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A Global Assessment: Can Renewable Energy Replace Fossil Fuels by 2050?

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Abstract

Our study evaluated the effectiveness of using eight pathways in combination for a complete to transition from fossil fuels to renewable energy by 2050. These pathways included renewable energy development; improving energy efficiency; increasing energy conservation; carbon taxes; more equitable balancing of human wellbeing and per capita energy use; cap and trade systems; carbon capture, utilization, and storage; and nuclear power development. We used the annual British Petroleum statistical review of world energy 2021 report as our primary database. Globally, fossil fuels, renewable (primarily hydro, wind and solar), nuclear energy accounted for 83%, 12.6%, and 6.3% of the total energy consumption in 2020. To achieve zero fossil fuel use by 2050, we found that renewable energy production will need to be increased by up to 6-fold or 8-fold if energy demand is held constant at, or increased 50% from, the 2020 energy demand level. Constraining 2050 world energy demand to a 25% increase over the 2020 level, improves the probability of achieving independence from fossil fuels. Improvements in energy efficiency need to accelerate beyond the current rate of ~1.5% per year. Aggressive application of energy conservation policies involving land use and taxation could potentially reduce world energy use by 10% or more by 2050. Our meta-analysis shows that the minimum level of per capita energy consumption that would allow 8 billion people to have a Decent Living Standard is on average ~70 GJ per capita per year, which is 93% of the 2020 global average. Developed countries in temperate climates with high vehicle-dependency needed ~120 GJ per capita year1, whereas equatorial countries with low vehicle-dependency needed 30 GJ per capita year1. Our meta-analyses indicated replacement of fossil fuels with renewable energy by 2050 may be possible but will require aggressive application of all eight pathways, major lifestyle changes in developed countries, and close cooperation among all countries.

Keywords: fossil fuel phase-out, renewable energy, energy transition pathways, energy demand, energy efficienc

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