EXECUTIVE SUMMARY

Lessons from the Clean Air Act

Building Durability and Adaptability into U.S. Climate and Energy Policy

Ann E. Carlson and Dallas Burtraw

AMERICAN ACADEMY OF ARTS & SCIENCES

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To Bob Fri (1935–2014),
our intellectual leader on this project
and our dear friend.

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Study Group on Durability and Adaptability in U.S. Climate and Energy Policy

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and edited the chapters in *Lessons from the Clean Air Act* to create this companion executive summary.

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EXECUTIVE SUMMARY

Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy

Meeting the climate challenge will require a massive transition to a largely decarbonized economy—one that scientific consensus tells us must occur over the next four and a half decades. As the United States' recent retrenchment from its climate efforts underscores, any meaningful policy solution will need to be **durable** enough to produce emissions reductions over the course of decades, long after the coalition that led to its adoption gives up the reins of power.

But durability alone will not suffice. Policies will need to be **adaptable** to new scientific, technological and economic information. What if initial targets for emission reductions are too lax? What if technological change occurs more rapidly and at lower cost than previously predicted? What if we discover that a particular greenhouse gas is accumulating in the atmosphere at a faster rate than anticipated? What if warming is occurring at the lower rather than higher end of current predictions?

The transition to a largely decarbonized economy in the next four decades will be enormously complex and massive in scope. To achieve as many emissions reductions as possible at the lowest possible cost, policy also cannot be overly prescriptive; it will be far more effective if regulated entities can respond to **flexible** policy using their own knowledge and perspective.

In *Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy* (Cambridge University Press, 2019), the authors suggest that well-designed energy policy should reflect and account for these three characteristics—durability, adaptability and flexibility—recognizing the tensions and complementarities among them. The Clean Air Act (CAA)—the most important domestic environmental framework of the last century—offers a single institution that has all

Key Findings

1. **Healthy—but not unlimited—agency discretion is necessary for adaptability.** One of the most difficult questions policymakers face in addressing climate change is how to appropriately balance administrative discretion and constraints on that discretion. Experience with the CAA suggests that broad agency discretion is imperative to adaptability, but that it should be constrained by backstops like deadlines for compliance, citizen suits and federalism arrangements to avoid inaction.

2. **Durable policy is related to its adaptability.** Regularized adaptability, with built-in processes for incorporating new information, will make energy policy more durable by providing clear signals to regulated parties and safeguarding against the elimination of a regulation under new political leadership.

3. **Flexibility is important to a policy's durability and adaptability.** Flexibility can make long-term energy policy more *durable* by ensuring the cost of regulation is not prohibitive and more *adaptable* by producing information about cost-effective technologies that can lead to additional greenhouse gas reductions over time.

4. **Political challenges inform the balance between durability and adaptability.** Evaluation of CAA programs suggests that politics matter in particular ways that are highly relevant to initial design choices about the appropriate balance between durability and adaptability. Given the gridlock besetting Congress and the highly politicized nature of the climate change issue, the authors recommend that policy should be crafted to maximize the discretion and flexibility granted to the implementing expert agency.

5. **The CAA's provisions are intertwined in ways that affect adaptability, durability and flexibility.** The CAA programs analyzed by the authors do not act in isolation; for example, greenhouse gas regulation arose in part because of statutory provisions covering automobiles and stationary sources, but it is also the result of a broad definition of air pollutants that led the US Supreme Court to hold that greenhouse gases fit within the definition.

6. **Process and cooperative federalism are key ingredients of the CAA's success.** The processes of the CAA, including citizen suits and notice and comment, as well as the role of cooperative federalism in sharing responsibility among levels of government, provide engines of progress and stability in achieving environmental goals. They should be important components in the future design of energy and climate policy.

three attributes under its rubric. Over the course of its fifty-year history, the CAA has contributed to massive reductions in harmful air pollutants and endured significant ideological and political change. Even today, as the country shifts from eight years of proactive environmental initiatives under President Obama to a period of administrative retrenchment under the Trump administration, many of the features of the CAA—from federalism arrangements to statutory deadlines to citizen suits—will likely keep it moving forward.

With the CAA as its centerpiece, *Lessons from the Clean Air Act* challenges five prominent energy policy scholars to examine how the Act has exhibited durability, adaptability and flexibility—and, in some cases, how it has failed to do so. From these case studies, the authors draw six key lessons on how policymakers can incorporate mechanisms to ensure a long-lasting but evolutionary and cost-effective approach to cutting greenhouse gases to almost zero. The analysis is helpful not only at the federal level but also for state policymakers focused on regulating carbon emissions from their transportation and electricity sectors, and ultimately for buildings and industry.

Why Durability, Adaptability and Flexibility are Needed for Sound Energy Policy

The transportation and electricity sectors, as well as buildings and industrial facilities, are infrastructure intensive and involve large capital investments that often last many decades. Some power plants in the United States were built over seventy years ago.[1] The average age of the nuclear fleet is approaching forty years.[2] Cars built today can last for 150,000 miles or more with an average lifetime of fifteen years,[3] heavy-duty trucks may stay on the road for thirty years, and US rail cars, ships and airplanes remain in

1. See Steven Mufson, "Vintage US Coal-Fired Power Plants Now an 'Aging Fleet of Clunkers,'" *The Washington Post*, June 13, 2014, https://www.washingtonpost.com/business/economy/a-dilemma-with-aging-coal-plants-retire-them-or-restore-them/2014/06/13/8914780a-f00a-11e3-914c-1fbd0614e2d4_story.html?utm_term=.58b4def10fce.

2. See US Energy Information Administration, "Frequently Asked Questions: How Old Are US Nuclear Power Plants, and When Was the Newest One Built?" June 21, 2017, http://www.eia.gov/tools/faqs/faq.php?id=228&t=21.

3. National Highway Transportation and Safety Administration, *Final Regulatory Impact Analysis, Corporate Average Fuel Economy for MY 2017–MY 2025 Passenger Cars and Light Trucks* (Washington, D.C.: US Department of Transportation, 2012).

operation for decades.[4] The United States will need stable, durable policies across multiple decades to induce the innovations required to decarbonize these capital-intensive industries by mid-century. Stability and durability in policy will provide the signal necessary to investors and innovators to develop technologies and systems that can help accomplish the United States' long-term emissions goals. Stability and durability will also reduce the attendant risk that accompanies investments in the research and development of these technologies.

By stability and durability, however, the authors do not mean that a policy must be fixed for the next forty-five years. Instead, they advocate for a policy framework that continues to accomplish the objectives for which it was adopted, long after it was adopted. In political terms, they argue that a durable policy outlasts its initial supporters. And the policy must accomplish its goals even in the face of changes in scientific knowledge, technological innovation and economic change.[5]

To maintain its effectiveness for multiple decades, a durable policy must also, then, include mechanisms to adapt to new information about science, technology and economics. The world will not remain static over the next several decades: already, the electricity and transportation sectors are transforming with a rapidity that is outpacing predictions of just a few years ago. At the same time, the methods to adapt policy to new information must be predictable, the authors believe, in order to provide clear signals to regulated industries that policies will change. Put a different way, the country needs durable yet evolving policy that—through its adaptive mechanisms—is predictable.

Flexibility adds a third element to many successful policies. Regulators want to get the biggest bang for the buck out of regulations that impose costs on the economy, but they often lack complete knowledge about where to find the biggest bang. A flexible approach will provide incentives to a group of regulated entities to reduce emissions, rewarding those individual entities that can reduce the most and operate most cleanly, while calibrating the overall effort to meet environmental goals.

4. California Environmental Protection Agency Air Resources Board, *Draft Supporting Information For Technology Assessments: Truck And Bus Sector Description* (Sacramento: California Environmental Protection Agency, 2016).

5. Eric M. Patashnik, *Reforms at Risk: What Happens after Major Policy Changes are Enacted* (Princeton, N.J.: Princeton University Press, 2008).

Durability, Adaptability and Flexibility in the Clean Air Act

The Clean Air Act is a remarkable statute in its accomplishments. Over the course of its fifty-year history, it has resulted in large reductions in harmful air pollutants. These reductions have occurred across all areas of the country, a wide range of pollutants and a huge number of sources, including in the electricity and transportation sectors that must be at the heart of long-term climate and energy policy. All six of the pollutants covered by the National Ambient Air Quality Standards (NAAQS) have declined significantly: Carbon monoxide is down 86 percent on average nationwide. Lead has declined 99 percent. Nitrogen dioxide has declined 60 percent and sulfur dioxide 84 percent. Ozone, which remains one of the toughest pollutants to control, is down 32 percent. And in the fifteen years since the Environmental Protection Agency (EPA) began regulating fine particulate matter (PM2.5, or particles smaller than 2.5 micrometers in diameter), concentrations have fallen 37 percent.[6] All of these declines have occurred while the US economy has grown dramatically (16-fold since 1971)[7] and the population has increased by 150 percent.[8] The challenge facing the United States is to achieve comparable declines in greenhouse gas emissions over a roughly similar period of time, by mid-century; this makes the CAA an important statute to study.

The longevity of the CAA demonstrates another of its rather remarkable accomplishments: it has endured through significant ideological and political change, as the country has elected both Republican and Democratic presidents throughout the statute's history. The CAA was first enacted with broad bipartisan support and signed into law by a Republican president (Nixon), saw major amendments in 1977 under a Democratic president (Carter), and another round of major amendments in 1990 under George

6. These figures come from the US EPA's Air-Trends reporting. See US Environmental Protection Agency, "National Air Quality: Status and Trends of Key Air Pollutants," https://www.epa.gov/air-trends.

7. According to the National Bureau of Economic Analysis, gross domestic product was, when adjusted for inflation, $1,137.8 billion in the first quarter of 1971, when the CAA took effect, and $18,164.8 billion at the end of 2015 (EPA data about pollutants are through 2015). See US Department of Commerce, Bureau of Economic Analysis, "National Data: GDP and Personal Income," https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2#reqid=19&step=2&isuri=1&1921=survey.

8. See US Census Bureau, "Historical National Population Estimates: July 1, 1900 to July 1, 1999," https://www.census.gov/population/estimates/nation/popclockest.txt [showing 1971 US population as 207.66 million people]; and US Census Bureau, "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2015," https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk [showing 2015 US population as 321.42 million people].

H. W. Bush. Since its passage in 1970, very different administrators with very different ideological predilections have led the implementing agency. Yet even in the face of the current administrative retrenchment, the CAA is protected by features like federalism arrangements, statutory deadlines and citizen suits and will likely continue to move forward.

In addition to durability, the statute has also exhibited adaptability by providing a regularized administrative process that allows agencies to respond to new information. Regulated parties are on notice that the CAA will adapt, but only with significant lead time, an opportunity for broad public participation and the input of sophisticated scientific and technical experts.

Flexibility through market-based mechanisms has been another key ingredient of some of the most successful regulations under the CAA. The Acid Rain Trading Program and NO_X Budget Trading Program, for example, both led to significant pollution reductions while allowing regulated entities to reach compliance at their lowest possible cost through the trading and banking of emissions permits. However, in some cases, provisions of the CAA have undermined environmental outcomes and threatened the durability of some initiatives.

At the heart of *Lessons from the Clean Air Act* are five case studies in which the authors discuss how a variety of mechanisms in the CAA promote—and in some cases undermine—flexible, adaptable yet durable policy:

- Law professor William Boyd focuses on **the National Ambient Air Quality Standards** to show how this centerpiece of the CAA has produced significant reductions of major pollutants across multiple decades. His chapter also sets the stage for those that follow, given the centrality of the NAAQS in the way the CAA operates.

- Law professor Hannah Wiseman examines **the regulation of stationary sources** of air pollution—that is, factories and industrial plants—under the CAA. Her comprehensive account of the many regulatory programs under the CAA show both real successes in establishing durable yet adaptable policy as well as some significant failures.

- Political scientist Barry Rabe addresses **the regulation of mobile sources** of air pollution. He focuses on the CAA's unique federalism arrangement—which gives California special authority to regulate emissions from cars, trucks and other mobile sources while preempting all other state authority to regulate separately—and shows how it has been among the most durable yet adaptable provisions.

- Economist Joseph Aldy looks at the CAA's **regulation of fuels**, in which the story of durability and flexibility is perhaps most mixed.

The CAA has produced some great successes in its regulation of fuel—for instance, the elimination of lead from gasoline—as well as one of its greatest failures to date: the attempt to produce low-carbon renewable fuels.

- Political scientist Eric Patashnik offers an account of a regulatory approach—**the use of market-based tools**—that cuts across multiple parts of the CAA. Among his findings are that several market-based programs have proven to be less durable than more traditional regulatory programs, and that the CAA has not always provided EPA with the adaptability necessary to design market-based programs effectively. Other market-based programs have proven to be more successful in promoting adaptability, durability and flexibility, however, and his chapter provides important insights about how and why.

Six Key Lessons for Climate Change Policy

From these case studies, the book draws six overarching conclusions to help guide future climate efforts. The first three directly address the core concepts of durability, adaptability and flexibility. The fourth conclusion considers the reality that the United States has experienced, and continues to experience, sudden swings in political outcomes and the ways in which long-term policy goals have and can continue to endure in this context. The fifth conclusion reflects on the ways that the core concepts of the CAA are intertwined and mutually dependent. Finally, in search of guidance for the development of climate policy, the authors observe that two features of the CAA have come up time and again in addressing the core concepts of their study: process and cooperative federalism. These unusual features have played an important role in the success of the CAA over nearly half a century.

1. Healthy—But Not Unlimited—Discretion Is Necessary for Adaptability

One of the most difficult questions policymakers face in addressing a pollution problem on the scale of that driving climate change is how to achieve the appropriate balance between administrative discretion and constraints on that discretion. In theory, the more discretion an agency is given to address a pollution problem, the more adaptable the policy is likely to be over time. However, analysis of the discretion provided in the CAA leads to a somewhat counterintuitive conclusion: in seeking to promote adaptable governance, legislation can provide *too much* discretion to an agency, just as it can be too prescriptive. Wide-open discretion, unbounded by deadlines and without at least some constraining guidelines, may lead to agency inaction.

If an agency is given broad discretion to develop regulations, various mechanisms can enhance the likelihood that the discretion will be exercised. One mechanism is to set a statutory deadline for compliance that is subject to a citizen suit provision. The combination of broad delegated authority to EPA to establish the NAAQS, statutory deadlines requiring review of the NAAQS every five years and citizen suits that require EPA to meet those deadlines has led to what the authors find to be among the most powerful adaptive mechanisms in the CAA.

Another strategy is to have states as backstop or concurrent regulators. California's special authority to regulate mobile sources, for example, has led to its long history of tightening automobile emissions standards. Once California demonstrates that a particular standard is feasible, the federal government often reacts by following suit and revising the federal standard to assimilate California's. Hence, California's use of its authority provides a means to push EPA to use the broad discretion it is given under the CAA to regulate mobile sources.

When designing climate policy, providing the implementing agency with little to no discretion to adapt can mean that necessary pollution reductions will not be addressed. The CAA provides some important cautionary examples. Exempting specific sources from regulation (like existing sources under the CAA) or setting emissions reduction levels by statute with no mechanism for adjustment is likely to lead to significant delay in addressing further reductions. This may be particularly true in addressing greenhouse gas emissions because of the super wicked nature of the problem. As a number of observers have described, many attributes of the problem of climate change make political action to solve it especially difficult. Thus, in crafting long-term energy policy, it is imperative that policy be made adaptable by giving agencies sufficient discretion to respond to ongoing problems.

2. Durable Policy Is Related to Its Adaptability

The authors' analyses of policies that are durable yet adaptable lead to a second conclusion: policies that include *regularized* adaptability, with built-in *process*, can make policy more durable. Regularized process has provided both predictability and legitimacy to regulated parties, to courts reviewing EPA rulemakings and to the public. Well-designed procedures can provide clear signaling about a regulation's future, helping stakeholders to form expectations that guide their own decisions.

Moreover, regularized process also safeguards against the potential arbitrary removal of regulations that might otherwise result from a sudden change in political leadership. Regulations under the CAA are undergirded by scientific data. While political preferences can change and

democratically elected officials may even want to eliminate regulations, it takes time to unwind regulations that have been carefully and transparently built around the state of the science and technology. The process that enables policy evolution therefore also safeguards durability in the face of fickle short-run political outcomes.

A number of CAA programs demonstrate the relationship between process, durability and adaptability. The most comprehensive is the NAAQS program. Not only does the NAAQS review process contain a statutory deadline, but it also has been accompanied by a rigorous scientific review process. The process, though lengthy, contributes to public legitimacy through exhaustive analysis of the underlying science. It has also resulted in courts largely deferring to EPA judgments about where to set the NAAQS provided that those decisions are based on the best available science. And the inclusion of a regularized decision-making process allows regulated parties to anticipate and plan for strengthening of pollution standards.

By contrast, the Renewable Fuel Standard annual rulemaking process to establish yearly biofuel targets has faced a series of difficulties, occasionally resulting in the announcement of annual targets for years that have already ended. This process has led to widespread criticism and legal challenges and, unless reformed, could eventually lead to its demise.

Climate change is a long-run challenge, and mitigating greenhouse gas emissions requires long-term commitments to research, investments and infrastructure. In designing climate policy, then, it is important to put in place a process that requires the administering agency to gather and incorporate new scientific and economic information into a regularized process that requires policy to evolve in response to new information.

3. Flexibility Is Important to a Policy's Durability and Adaptability

Incorporating flexibility into the implementation and enforcement of CAA policies is important to produce cost-effective measures to reduce pollution that draw upon the expertise and incentive structure of private regulated entities. But flexibility is also important to the *durability* of various provisions of the CAA. Indeed, the cost of regulation in a complex and dynamic setting could be prohibitive without flexible approaches to pollution reduction, and inflexible policies could ultimately undermine the political viability of the CAA. Flexibility can make policies *adaptable* by producing information about cost-effective technologies that can lead to additional pollution reductions over time.

The most well-known flexible mechanism, cap-and-trade, served as the centerpiece of the Acid Rain Trading Program. In addition to geographic flexibility in deciding where emissions reductions could be achieved at least cost, the program conveyed temporal flexibility through the ability to

bank emissions allowances in anticipation of a tighter cap in the second phase of the program. This option provided firms flexibility to rationalize their investment decisions and led to earlier-than-required environmental improvement. The success of the Acid Rain Trading Program led, in turn, to other applications of emissions trading, including a regional cap-and-trade program to reduce NO_x emissions, which EPA extended to additional states. Successful implementation of the flexible implementation mechanism through the Acid Rain Program, in other words, led to adaptive regulation in other programs to address other pollutants that cross state borders.

The CAA's experience with regulation fuels, however, provides a cautionary tale of flexibility mechanisms in the reformulated gasoline program, which gives refiners the ability to decide which volatile organic compounds (VOCs) to reduce. The result has been that many refiners have reduced the less-reactive VOCs, which has led to lower total ozone reduction benefits than had refiners reduced more reactive VOCs. This case illustrates that effective flexibility mechanisms must allow regulated entities to reduce their compliance costs without giving them the flexibility to deviate from the desired environmental outcomes.

Mitigating climate change will be the most expensive environmental policy in history, and achieving long-term goals depends on doing so in a cost-effective way. It will be important, for example, to allow emitters both temporal and geographic compliance flexibility in making large greenhouse gas reductions. If cap-and-trade is the chosen regulatory mechanism to reduce emissions, allowance banking and a broad geographic reach will be critical to providing the flexibility necessary to solidify long-term policy. If, instead, a carbon tax is the chosen means to regulate, designers should ensure sufficient geographic and temporal flexibility to achieve greenhouse gas reductions while maximizing cost-effectiveness.

4. Political Challenges Inform the Balance between Durability and Adaptability

It may seem axiomatic that politics matter in crafting long-term energy policy. But the fourth broad conclusion suggests that politics matters in particular ways that are highly relevant to initial design choices about the appropriate balance between durability and adaptability.

The climate policy process will take decades and ideally would include relatively frequent Congressional evaluation to ensure that the goals are being met in the most equitable, cost-effective and efficacious ways possible. The Clean Air Act amendment process worked that way for two decades after its passage, with two major amendments in 1977 and 1990 to address areas that needed reform or updating. Since 1990, however, Congress has largely stayed on the sidelines and let EPA do the regulating with its extant authority.

This inaction raises the question of how much discretion to afford an agency tasked with decarbonizing the United States' energy sectors. If the current gridlock besetting Congress persists, in designing climate policy it might be safe to assume that should Congress eventually act to reduce greenhouse gases, it will get only one crack at the effort. Conversely, if regulatory issues remain highly politicized, swings in policy goals could make durable policy challenging and expensive, with progress only in fits and starts. Given the current political environment, policy should be crafted to maximize the discretion and flexibility granted to the implementing expert agency, consistent with other conclusions about including regularized process and backstops like deadlines, citizen suits and federalism arrangements.

5. The CAA's Provisions Are Intertwined in Ways that Affect Adaptability, Durability and Flexibility

A fifth conclusion is that the CAA programs analyzed by the authors do not act in isolation. Here are several examples:

- California uses its unique mobile source authority in large part because it is required to meet National Ambient Air Quality Standards.
- The success story of eliminating lead from gasoline is in part the result of EPA authority to regulate both tailpipe emissions and fuels, in part because the agency chose effective and flexible tools for doing so and in part because EPA listed lead as a NAAQS and eliminating lead from gasoline was one of the most effective tools for meeting the NAAQS.
- The regulation of greenhouse gases from automobiles, existing power plants and new sources is in part the result of statutory provisions covering automobiles and stationary sources. But it is also the result of a broad definition of air pollutants that led the US Supreme Court to hold that greenhouse gases fit within the definition.
- The regulation of mercury and other hazardous air pollutants from coal-fired power plants leads to large reductions in other pollutants, including NAAQS pollutants like fine particulates. Thus, even though the existing/new source distinction the CAA makes in regulating stationary sources has kept many coal-fired power plants in operation long after initial predictions, the regulation of hazardous air pollutants is now bringing about NAAQS reductions indirectly.
- The market-based programs that arose out of the good neighbor provision of the CAA have helped achieve cost-effective NAAQS reductions from existing stationary sources, such as coal-fired power

plants that might otherwise be exempt from stationary source provisions, like New Source Review. This is because the flexible compliance mechanisms of the cap-and-trade programs allow the regulated party, rather than the regulator, to decide where to make the reductions.

6. Process and Cooperative Federalism Are Key Ingredients of the CAA's Success

Finally, it is important to emphasize that two design elements have played highly important roles in the history of the CAA: process and cooperative federalism.

Process subsumes many of the features the authors mention, including formal fact finding, peer review, notice and comment, citizen lawsuits and other details of making, implementing and enforcing rules and regulations. Process can be time consuming, tedious and frustrating. Sometimes critics of the frequently slow pace of promulgating regulations complain that process gets in the way of progress. But when political tides change, the same process can protect the carefully constructed design of regulatory programs from short-run political gamesmanship.

A second design element built into the CAA that frequently shines is **cooperative federalism**, the division of authority between levels of government. Cooperative federalism has often led to policy and technical innovation and has played an essential role in enabling the adaptability of the CAA and ensuring the durability of environmental outcomes. The authors have observed examples of this in the implementation of the NAAQS and in the very first applications of emissions trading and other approaches to incentive-based regulation, in which states have been test beds for new ideas. In standard-setting and planning, subsidiary jurisdictions must meet federal standards, but also are sometimes permitted to set more ambitious ones. Under the CAA, this idea has enabled state-level ratcheting of stringency, which sometimes propagates into an evolution into federal standards. With respect to climate policy under the CAA, the technical findings of EPA, which provided a legal determination of adequately demonstrated technologies for greenhouse gas emissions reductions under the Clean Power Plan, were in fact built almost entirely on experience and actions taken by the states in various energy efficiency, renewable technology and carbon dioxide cap-and-trade programs.

The process of the CAA and the role of cooperative federalism in sharing responsibility among levels of government might serve well in the future design of energy and climate policy. For example, even when the federal government enacts comprehensive policy including carbon pricing, that policy might be implemented by an expert agency, such as EPA, which could pursue a formal process to evaluate and reform the policy in

order to achieve statutory goals. In the likely event that policy has multiple dimensions affecting ubiquitous emissions sources, Congress might again invoke the power of cooperative federalism to achieve outcomes in innovative ways. Indeed, it is worth remembering that under the CAA, the original authority for regulation rests with the states and is only taken up to the federal level through overt action. Congress would do well to consider that balance carefully.

Conclusion

The hope is that these six broad conclusions, and the more in-depth analyses the authors have conducted in *Lessons from the Clean Air Act*, can provide guidance for a long-lasting, evolving and cost-effective energy and climate policy for the rest of this century.

Finding the right balance between discretion and prescription will be critical to making long-term energy policy adaptable. Perhaps counterintuitively, the CAA demonstrates that adaptability may actually produce policy durability and will be crucial in enabling long-term emissions reduction in US energy sectors. Flexibility in compliance, too, can enhance both durability and adaptability, particularly given the scope and scale of the climate change problem.

In designing long-term climate policy, legislators will also need to be sensitive to the likelihood that they will engage in necessary revisions in the future; if revision and reform are unlikely, or might come too often, the implementing agency should be given more discretion to adhere to science and adapt to new information (but with processes designed to check excess discretion).

Additionally, paying attention to the interactions between and among a statute's provisions may well enhance the adaptability, durability and flexibility of the statute. The authors find that policies across a complex statute like the CAA can be mutually reinforcing so that broad definitions combined with regulatory discretion, for example, can produce adaptable, effective regulation.

And finally, future energy and climate policy should consider the crucial roles of regulatory process executed by an expert agency and cooperative federalism as mechanisms that maintain momentum while enabling democracy in pursuit of initial and potentially far-reaching legislative goals.

Designing long-term climate and energy policy in a very dynamic and complex world is one of today's greatest policy challenges. The CAA's successes in continuing to address pollution problems for fifty years in innovative and cost-effective ways provide a story that can guide policymakers in addressing this challenge.

Timeline of major legislation, agency actions and judicial decisions affecting the regulation of NAAQS, regulation of stationary sources, relationship between federal and California emissions standards, regulation of fuels and use of market mechanisms. Adapted from *Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy*, Cambridge University Press, 2019.

1959
California begins developing first modern air pollution control regime

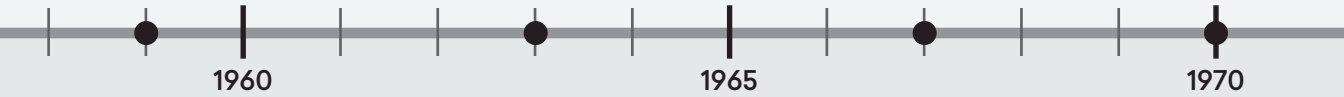
CAA of 1963
Federal research on air pollution; grants to states; authorizes abatement conferences for interstate pollution

Air Quality Act of 1967
establishes air quality management approach; directs states to develop air quality criteria and standards; authorizes creation of air quality control regions

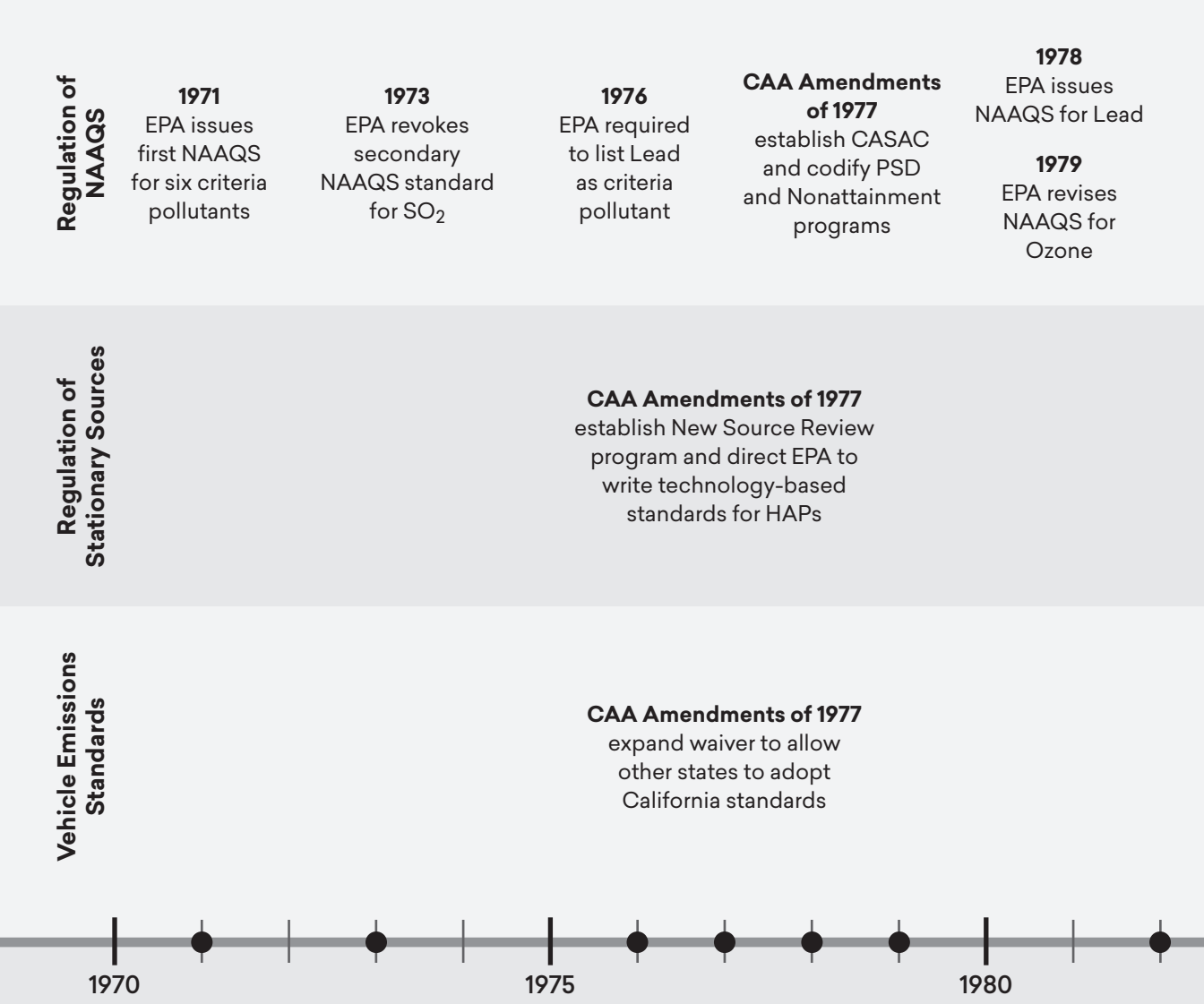
CAA Amendments of 1970
establish NAAQS Program

CAA Amendments of 1970
direct EPA to set NAAQS and identify and write standards for HAPs; establish New Source Performance Standards; direct states to write SIPs

Air Quality Act of 1967
introduces California waiver process



CAA Amendments of 1970
grant EPA the authority to regulate the composition of fuels and fuel additives


Regulation of NAAQS
1971
EPA issues first NAAQS for six criteria pollutants
1973
EPA revokes secondary NAAQS standard for SO_2
1976
EPA required to list Lead as criteria pollutant
CAA Amendments of 1977
establish CASAC and codify PSD and Nonattainment programs
1978
EPA issues NAAQS for Lead
1979
EPA revises NAAQS for Ozone
Regulation of Stationary Sources
CAA Amendments of 1977
establish New Source Review program and direct EPA to write technology-based standards for HAPs
Vehicle Emissions Standards
CAA Amendments of 1977
expand waiver to allow other states to adopt California standards
1970
1975
1980
Regulation of Fuels
1974
EPA begins to mandate the phase-down of lead in gasoline
CAA Amendments of 1977
1982
EPA establishes more ambitious lead phase-down targets and creates a flexible compliance regime
Use of Market Mechanisms
CAA Amendments of 1977
1982
EPA allows refineries to trade lead credits

1984
EPA removes Hydrocarbons from list of criteria pollutants

1987
EPA issues revised NAAQS for PM10

CAA Amendments of 1990
strengthen connections between the NAAQS and other CAA programs; new provisions added to Nonattainment programs

CAA Amendments of 1990
establish list of HAPs; set more stringent limits for SO_2 and NO_X emissions; establish SO_2 allowance trading program

CAA Amendments of 1990
include new federal standards for mobile sources directly linked to existing California standards

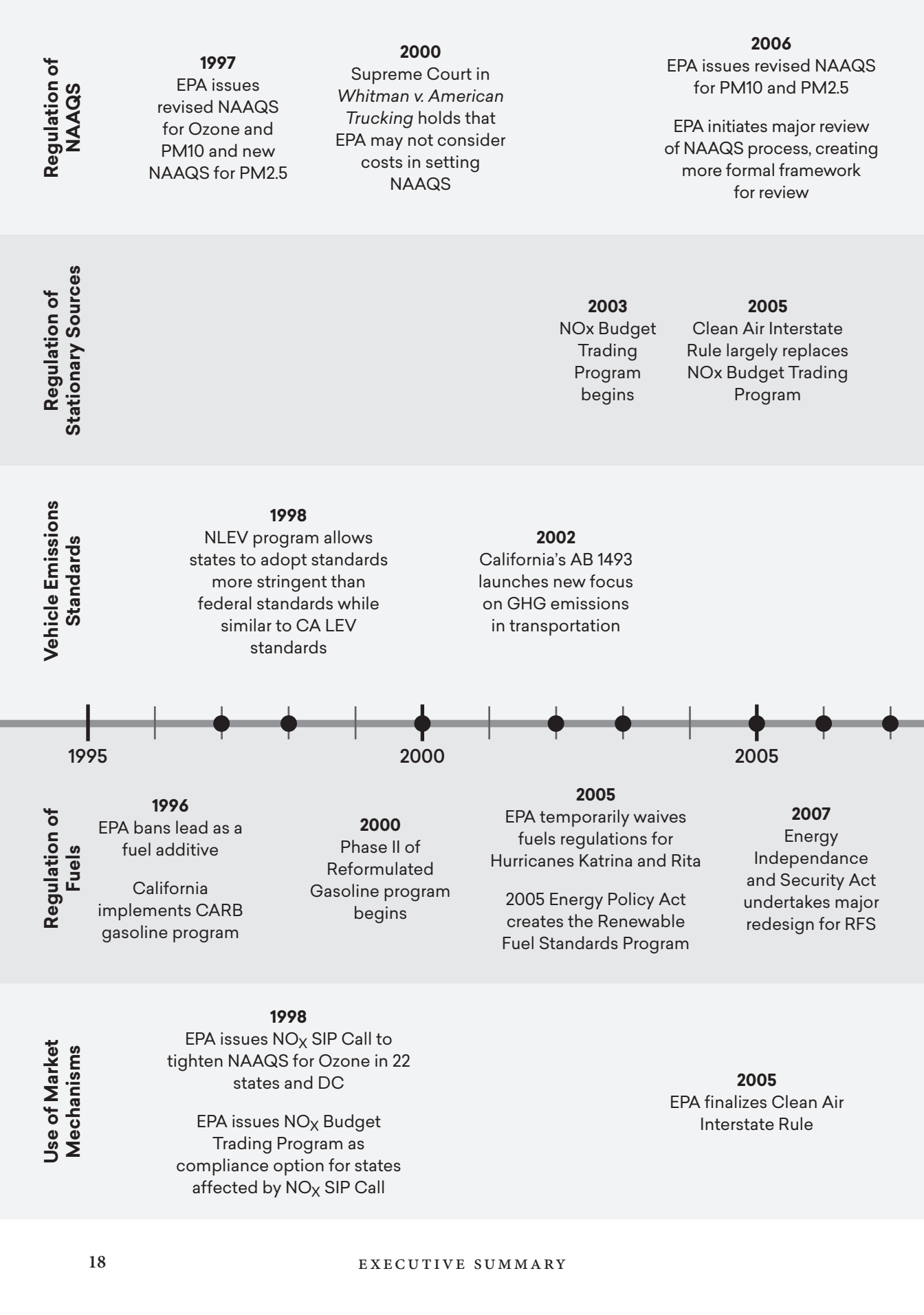
CAA Amendments of 1990
create basic structure of the boutique fuels program

1992
Oxyfuels program and Phase II of Low Volatility Gasoline program begin

1995
Phase I of Reformulated Gasoline program begins

CAA Amendments of 1990
establish SO_2 allowance trading program and create Ozone Transport Commission to coordinate state action on NO_X

1994
Nine Northeastern states and DC create the NO_X Budget Program


Regulation of NAAQS
1997
EPA issues revised NAAQS for Ozone and PM10 and new NAAQS for PM2.5
2000
Supreme Court in *Whitman v. American Trucking* holds that EPA may not consider costs in setting NAAQS
2006
EPA issues revised NAAQS for PM10 and PM2.5
EPA initiates major review of NAAQS process, creating more formal framework for review
Regulation of Stationary Sources
2003
NOx Budget Trading Program begins
2005
Clean Air Interstate Rule largely replaces NOx Budget Trading Program
Vehicle Emissions Standards
1998
NLEV program allows states to adopt standards more stringent than federal standards while similar to CA LEV standards
2002
California's AB 1493 launches new focus on GHG emissions in transportation
1995
2000
2005
Regulation of Fuels
1996
EPA bans lead as a fuel additive
California implements CARB gasoline program
2000
Phase II of Reformulated Gasoline program begins
2005
EPA temporarily waives fuels regulations for Hurricanes Katrina and Rita
2005 Energy Policy Act creates the Renewable Fuel Standards Program
2007
Energy Independance and Security Act undertakes major redesign for RFS
Use of Market Mechanisms
1998
EPA issues NO_X SIP Call to tighten NAAQS for Ozone in 22 states and DC
EPA issues NO_X Budget Trading Program as compliance option for states affected by NO_X SIP Call
2005
EPA finalizes Clean Air Interstate Rule

2008
EPA issues revised NAAQS for Lead and Ozone

2010
EPA issues revised NAAQS for SO_2 and NO_X

2012
EPA issues revised NAAQS for PM2.5

2015
EPA issues revised NAAQS for Ozone

2015
EPA issues CPP Final Rule under Section 111(d) of the CAA

Cross-State Pollution Rule replaces CAIR due to *North Carolina v. EPA*, 531 F.3d 896 (D.C Cir. 2008)

2017
EPA issues CPP Repeal Proposed Rule

2009
EPA issues Endangerment Finding

2010
Federal CAFE standards build off CA LEV standards to address GHG emissions

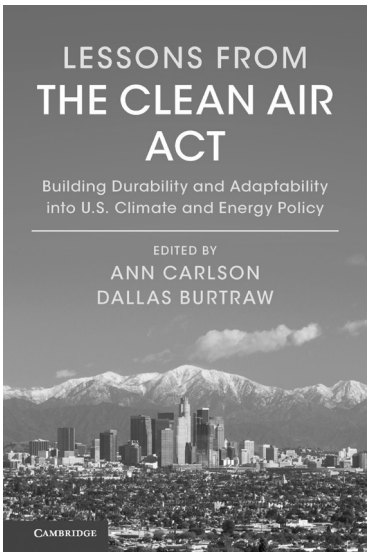
2008
EPA temporarily waives fuels regulations for Hurricanes Gustav and Ike

2012
EPA temporarily waives fuels regulations for Superstorm Sandy

2009
Congress fails to pass carbon cap-and-trade legislation

2011
EPA finalizes Cross State Air Pollution Rule

This executive summary is based on the following publication of the American Academy of Arts & Sciences



Lessons from the Clean Air Act

Building Durability and Adaptability into U.S. Climate and Energy Policy

Edited by Ann Carlson (University of California, Los Angeles School of Law) and Dallas Burtraw (Resources for the Future)

Contributors: William Boyd, Hannah J. Wiseman, Barry G. Rabe, Joseph E. Aldy, Eric M. Patashnik

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Climate and energy policy needs to be durable and flexible to be successful, but these two concepts often seem to be in opposition. One venerable institution in which both ideas are apparent is the Clean Air Act, first passed by the United States Congress in 1963, with amendments in 1970 and 1990. The Act is a living institution that has been hugely successful in improving the environment. It has programs that reach across the entire economy, regulating various sectors and pollutants in different ways. This illuminating book examines these successes—and failures—with the aim to offer lessons for future climate and energy policymaking in the United States at the federal and state level. It provides critical information to legislators, regulators and scholars interested in understanding environmental policymaking.

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