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ENVIRONMENTAL BENEFITS OF ELECTRICITY POLICY REFORM

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INTRODUCTION

The structure of the electric industry can help shape environmental outcomes. In the United States, we have significant experience with the regulated monopoly model, which dates back to the early 19th century. Under that model, private utilities subjected themselves to tight regulatory oversight of their rates and services, based on their underlying costs, in exchange for the right to enjoy exclusive franchises.[1] The regulated monopoly model electrified most of the country fairly quickly but created inefficiencies and failed to control pollution, while also discouraging innovation.[2]

In the 1990s, Texas, Illinois, Ohio and most mid-Atlantic and Northeast states responded to high monopoly-utility costs and poor investment decisions by restructuring their electric industries. This broke apart the monopoly model by forcing merchant generators and transmission owners to compete in an open wholesale marketplace. The outcomes of these competitive markets determined wholesale electric rates, rather than cost-of-service regulation. Independent third parties known as regional transmission organizations (RTOs) or independent system operators (ISOs) administered these markets. Restructuring limited the monopoly-utility model to distribution services, leaving customers to choose their electricity supplier (also known as retail choice).

Economic theory suggests that competition provides incentives for companies to cut costs, increase efficiency and make prudent investments in resource deployment and technological innovation.[3] Electricity restructuring has realized these benefits. This portends well for the environment, as merchants have greater incentive to reduce costs and risks associated directly (e.g., policy compliance) and indirectly (e.g., fossil fuel savings) with pollution. On the other hand, there may be select cases in which competitive market participants adopt technologies that produce higher emissions if they prove more prudent than alternatives. As such, multiple short-term factors may have countervailing influences on emissions.[4]

Contradictory results in the short term give way to longer-term factors that more consistently align competitive market behavior with emissions reductions. These factors stem from both supply-side and demand-side influences, as well as the ways that politics and regulatory compliance interplay with

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[1] Local and state authorities historically granted companies exclusive franchises in exchange for extensive regulatory oversight of their rates and services. These vertically integrated utilities owned all aspects of electricity production, transfer and final delivery (generation, transmission and distribution).

[2] L. Lynne Kiesling and Dick Munson, "A Revolution in Power: Where We've Come from, Where We're Headed," Electricitypolicy.com, September 2016. https://www.electricitypolicy.com/images/2016/September/14Sep2016/Kiesling/Kiesling-2016Sep14.pdf

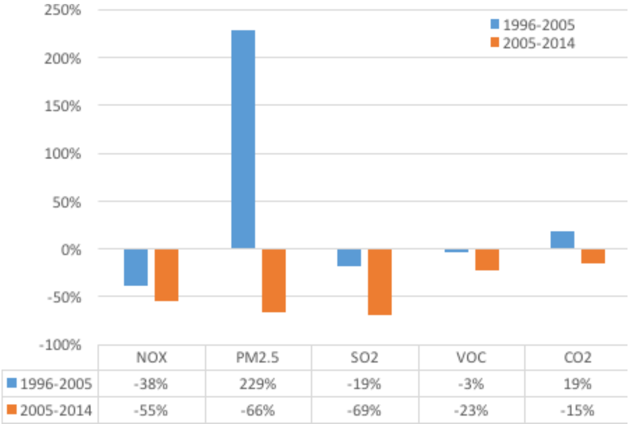
[3] Lucas W. Davis and Catherine Wolfram, "Deregulation, Consolidation, and Efficiency: Evidence from U.S. Nuclear Power," National Bureau of Economic Research, August 2011. http://www.nber.org/papers/w17341.pdf

[4] Karen Palmer and Dallas Burtraw, "The Environmental Impacts of Electricity Restructuring," Resources for the Future, April 2005.

environmental policy. The value of enhanced innovation and rapid technology adoption under the competitive model holds great promise for transformative emissions reductions, especially for climate-altering emissions. This effect remains difficult to forecast.

Considerable research on the environmental effects of competitive electricity markets, especially air-pollution impacts, began in the early years of restructuring. The environmental effects of restructuring were unclear as of the mid-2000s, but early signs appeared positive.[5] Since then, the literature on this subject has been sparse. Meanwhile, the emissions performance of the electric industry improved radically from 2005-2014 compared to 1996-2005. This suggests conclusions reached in the early literature warrant revisiting.

FIGURE 1: CHANGES IN U.S. POWER GENERATION EMISSIONS



	NOX	PM2.5	SO2	VOC	CO2
1996-2005	-38%	229%	-19%	-3%	19%
2005-2014	-55%	-66%	-69%	-23%	-15%

SOURCE: Data derived from EPA inventories for greenhouse gas emissions[6] and air pollutants[7]

Note: Labels refer to nitrogen oxides (NO_X), particulate matter 2.5 micrometers in diameter and smaller (PM2.5), sulfur dioxide (SO_2), volatile organic compounds (VOC) and carbon dioxide (CO_2).

Recent empirical reviews have cast far more favorable light on the environmental prospects of restructuring than those in the mid-2000s. Significant advances in technology, shifts in customer preferences, the shale natural gas revolution and developments and prospects for market-based greenhouse gas emissions have bolstered the environmental outlook for restructuring considerably.

SUPPLY-SIDE INFLUENCES ON EMISSIONS

Restructuring results in more prudent decisions about generation investments and asset management. In the short term, this can by happenstance lead to emissions increases or decreases. Over the long term, competitive forces drive emissions reductions through more prudent emissions-management decisions. Competitive markets also provide a platform for transformative change that creates a level playing field for a broader suite of resources, while also spurring innovation.[8]

Unlike regulated monopoly utilities that recover costs directly from ratepayers, merchants seek to reduce costs to increase profits. This economic discipline drives merchants to use fossil fuels more efficiently when operating power plants and to invest in more efficient new plants.[9] Reduced fossil-fuel consumption directly translates into superior environmental performance. Reducing emissions also mitigates regulatory compliance costs. Thus, merchants generally have greater financial incentive to reduce emissions than regulated monopoly utilities.

Prudent operation incentives

Most regulated states treat fuel and environmental compliance as full pass-through costs.[10] Restructured states do not permit such cost pass-throughs; rather, merchant-generators incur the costs in full. This difference results in a sharp divergence in incentive structures. A monopoly utility is relatively indifferent to the costs and risks of fuel consumption and pollution, whereas merchants actively manage them (i.e., the shadow price of emissions is much higher for merchants, especially when factoring in environmental compliance costs).

Competitive incentives have resulted in more efficient operations by generators.[11] Merchants have adopted technologies and practices that use fuel more efficiently and that boost environmental performance.[12] One study found that ther-

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[5] Palmer and Burtraw, 2005.

[6] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2014

[7] U.S. Environmental Protection Agency, Air Pollutant Emissions Trends Data. https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

[8] These effects rely on healthy price formation, which is determined by market design and participant behavior. The behavior of monopoly utilities is less aligned with economic fundamentals than merchants, which can drive differences in pricing outcomes. This is especially the case in capacity markets, which suffer the most from the market-agnostic behavior of regulated monopolies.

[9] New York Independent System Operator, "NYISO Markets: New York's Marketplace for Wholesale Electricity." http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Other_Reports/Other_Reports/NYISO%20Markets%20-%20New%20Yorks%20Marketplace%20for%20Wholesale%20Electricity.pdf

[10] Paul M. Sotkiewicz, "The Impact of State-Level Public Utility Commission Regulation on the Market for Sulfur Dioxide Allowances, Compliance Costs, and the Distribution of Emissions," PhD diss. University of Minnesota, 2003.

[11] PJM Interconnection, "Resource Investment in Competitive Markets," May 5, 2016. http://www.pjm.com/-/media/documents/reports/20160505-resource-investmentin-competitive-markets-paper.ashx

[12] E.g., see James B. Bushnell and Catherine Wolfram, "Ownership Change, Incentives and Plant Efficiency: The Divestiture of U.S. Electric Generation Plants," CSEM Working Paper Number 140, March 2005. http://faculty.haas.berkeley.edu/wolfram/Papers/Divest_0331.pdf

mal efficiencies are 9 percent higher in restructured states.[13] Nuclear generators that are subject to competitive pressures improved their availability and reduced refueling outage times, resulting in a 10 percent gain in operating efficiency.[14]

Merchant-generators also procure fuel more efficiently, which can lead to reduced emissions. For example, regulated coal plants use a costlier fuel-procurement approach and hold higher levels of fuel inventory on-site.[15] Increases in coal stockpiles cause an increase in particulate-matter emissions.[16] From 1991 to 2005, restructuring led coal plant owners to improve fuel efficiency, resulting in emissions reductions of between 4.6 and 7.6 percent in SO_2, NO_x and CO_2.[17]

Prudent investment incentives

Generation investments carry large risks and uncertainties that affect how prudent they will prove to be. Sources of risk and uncertainty include shifts in market fundamentals, technology breakthroughs, policy intervention and regulatory reform. Rapid changes in policy and economics call for shifting investment decisions away from a central planning process and toward the judgments of the dispersed wisdom of highly motivated entities that bear the risks and reap the rewards.[18] As many drivers of risk and uncertainty have environmental consequences, the merchant model creates stronger incentives for environmental management in capital-expenditure decisions (e.g., new power plant or emissions controls).

A cost-of-service regulatory model requires approving the cost recovery of utilities' major capital expenditures in advance, which in turn places investment risk on ratepayers.[19] Once built, utilities continue to recover these costs in full over prolonged periods, even if shifts in economic or policy conditions render continued operation of the plants imprudent. By virtually guaranteeing the recovery of sunk costs, the monopoly model inhibits rapid adaptation to new technologies. (i.e., power plants remain in use and receive ongoing cost recovery even if they would be unprofitable in a competitive context, thus displacing adoption of new profitable technology).

Competitive markets provide no guarantee that a firm will recover sunk costs and thus allocate risk to investors, rather than ratepayers. This avoids problems of "regulatory lag" and enables swifter adoption of more economical technologies and practices. As a result, competition encourages more rapid turnover in capital stock in the long run, which generally leads to reductions in pollution, as new power plants tend to pollute less.[20] For example, merchants have led coal-to-natural gas switching in response to the falling natural-gas prices of the shale revolution. The rapid transition away from coal in the PJM Interconnection, an RTO spanning the mid-Atlantic, is the primary driver behind massive emissions reductions in the region since 2005.[21] The same phenomenon has contributed to nuclear retirements, a rare exception where replacing unprofitable power plants leads to an emissions increase. Going forward, marketplace choice is clearly the best method to guarantee rapid platform change.[22]

Spurring innovation

Achieving a low emissions future requires innovation and invention, with success more likely if appropriate price signals and incentives drive decentralized decisions of electricity market participants.[23] The fastest way to drive innovation is to create open platforms for economic activity that minimize barriers to entry, reward risk-taking investment and attract new players, ideas and capital.[24] The "open access" transmission model of competitive wholesale electricity markets embraces these platform characteristics in principle and functions best in fully restructured areas. This technology-neutral market architecture fosters innovation by allowing new technologies to compete on a level playing field.[25]

Investors will not fund clean technology development without a realistic opportunity to capture market share and earn

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[13] J. Dean Craig and Scott J. Savage. 2013. "Market Restructuring, Competition and the Efficiency of Electricity Generation: Plant-level Evidence from the United States 1996 to 2006." *The Energy Journal* 34 (1): 1. http://search.proquest.com/docview/1266769666?pqorigsite=gscholar.

[14] Bushnell and Wolfram (2005).

[15] Akshaya Jha, "Dynamic Regulator Distortions: Coal Procurement at U.S. Power Plants," Jan. 11, 2016.

[16] Akshaya Jha and Nick Muller, "The Local Environmental Consequences of Coal Procurement at U.S. Power Plants," December 1, 2016.

[17] H.R. Chan, et al., "Efficiency and Environmental Impacts of Electricity Restructuring on Coal-fired Power Plants", March 2013. http://econbus.mines.edu/working-papers/wp201301.pdf

[18] William W. Hogan, "Electricity Market Structure and Infrastructure," Harvard University, September 2008. http://belfercenter.ksg.harvard.edu/actingintimeonenergy/papers/hogan-electricity.pdf

[19] State regulators may require regulated utilities to cover certain imprudent costs, such as gross mismanagement leading to construction cost overruns.

[20] Karen Palmer and Dallas Burtraw, "Electricity Restructuring and Regional Air Pollution," Resource and Energy Economics 19:139-174 (1997).

[21] Christina Simeone and John Hanger, "A Case Study of Electric Competition Results in Pennsylvania: Real benefits and important choices ahead," Kleinman Center for Energy Policy, University of Pennsylvania, Oct. 28, 2016.

[22] Reed Hundt and Jill Bunting, "Competition as the Means to Building the Clean Power Platform," prepared for The Climate Implementation Project Conference Series, September 2016.

[23] William W. Hogan, "Electricity Wholesale Market Design in a Low Carbon Future," draft chapter for *Harnessing Renewable Energy*, Jan. 23, 2010. https://www.hks.harvard.edu/fs/whogan/Hogan_Market_Design_012310.pdf

[24] Michael Moynihan, "Electricity 2.0: Unlocking the Power of the Open Energy Network (OEN)," NDN and the New Policy Institute, February 4, 2010.

[25] Devin Hartman "Wholesale Electricity Markets in the Technological Age," R Street Institute, August 2016. http://www.rstreet.org/wp-content/uploads/2016/08/67.pdf

profits as the technology becomes cost-effective.[26] The more easily investors can assemble accurate market data, the better they can assess risk-return trade-offs in low-emissions generation.[27] Open electricity markets provide transparent prices for discrete services that more accurately reflect the value of different resources. This robust information allows clean-energy developers to determine whether particular investments will produce the cash flows needed to support required returns.[28] Such information about the market value of particular services is critical to spur early and late-stage innovation in a way that maximizes market returns. Accurate price signals steer efficient investments in innovation, including technologies applied to existing generators. For example, restructuring drove increases in the operating efficiency of nuclear plants and the adoption of advanced technology that increased output and reduced outage times.[29]

The long development time of new technologies makes it difficult to glean hard data on how effective restructuring has been in encouraging low-emissions innovation. For example, many emissions-control technologies have a 20-year maturation curve.[30] But there is evidence to show that innovators have demonstrated greater willingness to install advanced technologies in RTO/ISO markets, due to their ease of entry, nondiscriminatory rules, level playing field and transparent prices.[31] Merchants have proven more adept at adopting economical emerging low-emissions technologies. For example, new energy storage technologies have been developed in response to organized markets' transparent price signals.[32] Technology developers perceive quicker and greater returns in a competitive environment, which have shown greater propensity to adopt new technology quickly.

Competitive wholesale electricity markets enable a wider range of resource options, including innovative technologies, than the regulated monopoly model.[33] Utilities' current business and regulatory models present barriers to new technology development and the entry of new firms, particularly in the case of unconventional and distributed generation technologies.[34] The resource-planning processes of monopoly utilities are relatively opaque, clouding the value proposition for technology innovators and stunting prospective adoption rates. In short, more innovative ideas are less likely to be adopted under the regulated monopoly model.[35]

> **"Innovation thrives in a competitive environment; it's an indulgent luxury in a regulated monopoly."**
>
> Dr. Lynne Kiesling, Northwestern University, and
> Dick Munson, Environmental Defense Fund

Recent initiatives at the state level generally have demonstrated growing awareness that policy should encourage technological change. Industry participants are demonstrating the power of markets to stimulate investment and innovation.[36] States decide industry structure and should recognize that innovation thrives in a competitive environment. A healthy competitive environment depends on appropriate price signals and incentives. Healthy price signals require emphasis on the interaction between wholesale electricity market design and innovation with renewables and other low emissions technologies.[37]

Unconventional resource integration

As a platform, competitive markets are better at integrating unconventional resources in cost-effective and reliable ways. Resources like wind and solar produce relatively low or no emissions, but their output capability varies based on conditions like location and weather. This causes larger and more frequent shifts in supply, making grid operations more challenging. The central planning approach of monopoly utilities has struggled to account for these unconventional performance profiles. Competitive electricity markets can optimize the value of renewable energy and increase its access to the grid.[38]

The value of well-designed wholesale markets is amplified when dealing with resources that experience greater variability and uncertainty in supply. RTO/ISO markets pro-

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[26] National Academies of Sciences, Engineering, and Medicine, "The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies," The National Academies Press, 2016.

[27] Navigant Consulting, Inc., "Price Signals and Greenhouse Gas Reduction in the Electricity Sector," prepared for the COMPETE Coalition. http://www.competecoalition.com/files/Navigant%20Study%20FINAL.pdf

[28] Navigant Consulting, Inc.

[29] Fan Zhang, "Does Electricity Restructuring Work? Evidence from the U.S. Nuclear Energy Industry," *Journal of Industrial Economics* 55, no. 3: 397-418, 2007. http://www.iaee.org/en/students/best_papers/fan_zhang_2006.pdf

[30] Deloitte Development, LLC, "Clean: The 1st step to green?," 2010. http://oportunidades.deloitte.cl/marketing/Reportes-internos/Energy/Septiembre/hacia-lo-verde.pdf

[31] COMPETE Coalition, "RTO and ISO Markets are Essential to Meeting Our Nation's Economic, Energy and Environmental Challenges," Dec. 2, 2014. http://www.compete-coalition.com/files/COMPETE%20RTO%20White%20Paper_December%202%20 2014%20FINAL.pdf

[32] Hartman, 2016.

[33] The Brattle Group, "Response to U.S. Senators' Capacity Market Questions," open letter to the U.S. Government Accountability Office, May 5, 2016.

[34] National Academies of Sciences, Engineering and Medicine, 2016.

[35] Hogan, 2010.

[36] Kiesling and Munson, 2016.

[37] Hogan, 2010.

[38] Navigant Consulting, Inc.

vide more economical balancing services for variable generation.[39] These markets use granular (by location and time interval) market prices and resource dispatch that manage supply variation more reliably and cost-effectively than a regulated monopoly's grid operations.[40] In the absence of granular prices and defined supply quantities, the incentives to invest in low-emission resources diverge from the real costs to operate the electric system.[41] The greater this gap, the greater the need to rely on central mandates and regulation to support low-emission technologies.[42] As noted by John Moot, former general counsel and chief of staff to the Federal Energy Regulatory Commission:

> [C]ompetitive markets are essential to the development of clean energy resources because they provide the geographic scope and transparent prices necessary to integrate those resources into the supply mix. The objective of strengthening competitive markets is therefore consistent, not in conflict, with removing barriers to the development of clean energy technologies.[43]

RTO/ISO market design reforms have been generally good for integrating unconventional resources. FERC, which approves these reforms, has acted on multiple occasions to reduce barriers to integrating renewables.[44] RTO/ISOs increasingly use tools to dispatch weather-dependent resources and procure resources to meet expected and unexpected swings in available supply. Some have created new products that discretely value services that are increasingly important to unconventional resource integration. These include ramp products (i.e., procuring the ability of resources to adjust output) and enhanced ancillary services (low-volume services vital to maintain grid reliability).[45] Such progress allows for more accurate price signals, which in turn drive more efficient investment and operating decisions by unconventional resource developers (e.g., reducing wind forecasting error and citing new resources in areas of highest system value) and conventional resources (e.g., investment in more flexible generation that adjusts output to mirror increased system supply variability).

Competitive markets are far more conducive to serving active demand, which is more valuable where there is greater variation in generation. For example, merchant demand-response providers have developed creative business models to provide more economic and reliability benefits to the grid than regulated-utility demand response programs have.[46] These demand-response programs can offer into competitive markets as unconventional supply resources. But a broader array of demand-side resources and changing consumer preferences could yet yield even greater environmental benefits.

DEMAND-SIDE INFLUENCES ON EMISSIONS

Evolving customer preferences and technologies have transformed the environmental value proposition of retail choice, which serves to promote green power derived from environmentally benign generation, self-generation and energy-efficiency and management systems.[47]

Advances in digital technology have lowered the transaction costs of customer choice and enabled transactional platforms for customer-generators. These advances have converged with those in distributed energy resources (DERs), including a broad family of low-to-zero emission technologies such as solar photovoltaics, storage, biogas, microgrids, electric vehicles, demand response and combined heat and power. As the heterogeneity of demand-side resources grows, so does the value proposition of competitive markets. For example, assessing the value of a new demand response program is simpler in a competitive wholesale market than for a monopoly utility.[48]

Technological progress has made it easier to capture varying consumer preferences, with significant implications for the environment. There is growing demand for green power, active energy management and self-generation. As customers begin to take up these technologies, their consumption and generation profiles increasingly differ from one other, which proves to be a weakness in regulated rate-setting.[49] The advent of active demand portends a future of competitive markets on transactive platforms and erodes the histor-

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[39] COMPETE Coalition, 2014.

[40] Hogan, 2010.

[41] Hogan, 2010.

[42] Hogan, 2010.

[43] John Moot, "Subsidies, Climate Change, Electric Markets and the FERC." *Energy Law Journal*, 35(2), 345–374, 2014. http://heinonlinebackup.com/hol-cgibin/get_pdf.cgi?handle=hein.journals/energy35&section=24

[44] Moot, 2014.

[45] For example, see the ramp capability product in the Midcontinent Independent System Operator and frequency regulation in PJM.

[46] Devin Hartman "Pathways to competition in demand response," R Street Institute, July 2016. http://www.rstreet.org/policy-study/pathways-to-competition-in-demandresponse/

[47] Mathew J. Morey and Laurence D. Kirsch, "Retail Choice in Electricity: What Have We Learned in 20 Years?" Christensen Associates Energy Consulting LLC, prepared for the Electric Markets Research Foundation, Feb. 11, 2016. https://www.hks.harvard.edu/hepg/Papers/2016/Retail%20Choice%20in%20Electricity%20for%20EMRF%20Final.pdf

[48] Ryan Hledik and Ahmad Faruqui, "Valuing Demand Response: International Best Practices, Case Studies, and Applications," The Brattle Group, January 2015. http://www.brattle.com/system/publications/pdfs/000/005/343/original/Valuing_Demand_Response_-_International_Best_Practices__Case_Studies__and_Applications.pdf?1468964700

[49] L. Lynne Kiesling, "Alternatives to Net Metering: A Pathway to Decentralized Electricity Markets," R Street Institute, February 2016. http://www.rstreet.org/wp-content/uploads/2016/02/RSTREET52_2016.pdf

FIGURE 2: GREEN PRICING CUSTOMERS BY STATE REGULATORY STATUS

SOURCE: U.S. Energy Information Administration, Form 861.

ical justification for regulated monopolies.[50] A monopolist lacks motivation to improve customer service and provide customized service offerings, whereas a competitive retail market enables product and service customization that captures customer heterogeneity. The transparent prices of competitive markets drive more efficient customer behavior (e.g., energy management under dynamic pricing) and investments (e.g., DERs).

Voluntary clean-energy demand

Retail choice facilitates organic green energy demand.[51] Specifically, it allows consumers to express individual demand for green power in an open marketplace. Consumers appear to vary considerably in their desire and willingness to pay for green energy. Such heterogeneity is well-suited for differentiated market services. Some surveys indicate from 50 percent to up to 95 percent of consumers would pay a premium to purchase green energy, although the share actually willing to pay a premium may be considerably less.[52] Corporate demand for green energy has grown, stimulated by financial concerns over fossil energy costs and desires to improve branding.[53]

Retail choice states have clearly outperformed regulated monopoly states in terms of the number of participants in green pricing programs, as well as participation rate.[54] The gap has grown in recent years, as the number of green pricing customers in retail choice states increased by 142 percent from 2010 to 2012 but remained flat in regulated monopoly states.[55] In 2013, retail choice states had twice the annual green sales by volume than regulated monopoly states.[56]

Green pricing programs typically carry a bill premium relative to conventional generation sources.[57] Competition among suppliers helps drive down the premium for green power offered to customers, which encourages cost reductions and performance improvements in clean-energy development. It may also increase demand for green energy by lowering the premium to a level that entices new customers.

Dynamic pricing

Retail choice induces comparatively high participation in dynamic pricing programs, where end-use customers pay the spot price for electricity (i.e., day-ahead and real-time energy prices).[58] This is consistent with the incentive structure of restructuring. Greater reliance on wholesale spot markets along with retail product differentiation provides a stronger incentive to offer real-time prices to customers with the capability of managing the risk of price fluctuations.[59] Dynamic pricing improves the efficiency of customer use of the power system and reduces the average price paid by customers.[60]

The value of dynamic pricing also has been enhanced by technological advances. Given how frequently real-time prices fluctuate, most customers will neglect to monitor and adjust their consumption or investment behavior manually, even if they have access to real-time data. New automated energy systems monitor and control devices, which act autonomously to manage a portion of customer energy use (e.g., shift the operation of a dryer or dishwasher, or charging of an electric vehicle, to lower-priced time periods). Monitoring services also provide customers with greater insight on how to optimize their investment decisions (e.g., when to buy a new appliance or invest in self-generation).

The environmental effects of dynamic pricing depend on the emissions intensity of the fuel mix at high-priced periods relative to other periods. One early study suggested dynamic pricing could increase emissions by shifting demand from on-peak to off-peak periods, which shifts the generation mix

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[50] http://www.utilitydive.com/news/retooling-regulation-clean-air-and-clean-energy-demand-an-integrated-overs/426112/

[51] In contrast to mandated green energy demand, such as renewable portfolio standards.

[52] Palmer and Burtraw, 2005.

[53] Michael Copley. "States urged to accommodate corporate appetite for renewables" SNL Energy, Dec. 6, 2016.

[54] Morey and Kirsch, 2016.

[55] 2012 was the last year this data was collected by the U.S. Energy Information Administration.

[56] National Renewable Energy Laboratory, "Status and Trends in the U.S. Voluntary Green Power Market," November 2014. http://www.nrel.gov/docs/fy15osti/63052.pdf

[57] Morey and Kirsch, 2016.

[58] Morey and Kirsch, 2016.

[59] Palmer and Burtraw, 2005.

[60] Morey and Kirsch, 2016.

toward coal and away from gas.[61] Regional fuel mixes have changed considerably since then, highlighted in many areas by the decline of coal and increase in renewables capacity that substantially alters the emissions impact of shifted power consumption to lower-priced periods. More recent analyses indicate that dynamic pricing programs result in considerable emissions reductions at peak, while inducing slight increases in off-peak periods.[62] Dynamic pricing is particularly advantageous when coupled with emissions pricing, where customers would receive a direct price signal that accounts for environmental effects (see next section).

Customer-producers

The regulated monopoly model hinders the efficient deployment of distributed energy resources (DER) and stifles the innovation signals that are critical to develop the next generation of DERs. Advances in DERs may even erode or end the natural monopoly characteristics of electric distribution utilities.[63] Given the environmental advantage of DERs, the monopoly model constrains potentially transformative long-term emissions reductions.

DER adoption is increasing due to policy and economic drivers. Adoption beyond certain levels causes significant challenges for regulatory ratemaking.[64] The most prominent problems include adjusting retail rates to reflect the causes of various system costs (i.e., attempting to avoid cross-subsidies between ratepayer classes); compensation for DER benefits (e.g., excess generation provided back to the grid); and lost utility revenue. Declining utility revenue is particularly problematic in areas with declining demand, where the sunk costs incurred by the utility require recovery from a diminishing demand base. Rate adjustments for sunk cost recovery artificially undermine the price signal for DERs, whose value should be based on going-forward avoided utility costs (also known as system benefits). Administrative determinations of the costs and benefits of DERs to the utility system are very difficult, given that DERs are exceptionally heterogeneous, even within a technology class (e.g., solar photovoltaics have numerous configurations and site-specific applications). This translates into inefficient rate design for DER ratepayers, as even defining a distinct DER ratepayer class fails to account for the heterogeneity of costs and benefits among that classification.

Competitive markets provide no guarantee for sunk-cost recovery. Merchant generation owners face the risk of reduced market revenues from DER growth and account for it in investment decisions. Retail choice also separates generation from transmission and from the recovery of distribution costs. In comparison, the monopoly model is limited in its ability to reform retail rates to reflect costs caused by individual customers. Retail choice frees rates to reflect going-forward generation costs determined by markets, which send more accurate investment signals to current and prospective DER owners (i.e., markets, not administrative prices set by regulators, determine DER valuation).

A major advantage for restructured areas is that such regimes are compatible with voluntary, market-driven investments in DERs. Retail choice allows retail energy suppliers to offer DER as part of their portfolio of services, whose business models have evolved rapidly in recent years. To date, DER development has resulted in large part from the rise of market-driven investment, as opposed to central planning.[65] In short, retail choice reduces regulatory barriers and fosters more efficient DER development.

ENVIRONMENTAL POLICY SYNERGIES

Restructuring alters the economic and political incentives of market participants to comply with, and influence, environmental policy. Market exposure encourages generators to reduce all costs, including those for environmental compliance. In theory, this provides incentives for lower-cost compliance with existing environmental rules and motivates political support for lower-cost environmental reforms. These actions have positive policy ramifications for emissions reductions.

Abatement costs

Empirical evidence reveals that merchants seek lower-cost environmental compliance pathways than monopoly utilities. Competitive electricity markets provide incentives to lower the abatement costs for command-and-control and market-based environmental policies alike. Markets reduce costs for some forms of green industrial policy, as evidenced by more efficient procurement of resources to meet renewable portfolio standards.[66] Merchant environmental compliance costs reductions are particularly apparent for market-based emissions policies, where generators have greater compliance flexibility to pursue least-cost emissions reductions.

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[61] Palmer, Karen, Dallas Burtraw, Ranjit Bharvirkar, and Anthony Paul. 2002. Electricity Restructuring, Environmental Policy and Emissions. Report. Washington, DC: Resources for the Future. December.

[62] See e.g., Olivia Chen Valentine, "Emissions Impacts of Dynamic Pricing," thesis at Cornell University, January 2015. https://ecommons.cornell.edu/bitstream/handle/1813/39475/xc237.pdf;sequence=1

[63] Steve Corneli and Steve Kihm, "Will distributed energy end the utility natural monopoly?" Electricitypolicy.com, June 2016. https://www.electricitypolicy.com/images/2016/June/29Jun2016/Corneli_29June2016.pdf

[64] National Association of Regulatory Utility Commissioners, "NARUC Manual on Distributed Energy Resources Compensation," July 21, 2016. http://pubs.naruc.org/pub/88954963-0F01-F4D9-FBA3-AC9346B18FB2

[65] Morey and Kirsch, 2016.

[66] Competitive procurement reduces resource acquisition and energy costs. Competitive load serving entities also have an incentive to procure renewables at the most economic periods, whereas regulated utilities often procure renewable energy regardless of the market price – even encouraging renewable production when energy prices are negative (i.e., the utility must pay the market to take their production).

Competitive markets have maximum compatibility with market-based environmental policy. Economists have consistently supported policies that use incentives to address environmental problems.[67] Market instruments for air pollution either directly (i.e., emissions tax) or indirectly price emissions (i.e., tradeable permits). This incorporates the social cost of pollution (i.e., the unaccounted externality) into a generator's supply curve. Specifically, an emissions price adds to the variable cost of power production from fossil generators, which shifts portions of the market production cost curve. This affects market-clearing prices in ways that reflect emissions costs.

A competitive market structure is compatible with emissions pricing in ways that can produce synergies. Price signals for electricity and emissions work in concert to achieve cleaner generation through the dispatch of lower-carbon resources and investments in clean energy.[68] Prices in competitive markets reflect the marginal cost to operate the electricity system. In contrast, traditional regulated prices reflect the average cost of generation and mask emissions price signals, limiting their effectiveness.[69]

In short, competitive electricity markets reinforce market-based emissions policies. Flexible and robust electricity markets increase the effectiveness of market-based incentives for pollution control.[70] Case studies demonstrate an economically superior response to emissions pricing in competitive markets.

There is considerable research on the effects of restructuring on compliance with the Acid Rain Program created by the 1990 Clean Air Act amendments, which capped sulfur dioxide (SO_2) emissions and allowed for trading of emission permits. This provided flexibility in compliance pathways, creating more opportunity for firms to lower their compliance costs. Compliance options included adding pollution controls, switching to lower-sulfur coal, shifting output between generating plants and trading pollution permits. Merchants were less likely to adopt capital-intensive compliance options than regulated or publicly owned generators.[71]

An early study did not find evidence of monopoly regulation impeding SO_2 allowance trading.[72] However, subsequent studies indicated much greater cost reductions under restructuring. One estimated that regulatory rules could more than double the cost of SO_2 compliance, undermining the efficiency of tradeable pollution-permit markets.[73] A separate study simulated 1996 data and found that regulation increased compliance costs by between 4.5 percent and 139 percent.[74]

Competitive markets also amplify the low abatement-cost advantages of emissions pricing by enhancing innovation signals to generators, demand-side resource aggregators and technologists. Competitive markets enhance dynamic pricing, which may increasingly serve as an essential driver of price-responsive demand and DER investments that reflect the value of avoided emissions. The advantages of competitive markets for facilitating demand response portends favorably for price-responsive demand that drives emissions reductions.[75]

Environmental political economy

The primary environmental consequence of restructuring actually may be its effect on new environmental policies.[76] Restructuring affects the political economy of environmental policy through at least two mechanisms. First, the alternative industrial organization under restructuring creates different political incentives than those facing monopoly utilities. Secondly, lowering abatement costs alters political motivations.

Restructuring reconfigures political economy, which can alter environmental policy outcomes. For example, restructuring in the Northeast diminished individual states' influence over electricity rates and created a more heterogeneous incentive structure in the electric industry.[77] The resulting shift in political incentives drove the implementation of an auction system for permits under the Regional Greenhouse Gas Initiative.[78] This had a beneficial effect, as auctioning

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[67] Robert N. Stavins, "What Can We Learn from the Grand Policy Experiment? Lessons from SO2 Allowance Trading," The Journal of Economic Perspectives, Vol. 12, No. 3, 69-88, Summer 1998. http://www.owlnet.rice.edu/~econ480/notes/stavins.pdf

[68] Navigant Consulting, Inc.

[69] Navigant Consulting, Inc.

[70] Robert N. Stavins, "Experience with Market-Based Environmental Policy Instruments," Resources for the Future, November 2001. http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-01-58.pdf

[71] Meredith Fowlie, "Emissions Trading, Electricity Restructuring, and Investment in Pollution Abatement," American Economic Review 100, 837-869, June 2010. https://nature.berkeley.edu/~fowlie/emissionstradingelectricity.pdf

[72] Elizabeth M. Bailey. "Allowance Trading Activity and State Regulatory Rulings: Evidence from the U.S. Acid Rain Program," MIT Center for Energy and Environmental Policy Research Working Paper 96-002, 1996.

[73] See e.g., Don Fullerton, Shaun P. McDermott, and Jonathan P. Caulkins, "Sulfur Dioxide Compliance of a Regulated Utility," *Journal of Environmental Economics and Management*, 34(1): 32–53, 1997.

[74] Sotkiewicz, 2003.

[75] Navigant Consulting, Inc.

[76] Palmer and Burtraw, 2005.

[77] Bruce R. Huber, "How Did RGGI Do It? Political Economy and Emissions Auctions," Scholarly Works, Paper 473, 2013. http://scholarship.law.nd.edu/cgi/viewcontent.cgi?article=1477&context=law_faculty_scholarship

[78] Huber, 2013.

permits provides significant gains in economic efficiency, compared to allocating pollution permits for free.[79]

The greatest effect of U.S. policies on climate change will come by spurring behavior change abroad.[80] Economists often label global climate change a "free-rider" problem, where each country lacks the incentive to reduce its own emissions (country-specific abatement costs outweigh the benefits) but benefits when other countries abate.[81] This creates potential value in cooperation, as all countries benefit when collective emissions decrease (collective benefits outweigh costs). International environmental agreements must be self-enforcing, since countries' sovereignty precludes external enforcement.[82] This limitation has rendered repeated attempts to forge international climate agreements unsuccessful.[83]

Some argue that quickly achieving domestic emissions reductions should stand as the policy priority, with lesser or no attention paid to abatement costs. This, the argument goes, will provide a good-faith international negotiation platform that will encourage similar commitments from other countries. The view overlooks that high-cost, controversial policies (e.g., policies that subvert markets) risk the stability of U.S. climate policy. A simple scan of the political responses to the Clean Power Plan substantiates this point. Erratic domestic policy is prone to discourage international cooperation in the long term. In this sense, domestic political economy spills over into international political economy and underscores the importance of politically durable policy.

The key to global emissions reductions is to reduce the free-rider effect, which requires rapid reduction in abatement costs.[84] For a variety of pollutants, abatement cost reduction is linked to increased levels of emissions abatement.[85] Strategic climate policy must recognize the power of competitive electricity markets as a catalyst to lower abatement costs.

Implications for climate policy

Emissions pricing requires healthy, competitive markets to achieve its potential. In this regard, electricity policy is integral to efficient and effective climate policy. Even if the politics of emissions pricing continue to lack traction into the 2020s, expanding and strengthening competitive markets today will reduce emissions in the interim. Most importantly, it will lay the foundation for long-term climate policy success.

The restructuring that's been accomplished thus far took roughly a decade to implement. Applying lessons learned would expedite and smooth a second wave of restructuring, but implementing immediate reforms would still carry over into the 2020s. In existing competitive markets, enhancing retail choice policies and the competitiveness of wholesale markets both hold great promise to usher the transformative change required for deep decarbonization. Such actions would improve market performance, as well, by enhancing price formation, remedying incomplete markets and reducing artificial barriers to entry and exit.[86]

U.S. climate policy should plan decades forward. This means avoiding the temptation of policies that achieve short-term emissions reductions but undermine competitive markets. Sacrificing policy quality for political expedience will come at high economic and political cost, with extensive long-term unintended consequences.[87] This danger has been amplified in recent years with domestic climate policy becoming uncoordinated (e.g., patchwork of state policies) and ad hoc, such as sporadic subsidies for unprofitable technologies or artificial rejections of profitable ones. Ad hoc climate policy has demonstrated a propensity for symbolism over substance, highlighted by the "Keystonization" of energy decisions.[88] A recent report from the Brookings Institution appropriately recognized that when "the politics of serious energy policy become impossible to manage then a torrent of symbolic actions fills the space."[89]

The common presumption that short-term emissions targets must be met through any means risks eroding the policy emphasis on long-term strategy. The bridge to emissions pricing will incur political lumps, perhaps none larger than premature nuclear retirements (i.e., generators that would remain profitable under efficient emissions pricing).[90] This

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[79] This is often done by "grandfathering," which allocates permits for future emissions based on past emissions.

[80] David Victor, "Energy and climate: Moving beyond symbolism," Brookings Institution, Oct. 18, 2016. https://www.brookings.edu/research/energy-and-climate-moving-beyond-symbolism/

[81] For example, see works by William Nordhaus.

[82] Ulrich J. Wagner, "The Design of Stable International Environmental Agreements: Economic Theory and Political Economy," *Journal of Economic Surveys*, Vol. 15, Issue 3, 377-411, July 2001. http://onlinelibrary.wiley.com/doi/10.1111/1467-6419.00143/full

[83] Catrina Rorke, "A Conservative Answer to Climate Change," *The American Conservative*, Dec. 9, 2015. http://www.theamericanconservative.com/articles/a-conservative-answer-to-climate-change/

[84] This improves the benefit-cost ratio of abatement to a single country. The result is an increased likelihood of voluntary reductions or facilitating an international agreement and maintaining compliance. For evidence, look to the success of the Montreal Protocol, which is largely attributed to the availability of low-cost emissions abatement technologies.

[85] Wallace E. Oates and Paul R. Portney, "The Political Economy of Environmental Policy," Handbook of Environmental Economics, Elsevier Science B.V., Vol. 1, 2003. http://econweb.umd.edu/~oates/research/PoliticalEconomyEnvironmentalPolicy.pdf

[86] Devin Hartman "Wholesale Electricity Markets in the Technological Age," R Street Institute, August 2016. http://www.rstreet.org/wp-content/uploads/2016/08/67.pdf

[87] Contentious, high-cost interventions intensify the political divide over climate policy.

[88] Victor, 2016.

[89] Victor, 2016.

[90] Actions to correct for socially premature nuclear retirements must account for the long-term implications to cost-effective emissions reductions. This requires a close examination of the value of competitive electricity markets to long-term emissions reductions and the damage done by bailing out power plants.

should compel the case for emissions pricing, but does not justify political interventions that undermine the integrity of market institutions. Caving to pressures for political expediency risks setting a legal and political precedent for expanded ad hoc climate policy.

Ad hoc climate policy weakens competitive markets at a time they need strengthening to meet economic and environmental objectives. Clean-energy mandates, subsidies and inflexible regulation often reduce emissions in the short run, but undermine competitive market performance. Indeed, the future health of electricity markets depends on unwinding the existing subsidy regime.[91] Sacrificing competitive markets for temporary emissions reductions is exceptionally high cost and risks undermining the ultimate foundations of climate success.

A coherent climate strategy must remain cognizant that emissions accumulate (i.e., stock not flow pollutants), are globally mixed and that the United States accounts for a small proportion of global emissions. This makes maximizing the leverage of domestic policies on the international stage centrally important to U.S. climate strategy.[92] Addressing climate concerns effectively will require technologies that are globally scalable and affordable.[93] Innovation plays a pivotal role, given the high cost of clean power generation.[94] The United States should serve as a policy model to follow and assist in driving down the costs of emissions abatement, which maximizes the likelihood of emissions reductions abroad. In the long term, global climate progress is linked to the performance of the electricity industry, which outperforms under a competitive model. The clear path to climate success is emissions pricing and competitive electricity markets.

CONCLUSION

The rise of competitive electricity markets has had positive environmental implications and should serve as a domestic and global foundation to achieve a low-emissions future. Markets create pathways to voluntary, low-cost emissions reductions. The competitive platform spurs innovation and facilitates transitions to breakthrough technologies far more effectively than the regulated monopoly model. These effects amplify when combined with emissions pricing, which is far more effective in competitive markets where participants have incentives to follow price signals.

The past two decades demonstrated the natural fit of market-based environmental policy with competitive wholesale power markets, especially the ability of these structures to drive efficient market outcomes while minimizing the costs of reducing emissions.[95] Still, recent primary research on the prospective and retrospective emissions effects of restructuring is limited. Policymakers would benefit from additional research.

The health of competitive electricity markets and environmental quality are interdependent. Healthy markets require quality market design and minimal out-of-market interventions that distort price formation. This means policy intervention that temporarily reduces emissions may compromise long-term emissions reductions by disrupting competitive market performance.

Protecting, expanding and strengthening competitive electricity markets is an economic and environmental imperative. It begins with introducing competitive reforms in states that retain the regulated monopoly model, which is outdated and constrains innovation.[96] In restructured areas, improving wholesale electricity market design and retail choice policies would yield further benefits. These rather technical, specific items are often overshadowed by higher-profile policy discussions, but they may well prove more significant in the aggregate.

The competitive electricity model has upside to usher in enormous innovation and rapid technological change with profound environmental benefits. Simultaneously achieving economic and environmental objectives provides an ideal recipe for global emissions reductions. The competitive electricity model is a key ingredient to a wealthier, healthier world.

ABOUT THE AUTHOR

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[91] Victor, 2016.

[92] Victor, 2016.

[93] National Academies of Sciences, Engineering, and Medicine, 2016.

[94] National Academies of Sciences, Engineering, and Medicine, 2016.

[95] Susan F. Tierney and Paul J. Hibbard, "Carbon Control and Competitive Wholesale Electricity Markets: Compliance Paths for Efficient Market Outcomes," Analysis Group, May 2015.

[96] Kiesling, 2016.