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The Potential for a Global Renewable Energy System and the Implications for Synthetic Fuels and Chemicals

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Abstract:

The power sector is faced with strict requirements in reducing harmful emissions and substantially increasing the level of sustainability. Renewable energy (RE) in general and solar photovoltaic (PV) in particular can offer societally beneficial solutions. The LUT Energy System Transition model is used to simulate a cost-optimised transition pathway towards 100% RE in the power sector by 2050. The model is based on hourly resolution for an entire year, the world structured in 145 regions, high spatial resolution of the input RE resource data, and transition steps of 5-year periods. The global average solar PV electricity generation contribution is found to be about 69% in 2050, the highest ever reported, followed by wind energy (18%), hydropower (8%) and bioenergy (2%). Detailed energy transition results are presented on global-local resolution.
The global average energy system levelised cost of electricity gradually declines from 70 €/MWh in 2015 to 52 €/MWh in 2050 throughout the transition period, while deep decarbonisation of more than 95% around 2040, referenced to 2015, would be possible. The targets of the Paris Agreement can be well achieved in the power sector, while increasing societal welfare, given strong policy leadership.

Decarbonisation of the sectors mobility and industry is partly driven by direct electrification (in particular battery electric vehicles and railway) and for many cases by indirect electrification via power-to-fuels (H_2, CH_4, liquids), power-to-chemicals (MeOH, DME, NH_3, etc.) or H_2-DRI steel. In a highly decarbonized energy system CO_2 will be turned from an exhaust fume to a raw material which can be harvested from sustainable sources, such as CO_2 content of limestone from cement carbon capture and utilization (CCU), waste-to-energy CCU or pulp & paper CCU, and direct from the environment via CO_2 direct air capture (DAC). It seems to be most likely that almost all parts of the chemical industry will substitute the unsustainable petrochemical feedstock by renewable electricity, water and CO_2 from sustainable CCU and DAC sources.