

# THE COMPLEXITY DILEMMA IN POLICY MARKET DESIGN

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*Regulators are increasingly pursuing their policy objectives by creating markets. To create a policy market, regulators require firms to procure a product that is socially useful but that confers little direct private benefit to the acquiring party. Examples of policy markets include pollutant emissions trading programs, renewable energy credit markets, and electricity capacity markets. Existing scholarship has tended to analyze policy markets simply as market-based regulation. Although not inaccurate, such inquiries are necessarily incomplete because they do not focus on the distinctive traits of policy markets. Policy markets are neither typical regulations nor typical markets. Concentrating on policy markets as a distinctive type of market brings to light common characteristics of such markets, which in turn generates insights into how they can be used more effectively to implement policy. In particular, this Article focuses on a recurring fundamental challenge in policy market design: managing complexity. Typical markets manage complexity through market forces. As a regulatory creation, however, policy markets require regulators to manage their complexity. This poses what we call the complexity dilemma, which requires regulators to balance strong pressures both toward and away from complexity. The central argument of this Article is that although policy markets are an important part of a regulator's toolkit, they are also subject to complexity that limits their usefulness. Understanding the complexity dilemma and*

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*its crucial role in policy market design forms an essential step toward progress in improving the design and function of these markets.*

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## I. INTRODUCTION

The value of markets to society is clear. Two parties choose to enter into a transaction for an exchange of goods or services. Since the transaction leaves both parties better off than before—self-evident by their voluntary decisions to enter into the transaction—the benefit of the transaction is apparent. People engaged in numerous transactions of identical or similar products comprise a *market*. Since each transaction in a market improves the well-being of parties to the transaction, a properly functioning market should substantially improve overall well-being.<sup>1</sup> Moreover, markets often function effectively with relatively little government involvement.<sup>2</sup> As long as

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1. See RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* 11 (2d ed. 1977) (“The transaction would not have occurred if both parties had not expected it to make them better off.”).

2. This is not to say that governments are unnecessary to markets. At a minimum, governments are generally necessary to enforce legal rights of property and contract. N. GREGORY MANKIW, *PRINCIPLES OF MICROECONOMICS* 11–12 (7th ed. 2012); see also ALEX

there is an underlying structure in place to define rights and enforce bargains, markets can arise organically and generate wealth for society, as Adam Smith described through his metaphor of the “invisible hand.”<sup>3</sup>

The role of government in regulating markets, at least at its basic level, is also rather clear. Sometimes markets have problems, which economists call *market failures*.<sup>4</sup> Perhaps one of the parties to a transaction did not have sufficient information to understand the value of what was being exchanged. Perhaps the transaction harmed some third party who was not represented in the transaction. Perhaps one of the parties was able to eliminate the choices of the other, changing the terms of exchange. Government regulation aims to address market failures in order to make markets more socially beneficial.<sup>5</sup>

Market forces are so powerful that government policy sometimes creates entirely new markets to alleviate market failure in other markets. These markets would not exist but for active government involvement. Indeed, in these circumstances, the extent of government involvement in these markets is so deep that labeling its role as an “intervention” fundamentally misstates the relationship. The government is not just regulating the market; the government is regulating *through* the market. The basic reason for creating these markets is to reduce, through trading, the cost of government intervention and, therefore, better address the underlying market failure.

These government-created markets, which we call *policy markets*,

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MARSHALL, THE SURPRISING DESIGN OF MARKET ECONOMIES 9–114 (2012) (discussing examples in other countries of government regulations enhancing productivity).

3. ADAM SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS 477–78 (Edwin Cannan ed., 1976) (“[B]y directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention . . . . By pursuing his own interest he frequently promotes that of society more effectively than when he really intends to promote it.”); see, e.g., MANKIW, *supra* note 2, at 10–11 (quoting Smith and noting the importance and relevance of Smith’s insights).

4. See COMPTROLLER GENERAL OF THE UNITED STATES, NO. PAD-77-34, GOVERNMENT REGULATORY ACTIVITY: JUSTIFICATIONS, PROCESSES, IMPACTS, AND ALTERNATIVES 6 (1977) (defining “market failure” as “a term which economists use to designate a flaw in the marketplace which produces undesirable consequences”).

5. The mere existence of a market failure does not by itself fully justify government regulation to address the market failure. Government regulation may not be effective in counteracting the market failure. Even when government regulation effectively counteracts the market failure, regulation may impose other costs that outweigh its benefits. See *id.* at 9 (“Thus, the cost of an uncorrected market failure must be weighed against the costs of regulation to correct the failure.”).

are of two primary types.<sup>6</sup> In the first type, the government seeks to restrict the output of things that are harmful to society, such as pollution. It is generally costly for firms to reduce their pollutant emissions, so policy markets have been created to reduce the regulatory burdens on firms by allowing them to reallocate emissions rights among themselves through market transactions. In the second type of policy market, the government seeks to increase the production of products that may be good for society, such as renewable energy sources and electricity capacity. Here, the government creates a market so that suppliers compete to sell the beneficial product, reducing the price that buyers of the product must pay.

Policy markets, even when they are noticed as particular institutions, tend not to receive attention as a coherent and distinctive phenomenon. Examinations of policy markets usually analyze these markets as a form of regulation—that is, they frame policy markets simply as market-based regulation, and they compare policy markets, either favorably or unfavorably, to non-market-based regulation.<sup>7</sup> These inquiries offer important insights and policy prescriptions, but the story they tell is incomplete because they do not focus on the distinctive traits of policy markets—that is, the ways in which policy markets are markets and the ways in which such markets differ from typical markets. Policy markets are properly considered markets because they seek to gain the same welfare-enhancing benefits from voluntary transactions that come out of markets that have arisen organically, without direct government action. Yet, they are not typical markets because they do not arise organically; rather, fundamental elements of these markets must be determined through direct government regulation.

Policy markets thus differ in important ways from more conventional markets. Concentrating on policy markets as a distinctive type of market brings to light common characteristics of such markets, which in turn generates insights into how they can be used most effectively. In particular, this Article focuses on a recurring fundamental challenge in policy market design: managing complexity.

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6. See MANKIW, *supra* note 2, at 11–12 (discussing government intervention in markets).

7. See generally, e.g., Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985) (extolling the advantages of market-based environmental regulation over traditional forms of regulation); TERRY L. ANDERSON & GARY D. LIBECAP, *ENVIRONMENTAL MARKETS: A PROPERTY RIGHTS APPROACH* (2014) (similar); Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 U. COLO. L. REV. 533 (2007) (criticizing market-based environmental regulation as unwise privatization of the environment).

One of the great beauties of a typical market is its extraordinary ability to manage a complex network of relationships between many sellers and buyers without active, centralized coordination. Policy markets, however, require more active supervision, and so regulators must make administrative decisions that directly affect complicated relationships. This sets up what we call the *complexity dilemma*.

On the one hand, the ability of policy markets to harness the benefits of competitive markets depends on keeping them simple. Policy markets function best as markets—that is, they generate more of the welfare-enhancing benefits that we associate with markets—when they are kept uncomplicated, allowing more trading. Simplicity facilitates transactions, and transactions improve well-being.

On the other hand, the real world is extremely complex, and this exerts strong pressures toward increasing the complexity of policy markets. Regulators attempt to respond to real-world conditions, which involve a multiplicity of potentially relevant factors. Reflecting reality generates complexity.

The challenge that this creates—balancing the strong pressures both toward and away from complexity—forms the complexity dilemma. Understanding the complexity dilemma and its key role in policy market design forms an essential step toward progress in improving the design and function of these markets.

Thus, the central argument of this Article is that although policy markets are an important part of a regulator’s toolkit, they are subject to complexity that limits their usefulness. To illustrate the complexity dilemma, we focus on two different policy markets as case studies: emissions trading markets (also known as “cap and trade”) and electricity capacity markets. Both examples attempt to leverage market forces by creating a market for a product that is not believed to be adequately managed in organically arising markets due to market failures in the primary market. The product in each market is synthetic, created by regulators to advance a policy objective, and then imposed as a regulatory mandate on participants in a primary market.

This paper proceeds in three Parts. Part II introduces policy markets by explaining the value of markets, how regulation can address market failures, and how regulating by creating a policy market differs from traditional regulatory approaches. Part III describes the basic concepts of policy markets and the potential challenges of designing and operating such markets. Part IV analyzes two examples of policy markets that have grappled with the complexity dilemma. First, the Clean Air Act Amendments of 1990 created a sulfur dioxide emissions

“cap-and-trade” program to address pollution that causes acid rain.<sup>8</sup> At the time, this system was a novel and innovative approach that allowed more flexibility and therefore lower compliance costs than traditional environmental regulations. Over time, this relatively simple emissions trading program has been replaced by a far more complex interstate emissions market with significant barriers to trading. Second, electricity capacity markets arose in the late 1990s as a mechanism for inducing investment in newly competitive electricity generation markets.<sup>9</sup> As with the Acid Rain Program, capacity markets have become increasingly complex and controversial over time. The challenges for the increasing complexity of the Clean Air Act emissions trading markets and the electricity capacity markets aptly illustrate the dilemma facing regulators who design and operate policy markets and provide the basis for observations about how regulators should approach the complexity dilemma.

## II. MARKETS AND REGULATION

Before examining policy markets in particular, we must understand the benefits of markets generally and how regulation can address inadequacies in markets. Properly functioning markets are important mechanisms for increasing social welfare. But when markets do not function properly—when they suffer from market failures—they can fall short of providing all possible benefits. Market regulation attempts to correct or redress market failures to increase markets’ effectiveness in providing social benefits. Conventional market regulation acts by constraining existing markets to counteract their market failures—for example, by limiting the pollution that a factory can emit, thereby limiting the environmental damage the factory imposes on society. Some regulations, however, create their own markets. We call these markets *policy markets* because the good or service traded in the market exists only to comply with policy requirements imposed by the regulator. Policy markets thus differ from typical markets, in which demand is driven by the preferences of the buyer rather than an obligation to comply with regulatory mandates.

### A. *The Benefits of Markets*

Markets can be extremely powerful structures for organizing individual economic decisions and conduct to the advantage of the

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8. See *infra* Part IV.A (discussing the history of the Acid Rain Program).

9. See *infra* Part IV.B (discussing the background of capacity markets).

individual market participants as well as for the overall benefit of society.<sup>10</sup> Markets achieve these benefits through several different mechanisms.

First, properly functioning markets improve social welfare. Markets operate as a system of voluntary transactions matching willing buyers with willing sellers. Each party, buyer or seller, enters into the transaction only because that party will, in its own assessment, be better off after the transaction than before it.<sup>11</sup> As long as we trust each party's assessment of its own welfare, it follows that each transaction improves the well-being of both the buyer and the seller who willingly enter into the transaction.<sup>12</sup>

Second, properly functioning markets maximize the value of the goods and services being traded.<sup>13</sup> This principle, too, follows directly from the voluntary nature of market transactions. The previous paragraph noted that both the seller and the buyer of a product improve their well-being through the transaction.<sup>14</sup> This implies that the value of the product being exchanged must increase as well. Because the transaction is voluntary, it must be the case that the buyer attaches a higher value to the product than the seller does, and this difference in values leads each of them to prefer the transaction to the status quo. Thus, transactions move goods and services from lower- to higher-value uses.<sup>15</sup>

Third, markets often manage multiple differentiated (heterogeneous) attributes. The textbook model of a perfectly competitive market generally posits many sellers competing to sell an identical—that is, undifferentiated or homogenous—product to many

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10. Economists readily acknowledge that the benefits of markets depend on the satisfaction of certain conditions, which are generally collectively referred to as conditions of a competitive market. *See, e.g.,* MANKIW, *supra* note 2, at 66 (defining a competitive market as one in which “there are many buyers and many sellers so that each has a negligible impact on the market price”).

11. *See* POSNER, *supra* note 1, at 11 (“The transaction would not have occurred if both parties had not expected it to make them better off.”).

12. *Id.* at 11; W. Kip Viscusi, *Risk Equity*, 29 J. LEGAL STUD. 843, 846 (2000).

13. *See* POSNER, *supra* note 1, at 9 (noting that “resources [tend] to gravitate toward their most valuable uses if voluntary exchange—a market—is permitted”); *see also* R.H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 15 (1960) (noting that market transactions will “lead to an increase in the value of production”).

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15. *See* POSNER, *supra* note 1, at 10 (“By a process of voluntary exchange, resources are shifted to those uses in which the value to consumers, as measured by their willingness to pay, is highest.”).

buyers.<sup>16</sup> Since the idealized textbook product is identical, the buyers' only preference is to minimize price. However, the products in a market are often significantly differentiated across multiple attributes in addition to price. The market for hamburgers, for example, allows sellers to offer a variety of attributes. Some of these attributes involve the hamburger itself, such as size, method of cooking, quality of meat, type of bun, and condiments. Others are attributes of the broader customer experience, such as cleanliness of the restaurant, quality of service, and location of the restaurant. Individual buyers have particular preferences for each of the attributes.

Thus, what we think of as the market for a single product—in our example, hamburgers—is really a category that aggregates multiple smaller markets of individual products, each with its own unique set of attributes. The market for a McDonald's Big Mac is not exactly the same market as the market for a Shake Shack Shackburger. Because these individual markets are close substitutes, however, we can aggregate them for conceptual purposes into a coherent overall market. As such, Big Macs and Shackburgers can be considered as part of an overall market for restaurant hamburgers.

The fact of attribute differentiation, although often overlooked or assumed away,<sup>17</sup> highlights an important aspect of how markets benefit society. Markets function well even when products are differentiated and manage those differentiated attributes for the mutual benefit of sellers and buyers. Markets manage these differences by matching the offerings of sellers with the preferences of buyers. Some hamburger sellers may offer inexpensive run-of-the-mill ground beef, while others offer freshly ground, organic beef at a higher price because of the higher costs. Some buyers will prefer to pay more for the organic beef, while others will not. Markets, by performing this matching of sellers with buyers across multiple differentiated attributes that include both

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16. See, e.g., MANKIW, *supra* note 2, at 66 (noting the common assumption that, in a perfectly competitive market, “[t]he goods and services offered for sale are all exactly the same”); Maurice E. Stucke, *Morality and Antitrust*, 2006 COLUM. BUS. L. REV. 443, 453 n.25 (2006) (“A model of perfect competition generally assumes homogenous products . . . .”); see also Christopher S. Yoo, *Rethinking the Commitment to Free, Local Television*, 52 EMORY L.J. 1579, 1588 (2003) (noting that “perfect competition assumes that there are a large number of producers each selling undifferentiated products”).

17. See, e.g., Michal S. Gal, *Reducing Rivals' Prices: Government-Supported Mavericks as New Solutions for Oligopoly Pricing*, 7 STAN. J.L. BUS. & FIN. 73, 80 (2001) (“Let us assume an industry with an almost perfectly homogenous product . . . .”); see also Edward J. Green & Robert H. Porter, *Noncooperative Collusion Under Imperfect Price Information*, 52 ECONOMETRICA 87, 91 (1984) (“Consider an oligopoly of  $n$  firms which produce an undifferentiated product in a stationary and time separable environment.”).



price and other attributes, function as structures for coordinating economic activity. And, they serve this coordination function simply by buyers responding to sellers' offerings and sellers responding to buyers' preferences, without any action by a centralized authority. No government authority needs to decide whether hamburgers should be organic or not; the balance between conventional and organic hamburgers is determined by the relative cost to the seller of conventional versus organic beef and the relative appeal to the buyer of conventional versus organic beef.

### *B. Market Failures*

Despite the textbook model, markets do not always maximize social value. In such circumstances, a market does not generate all the theoretically possible value for society. Economists use the term *market failure* to describe less than optimally functioning markets.<sup>18</sup> Even the basic description in the previous section reveals some potential limitations to the general principle that markets enhance overall well-being. For example, the principle may not hold true if the transaction affects persons other than the buyer and the seller—that is, the transaction may improve the well-being of both the buyer and seller, but if it negatively affects other persons, the transaction may have an overall harmful effect on society.

Monopoly is one category of market failure.<sup>19</sup> The classic microeconomic model assumes competitive market conditions in which sellers in the market act as “price takers.”<sup>20</sup> A seller is a price taker if its decisions regarding how much product to offer at what price do not

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18. See COMPTROLLER GENERAL, *supra* note 4, at 6 (defining market failure as “a term which economists use to designate a flaw in the marketplace which produces undesirable consequences”); MANKIW, *supra* note 2, at 12 (defining market failure as “a situation in which the market on its own fails to produce an efficient allocation of resources”); see also Frances M. Bator, *The Anatomy of Market Failure*, 72 Q.J. ECON. 351, 351 (1958) (defining market failure as “the failure of a more or less idealized system of price-market institutions to sustain ‘desirable’ activities or to stop ‘undesirable’ activities”). Governments sometimes regulate for reasons other than addressing market failures. See COMPTROLLER GENERAL, *supra* note 4, at iii (noting that, in addition to regulating to address market failures, “[r]egulation is also used to achieve social policy or other objectives”).

19. COMPTROLLER GENERAL, *supra* note 4, at 4.

20. See MANKIW, *supra* note 2, at 66 (“Because buyers and sellers in perfectly competitive markets must accept the price the market determines, they are said to be *price takers*.”); G. Marcus Cole, *Rational Consumer Ignorance: When and Why Consumers Should Agree to Form Contracts Without Even Reading Them*, 11 J.L. ECON. & POL’Y 413, 420 (2015) (“In perfectly competitive markets, sellers are, therefore, ‘price takers,’ because they have no control over prices. Each seller must take the market price as given.”).

affect the market price of the product in question.<sup>21</sup> Essentially, in a competitive market, individual firms are too small to influence the market appreciably. For example, in a country with many wheat farmers, no individual farmer can affect the market price of wheat. Each seller produces its product until the marginal cost of producing a product unit equals the price the seller receives for selling the product unit—that is, until the point at which the seller loses money on the marginal product unit.<sup>22</sup> The overall wheat market settles on a quantity and price of wheat that, by balancing supply and demand, maximizes the net gain to society. In the absence of perfect competition, however, a seller is not a price taker and instead is large enough in the market that it has the ability—known as *market power*—to profitably raise the market price of its product above the competitive level.<sup>23</sup> Take, for example, a farmer in a market with only one or two farmers. An unrestrained monopolist will reduce its production output below competitive levels, which will increase the market price above the competitive level.<sup>24</sup> The farmer can charge more for its grain because buyers of grain have only limited alternatives. This increases the profit to the monopolist seller but reduces overall well-being as compared with the perfect competition scenario.

Externalities are another important category of market failure.<sup>25</sup> An externality occurs when someone imposes costs or benefits on others without facing the costs or benefits of these effects.<sup>26</sup> For

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21. See MANKIW, *supra* note 2, at 66 (noting that a buyer or seller is a price taker if “buyers and sellers are so numerous that no single buyer or seller has any influence over the market price”).

22. See *id.* at 284 (“At the profit-maximizing level of output, marginal revenue [price] and marginal cost are exactly equal.”).

23. See, e.g., Cole, *supra* note 20, at 460 (discussing Disney’s substantial market power and its subsequent effects on the market).

24. See COMPTROLLER GENERAL, *supra* note 4, at 9 (“Unregulated monopolists usually produce too little output and charge prices that are too high when compared to a competitive regime . . .”).

25. See *id.* at 14 (discussing externalities).

26. See WILLIAM J. BAUMOL & WALLACE E. OATES, *THE THEORY OF ENVIRONMENTAL POLICY* 17 (2d ed. 1988) (“An externality is present whenever some individual’s (say A’s) utility or production relationships include real (that is, nonmonetary) variables, whose values are chosen by others (persons, corporations, governments) without particular attention to the effects on A’s welfare.”); ORG. FOR ECON. CO-OPERATION & DEV. (OECD), *GLOSSARY OF STATISTICAL TERMS* 256 (2007) (“Externalities refers to situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided.”); TOM TIETENBERG, *ENVIRONMENTAL AND NATURAL RESOURCES ECONOMICS* 47 (4th ed. 1996) (“An externality exists whenever the welfare of some agent, either a firm or household, depends directly on his or her activities and on activities under the control of some other agent as well.”).

example, a homeowner rents out a home for parties, without regard for the harm it is imposing on its neighbors by disturbing them.<sup>27</sup> The problem arises because of “interdependences that are external to the price system, hence unaccounted for by market valuations.”<sup>28</sup> The “party house” homeowner, not facing the costs of the adverse impacts on neighbors, charges a rental rate that does not reflect the harm to neighbors. Because externalities are not directly reflected in market valuations,<sup>29</sup> they induce a divergence between the conduct of private actors, which reacts only to market prices, and overall social welfare, which depends on all effects on well-being whether or not they are reflected in market valuation.<sup>30</sup> Overall, social well-being depends on the harm to the neighbors of the “party house,” even if the “party house” homeowner does not care about harming its neighbors.

A third type of market failure involves public goods.<sup>31</sup> A public good is a good that is non-rivalrous and non-excludable.<sup>32</sup> National security is a classic example of a public good.<sup>33</sup> Non-rivalrous means that one person’s use of the good does not diminish another person’s use of it.<sup>34</sup> Therefore, for example, the benefit that one American citizen gains from the existence of the U.S. diplomatic corps and armed forces does not affect the benefit that another citizen receives. This

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27. See, e.g., Brittany Levine, *Airbnb ‘Party House’ in Glendale Shut Down After Police Visits*, L.A. TIMES (Jan. 6, 2014), <https://www.latimes.com/local/lanow/la-me-ln-airbnb-party-house-glendale-20140106-story.html> (noting a home in Glendale, California, had been advertised as “party central” on Airbnb, and that “constant partying” at the house was disturbing neighbors, “interfering with their sleep in the early-morning hours”).

28. Bator, *supra* note 18, at 358.

29. Externalities may be reflected indirectly in property values. See, e.g., Dennis Guignet, Rachel Northcutt & Patrick Walsh, *Impacts of Ground Water Contamination on Property Values: Agricultural Run-off and Private Wells*, 45 AGRIC. & RESOURCE ECON. 293, 293 (2016) (finding that groundwater contamination in Lake County, Florida, negatively affected property values); P. Joan Poor et al., *Objective Versus Subjective Measures of Water Clarity in Hedonic Property Value Models*, 77 LAND ECON. 482, 491 (2001) (finding that water clarity of freshwater lakes in Maine, a measure of water quality, affected property values of lakefront properties).

30. See Guignet, *supra* note 29, at 294 (discussing how buyers and sellers can perceive change in quality in the market).

31. See generally Paul A. Samuelson, *The Pure Theory of Public Expenditure*, 36 REV. ECON. & STAT. 387 (1954) (discussing why it is necessary for the government to invest in certain sectors of the economy).

32. John P. Conley & Christopher S. Yoo, *Nonrivalry and Price Discrimination in Copyright Economics*, 157 U. PA. L. REV. 1801, 1805 (2009); MANKIW, *supra* note 2, at 216.

33. E.g., Leonard Champney, *Public Goods and Policy Types*, 48 PUB. ADMIN. REV. 988, 988 (1988); Richard B. McKenzie & Hugh H. Macaulay, *A Bureaucratic Theory of Regulation*, 35 PUB. CHOICE 297, 308 (1980); Richard Morrison, *Price Fixing Among Elite Colleges and Universities*, 59 U. CHI. L. REV. 807, 828 (1992).

34. Morrison, *supra* note 33, at 828.

contrasts with a private good, such as an orange. If one consumer eats an orange, another consumer cannot enjoy that product.<sup>35</sup> National defense is also non-excludable, meaning that people cannot easily be excluded from using it. A private company providing national defense protection for the entire United States would have difficulty effectively charging people for its services. Rather, any individual citizen would have a strong incentive to free ride, availing himself of the company's services without paying.<sup>36</sup> Thus, the national security firm could not expect to make money directly by supplying defense services to customers. In contrast, a seller of oranges can easily require consumers to pay for any oranges they are going to consume.

### C. Regulating Markets

When market failures undermine a market's social benefits, governments often turn to regulation. The presence of market failures may justify government regulation to counteract the inefficient distortions caused by the market failures.<sup>37</sup> Different market failures are associated with different regulatory responses.

Regulation to address monopoly power can take either of two approaches. The classic antitrust enforcement strategy restricts actions that reduce competition in otherwise competitive markets.<sup>38</sup> If, for

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35. Although generally classified as distinct concepts, a public good can be considered as an extreme form of a positive externality—that is, a good for which the externality in the form of the public benefit to others swamps any private benefit to the owner. See Alan W. Evans, *Private Goods, Externality, Public Goods*, 17 SCOTTISH J. POL. ECON. 79, 79 (1970) (“[W]e have a range of externality with the pure private good and the pure public good as polar cases.”); John Hudson & Philip Jones, “*Public Goods*”: *An Exercise in Calibration*, 124 PUB. CHOICE 267, 268 (2005) (“Publicness is measured by the extent of the externality.”).

36. See Timothy J. Muris, *Economics and Consumer Protection*, 60 ANTITRUST L.J. 103, 104 (1991) (“As with defense, there is a problem of efficiently excluding those who receive the benefit.”).

37. This is not to say that government policies can only be justified to the extent they correct a market failure. Other policy objectives, such as addressing distributional inequities to increase the fairness of society, may also justify government intervention. See COMPTROLLER GENERAL, *supra* note 4, at 6–7 (discussing the reasons government decides to regulate). Because the purpose of such policies is not to correct a market failure, their justification cannot be evaluated merely by whether they increase or decrease the efficiency of markets. See *id.* at 7. That said, because virtually every government program affects markets, a program that does not correct a market failure almost necessarily distorts markets in some way and to some extent. Whether the costs of these distortions are sufficiently large in comparison to the perceived benefits of the program will determine whether the program is nevertheless worthwhile.

38. See, e.g., *N. Pac. Ry. Co. v. United States*, 356 U.S. 1, 19 (1958) (holding that railroad deeds and leases that required grantees and lessees of land to ship products by way of the railroad were per se unlawful restraints of trade in violation of the Sherman Antitrust Act); *Loewe v. Lawlor*, 208 U.S. 274, 300–01 (1908) (holding that attempts by defendants to prevent plaintiffs

example, Coca-Cola and Pepsi wished to merge to reduce competition in the soft drink market, the Federal Trade Commission would likely intervene to block the merger under the authority of federal antitrust statutes.<sup>39</sup>

In some situations, however, inducing competition is not the best course of action. Competition in a market may not be possible if the costs of supplying the market by using only one producer are less than the costs of supplying the market through two or more producers—what is known as a natural monopoly.<sup>40</sup> Mandating competition in such a circumstance would only increase the costs of production to the detriment of buyers. An example of such a market is the local distribution of electricity. It would not make sense for regulators to force competition by requiring more than one local electricity distribution company to provide service, necessitating construction of parallel distribution networks. Instead, state public utility commissions allow local electricity distribution companies to operate as state-approved monopolists within a defined geographic service area. Commissions, however, regulate retail electricity rates so that the companies only receive enough revenue to obtain a “fair” rate of return on the companies’ investment, thereby limiting the companies’ ability to exercise their market power.<sup>41</sup>

Take, as another example, regulation to address externalities. Recall that the problem with externalities is the presence of effects on third parties who are not reflected in the market, such as the neighbors of the rental “party house” whose sleepless nights do not factor into either the homeowner’s decision to rent the house for parties or into the decision of party organizers to rent the house. If regulation is warranted, the ideal regulation would internalize the externality by forcing the homeowner to face the costs it is imposing on its neighbors

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from reselling hats violated Sherman Antitrust Act).

39. See 15 U.S.C. § 1 (2012) (stating every “combination in the form of trust or otherwise . . . in restraint of trade” is illegal); *FTC v. Coca-Cola Co.*, 641 F. Supp. 1128, 1128 (D.D.C. 1986) (granting the FTC’s request for a preliminary injunction blocking Coca-Cola’s attempted acquisition of Dr. Pepper).

40. See MANKIW, *supra* note 2, at 302 (“An industry is a natural monopoly when a single firm can supply a good or service to an entire market at a lower cost than could two or more firms.”).

41. See, e.g., David B. Spence, *The Politics of Electricity Restructuring: Theory vs. Practice*, 40 WAKE FOREST L. REV. 417, 419 (2005) (“Price regulation [of investor-owned utilities] was necessary to prevent the deadweight losses and producer surpluses associated with monopoly pricing.”). These “fair” rates of return theoretically mimic the return a company would receive in a comparable, competitive market. Herbert Hovenkamp, *Technology, Politics, and Regulated Monopoly: An American Historical Perspective*, 62 TEX. L. REV. 1263, 1274 (1984).

by disturbing their sleep. This internalization could be accomplished by, for example, holding the homeowner liable to its neighbors for damages paid under a nuisance claim.<sup>42</sup>

Regulation generates both benefits and costs.<sup>43</sup> The goal of regulation is to improve well-being.<sup>44</sup> Generally, this will mean attempting to create more benefits than costs, although the distribution of benefits and costs may matter as well.<sup>45</sup> Regulators often justify their regulatory proposals by showing that benefits exceed costs.<sup>46</sup> A more exacting criterion requires that a policy maximizes net benefits—that is, the difference between the benefits and costs of a policy.<sup>47</sup>

In each of the examples in this section, regulating markets means constraining options available to sellers and buyers in the market. For example, regulation might restrain the price that could be charged by a monopolist. It also might limit the hours that houses in a particular neighborhood can hold noisy parties that can be heard by neighbors. Essentially, regulating markets to address market failures requires fixing the markets to reduce or eliminate the distortions caused by the market failures. The market itself, however, continues to operate relatively autonomously with buyers and sellers participating voluntarily, within the constraints of the regulation, without active government intervention to sustain it.

Some regulations, however, flip this observation on its head. Instead of using regulations to constrain markets, some regulations create markets as the regulatory mechanism. Regulators are not so much intervening in markets as they are regulating *through* markets.

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42. See Coase, *supra* note 13, at 14–15 (discussing the case *Bass v. Gregory* and how internalizations can be accomplished through the judicial system).

43. See, e.g., Eric A. Posner & Cass R. Sunstein, *Moral Commitments in Cost-Benefit Analysis*, 103 VA. L. REV. 1809, 1821 (2017) (“A regulation typically has both positive and negative effects on welfare.”).

44. See *id.* at 1821–22 (noting that “the ultimate goal of regulation is to advance well-being”).

45. See John D. Graham, *Saving Lives Through Administrative Law and Economics*, 157 U. PA. L. REV. 395, 414 (2008) (arguing in favor of using cost-benefit analysis to “distinguish[] good rules from bad rules,” but acknowledging also the importance of “distributional values, such as fairness to the poor”).

46. See, e.g., Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnaces, 80 Fed. Reg. 13,120, 13,122 (proposed Mar. 12, 2015) (codified at 10 C.F.R. pt. 430) (summarizing costs and benefits of proposed rule to consumers); Occupational Exposure to Respirable Crystalline Silica, 78 Fed. Reg. 56,274, 56,277 (proposed Sept. 12, 2013) (to be codified at 29 C.F.R. pts. 1910, 1915 & 1926) (same).

47. See Exec. Order No. 12,866, 3 C.F.R. § 638, *reprinted in* 5 U.S.C. § 601 (1994) (“[I]n choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits . . . unless a statute requires another regulatory approach.”).

### III. POLICY MARKETS: REGULATING *THROUGH* MARKETS

Some regulations do not follow the traditional paradigm of intervening in extant markets to correct perceived failures or shortcomings in those markets. Instead, these regulations regulate *through* markets by creating new markets that directly drive implementation of policy objectives. In a *policy market*, the regulator does not mandate certain attributes of the good or service, as in typical market regulation, but instead requires procurement of the product itself. An example would be an emissions trading program, in which sources of pollution can buy and sell pollution credits in a market.<sup>48</sup> Polluters have no innate demand for emissions credits, but the government requires polluters to procure credits for their emissions, thereby creating a market for such credits.<sup>49</sup>

This Article is the first to focus on policy markets as a discrete policy phenomenon. Prior academic work and commentary have used other terms to describe related market institutions. The term *compliance market*, for example, refers to markets in which product purchases are compelled to comply with a regulatory mandate.<sup>50</sup> The term *compliance market*, however, is generally employed for the specific purpose of differentiating markets in which product purchases are compelled to comply with a regulatory mandate from voluntary markets for the same product, in which purchases are driven by voluntary demand.<sup>51</sup> Most policy markets do not have corresponding

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48. See BAUMOL & OATES, *supra* note 26, at 177 (citing J.H. DALES, POLLUTION, PROPERTY AND PRICES (1968)). These authors credit J.H. Dales for the idea of pollution permit markets.

49. Not every government-created market is a policy market. For example, to the extent that governments are the only purchasers of some military equipment such as ships, tanks, and warplanes, the markets for such equipment is government-created. The government can also create markets by subsidizing markets that are insufficiently profitable to exist otherwise, such as the market for flood insurance in flood-prone areas.

50. See, e.g., Henry M. Banta & Sheldon L. Bierman, *Acid Rain Legislation's Complex Problem—Fair and Efficient Emissions Limitation*, 125 PUB. UTIL. FORT., Mar. 1990, at 19, 19 (referring to “an emissions reduction compliance market”); William Boyd & James Salzman, *The Curious Case of Greening in Carbon Markets*, 41 ENVTL. L. 73, 73 (2011) (discussing “environmental compliance markets”).

51. See, e.g., Aaron Ezroj, *Climate Change and International Norms*, 27 J. LAND USE & ENVTL. L. 69, 83 (2011) (“[T]here is currently no national policy market for carbon offsets. There is, however, a significant and growing voluntary market.”); David Schraub, *Renewing Electricity Competition*, 42 FLA. ST. U. L. REV. 937, 964 (2015) (noting that “Renewable Energy Credits are traded in two primary markets,” the “compliance market” and the “voluntary market”); Michael Zimmer, Jason T. Hungerford & Jennifer M. Rohleder, *Recs Get Real*, PUB. UTIL. FORT., Nov. 2007, at 25, 25 (“Currently, the United States has two distinct REC markets — the compliance market and the voluntary market.”).

voluntary markets for the same product; hence the term *compliance market* is under-inclusive for the category of market that is the subject of this paper. Similarly, the term *fabricated markets* refers to consciously designed product markets.<sup>52</sup> The concept of fabricated markets is broader than a policy market, as it includes consciously designed product markets even if the market would exist in the absence of the conscious design.<sup>53</sup> Thus, neither *compliance markets* nor *fabricated markets* are congruent with the term *policy market*, nor do the works employing those terms examine policy markets as a coherent category of policy or of market.

Regulators designing policy markets face a common set of challenges. Part III.A explains the basic concept of policy market design through an idealized simple example. Part III.B examines policy market design in more detail, explaining how the various decisions necessary to design a policy market inevitably encounter the complexity dilemma.

#### A. An Idealized Example

To illustrate the basic workings of a policy market, we start with a conceptually straightforward example—a simple cap-and-trade system of air pollutant emissions regulation. Assume that a government authority decides that nitrogen oxide emissions in a particular area are too high. Emissions are adversely affecting local air quality and thereby posing risks to public health, such as an increase in respiratory ailments. The government decides what level of air quality would be acceptable and then determines how much emissions need to be reduced in order to reach that air quality objective. This is the “cap” in the cap-and-trade system.<sup>54</sup> The purpose of the cap is to achieve

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52. See, e.g., STEVEN K. VOGEL, *MARKETCRAFT* 38–42 (2018) (discussing the concept of “fabricated markets,” which refers to markets “characterized by the deliberate planning of market design, a specific moment of market launch, and/or the creation of a product and a market that would not exist in the absence of conscious design”); see also Joseph P. Tomain, *The Dominant Model of United States Energy Policy*, 61 U. COLO. L. REV. 355, 379–83 (1990) (explaining the concept of a “government market” in energy policy).

53. See, e.g., VOGEL, *supra* note 52, at 40 (discussing the Affordable Care Act because it created a consciously designed health care market even though the market existed absent of the conscious design); see also Adam J. Levitin, *Safe Banking: Finance and Democracy*, 83 U. CHI. L. REV. 357, 364 (2016) (“Financial markets are not organic developments steered by the invisible hand. Instead, they are marionettes, manipulated by the strings of the government. Market forces operate within the framework created by the government.”).

54. See A. DENNY ELLERMAN, PAUL L. JOSKOW, & DAVID HARRISON, JR., PEW CTR. ON GLOBAL CLIMATE CHANGE, *EMISSIONS TRADING IN THE U.S.: EXPERIENCE, LESSONS, AND CONSIDERATIONS FOR GREENHOUSE GASES* 4 (2003) (“Under a cap-and-trade program, an



environmental improvement by reducing emissions and improving air quality.

The government then allocates emissions allowances to the various individual sources of emissions in the particular area, such that the total amount of emissions allowances across all sources is no more than the amount of total emissions that will allow the area to reach its air quality objective.<sup>55</sup> Every source is required to have sufficient allowances to cover its emissions.<sup>56</sup> A source can either use its emissions allowances for its own emissions or sell its emissions rights to other sources.<sup>57</sup> Transactions of allowances are the “trade” in the cap-and-trade system.<sup>58</sup> The purpose of trading is to minimize the costs of reducing emissions to the level mandated by the cap. Thus, firms with high pollution abatement costs will buy allowances from firms with lower costs of abatement.<sup>59</sup> The trading does not itself improve air quality, but rather reduces the costs of meeting the emissions limit of the cap.<sup>60</sup>

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aggregate cap on emissions is set that defines the total number of emissions ‘allowances,’ each of which provides its holder with the right to emit a unit (typically a ton) of emissions.”); *see also* WORLD BANK GRP., EMISSION TRADING IN PRACTICE: A HANDBOOK ON DESIGN AND IMPLEMENTATION 3 (2016) (“Under an ETS [Emission Trading System], the relevant authority imposes a limit (cap) on the total emissions in one or more sectors of the economy . . .”).

55. *See* ELLERMAN, JOSKOW, & HARRISON, *supra* note 54, at 4 (“The permits are initially allocated in some way, typically among existing sources.”); PETER HEINDL & ANDREAS LÖSCHEL, CTR. FOR EUROPEAN ECON. RESEARCH, DESIGNING EMISSIONS TRADING IN PRACTICE: GENERAL CONSIDERATIONS AND EXPERIENCES FROM THE EU EMISSIONS TRADING SCHEME (EU ETS) 2 (2012) (“Permits can be sold or auctioned by the regulator or can be partly or fully distributed for free (known as grandfathering).”).

56. ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 4 (“Each source covered by the program must hold permits to cover its emissions . . .”); HEINDL & LÖSCHEL, *supra* note 55, at 2 (noting that permits “must be surrendered (handed in to the regulator) for each emitted unit”).

57. *See* ELLERMAN, JOSKOW, & HARRISON, *supra* note 54, at 4 (“[S]ources [are] free to buy and sell permits from each other.”); WORLD BANK GROUP, *supra* note 54, at 3–4 (noting that an emission source can choose to surrender an allowance for its emissions, trade allowances to other sources, bank allowances for future use, or purchase allowances from other sources).

58. *See, e.g.,* ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 3 (providing a sample transaction involving emissions in a cap-and-trade system).

59. *Id.* at viii.

60. That said, to the extent the emissions cap is set through a political compromise in which cost feasibility is a factor, reducing compliance costs is likely to enable a political compromise that adopts greater emissions reductions. *Cf.* Joseph Goffman, *Title IV of the Clean Air Act: Lessons for Success of the Acid Rain Emissions Trading Program*, 14 PENN ST. ENVTL. L. REV. 177, 180 (2006) (noting that “the promise of cost savings through emissions trading . . . persuaded the Bush administration to propose in its Clean Air legislation that the SO<sub>2</sub> program stipulate an annual reduction of 10 million tons,” as compared with prior proposals for an 8-million-ton reduction); *infra* notes 165–169 and accompanying text (describing the political process that led to the establishment of the emissions cap in the Clean Air Act’s Acid Rain Program).

As long as transaction costs are sufficiently low and the costs of pollution abatement differ across sources, firms will trade emissions allowances among themselves to their mutual advantage. Each trade will transfer emissions allowances from a source with lower abatement costs to a source with higher abatement costs. We know this because the value of an emissions allowance is necessarily higher for the source that faces a higher pollution abatement cost. If the higher-cost source does not purchase the allowance from a lower-cost source, it must abate the emissions itself, at a higher cost. The price negotiated for the transfer of the allowances will therefore be somewhere above the lower-cost source's abatement cost and below the higher-cost source's abatement cost, such that both sources are benefitted by the transaction. This is a classic Coasean bargain.<sup>61</sup>

Trades from sources with lower abatement costs to sources with higher abatement costs will continue until no source can, at the margin, reduce its emissions by an additional unit at a lower cost than other sources—that is, until the marginal cost of pollution abatement is equal across all sources in the area. As allowances move to higher-cost sources, pollution abatement migrates to lower-cost sources. The overall effect of the trades will be to allocate emissions across the sources in a way that minimizes the aggregate cost of pollution abatement.<sup>62</sup>

### *B. Policy Market Design*

Market-based regulations that act through the mechanism of policy markets can reduce the cost of regulation by leveraging market forces to accomplish regulatory objectives while reducing regulatory burdens.<sup>63</sup> Policy market design, therefore, requires regulators to focus on creating well-functioning markets. Policy markets are most effective at reducing costs when they are simple and unconstrained.<sup>64</sup> This maximizes the size of the market, which enhances competition and enables transactions that reduce the costs of complying with the regulatory mandate.<sup>65</sup>

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61. See Coase, *supra* note 13, at 16 (discussing how the market naturally will achieve a more efficient outcome the lower the transaction costs).

62. See Goffman, *supra* note 60, at 178 (“The virtue of cap and trade is simply that it makes it easier to reach the right pollution reduction levels . . .”).

63. See, e.g., ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 1 (discussing “emissions trading [as] one of several market-based approaches that theoretically should improve the performance of regulatory regimes”).

64. *Id.* at 19–20.

65. See MANKIWI, *supra* note 2, at 66 (defining a competitive market as one in which there

Keeping policy markets large and simple, however, often requires oversimplifying reality. Policy markets in the real world operate in a context that is much more complex than in the idealized conceptual example described above.<sup>66</sup> Regulators must decide how to construct demand—or supply, depending on the type of policy market—in a market in which transactions are driven by regulation rather than the preferences of the market participants. Regulators must decide whether to overlook differences among products in the policy market that render the products not perfectly equivalent. Regulators have to weigh additional policy judgments beyond just correcting the relevant market failure. All of these factors add complexity. But accounting for complexity in market design requires limiting the market—for example, by segmenting the market to take account of variations in the product being traded. Limiting the market constrains its ability to reduce costs, which is the primary purpose of these markets.

Thus, policy market design poses a complexity dilemma for regulators: simplify the market to decrease the regulatory burden or complicate the market to reflect reality.<sup>67</sup> This complexity dilemma underlies many of the key decisions regulators must make in creating policy markets. Both factors—creating an effective market and accurately reflecting reality—instrumentally advance the objectives of the policy market, so there is no clear or easy answer to the dilemma.<sup>68</sup>

The complexity dilemma can be characterized in terms of the cost-benefit framework widely used in assessing regulatory decisions.<sup>69</sup> As noted,<sup>70</sup> the purpose of a policy market is to use market transactions to reduce the burdens of regulation. The benefits of a regulation involve the advantages of counteracting the market failure that led to the

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are many buyers and many sellers).

66. See *supra* Part III.A (discussing the interaction of market goals and market complexity).

67. The field of market design examines how differences in the characteristics of markets affect their performance. See, e.g., Alvin E. Roth, *Marketplaces, Markets, and Market Design*, 108 AM. ECON. REV. 1609, 1609–10 (2018) (“Market design . . . strives to understand how the design of marketplaces influences the functioning of markets.”).

68. All regulators face the complexity dilemma in some form, regardless whether they are working with a market-based program or some other form of regulation. The complexity dilemma is a factor in all regulatory design and is not unique to policy market design. In contrast to policy markets, the complexity dilemma does not occur in organically arising markets. Natural markets, driven by the preferences and budget constraints of market participants, manage complexity themselves. Policy markets, propelled by regulatory mandate, must manage complexity through market design.

69. See *supra* notes 43–47 and accompanying text (discussing cost-benefit analysis).

70. See *supra* note 63 and accompanying text (discussing emissions trading as a market-based approach).

regulation. The better the regulation is at counteracting the market failure, the greater the benefits the regulation should generate. But generating benefits can also generate cost. Some of the burdens of regulation take the form of program costs—the cost to the regulator of creating, monitoring, and enforcing the regulatory program.<sup>71</sup> Other burdens take the form of compliance costs—the cost of complying with the regulation.<sup>72</sup>

In this context, the complexity dilemma in policy markets can be understood as a particular aspect of the benefit-cost tradeoff. Regulators can increase the benefits of a policy market by tailoring it more closely to the realities of the problem they are trying to address. But doing so increases the complexities of the policy market, which increases the costs—both program costs to the regulator and compliance costs. Regulators designing a policy market must balance the advantages of a policy market that better matches reality against the disadvantages of a policy market that is, as a consequence of better matching reality, necessarily more complex.

### 1. Constructed Supply or Demand

Policy markets, as we have defined them, create new markets that would not otherwise exist, through regulations that mandate procurement of the product sold in the market.<sup>73</sup> Policy markets require firms to acquire a product that firms would not otherwise demand because acquiring the product does not bring significant direct private benefits to the firms.<sup>74</sup> Regulators create policy markets for one of two reasons. First, regulators may create a policy market to limit the amount of the product when the product represents a negative externality or “public bad,”<sup>75</sup> such as pollution. We will refer to such

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71. See, e.g., ELLERMAN, JOSKOW, & HARRISON, *supra* note 54, at 1–2 (providing a simple numerical example of how emissions trading can control costs).

72. *Id.*

73. See *supra* text accompanying notes 49–50 (discussing the nature of policy markets).

74. Thus, not all government mandates to acquire a product create policy markets. For example, a building code requirement for homes to have smoke detectors, see generally NFPA 72, NATIONAL FIRE ALARM AND SIGNALING CODE (2019), does not create a policy market because (a) a market for smoke detectors would exist even in the absence of the building code requirement, because smoke detectors provide a private benefit to residents; and (b) the building code requirement does not directly or even indirectly determine the quantities of home detectors sold in the market. By contrast, a cap-and-trade program creates a market for emission allowances that would not exist but for the regulatory program, and the program directly determines the quantities of emission allowances sold in the market. COMPTROLLER GENERAL, *supra* note 4, at 6 (discussing the reasons for government regulation of the private market).

75. See Peter H. Aranson et al., *A Theory of Legislative Delegation*, 68 CORNELL L. REV. 1,

markets as *negative-externality policy markets*. Second, regulators may create a policy market to increase the amount of the product when the product represents a positive externality or public good, such as reliability of the electricity grid.<sup>76</sup> We will refer to such markets as *positive-externality policy markets*.

*a. Constructed Supply in Negative-Externality Policy Markets*

Negative-externality policy markets, such as emissions trading markets, create rights that entitle the holders to engage in some private activity with negative externalities. A regulator creating a negative-externality policy market seeks to limit the amount of overall harm caused by the negative externalities, such as pollution, by limiting the total number of rights to pollute. The regulator initially allocates (either by auction or by some other means) the rights to the regulated industry. In a cap-and-trade emissions trading program, the total amount of rights allocated are the cap.<sup>77</sup> Firms in the regulated industry then can reallocate the rights through market transactions with each other.<sup>78</sup>

In deciding on a cap and then allocating the rights to the regulated industry, the regulator is essentially creating the supply curve for the policy market, insofar as a supply curve is simply a representation of the quantities of product offered for sale at different prices.<sup>79</sup> The price

28 (1982) (“Public-bads problems emerge because people may not face incentives optimally to reduce production of goods that display negative externalities.”); Joshua A.T. Fairfield & Christoph Engel, *Privacy As A Public Good*, 65 DUKE L.J. 385, 387–88 (2015) (“A public bad is the mathematical mirror image of a public good.”).

76. See Morrison, *supra* note 33, at 828–29 (noting the relationship between public goods and positive externalities). An analogous relationship exists between public bads and negative externalities. Aranson et al., *supra* note 75, at 28–29 (discussing the concept of a public bad and its externalities).

77. See *supra* note 55 and accompanying text (defining cap-and-trade systems).

78. See *supra* note 58 and accompanying text (discussing the transferability of permits in a cap-and-trade system).

79. See MANKIW, *supra* note 2, at 74 (defining a supply curve as “a graph of the relationship between the price of a good and the quantity supplied”). Recall that we have defined policy markets by the existence of a regulatory mandate to procure the product sold in the markets. See *supra* notes 50–52 and accompanying text (discussing the difference between policy markets and other regulatory markets). This specification, which focuses on demand in the policy market, may seem inconsistent with the observation here that, for a negative-externality policy market, the regulator creates the supply curve for the market (and not the demand curve). Although the regulator creates the supply curve, this is not what creates the policy market. Merely making emission allowances available, for example, would not create a market for emission allowances. Rather, it is the requirement that the regulated industry procure the product—for example, the requirement for pollution sources to procure allowances for their emissions—that creates the market. The creation of the supply curve for the market just influences the equilibrium price and

at which a product is offered should reflect the marginal cost of producing the product.<sup>80</sup> For a negative-externality policy market, the product is the right to create some social harm, such as the right to emit pollution. The marginal cost of producing the product, therefore, is the marginal social cost of allowing the harm—for example, the cost to society of allowing one more ton of pollutant emissions. We would expect this marginal cost of harm to vary depending on the amount of the harm—for example, the harm from each additional unit of pollution may increase as the total amount of pollution increases. This would yield an upward sloping supply curve, with lower values at lower quantities and higher values at higher quantities.

In reality, however, negative-externality policy markets seldom, if ever, reflect this complicated reality. Regulators rarely decide on an emissions cap based on even an approximation of the marginal social cost of pollution. There is simply not enough information available to regulators to make such a determination.<sup>81</sup> Instead, regulators tend to decide the cap based on a pragmatic judgment regarding what is appropriate and acceptable.<sup>82</sup> Moreover, regulators also generally choose a fixed total quantity of allowances that does not depend on the price at which the allowances are sold.<sup>83</sup> In effect, the regulator has created a vertical supply curve, in which the quantity of allowances offered for sale is fixed at the amount of the emissions cap and does not vary with price.

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quantity of the policy market that the regulator has created.

80. See Alan O. Sykes, *Countervailing Duty Law: An Economic Perspective*, 89 COLUM. L. REV. 199, 229 (1989) (noting that “the domestic supply curve reflects the marginal costs of production for domestic producers”); Richard O. Zerbe, Jr., *An Empirical and Theoretical Comparison of Alternative Predation Rules*, 61 TEX. L. REV. 655, 659 (1982) (“The supply curve equals the marginal costs of production and represents the social costs of allocating resources to the production of the good or service.”).

81. See William J. Baumol & Wallace E. Oates, *The Use of Standards and Prices for Protection of the Environment*, 73 SWEDISH J. ECON. 42, 43 (1971) (“[I]t is usually not easy to obtain a reasonable estimate of the money value of this marginal damage.”).

82. See *id.* at 45 (noting that regulators set targets “so as to achieve specific acceptability standards rather than attempting to base them on the unknown value of marginal net damages”).

83. See *id.* at 54 (discussing the results of fixing emissions at a certain quantity and what occurs if the “emission is taxed at a fixed rate per unit” as opposed to the imposition of a ceiling on emissions).

Figure 1: Negative-Externality Policy Market with Vertical Supply Curve

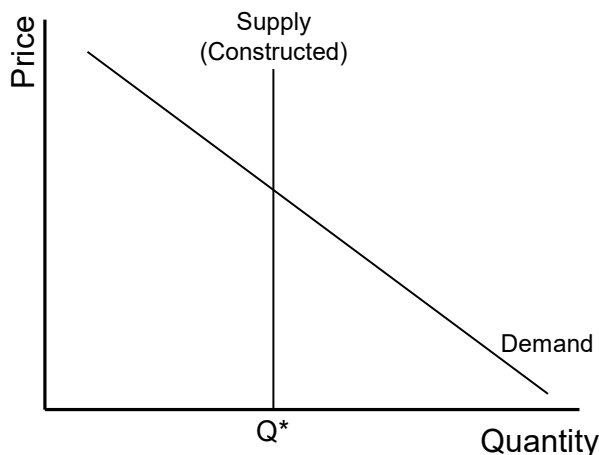


Figure 1 illustrates supply and demand in a negative-externality policy market with a fixed cap on allowances. The fixed cap means that quantity will always remain at the amount of the cap ( $Q^*$ ) regardless of the price. This creates a vertical supply curve at quantity  $Q^*$ . The shape of the demand curve therefore solely determines the price, and changes in demand may result in dramatic changes in price.

Although understandable in light of the difficulties with estimating the marginal social cost of pollution, the use of fixed emissions caps is unfortunate. For example, in the event that emissions are much less expensive to abate than originally assumed, or the harms from pollution exposure are worse than originally assumed, an upward-sloped supply curve would result in fewer emissions and an improvement in social welfare. With a fixed vertical supply curve, however, emissions are unaffected unless the regulator changes the cap, which can be burdensome on the regulator and creates uncertainty for the regulated industry.

Economists Dallas Burtraw, Karen Palmer, and Danny Kahn have proposed a policy for emission trading markets that bears some resemblance to an upward-sloped supply curve.<sup>84</sup> Their proposal calls for adding a “symmetric safety valve,” a design feature that would

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84. See Dallas Burtraw, Karen Palmer & Danny Kahn, *A Symmetric Safety Valve*, 38 ENERGY POL’Y 4921, 4921 (2010) (discussing “how to set policy in the presence of uncertainty . . . where meaningful efforts to control emissions could prove much more costly than prior regulatory efforts to limit emissions of air pollution, and where the costs and benefits of controlling emissions of greenhouse gases are highly uncertain”).

increase an emissions cap in the event that the price of emissions allowances exceeded a specified ceiling price level and decrease the cap in the event that the price of allowances fell below a specified floor price level.<sup>85</sup> They contend that the symmetric safety valve would reduce price volatility by adjusting supply in response to dramatic increases or decreases in price.<sup>86</sup> Burtraw, Palmer, and Kahn's proposal essentially creates a three-step supply curve, with the supply of allowances changing at the low-side safety valve price, the cap, and the high-side safety valve price, but fixed—that is, vertical—in the intervals between these points.<sup>87</sup> Thus, their proposal resembles a very simple sloped supply curve and provides support for investigating the potential gains from implementing sloped supply curves in negative-externality policy markets.<sup>88</sup>

Figure 2: Negative-Externality Policy Market with Stepped Supply Curve

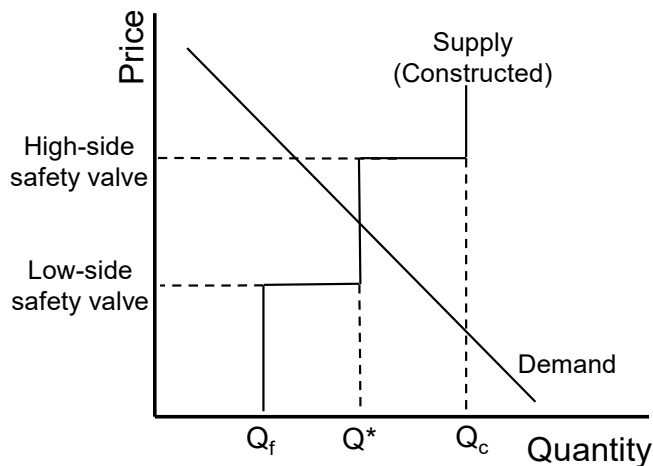


Figure 2 illustrates supply and demand in a negative-externality policy market with a stepped demand curve along the lines of Burtraw, Palmer, and Kahn's proposed symmetric safety valve. The presence of

85. *See id.* at 4922 (describing the symmetric “safety valve” as “provid[ing] a floor as well as a ceiling on the price of emission allowances”).

86. *See id.* at 4922, 4931 (“[T]his design does a better job of insuring against price volatility than does a one-sided safety valve.”).

87. *See id.* at 4931 (“A symmetric safety valve is a price stabilization policy that works in the case of unanticipated spikes or drops in allowance price.”).

88. *See id.* (showing graphs that show the potential gains from using a symmetric safety valve as opposed to other safety valves).



the safety valves means that quantity will remain at the amount of the cap ( $Q^*$ ) as long as the price of allowances remains below the ceiling price and above the floor price. At prices above the ceiling price, quantity increases to  $Q_c$ . At prices below the floor price, quantity decreases to  $Q_f$ . This creates a stepped supply curve with vertical segments at quantities  $Q_f$ ,  $Q^*$ , and  $Q_c$ . As a result of the steps in the supply curve, prices will be less volatile in response to changes in demand than they would be with a vertical supply curve.

*b. Constructed Demand in Positive-Externality Policy Markets*

Positive-externality policy markets, such as renewable energy credit markets<sup>89</sup> and electricity capacity markets,<sup>90</sup> require firms in the regulated industry to acquire a good that gives little, if any, direct private benefit to the acquirer but generate positive externalities for others. The regulator creates the policy market to increase the total magnitude of the positive externality or public good at minimum cost. The policy market effectuates this goal by forcing firms to purchase a good in the market that generates social benefit. The regulator initially allocates demand for the product by assigning firms quotas of the good in question.

Firms can then meet their quotas in one of two ways. First, as in renewable energy credit markets, they can be assigned a quantity quota, which they can meet through a combination of their own production and purchases in the policy market. Second, as in electricity capacity markets, firms can be assigned a revenue quota and then

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89. Renewable energy credits are tradeable environmental commodities intended to incentivize generation of electricity from renewable energy sources. See Michael Gillenwater, *Redefining RECs—Part I: Untangling Attributes and Offsets*, 36 ENERGY POL'Y 2109, 2109 (2008) ("Renewable Energy Certificates (RECs) are one type of environmental commodity intended to provide an economic incentive for electricity generation from renewable energy sources."). A renewable energy credit represents a megawatt of electricity generated from a renewable source. See *id.* (discussing how RECs function and how REC marketplaces have been established in the United States). Many states have adopted some form of renewable portfolio standards policy that requires electricity providers to obtain a specified percentage of their electricity from renewable energy, with renewable energy credits as one way to meet that obligation. See Lincoln L. Davies, *State Renewable Portfolio Standards: Is There a "Race" and Is It "To the Top"?*, 3 SAN DIEGO J. CLIMATE & ENERGY L. 3, 10–11 (2012) ("The RPS's dominance as the preferred way to promote renewable energy became clear only in the last decade. States, however, have used the RPS since at least the early 1990s."); Joshua P. Fershee, *When Prayer Trumps Politics: The Politics and Demographics of Renewable Portfolio Standards*, 35 WM. & MARY ENVTL. L. & POL'Y REV. 53, 57–58 (2010) ("An RPS requires, subject to penalty, that covered electricity sellers procure a specific amount of their energy from renewable sources, with those sources defined by the applicable statute or regulation.").

90. See *infra* Part IV.B. (discussing electricity capacity markets in-depth).

required to pay that quota share of the revenues in an auction market for the relevant good.<sup>91</sup>

In deciding on the total amount of the good that must be acquired and then allocating the purchase quotas to the regulated industry, the regulator is essentially creating the demand curve for the policy market. In typical markets, the demand curve is simply a representation of the buyer's willingness to pay for different quantities of the good.<sup>92</sup> A buyer's willingness to pay normally reflects the marginal benefit to the buyer of acquiring the product.<sup>93</sup> For a positive-externality policy market, however, the buyer's willingness to pay does not derive from the buyer's marginal private benefit from acquiring the good. Rather, the buyer's willingness to pay derives from its regulatory mandate to purchase the good.<sup>94</sup> The regulatory mandate, in turn, should derive from the social benefit of the good—for example, the benefit to society of adding more reliability to the electricity grid.

Ideally, the regulator should construct a demand curve that represents the marginal social benefit of the good that is transacted in the policy market.<sup>95</sup> We would expect this marginal social benefit to vary depending on the amount of the benefit—for example, grid reliability may yield decreasing returns, and so the benefit from each additional unit of grid reliability may decrease as the total amount of reliability increases. This would yield a downward-sloping demand curve, with higher values at lower quantities and lower values at higher quantities.

Like negative-externality policy markets, most positive-

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91. For example, assume that a particular electricity consumer is measured as having contributed 0.1 percent of demand during the time period used to allocate the costs of a capacity markets for a particular year. Also assume that the capacity market outcome was a price of \$150/MW (mega-watt)-day and a quantity of 10,000 MWs. This consumer would be required to pay  $0.001 * \$150/\text{MW-day} * 365 \text{ days/year} * 10,000 \text{ MW} = \$547,500$  in that year for capacity charges.

92. See MANKIW, *supra* note 2, at 68 (showing a demand curve demonstrating this connection between willingness to pay and price).

93. See David N. Hyman, *Using Marginal Benefit Curves to Illustrate Income and Substitution Effects*, 21 J. ECON. EDUC. 383, 386 (1990) (“Each point on a demand curve gives the marginal benefit of a given quantity at that price . . . .”). For example, John J. Donohue III, *Prohibiting Sex Discrimination in the Workplace: An Economic Perspective*, 56 U. CHI. L. REV. 1337, 1346 (1989), examined the demand curve for female workers and noted that it “reflects the marginal benefit from hiring additional female workers.”

94. See BAUMOL & OATES, *supra* note 48, and accompanying text (discussing emissions trading programs as examples of policy markets where a regulator requires procurement of a product).

95. See Peter Cramton, Axel Ockenfels & Steven Stoft, *Capacity Market Fundamentals*, 2 ECON. ENERGY & ENVTL. POL'Y, Sept. 2013, at 27, 28 (“[G]iven the demand-side flaws, fully eliminating blackouts due to insufficient generation is unlikely to be optimal.”).

externality policy markets appear to employ vertically downward-sloping demand curves. Renewable portfolio standards, the state policies that create policy markets for renewable energy credits, adopt fixed purchasing quotas in amounts that do not vary based on price. Electricity providers are required to purchase renewable energy credits or else be charged an alternative compliance payment.<sup>96</sup> In that sense, they create vertical demand curves, with firms required to purchase a fixed number of credits at any price, up to the amount of the alternative compliance payment. These requirements do often, however, increase over time.<sup>97</sup>

Figure 3: Positive-Externality Policy Market with Vertical Demand Curve

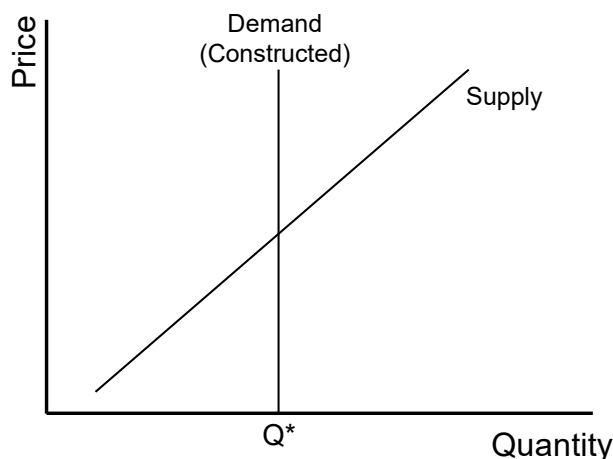


Figure 3 illustrates supply and demand in a positive-externality policy market with a fixed purchasing quota. The fixed quota means that quantity will always remain at the amount of the quota ( $Q^*$ )

96. See, e.g., N.J. ADMIN. CODE §§ 14:4-8.8(c), 14:8-2.3(e), -2.10 (2019) (requiring electricity providers to generate or purchase renewable energy certificates or make an Alternative Compliance Payment); Steven Ferrey et al., *Fire and Ice: World Renewable Energy and Carbon Control Mechanisms Confront Constitutional Barriers*, 20 DUKE ENVTL. L. & POL'Y F. 125, 152 (2010) (noting that in Rhode Island at the time of publication, “[a]n alternative compliance payment of \$50 per MWh in 2003 dollars can be made in lieu of meeting the portfolio standard”).

97. See, e.g., Ferrey et al., *supra* note 96, at 152 (“Rhode Island requires that 3% of the electricity portfolio be renewable energy starting in 2007, rising to sixteen percent in 2020.”); James W. Moeller, *Of Credits and Quotas: Federal Tax Incentives for Renewable Resources, State Renewable Portfolio Standards, and the Evolution of Proposals for A Federal Renewable Portfolio Standard*, 15 FORDHAM ENVTL. L. REV. 69, 98 (2004) (noting that Arizona’s renewable portfolio standard will increase between 2002 and 2012).

regardless of the price. This creates a vertical demand curve at quantity  $Q^*$ . The shape of the supply curve therefore solely determines the price, and changes in supply may result in dramatic changes in price because demand is constant at the quota quantity.

Scholars have identified several problems with these price-insensitive quotas, including price volatility and increased investment risks.<sup>98</sup> Demand curves with slope and shape, however, add complexity and costs to policy market design. Administering a sloped demand curve can impose burdens on regulators and may create uncertainty for the regulated industry, leaving firms chasing moving quotas that vary based on market conditions.<sup>99</sup>

## 2. Product Differentiation

A textbook, perfectly competitive market requires that the products offered for sale in the market are identical.<sup>100</sup> This allows sellers to compete purely on the basis of price. In reality, however, this seldom holds true. Rather, product markets tend to be examples of monopolistic competition, in which firms sell products that are similar enough to be considered part of the same market but not identical in every respect.<sup>101</sup> We can, for example, conceive of a market for fast-food hamburgers, but not all hamburgers in that market will be identical.<sup>102</sup>

Policy markets are typical in this regard. The products sold in a policy market almost inevitably differ from each other. Although product differentiation is not unique to policy markets, differentiation poses a unique challenge to policy markets as compared with markets that arise organically. For example, as we examine in more detail

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98. See, e.g., FRANK A. FELDER & COLIN J. LOXLEY, *THE IMPLICATIONS OF A VERTICAL DEMAND CURVE IN SOLAR RENEWABLE PORTFOLIO STANDARDS 15* (2017) (criticizing fixed renewable energy requirements that impose a vertical demand curve and advocating a downward-sloping demand curve that adjusts requirements based on market conditions); Javad Khazael, Michael Coulon & Warren B. Powell, *ADAPT: A Price-Stabilizing Compliance Policy for Renewable Energy Certificates: The Case of SREC Markets*, 65 OPERATIONS RES. 1429, 1430 (2017) (noting “artificial vertical demand curve[s] imposed by regulations” in renewable energy credit markets that cause problems “such as an uncompetitive market, volatile prices, higher cost of investment (due to higher risk), and difficult policy evaluation”).

99. See *infra* Part IV.B.3 (exploring the complexities of constructing demand in electricity capacity markets).

100. See *supra* note 16 (describing perfectly competitive markets).

101. See MANKIW, *supra* note 2, at 330–31 (defining monopolistic competition as “a market structure in which there are many firms selling products that are similar but not identical”).

102. See *supra* note 17 and accompanying text (employing hamburgers as an example of a traditional market).

below,<sup>103</sup> pollutant emissions from one source may not have precisely the same environmental consequences as the same amount of emissions from another source.

In a typical market, buyers work out product differentiation through their individual preferences. If the method of cooking a hamburger or the cleanliness of the bathroom in a restaurant matter to consumers, then consumers will factor those attributes into their decisions about how much they are willing to pay for different hamburger purchasing options. Each purchaser, moreover, is able to adjust their preferences to the particular circumstances of the transaction—for example, today they may want a grilled hamburger, and tomorrow they may want a fried hamburger.

Consider, however, a policy market where buyers are required to purchase products according to a regulatory mandate. In this case, buyers generally will have no preferences regarding the attributes of the product they are purchasing. They are only purchasing the product to satisfy regulatory requirements, so their preferences are simply to purchase a product that meets the requirements at the minimum price. If some products are better than others, buyers will tend not to care. Indeed, if a higher-quality product costs more, as we might expect it to, then buyers will actually have a preference against it. Therefore, if product differentiation is to affect purchasing decisions, regulators have to create regulatory requirements that differentiate among products in the market—for example, a requirement that emissions allowances may only be traded within the same local area, so that trading does not concentrate emissions from a region in a particular area.<sup>104</sup> These requirements, to be workable, generally must apply categorically and cannot be created or adjusted on a case-by-case basis.

This creates a principal-agent problem in policy markets, as the buyer in the policy market acts to meet its regulatory requirement at the lowest possible cost, rather than advancing the goals of the policy market. Apart from complying with the regulatory requirements, the buyers in the policy market have no preference for advancing the goals

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103. See *infra* Part III.B.2 (discussing the nature of emissions from varying sources).

104. In many ways, this question of product differentiation is similar to the question of market definition in antitrust. In antitrust, the decision-maker seeks to determine in what market the relevant product(s) compete. A theoretical market is then determined, with location and type specifications, in which products are assumed to be fungible. Gregory J. Werden, *The History of Antitrust Market Definition*, 76 MARQ. L. REV. 123, 127–28 (1992). For example, Coca-Cola and Pepsi are not identical products. In an antitrust matter involving soft drinks, however, the two products are likely to be treated as fungible. *FTC v. Coca-Cola Co.*, 641 F. Supp. 1128, 1132–34 (D.D.C. 1986).

of the policy market with their individual purchasing decisions. This is because the nature of a policy market is such that the product being sold and purchased creates social benefit, but not direct private benefit for the purchasers.<sup>105</sup>

There are likely to be many potentially relevant distinctions to be drawn in a policy market. To ensure that the products transacted are as close to equivalent as possible therefore requires imposing many different requirements on transactions. A policy market generally reduces costs most effectively. However, if the attributes of the product being traded are undifferentiated, the market for that product has essentially just two attributes: price and quantity. This maximizes the size of the market, enhancing competition and the ability of transactions to increase the well-being of participants in the market. Trading migrates allowances from sources with low abatement costs to sources with high abatement costs, reducing the total cost of abatement.<sup>106</sup> In the absence of constraints on trading, this migration of allowances will occur without regard to the geographic location of the sources or how much harm the emissions are causing.<sup>107</sup> Thus, the cost minimization benefits of market forces are harnessed most effectively when the policy market is broad and unconstrained.<sup>108</sup>

The more requirements regulators impose to ensure equivalence, the more complex the policy market becomes, and the less effectively the policy market accomplishes its purpose of reducing costs. Creating regulatory requirements that differentiate among products for purposes of trading generally has the effect of segmenting the policy market into smaller sub-markets.<sup>109</sup> This hinders trading and reduces

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105. *But see* Boyd & Salzman, *supra* note 50, at 90–94 (noting a market for “premium” greenhouse gas credits that exceeds regulatory requirements, a phenomenon that the authors attribute to the fact that governments, not private firms, are purchasing the credits).

106. *See supra* Part III.A (describing the effect of trading on emissions).

107. *See* Gabriel Chan et al., *The SO<sub>2</sub> Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation* 20–21 (Harvard Kennedy Sch., RWP12-003, 2012) (noting that cap and trade “directs abatement to where it is least costly, not necessarily to facilities causing the most geographic-specific damage”).

108. *See id.* at 21 (noting “something of a tension between geographically broad-based, cap-and-trade approaches and state and local authorities’ desires to limit emissions within a particular area or from a particular set of sources”).

109. Some policy markets have been able to allow and facilitate transactions among differentiated products in the market. An example is the market for emissions offsets in some Clean Air Act programs, in which emissions from a new source must be offset by a greater reduction in emissions from an existing source. *See, e.g.*, 42 U.S.C. § 7511a(e)(1) (2012) (“For purposes of satisfying the offset requirements pursuant to this part, the ratio of total emission reductions of VOCs to total increased emissions of such air pollutant shall be at least 1.5 to 1 . . .”). This essentially differentiates between new emissions and existing emissions, deeming

the number of sellers and buyers in each market, impeding competition and impairing the ability of the markets to reduce compliance costs through trading.<sup>110</sup> Segmenting the market also creates conditions susceptible to market power.<sup>111</sup> Regulatory requirements also increase the complexity and cost (both administrative and compliance) of the policy market.<sup>112</sup>

Regulators therefore face a dilemma between acknowledging and ignoring differentiation. Acknowledging differentiation more accurately matches reality, but ignoring differentiation creates a policy market that more effectively reduces cost. Among the most salient differentiations among products in policy markets are type, location, and time.<sup>113</sup> We will examine each factor, considering them in the context of the emissions market example in Part IV.A.

#### *a. Type*

Policy markets assume that the products traded in the market are identical in type.<sup>114</sup> If, for example, an emissions trading market for nitrogen oxide emissions allows one source to sell an emissions allowance to another source, the market is assuming that the nitrogen oxide the seller would have emitted is equivalent to the nitrogen oxide that the buyer will emit. That may be true with respect to some products, but not necessarily for all products, as the case of air pollutants illustrates.

Some air pollutants are actually categories of substances, and not

1.5 tons of new emissions equivalent to 1 ton of existing emissions. Both policymakers and academics have considered the possibility of interpollutant markets, which can broaden markets but also pose difficult challenges in market design. *See* 42 U.S.C. § 7651b(c) (2012) (directing EPA to study interpollutant trading between sulfur dioxide emissions allowances and nitrogen oxides emissions allowances); Juan-Pablo Montero, *Multipollutant Markets*, 32 RAND J. ECON. 762, 764 (2001); Carson Reeling, Cloé Garnache & Richard D. Horan, *Efficiency Gains from Integrated Multipollutant Trading*, 52 RESOURCE & ENERGY ECON. 124, 125 (2018).

110. *See* MANKIW, *supra* note 2, at 348, 352 (describing how a smaller market can “hinder a group of firms from maintaining the cooperative outcome”).

111. *See, e.g.,* Rory Van Loo, *Making Innovation More Competitive: The Case of Fintech*, 65 UCLA L. REV. 232, 279 (2018) (noting that state-specific renewable energy standards “splinter[] undifferentiated nationwide markets, and create[] new opportunities for energy companies to exercise market power in smaller market segments”).

112. *See* ANDERSON & LIBECAP, *supra* note 7, at 23 (“[G]overnment regulation has many of the same costs inherent to markets . . . . Regulatory costs cannot be ignored any more than bargaining costs in markets can be.”).

113. *See* James Salzman & J.B. Ruhl, *Currencies & the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 625 (2000) (“Nonfungibilities can arise across three dimensions—space, type, and time . . . .”).

114. *See id.* at 629 (“Apples are traded for apples, not oranges.”).

all substances within the category are identical. For example, the Clean Air Act regulates two categories of particulate matter: PM<sub>10</sub>, which includes particles with diameters of 10 micrometers and smaller, and PM<sub>2.5</sub>, which includes particles with diameters of 2.5 micrometers and smaller.<sup>115</sup> As EPA acknowledges, each category encompasses a variety of substances.<sup>116</sup> A trade of one ton of PM<sub>10</sub> emissions from one source to another therefore may change the substances that are emitted, with potential consequences for public health and the environment.<sup>117</sup>

Greenhouse gases provide another important example of a category of pollutants regulated as a single pollutant.<sup>118</sup> EPA and other regulators use the concept of global warming potential to draw equivalence between different individual pollutants that contribute to climate change.<sup>119</sup> This allows regulators to regulate a broad array of greenhouse gases in terms of a single unit, CO<sub>2</sub>-equivalent.<sup>120</sup> Global warming potential factors take into account the persistence of the substance in the atmosphere (“lifetime”), the potential conversion of the substance into another greenhouse gas pollutant, and the amount of energy the substance absorbs and re-emits while in the atmosphere and (“radiative efficiency”).<sup>121</sup>

Similarly, if a state’s renewable portfolio standard gives the same renewable energy credit for electricity generated from different sources,<sup>122</sup> it assumes that both are equivalent. In fact, however, the

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115. See *Particulate Matter (PM) Basics*, EPA (Nov. 14, 2018), <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>.

116. See *id.* (“These particles come in many sizes and shapes and can be made up of hundreds of different chemicals.”).

117. See also Salzman & Ruhl, *supra* note 113, at 629–30 (making a similar point regarding volatile organic compounds).

118. See, e.g., 40 C.F.R. § 1036.108 (2019) (noting that greenhouse gas emission standards for new motor vehicles regulate “the aggregate group of six greenhouse gases: carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride”).

119. See *Understanding Global Warming Potentials*, EPA (Feb. 14, 2017), <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>.

120. See, e.g., Greenhouse Gas Reporting Program: Addition of Global Warming Potentials, 79 Fed. Reg. 44,332, 44,335 (proposed July 31, 2014) (to be codified at 40 C.F.R. pt. 98) (“GWPs are used to convert tons of chemical into tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) for purposes of various calculations and reporting under the rule.”).

121. *Id.*

122. See, e.g., WASH. REV. CODE § 19.285.030(21) (defining renewable resources fungible under Washington’s Energy Independence Act as water; wind; solar; geothermal; landfill gas; wave, ocean, or tidal power; gas from sewage treatment facilities; certain biodiesel fuels; and biomass energy); *Maryland Renewable Energy Portfolio Standard Program – Frequently Asked Questions*, MD. PUB. SERV. COMM’N, <https://www.psc.state.md.us/electricity/maryland-renewable-energy-portfolio-standard-program-frequently-asked-questions> (last visited Dec. 15, 2019) (noting that Maryland treats as fungible electricity generated from “Solar, Wind, Qualifying



environmental effects of such electricity may vary considerably between generation sources.<sup>123</sup>

*b. Location*

If a regulated source sells an emissions allowance to another regulated source, the resulting overall amount of emissions does not change. Unless the two sources are co-locational, however, the trade changes the location of those emissions.<sup>124</sup> If emissions do not readily mix within the geographic area covered by the market, then changes in location of emissions may matter to air quality.<sup>125</sup> A trade may move emissions to an area with different population density, so that more (or fewer, depending on the difference) people are exposed to the pollutant. Trading also can lead to a concentration of emissions in particular areas within the overall market. This is known as the “hot spot” problem.<sup>126</sup> Whether this concentration has public health or environmental consequences depends on the circumstances—how close the two locations are, how readily emissions mix in the ambient air between those locations, and what populations are exposed to air pollution at the two locations.<sup>127</sup>

One way to address a “hot spot” problem is to segment the market geographically, to reduce the extent to which trades can change the location of emissions.<sup>128</sup> The problem with this solution is that it

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Biomass, Methane from a landfill or wastewater treatment plant, Geothermal, Ocean, Fuel Cell that produces electricity from a Tier 1 source, Hydroelectric power plants of less than 30 MW capacity, Poultry litter-to-energy, Waste-to-energy, and Refuse-derived fuel”).

123. See, e.g., A.K. Akella, R.P. Saini & M.P. Sharma, *Social, Economical and Environmental Impacts of Renewable Energy Systems*, 34 RENEWABLE ENERGY 390, 392 tbl.2 (2009) (reporting significantly differing life cycle pollutant emissions for, among other energy sources, solar, wind, and geothermal).

124. See THOMAS H. TIETENBERG, *EMISSIONS TRADING: PRINCIPLES AND PRACTICE* 75–106 (2d ed. 2006) for an in-depth analysis on the “spatial dimension” of emission credit trading.

125. See *id.* at 75–77 (describing the challenge that trading between different locations can present to maintaining optimal levels of emissions at all monitoring sites).

126. See *Nat. Res. Def. Council, Inc. v. U.S. Dep’t of Transp.*, 770 F.3d 1260, 1264–65 (9th Cir. 2014) (describing how EPA addresses hotspot problems); TIETENBERG, *supra* note 124, at 86 (“Hot spots arise when emissions are geographically concentrated, causing unacceptable ambient concentrations in that location.”). See generally Ann E. Carlson, *The Clean Air Act’s Blind Spot: Microclimates and Hotspot Pollution*, 65 UCLA L. REV. 1036 (2018) (describing hotspot problems under the Clean Air Act).

127. See TIETENBERG, *supra* note 124, at 86–88 (outlining the issues that emerge from the uncontrolled transferring of permits from one location to another and the factors that contribute to those issues).

128. See *id.* at 89 (noting the option of creating “a zoned emissions permit system,” in which “the control region is divided up into a specific number of zones,” and “trading among zones is prohibited”).

decreases the effectiveness of the policy market by constraining potential trades.<sup>129</sup> Thus, locational restrictions present a tradeoff: taking into account location better reflects the reality of air pollution but undermines the advantages of creating the policy market.<sup>130</sup> It also might create a market power problem because the smaller the market, the easier it generally is to exercise market power due to decreased competition from other sellers.

*c. Time*

Emissions allowances are generally measured over a period of time, often one year.<sup>131</sup> As a result, any trades neglect differences in time within the relevant period. An avoided emission during November is treated as equivalent to an additional emission during July. Yet emissions during November are not necessarily equivalent to July emissions. Weather factors such as temperature, sunlight, precipitation, and wind can affect the impact of emissions.<sup>132</sup> Thus, trading can cause temporal hot spots that concentrate emissions during certain periods.<sup>133</sup>

The problem of temporal non-equivalence is exacerbated by programs that allow banking—saving emissions allowances from one period and using them in another.<sup>134</sup> The rationale for banking is the same as the overall rationale for trading. Banking is designed to reduce costs by allowing trades across time.<sup>135</sup> Essentially, banking is an

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129. *See id.* at 90 (“The inability of sources to trade permits across zonal boundaries restricts trading opportunities and reduces the potential for cost savings.”).

130. *See id.* (“To provide maximum protection against hot spots, the zones should be relatively small. On the other hand, by restricting trading opportunities, small zones raise costs.”).

131. *See id.* at 108 (“In cap-and-trade systems, the allocated permits usually are dated with the year of allocation. In systems without temporal flexibility, the permit can only be used during that year.”).

132. *See id.* at 109 (explaining that “[s]ome emissions rates show a striking seasonal or daily pattern” and that “[v]ariation in meteorological conditions is a second source of concentration variation”).

133. Even without trading, regulatory systems can give rise to temporal hot spots by limiting emissions per some period of time, allowing sources to allocate their emissions within a given period. This is especially true if there are reasons common to regulated sources why they would want to allocate their emissions temporally according to a certain pattern. *See id.* at 111–14 (examining possible “banking and borrowing” solutions for when “emissions timing also matters”).

134. *See* ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 5–6 (describing banking as “reducing emissions more than required in a given year and ‘banking’ the surplus for future internal use or sale”).

135. *See, e.g.*, Judith Chevallier, Joanne Etner & Pierre-Andres Jouvét, *Bankable Emission Permits under Uncertainty and Optimal Risk-Management Rules*, 65 RES. ECON. 332, 333 (2011) (examining how firms who engage in banking respond to increased risk over time).

intrafirm temporal trade. For example, a firm may believe that in the future it will undergo changes to make it hard for it to reduce emissions. In such circumstances, it may reduce its emissions today in order to meet its challenges in the future. In this way, the firm will reduce its total cost of pollution abatement while keeping the amount it pollutes constant. Yet, because banking limits the product differentiation across time, it may pose the threat of creating a temporal hot spot. The extent to which banking schemes are proper or improper is thus not clear.

Ultimately, two products in a policy market are seldom equivalent in all relevant respects. Regulators are faced with a tradeoff between emphasizing equivalence and emphasizing trading. To emphasize equivalence, they can segment the market locationally, temporally, or by product—or even require preapproval of trades to monitor for equivalence.<sup>136</sup> But imposing such requirements reduces and constrains the market, creating an obstacle to trading and hindering the market from providing the benefits for which it has been created.

### 3. Policy Judgments

Policy market design requires regulators to make numerous policy judgments. These judgments include the goals of the program, the scope of the program, and distributional issues. Policy judgments add complexity to policy markets. As with product differentiation, these judgments pose a dilemma for regulators, because taking account of these concerns can reduce the internal efficiency of the policy market by adding complexity.

#### *a. Interplay Among Goals*

Policy markets generally have a clear primary policy goal. An emissions trading market, for example, aims to reduce the costs of improving air quality by reducing air pollutant emissions.<sup>137</sup> The task of creating a policy market that effectively advances its policy goal is itself a complex task, and Part III.B.2 examined several product differentiation factors that complicate a policy market's attempts to accomplish its primary goal.

In addition to their primary policy goals, however, policy markets also often aim to advance other secondary goals. The pursuit of these other goals also complicates policy market design. Secondary goals

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136. Cf. Salzman & Ruhl, *supra* note 113, at 670–73 (comparing categorical “wholesale review” of transactions with individualized “retail review”).

137. See MANKIW, *supra* note 2, at 205–06 (describing the economic background behind tradable pollution permits).

vary. Regulators may wish to reduce the administrative burden of the policy market on themselves.<sup>138</sup> Regulators may want to prevent firms in the policy market from exercising market power.<sup>139</sup> Regulators also may want to mitigate unemployment and other economic dislocation that may result from the policy market.<sup>140</sup> Balancing the primary goals of the policy market with these secondary goals adds complexity to the policy market, especially insofar as secondary goals lead regulators to add design features to the policy market.

Another factor complicates the goals of a policy market. The classic paradigm of the policy market assumes that the market is merely a means of minimizing the costs of reaching an already determined regulatory objective—in other words, that the goal of the market itself, as opposed to the program of which the market is a component, is merely to reduce compliance costs.<sup>141</sup> In the emissions trading example, the emissions trading market allows sources to reduce the costs of complying with the overall cap on emissions. The existence of emissions trading (the means), therefore, does not affect the emissions

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138. See, e.g., Sam Napolitano et al., *The U.S. Acid Rain Program: Key Insights from the Design, Operation, and Assessment of a Cap-and-Trade Program*, ELECTRICITY J., Aug./Sept. 2007, at 47, 51 (noting the advantage of policy design elements that reduced administrative costs for the regulatory agency); Richard Schmalensee & Robert N. Stavins, *Lessons Learned from Three Decades of Experience with Cap and Trade*, 11 REV. ENVTL. ECON. & POL'Y 59, 63 (2017) (same).

139. See, e.g., Makoto Tanaka & Yihsu Chen, *Market Power in Emissions Trading: Strategically Manipulating Permit Price Through Fringe Firms*, 96 APPLIED ENERGY 203, 210 (2012) (suggesting that initially allocating more emission permits to smaller “fringe” producers could mitigate the abuse of market power in emission permit trading); Yihsu Chen, Makoto Tanaka & Afzal S. Siddiqui, *Market Power with Tradable Performance-Based CO<sub>2</sub> Emission Standards in the Electricity Sector*, 39 ENERGY J. 121, 121 (2018) (examining the difference between a state using a “performance-based” standard versus using a “mass-based” standard in its emission permit program); Corina Haita, *Endogenous Market Power in an Emissions Trading Scheme with Auctioning*, 37 RESOURCE & ENERGY ECON. 253, 253 (2014) (creating a model that assesses the effect of market power in an emissions market on both an initial auction stage and on the secondary market); Bodo Sturm, *Market Power in Emissions Trading Markets Ruled by a Multiple Unit Double Auction: Further Experimental Evidence*, 40 ENVTL. & RESOURCE ECON. 467, 470 (2008) (studying whether a Double Auction is able to suppress market power).

140. See generally, e.g., MUSTAFA BABIKER & RICHARD S. ECKAUS, MIT JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE, UNEMPLOYMENT EFFECTS OF CLIMATE POLICY (2006) (analyzing and discussing the effects of emissions reductions on employment); Taran Fæhn, Antonio G. Gómez-Plana & Snorre Kverndokk, *How Can Carbon Policies Impact Unemployment?*, 4 CARBON MGMT. 27 (2014) (studying the effect of emissions permits on unemployment in Spain); Thomas Wagner, *Environmental Policy and the Equilibrium Rate of Unemployment*, 49 J. ENVTL. ECON. & MGMT. 132 (2005) (investigating “whether a low equilibrium rate of unemployment and a high quality of the environment are complementary policy goals or must be traded off”).

141. See Goffman, *supra* note 60, and accompanying text (explaining that markets are only a tool for encouraging emissions reduction).

cap (the ends). In reality, however, the two are not necessarily that separate. Policy programs are created via political processes. One of the key factors in political processes, either explicitly or implicitly, is the cost that a new regulation will impose on the economy. A policy market design that reduces compliance costs therefore may induce a political bargain with a more stringent emissions cap, as the regulated industry is less opposed to a target that is less expensive to achieve.<sup>142</sup> This feedback loop complicates policy market design by turning what might be a unidirectional relationship between the policy market and its objective into a bidirectional relationship. In this bidirectional relationship, the design of the policy market may alter the policy objective that the market is designed to achieve.

Regulators also must deal with the interplay of their own goals with the goals of other markets and other programs. Policy markets do not operate in isolation from other markets and regulatory programs. Indeed, policy markets are designed to correct market failures in other markets—for example, the emissions trading market aims to correct the problem of externalities in electricity and other product markets. The relationships between policy markets and other markets substantially complicates the design of policy markets. For example, an emissions trading market operates on the assumption that the participating firms are seeking to maximize their profits, for it is the profit-maximizing incentive that leads firms to trade in the policy market to reduce their compliance costs.<sup>143</sup>

However, in the energy sector—a common target of emissions trading programs—many firms are subject to “rate of return” regulation, by which the firms receive revenues as determined by a public utility commission rather than as determined by a competitive market.<sup>144</sup> Public utility commissions generally approve revenue requirements based on the costs incurred by the firms providing electric utility service to the public. Firms operating within such a

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142. By at least some accounts, this appears to have been true with respect to negotiations regarding the Clean Air Act’s Acid Rain Program. See Chan et al., *supra* note 107, at 14 (“By reducing the costs of regulation relative to conventional prescriptive approaches, cap and trade made it politically feasible to reduce emissions more than might otherwise have been the case.”); Goffman, *supra* note 60, at 180 (“It was the promise of cost savings through emissions trading that persuaded the Bush administration to propose in its Clean Air legislation that the SO<sub>2</sub> program stipulate an annual reduction of 10 million tons.”).

143. See MANKIW, *supra* note 2, at 205–06 (“Those firms that can reduce pollution at a low cost will sell whatever permits they get, and firms that can reduce pollution only at a high cost will buy whatever permits they need.”).

144. See Alexander J. Black, *Responsible Regulation: Incentive Rates for Natural Gas Pipelines*, 28 TULSA L.J. 349, 373–75 (1993) (explaining rate-of-return regulation).

regulatory system may have little incentive to minimize their costs.<sup>145</sup> This may limit their incentive to trade emissions allowances to reduce their costs.<sup>146</sup> Worse, the firms may avoid trading emissions allowances because they are uncertain how the public utility commission will treat the cost or revenue generated from trading.

The existence of multiple interacting goals and markets complicates both the process and substance of policy market design. Regulators must take into account additional interrelationships and goals in creating a policy market, which complicates the process of market design. Regulators also must decide whether to add elements to the policy market targeted at accomplishing the additional goals, which may complicate the policy market at the risk of degrading its effectiveness in reducing costs.

*b. Scope*

Regulators must decide who will participate in the policy market.<sup>147</sup> To be comprehensive, a policy market should include the entire category of firms that participate in the market failure. In an emissions trading market, for example, this would mean including every source of emissions of the air pollutant in question. Covering every source, however, no matter its quantity of emissions, may needlessly drive up the regulator's costs of administering the policy market and the regulated industry's costs of compliance with little resulting benefit. A regulator may reasonably decide to exempt sources with small amounts of emissions so as to reduce the overall costs of the program.<sup>148</sup> Exempting small sources, however, requires relinquishing some control over the total amount of emissions, which may reduce the program's effectiveness in accomplishing its environmental goal and

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145. See Andrei Schliefer, *A Theory of Yardstick Competition*, 16 RAND J. ECON. 319, 319 (1985) (noting that under cost-of-service regulation, "the firm has no profit incentive to minimize costs" because "the regulator adjusts the firm's prices to equal the costs it incurs in providing service to consumers").

146. Cf. Robert N. Stavins, *Vintage-Differentiated Environmental Regulation*, 25 STAN. ENVTL. L.J. 29, 58 (2006) (noting that "selective deregulation of electricity markets has presumably rendered affected generators more sensitive to environmental compliance costs than they were in a world of rate-of-return regulation").

147. See ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 6 (noting the importance of determining which emission sources are required or allowed to participate in the market).

148. Several Clean Air Act programs, for example, regulate only major sources of emissions. See, e.g., 42 U.S.C. § 7475(a) (2012) (requiring preconstruction permits for any new "major emitting facility"); *id.* § 7502(c)(5) (requiring permits "for the construction and operation of new or modified major stationary sources"); *id.* § 7661a(a) (requiring an operating permit for any, *inter alia*, "major source").

give small, exempt sources a competitive advantage over larger, non-exempt sources.

*c. Distributional Issues*

Regulators have a variety of options for allocating requirements across sources, the most commonly cited being to distribute allowances for free or to auction them off.<sup>149</sup> Allocations are politically contentious for regulators because they are granting valuable rights and costly obligations.<sup>150</sup> Once the initial cap is set, allocation becomes a zero-sum game. Auctions are unpopular with the regulated industry because they increase costs.<sup>151</sup> When regulators have allocated allowances based on historical data, they have used a variety of different bases on which to make allocations, including production inputs, production outputs, and emissions.<sup>152</sup> The decision regarding how to allocate allowances adds further complexity to the policy market design process. Once a regulator has decided how to allocate allowances, the implementation of that decision itself also adds complexity to the policy market.

*d. Responsiveness to New Information*

The success of a policy market depends in significant part on the ability of the regulated industry to make investment decisions based on future conditions. Stable policy markets with predictable future conditions create simplicity that increases the efficiency of the policy market.<sup>153</sup> But the stability of simplicity has its downside as well. Regulators initially create policy markets based on assumptions that experience or additional information may show to be inaccurate. For

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149. See, e.g., TIETENBERG, *supra* note 26, at 128 (identifying grandfathering and auctions as the two initial allocation methods “of most importance”).

150. See, e.g., Bruce R. Huber, *How Did RGGI Do It? Political Economy and Emissions Auctions*, 40 *ECOLOGY L.Q.* 59, 84–85 (2013) (examining the history of the Regional Greenhouse Gas Initiative (“RGGI”) and how the Working Group in charge of designing the RGGI worked through the “question of whether allowances would be sold, given away, or, most likely, some combination of the two”).

151. See *id.* at 80–81 (noting that industry “can be expected in general to oppose auctioning, for it adds regulatory and competitive uncertainty to their business environment, increases their costs of doing business and on the margin reduces demand for the [products] they provide”).

152. ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 39 (“The metric used in the grandfathering formulas has also varied considerably, from inputs, to output, to emissions.”).

153. See Chan et al., *supra* note 107, at 9 (“A regulatory instrument that offers a predictable compliance regime and greater cost certainty will usually enable companies to take advantage of longer-term investments that may reduce costs over time.”); Richard Schmalensee & Robert N. Stavins, *The SO<sub>2</sub> Allowance Trading System: The Ironic History of a Grand Policy Experiment*, 29 *J. ECON. PERSP.* 103, 117 (2013) (noting that “policy stability encourages efficient investment”).

example, an unforeseen technological innovation may reduce the costs of reducing emissions or the health benefits of reducing exposure to a pollutant may be greater than originally estimated.<sup>154</sup> To take advantage of developing knowledge and technology, the policy market must be designed to be flexible and adaptable to changing conditions.<sup>155</sup> The complexity dilemma manifests itself here as a choice between simple fixed conditions, which add predictability and facilitate investment, and more complex flexible conditions that allow the policy market to adapt to new information and conditions.<sup>156</sup>

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Regulators designing policy markets face policy judgments that complicate both the process of creating a policy market and the substantive design of the market. Regulators must consider the interplay among different policy goals, regulatory programs, and markets; the scope of the policy market; distributional issues; and how to respond to new information. Policy market design requires regulators to make numerous policy judgments. Like other policy design issues, these elements pose the complexity dilemma to regulators: either complicate the market to reflect these concerns and generate more benefits or ignore or oversimplify these concerns to keep the market simple and reduce program and compliance costs.<sup>157</sup>

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154. See Winston Harrington, Richard D. Morgenstern & Peter Nelson, *On the Accuracy of Regulatory Cost Estimates*, 19 J. POL'Y ANALYSIS & MGMT. 297, 313 (2000) (stating that "estimation errors come not only from an understandable failure to anticipate technological change, but from equally understandable errors in characterizing the universe of firms or agents likely to be affected by the regulation, as well as the cost and effectiveness of the compliance technologies employed").

155. See Schmalensee & Stavins, *supra* note 153, at 117 (noting that "it can be important for policies to be flexible and responsive to changes in knowledge and technology").

156. See Chan et al., *supra* note 107, at 10 ("Tension exists between providing regulatory certainty over long periods of time (which is desirable from the standpoint of reducing costs) and allowing for flexibility to adjust program goals (which may be desirable from the standpoint of maximizing net program benefits over time).").

157. Commentators often compare policy markets to Pigouvian taxes and subsidies. *E.g.*, Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENVTL. L. REV. 293, 348–53 (2008); Reuven S. Avi-Yonah & David M. Uhlmann, *Combating Global Climate Change: Why A Carbon Tax Is A Better Response to Global Warming Than Cap and Trade*, 28 STAN. ENVTL. L.J. 3, 37–50 (2009). Such a comparison is beyond the scope of this Article. That said, we note that Pigouvian taxes and subsidies do not avoid the complexity dilemma. When factors such as location and type matter, a Pigouvian tax faces the same complexity dilemma as policy markets—either differentiate to match reality and generate more program benefits, or keep the policy simple to reduce compliance costs. *See, e.g.*, NICK HANLEY, JASON SHOGREN & BEN WHITE, ENVIRONMENTAL ECONOMICS IN THEORY AND PRACTICE 115–20 (1997) (explaining that to maximize the benefits of an air pollutant emissions tax for a "non-uniformly mixed pollutant"—that is, a pollutant for which location of emission



#### IV. POLICY MARKET CASE STUDIES

Part IV examines two case studies of policy markets that illustrate the complexity dilemma. Part IV.A looks at one of the better-known examples of a policy market—emissions trading markets established under the Clean Air Act. The Clean Air Act emissions trading programs and, in particular, the Acid Rain Program and Interstate Air Pollution Program, are examples of negative-externality policy markets; they use trading to reduce the burdens of complying with air pollutant emissions limits. Part IV.B takes on the more daunting example of electricity capacity markets, which may be the most complex policy markets in existence. Capacity markets are examples of positive-externality policy markets; they use trading to reduce the burdens of complying with requirements that electricity distribution companies purchase electricity capacity so as to support the overall reliability of the electricity grid.<sup>158</sup> Both the Clean Air Act markets and electricity capacity markets have become increasingly complex over time as they have faced greater pressure to reflect the complicated context in which they operate.

##### A. Clean Air Act Emissions Trading Markets

###### 1. Acid Rain Program

In the 1980s, scientific and public concern arose regarding the problem of acid rain.<sup>159</sup> The popular term *acid rain* refers to the scientific problem of acidic deposition, in which pollution, caused primarily by sulfur dioxide and nitrogen oxide emissions from burning fossil fuels, falls to the ground as gases, aerosols, and particles or through precipitation as rain, fog, or snow.<sup>160</sup> This acidic deposition

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matters—would require “a perfectly differentiated tax system” in which every source faced “a unique tax rate” reflecting its location).

158. See *supra* Part III.B.1.b. for a discussion on positive-externality policy markets.

159. E.g., Philip H. Abelson, *Acid Rain*, 221 SCIENCE 115, 115 (1983); *Acid Rain Assailed in New Hampshire*, N.Y. TIMES, Mar. 10, 1983, at A20; Ronald Kotulak, ‘Acid Rain’ Means a Dead Lake, ‘Acid Rain’ Means Pollution, THE DAY (New London, Conn.), Apr. 4, 1982, at D4; *Tapped Out: Vermont’s Poor Maple Sap Harvest Linked to Acid Rain* (NBC News television broadcast Apr. 18, 1987); Philip Shabecoff, *Scientists Give E.P.A. Chief Varying Views on Acid Rain Problem*, N.Y. TIMES, July 21, 1983, at A10.

160. See Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. 63,002, 63,004 (proposed Dec. 3, 1991) (to be codified at 40 C.F.R. pts. 72, 73, 75 & 77) (“Acid rain is the accepted term which encompasses a complex set of phenomena that begins with fossil fuel emissions, includes the transport and transformation of those emissions through the atmosphere, and ends with the effects of those emissions and their resulting transformation products on the environment.”); Acid Rain Provisions, 56 Fed. Reg.

disrupts ecological systems—for example, by killing fish, wildlife, plants, and trees—and damages human-made materials, such as buildings and statues.<sup>161</sup>

When Congress amended the Clean Air Act in 1990, it created a regulatory program to address acid rain by reducing emissions of sulfur dioxide and nitrogen oxide from power plants operated by electric utilities.<sup>162</sup> The Clean Air Act's Acid Rain Program actually entails two programs: a cap-and-trade system for sulfur dioxide emissions<sup>163</sup> and a more traditional set of emissions limitations (without trading) for nitrogen oxide emissions.<sup>164</sup> We focus here, as do most descriptions and analyses of the Acid Rain Program, on the market-based sulfur dioxide program.

The Acid Rain Program covers virtually every coal-fired power plant in the continental United States.<sup>165</sup> The Program set a fixed cap on the total amount of sulfur dioxide emissions from such plants.<sup>166</sup> The amount of the cap was set by political negotiation amongst members of

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10,427, 10,428 (Mar. 12, 1991) (“Acid rain occurs when sulfur dioxide and nitrogen oxide emission are transformed in the atmosphere and return to earth in rain, fog or snow.”).

161. See Acid Rain Provisions, 56 Fed. Reg. at 10,428 (“Acid rain damages lakes, harms forests and buildings, contributes to reduced visibility, and is suspected of damaging health.”).

162. 42 U.S.C. §§ 7651–7651o (2012); see also Chan et al., *supra* note 107, at 3–4 (describing the origins of the Acid Rain Program); Richard Conniff, *The Political History of Cap and Trade*, SMITHSONIAN MAG. (Aug. 2009), <https://www.smithsonianmag.com/science-nature/the-political-history-of-cap-and-trade-34711212> (same). Power plants were responsible for a majority (but not nearly all) of sulfur and nitrogen oxide emissions. See Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. at 63,004 (“Of the approximately 23 million tons of SO<sub>2</sub> and 19 million tons of NO<sub>x</sub> emitted annually from all sources in the United States in 1985, about 16 million tons of SO<sub>2</sub> and 7 million tons of NO<sub>x</sub> were emitted by electric utilities.”).

163. 42 U.S.C. §§ 7651b–7651e.

164. *Id.* § 7651f.

165. The Program proceeded in two phases. Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. at 63,004. The first phase, from 1995 to 1999, included 110 of the largest coal-fired power plants located in 21 eastern and midwestern states. 42 U.S.C. § 7651c(e). The second phase, which began in 2000, expanded the Program to most coal-, oil-, and gas-fired power plants in the lower 48 states. *Id.* § 7651d. EPA's regulations under the Program exempt power plants with only de minimis sulfur dioxide emissions because they operate only a few hours per year, during periods of peak electricity demand. See Acid Rain Program: General Provisions and Permits, Allowance System, Continuous Emissions Monitoring, Excess Emissions and Administrative Appeals, 58 Fed. Reg. 3590, 3594 (January 11, 1993) (Final Rule) (to be codified at 40 C.F.R. pts. 72, 73, 75, 77, & 78) (noting that most new units under 25 MWe will likely be peaking plants).

166. See 42 U.S.C. § 7651(b) (noting that the Program would force “reductions in annual emissions of sulfur dioxide of ten million tons from 1980 emission levels”); Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. at 63,004 (“As a result, total annual SO<sub>2</sub> emissions will be reduced by 10 million tons below 1980 levels.”).

Congress, the White House, EPA, and industry and environmental groups, rather than as the direct result of a health-based or cost-benefit analysis.<sup>167</sup> Indeed, by some accounts the Program's cap was chosen because the amount of the emissions reduction was a double-digit number (ten million tons) and the reduction was about 50% of existing emissions, both of which sounded significant.<sup>168</sup>

The Acid Rain Program allocated emissions allowances to power plants based on their historic emissions and allowed plants to trade allowances amongst themselves and to bank allowances to use in future years.<sup>169</sup> Each plant can only emit as much sulfur dioxide as it holds allowances.<sup>170</sup> The total amount of allowances across all plants equals the Program's total cap on sulfur dioxide emissions. To facilitate compliance, compliance monitoring, and enforcement, the Program requires plants to install and operate a continuous emissions

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167. See Chan et al., *supra* note 107, at 13, 15 (noting that “the SO<sub>2</sub> emissions cap was not determined by formal benefit-cost analysis” but instead “in a somewhat *ad hoc* manner”); Schmalensee & Stavins, *supra* note 153, at 105 (noting that the cap was chosen at “a level of abatement that was possible at relatively low costs” but “big enough to gain the support of the environmental community and to be seen as satisfying a campaign pledge of newly elected President George H.W. Bush”); Conniff, *supra* note 162 (describing political negotiations that led President George H.W. Bush to decide on a cap that represented an emissions reduction of 10 million tons).

168. See Chan et al., *supra* note 107, at 14 (“This ten-million-ton option presented marketing opportunities: It was a double-digit number, and it represented a 50 percent reduction in emissions, both of which signified that [President George H.W.] Bush was serious about pollution reductions.”); Conniff, *supra* note 162 (noting the appeal of a reduction “in double digits” and that “[t]en million tons just sounded better” than less aggressive proposals); see also Chan et al., *supra* note 107, at 27 (noting that President Bush, during his campaign, had “explicitly promis[ed] . . . to cut acid rain by half”); Goffman, *supra* note 60, at 181 (“The 10 million ton target was much closer to the reduction level first suggested by the National Academy of Sciences as that required to curb acid deposition.”).

169. 42 U.S.C. §§ 7651b(a)–(b), 7651c(e); see also Acid Rain Program: General Provisions and Permits, Allowance System, Continuous Emissions Monitoring, Excess Emissions and Administrative Appeals, 58 Fed. Reg. at 3590 (“Existing utility sources are allocated allowances based on their historic fuel use and the emissions limitations specified in the Act. Utility units are required to limit SO<sub>2</sub> emissions to the number of allowances they hold, but since allowances are fully transferrable, utilities may meet their emissions control requirements in the most cost-effective manner possible.”). *But see* Paul L. Joskow & Richard Schmalensee, *The Political Economy of Market-Based Environmental Policy: The U.S. Acid Rain Program*, 41 J.L. & ECON. 37, 52, 56–58 (1998) (characterizing the claim that allowances were allocated based on historic emissions as “only approximately correct” and concluding that the allocation was influenced by interest-group politics); JUHA SIIKAMÄKI ET AL., RESOURCES FOR THE FUTURE, THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S ACID RAIN PROGRAM 2 (2012) (noting that EPA allocated additional allowances to facilities that installed certain pollution control equipment, in an attempt to protect high-sulfur coal from the eastern United States). Each allowance authorizes a plant “to emit, during or after a specified calendar year, one ton of sulfur dioxide.” 42 U.S.C. § 7651a(3).

170. 42 U.S.C. § 7651b(g).

monitoring system so that the plant owners and regulators can compare a plant's actual emissions to its regulatory limits.<sup>171</sup>

The idea of cap and trade was novel when the Acid Rain Program was enacted in 1990.<sup>172</sup> The Program created the first large-scale, long-term tradeable emissions markets.<sup>173</sup> By contrast, conventional environmental regulation, often labeled pejoratively as “command and control,” dictates either emissions limits or specific technological controls for each emissions source, with relatively few opportunities for flexibility.<sup>174</sup> Economists grimace at such regulations because their uniformity and rigidity precludes emissions sources from reallocating emissions in ways that can reduce compliance costs without increasing emissions.<sup>175</sup>

The Acid Rain Program's cap-and-trade system for sulfur dioxide emissions is widely regarded as highly successful by several different measures.<sup>176</sup> The system reduced sulfur dioxide emissions dramatically and more quickly than expected.<sup>177</sup> Compliance was nearly universal.<sup>178</sup>

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171. *Id.* § 7651k.

172. See Goffman, *supra* note 60, at 184 (describing the Acid Rain Program as “creating a new paradigm for pollution policy”); Schmalensee & Stavins, *supra* note 153, at 103 (describing the Acid Rain Program's cap-and-trade approach as “quite novel”); see also Conniff, *supra* note 162 (describing advocates for cap-and-trade as “a strange alliance of free-market Republicans and renegade environmentalists”).

173. See Chan et al., *supra* note 107, at 3 (“The SO<sub>2</sub> allowance-trading program . . . was the world's first large-scale pollutant cap-and-trade system.”); Schmalensee & Stavins, *supra* note 153, at 117 (describing the Acid Rain Program as “the world's first large-scale market-based environmental initiative”). EPA had implemented smaller-scale market-based regulatory systems in the 1970s and 1980s, including the nonattainment offsets program and a program phasing out leaded gasoline. See Chan et al., *supra* note 107, at 29 (noting that academic works advocating market-based regulation “eventually led EPA to experiment with small-scale emissions-credit-trading systems in the 1970s and 1980s, including most importantly the phase out of leaded gasoline in vehicle fuel in the mid-1980s”).

174. Chan et al., *supra* note 107, at 4; Joskow & Schmalensee, *supra* note 169, at 41.

175. See Chan et al., *supra* note 107, at 4 (“Such requirements are relatively inflexible, imposing the same abatement path upon a range of heterogeneous facilities and ignoring the fact that the costs of compliance might vary widely across individual facilities depending on the age, technology characteristics, operating conditions, and quality of fuel used.”); see also *supra* Part III.A (explaining the benefits of emissions trading).

176. *E.g.*, Chan et al., *supra* note 107, at 1; Schmalensee & Stavins, *supra* note 153, at 106; KATE C. SHOUSE, CONG. RESEARCH SERV., R45299, THE CLEAN AIR ACT'S GOOD NEIGHBOR PROVISION: OVERVIEW OF INTERSTATE AIR POLLUTION CONTROL 12 (2018); SIIKAMÄKI ET AL., *supra* note 169, at 1.

177. See Chan et al., *supra* note 107, at 15 (noting that the program “delivered emissions reductions more quickly than expected”); Schmalensee & Stavins, *supra* note 153, at 106 (same).

178. See Schmalensee & Stavins, *supra* note 153, at 106 (noting “compliance was nearly 100 percent”); SIIKAMÄKI ET AL., *supra* note 169, at 3 (noting that under the Program, “regulated power plants achieved a nearly perfect compliance record”).

Compliance costs were substantially less than alternative policy designs and also less than predicted.<sup>179</sup> The benefits of the system have far outweighed its costs.<sup>180</sup> High trading volume demonstrates the market's effectiveness in reallocating allowances to reduce compliance costs.<sup>181</sup> Power plants also used banking to reduce their costs.<sup>182</sup> Anticipating more stringent emissions caps in future years, power plants reduced their emissions more than required in early years of the Program to save allowances to use in future years, when emissions caps became more stringent.<sup>183</sup>

The Acid Rain Program emphasized simplicity in its market design.<sup>184</sup> The Program included a nationally standardized permitting program so that allowances would be fungible.<sup>185</sup> The Program also allowed EPA to auction some of the allowances and to publicly report the results of the auction, including prices, thereby providing vital price information to the market.<sup>186</sup> This increased transparency in the market, reducing transaction costs for allowance trading and facilitating the development of the market.<sup>187</sup> Although Congress left

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179. See Chan et al., *supra* note 107, at 5 (“In addition to being less costly than traditional command-and-control policies would have been, the program’s costs were significantly below estimates generated by government and industry analysts in the debate leading up to the passage of the CAAA.”); ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 16 (reporting cost savings of \$20 billion through emissions trading under the Acid Rain Program over a period of thirteen years); Schmalensee & Stavins, *supra* note 153, at 107 (noting that compliance costs “were significantly less than they would have been with a command-and-control regulatory approach”); SIIKAMÄKI ET AL., *supra* note 169, at 4 (“Generally, the actual cost of the [Acid Rain Program] has been lower than that estimated by studies.”).

180. See Lauraine G. Chestnut & David M. Mills, *A Fresh Look at the Benefits and Costs of the U.S. Acid Rain Program*, 77 J. ENVTL. MGMT. 252, 265 (2005) (reporting results of an analysis that showed “benefits exceed costs by two orders of magnitude”).

181. See SIIKAMÄKI ET AL., *supra* note 169, at 4 (noting “market efficiency . . . as indicated by high volumes of trade between economically unrelated entities”).

182. See *id.* (“Regulated power plants also heavily relied on banking allowances to reduce costs.”).

183. See *id.* at 4–5 (“In preparation for Phase II, regulated power plants essentially overachieved reductions in Phase I and banked the associated unused allowances for Phase II.”).

184. See Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. 63,002, 63,006 (proposed Dec. 3, 1991) (to be codified at 40 C.F.R. pts. 72, 73, 75 & 77) (“EPA’s goal is to structure simple, flexible and predictable Acid Rain permit program requirements that will promote [an active allowance trading market and compliance cost minimization].”).

185. See 42 U.S.C. § 7651g (2012) (establishing the permit program); Acid Rain Program: Permits, Allowance System, Continuous Emissions Monitoring, and Excess Emissions, 56 Fed. Reg. at 63,006 (noting that the regulations would “establish nationally standardized permitting”).

186. See 42 U.S.C. § 7651o (regarding “contingency guarantee, auctions, [and] reserve”).

187. See Chan et al., *supra* note 107, at 9 (noting that the auctions “allowed firms to forecast allowance prices more accurately”); ELLERMAN, JOSKOW & HARRISON, *supra* note 54, at 14

open the possibility of an interpollutant trading market in the future, it limited the market to a single pollutant: sulfur dioxide.<sup>188</sup> The Program limited its scope to a single industry—electric power plants.<sup>189</sup>

More important, the Acid Rain Program created a nationwide allowance trading market that ignored locational differences among emissions.<sup>190</sup> As explained previously,<sup>191</sup> trading most effectively reduces compliance costs when such trading is unconstrained and the policy market has many sellers and buyers. A nationwide market for sulfur dioxide emissions therefore maximized the opportunities for trades to reduce costs.

At the time the Program was created, ignoring location appeared to be consistent with the reality of the acid rain problem. The original purpose of the Acid Rain Program was to mitigate the ecological impacts of acid deposition.<sup>192</sup> It was thought that the total amount of acid deposition, rather than the specific location of the emissions, was the primary driver of ecological damage.<sup>193</sup> Thus, there was some justification for Congress to create an emissions trading program that did not impose locational constraints.

Over time, however, scientific understanding of the impacts of sulfur dioxide and nitrogen oxide emissions advanced. Epidemiological research determined that sulfur dioxide emissions, which are precursors to the formation of fine particulate matter in the ambient air, have significant public health impacts, in addition to contributing

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(noting that the auctions “provided a transparent mechanism to reveal prices, which was very important in the early years when few private transactions were being reported”).

188. See 42 U.S.C. § 7651b(c) (directing EPA to study interpollutant trading between sulfur dioxide emissions allowances and nitrogen oxides emissions allowances).

189. Electric power generators are responsible for about two-thirds of the sulfur dioxide in the atmosphere. *What Is Acid Rain?*, EPA, <https://www.epa.gov/acidrain/what-acid-rain> (last visited Nov. 3, 2019). Other significant emission sources that are not part of the Acid Rain Program include the vehicles and heavy equipment, manufacturing, oil refineries and other industries.

190. See Schmalensee & Stavins, *supra* note 153, at 108 (“Although it was clear at the time the program was enacted that emissions from different plants had different impacts, the Title IV emissions trading scheme ignored this fact.”).

191. See *supra* notes 106–108 and accompanying text (discussing the efficiency benefits of widely tradeable permits).

192. See 42 U.S.C. § 7651(b) (“The purpose of this subchapter is to reduce the adverse effects of acid deposition . . .”); Schmalensee & Stavins, *supra* note 153, at 109 (“The central purpose of the SO<sub>2</sub> allowance trading program was to reduce the acidification of forest and aquatic ecosystems by cutting precursor SO<sub>2</sub> emissions, primarily in the northeastern United States.”) (internal citation omitted).

193. See Goffman, *supra* note 60, at 188 (“Since it is the total accumulation of acid deposition that principally determines its effect on the environment, . . . Congress concluded that it was acceptable to allow emissions trading to occur *without restrictions*.”).

to the acid rain problem.<sup>194</sup> Moreover, the public health impacts of pollutant emissions depend significantly on the location of the emissions. Recognition of the adverse health impacts of sulfur dioxide emissions led to development of more stringent regulatory programs under other Clean Air Act provisions, essentially displacing the Acid Rain Program.<sup>195</sup> As explained in the next section, these new regulatory programs paid more attention to the location of emissions.<sup>196</sup> By imposing location-based constraints on emissions trading, the new rules increased protection of air quality and the public health, but with the inevitable downside of increasing compliance costs.<sup>197</sup>

The Acid Rain Program also emphasized policy stability and consistency over flexibility. For example, Congress legislated a fixed cap on emissions.<sup>198</sup> The fixed cap created predictability that made it easier for firms to anticipate allowance prices, which in turn helped them to decide whether to abate their emissions or to purchase or hold allowances. However, with policy stability came inflexibility, which hampered the Program's ability to improve in response to new information about costs and benefits of emissions control.<sup>199</sup> This rigidity in the Acid Rain Program ultimately prevented changes that would have made the program even more effective in reducing emissions.<sup>200</sup>

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194. See Schmalensee & Stavins, *supra* note 153, at 109 (“Epidemiological evidence of the harmful human health effects of these fine particulates mounted rapidly in the decade *after* the CAAA was enacted.”) (citation omitted).

195. See RON CHAN ET AL., *THE IMPACT OF TRADING ON THE COSTS AND BENEFITS OF THE ACID RAIN PROGRAM* 181 (2018) (“Once the health benefits of Title IV were recognized, the ARP was replaced by more stringent regulations.”) (citations omitted).

196. See SHIKAMÄKI ET AL., *supra* note 169, at 6–7 (noting that the Cross-State Rule “introduces a new compliance instrument that can be traded; however, it limits the amount of interstate trading or allowance banking that can occur”).

197. See Chan et al., *supra* note 107, at 23 (noting that interstate air pollution rules “will reduce cost-effectiveness in favor of what is intended to be a more equitable distribution of benefits across geographical regions”).

198. See *id.* at 9 (noting that the Program used a fixed emissions cap instead of allowing adjustments).

199. See *id.* at 10 (“[T]he 1990 Amendments may have leaned too heavily towards providing certainty at the cost of allowing for flexibility to adjust the policy as understanding of both science and markets improved.”); Schmalensee & Stavins, *supra* note 153, at 117 (“It can be argued that the SO<sub>2</sub> cap-and-trade system provided valuable stability, but the legislation also made it impossible to make what would have been responsive, effective, and efficient changes in the policy.”).

200. See Chan et al., *supra* note 107, at 9 (“Instead of legislating a fixed cap on emissions in years well beyond the planning horizon of decision makers at the beginning of the program, the 1990 Amendments could have given EPA authority to adjust the SO<sub>2</sub> cap in future years as the science evolved and as better information on real-world control costs became available.”);

Despite its success in reducing compliance costs, there is some indication that the Acid Rain Program could have been even more effective but for the unfortunate and unintentional effects of programs under the auspices of energy regulators. The cost-reducing incentives of policy markets derive from efforts by firms to maximize their profits by reducing their costs of compliance.<sup>201</sup> Many sources of sulfur dioxide emissions were electricity generators subject to rate-of-return regulation,<sup>202</sup> which provides much weaker cost-reduction incentives than competitive markets do.<sup>203</sup> This reduces the incentive for plants to engage in trading.<sup>204</sup> In addition, utilities were uncertain whether their state regulators would allow them to pass on the costs of allowances to their customers, which may have discouraged power plants from pursuing advantageous trades in the market.<sup>205</sup> Furthermore, utility transactions often had to be approved by a regulatory body, which increased the transaction costs of such trades.<sup>206</sup> All of these factors limited the gains from the Acid Rain Program.

While the Acid Rain Program had its complications, it was simple compared to its successors. By creating a nationwide market of virtually all power plants in the United States, with highly inclusive definitions of allowances that did not discriminate by product type (lumping together all sulfur dioxide emissions), time (allowing banking), and location (not differentiating by location), the Program maximized the size of its market and therefore the opportunities for cost-reducing transactions. The Interstate Air Pollution Program that has effectively succeeded the Acid Rain Program, by contrast, is much more complex, with many more constraints on trading. The transition away from the simplicity of the Acid Rain Program to the complexity

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Schmalensee & Stavins, *supra* note 153, at 117 (“Thus it can be important for policies to be flexible and responsive to changes in knowledge and technology.”).

201. See *supra* notes 141–142 and accompanying text (discussing the incentives created by policy markets).

202. See Black, *supra* note 144, at 349 (1993) (“But despite alleged defects, rate-of-return regulation remains the predominant means of exerting regulatory control over costs and preventing the abuse of monopoly power in North America.”).

203. See *id.* at 373–75 (1993) (explaining rate-of-return regulation).

204. See ELLERSON, JOSKOW & HARRISON, *supra* note 54, at 17–18 (“The fact that initially the emissions sources were primarily regulated utilities may have reduced incentives to trade and slowed the development of efficient markets.”).

205. See Chan et al., *supra* note 107, at 8 (“Some [utilities] faced uncertainty over whether state regulators would approve the inclusion of costs incurred to purchase emissions allowances, in those states that allowed costs to be recovered from electric ratepayers.”).

206. See Don Fullerton, Shaun P. McDermott & Jonathan P. Caulkins, *Sulfur Dioxide Compliance of a Regulated Utility*, 34 J. ENVTL. ECON. & MGT. 32, 32–33 (1997) (discussing utility regulation by state commissions).



of the Interstate Air Pollution Program can be considered a version of Paradise Lost, even if—like the original—the transition may have been unavoidable.<sup>207</sup>

## 2. Interstate Air Pollution

Unfortunately, the problem of air pollution does not always provide conditions that conveniently conform to a simple, geographically confined emission trading market. Air pollutants emitted in one state can be carried hundreds of miles, affecting air quality in other, downwind states. Thus, improving ambient air quality in an area may require regulating emissions in another area, perhaps even in another state. Consequently, many programs to regulate air pollution are constrained by location—that is, they limit emissions within a particular geographic area in order to improve air quality within that area.<sup>208</sup>

To address interstate air pollution, the so-called Good Neighbor Provision of Clean Air Act § 110 requires states to prohibit emissions within the state that would cause air quality problems in another state.<sup>209</sup> EPA's Cross-State Air Pollution Rule, also known as the Transport Rule, creates a program for implementing this requirement.<sup>210</sup> The Transport Rule limits emissions of sulfur dioxide

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207. See generally JOHN MILTON, PARADISE LOST (1667).

208. See, e.g., 42 U.S.C. § 7503(a)(1)(A) (requiring new sources of air pollutant emissions in areas that already violate ambient air quality standards to obtain offsetting emissions reductions from existing sources in the area, such that air quality improves despite the addition of a new source of emissions).

209. See *id.* § 7410(a)(2)(D)(i). More specifically, the provision requires states to “prohibit[], . . . any source or other type of emissions activity within the State from emitting any air pollutant in amounts which will . . . contribute significantly to nonattainment in, or interfere with maintenance by, any other State with respect to any such national primary or secondary ambient air quality standard.” *Id.*

210. See Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. 48,208, 48,209 (Aug. 8, 2011) (codified in 40 C.F.R. pts. 51 et al.). Prior to the Transport Rule, EPA addressed the Good Neighbor Provision in two different rules aimed at reducing interstate air pollution. In 1998, EPA issued a rule requiring twenty-two states and the District of Columbia to reduce nitrogen oxide emissions in order to reduce ozone pollution in downwind states (nitrogen oxides form ozone in the air). See Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone (“Final Rule”), 63 Fed. Reg. 57,356 (1998) (codified in 40 C.F.R. pts. 51 et al.). The rule, known as the NO<sub>x</sub> SIP Call, was for the most part upheld by the D.C. Circuit in *Michigan v. EPA*, 213 F.3d 663 (D.C. Cir. 2000). In 2005, EPA issued a new, broader rule requiring twenty-eight states and the District of Columbia to reduce their emissions of SO<sub>2</sub> and NO<sub>x</sub> in order to reduce ozone and particulate matter pollution in downwind states (SO<sub>2</sub> “is a precursor to PM<sub>2.5</sub>, and NO<sub>x</sub> is a precursor to both ozone and PM<sub>2.5</sub>”). See Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone

and nitrogen oxide from power plants in twenty-seven eastern, midwestern, and southern states that contribute significantly to air quality problems in downwind states.<sup>211</sup> Through complex modeling that analyzed air pollutant emissions, transport, and control costs, EPA determined how much pollutants each of the upwind states could emit without significantly contributing to air quality problems in downwind states.<sup>212</sup> These emissions targets became each state's emission "budget"<sup>213</sup>—the equivalent of a cap. EPA then allocated these emission budgets across power plants in the state, setting limits on each source's emissions of sulfur dioxide and nitrogen oxide, and allowed trading of emissions allowances across sources.<sup>214</sup>

EPA faced two major challenges in designing this rule. First, the task of linking emissions in one upwind emissions location to air quality in another downwind location is extremely complex.<sup>215</sup> Some emissions stay in the area in which they are emitted, while others are carried by wind into other states.<sup>216</sup> Emissions in an upwind state may be carried into multiple downwind states.<sup>217</sup> Some of these downwind states may have air quality problems, and others may not.<sup>218</sup> Multiple downwind states may receive pollutants from multiple upwind states.<sup>219</sup> Some states may have both upwind and downwind relationships—that is, they may both send pollution to other states and receive pollution from

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(Clean Air Interstate Rule), 70 Fed. Reg. 25,162 (May 12, 2005) (codified in 40 C.F.R. pts. 51 et al.). This rule, known as the Clean Air Interstate Rule ("CAIR"), was remanded by the D.C. Circuit in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008), *modified on reh'g*, 550 F.3d 1176 (D.C. Cir. 2008), although the court left the rule in place pending EPA's development of a new rule. The Transport Rule replaced CAIR. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,211. The Supreme Court upheld the Transport Rule in *EPA v. EME Homer City Generation, L.P.*, 134 S. Ct. 1584, 1593 (2014).

211. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,209.

212. *Id.* at 48,211–12.

213. *See id.* at 48,212. ("EPA developed individual state budgets for emissions from covered units under the Transport Rule.")

214. *See id.* ("Under the Transport Rule FIPs, EPA is distributing ('allocating') allowances under each state's budget to covered units in that state.")

215. *See EME Homer City Generation*, 134 S. Ct. at 1593–94 ("[C]urtailing interstate air pollution poses a complex challenge for environmental regulators. First, identifying the upwind origin of downwind air pollution is no easy endeavor. Most upwind States propel pollutants to more than one downwind State, many downwind States receive pollution from multiple upwind States, and some States qualify as both upwind and downwind.")

216. *Id.* at 1594.

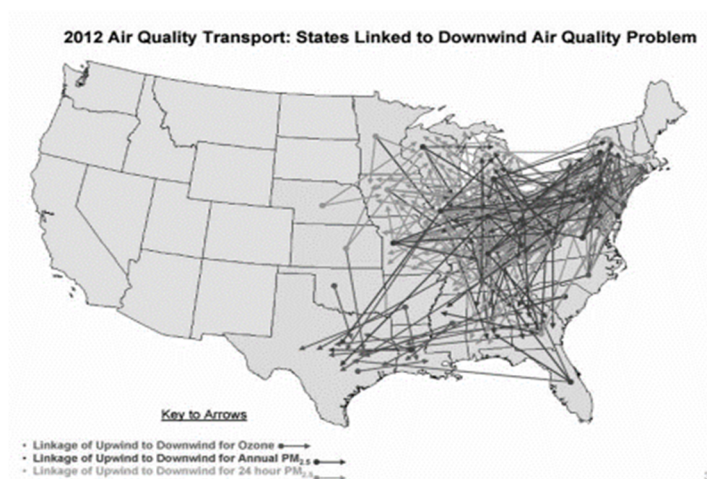
217. *Id.*

218. *Id.*

219. *Id.*

other states.<sup>220</sup> Thus, the problem of interstate air pollutant transport involves “thousands of overlapping and interwoven linkages between upwind and downwind States.”<sup>221</sup> Figure 4 provides a graphic illustration of the complexity of the numerous linkages that comprise interstate air pollutant transport. To make things more complicated, pollutants can transform through chemical processes, such that a pollutant emitted in one form may pose air quality problems in the form of a different pollutant.<sup>222</sup>

Figure 4: Interstate Air Pollutant Linkages<sup>223</sup>



In designing its Transport Rule, EPA had to regulate interstate air pollution in the context of these thousands of linkages between upwind emissions and downwind air quality. This required complicated air quality modeling. The Good Neighbor Provision prohibits emissions from upwind states that “contribute significantly” to nonattainment in downwind states.<sup>224</sup> Therefore, EPA first identified all downwind locations (receptors) that had difficulty attaining or maintaining

220. *Id.*

221. *Id.*

222. For example, nitrogen oxide ( $NO_x$ ) and sulfur dioxide ( $SO_2$ ) develop into ozone and fine particulate matter in the atmosphere. *North Carolina v. EPA*, 531 F.3d 896, 903 (D.C. Cir. 2008), *modified on reh'g*, 550 F.3d 1176 (D.C. Cir. 2008).

223. Image retrieved from EPA, PROPOSED AIR POLLUTION TRANSPORT RULE 35 (July 26, 2010), [https://www.epa.gov/sites/production/files/2016-09/documents/trpresentationfinal\\_7-26\\_webversion.pdf](https://www.epa.gov/sites/production/files/2016-09/documents/trpresentationfinal_7-26_webversion.pdf).

224. 42 U.S.C. § 7410(a)(2)(D)(i) (2012).

compliance with the applicable National Ambient Air Quality Standards.<sup>225</sup> EPA then used air quality modeling to determine which upwind states contributed to air quality problems in those downwind receptors with air quality problems.<sup>226</sup>

After identifying upwind states that contributed to nonattainment in downwind states, EPA then needed to determine the amount by which each upwind state had to reduce its emissions so as not to significantly contribute to nonattainment in downwind states.<sup>227</sup> This was known as the “‘control’ analysis.”<sup>228</sup> EPA confronted two major challenges during the control analysis: policy design and political judgment. As to matters of policy design, the complexity of the linkages among upwind states and downwind states made it impossible simply to allocate emissions reductions across upwind states according to the proportions of their physical contributions. This is because a single upwind state often contributes to nonattainment in multiple downwind states, and a single downwind state’s nonattainment can be caused by multiple upwind states.<sup>229</sup> EPA needed to find a method of allocating

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225. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. 48,208, 48,211 (Aug. 8, 2011) (codified at 40 C.F.R. pts. 51, 52, 72, 78, & 97); see also *EME Homer City Generation*, 134 S. Ct. at 1596 (defining a “receptor” as “a location at which EPA measures air quality”). The relevant NAAQS are the 1997 and 2006 standards for fine particulate matter and the 1997 standard for ozone. 76 Fed. Reg. at 48,208. Because nitrogen oxides and sulfur dioxide contribute to the formation of fine particulate matter and ozone in the ambient air, the Rule limits emissions of nitrogen oxides and sulfur dioxide. *Id.* at 48,208, 48,222.

226. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,211. To avoid including upwind states that contributed only minimally to downwind air quality problems, EPA set threshold levels equal to one percent of the corresponding NAAQS. *Id.* at 48,236. A state that contributed less than the threshold level of air pollution at downwind receptors was excluded from the Rule. *Id.* This was known as the “‘screening’ analysis.” *EME Homer City Generation*, 134 S. Ct. at 1596.

227. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,211.

228. *EME Homer City Generation*, 134 S. Ct. at 1596.

229. See *id.* at 1604, 1605 (noting the “thorny causation problem” resulting because “multiple contributing upwind states” cause “a downwind State’s excess pollution” and that proportionality “appears to work neither mathematically nor in practical application”). The *Homer City* majority offered the following hypothetical example to illustrate:

Assume the world is made up of only four States—two upwind (States X and Y), and two downwind (States A and B). Suppose also . . . that the reductions State X must make to eliminate its share of the amount by which State A is in nonattainment are more than necessary for State X to eliminate its share of State B’s nonattainment. . . . Suppose, however, that State Y also contributes to pollution in both State A and State B such that the reductions it must make to eliminate its proportion of State B’s overage exceed the reductions it must make to bring State A into attainment. In this case, the dissent [which advocated a rule based solely on proportion of physical contribution] would have State X reduce by just enough to eliminate its share of State A’s nonattainment and more than enough to eliminate its share of State B’s overage. The converse will be true as to State

emissions reductions across upwind states in a rational manner that took account of the complex web of interstate linkages.

EPA's second major challenge was to treat upwind emissions equitably in its initial allocation of allowances. This distributional issue was largely a matter of political judgment, as equity is not self-defining. EPA originally proposed allocating allowances to power plants based on their historical or projected emissions,<sup>230</sup> which was the method Congress had primarily used to allocate allowances in the Acid Rain Program.<sup>231</sup> However, the agency ultimately decided that basing emissions reductions on baseline emissions would reward sources with high historical emissions, favoring power plants that burned higher-emitting fuels or that had not already taken extensive measures to reduce their emissions. EPA decided that its approach should "avoid[] allocating [allowances] in a way that would effectively penalize units that have already invested in cleaner fuels or other pollution reduction measures."<sup>232</sup>

Instead of basing emissions reductions on historic emissions, EPA chose to use a baseline of historic heat input data.<sup>233</sup> EPA preferred

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Y: Under the dissent's approach, State Y would have to reduce by the "minimum" necessary to eliminate its proportional share of State B's nonattainment and more than enough to eliminate its proportion of State A's overage. The result is that the total amount by which both States X and Y are required to reduce will exceed what is necessary for attainment in all downwind States involved (i.e., in both State A and State B). . . . The problem would worsen were the hypothetical altered to include more than two downwind States and two upwind States, the very real circumstances EPA must address.

134 S. Ct. at 1605–06 n.19.

230. See Federal Implementation Plans To Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,210, 45,309 (Aug. 2, 2010) (to be codified in 40 C.F.R. pts. 51 et al.) ("EPA proposes that, for 2012, each existing unit in a given state receives allowances commensurate with the unit's emissions reflected in whichever total emissions amount is lower for the state, 2009 emissions or 2012 base case emissions projections.").

231. See *supra* note 169 and accompanying text (describing the design of the Acid Rain Program).

232. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,288.

233. *Id.* at 48,286. Heat input, also known as thermal power, measures the amount of thermodynamic power consumed in a power plant. Heat input is not to be confused with heat rate, also known as thermal efficiency, which measures the efficiency of a power plant by comparing the heat output to the heat input. Bethel Afework et al., *Thermal Power*, ENERGY EDUCATION, , [https://energyeducation.ca/encyclopedia/Thermal\\_power](https://energyeducation.ca/encyclopedia/Thermal_power) (last updated July 21, 2018) (citing RICHARD WOLFSON, ENERGY, ENVIRONMENT AND CLIMATE 86–87 (2d ed. 2012)). The Transport Rule limits emissions from "any stationary, fossil-fuel-fired boiler or stationary, fossil-fuel-fired combustion turbine serving at any time, on or after January 1, 2005, a generator with nameplate capacity of more than 25 MWe producing electricity for sale." 40 C.F.R. §§ 97.404(a)(1), 97.504(a)(1), 97.604(a)(1), 97.704(a)(1). EPA chose to allocate allowances based on the heat input of each power plant because such an approach is neutral with respect to the type

historic heat input data because they are fuel-neutral, meaning that they do not yield higher allocations for plants burning higher-emitting fuels, and emission-control-neutral, meaning that they do not yield lower allocations for plants that have installed pollution control technology to reduce emissions.<sup>234</sup> EPA also relied on both air quality impacts (how much upwind emissions affected downwind air quality) and abatement costs (how much it would cost to reduce emissions) to determine the amount by which each state was required to reduce its emissions.<sup>235</sup> This approach allowed EPA to take into account the extent to which existing plants already controlled their emissions and, as a result, how difficult and costly additional emission reductions would be.<sup>236</sup>

The challenges that EPA faced in developing the Transport Rule added complexity to the market the Rule created for trading emissions allowances among sources—much more complexity than the Acid Rain Program had to address in its allowance trading market. As explained previously, any emissions trading market creates a potential “hot spot” problem—the risk that trading may concentrate emissions in a particular area, causing local impairments in air quality in that area.<sup>237</sup> For interstate pollution transport, impacts on local air quality

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of fuel combusted by the power plant and the type of pollution control technology the plant employs. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,289. But the agency also limited each power plant’s allowances to its historic emissions. *Id.* at 48,288.

234. See Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,286. In addition, EPA determined that heat-input data, which is generated from continuous monitoring systems, is more accurate than unit-level emissions data, which relies on modeling projections. *Id.*

235. See *id.* The greater the contribution of air quality impacts and the lower the cost of abating those impacts, the more significant the contribution. *Id.* EPA’s use of cost to judge significant contribution under the Good Neighbor Provision has been controversial. See, e.g., *Michigan v. EPA*, 213 F.3d 663, 679 (D.C. Cir. 2000) (upholding EPA’s use of costs in the NO<sub>x</sub> SIP Call as consistent with the Good Neighbor Provision); *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008) (rejecting EPA’s use of costs in the Clean Air Interstate Rule as inconsistent with the Good Neighbor Provision), *modified on reh’g*, 550 F.3d. 1176. In *EPA v. EME Homer City Generation, L.P.*, the Supreme Court upheld the Transport Rule’s use of costs as a basis for setting emissions limitations pursuant to the Good Neighbor Provision. 134 S. Ct. 1584, 1593 (2014). EPA includes cost as a factor in determining significant contribution because “considering cost takes into account the extent to which existing plants are already controlled as well as the potential for, and relative difficulty of, additional emission reductions.” Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,248.

236. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,248.

237. See *supra* note 126 and accompanying text (defining and discussing “hot spot” problem).

are not the relevant focus; only downwind impacts matter.<sup>238</sup> However, trading across states nevertheless creates risks that trading may shift emissions in ways that concentrate air quality impacts in certain downwind states. Even trading between power plants in two states that affect the same downwind states may cause a state to contravene the Good Neighbor Provision's prohibition against "significant contribution" to downwind nonattainment.<sup>239</sup>

The Transport Rule includes requirements in its trading program to address these risks. To ensure that reallocation of emissions through trading does not result in a concentration of emissions in an upwind state, the Rule prohibits each state from exceeding a limit of overall emissions, known as an "assurance level."<sup>240</sup> If a state exceeds its assurance level of emissions, EPA forces power plants within the state that have exceeded their proportionate share of the state's assurance level of emissions to surrender allowances to compensate for and to penalize the excessive emissions.<sup>241</sup>

Thus, the Transport Rule's trading provisions trigger a collective action problem:<sup>242</sup> Power plants can freely trade allowances, even across state lines, as long as overall trading does not cause a state to exceed its assurance level of emissions. If a state exceeds its assurance level, power plants within the state face substantial penalties in the form of emissions reductions beyond the amount of their excessive emissions. Power plants considering a trade of allowances must

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238. The Clean Air Act addresses local air quality impacts with other provisions that are in fact the focus of the Act's cornerstone regulatory tool: state implementation plans. 42 U.S.C. § 7410 (2012).

239. See Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,210 ("The Transport Rule requires substantial near-term emission reductions in every covered state to address each state's significant contribution to nonattainment and interference with maintenance downwind. This rule achieves these reductions through [provisions] that regulate the power sector using air quality-assured trading programs whose assurance provisions ensure that necessary reductions will occur within every covered state.").

240. See *id.* at 48,294. These state-specific limits, known as an "assurance level," are equal to a state's budget plus its variability limit. Variability limits are essentially cushions that give states some limited leeway beyond their allowance budgets to increase emissions due to factors such as weather, changes in demand, or changes in power system operations. *Id.* at 48,212.

241. See *id.* at 48,294. Power plants must surrender twice as many allowances as the amount by which they exceed their proportionate share—one allowance to compensate for their excessive emissions, and one allowance to penalize them for their excessive emissions. *Id.*

242. See MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION 2 (1965) ("[E]ven if all of the individuals in a large group are rational and self-interested, and would gain if, as a group, they acted to achieve their common interest or objective, they will still not voluntarily act to achieve that common or group interest.").

consider the risk that the trade will cause the state to exceed its assurance level of emissions and trigger the penalties.<sup>243</sup> Ultimately, whether a state will exceed its assurance level of emissions and trigger the penalties depends primarily on the collective decisions of all power plants, which is only minimally under the control of any individual power plant.

The Transport Rule is considerably more complex than the Acid Rain Program. EPA did not necessarily choose to make the Transport Rule complex. The problem of interstate air transport is inherently complex. Moreover, the Clean Air Act's Good Neighbor Provision created what courts have interpreted as relatively strong directives for EPA to manage interstate air transport of air pollutants on a state-by-state basis, so that each state abides by an individualized obligation not to contribute significantly to air quality problems in any downwind state.<sup>244</sup>

The complexity of the Transport Rule is in some respects an improvement over the Acid Rain Program's simplicity. For example, the Acid Rain Program's nationwide market, without consideration of the location of the emissions, did not accurately reflect the air quality problems that sulfur dioxide emissions cause, which do depend on the location of the emissions. The Transport Rule's use of heat input data to allocate initial emissions allowances also arguably distributes regulatory burdens more equitably than the Acid Rain Program's reliance on historic emissions data. Whether the Transport Rule went too far in its complexity, and thereby increased compliance costs as compared with what might have been possible under a simpler policy market, has not been analyzed adequately in the economic literature. To confront that question, as Congress and EPA ideally should, would be to grapple head-on with the complexity dilemma.

### *B. Electricity Capacity Markets*

In this Part, we examine electricity capacity markets, a large and important—but also extremely complex—example of a positive-externality policy market. Capacity markets illustrate the complexity dilemma that all regulators face in designing policy markets. In the Clean Air Act emissions trading markets, EPA has allowed emissions

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243. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 76 Fed. Reg. at 48,295.

244. See, e.g., *North Carolina v. EPA*, 531 F.3d 896, 907 (D.C. Cir. 2008) (holding that EPA must prevent significant contribution on a state-by-state rather than regional basis), *modified on reh'g*, 550 F.3d. 1176 (D.C. Cir. 2008).



trading to become somewhat more complex over time while limiting the complexity of the policy markets to enhance trading. In contrast, the primary regulator of capacity markets, the Federal Energy Regulatory Commission (FERC), has repeatedly pushed policy market design in the direction of increased complexity. Although in some respects laudable for its ambition, we raise the possibility that FERC has become lost in its complexity, apparently unable to see how the details of its market design have undermined some of the core premises of its market.

Part IV.B.1 explains the background of capacity markets, including the reason regulators have felt compelled to create them. Part IV.B.2 summarizes some of the key policy design issues regulators have confronted with capacity markets, drawing on the framework developed earlier in this paper.<sup>245</sup> Part IV.B.3 focuses more specifically on particular policy design challenges—concern over buyer market power in capacity markets and restrictions on subsidized generators—that have led regulators to add significant complexity to the already intricate capacity markets.

### 1. Background

Each year, in many parts of the United States, electricity distribution companies spend billions of dollars purchasing something called *capacity*. Capacity is the ability to produce electricity, a concept distinct from electricity itself.<sup>246</sup> Capacity is sold by power generators through auctions created by the organizations known as Regional Transmission Operators (RTOs), sometimes called Independent System Operators (ISOs), that operate large parts of the electric grid.<sup>247</sup>

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245. See *supra* Part III.B (discussing the background of policy markets, including the considerations that go into their design).

246. Conn. Dep't of Pub. Util. Control v. FERC, 569 F.3d 477, 479 (D.C. Cir. 2009).

247. See *Ameren Servs. Co. v. Fed. Energy Regulatory Comm'n*, 893 F.3d 786, 789 (D.C. Cir. 2018) (“Electric transmission in the United States is largely managed by regional transmission organizations (RTOs) and independent system operators (ISOs). Those entities operate the electric transmission systems for a geographic region on behalf of the local utilities (known as transmission providers) in a region.”); Seth Blumsack, *Measuring the Benefits and Costs of Regional Electric Grid Integration*, 28 ENERGY L.J. 147, 153 (2007) (noting that RTOs centrally dispatch generation within their footprint); Joel B. Eisen, *FERC's Expansive Authority to Transform the Electric Grid*, 49 U.C. DAVIS L. REV. 1783, 1849 n.44 (2016) (“ISO/RTOs manage energy, capacity, and ancillary services markets.”). RTOs exist in New England (ISO-NE), New York (NYISO), the mid-Atlantic region (PJM), the Midwest (the Midcontinent ISO and Southwest Power Pool), most of Texas (ERCOT), and California (CAISO). *Regional Transmission Organizations (RTO)/Independent System Operators (ISO)*, FERC, <https://www.ferc.gov/industries/electric/indus-act/rto.asp> (last updated Dec. 20, 2019). FERC regulates all of the RTOs except ERCOT. Darryl Bush & David Spence, *Why ERCOT Only Has*

Although the business of these distribution companies is to supply electric power to their customers, capacity is not power.<sup>248</sup> Purchasing capacity in a capacity market thus does not entitle distribution companies to any electricity. These firms do not turn around and sell capacity to their customers. They purchase electricity itself from generators in separate transactions in what are called *energy markets*.<sup>249</sup> Although capacity is forward-looking, the purchase of capacity is not an option or a futures contract.<sup>250</sup> Purchasing capacity does not entitle a utility to purchase electricity at a particular price at some future date or to otherwise hedge a price risk. The generator that sells capacity is not being paid for generating electricity; instead, it is merely being paid to be available to generate electricity.<sup>251</sup> So, why are distribution companies forced to spend billions of dollars buying something that has no apparent value to them? The answer comes from the nature of electricity and electricity markets and provides an example of an extremely complex positive-externality policy market.<sup>252</sup>

In the parts of the country with competitive wholesale electricity markets, electric distribution companies buy electric power from generators in wholesale energy markets and sell it to final consumers in retail markets.<sup>253</sup> If, however, the RTO does not have sufficient

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*One Regulator*, in *ELECTRICITY RESTRUCTURING: THE TEXAS STORY* 9–21 (Andrew Kleit & Lynne Kiesling eds., 2009).

248. See Office of Energy Efficiency & Renewable Energy, *What's the Difference between Installed Capacity and Electricity Generation?*, DEP'T OF ENERGY (Aug. 7, 2017), <https://www.energy.gov/eere/articles/whats-difference-between-installed-capacity-and-electricity-generation> (last visited Nov. 3, 2019) (“According to EIA, wind turbines accounted for 8% of U.S. installed electricity generation ‘capacity,’ as of December 2016. This means under ideal conditions, utilities would be able to supply 8% of the country’s electricity needs with wind power, but this won’t necessarily be the actual amount of electricity produced.”).

249. PJM, PJM MANUAL 11: ENERGY & ANCILLARY SERVICES MARKET OPERATIONS 17 (rev. 96, July 1, 2018).

250. Courts nevertheless sometimes incorrectly label capacity transactions as a form of an option contract. See, e.g., *NRG Power Mktg., LLC v. Me. Pub. Utilities Comm’n*, 558 U.S. 165, 168 (2010) (“In a capacity market, . . . an electricity provider purchases from a generator an option to buy a quantity of energy . . .”).

251. See *Advanced Energy Mgmt. All. v. FERC*, 860 F.3d 656, 659 (D.C. Cir. 2017) (“Capacity is not actual electricity. It is a commitment to produce electricity or forgo the consumption of electricity when required.”); *Conn. Dep’t of Pub. Util. Control*, 569 F.3d at 479 (“‘Capacity’ is not electricity itself but the ability to produce it when necessary.”). Capacity is purchased on behalf of the overall system, and the obligation to generate and sell electricity runs to the grid operator, not to individual buyers in the capacity market. See *Advanced Energy Mgmt. All.*, 860 F.3d at 659 (“PJM procures capacity for the entire system.”).

252. See *supra* note 76 and accompanying text (explaining positive-externality policy markets).

253. The distribution companies may purchase the electric power from generators in a variety of arrangements, including long-term bilateral contracts, “day ahead” markets in which power is

power to deliver to its distribution companies, major problems may occur.

Electricity markets are more susceptible to shortages than typical markets are.<sup>254</sup> Three factors— an inability to store electricity, inelastic demand, and price caps— make shortages more likely in electricity than in typical markets. First, electricity cannot easily be stored.<sup>255</sup> Although electricity storage technology is advancing rapidly, storage cannot economically be used at a sufficient scale to contribute meaningful amounts of electricity supply to meet demand. Therefore, electricity cannot be stockpiled in advance of periods of peak demand.

Second, shortages are also more likely in electricity markets because demand for electricity is often less responsive to the wholesale price.<sup>256</sup> If wholesale prices increase in a typical market, a retail seller passes the wholesale price increase on to retail customers by increasing the retail price. Demand in the retail market decreases in response to the retail price increase, and retail sellers sell less product at the new higher price. The two markets—wholesale and retail—operate in tandem, each one responding to changes in the other.

In electricity markets, however, the relationship between wholesale and retail markets is impaired. Power usage by most electricity consumers is measured by old-style “flow” meters. These meters can measure the amount of power consumed across a reporting period—for example, a month—but cannot determine the particular

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purchased for the next day, and “real time” markets. See PJM, *supra* note 249, at 17. These are known as *energy markets*. *Id.* The overriding goal of a utility in a competitive market is to purchase sufficient power in the energy markets to meet its customers’ demand for electricity at the lowest cost. *Id.*; cf. Gavin Bade, *Electricity Markets: States Reassert Authority over Power Generation*, UTILITY DIVE (Oct. 16, 2018), <https://www.utilitydive.com/news/electricity-markets-states-reassert-authority-over-power-generation/539658/> (reporting that “23 states and the District of Columbia have enacted some form of competition in generation, energy retailing or both”).

254. In a typical market, prices reflect an equilibrium of supply and demand—the point at which the marginal seller is willing to sell at a price equal to the price the marginal buyer is willing to pay. At any price higher than the equilibrium price, sellers would make more product available than buyers would be willing to buy, there would be a surplus, and the price would decrease. At any price lower than the equilibrium price, buyers would attempt to buy more product than sellers have available, there would be a shortage, and the price would increase. Thus, the market price naturally moves toward a level in which the quantity demanded equals the quantity supplied. This leads to the optimal production of the good in question. While shortages can occur, they are rare, and usually can be fixed relatively quickly without serious cost by some combination of either an increase in production or an increase in price.

255. Andreas Bublitz et al., *A Survey on Electricity Market Design: Insights from Theory and Real-World Implementations of Capacity Remuneration Mechanisms*, 80 ENERGY ECON. 1059, 1060 (2019).

256. Miles Bidwell & Alex Henney, *Will the New Electricity Trading Arrangements Ensure Generation Adequacy?*, ELECTRICITY J., Aug./Sept. 2004, at 15, 16, 23.

time when power is consumed.<sup>257</sup> As a consequence, consumers with flow meters cannot be charged rates for their electricity usage that vary by time of day, even though the wholesale price of electricity varies based on time of day, as overall electricity usage varies.

Even if consumers have access to “smart meters” that can measure the time of electricity usage, they may not want their electricity prices to vary. An effective variable pricing scheme requires consumers to be aware of, and to understand, the different prices they may pay for power and to be able to adjust their usages of electricity accordingly. Given the burden of dealing with this complexity, the advantages to consumers from variable pricing may be limited, especially for smaller consumers. In addition, variable pricing subjects consumers to financial risk due to the possibility of price spikes during high consumption periods. Thus, consumer demand for variable electricity pricing may be limited.<sup>258</sup>

Given these two factors, the price consumers generally pay for electricity is a fixed rate that does not vary based on when that power is used. This is the case even though the wholesale price of power changes numerous times during a day and can vary greatly.<sup>259</sup> This in turn implies that most consumers can only be charged an average price for power, rather than a price based on the wholesale price of power when that power is consumed.<sup>260</sup>

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257. For a discussion of the difference between flow and smart meters, see *Naperville Smart Meter Awareness v. City of Naperville*, 900 F.3d 521, 524 (7th Cir. 2018) and Umang Patel & Mitul Modi, *A Review on Smart Meter System*, 3 INT'L J. INNOVATIVE RES. ELECTRICAL ELECTRONICS INSTRUMENTATION & CONTROL ENGINEERING 70 (2015).

258. See Christian Schlereth, Bernd Skiera & Fabian Schulz, *Why Do Consumers Prefer Static Instead of Dynamic Pricing Plans? An Empirical Study for a Better Understanding of the Low Preferences for Time-Variant Pricing Plans*, 269 EUR. J. OPERATIONAL RES. 1165, 1175 (2018) (finding that “for electricity markets, consumers mostly neglect time-variant pricing plans”); Mattias Vesterberg & Chandra K.B. Krishnamurthy, *Residential End-Use Electricity Demand: Implications for Real Time Pricing in Sweden*, 37 ENERGY J. 141, 160 (2016) (finding that households generally do not adjust consumption to prices but may if the savings are substantial). There are various programs that encourage “real-time” pricing, but their penetration rate appears uncertain. See FERC, STAFF REPORT, DEMAND RESPONSE AND ADVANCED METERING 1–28 (2015) (reporting on demand response and advanced metering efforts in the U.S.).

259. For example, PJM’s average price for “day-ahead” power for the first nine months of 2018 was \$36.04/MWh, with a standard deviation of \$25.12.74/MWh, implying a percentage standard error of 69.7. See MONITORING ANALYTICS, 2019 STATE OF THE MARKET REPORT 156, [https://www.monitoringanalytics.com/reports/PJM\\_State\\_of\\_the\\_Market/2019/2019q3-som-pjm-sec3.pdf](https://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2019/2019q3-som-pjm-sec3.pdf).

260. More variable rates sensitive to time of use may not even be possible, if customers have electricity meters that only measure total usage, rather than “smart” meters that measure usage by time. There are various programs that encourage “real-time” pricing, but their penetration rate appears uncertain. FERC, *supra* note 258, at 3–9.

Hence, demand in wholesale electricity markets is much less responsive to wholesale prices than in typical markets. Consequently, demand during periods of peak electricity usage may be unlikely to be significantly deterred by even large increases in wholesale prices. Thus, an important reason why markets do not face shortages—because demand will decrease when the price increases—may not be present in electricity markets.

Third, wholesale electricity markets often have price caps that restrict wholesale prices from rising above specified levels.<sup>261</sup> The precise rationale for these price caps is unclear. To the extent that electricity distribution companies are able to pass on wholesale price increases to their customers, price caps may be intended to protect retail customers from higher rates. To the extent that electricity distribution companies are not able to pass on wholesale price increases to their customers, wholesale price caps may be intended to protect distribution companies from losses incurred if they had to buy at very high wholesale prices which they could not then pass on to their retail customers. Wholesale price caps also may aim to limit the ability of electricity suppliers to exert market power during periods of peak demand when demand is close to total generation capacity.<sup>262</sup>

Generally, however, price caps tend to cause shortages by preventing the market from reaching an equilibrium price that matches supply and demand.<sup>263</sup> In the longer term, price caps suppress supply by reducing incentives for new firms to enter the market or for existing firms to expand production. Electricity generators are incentivized to enter wholesale electricity markets for the opportunity to make money in the market. Imposing price caps that constrain wholesale prices reduces the ability of generators to earn profits, which in turn reduces incentives for new generation to enter the market.

This combination of features—an inability to store electricity,

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261. For PJM, the Mid-Atlantic Regional Transmission Organization on which we focus in this article, the price cap was \$1,000/MWh prior to 2014. *PJM Interconnection, LLC*, 146 F.E.R.C. ¶ 61,078, 61,330 (2014); SUSAN KENNEY, PJM INTERCONNECTION, PRICE-BASED OFFERS > \$1,000/MWH (June 6, 2018), <https://www.pjm.com/-/media/committees-groups/committees/mic/20180606/20180606-item-14a-1000-price-based-offers.ashx>. PJM adopted slightly different approaches between 2014 and 2018. As of April 2018, the price cap for most generators in PJM is again at \$1,000/MWh. Some generators, however, can gain approval for bids above that level if they can show that their marginal costs exceed the price cap.

262. See, e.g., James F. Wilson, *Scarcity, Market Power, and Price Caps in Wholesale Electric Power Markets*, ELECTRICITY J., Feb. 2000, at 33, 34 (discussing setting price caps in response to market price spikes during periods of high demand).

263. MANKIW, *supra* note 2, at 114–19.

demand that is not responsive to price in the wholesale market, and wholesale price caps—is perceived as contributing to an underinvestment in generation resources that threatens grid reliability—what is known as the “missing money” problem.<sup>264</sup> In many—but not all—competitive electricity markets, RTOs have created capacity markets as a tool to address the “missing money” problem—that is, a means of ensuring that the grid will have sufficient generation capacity in the future to satisfy peak demand and thereby to avoid widespread grid failure.<sup>265</sup> The revenues from capacity markets are essentially an incentive payment for capital investment aimed at creating the public good of grid reliability.<sup>266</sup> Whether the “missing money” problem actually exists, and whether capacity markets are the appropriate means of addressing the “missing money” problem if it does exist, are controversial questions.<sup>267</sup> Addressing the perceived problem, however, represents a significant part of retail consumers’ electricity bills. Capacity market revenues for PJM are

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264. Cramton, Ockenfels & Stoft, *supra* note 95, at 30 (2013) (“[T]here is ‘missing money,’ which implies too low a level of investment in capacity.”); MICHAEL HOGAN, HITTING THE MARK ON MISSING MONEY: HOW TO ENSURE RELIABILITY AT LEAST COST TO CONSUMERS 3 (2016) (“It has become commonplace to hear it said that wholesale electricity markets are plagued by a ‘missing money’ problem.”); Emily Hammond & David B. Spence, *The Regulatory Contract in the Marketplace*, 69 VAND. L. REV. 141, 169–70 (2016) (“[S]ome economists worry that in competitive wholesale markets, prices based on marginal costs will not attract sufficient investment in new capacity—referred to as the ‘missing money’ problem.”); David B. Spence, *Naïve Energy Markets*, 92 NOTRE DAME L. REV. 973, 1015 (2017) (noting that fixed retail electricity rates “lead[] the market to undervalue generating capacity, a problem electricity economists call ‘the missing money problem’”).

265. See generally HOGAN, *supra* note 264.

266. Cf. *Regional Transmission Organizations*, Order No. 2000, 89 F.E.R.C. ¶ 61,285, at 128 (1999) (noting that “many reliability functions are, in economic terms, ‘public goods’”).

267. See, e.g., Katharine Fraser, *CERAWeek Day 3: Texas Power Struggle Over Generation Capacity Markets*, THE BARREL (Mar. 7, 2013), <https://blogs.platts.com/2013/03/07/cera-day3/> (reporting “a searing debate” in Texas “over whether the state’s deregulated power market should add a capacity market”); MIKE HOGAN, BEYOND CAPACITY MARKETS: ENSURING RELIABILITY IN COMPETITIVE WHOLESALE POWER MARKETS UNDER THE NEW RESOURCE PARADIGM (Aug. 14, 2012), <https://www.raponline.org/wp-content/uploads/2016/05/rap-hogan-what-lies-beyond-cap-mkts-2012-aug-14.pdf> (criticizing capacity markets as “the ‘fax machine’ of the power industry,” in that they already have become obsolete). The controversy extends to the question whether grid reliability is a public good. See generally, e.g., LYNNE KIESLING & MICHAEL GIBERSON, ELECTRIC NETWORK RELIABILITY AS A PUBLIC GOOD (2015) (arguing that “network reliability . . . is both a congestible public good and a private good”); RICHARD SEDANO, THE NATIONAL COUNCIL ON COMPETITION & ELECTRIC INDUSTRY, DIMENSIONS OF RELIABILITY: A PAPER ON ELECTRIC SYSTEM RELIABILITY FOR ELECTED OFFICIALS (2001) (“Electric system reliability is a classic public good.”); ANUPAMA KOWLI, MATIAS NEGRETE-PINCETIC, & GEORGE GROSS, A SUCCESSFUL IMPLEMENTATION WITH THE SMART GRID: DEMAND RESPONSE RESOURCES (2015) (“We continue to view the provision of such minimum reliability level of the system as a public good.”).

consistently in the billions of dollars annually.<sup>268</sup> Since 2010, annual capacity market revenues have ranged between \$6.1 and \$9.5 billion, constituting between 17.8 and 24.0% of total revenues in PJM markets.<sup>269</sup>

## 2. Capacity Market Design

There are many common issues in capacity market design, consistent with the general framework for policy market design we identified previously.<sup>270</sup> These common issues include the type of capacity product transacted in the market, the timing of commitments and performance, and the location of the capacity in the grid. Each RTO operates in slightly different ways. We will focus on the capacity market of the largest RTO, PJM.<sup>271</sup> PJM implemented its current capacity market (often referred to as the “Reliability Pricing Model”) in 2007.<sup>272</sup>

First, PJM has to make decisions regarding the *type* of capacity that can be sold in its capacity market.<sup>273</sup> The basic product in a capacity market is capacity to generate electricity, but not all capacity sold in the capacity market is identical. Because the ultimate goal of the capacity market is to enhance grid reliability, capacity offered for sale in the market should be evaluated for its ability to contribute to grid reliability. Trying to capture the various attributes of capacity that affect its contribution to grid reliability, however, makes the capacity market complex and difficult to administer. For example, some types of renewable energy generation, particularly wind and solar power, are not always available.<sup>274</sup> PJM deals with this issue by discounting the

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268. PJM, A STEP BEYOND: 2017 PJM ANNUAL REPORT 28 (2018); PJM, PJM 2015 FINANCIAL REPORT 6 (2016).

269. PJM, A STEP BEYOND: 2017 PJM ANNUAL REPORT 28 (2018); PJM, PJM 2015 FINANCIAL REPORT 6 (2016).

270. See *supra* Part III.B (discussing the background and design considerations of policy markets).

271. PJM was originally formed in 1927 as a power pool of three utilities serving customers in Pennsylvania and New Jersey. *Electric Power Markets: PJM*, FERC (Aug. 22, 2017), <https://www.ferc.gov/market-assessments/mkt-electric/pjm.asp>. PJM has since expanded to serve all or parts of thirteen states and the District of Columbia. *Id.* It supplies power from almost 1400 generation sources to approximately 65 million customers. *PJM—At a Glance*, PJM (Mar. 13, 2019), <https://www.pjm.com/-/media/about-pjm/newsroom/fact-sheets/pjm-at-a-glance.ashx> (last visited Sept. 25, 2019).

272. *PJM Interconnection, LLC*, 117 F.E.R.C. ¶ 61,331, 62, 657 (2006).

273. See *supra* Part III.B.2.a (describing the generic issue of differentiating products in a policy market by type).

274. See Hammond & Spence, *supra* note 264, at 164 (2016) (“Because of their intermittency, neither wind nor solar facilities can provide the load-following services offered by fossil-fueled

generation capacity from these generators in the capacity market.<sup>275</sup> These discounted capacity factors add complexity to the capacity market, while still oversimplifying the effect of intermittency on grid reliability.<sup>276</sup> The actual effect of intermittency on reliability hinges, for example, on the extent to which different generators are independently or dependently intermittent.<sup>277</sup> The effect of intermittency on reliability also hinges on whether a generator is producing power at periods of peak demand, when the grid is most vulnerable.<sup>278</sup> A single discounting factor does not capture all these complications, but attempting to capture them would add considerable complexity to the capacity market design.

Second, PJM has to regulate the *timing* of capacity sold in its capacity market.<sup>279</sup> Timing in the capacity market context has two features: the interval between capacity transactions and performance of the capacity obligation and the commitment period over which the performance obligation must be met.<sup>280</sup> As to the interval between capacity transactions and performance of the capacity obligation, the original PJM capacity market had daily markets, in which capacity was purchased in the market the day before it was to be supplied—essentially, a market for current capacity.<sup>281</sup> In 2007, PJM changed to a market for future capacity, in which capacity is purchased in the market

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plants. To the contrary, their intermittency increases the load-following burden on grid operators by adding another source of short-term variation in addition to variations in demand.”); Andrew H. Meyer, *Federal Regulatory Barriers to Grid-Deployed Energy Storage*, 39 COLUM. J. ENVTL. L. 479, 502 (2014) (“Many renewable energy resources, wind and solar in particular, are variable, non-dispatchable resources, whose output can neither be entirely controlled nor predicted.”).

275. For example, PJM capacity factors for capacity market participation range from 14.7 to 17.6 percent for wind sources, and from 38 to 60 percent for solar sources. Conleigh Byers, Todd Levin & Audun Botterud, *Capacity Market Design and Renewable Energy: Performance Incentives, Qualifying Capacity, and Demand Curves*, ELECTRICITY J., Jan./Feb. 2018, at 65, 69.

276. See MICHAEL GOGGIN ET AL., WIND SOLAR ALLIANCE, CUSTOMER FOCUSED AND CLEAN: POWER MARKETS FOR THE FUTURE 27–28 (2018) (criticizing PJM’s proposed method for determining capacity factors as “a crude methodology” not reflecting “true capacity value” for renewable resources); see also Byers, Levin & Botterud, *supra* note 275, at 69 (noting the existence of different approaches to calculating capacity values for intermittent resources).

277. See GE ENERGY CONSULTING, PJM RENEWABLE INTEGRATION STUDY: EXECUTIVE SUMMARY REPORT 15 (rev. 05, 2014) (noting that “the impacts of short-term variability in wind and solar production is greatly reduced by aggregation and geographic diversity”).

278. *Id.*

279. See *supra* Part III.B.2.c (describing the generic issue of differentiating products in a policy market by timing).

280. *Id.*

281. See Anna Creti & Natalia Fabra, *Capacity Markets for Electricity* 4 (Ctr. for the Study of Energy Mkts., Working Paper No. 124, 2003) (noting that in PJM, “daily capacity markets were introduced in 1999”).



three years before it is to be available.<sup>282</sup> The three-year period is meant to create a better signal for investment in capacity, a crucial goal of capacity markets. It also allows more resources—such as demand response<sup>283</sup> and planned new generation—to participate as supply in the market.<sup>284</sup> Adding a lag time between the purchase of capacity and performance, however, adds complexity to the market, particularly to enforcement of the performance obligation.

As to the commitment period, PJM also has made adjustments over time. When PJM introduced the Reliability Pricing Model in its 2007 reforms, it required generation resources to commit to supplying the capacity market over an entire year.<sup>285</sup> A single annual capacity obligation required resources bidding into the capacity market to maintain their capacity throughout the year.<sup>286</sup> Some have argued, however, that winter peak demand and summer peak demand periods have different features that should be reflected in capacity commitments that vary by season.<sup>287</sup> Thus far, PJM has resisted calls for moving away from its annual commitment period to a more complex, but perhaps more realistic, seasonal market.

Third, PJM has to consider how to incorporate *location* of capacity sold in its capacity market.<sup>288</sup> This has been a serious challenge. On the one hand, the capacity market functions most effectively in minimizing the cost of capacity when the market operates broadly, with as many sellers and buyers in the same market as possible. This would seem to counsel against differentiating capacity by location. Location matters, however, because physical limitations on electricity transmission can

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282. *PJM Interconnection, LLC*, 115 F.E.R.C. ¶ 61,079, 61,245 (2006).

283. Demand response is defined as “a reduction in the consumption of electricity of electric energy by customers from their expected consumption in response to an increase in the price of electricity or to incentive payments designed to induce lower consumption of electric energy.” 18 C.F.R. § 35.28(b)(4) (2010). See generally Sharon B. Jacobs, *Bypassing Federalism and the Administrative Law of Negawatts*, 100 IOWA L. REV. 885 (2015).

284. See *PJM Interconnection, LLC*, 117 F.E.R.C. ¶ 61,331, 62,654 (2006) (discussing new generation).

285. See *id.* at ¶ 62,658 (“The commitment period for capacity offered into the Base Residual Auction remains one year . . .”).

286. See SAM NEWELL ET AL., BRATTLE GROUP, OPPORTUNITIES TO MORE EFFICIENTLY MEET SEASONAL CAPACITY NEEDS IN PJM 1 (2018) (“The implementation of the PJM capacity market as an annual design made sense in the historical context with summer having both the highest demand and shortest supply.”).

287. See *id.* (“Because it maintains an annual design, PJM effectively imposes the same reliability requirement in both the summer and winter seasons even though winter peak load is substantially lower and could be met reliably with . . . less capacity.”).

288. See *supra* Part III.B.2.b (describing the generic issue of differentiating products in a policy market by location).

create bottlenecks that prevent electricity from moving freely through the grid.<sup>289</sup> Thus, capacity available through, for example, power generated in Dayton may not be able to be used to meet shortages of power in Philadelphia.<sup>290</sup>

To address this problem, PJM divided its grid into numerous zones.<sup>291</sup> It then modeled the transmission limits between zones to determine how much capacity in one zone can provide power to another zone.<sup>292</sup> When transmission constraints limit capacity in one zone from providing power to another zone, the zones are treated as separate markets, with separate prices based on the balance of supply and demand within that zone.<sup>293</sup> When transmission constraints are not present and one zone can freely provide power to another zone, the zones are treated as the same market with the same price.<sup>294</sup>

In an ideal policy market, trading continues until marginal costs are equal throughout the market.<sup>295</sup> With transmission constraints, however, this condition does not apply to capacity markets. Table 1 shows the regional differences in price across the twenty PJM control zones for auction years 2020/21 and 2021/22, with the auctions occurring three years prior to the years in question. In general, the western part of PJM (except for the isolated Chicago region) has lower prices than the more congested eastern region. In the 2020/21 market, the capacity market price in Public Service Electric and Gas Company zone (New Jersey) was \$188/MW-day, while in the Dayton, Ohio zone it was \$77. This implies that, at the margin, if transmission capacity had been available, there was a potential savings of approximately \$111/MW-day if more trading were allowed between the two zones. Even in the less differentiated 2021/2022 market, there were potential

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289. See Gary L. Hunt & Richard Lauckhart, *A Day in the Life of Transmission Congestion*, PUB. UTIL. FORT., May 2005, at 10 (“Transmission congestion affects both the cost and the efficiency of the electric power grid.”).

290. See generally, e.g., Mostafa Sahraei-Ardakani et al., *Distributional Impacts of State-Level Energy Efficiency Policies in Regional Electricity Markets*, 49 ENERGY POL’Y 365 (2012) (analyzing the impacts of Pennsylvania energy legislation in a system with transmission congestion).

291. See Adil Caner Sener & Stefan Kimball, *Reviewing Progress in PJM’s Capacity Market Structure via the New Reliability Pricing Model*, ELECTRICITY J., Dec. 2007, at 40, 44 (“PJM proposed 23 LDAs [Local Deliverability Areas] categorized according to geographical regions and transmission ownership zones.”).

292. See *id.* at 45–48 (describing the Variable Resource Requirement Curve).

293. *Id.* at 47.

294. *Id.*

295. See Coase, *supra* note 13, at 15 (“[I]t was argued that such a rearrangement would be made through the market whenever this would lead to an increase in the value of production.”).

savings of \$65/MW-day if more trading were available between these zones.

Table 1: Seller Capacity Prices Across PJM Control Zones<sup>296</sup>  
2020/21 and 2021/22 Auction Years (\$/megawatt day)

<b>Control Zone (Primary Location)</b>	<b>Obligation 2020/21</b>	<b>Obligation 2021/22</b>	<b>Capacity Price 2020/21</b>	<b>Capacity Price 2021/22</b>
Atlantic City (New Jersey)	1.67%	1.64%	\$188.41	\$166.31
AEP (Ohio)	7.77%	7.77%	\$76.83	\$140.53
APS (Western PA)	6.08%	6.31%	\$76.83	\$140.53
ATSI (Ohio)	8.83%	8.84%	\$76.83	\$171.86
BGE (Maryland)	4.63%	4.54%	\$86.52	\$203.19
COMED (Chicago)	15.23%	15.27%	\$188.43	\$196.08
DAYTON (Ohio)	2.33%	2.31%	\$76.83	\$140.53
DEOK (Kentucky)	3.15%	3.17%	\$130.30	\$140.53
DLCO (Western PA)	1.96%	1.95%	\$76.83	\$140.53
DOM (Virginia)	13.71%	13.75%	\$76.83	\$140.53
DPL (Delmarva)	2.71%	2.67%	\$188.41	\$166.31
EKPC (Kentucky)	1.49%	1.55%	\$76.83	\$140.53
JCPL (New Jersey)	4.10%	4.00%	\$188.41	\$166.31
METED (South Central PA)	2.02%	2.04%	\$86.52	\$140.53
PECO (Philadelphia)	5.86%	5.94%	\$188.41	\$166.31
PENLC (Western PA)	1.96%	1.96%	\$86.52	\$140.53
PEPCO (D.C.)	4.43%	4.35%	\$86.52	\$140.53
PPL (Northeastern PA)	4.99%	5.00%	\$86.52	\$140.53
PSEG (New Jersey)	6.80%	6.66%	\$188.41	\$204.92
RECO (New Jersey)	0.27%	0.27%	\$188.41	\$166.31
Weighted Average			\$121.14	\$162.65

296. See PJM, SUMMARY OF 2021/2022 BASE RESIDUAL AUCTION RESULTS (May 2018), <https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2021-2022/2021-2022-base-residual-auction-results.ashx?1a=en> (documenting seller capacity prices across PJM Control Zones); PJM, SUMMARY OF 2020/2021 BASE RESIDUAL AUCTION RESULTS (May 2017), <https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2020-2021-base-residual-auction-results.ashx?1a=en> (same); see also ZONE MAP OVEC, <https://www.pjm.com/library/~/media/about-pjm/pjm-zones.ashx> (last visited Nov. 3, 2019) (depicting a map of the PJM transmission zones).

The price differentials between zones show that segmenting the market into zones significantly reduces the potential gains available from trade. It is unclear how FERC and PJM weighed the benefits of adding locational constraints to the capacity market—that is, more accurately reflecting the reality of transmission-constrained capacity—against the costs in terms of lost opportunities for cost-reducing transactions. That balancing, however, illustrates the crux of the complexity dilemma that regulators face in designing policy markets.

Thus, capacity market design requires FERC and the RTO to make a series of decisions regarding how to treat differences in the type, timing, and location of capacity sold in the market.<sup>297</sup> With respect to each of these decisions, FERC and the RTO must balance simplicity that harnesses market forces against the complexities of the reality in which the capacity market operates. At least in the PJM market, FERC has repeatedly pushed the capacity market in the direction of greater complexity.

### 3. The Limits of Complexity

The challenges FERC and PJM have faced with respect to differences in capacity pale in comparison with the difficulties they have encountered in designing the capacity market demand curve and in regulating the participation of sellers in the capacity market.<sup>298</sup> As with other aspects of policy market design, FERC and PJM have chosen to add complexity to the market over time. Although often understandable when viewed individually, collectively, these decisions have created a market that is almost hopelessly complicated. Indeed, even FERC seems overwhelmed by the complexity it has created.

There is no natural demand for capacity because an individual buyer receives very little benefit from its purchase of capacity. This is because the benefit of capacity—enhanced reliability—has attributes of a public good that inure to the advantage of all buyers of electricity in the market.<sup>299</sup> When PJM capacity markets began in the late 1990s,

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297. See *supra* Part III.B.2 (discussing these three factors in policy market design generally).

298. See *supra* Part III.B.1.b (discussing the construction of demand in positive-externality policy markets generally).

299. See PJM Installed Capacity Credit Mkts., 218 P.U.R. 4th 149 (Pa. Util. Comm'n June 13, 2002) (“An LSE obtains no direct benefit from purchasing [capacity] sufficient to cover its obligation, other than the avoidance of the requirement to pay a . . . penalty. Indirectly, all market participants benefit from the theoretical improvement in system reliability which results from the fact that all energy transactions are backed up by deliverable generation capacity which may not be committed to serve load outside PJM.”); Daniel Breslau, *Designing a Market-Like Entity: Economics in the Politics of Market Formation*, 43 SOC. STUD. SCI. 829, 836 (2013) (“There is no

the capacity requirement did not vary by price—essentially, the capacity demand curve was a vertical line at the required level of capacity, and the market cleared daily.<sup>300</sup> This is similar to the design of emissions trading markets for environmental pollution, such as cap and trade.<sup>301</sup> The complete insensitivity of demand to price in these early capacity markets created both peculiar pricing and severe market power problems.<sup>302</sup> The early PJM capacity market often had prices that were at the extremes of the possible range.<sup>303</sup>

To address this dysfunctional pricing, PJM did three things in its 2007 capacity market reform.<sup>304</sup> First, it instituted requirements aimed at preventing existing generators from withholding capacity from the market.<sup>305</sup> Withholding supply from the market could allow a generator to exercise market power.<sup>306</sup> Second, as discussed previously, PJM

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demand for the capacity credits that are transacted in a capacity market, at least no intrinsic interest in the credits on the part of the supposed buyers. Because reliability is a public good – investments in reliability benefit all participating in the market, not only those making the investment – LSEs will not pay for reliability on their own accord.”).

300. See Breslau, *supra* note 299, at 837 (explaining the vertical demand curve); PJM Installed Capacity Credit Mkts., 218 P.U.R. 4th at 149 (noting that the demand curve derived from PJM’s capacity requirement “approached the pathological case of a vertical demand curve”); JOHN D. CHANDLEY, ICAP REFORM PROPOSALS IN NEW ENGLAND AND PJM 12 (2005) (“The ICAP markets were thus characterized by a vertical demand curve . . .”).

301. See *supra* Part III.A (describing a simplified cap-and-trade program).

302. See Joseph Bowring, *Capacity Markets in PJM*, 2 ECON. ENERGY & ENVTL. POL’Y 47, 48–49 (2013) (noting that “market power was exercised at all times” and that “the marginal cost of daily capacity was effectively zero”). For example, assume a system operator determined that the system would require 100,000 MW of capacity for the next day. Also assume that there was only 110,000 MW available to be bid into the market and that all generators bid into the market at their opportunity costs. Since those generators were already planning to serve the market the next day, they would bid a price of zero. With supply (110,000 MWs) greater than demand (100,000 MW), the clearing price in the market would be zero.

Now assume that that one firm controlled 25,000 MW. That firm would be able to bid 14,000 MWs into the market, holding back 11,000 MW. At this point, the supply bid into the market (99,000 MWs) would be less than the demand (100,000 MW). The market price would rise, capped only by the amount of the penalty firms would have to pay for not complying with PJM regulations. In this scenario, the firm that withheld supply has exercised market power to increase the market clearing price.

303. See PJM Installed Capacity Credit Mkts., 218 P.U.R. 4th at 149 (“[T]o correct flaws in the market which were enabling a participant in the market to force prices up to or above the PJM capacity deficiency rate . . .”).

304. See *PJM Interconnection, LLC*, 117 F.E.R.C. ¶ 61,331, 62,652 (2006) (“PJM filed a proposal . . . to revise its markets to deal with current and projected violations . . .”).

305. See Bowring, *supra* note 302, at 51 (noting the objective of creating market conditions “without the exercise of market power through withholding”).

306. See *PJM Interconnection, LLC*, 117 F.E.R.C. at ¶ 62,659 (revealing that physical withholding involves actually not bidding some capacity into the market, while economic withholding entails bidding some capacity into the market at such high prices that it is effectively withheld); *Terms and Conditions of Pub. Util. Mkt.-Based Rate Authorizations*, 97 F.E.R.C. ¶

changed from daily capacity markets clearing one day before the time in question to annual markets clearing three years before the time in question.<sup>307</sup> This may have facilitated the entry of new generators into the capacity market, increasing competition. Third, PJM introduced slope into its capacity demand curve, known as the “variable reserve requirement” or “VRR” curve.<sup>308</sup> A downward-sloping demand curve (rather than the completely vertical demand curve in the previous capacity market) makes price less responsive to changes in supply, which reduces the incentive (as compared with a vertical demand curve) for generators to withhold supply in the hopes of inflating the market clearing price.<sup>309</sup> PJM made these changes for good reasons, but each of these changes introduced additional complexity into the capacity market.

In Part III.B.1, we criticized policy markets that impose a vertical constructed supply curve or demand curve, noting that they reflect an unrealistic assumption that supply or demand is unresponsive to price.<sup>310</sup> Thus, FERC and PJM should to some extent be commended for creating a demand curve for the capacity market that is responsive to price. However, the complexity of the capacity market’s demand curve and its dependence on and sensitivity to the accuracy of the

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61,220, 61,976 (2001) (explaining that to suppress physical withholding, PJM requires generators to bid all of their capacity as suppliers in the capacity market); Bowring, *supra* note 302, at 51 (explaining that to address economic withholding, PJM regulates the value of bids); *see infra* notes 347–349 and accompanying text (discussing that PJM was concerned about both physical and economic withholding).

307. *See supra* notes 279–284 and accompanying text (discussing the timing of PJM capacity auctions).

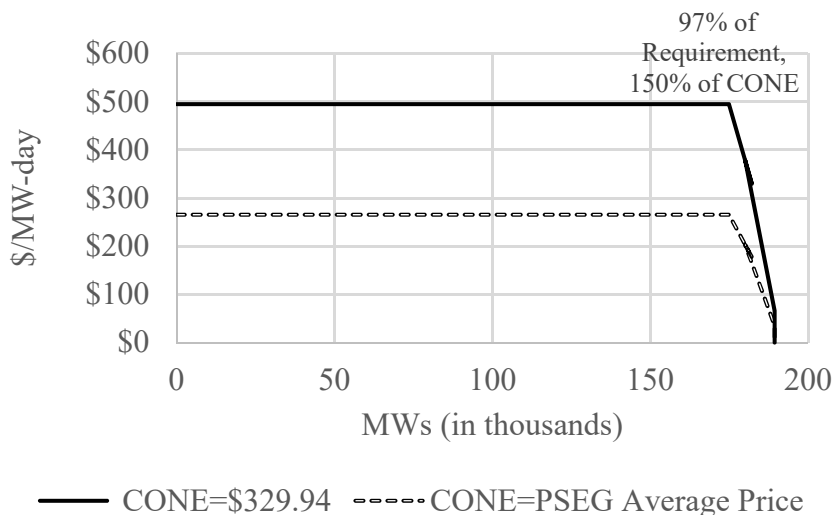
308. *See PJM Interconnection, LLC*, 117 F.E.R.C. at ¶ 62,657 (2006) (noting the PJM market’s use of the “Variable Resource Requirement Curve,” described as “a downward-sloping demand curve”); *PJM Interconnection, LLC*, 115 F.E.R.C. ¶ 61,079, 61,254 (2006) (approving the “Variable Resource Requirement,” which includes “a sloped demand curve”).

309. *See PJM Interconnection, LLC*, 115 F.E.R.C. ¶ 61,079, at 61,254 (noting that “a sloped demand curve would reduce the incentive for sellers to withhold capacity in order to exercise market power”). In addition to preventing buyer market power, a sloped demand curve has other advantages as well. It potentially more accurately reflects the actual value of capacity, which can be expected to have declining marginal value and to have value at capacity levels above the reserve requirement. *See id.* (noting that “incremental capacity above the IRM [reserve requirement] is likely to provide additional reliability benefits, which is reflected in the positive prices in the sloped demand curve to the right of IRM”). By contrast, a vertical demand curve essentially assumes that capacity in excess of the reserve requirement has no benefit. *See id.* (noting that the “additional reliability benefits” of capacity above the reserve requirement were “not reflected” in the prior vertical demand curve). The sloped demand curve also makes prices in the capacity market less volatile, which in turn makes investments in capacity less risky and perhaps reduces the cost of financing new capacity. *Id.*

310. *See supra* notes 84–97 and accompanying text (discussing the interplay of economics and energy).

estimates that underlie it highlight the difficulties of creating a precise sloped demand curve.

Figure 5: 2016/17 PJM Capacity Market Demand Curve<sup>311</sup>



The top solid line in Figure 5 illustrates the variable reserve requirement curve for the 2016/2017 PJM capacity market.<sup>312</sup> The variable reserve requirement curve derives from two elements: PJM’s forecast estimate of the capacity requirements for the relevant year and the “Cost of New Entry” (CONE).<sup>313</sup> The estimated capacity requirements drive the quantities in the demand curve because the purpose of the demand curve is to result in transactions that will ensure sufficient capacity. CONE is an administrative construct that attempts to reflect the funds that a generator would need to receive from a

311. See PJM, 2016/2017 RPM BASE RESIDUAL AUCTION PLANNING PERIOD PARAMETERS 2, 6, <https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2016-2017-planning-period-parameters-report.ashx?la=en> for capacity requirement and CONE data.

312. See Bowring, *supra* note 302, at 51–52 (enforcing the requirement for purchase capacity through the demand curve); *supra* Fig. 5 (demonstrating the variable requirement curve with the simplifying assumption that there are not binding transmission constraints between PJM zones).

313. See James F. Wilson, *Forward Capacity Market CONEfusion*, ELECTRICITY J., Nov. 2010, 25, 26 (discussing the difficulty of calculating CONE, for example, “[c]ombustion turbines are considered to be the least expensive source of incremental capacity”); *supra* Fig. 5 (using the calculated CONE for gas turbines).

capacity market to recover its costs and earn a market rate of return.<sup>314</sup>

When capacity is at a quantity below 97% of the capacity requirement of 180,346 MW—here, 174,396 MW—demand is flat at a level equal to 150% of CONE (\$495/MW).<sup>315</sup> When capacity is at a quantity approaching the capacity requirement, the demand curve is very steep (inelastic),<sup>316</sup> but not completely vertical.<sup>317</sup> Together with the inelastic supply curve in the relevant region, this implies that the market price is very sensitive to changes in demand. For example, PJM Market Monitor Joseph Bowring’s analysis shows that, for the 2015/2016 capacity market, reducing the capacity requirement by 2.5% decreased capacity market prices from \$154/MW-day to \$98/MW-day.<sup>318</sup> This implies reduced revenues from the capacity market would have been by about \$3.7 billion for that year, or approximately 38%.<sup>319</sup> Thus, a very small change in capacity market parameters can imply a very large change in the revenues consumers pay to generators.

The variable reserve requirement curve is highly dependent on the level of CONE adopted by PJM. The dotted line in Figure 5 shows what the 2016/2017 variable reserve requirement would have looked like if the CONE used was the average price in the PSEG (New Jersey) zone for 2008 to 2022 markets for \$177/MW-day, rather than the “correct” value of \$330. Note that Figure 5 implies that, given positive market prices, the higher the level of CONE, the higher the resulting market price. Further, as discussed below, capacity market prices in PJM are

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314. See *PJM Power Providers Grp. v. FERC*, 880 F.3d 559, 561 (D.C. Cir. 2018) (describing CONE as a value that “approximates the revenue that a newly constructed power generator would need to recoup its costs”); *TC Ravenswood, LLC v. FERC*, 741 F.3d 112, 115 (D.C. Cir. 2013) (“In plain English, the cost of new entry equals the hypothetical plant’s total cost of producing a unit of electricity—the cost of constructing and operating a plant divided by its expected lifetime energy output—minus what the plant will receive for selling this electricity.”).

315. See *supra* Fig. 5 (showing that for 2016/2017, the CONE for the eastern part of PJM including PSEG was calculated to be \$330 per mega-watt day (MW-day), and the capacity requirement was 180,346 mega-watt hours), demonstrating the variable reserve requirement curve can be constructed from these values and for quantities of capacity from 0 to 97 percent of the capacity requirement (174,936 MW), the demand price equals 150 percent of CONE—in our example, \$495).

316. Cf. MANKIW, *supra* note 2, at 90 (defining price elasticity of demand as “a measure of how much the quantity demanded of a good respond to a change in the price of that good”).

317. See *supra* Fig. 5 (demonstrating the demand price at 101% of needed capacity (182,149 MW) is CONE (\$330), decreasing to twenty percent of CONE (\$66) at 105% of the capacity requirement (189,363 MW) and that beyond 105% of the capacity requirement, the demand curve is a vertical line down to where price equals zero).

318. See Bowring, *supra* note 302, at 59–61 (“[T]he use of the 2.5 percent demand reduction resulted in a 21 percent reduction in RPM revenues of the 2015/2016 Base Residual Auction . . .”).

319. See *id.* (explaining that there would be “a difference of \$2.7 billion in market revenues”).



generally well below the administratively determined value of CONE, implying that PJM's CONE value is too high and, therefore, that capacity prices are too high as well.<sup>320</sup>

FERC changed the PJM variable reserve requirement curve starting with the 2018/2019 market.<sup>321</sup> FERC acted in response to a report by the consulting firm Brattle that estimated that the then-existing variable reserve requirement would lead to 1.2% loss of load events per 10 years, slightly above the industry standard of 1 event per 10 years.<sup>322</sup> Abstracting from questions of false precision, this implied that the previous variable reserve requirement was underestimating the revenues needed through the capacity market.

Instead of being defined by five points, the new variable reserve requirement is defined by four new points, which effectively moved the variable reserve requirement slightly outward and made it convex instead of concave.<sup>323</sup> Using a CONE of \$330/MH-day and a desired capacity of 180,346 MW, as in Figure 5, Figure 6 compares the new and old variable reserve requirements, where the solid line represents the old variable reserve requirement and the dashed line represents the new variable reserve requirement. Note that the new variable reserve requirement is closest to the old variable reserve requirement at a price of about 75% of CONE and moves away from the old variable reserve requirement as the price moves away from 75% of CONE.<sup>324</sup> PJM estimated that the net increase in costs to consumers would be less than 1% per year,<sup>325</sup> though our estimates are larger.<sup>326</sup> FERC reports that

320. See *infra* note 344 and accompanying text (demonstrating the issues with PJM's CONE).

321. See *PJM Interconnection, LLC*, 149 F.E.R.C. ¶ 61,183, 62,121 (2014) ("PJM proposes: (i) a revised shape for its VRR Curve . . .").

322. See *id.* ("Brattle used these results to determine whether PJM's existing VRR Curve would meet PJM's resources adequacy and other capacity market design objectives . . .").

323. See *id.* (highlighting the key points on the new variable reserve requirement). The key points are as follows: At zero quantity, price is 150% of CONE. When quantity is at 99% of the capacity requirement, price is 150% of CONE. Thus, the curve is horizontal between those quantities. When quantity is at 101% of the capacity requirement, price is 75% of CONE. When quantity is at 107.5% of the capacity requirement, price is 0. *Id.*

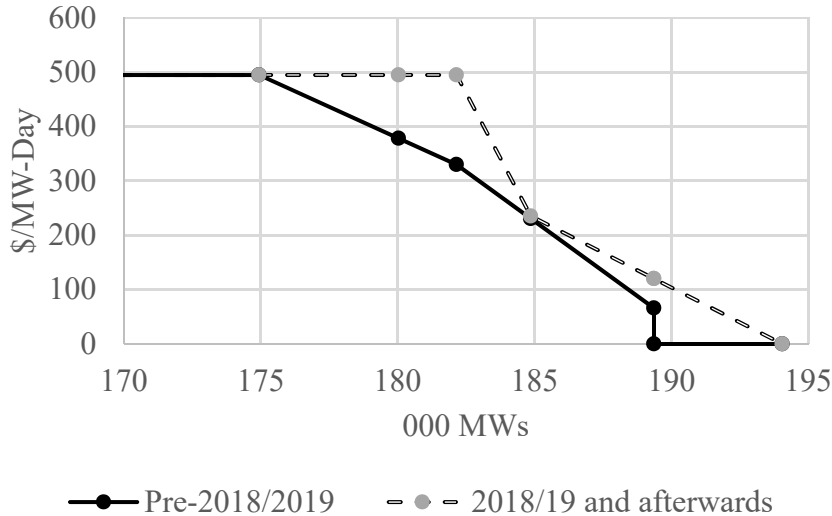
324. See *supra* Fig. 5 (demonstrating the PJM Capacity Demand Curve).

325. *PJM Interconnection, LLC*, 149 F.E.R.C. ¶ 61,183, 62,124 (2014).

326. We are unable to replicate the less than 1% result reported by FERC. The percent increase in revenues will depend on what the price would have been using the old variable reserve requirement curve. For example, using an elasticity of supply implied by Bowring, *supra* note 302, if the old variable reserve requirement would have resulted in a capacity market price of 75% of CONE, the new variable reserve requirement would increase capacity market revenues by approximately 1.7%. This, however, is the area where the two curves are closest. If the old variable reserve requirement would have resulted in a price equal to 100% of CONE, the increase in revenues would have been about 6.5%. If the old variable reserve requirement price was 50%

the rationale for a concave variable reserve requirement is that the marginal value of capacity with respect to alleviating loss of load does not decline as quickly as implied by the previous variable reserve requirement,<sup>327</sup> though it does not explain this argument in detail.<sup>328</sup>

Figure 6: Old vs. New Capacity Demand Curve



Because the constructed demand curve for PJM’s capacity market is so steep—that is, price inelastic—the market clearing price will depend greatly on the amount of supply. Unlike the demand curve, the supply curve in a capacity market is set by private companies in the market rather than regulators.

Successful suppliers in the capacity auction promise, at the risk of financial penalties for non-compliance, to have generation capacity available in the relevant period. In exchange for this obligation to provide capacity, suppliers are paid capacity market revenues.<sup>329</sup> If supply in the capacity market is competitive, suppliers can be expected to bid the money they expect they will need to reach a zero economic

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of CONE, the new variable reserve requirement would increase revenues by about 7.6%.

327. *PJM Interconnection, LLC*, 149 F.E.R.C. at 62,123.

328. We note that the new VRR continues to have the property that the higher the level of CONE, the higher the resulting price in the VRR for positive market prices.

329. See *Conn. Dep’t of Pub. Util. Control v. FERC*, 569 F.3d 477, 480 (D.C. Cir. 2009) (noting that suppliers’ bids into the capacity market “commit them to supply the amount they offer at the clearing price”).

profit,<sup>330</sup> which can be thought of as the market rate of return.<sup>331</sup>

The long-term nature of capital investment in electricity, however, adds complications to the supply analysis. Assume, for example, that an operator builds a generator, expecting it to continue producing electricity for the next twenty years. The operator is likely to continue operating, at least for a while, even if its revenues from the energy market cover only its variable costs and not its fixed costs, so that the generator is losing money on the sale—but less money than if it were not operating. The generator therefore may require no revenues from the capacity market in the short run to induce it to remain in operation. Thus, it is likely to bid zero in the capacity market. Generators who are considering either entering the generator market or exiting it, by contrast, are likely to bid positive values into the capacity market, indicating that they need additional revenues—that is, beyond what they earn in the energy market—to operate. As a result, capacity market supply curves remain at the level of a zero price for most of the relevant capacity. When the price moves above zero, the elasticity of supply is relatively inelastic. This implies that a small percentage increase in the quantity supplied can result in a large percentage increase in price.<sup>332</sup> This, in turn, implies that a relatively small change

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330. Profit refers here to economic profit, not accounting profit. See Michael A. Williams et al., *Estimating Monopoly Power with Economic Profits*, 10 U.C. DAVIS BUS. L.J. 125, 128 (2010) (“[A]ccounting profits and economic profits are very different concepts.”). Economic profit accounts for the market rate of return to invested capital. *Id.* at 135. Thus, a competitive rate of return is theoretically equivalent to zero economic profits. Accounting profits are calculated based on rules of the accounting profession that “do not reflect the true economic cost of producing goods or services.” *Id.* at 128. For example, the return on capital necessary to compensate investors for the risk of their investment does not factor into accounting profit but would be deducted from economic profit. *Id.* at 129. “Thus, a highly risky investment that generates a high accounting return may, in fact, reflect only a modest economic rate of return.” *Id.*

331. For example, assume that a (potential) generator has average incremental costs of \$400 per mega-watt (MW) day and expected revenues of \$300/MW-day. The generator can be expected to bid \$100/MW-day in the capacity market—the amount of money it needs to earn so as not to lose money by producing electricity. If the price for the capacity market is greater than \$100/MW-day, then this generator “clears” the auction and is committed to be available to supply power in three years’ time. If the market clearing price is less than \$100/MW-hour, the generator does not clear the market and can be expected to cease generation, or alternatively to continue to operate and lose money (at least in the short run). See MONITORING ANALYTICS, LLC, 2017 STATE OF THE MARKET REPORT FOR PJM 33 (2018) (describing “a forward-looking, annual, locational market”). Some generators may profit without revenues from the capacity market. These generators would be expected to bid ‘zero’ in the capacity market, a bid that would always clear. Thus, a generator whose bid does not clear the capacity market can be presumed to lose money overall, because its unaccepted bid represents the amount of revenues needed to avoid failing to cover its costs.

332. See Bowring, *supra* note 302, at 60 (explaining how supply and demand are driven in

in the demand curve (for example, the forecasted amount of capacity needed that is used in the VRR) will result in relatively large changes in market price. The most important capacity market outcome—price—is thus highly sensitive to the various administrative judgments that form the demand curve.

The amount of supply offered in the capacity market depends on which generators are allowed to participate in the market. At first consideration, it might seem obvious that regulators would want to encourage as many generators as possible to bid into the capacity market in order to maximize competition, but decisions regarding which generators to allow to participate under what conditions implicates other policy judgments, which quickly become very complicated. In particular, FERC has become concerned that unconstrained bidding from some generators may threaten the ability of capacity markets to produce “just and reasonable” prices.

The Federal Power Act directs FERC to review wholesale electricity rates to ensure that they are “just and reasonable.”<sup>333</sup> While the “just and reasonable” standard cannot be precisely defined,<sup>334</sup> it has been interpreted by agencies and courts to mean a price at which the electricity provider is able to recover its costs and earn a reasonable return on its capital investments.<sup>335</sup> Traditionally, FERC implemented the “just and reasonable” standard by directly reviewing rates in a cost-of-service ratemaking proceeding, in which the agency examines financial data and projections from a wholesale electricity provider to determine the appropriate rate.<sup>336</sup> More recently, FERC has relied on

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RPM).

333. See 16 U.S.C. § 824d(a) (2012) (“All rates and charges made, demanded, or received by any public utility for or in connection with the transmission or sale of electric energy subject to the jurisdiction of the Commission, and all rules and regulations affecting or pertaining to such rates or charges shall be just and reasonable, and any such rate or charge that is not just and reasonable is hereby declared to be unlawful.”).

334. See *Morgan Stanley Capital Grp. v. Pub. Util. Dist. No. 1 of Snohomish City*, 554 U.S. 527, 532 (2008) (“The statutory requirement that rates be ‘just and reasonable’ is obviously incapable of precise judicial definition . . . .”); *Alabama Elec. Co-op. v. FERC*, 684 F.2d 20, 27 (D.C. Cir. 1982) (noting that “neither statutes nor decisions of this court require that the Commission utilize a particular formula or a combination of formulae to determine whether rates are just and reasonable”).

335. See *City of Charlottesville v. FERC*, 774 F.2d 1205, 1207 (D.C. Cir. 1985) (stating that “just and reasonable” rates “under cost-of-service ratemaking principles” allow an electric utility to earn “sufficient revenue to cover all proper costs . . . plus a specified return on invested capital”); *Alabama Elec. Co-op.*, 684 F.2d at 27 (stating that a “just and reasonable” rate includes “the costs of providing service to the utility’s customers, plus a just and fair return on equity.”).

336. See, e.g., *NorthWestern Corp. v. FERC*, 884 F.3d 1176 (D.C. Cir. 2018) (examining FERC’s analysis of electricity rates); *Boroughs of Ellwood City v. FERC*, 731 F.2d 959 (D.C. Cir.

market competition, rather than direct supervision of rates, to ensure that rates are “just and reasonable.”<sup>337</sup> FERC has reasoned that competition results in a market price at the marginal cost of production, which covers the marginal electricity provider’s costs but does not allow it to earn monopoly profits.<sup>338</sup>

Thus, in restructured electricity markets, FERC’s concern is that market prices reflect the forces of competition. In capacity markets, that can be difficult due to vertical integration between generators and load serving entities (distribution companies). A firm that both buys and sells in the capacity market may gain advantage from bidding into the market at below its costs in an effort to drive down the market clearing price.<sup>339</sup> Although this could reduce the firm’s revenues from capacity payments, the gains to the firm from lower expenses (due to a lower market clearing price) in purchasing capacity could more than offset the lost revenue from selling capacity. FERC refers to the strategy of bidding below costs in this circumstance as “buyer market power.”<sup>340</sup>

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1984).

337. See *FERC v. Electric Power Supply Ass’n*, 136 S.Ct. 760, 768 (2016) (“FERC often forgoes the cost-based rate-setting traditionally used to prevent monopolistic pricing. The Commission instead undertakes to ensure ‘just and reasonable’ wholesale rates by enhancing competition . . .”).

338. See *Tejas Power Corp. v. FERC*, 908 F.2d 998, 1004 (D.C. Cir. 1990) (“In a competitive market, . . . it is rational . . . to infer that the price is close to marginal cost, such that the seller makes only a normal return on its investment.”); see also Jeffrey McIntyre Gray, *Reconciling Market-Based Rates with the Just and Reasonable Standard*, 26 *ENERGY L.J.* 432 (2005) (exploring FERC’s obligations to regulate the energy market and competition).

339. A firm could have, for example, 1000 MWs of generation capacity. It also might be serving a load with a peak demand for 2000 MWs. In such a case, this firm is “long” net 1000 MWs of load. Thus, on balance, as a net buyer of capacity, it might want a lower price in the capacity market than a higher price. Such a firm could be expected to bid into the capacity market at below its costs.

340. See *PJM Interconnection, LLC*, 117 F.E.R.C. ¶ 61331, 62,659 (2006) (discussing market power provisions generally and distinguishing “between sellers that are net buyers that may have incentives to depress market clearing prices below competitive levels and sellers of planned generation that may have incentives to increase market clearing prices above competitive levels.”). Assume, for example, that a capacity market equilibrium is reached at a price of \$200/MW day and a quantity of 162,000 MW. Assume that a generator owned by a vertical integrated company with 500MW of capacity had an economic cost of entry of \$250/MW-day. Due to the incentives arising from vertical integration, however, it bid a price of \$150/day. This bid cleared the market and the generator received the relevant payment. In economic terms, however, this generator should not have cleared the market. In that case, the market would have reached equilibrium by finding the next available 500 MW of capacity on the supply curve above \$200/MW-day, which would increase the market clearing price. Thus, if the bid of the vertically integrated generator is allowed the market price is considered too low, and therefore in FERC legal terms not just and reasonable.

The term *buyer market power* as used by FERC is not the same as the somewhat more

PJM created its Minimum Offer Price Rule (MOPR) to prevent buyers in the capacity market from exercising buyer market power.<sup>341</sup> MOPR regulates bids into the capacity auction for new generation resources, seeking to make sure that those bids are offered competitively, without an attempt to exercise buyer market power.<sup>342</sup> First, MOPR screens capacity offers from new generation resources to determine whether they are too low (noncompetitive).<sup>343</sup> Then, if this process deems an offer noncompetitive, MOPR requires the new resource to be bid at or above the relevant CONE.<sup>344</sup>

Figure 7 shows capacity market prices in two PJM zones: the PSEG zone in eastern PJM (New Jersey) and the Dayton zone in western PJM (Ohio). The average Dayton price of \$100/MW-day is well below the PSEG average of \$177. Also included is a line depicting the CONE for the eastern region of PJM, where PSEG is located. For every year after auction year 2010/11 the PSEG CONE exceeds the capacity market clearing price.<sup>345</sup> The CONE average price of

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commonly used term *monopsony*. In monopsony, a monopoly buyer will consume less than the economically efficient quantity of an input in order to reduce the price of that input. *See, e.g.,* ROGER BLAIR AND JEFFREY HARRISON, *MONOPSONY IN LAW AND ECONOMICS* (1991) (explaining how a monopsony works). Buyer market power, on the other hand, will change the shape of the relevant supply curve.

341. *See* *New Jersey Bd. of Pub. Util. v. FERC*, 744 F. 3d 74, 85 (3d Cir. 2014) (“MOPR,” that is designed to curb monopsony power”); *Monitoring Analytics, LLC*, *supra* note 331, at 42–43 (discussing generally the impacts of MOPR).

342. *See* *MONITORING ANALYTICS, LLC*, *supra* note 331, at 42 (explaining that MOPR addresses new entry).

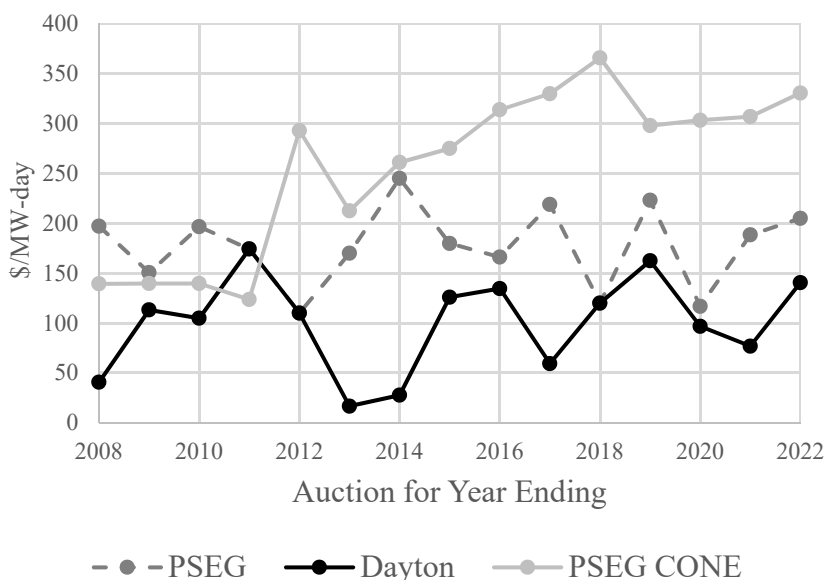
343. *See* *PJM Interconnection, LLC*, 137 F.E.R.C. ¶ 61,145, at P 2 (2011) (“The MOPR imposes a minimum offer screen to determine whether an offer from a new resource is competitive . . .”). The restriction on bidding only applies to the first year a generator participates in the capacity market and submits a market-clearing bid. *See* *MONITORING ANALYTICS, LLC*, *supra* note 331, at 265 (explaining how MOPR Screened Generation Resource are subject to the MOPR Floor Offer Price in many circumstances). Once a generator has entered a market, the sunk costs of construction presumably commit the generator to operate for several years. *See* *PJM Interconnection, LLC*, 137 F.E.R.C. at P 132 (“[C]onstruction costs become sunk.”). It thus is common for existing generators in a market to bid zero for their capacity, indicating a willingness to operate regardless of the capacity price. *See id.* (“[A] competitive offer would typically be very low . . .”). This assumption does not hold if a generator is considering exiting the market. In that case, capacity market revenues could affect the generator’s decision to stay in or exit a market, and the generator might decide to bid above zero. *See id.* (discussing possible bidding scenarios).

344. *See* *PJM Interconnection, LLC*, 137 F.E.R.C. ¶ 61,145 at P 9 (discussing a change in Net Asset Class Cost of New Entry).

345. The difference between the average prices is a statistically significant \$77.56/MW-day. Similar data, with similar results, can be generated for other PJM capacity zones. *See infra* Fig. 7 (demonstrating capacity market prices in two PJM zones). Independently, the volatility of the prices raises concerns about the capacity market’s effectiveness in sending a signal to investors to build the desired level of capacity. Price volatility creates noise in that signal.

\$255/MW-day is \$78/MW-day above the PSEG average price. (Both differences are statistically significant.) Thus, as this data implies, the PJM's CONE value is systematically too high. In turn, as the discussion relating to Figure 5 indicates, this implies that the resulting market price is too high. Simply put, it means that PJM capacity prices are higher than what is needed to provide the desired level of capacity. In addition, it also implies that the MOPR, by forcing affected units to bid at CONE, effectively excludes those units from earning capacity market revenues. This in turn will further increase the capacity market price.

Figure 7: PJM Capacity Market Prices<sup>346</sup>



As this discussion demonstrates, PJM's capacity market has become bewilderingly complex. Policy decisions and market design decisions has been layered upon each other. It is not clear that, as it makes these successive decisions, FERC has been able to maintain a focus on the overall policy market design and the core assumptions and objectives on which it is built. The agency is increasingly focused on ancillary objectives, such as buyer market power, at the risk of

346. The data underlying this figure is available at *Capacity Market (RPM)*, PJM, <https://www.pjm.com/markets-and-operations/rpm.aspx> (last visited Dec. 21, 2019), under "Delivery Years." For the relevant years listed in the figure, the data is located in the files labeled "Planning Period Parameters for Base Residual Auction" and "Base Residual Auction Results."

undermining its chief objective, which is to supply the public good of capacity at the lowest possible cost. This has become more apparent in recent decisions in which FERC has attempted to modify capacity market rules to counteract state subsidies that affect electricity generation.<sup>347</sup>

In addition to its concern about buyer market power in capacity markets, FERC has become increasingly worried about capacity bids by state-subsidized generators. FERC is concerned that subsidies of generation will artificially reduce energy and capacity prices in the near term, suppressing construction of additional generation, which will increase prices in the long term. This could lead to “boom and bust” cycles over time, caused by the inability of capacity prices to send accurate price signals to the market.<sup>348</sup> This is a potential problem for capacity markets because their purpose is to encourage investment in generation.

Significant increases in unconventional natural gas production have decreased the price of natural gas.<sup>349</sup> Lower natural gas prices, in turn, reduce the cost of producing electricity from natural gas generators.<sup>350</sup> In addition, state policies mandating and encouraging renewable generation are increasing generation of electricity from wind and solar energy.<sup>351</sup> The result has been lower energy prices for electricity and threats to the economic viability of nuclear generators across the PJM region.<sup>352</sup> Several states, including Illinois, Ohio,

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347. See, e.g., *PJM Interconnection, LLC*, 137 F.E.R.C. ¶ 61,145, at P 3 (“We are forced to act, however, when subsidized entry supported by one state’s or locality’s policies has the effect of disrupting the competitive price signals . . .”).

348. See *PJM Interconnection, LLC* 128 F.E.R.C. ¶ 61,787, at P 91 (2009) (“Although capacity prices might be lower in the short run, such a strategy will not attract sufficient private investment to maintain reliability.”). Academic studies provide some support for FERC’s concern. R.J. Briggs and Andrew Kleit’s theoretical economic model concluded that government subsidies of generation reduces resource adequacy, which can induce states to increase subsidies, further impairing market incentives for new capacity. See R.J. Briggs & Andrew Kleit, *Resource Adequacy Reliability and the Impacts of Capacity Subsidies in Competitive Electricity Market*, 40 ENERGY ECON. 297, 298 (2013) (“[T]he presence of price caps in the wholesale energy market further reduces incentives for resource adequacy.”). Extending the Briggs and Kleit model, David Brown derived that, because state subsidies would narrow the range of firms willing to supply generation, subsidies would decrease the responsiveness of the market to capacity needs. See David Brown, *The Effect of Subsidized Entry on Capacity Auctions and the Long-Run Resource Adequacy of Electricity Markets*, 70 ENERGY ECON. 205, 213 (2018) (Proposition 6).

349. See U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2019, at 71, 74 (2019) (discussing the development of natural gas).

350. See *id.* at 98 (discussing the dynamics of electricity prices and natural gas prices).

351. See *id.* at 102 (“[E]xtended tax credits account for much of the accelerated growth . . .”).

352. See *id.* at 105–06 (predicting continued retirements of nuclear power plants as a result of



Pennsylvania, New Jersey, New York, and Connecticut, have enacted or considered enacting subsidies on these plants with the stated purpose of protecting employment in state nuclear sectors.<sup>353</sup> Between the nuclear and the renewable subsidies, nearly 10,000 MWs of subsidized power are in a position to supply power to PJM.<sup>354</sup>

In a recent proceeding, captioned *Calpine Corp. v. PJM Interconnection, LLC*, FERC attacked these state subsidies on the grounds that they have an anticompetitive impact on the capacity market.<sup>355</sup> FERC reasoned that state subsidies artificially reduce the costs to generators that receive the subsidies, which allows those generators receiving subsidies to outbid other generators that do not receive subsidies and that would be successful in a purely competitive capacity market.<sup>356</sup>

In light of this concern, FERC ruled that PJM must amend its MOPR to restrict the bids of resources receiving state subsidies to prevent any uncompetitive effects from the subsidies.<sup>357</sup> FERC focused solely on counteracting the effects of state energy-specific subsidies, while apparently excluding state subsidies that are not energy-specific and all federal subsidies, energy-specific or not.<sup>358</sup> Yet, whether a

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low electricity prices).

353. See, e.g., Daniel Carson, *New Coalition Seeks to Save Ohio Nuclear Plants*, *FREMONT NEWS-MESSENGER* (Oct. 9, 2018), <https://www.wkyc.com/article/news/local/ohio/new-coalition-seeks-to-save-ohio-nuclear-plants/95-602533240>; Sonal Pakel, *Connecticut, Ohio, Pennsylvania Make Substantive Gains for State Nuclear Subsidies*, *POWER* (Nov. 1, 2017), <https://www.powermag.com/connecticut-ohio-pennsylvania-make-substantive-gains-for-state-nuclear-subsidies> (discussing generally the state of nuclear subsidies in three states).

354. See *Calpine Corp. v. PJM Interconnection, LLC*, 163 F.E.R.C. ¶ 61,236, at P 1 (2018) (“[S]upport for thousands of megawatts (MWs) of resources ranging from small solar and wind facilities to large nuclear plants.”); see also Danny Cullenward & Shelley Welton, *The Quiet Undoing: How Regional Electricity Market Reforms Threaten State Energy Goals*, 36 *YALE J. REG.* 106, 108 (2018) (referring to the “maddingly technocratic veneer” of FERC’s rule).

355. See *Calpine Corp. v. PJM Interconnection*, 163 F.E.R.C. ¶ 61,236 at P 156 (explaining the impact of a state subsidy on the energy market).

356. *Id.* at P 2. The Commission stated:

Over the last few years, the integrity and effectiveness of the capacity market administered by PJM Interconnection, L.L.C. have become untenably threatened by out-of-market payments provided or required by certain states for the purpose of supporting the entry or continued operation of preferred generation resources that may not otherwise be able to succeed in a competitive wholesale capacity market. The amount and type of generation resources receiving such out-of-market support has increased substantially. What started as limited support primarily for relatively small renewable resources has evolved into support for thousands of megawatts of resources ranging from small solar and wind facilities to large nuclear plants.

*Id.* at P 1.

357. See *id.* at P 8 (requiring regulation of capacity market bids by generators that receive subsidies, which FERC refers to as “out-of-market support”).

358. See *id.* at PP 35–41 (discussing the impact of different definitions for Material Subsidy).

subsidy distorts the capacity market, which is FERC's putative concern, does not depend on which level of government creates the subsidy or whether the subsidy is energy-specific.<sup>359</sup> Thus, FERC's attempt to counteract subsidies has no logical conclusion and theoretically requires the agency to counteract all sorts of federal, state, and local policies that affect electricity markets.

This restriction will apply to new and existing generators.<sup>360</sup> FERC gave subsidized generators two options. First, subsidized generators can bid into capacity markets at the level of CONE.<sup>361</sup> The effect of this restriction is likely to preclude a generator from receiving any capacity market payments because a bid at CONE is generally above the market clearing price in the capacity market.<sup>362</sup> Second, subsidized generators may sell capacity through bilateral contracts with electricity providers that satisfy the providers' purchasing quotas in the capacity market.<sup>363</sup> Thus, an electricity provider would have a choice between either buying capacity from generators subject to the MOPR, paying the capacity market clearing price, or engaging in some combination of the two.<sup>364</sup>

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359. *See id.* (discussing PJM's proposed definition of Material Subsidy and the different levels of government it would impact).

360. *See id.* at P 8 (directing PJM to "modify PJM's MOPR such that it would apply to new and existing resources that receive out-of-market payments, regardless of resource type, but would include few to no exemptions"). Prior MOPR restrictions on bidding applied only to new entrants.

361. *See id.* (directing PJM to apply its MOPR to "new and existing resources that receive out-of-market payments" and noting that MOPR requires generators to bid at or above CONE); *see also* Wilson, *supra* note 312, and accompanying text (explaining the concept of Cost of New Entry (CONE)).

362. *See supra* Fig. 6 (illustrating the demand curve for PJM's capacity market).

363. *See Calpine Corp. v. PJM Interconnection*, 163 F.E.R.C. ¶ 61,236, at P 161 (allowing subsidized generators to sell their capacity outside of the capacity market and load-serving entities that purchase their capacity to reduce their load in the market).

364. The precise FRR mechanism of this second approach, referred to as "Fixed Resource Requirements" (FRR), was left to be determined in future proceedings. FERC did not explain the rationale for this approach—that is, why subsidized generators should not be allowed to submit unconstrained bids into the capacity market, but should be allowed to negotiate bilateral contracts that circumvent the capacity market. FERC may be reasoning that, once subsidized generators and matching demand are excluded from the capacity market, the capacity market price will reflect competitive conditions and therefore be "fair and reasonable." Further, as Gramlich and Wilson point out, buyers of capacity should be indifferent between buying one unit of capacity unilaterally through the FRR process or purchasing that unit through capacity auctions. ROB GRAMLICH & JAMES WILSON, MAINTAINING RESOURCE ADEQUACY IN PJM WHILE ACCOMMODATING STATE POLICIES: A PROPOSAL FOR THE RESOURCE-SPECIFIC FRR ALTERNATIVE 10 (2018). Thus, the FRR price and the expected capacity auction price should be the same.

Because under the July 2018 order any FRR obligations contracted for would have to be

Under FERC's MOPR order, subsidized resources will likely choose to pursue bilateral contracts with load-serving entities rather than to take part in the capacity auction. This raises a question: should the capacity market constructed demand curve be adjusted to exclude load that has its capacity needs covered through bilateral trades? If the demand curve should be adjusted, by how much should it be adjusted? There is unfortunately no non-arbitrary answer to these questions.

FERC and PJM may decide to exclude subsidized capacity sold through bilateral contracts from the capacity market constructed demand curve and the supply curve, on the ground that the total amount of capacity sold in the capacity auction and bilateral contracts remains constant. If a generator enters into a bilateral contract with a load-serving entity, then it would make sense to reduce both supply and demand by the amount of capacity sold in the bilateral contract. Since both supply and demand move by the same amount—that is, the amount of capacity sold in the bilateral contract—the market clearing price should not change.<sup>365</sup> FERC's order in *Calpine* seems to preclude such a resolution, concluding that the clearing price in PJM's capacity market is not just and reasonable. To address FERC's concern, a capacity market design apparently must change the capacity price. Thus, FERC, under the reasoning of its *Calpine* order, would have to reject a remedy that excludes subsidized capacity sold through bilateral contracts from the capacity market constructed demand curve and the supply curve, simply because such a remedy would not change the capacity price.

Alternatively, FERC and PJM may decide to exclude subsidized capacity sold through bilateral contracts from the capacity market demand curve only insofar as subsidized capacity has “crowded out” unsubsidized capacity.<sup>366</sup> Conceptually, a sensible approach would

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taken out of the demand curve during the capacity auction, FRR sales would have to happen before that auction. In such circumstance, buyers of capacity can be expected to be indifferent between purchasing through the FRR mechanism or having the level of their capacity payment obligation set during the capacity auction.

365. Assume, for example, that a subsidized generator enters into a bilateral contract to sell 500 MW of capacity to a load-serving entity. This would imply, under the option identified in the text, reducing both supply and demand by 500 MW. In graphical terms, both the demand curve and the supply curve move 500 MW inward, or to the left. Since both the demand curve and the supply curve move the same amount, the price does not change. *See, e.g.*, Affidavit of Hung-Po Chao Aff. ¶ 9, *Calpine v. PJM Interconnection, LLC*, Docket No. EL16-49-9000 (Oct. 1, 2018) (analyzing the impacts of RCO and subsidies).

366. For example, subsidies for renewable generation are clearly meant to replace “dirty” coal and gas generators with “clean” wind and solar sources of power. Theoretically, if more firms enter a market, this drives down the price, and there are fewer profit opportunities for other firms.

involve reducing demand by the amount of unsubsidized capacity crowded out by subsidized capacity. Unfortunately, what makes sense conceptually may be impossible to implement in practice. There is no way to accurately determine the amount of crowding out. This is relevant given that the capacity market demand curve is extremely inelastic—even small shifts in the curve can cause large changes in price.<sup>367</sup>

FERC's approval of the PJM capacity market, and other capacity markets, rests on the premise that these markets create competitive conditions in which the market clearing price reflects the point at which sellers are just barely earning enough revenue to recover their costs.<sup>368</sup> Over time, PJM—often at FERC's insistence—has repeatedly made decisions that add complexity to its capacity market. These decisions are intended to reflect the complicated context of the capacity market, which is a reasonable objective. But the overall effect of the decisions has been to add artificial values and unstated and untested assumptions to capacity markets. This calls into question whether FERC had any basis in its June 2018 order to conclude that the results of the markets do not satisfy the “just and reasonable” standard. The premise of that order was that state subsidies inject policy judgments into energy markets in ways that adversely affect the competitiveness of PJM's capacity market. But, as the discussion in this section has shown, that capacity market itself is constructed administratively via numerous policy judgments. State subsidies are thus not injecting policy into a pristine market; they are simply one of many policy judgments that impact the capacity market.

FERC's concerns regarding state subsidies raise a final question about the Commission's policy judgments. Subsidies of a wide variety are endemic to markets. Energy markets are no exception. The Federal Government subsidizes nuclear power plants under the Price-Anderson Act by limiting their liability.<sup>369</sup> Numerous federal tax

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Thus, the entry of subsidized capacity into the market would be expected to reduce the quantity of unsubsidized capacity. See Briggs & Kleit, *supra* note 346 (modeling a competitive electricity market); Brown, *supra* note 346. For example, if the subsidy to a 2000 MW nuclear power plant crowded out 800 MW of new natural gas generation, the net effect of the nuclear subsidy on capacity would be a reduction of 1200 MW. The demand curve should be reduced by the net effect of 1200 MW rather than the entire 2000 MW of subsidized capacity.

367. See Bowring, *supra* note 302, at 59–61 (showing that a 2.5% reduction in required capacity for 2015/16 led to an increase in capacity market payment of \$3.7 billion.).

368. See *supra* notes 336–337 and accompanying text (discussing recent court decisions affecting FERC).

369. See Jeffrey A. Dubin & Geoffrey S. Rothwell, *Subsidy to Nuclear Power Through Price-Anderson Liability Limit*, 8 CONTEMP. POL'Y ISSUES 73, 76 (1990) (estimating the amount of the

subsidies aid the production, transport, and consumption of fossil fuels.<sup>370</sup> State subsidies exist as well.<sup>371</sup> Indeed, a PJM study group compiled a list of over one hundred different energy subsidies across the PJM states.<sup>372</sup> In a context in which subsidies proliferate so widely, it is unclear whether FERC has any principled basis to treat some subsidies as “uncompetitive,” and therefore to be counteracted in the capacity market, while other subsidies are not addressed.<sup>373</sup> If such a judgment is to be made, it would not appear that FERC, as a federal regulatory agency focused on energy markets, has any special normative expertise in making such decisions.<sup>374</sup>

## V. CONCLUSION

Market-based regulation through the mechanism of policy markets increases the efficiency of regulation by leveraging market forces to accomplish regulatory objectives while reducing regulatory burdens. In this manner, regulatory goals can be reached while significantly reducing compliance costs. Policy markets have become

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subsidy to be about \$22 million per reactor-year). There does not appear to be recent research on the magnitude of this subsidy.

370. See GOV'T ACCOUNTING OFFICE, GAO/RCED-00-301R, TAX INCENTIVES FOR PETROLEUM AND ETHANOL FUELS 5–15 (2000) (describing the legislation behind some subsidies); John A. Bogdanski, *Reflections on the Environmental Impacts of Federal Tax Subsidies for Oil, Gas, and Timber Production*, 15 LEWIS & CLARK L. REV. 323, 325 (2011) (“Their activities are blessed with many special tax provisions, which provide benefits that most businesses find enviable.”). Estimates of the magnitude of these subsidies vary greatly. Compare Benedict Clements et al., *Energy Subsidies: How Large Are They and How Can They Be Reformed?*, 3 ECON. ENERGY & ENVTL. POL'Y 1, 5 (2014) (estimating that the annual tax subsidy in the U.S. for fossil fuels is approximately \$410 billion per year), with U.S. ENERGY INFORMATION ADMINISTRATION, DIRECT FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY IN FISCAL YEAR 2016, at 2 (Apr. 24, 2018) (estimating that the subsidy for fossil fuels in the U.S. for 2016 was \$15 billion).

371. See, e.g., Act of May 12, 1999 (Pub. L. No. 26-4) (eliminating the utilities gross receipts tax on natural gas in Pennsylvania); Va. Code § 58.1-433.1 (1999) (providing a tax credit for Virginia electricity generators that purchase and consume coal mined in Virginia).

372. See *Capacity Construct/Public Policy Senior Task Force*, PJM, <https://www.pjm.com/committees-and-groups/closed-groups/ccppstf.aspx> (last visited Nov. 3, 2019) (identifying ways states could improve subsidy programs).

373. See *Calpine Corp. v. PJM Interconnection, LLC*, 163 F.E.R.C. ¶ 61,236, at 5 (LaFleur, C., dissenting) (noting the lack of clarity in how PJM will be regulated going forward).

374. For other criticisms of FERC's decisions with respect to state subsidies, see Danny Cullenward & Shelley Welton, *The Quiet Undoing: How Regional Electricity Market Reforms Threaten State Clean Energy Goals*, 36 YALE J. ON REG. BULL. 106, 130 (2018) (criticizing FERC for “allow[ing] nebulous appeals to preserving ‘investor confidence’ or ‘market integrity’” to allow fossil fuel generators to subvert state climate policies); Joshua C. Macey & Jackson Salovaara, *Rate Regulation Redux*, 168 U. PA. L. REV. (forthcoming 2020) (criticizing FERC's decisions as “fossil fuel bailouts”).

more common as more policy advocates and commentators have come to accept the basic economic principles underlying them. These markets, however, are not simple. Embedded into them are a host of policy and political challenges that tends to push policy markets toward greater complexity.

Policy markets are most effective when they are large and simple because those are traits that facilitate cost-reducing transactions. Keeping policy markets large and simple, however, requires oversimplifying reality. Every policy market therefore poses a complexity dilemma for regulators: increase efficiency by simplifying or reflect reality by complicating. Both factors—accurately reflecting reality and creating an efficient market—instrumentally advance the objectives of the policy market, so there is no clear answer to the dilemma.

As the emissions trading and capacity market case studies in this Article illustrate, no policy market is nearly as simple either in concept or in operation as the textbook cap-and-trade market. Policy market design requires regulators to make difficult decisions about how to construct administrative demand or supply curves, whether and how to differentiate among products traded in the market, and how to balance numerous policy objectives. There is often little theoretical guidance to direct these decisions. This is in contrast to typical markets, where market forces can ably make these decisions without government intervention. The inherent complexity of policy markets reduces the cost reductions available from trade and forces challenging decisions for regulators.

The original Acid Rain Program policy market for sulfur dioxide emissions was a significant success in economic terms. It was also, not coincidentally, a relatively simple policy market. Yet, the Acid Rain Program's simplicity was only possible by overlooking what turned out to be important differences in the location of emissions. When the Transport Rule eventually implemented an emissions trading program that accounted for locational differences, it had to impose complicated locational constraints, based on highly complex environmental models. This complexity reduces the trades that can be made, limiting the ability of this policy market to reduce regulatory burdens—while, for the same reasons, also more accurately reflecting reality.

The challenge of managing complexity in policy market design becomes overwhelming in the context of FERC-approved electricity capacity markets. The design of capacity markets requires difficult decisions about geographic areas of trading, product definition, and

market timing. It also requires the creation of a market demand curve for capacity. In theory, such a demand curve should represent the marginal value of additional generating capacity to the electricity grid. In practice, this has resulted in PJM capacity market prices that are consistently higher than what is needed to reach the relevant policy goal.

FERC's recent decision to restrict participation by state-subsidized generators in PJM capacity markets signals a particularly worrisome development. Capacity markets interact with numerous other energy policies and markets. The idea that FERC can somehow create a pristine market insulated from other public policies sets up the agency for a whack-a-mole game in which it is bound to fail—and could lead to perpetual conflict with state regulators attempting to pursue their own policy objectives. More dangerous, FERC's efforts to pursue these ancillary objectives appear to have led the agency unwittingly to undermine some of the fundamentals of its capacity market. In short, chasing reality without regard to complexity has taken FERC “A Bridge Too Far”<sup>375</sup> and serves as a cautionary example for other regulators designing policy markets.

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375. See CORNELIUS RYAN, *A BRIDGE TOO FAR* 89 (1974) (purporting to quote British Lieutenant-General Frederick Browning warning Field Marshal Bernard Montgomery before the disastrous Battle of Arnhem, “I think we may be going a bridge too far”).