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Carbon Pricing and Markets in the Power Sector

WHITEPAPER

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The Cost of Carbon

Pricing Pollution in the U.S. Power Sector

Carbon pricing has become a key strategy for driving decarbonization in the U.S. electricity sector by assigning a direct cost to CO_2 emissions. Using either a carbon tax or a cap-and-trade system, policymakers aim to internalize the external costs of greenhouse gas emissions and steer investments toward cleaner electricity generation. Without a federal carbon price, thirteen states—accounting for approximately 36 percent of U.S. GDP—have enacted subnational carbon-pricing programs to influence dispatch decisions and long-term utility planning.

A carbon tax offers price stability: emitters pay a fixed fee per ton of CO_2, and governments receive predictable revenue. The drawback is that total emissions remain uncertain. On the other hand, cap-and-trade systems set an overall emissions cap (the cap) and use market-based emissions trading to allocate allowances among participating entities. Prices vary based on supply and demand, but total emissions stay within the cap. This tradeoff—between price certainty and emissions certainty—shapes how programs are designed.

Emissions trading mechanisms enable covered entities (usually power generators or fuel producers) to comply by submitting emissions allowances equal to their CO_2 emissions. Participants can acquire allowances either through government-run auctions or by purchasing them from other entities in the secondary market. Over time, a decreasing cap reduces supply, raising allowance prices and encouraging investment in renewable energy, natural gas as a replacement for coal, energy storage, and grid upgrades.

The Regional Greenhouse Gas Initiative (RGGI), launched in 2009 and covering Northeastern and Mid-Atlantic states, targets emissions from large power plants. Since 2005, RGGI states have reduced roughly 50 percent of CO_2 emissions while experiencing growth in regional GDP. In 2023, RGGI states invested $852 million from proceeds; these investments are expected to save $2.7 billion in lifetime bills and prevent 7.8 million short tons of CO_2 emissions. Revenue recycling into aid for low-income communities and clean energy programs helps address potential affordability issues caused by carbon pricing. Recent auctions in 2024–2025 cleared around $17–$26 per ton, with the Cost Containment Reserve triggered in March 2025 ($19.76) and the June 2025 auction clearing at $19.63.

California launched its statewide cap-and-trade program in 2013 under AB 32. Covering approximately 80 percent of the state's greenhouse gas emissions—including power generation, industry, buildings, and upstream fuel suppliers—the program establishes quarterly auctions, declining annual caps, banking provisions, and cost containment reserves. Independent estimates using synthetic control methods suggest that the program lowered power sector emissions by approximately 48 percent relative to a counterfactual scenario from 2005 to 2019. This decline was enabled by a shift from coal to renewable generation and natural gas, complemented by clean energy mandates.

Program design elements shared in both RGGI and California include declining caps, allowance auctions, secondary trading, banking rules, and periodic review processes. California distributes

climate-related credits through utilities to households and invests in disadvantaged communities, while RGGI states allocate proceeds to efficiency, renewable energy, and direct assistance programs. This revenue recycling is crucial for reducing regressive impacts and enhancing political support.

Critiques of carbon pricing often focus on the cost burdens and equity issues associated with it. Compliance costs may be passed on to consumers, disproportionately affecting low-income households. However, revenue recycling strategies can help reduce these effects. California's offset system has come under scrutiny, as approximately 75 percent of state-approved offsets originate from out-of-state forest projects that may not yield genuine emission reductions. Legal experts and environmental groups have raised concerns about environmental justice and questioned the transparency of offset accounting. As policymakers consider reauthorizing California's cap-and-trade program beyond 2030, proposals include replacing offset allowances with local community climate investments to better support public health and equity objectives.

From an economic theory perspective, carbon pricing is seen as an effective policy tool. By making emitters pay the social cost of their emissions, markets naturally encourage lower-carbon generation and innovation. In real-time dispatch, higher CO_2 costs increase the operating expenses of coal and older thermal generators, making renewables, combined-cycle gas, and storage more competitive. Over the long term, price signals direct capital toward clean energy infrastructure and upgrades for grid resilience.

The variety of state programs acts as policy laboratories. Variations in cap trajectories, offset use, jurisdiction linkages, and revenue use provide insights into how carbon markets perform in different settings. As utilities and regulators incorporate anticipated carbon costs into long-term integrated resource planning, lessons from RGGI and California influence expectations for future growth. These state-level experiences lay the groundwork for potential federal programs and illustrate how carbon pricing, whether through a carbon tax or cap-and-trade, can facilitate a transition to a decarbonized electricity grid.

Carbon pricing (via carbon tax or cap-and-trade) assigns a cost to CO_2 emissions, influencing utility planning, shifting investments toward cleaner energy, and balancing tradeoffs between price certainty and emissions certainty.

State programs like RGGI and California's cap-and-trade show significant emissions reductions, revenue recycling for clean energy and equity programs, and provide models for future federal carbon pricing.

Emissions for Sale

Inside Cap-and-Trade Markets

Cap-and-trade systems support the emissions trading model by balancing certainty in carbon emissions with market flexibility in the U.S. power sector. In such systems, a regulator issues a limited number of emission allowances, each granting the right to emit one metric ton of CO_2. The total allowances set the cap, which usually decreases over time, encouraging covered sources to lower emissions in accordance with long-term climate objectives.

In practice, covered entities—mainly power generators and fuel suppliers—must surrender allowances equal to their reported emissions at the end of a compliance period. If a generator emits less than its allowance allocation, it can sell surplus allowances on the secondary market; if it exceeds its emissions cap, it must buy additional allowances, creating economic incentives for mitigation and innovation. This flexibility allows entities with lower abatement costs to gain value by reducing emissions and selling allowances, while high-cost emitters can stay operational by purchasing allowances.

Well-designed cap-and-trade programs include several key elements to ensure market stability and policy integrity. Allowance allocation can be done through free distribution, auctions, or a mix of both. Auctions help establish market prices, while free allocation—often used in early stages or for energy-intensive industries—can ease the transition and reduce political resistance. Banking and borrowing options provide participants with flexibility across multiple periods, helping to smooth interest rates over time. Cost containment measures, such as price floors, ceilings, and reserve allowances, limit price fluctuations and prevent undue spikes in compliance costs.

Offset credits supplement allowance trading by enabling covered entities to meet part of their requirements through the purchase of verified emissions reductions from outside the regulated system, such as in forestry or methane capture. While offsets increase flexibility and reduce compliance costs, concerns about additionality, permanence, and local environmental justice have prompted stricter offset standards in more advanced programs.

The U.S. Environmental Protection Agency (EPA) offers essential guidance on cap-and-trade systems, emphasizing that emissions trading programs promote compliance flexibility while achieving overall emission reduction targets. The Acid Rain Program, established under the 1990 Clean Air Act Amendments, was the first large-scale U.S. cap-and-trade system, successfully cutting sulfur dioxide emissions by half by 2000. Its success proved that emissions trading programs can generate significant environmental benefits while supporting economic efficiency.

The power sector–focused RGGI program and California's economywide cap-and-trade system demonstrate how these design principles work in different jurisdictional contexts. The Regional Greenhouse Gas Initiative, which applies to power plants with a capacity of 25 MW and above in participating states, issues all allowances through an auction and reinvests the proceeds in energy efficiency and clean energy initiatives. California's program, which has broader coverage, distributes allowances via auctions and partially through free allocation, with the proceeds going to the Greenhouse Gas Reduction Fund.

From an economic perspective, cap and trade achieves cost-effective emissions reduction by motivating the most cost-effective abatement methods across the system. Entities that can reduce emissions cheaply—or that already operate relatively clean generation—gain financially and may spur technological innovation through sales or investment. Generators with fewer near-term abatement options face higher costs and might pass these costs onto wholesale electricity prices, leading to changes in dispatch order that favor lower-carbon sources.

Market stability is essential: excessive allowance banking can weaken the emissions target by delaying reductions, while sudden supply shocks can cause price spikes. Programs often include regular reviews to adjust cap paths, refine allowance allocations, and enhance oversight. California's cap-and-trade program, for example, periodically updates its cap reduction schedule, cost limits, and offset eligibility based on changing climate goals and stakeholder feedback.

Cap-and-trade markets also connect with electricity market frameworks. Independent system operators, such as CAISO, PJM, and ISONE, include carbon costs as part of generators' variable costs. This means facilities with higher carbon emissions face higher dispatch costs, which shifts the merit order toward cleaner resources. Over time, as allowance prices increase, they also impact long-term investment decisions, encouraging utilities to

prioritize lower-carbon capacity in their resource planning. Trading infrastructure is a crucial enabler. Organizations use tracking systems to oversee allowance holdings and compliance submissions. Secondary markets operate via brokers and exchanges, offering liquidity and transparency. Successful programs also depend on strong monitoring, reporting, and verification (MRV) systems to maintain accuracy and integrity in compliance.

Critiques of cap-and-trade systems include concerns about price volatility, market manipulation, and the potential for unfair impacts. Weak oversight or poorly designed reserve mechanisms can cause allowance prices to crash or spike, undermining emissions goals or unfairly burdening compliance entities. Offset mechanisms, while saving costs, have faced criticism when credits do not reflect real and additional reductions, raising issues about environmental justice and the program's credibility.

Lessons from thirty years of cap-and-trade implementation underscore the importance of transparent governance, stakeholder engagement, and adaptable design. Market design should anticipate political, legal, and economic changes, include transparent data sharing, and facilitate linkage where suitable. The development of RGGI and California's programs demonstrates how robust design features, such as auction reserves, offset limits, and phased cap reductions, support both environmental effectiveness and operational resilience.

In summary, cap-and-trade systems in the U.S. power sector combine emission caps, allowance trading, market stability tools, and revenue cycling to cost-effectively reduce CO_2 emissions. They utilize emissions trading mechanisms to promote innovation and abatement while balancing price and emissions certainty through careful design. The interaction between allowance prices, grid dispatch, and long-term utility planning underscores carbon pricing's capacity to transform the power sector's emissions profile. These foundational concepts prepare us for a detailed examination of real-world program performance in subsequent case studies.

POLICY

Laboratories of Policy

The Case of RGGI & California

The Regional Greenhouse Gas Initiative (RGGI) and California's statewide cap-and-trade program are two of the most influential carbon pricing experiments in the U.S. power sector. As natural laboratories, these policy frameworks showcase both the potential and practical challenges of implementing carbon markets at the subnational level. Each case offers unique insights into market design, emissions results, economic impacts, and stakeholder responses.

As of 2025, ten states actively participate in RGGI; Pennsylvania's participation is pending while the state Supreme Court reviews the matter, and Virginia remains outside RGGI as an appeal continues following a circuit court ruling that the withdrawal was illegal. California's cap-and-trade program began compliance in 2013, following the implementation of AB 32 (the Global Warming Solutions Act of 2006) and Executive Order S-0305. The program covers nearly 80 percent of the state's greenhouse gas emissions, including power generation, industry, buildings, and fuel use. Key features include quarterly auctions, declining caps, a cost containment reserve, limited free allowances for emissions-intensive, trade-exposed industries, and offset credit limits of 4% (2021–2025) and 6% (2026–2030), with at least half of the allowances providing direct environmental benefits within the state. Studies using the synthetic control method show that power sector emissions decreased by approximately 48 percent from 2005 to 2019 compared to a constructed counterfactual—mainly due to a shift from coal-fired generation to renewables and natural gas, supported by related clean energy mandates. Auctions have raised over $31 billion as of mid-2025, funding programs for disadvantaged communities, clean vehicle rebates, affordable housing, high-speed rail, and energy efficiency initiatives. By 2018 alone, roughly $3.4 billion had been invested, including $1.4 billion that year, demonstrating the program's significant scale.

Both programs achieved significant emissions reductions without harming economic growth. In RGGI states, power sector emissions were cut in half, while regional GDP continued to rise; in

California, statewide emissions remained below the 2020 AB 32 target as the economy expanded. Both regions experienced a sharp decline in coal use, accompanied by an increased reliance on natural gas and renewables. Although California's broader scope made program management more complex, it also enabled integration of emissions trading across different sectors. The use of offsets and free allocations in California provided extra flexibility but raised concerns over environmental integrity and fair distribution of benefits. RGGI's narrower focus made enforcement simpler and directed revenue investments primarily within the power sector.

Design features shaped outcomes. RGGI's cost containment reserve and emissions containment reserve mechanisms helped control extreme price swings, thereby enhancing market stability. California's offset limits and cost ceilings adjusted allowance supply as necessary. Regular program reviews ensure caps stay aligned with climate goals and permit governance to adapt. Banking rules in both programs helped contain costs, allowing entities to spread out compliance and reduce price shocks.

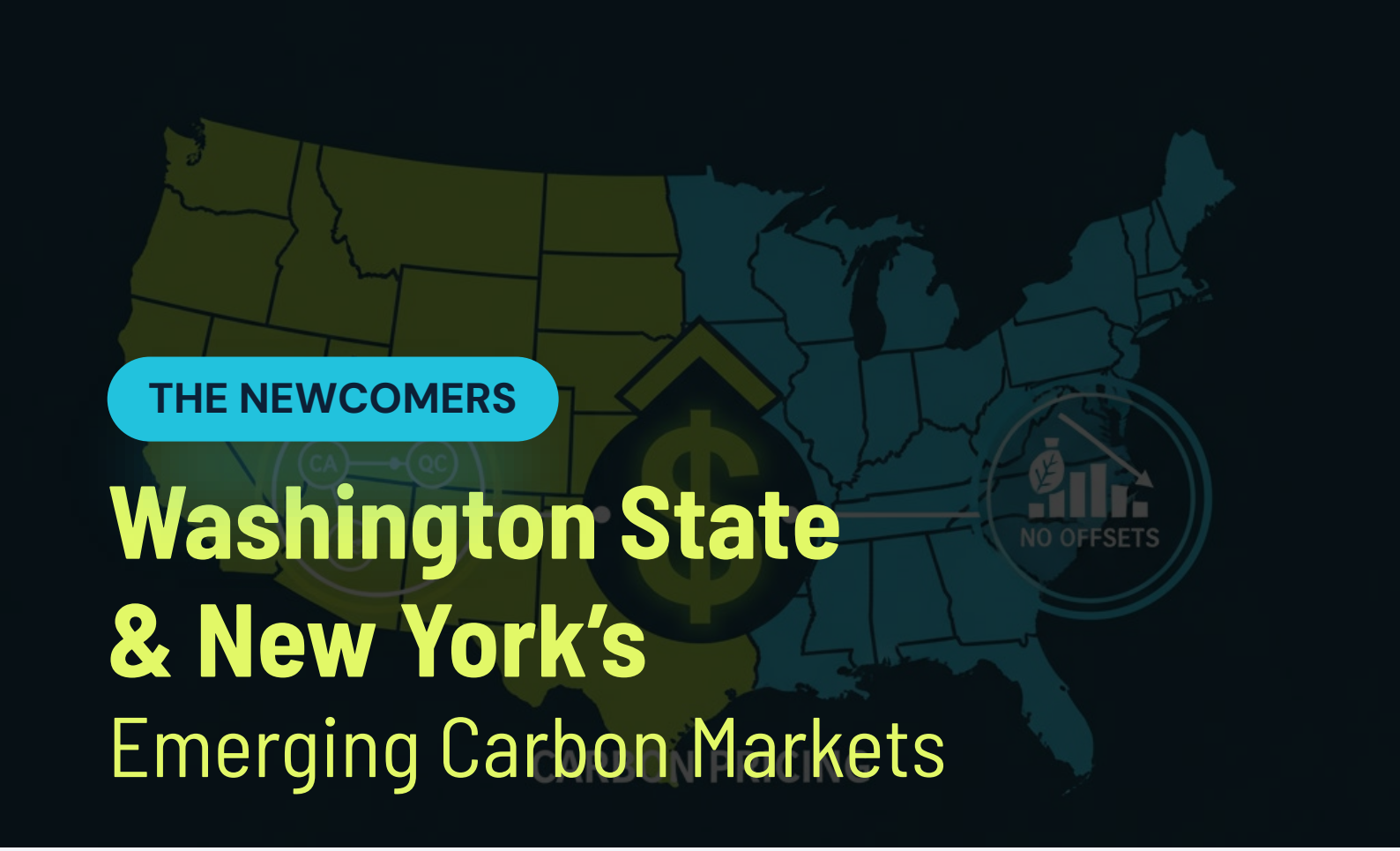
Revenue recycling was crucial for political approval. RGGI states utilized revenue for bill assistance and efficiency projects, thereby reducing consumer costs and encouraging clean energy investments. In California, cap-and-trade revenue has supported climate efforts in underserved communities, provided mobility grants, and funded renewable energy projects. Climate credits given to utility customers through their bill channels further spread benefits to households.

Despite these successes, both programs faced criticism. In RGGI, critics argued that allowance price floors were too low, leading to occasional oversupply and depressed prices. Legislation in Virginia and other states sparked political debate, with some policymakers calling RGGI allowances hidden taxes and challenging the program's withdrawal authority in court. In California, concerns over the quality of offsets and the heavy reliance on out-of-state forestry credits have attracted legal and advocacy scrutiny. Proposition 26 in 2010 challenged the cap-and-trade program as a tax, requiring supermajority approval; although courts ultimately rejected the challenge, the debate created uncertainty about the program's future beyond 2030.

Environmental justice advocates called for more direct investments in local communities, rather than relying on offsets. These critiques have sparked evolving policy proposals—such as limiting offset eligibility, increasing allocation to disadvantaged areas, and shifting toward in-state project investments.

The case studies demonstrate that scalable carbon pricing can lead to decarbonization in the power sector while also providing socioeconomic benefits. Both programs emphasize the importance of clear legal authority, strong monitoring and verification, transparent auction processes, and adaptable review mechanisms. RGGI's streamlined, sector-specific structure differs from California's broader economic scope, yet both achieve tangible results.

In summary, RGGI and California's cap-and-trade systems demonstrate how carbon pricing markets can lead to emissions reductions, incorporate cap-and-trade mechanisms, and support equitable transition strategies. These examples confirm the effectiveness of carbon pricing in the U.S. power sector and provide key lessons for future growth and development.



THE NEWCOMERS

Washington State & New York's Emerging Carbon Markets

Washington State became the second U.S. jurisdiction, after California, to launch a statewide cap-and-trade system when its Climate Commitment Act (CCA) introduced the Cap-and-Invest program in January 2023. The program covers approximately 70 percent of statewide greenhouse gas emissions across various sectors, including power generation, transportation, buildings, and industry. Regulated entities that emit at least 25,000 metric tons of CO_2e annually must obtain allowances through quarterly sealed-bid auctions or the secondary market. Auctions are supplemented by an Allowance Price Containment Reserve (APCR) to limit price volatility, with clear ceilings and floors that change over time. Auction layouts include current vintage and advance allowances, while APCR offerings are made at fixed tiered prices when auction results exceed certain thresholds. Vintage year rules, banking provisions, and compliance schedules are aligned to allow flexibility while supporting consistent emissions reductions in line with Washington's legal targets to reach net-zero emissions by 2050.

The program's early performance outperformed expectations. In the first auction of February 2023, allowance prices settled at around $48.50 per ton; by the third auction in August, prices had climbed to about $63, prompting APCR releases. Total auction volume in 2023 exceeded 38 million allowances, generating over $2.2 billion in revenue. By June 2025, cumulative proceeds had reached approximately $3.2 billion. Washington's Department of Ecology allocated revenues across multiple accounts: the Carbon Emissions Reduction Account funds low-carbon transportation and freight projects; the Climate Investment Account supports broader transition efforts; and a mandated Climate Justice Allocation ensures that at least 35 percent of investments benefit overburdened communities, with a target of 40 percent and tribal involvement. These investments aim to enhance air quality, expand public transportation, increase access to clean energy, and enhance community resilience over the next decade.

The state also faced political challenges. Initiative 2117, on the November 2024 ballot, aimed to

repeal the CCA and prohibit future carbon pricing laws. Voters rejected the measure by a margin of about 62% to 38%, confirming their support for the program. This result strengthened the state's ability to pursue potential linkage with California and Quebec under Senate Bill 6058 (effective January 1, 2025), with rulemaking in progress and the earliest possible linkage not before 2026.

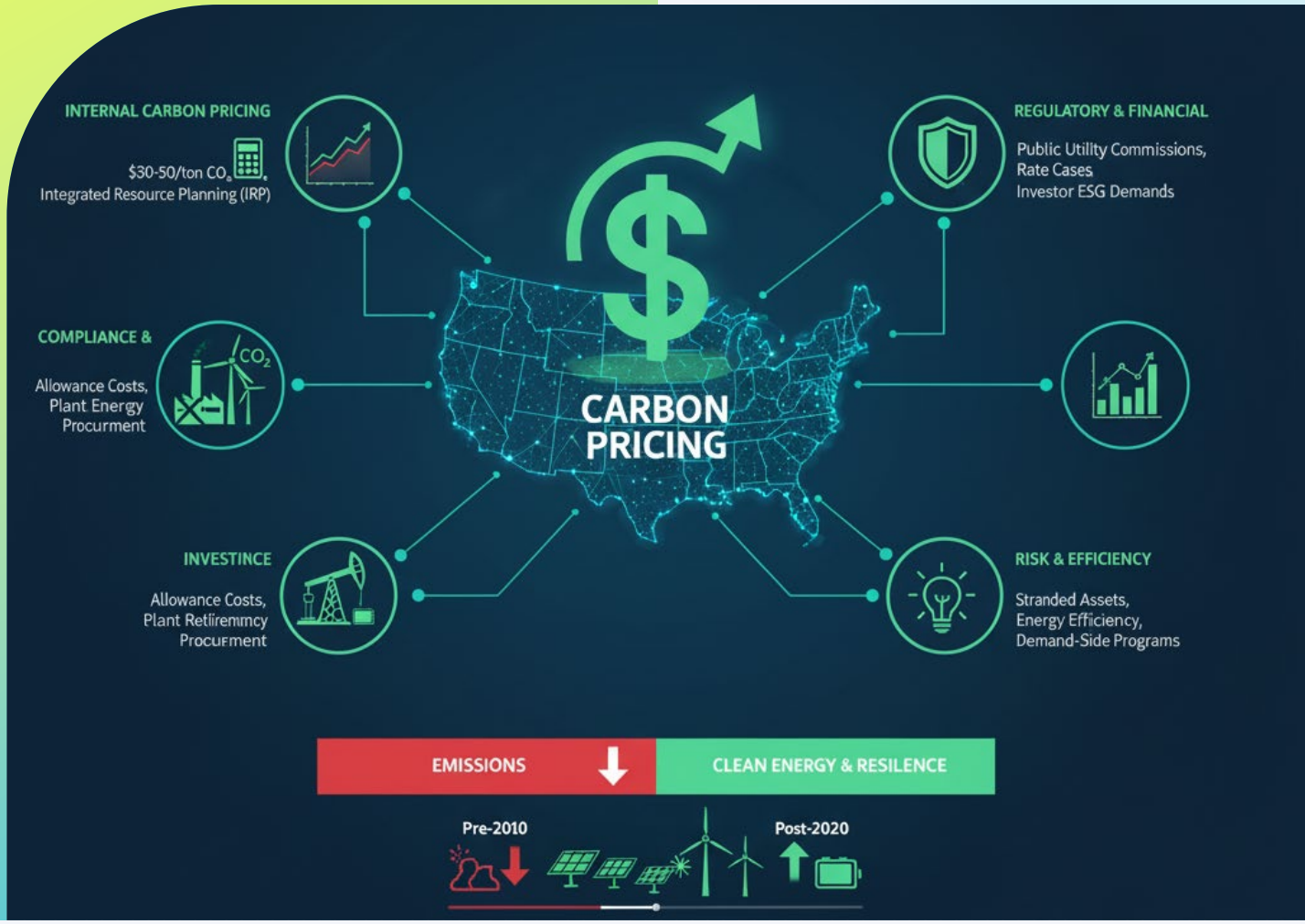
Looking ahead, the linkage could be finalized as early as late 2025, depending on rulemaking and agreement among jurisdictions, with the earliest practical trading commencing no earlier than 2026. Resources for the Future analysts have modeled linkage effects, projecting improved market stability and lower compliance costs without compromising emissions integrity. Environmental justice provisions support linkage discussions, ensuring that vulnerable communities do not face disproportionate impacts.

New York has proposed its own multi-sector cap-and-invest program, under the working name NYCI (New York Climate Initiative). Draft rules are expected to be released in 2025, with the program's launch targeted for 2026. NYCI will cover major sectors including power generation, transportation fuel suppliers, and industry. Offsets are explicitly excluded from the design, a notable departure from California and Washington, to ensure strict in-state emissions reductions. A greenhouse gas emissions reporting rule proposed in early 2025 would require facilities emitting 10,000 metric tons CO_2e or more to begin reporting in 2026 and submit verified data by 2027. This data foundation is vital for cap allocation and compliance mechanisms.

New York's statutory climate targets—enshrined in the Climate Leadership and Community Protection Act—set reduction goals of 40 percent below 1990 levels by 2030, 85 percent by 2040, and 100 percent zero-emission electricity by 2050. The cap trajectory will align with these goals, tightening annually to promote deep decarbonization. Funds generated from the program will support a Climate Action Fund, which will finance clean energy projects, energy retrofits, resilient infrastructure, public transportation, and access to clean vehicles for low- and moderate-income households. Political debate has already started over how to allocate the funds effectively; critics express concerns about bureaucracy and public benefit delivery, drawing parallels with challenges seen in Washington and California.

Washington's and New York's emerging carbon markets display different approaches. Washington's program is already active, generating significant revenue, facing political challenges, and focusing on justice-oriented reinvestment. Its CCA framework resembles California's in many ways but highlights linkage, substantial community investment, and transparent governance. New York's program is still in the pre-launch phase but draws on insights from RGGI and the Washington model. NYCI aims to avoid offset-related debates and begins with solid emissions monitoring and reliable data. Its synchronized integration with clean energy mandates and New York's ambitious decarbonization timeline offers a strong foundation for power sector change.

These emerging systems collectively expand the reach and scope of U.S. carbon markets within the power sector. Their design variations reflect lessons learned—Washington's early auction success and justice mandates highlight how political resilience and market experience are essential. New York's upcoming design adopts a more cautious and data-driven approach, avoiding offsets and prioritizing strict in-state reductions. As these systems evolve, they will influence broader policy discussions and could lead to future regional or national linkages that combine cap-and-trade, emissions trading, and fair carbon pricing, thereby supporting clean energy investments without compromising affordability or justice.



Utilities Under Pressure

How Carbon Costs Are Changing Business Models

Carbon pricing is not only reshaping the economics of electricity generation; it is also transforming utility business models across the United States. Whether through state-mandated cap-and-trade programs or self-imposed internal carbon pricing, utilities are reconsidering their investment strategies, resource planning frameworks, and long-term risk assessments to align with a decarbonizing energy landscape.

In many states, utilities are adopting internal carbon shadow prices to guide their Integrated Resource Planning (IRP) processes. These prices, typically ranging from $30 to $50 per metric ton of CO_2, enable utilities to forecast the future financial implications of carbon regulation. By modeling the cost of carbon, utilities can compare the cost of fossil fuel generation with that of renewable options, battery storage, and demand-side management. This internal pricing has become a strategic tool for identifying economically resilient portfolios in a carbon-constrained environment.

In states like California and Washington, where formal cap-and-trade systems are in place, utilities directly face the costs of emissions through the purchase of allowances. These compliance costs

are incorporated into dispatch models, rate cases, and procurement strategies. Utilities are increasingly realigning their resource portfolios with falling carbon caps and allowance supply pathways. Many have accelerated their retirement plans for high-emission plants and increased investments in renewables, hybrid gas-storage systems, and flexible grid technologies to mitigate exposure to compliance liabilities.

In California, investor-owned utilities have begun long-term planning that aligns with the state's emissions reduction goals and carbon pricing system. Their IRPs now include substantial procurements of zero-carbon generation, grid-scale energy storage, and grid-interactive efficiency technologies. Utilities in the state have pledged to meet clean electricity targets in line with Senate Bill 100 and Senate Bill 1020, which aim for 100% zero-carbon electricity retail sales by 2045 and 90% by 2035.

Nationwide, utility decarbonization trends are visible even outside states with active carbon markets. Many utilities are adjusting to investor pressure, customer expectations, and future regulatory risks by voluntarily including carbon cost scenarios in their planning models. Across the industry, there is a growing recognition that carbon pricing, whether required or expected, will become a key part of electricity market economics. Consequently, more utilities are setting net-zero targets, clarifying carbon risk in financial reports, and increasing their share of carbon-free electricity.

From a regulatory perspective, public utility commissions play a vital role in ensuring that carbon compliance costs are transparently reflected in rates and investment decisions. Utilities must demonstrate how allowance costs are factored into procurement planning and safeguard ratepayers. Regulatory oversight also influences how utilities reinvest carbon market revenues into customer climate dividends, low-income energy programs, and resilience infrastructure for disadvantaged communities.

Carbon pricing has also increased the focus on managing stranded asset risk. Fossil fuel plants with long remaining lifespans might become uneconomical under future carbon regulations. Utilities are conducting stress tests on their generation assets under various carbon price scenarios to assess cost risk. Many have responded by accelerating retirement plans for coal and inefficient gas units, while investing in clean energy procurement and transmission upgrades.

Energy efficiency is another area where carbon pricing has strengthened utility incentives. Internal carbon pricing increases the value of avoided emissions, making energy savings more cost-effective. As a result, utilities are expanding demand-side programs, including energy efficiency retrofits, behavioral programs, electrification incentives, and demand response technologies.

Investor sentiment is increasingly influencing utility decision-making. Institutional investors and corporate clients increasingly demand transparency on emissions, credible decarbonization strategies, and credible net-zero plans. Utilities that incorporate carbon pricing into governance, disclosure, and investment practices are seen as lower risk and more aligned with long-term capital markets. This change has helped make climate risk management a standard fiduciary duty in utility boardrooms.

In summary, U.S. utilities are adjusting their business models to account for carbon pricing, both current and anticipated. They are integrating carbon costs into dispatch economics, procurement strategies, and long-term capital planning. This approach is accelerating decarbonization, enhancing financial resilience, and transforming how electricity providers deliver value in a world with limited carbon emissions.

Price Signals and Power Prices

Impacts on Consumers and the Grid

Carbon pricing directly influences electricity prices by increasing the marginal cost of generating power from carbon-heavy resources. In markets with active cap-and-trade programs, the allowance cost is incorporated into real-time dispatch modeling used by grid operators and resource planners. The resulting price signals raise the operating costs of coal and older gas plants compared to lower-carbon alternatives, affecting both short-term dispatch and long-term investment decisions. Wholesale energy prices, therefore, reflect a broader cost of carbon emissions, shaping dispatch order and resource valuation.

In California, recent assessments from major utilities show that the cap-and-trade carbon price slightly raises retail electricity rates. Based on 2023 data, experts estimated the carbon price component added less than two cents per kilowatt-hour to PG&E's rates. Retail impact is roughly a four percent increase, but this is mostly offset by biannual climate credits included in customer bills. Notably, California's allowance revenues support infrastructure resilience, energy efficiency, and aid for disadvantaged communities—offering multiple ways to address affordability concerns and boost overall public support.

In organized wholesale markets like PJM, ISO-NE, and CAISO, states are examining the integration of state-set carbon prices directly into market algorithms. The Federal Energy Regulatory Commission (FERC) has indicated that such integration could boost market efficiency and increase transparency while maintaining state authority. Rules permitting regional transmission organizations to incorporate carbon costs into dispatch decisions could align generation decisions with state climate goals, while still operating within the jurisdiction of the wholesale market.

PJM's modeling, part of its stakeholder analysis, shows that adding a carbon price to dispatch could change how generation operates, reduce emissions in pricing zones, and potentially influence capacity pricing. Without complete jurisdiction coverage, resource shuffling—where emissions move across borders to regions without pricing—creates challenges. PJM's simulations indicate that a two-way border adjustment (tracking carbon across flows) more effectively reduces leakage than a one-way adjustment.

Capacity market developments also highlight sensitivities to carbon costs. In PJM's largest power region, the 2025 capacity auction settled at a record $329.17 per megawatt-day—22 percent higher than the previous year—partly due to structural supply constraints and increasing demand, particularly driven by data center growth. Although not directly caused by carbon pricing, these higher capacity payments are estimated to result in retail bill increases of between 1.5 percent and 5 percent, depending on the cost pass-through practices. These events show how carbon-related retirements and transition policies can gradually tighten supply, increasing price pressure in both energy and capacity markets.

In moderate carbon pricing scenarios—around $50 per metric ton—the expected increase in

wholesale electricity prices is offset by changes in the generation mix and dispatch patterns.

Estimates based on REC and SREC price data indicate that carbon-equivalent price signals in PJM jurisdictions range from $15 to $60 per ton of carbon dioxide equivalent. These correspond to wholesale price impacts of about one to two dollars per MWh—relatively small but significant signals in markets aiming for emissions reductions through dispatch order adjustments.

Consumer impacts mainly depend on rate design and how revenue is recycled. In California, climate credits lower monthly bills, and targeted subsidies assist low-income households; however, the overall effects on affordability remain limited. Conversely, states that lack rebate programs or explicit revenue recycling risk passing carbon-related rate increases directly to consumers, potentially worsening energy burdens for vulnerable groups and causing political backlash.

At the same time, carbon pricing can lower overall system costs by decreasing reliance on more costly regulatory measures. For example, the cost-effectiveness analysis of California's cap-and-trade program indicates that emissions reductions achieved through the market cost considerably less per ton than those achieved through alternative regulatory options. Reinvesting allowance revenue into resilience and efficiency also provides community benefits, improving affordability and environmental outcomes.

In the broader grid context, transparent price signals from carbon mechanisms can promote better system planning. Dispatches that incorporate carbon costs help align generation with climate goals, and capacity markets adjust to reflect resource contributions during supply constraints. Integrating carbon pricing into wholesale market structures can help operators anticipate retirement trends and align reliability planning with decarbonization goals.

In summary, carbon pricing affects electricity markets by signaling both energy and capacity prices. Although the overall impact is modest compared to total retail bills, it is significant at the dispatch level and over time. Integrating carbon prices into markets changes the order of generation, influences capacity procurement, and promotes investment in low-carbon assets. Revenue recycling and consumer protection measures are crucial to reduce affordability risks. The way carbon costs interact with wholesale market structures and consumer tariffs ultimately impacts customers, grid reliability, and progress toward decarbonization.

STRATEGY

Federal Climate Strategy

Is National Carbon Pricing on the Horizon?

Discussion of a federal carbon pricing mechanism has gained momentum amid increasing climate policy priorities. While no binding carbon tax or cap and trade system exists at the federal level as of mid-2025, various legislative proposals offer insight into how a national scheme might develop.

The Energy Innovation and Carbon Dividend Act of 2023 propose a fee on fossil fuels at the point of production or import, increasing each year, with the revenue returned to households through dividends. Supporters argue this approach can provide clear price signals while reducing regressivity by redistributing funds to consumers. Likewise, the Polluters Pay Climate Fund Act of 2025 holds major fossil-fuel producers financially responsible, aiming to fund clean energy infrastructure, adaptation, and equity programs without adopting traditional carbon market models.

Analyses from respected think tanks, including Brookings and the National Bureau of Economic Research, suggest that well-designed federal carbon pricing could closely align with national climate goals. They forecast that a fee starting around $50 per ton and increasing to $100–$150 by 2030 could produce significant emissions reductions while generating revenues in line with clean energy spending targets under current legislation.

Despite such momentum, federal regulatory actions in 2025 introduced uncertainty. On March 12, 2025, the EPA announced a broad deregulatory initiative and later, on July 29–30, 2025, proposed rescinding the 2009 Greenhouse Gas Endangerment Finding (initiating notice and comment rulemaking). Additionally, on April 8, 2025, the President issued Executive Order Protecting American Energy from State Overreach. These actions remain subject to legal and administrative processes.

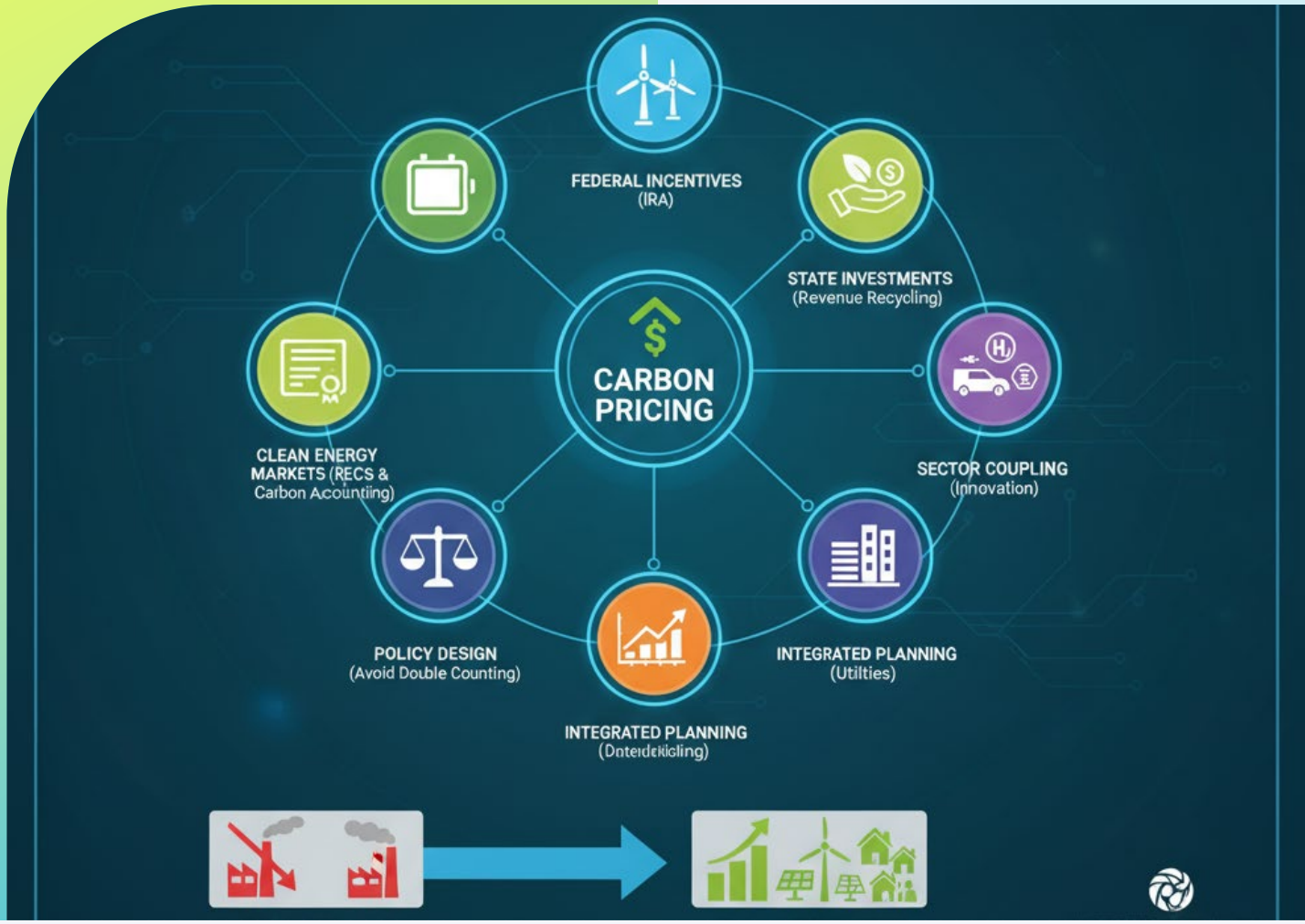
Moreover, a 2025 executive order directs federal agencies to challenge state carbon pricing

initiatives on grounds of federalism or preemption. These actions may erode the legal foundation for cap-and-trade programs, particularly in linked state markets, unless Congress enacts explicit federal authority or reaction.

Expansion of federal carbon policy may also depend on broader fiscal dynamics. A 2025 omnibus tax-and-spending package, informally referred to as One Big Beautiful Bill, reversed many renewable energy tax incentives while removing any carbon fee mechanisms. Although the legislative package did not establish new carbon pricing, its dismantling of existing climate-friendly tax structures highlights political challenges for future policy.

These elements create a complex landscape of federal climate policy. While significant federal carbon pricing proposals exist, executive deregulation and legislative retrenchment complicate the potential path forward. For utilities, state regulators, and power-sector stakeholders, closely monitoring both legislative developments and administrative rulemaking is essential—because a future national carbon price could dramatically reshape compliance requirements and market structure.

In summary, although national carbon pricing through a carbon tax or federal cap-and-trade has not yet been implemented, legislative activity and policy frameworks in 2025 show viable models. At the same time, major regulatory reversals and changes in tax law pose challenges to their feasibility. Stakeholders must navigate this duality—anticipating federal action while the political and legal environment remains highly uncertain.



Integration and Innovation

Linking Carbon Markets to Clean Energy Incentives

Carbon markets are becoming increasingly intertwined with domestic clean energy policies, creating synergistic frameworks that combine carbon pricing, cap-and-trade, and carbon markets with federal incentives and state climate investments. This integration allows for deeper emissions reductions while promoting economic sustainability and equity during the transition to clean energy.

Federal incentives enacted under the Inflation Reduction Act (IRA) serve as a key addition to carbon pricing systems. The IRA offers significant production and investment tax credits for wind, solar, battery storage, hydrogen, and carbon capture technologies. These credits reduce the actual cost of compliance for these technologies in carbon markets, enhancing project economics and enabling developers and utilities operating under cap-and-trade systems to benefit from both carbon allowance savings and federal rebate programs.

California's Greenhouse Gas Reduction Fund illustrates how state-level carbon pricing revenues

can be leveraged with IRA incentives to accelerate clean energy deployment. Auction proceeds fund projects that support energy equity, climate resilience, and clean mobility, with a particular focus on disadvantaged communities. Similarly, Washington State's Cap-and-Invest program directs over 35 percent of its revenues to historically overburdened communities, supporting transit electrification, clean energy access, and harm mitigation efforts.

Integrated resource planning now routinely includes both carbon price paths and federal clean technology incentive schedules. Utilities coordinate renewable procurement and storage capacity expansions with IRA credit windows and projected allowance price increases—timing investments for maximum cost benefit. This integrated approach ensures that clean technologies are deployed when tax benefits and carbon price signals align to enhance system value.

Technological innovation continues to accelerate through sector coupling strategies—linking electricity generation with hydrogen production, electric vehicle infrastructure, and building electrification. Carbon pricing boosts the value of flexibility and demand response, while IRA credits cut the capital costs of innovation. Together, they create new business models that monetize carbon savings and clean technology performance in both wholesale and retail markets.

In some regions, including Idaho and others exploring policy evolution, pilot efforts are underway to connect renewable energy certificate (REC) markets with carbon compliance frameworks. Although REC markets remain separate from cap-and-trade systems, aligning certificate-based claims with carbon accounting enhances transparency and improves claims regarding the emissions performance of clean energy assets.

However, integration introduces complexity. Policymakers must carefully design rules to prevent double-counting—where a single project receives both carbon allowances and REC credits for the same emissions reductions. Developers face administrative challenges when managing overlapping incentive systems, requiring clear guidance and strong interagency coordination. Equity considerations ensure that communities most affected by climate change get fair access to program benefits and that funds reach the intended recipients.

Effective policy integration depends on transparency, phased coordination of incentive timelines, and mechanisms that ensure carbon revenues support complementary investments. States and utilities benefit from coordinated policy roadmaps that align carbon price increases with tax credit expirations to smooth investment cycles and enhance impact. Regulatory training and stakeholder outreach further help align expectations and reduce implementation friction.

In summary, linking carbon markets with federal clean energy incentives creates a powerful combination where carbon pricing guides emissions reductions, while tax credits and state reinvestment programs help lower deployment barriers. Innovations in sector coupling and coordinated planning harness policy synergy, speeding up the scale-up of clean energy. When carefully designed and integrated, carbon and clean energy strategies can achieve deeper and fairer decarbonization of the U.S. power sector with less economic friction.

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