

# Pricing intermittent renewable energy\*

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## Abstract

The energy transition requires significant investment in intermittent renewable energy sources, such as solar and wind power. New generation capacities are generally procured through fixed price contracts, such as power purchase agreements and contracts for difference, or feed-in tariffs. With these designs, renewable technologies are selected based on their production regardless of their adequacy with demand and supply by other technologies. We show that fixed-price contracts implement the optimal portfolio of renewable technologies if the price is adjusted with a technology-specific bonus-malus system that depends on the correlation between renewable energy production and the wholesale electricity price. We estimate the bonus-malus for solar and wind power in California, France, Germany, and Spain and decompose it to identify the key market factors driving the adjustment. We argue that the bonus-malus should be subtracted to the levelized cost of energy (LCOE) to obtain the full cost of generating an additional megawatt-hour with a specific intermittent renewable technology in a given energy mix.

*Keywords:* Electricity market, levelized cost of energy, climate change, intermittent renewable energy, feed-in tariff, power purchase agreement, contract for difference.

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