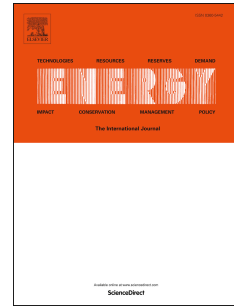
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Energy Transition roadmap towards 100% renewable energy and role of storage technologies for Pakistan by 2050

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ABSTRACT

The main aim of this study is to present an energy transition roadmap for Pakistan in which the total energy demand by 2050 is met by electricity generated via renewable sources, in particular, solar photovoltaic. Efforts have been made to assess the energy and cost required for the transition towards a sustainable energy supply covering the demand for power, desalination and industrial gas sectors. Hourly resolved model was used and optimization was carried out for each time period (transition is modeled in 5-year steps) on the basis of assumed costs and technological status till 2050 for all energy technologies involved. Solar PV dominates the installed technologies and contributes 92.7% and 96.6% in power and integrated scenarios. Seawater desalination sector dominates the integrated scenario and clean water demand is found to be $2.8 \cdot 10^{11}$ by 2050. The levelised cost of electricity declines from 106.6 €/MWh in 2015 to 46.2 €/MWh in 2050 in power scenario. In country-wide scenario, gas storage rules from 2040 to 2050 in terms of total storage capacities while battery storage is prominent in terms of storage output. The results indicates the 100% renewable system as cost competitive and least cost option for Pakistan's future energy transition.

Keywords: Pakistan, Energy Transition, 100% renewable energy, Desalination demand, Storage technologies, power-to-gas.

Nomenclature

A-CAES	Adiabatic compressed air energy storage
Capex	Capital expenditure
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage
CSP	Concentrating solar thermal power
FLH	Full load hours
GHG	Greenhouse gases
HVDC	High-voltage direct current
IEA	International Energy Agency
LCOC	Levelized cost of curtailment
LCOE	Levelized cost of electricity
LCOG	Levelized cost of gas
LCOS	Levelized cost of storage
LCOT	Levelized cost of transmission

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