P201 Back Pocket Insights

Value of Voluntary Carbon Markets in Energy Systems Decarbonization

by John Bistline, Anahi Molar-Cruz, Geoff Blanford, and Adam Diamant

New white paper explores how the value of voluntary carbon markets changes under different regional, technology, and policy conditions.

Although companies are increasingly pledging to reduce or eliminate their CO_2 emissions, technical and economic uncertainties remain. In this context, there are questions about the role that voluntary carbon markets* could play in hedging against decarbonization uncertainties and in meeting emissions reduction goals affordably and reliably.

This analysis uses EPRI's U.S. Regional Economy, Greenhouse Gas, and Energy (REGEN) model to explore the value of voluntary carbon markets under a range of scenarios related to:

- **Electricity CO_2 reductions:** Scenarios vary power CO_2 reduction targets as proxies for voluntary targets.
- **Regional flexibility:** Scenarios differ in whether targets are met at a national level or in each region, which illustrates the value of cross-regional credit trading.
- **Economy-wide decarbonization:** Scenarios examine economy-wide net-zero CO_2 to show how the role of carbon credits could change with deeper non-electric decarbonization.
- **Technological assumptions:** All scenarios are run with three scenarios with alternate views for how technology availability and cost could unfold.

*We use the terms "carbon markets" and "carbon credits" to refer to tradeable instruments representing net CO_2 emissions reductions in voluntary markets.

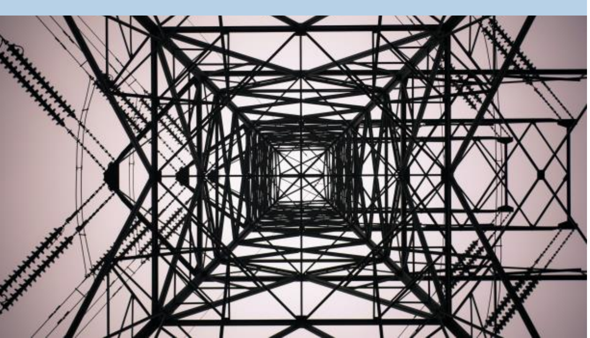
KEY INSIGHTS

- **Carbon markets can hedge against technological and policy uncertainties. They can lower power sector decarbonization costs by displacing high-cost direct mitigation**, including for emerging technologies such as carbon capture, advanced nuclear, and long-duration storage with cost and availability uncertainties.

- The value of carbon markets is shown to be higher in contexts where **technological costs are high, portfolios are limited, and deeper economy-wide decarbonization is targeted**.

- **Regional differences in decarbonization strategies are significant**, which lead to variation in abatement costs, value of carbon credits, and value of regional flexibility.

This brief is based on "Value of Voluntary Carbon Markets in Energy Systems Decarbonization: Regional Economic, Environmental, and Technological Impacts"



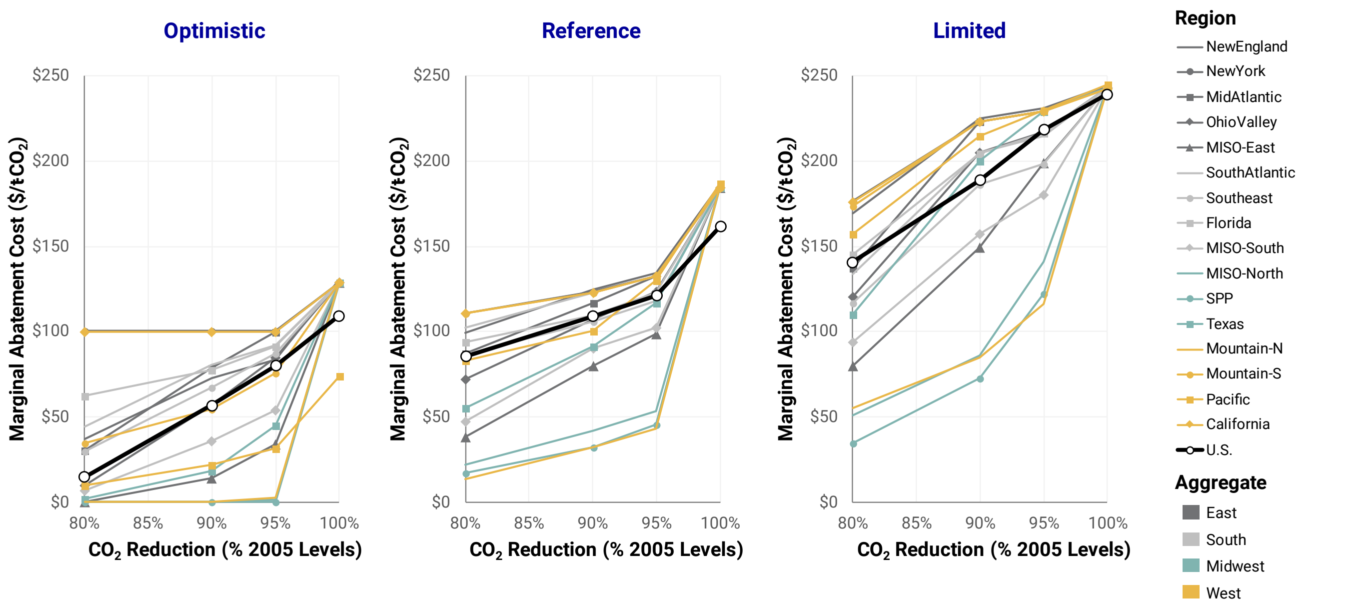


Figure 1. Marginal abatement costs of power sector decarbonization by region and CO_2 reduction level in 2050. Panels show results across optimistic, reference, and limited technologies (left, middle, and right panels, respectively). Regional values show scenarios with power sector targets applied to each region, and national values show scenarios with regional flexibility.

Model results suggest that costs increase as power sector emissions decline (Figure 1). These challenges increase the value of "last-mile" mitigation approaches, including carbon credits. Given these dynamics, such approaches can be viewed as backstop options in decarbonization portfolios when direct reductions are infeasible or costly. Hence, these approaches are not substitutes for substantial direct emissions reductions but instead can complement these efforts to enable greater emissions reductions that can be more affordable, rapid, and reliable.

Assumptions about future technologies are first-order drivers of technology deployment and decarbonization costs:

- Carbon credits are most valuable in contexts where technological costs are high and portfolios are limited, which can arise due to conditions such as siting and interconnection delays, low domestic and global spillovers from emerging technologies, sustained high interest rates, costly infrastructure buildout, high raw materials costs, or public acceptance.
- Voluntary carbon markets can lower power sector decarbonization costs by substituting other GHG abatement for high-cost direct mitigation. In particular, very deep decarbonization entails increasing deployment of clean firm options such as carbon capture and storage, advanced nuclear, long-duration energy storage, and hydrogen, which are technologies with high uncertainty about their cost and availability.
- **Carbon credits could function as hedges against technological uncertainty, especially for emerging technologies.**

Regional differences in decarbonization strategies are significant, which lead to variation in abatement costs, value of carbon credits, and value of regional flexibility. For all regions, decarbonization costs increase as power sector emissions approach zero, and costs are higher for regions with lower quality solar and wind resources, especially when technological portfolios are limited (Figure 1).

With deeper economy-wide decarbonization, model results highlight how market flexibility, both geographical and sectoral, alters

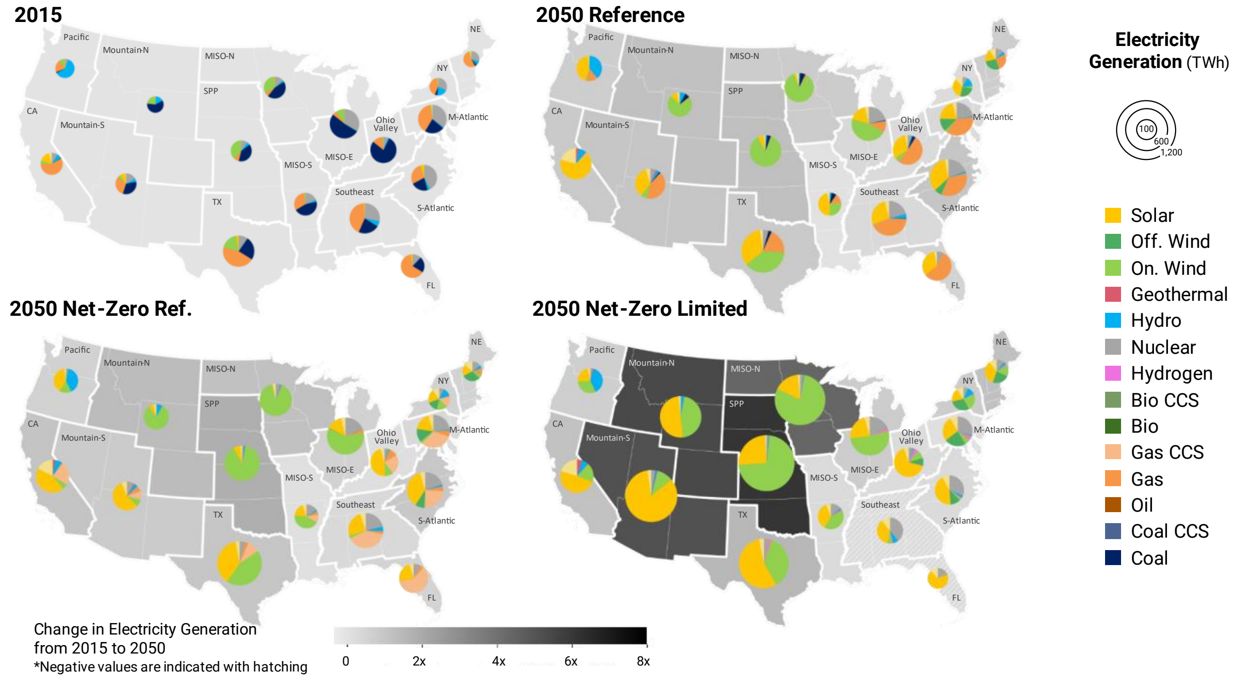


Figure 2. Regional electricity generation by technology across scenarios in 2050. The diameter of regional charts is proportional to total electricity generation. Regional shading reflects the change in generation from 2015 to 2050.

mitigation decisions (Figure 2) and the value of carbon credits under economy-wide net-zero targets:

- Flexibility can change electricity demand from direct electrification and electricity-derived fuels production.
- There are higher electric sector costs with deeper economy-wide decarbonization, especially with limited technologies and inflexible markets.
- Costly to decarbonize regions, sectors, and applications (e.g., aviation, high-temperature industry) create opportunities for use of GHG emissions offsets and carbon removal.

Reaching economy-wide net-zero CO_2 with limited technology entails much higher costs and value for GHG offsets. Marginal costs are an order of magnitude higher than other net-zero scenarios ($1,240-1,420/t-$CO_2$ with limited technology versus $128-314/t-$CO_2$ with optimistic and reference technology).

All scenarios exhibit large increases in the pace of electric sector capacity additions relative to today, especially variable renewables and battery storage (Figure 2). Power sector deployment is highest with economy-wide decarbonization targets, limited market flexibility, or pessimistic technology.

The electric sector plays a central role in achieving deep economy-wide decarbonization targets. This analysis illustrates how carbon markets can hedge against policy and technological uncertainties. These flexibilities can help to keep power sector mitigation costs more manageable, which increases the affordability of transition for customers and lowers costs of direct and indirect electrification.

FOR MORE INFORMATION

Read the full paper: Bistline, et al. (2024), "Value of Voluntary Carbon Markets in Energy Systems Decarbonization" (EPRI Report).

CONTACT

John Bistline (corresponding author)
jbistline@epri.com