Roles of diffusion patterns and environmental benefits in determining renewable subsidies

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Abstract

Wind and solar power are supported by governments around the world, this support often takes the form of financial subsidies. The benefits and costs of energy subsidies are complex, combining direct benefits from stimulating adoption and indirect benefits by reducing future technology costs. Using a benefit-cost framework, we build a model for 13 ISO regions covering the U.S. to find optimal subsidy schedules for residential solar and utility wind. The model accounts for technological progress, criteria pollutant and carbon emission benefits, and geographical differences between the ISOs. Numerical solutions to maximize net benefits (environmental benefits less subsidy costs) yield positive values for optimal solar subsidies, initially $175/kW-$965/kW depending on the region, but only if the subsidy induces future technological progress. In contrast, optimal wind subsidies are larger ($257/kW-$1600/kW) and positive in almost all regions even without technological progress. To explain these differences, we construct an analytically solvable model of optimal subsidies neglecting technological progress. Results show that wind subsides are justified due to a combination of both higher environmental benefits and higher elasticity of diffusion as a function of subsidy level. For example, wind subsidies would not be justified in CAISO and Florida regions if wind diffusion had a lower diffusion elasticity the same as residential solar. The specifics of diffusion of a technology thus play an important role in the degree to which subsidies are justifiable.

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