

THE DOZEN TYPES OF LEGAL TOOLS IN THE DEEP DECARBONIZATION TOOLBOX

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Synopsis: This article provides a description and analysis of the types of legal tools that are available to reduce U.S. greenhouse gas (GHG) emissions by at least 80% from 1990 levels by 2050. The “80 by 50” target and similarly aggressive carbon abatement goals are often referred to as “deep decarbonization,” a term that signals the need for systemic changes to the energy economy. This article builds on, but is different from, *Legal Pathways to Deep Decarbonization in the United States* (Michael B. Gerrard & John C. Dernbach eds. forthcoming 2019), which is a comprehensive description and explanation of more than 1,000 federal, state, local, and private law pathways that decision makers can employ. Using the compilation of instruments in *Legal Pathways*, this article develops a list of twelve types of legal instruments that can be employed by federal, state, local, and private actors. It is the first typology of legal instruments for deep decarbonization, and the only one drawn from such a comprehensive compilation.

Many of the categories of legal tools—additional regulation, tradable permits or allowances, market-leveraging instruments, property rights, and insurance—have been recognized in prior climate change and environmental law typologies. The article also confirms a conclusion drawn by other authors—that private governance can play a significant role in reducing U.S. emissions. Many of the types of legal tools in this article, however, have not previously been recognized, at least in this form. These are reduction or removal of regulatory barriers, removal of incentives for fossil fuel use, facilities and operations, infrastructure development, research and development, and social equity. This article also provides numerous examples of deep decarbonization legal tools that can be employed for each of the twelve categories.

The typology in this article shows the many different kinds of instruments that are available for deep decarbonization, and thus provides a structure for thinking about what types of instrument choices may be most likely to succeed under different circumstances. This typology also provides a structure for lawyers to design and advocate additional types of legal tools.

I.	Introduction	314
II.	How Typologies Can Help Manage the Risks of Climate Change	316
	A. Risk Assessment	316
	B. Risk Management	317

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	C. Broadening and Deepening Risk Management Options	319
III.	Legal Pathways to Deep Decarbonization	323
	A. Technical and Policy Foundation.....	323
	B. Legal Pathways Book.....	326
IV.	Typology of Legal Pathways	329
	A. Additional Regulation	329
	B. Reduction or Removal of Legal Barriers	332
	C. Market-leveraging Approaches.....	333
	D. Removal of Incentives for Fossil Fuel Use	335
	E. Tradable Permits or Allowances	335
	F. Information/Persuasion	336
	G. Facilities and Operations.....	339
	H. Infrastructure Development	341
	I. Research and Development.....	343
	J. Property Rights	344
	K. Insurance	345
	L. Social Equity	346
V.	Using and Applying This Typology.....	347
	A. Structure for Making Choices	347
	B. Structure for Creative Lawyering.....	350
VI.	Conclusion	351

I. INTRODUCTION

This article provides a description and analysis of the types of legal tools that are available to reduce U.S. greenhouse gas (GHG) emissions by at least 80% from 1990 levels by 2050. The “80 by 50” target and similarly aggressive carbon abatement goals are often referred to as “deep decarbonization,” a term that signals the need for systemic changes to the energy economy.¹ This article builds on, but is different from, a book that Michael Gerrard and I have edited, entitled *Legal Pathways to Deep Decarbonization in the United States* (“*Legal Pathways*”), which is a “playbook” for achieving the “80 by 50” target.² In North American football, a playbook describes all of the plays that a team could run; some of the plays will be used, and some will not be used, in any given game. Coaches will decide what

1. Deep decarbonization applies to not only reductions in carbon dioxide but also other GHG pollutants, such as methane, nitrous oxide, fluorinated compounds, and black carbon. “‘Deep decarbonization’ refers to the reduction of greenhouse gas (GHG) emissions over time to a level consistent with limiting global warming to 2°C or less, based on the scientific consensus that higher levels of warming pose an unacceptable risk of dangerous climate change.” James H. Williams et al., ENERGY AND ENVIRONMENTAL ECONOMICS, INC. ET AL., POLICY IMPLICATIONS OF DEEP DECARBONIZATION IN THE UNITED STATES 8 (2015), <http://usddpp.org/downloads/2015-report-on-policy-implications.pdf> [hereinafter DDPP U.S. POLICY REPORT].

2. LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES (Michael B. Gerrard & John C. Dernbach eds., forthcoming 2019) [hereinafter LEGAL PATHWAYS]. A shorter version is LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES: SUMMARY AND KEY RECOMMENDATIONS (Michael B. Gerrard & John C. Dernbach eds., forthcoming 2018).

plays to use based on what they believe necessary to win. Similarly, *Legal Pathways* describes and analyzes more than a thousand plausible legal options that could be used for that purpose.

This article focuses on four categories of actors—federal, state, local, and private—and attempts to identify the key types or categories of legal actions that are available to them for deep decarbonization. (Many of the state tools can also be employed by tribal governments and U.S. territories.) This typology is based on a careful review of all of the recommendations in *Legal Pathways*. To our knowledge, *Legal Pathways* provides the most comprehensive description and analysis to date of plausible legal options within the U.S. for deep decarbonization.

Typologies of legal tools are an important part of risk management in climate change. Section II of this article briefly summarizes the risks of climate change to the United States and argues that a comprehensive understanding of available legal instruments, and types of legal instruments, is needed to manage these risks in the most optimal way possible under the circumstances. It explains how the conflation of climate change science (risk assessment) with federal regulation (one form of risk management) has distorted public perception about how to proceed. It also provides an overview of other environmental law and climate change typologies, and explains how this one differs from them. Most fundamentally, the typology in this article focuses on climate change, and particularly decarbonization, synthesizing the comprehensive array of legal tools presented in *Legal Pathways*.

In Section III, this article explains *Legal Pathways* as well as the Deep Decarbonization Pathways Project (DDPP) and its key reports for the United States, which provide a foundation for *Legal Pathways*. The DDPP reports provide a technical and policy analysis of what is needed to reduce U.S. GHG emissions by 80% from 1990 levels by 2050. These reports provide a way of understanding how deep decarbonization would likely work in the United States and show that that key parts of the intellectual foundation for this effort have already been built. This section also describes *Legal Pathways* and explains how it builds on the DDPP reports by identifying and describing more than one thousand legal tools that can be employed to mitigate climate change.

Section IV sets out a typology of twelve types of legal instruments for deep decarbonization. Some of these categories are similar or identical to those in other typologies, but some are quite different. These twelve categories are: additional regulation, reduction or removal of legal barriers, market-leveraging approaches, removal of incentives for fossil fuel use, tradable permits or allowances, information/persuasion, facilities and operations, infrastructure development, research and development, insurance, property rights, and social equity. This section describes each of these types of legal options and provides a wide variety of examples of legal actions that could be taken by public and private actors for each type of legal instrument that is described.

Finally, Section V describes two ways that this typology can be used and applied. It provides decision makers and others with a structure for making decisions about legal tools for deep decarbonization. In addition, it provides a structure for creative lawyering on decarbonization.

II. HOW TYPOLOGIES CAN HELP MANAGE THE RISKS OF CLIMATE CHANGE

For decades, environmental regulation of pollutants has tended to proceed in a two-step process. The first step, risk assessment, is intended to gain an objective understanding of the risks to human health and the environment presented by a particular pollutant or set of pollutants.³ The second step, risk management, is the more subjective and political effort to determine what action, if any, to take to address the risks presented by the pollutant or pollutants in question.⁴ Risk management requires, at a minimum, an understanding of what legal choices are available.

For climate change mitigation, understanding the types of legal tools in the deep decarbonization toolbox is an essential part of risk management. Separation of the two steps is intended to help produce clearer thinking and better outcomes.⁵ This is particularly important because, for climate change, the two steps are all too often conflated.

A. Risk Assessment

For climate change pollutants, the risk assessment for the United States is quite clear. In 2009, after detailed analysis of the science and consideration of extensive public comment, EPA made a formal finding that “six greenhouse gases taken in combination endanger both the public health and the public welfare of current and future generations.”⁶ The endangerment finding was then challenged before the U.S. Court of Appeals for the District of Columbia Circuit, which unanimously upheld the finding.⁷ The U.S. Supreme Court assumed jurisdiction over another part of this case and reversed a portion of the D.C. Circuit’s decision on that part of the case, but did not assume jurisdiction over the endangerment finding decision.⁸

More recent information makes the risks even clearer. The U.S. Global Change Research Program, which was authorized by Congress in 1990, issued the

3. NAT’L RESEARCH COUNCIL, RISK ASSESSMENT IN THE FEDERAL GOVERNMENT: MANAGING THE PROCESS 18 (1983) [hereinafter RISK ASSESSMENT].

4. *Id.* at 18-19.

5. *Id.* at 3 (“At least some of the controversy surrounding regulatory actions [involving hazardous materials and situations] has resulted from a blurring of the distinction between risk assessment policy and risk management policy.”).

6. Final Rule, *Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act*, 74 Fed. Reg. 66,496 (2009) (codified at 40 C.F.R. ch. I). The EPA also found that “the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas air pollution that endangers public health and welfare” under §202(a) of the Clean Air Act, 42 U.S.C. §7521(a). *Id.* at 66,496. The six gases are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. *Id.* at 66,497. In a similarly well-documented notice, the EPA denied petitions for reconsideration of that finding. Notice, *EPA’s Denial of the Petitions To Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act*, 75 Fed. Reg. 49,556 (2010) (codified at 40 C.F.R. ch. I).

7. *Coalition for Responsible Regulation v. EPA*, 684 F.3d 102 (D.C. Cir. 2012), *rev’d in part on other grounds sub nom.*

8. *Utility Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014).

first portion of its fourth climate change assessment in 2017.⁹ Concentrations of carbon dioxide (CO₂) in the atmosphere, the report said, are now more than 400 ppm, “a level that last occurred about 3 million years ago, when both global average temperature and sea level were significantly higher than today.”¹⁰ Average global surface temperatures are about 1.8°F (1.0°C) warmer than they were 115 years ago, are likely to increase by another 2.5°F in the United States by 2050, and “could reach 9°F (5°C) or more by the end of this century” if the world continues on a business-as-usual pathway.¹¹ It projected a sea-level rise of one to four feet by the year 2100, and said that a rise of eight feet “cannot be ruled out.”¹² Already, it explained, rainfall intensity is increasing, there are a growing number of heat waves, the incidence of forest fires is greater, the ocean is acidifying, and glaciers are melting.¹³

The Intergovernmental Panel on Climate Change has indicated that an 80% to 95% reduction in GHG emissions by 2050 by developed countries, and substantial but less drastic reductions by developing countries, are needed to keep atmospheric concentrations of CO₂ below 450 parts per million (ppm).¹⁴ By that calculation, the U.S. should reduce its GHG emissions by at least 80% from 1990 levels by 2050. But how?

B. Risk Management

Risk management requires choosing among the various legal options that are available to address a known risk.¹⁵ The risk management issue on climate change in the U.S. has been handicapped by the lack of a clear-eyed understanding of the many legal choices that are available.¹⁶ To be sure, this is not the only reason, but it is one of them.¹⁷ The fundamental purpose of *Legal Pathways* is to provide a comprehensive compilation of these legal tools, and thus help enable that clear-eyed understanding.¹⁸ Many legal practitioners and others have a sophisticated

9. CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, U.S. GLOBAL CHANGE RESEARCH PROGRAM, vol. 1 (2017), https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf [hereinafter CLIMATE SCIENCE SPECIAL REPORT].

10. *Id.* at 11.

11. *Id.* at 10-11.

12. *Id.* at 10. This conclusion gains particular significance when coupled with a report that loss of the Antarctic ice sheet quadrupled between 1992-1997 and 2012-2017. The IMBIE Team, *Mass Balance of the Antarctic Ice Sheet Between 1992 and 2017*, 558 NATURE 219 (2018). The Antarctic ice sheet holds enough water to increase sea levels around the world by more than 150 feet. *Id.* at 219.

13. CLIMATE SCIENCE SPECIAL REPORT, *supra* note 9, at 10-11.

14. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007 MITIGATION OF CLIMATE CHANGE, 775-76 (2007).

15. RISK ASSESSMENT, *supra* note 3, at 18 (using risk management, in the context of chemical regulation, to “describe the process of evaluating alternative regulatory actions and selecting among them.”).

16. *See infra* text accompanying notes 21-28.

17. *Id.*

18. LEGAL PATHWAYS, *supra* note 2, Introduction.

understanding of the legal tools available within their particular area of specialization.¹⁹ But there had not been any comprehensive description or identification of the plausible legal tools that could be applied for deep decarbonization.²⁰

In the absence of such a compilation, it is easy for both specialists and the public to frame their understanding of climate change around particular legal tools. The partisan divide among Americans on climate change, of course, is large, and in recent years has appeared to grow.²¹ According to a 2017 Gallup poll, 66% of Democrats worry “a great deal” about global warming or climate change, compared to 45% of Independents and 18% of Republicans.²² A good deal of empirical data supports the proposition that the gap can be attributed to differences of opinion about the cost and efficacy of government regulation to reduce GHG emissions.²³ Put differently, those who are skeptical of or who oppose the scientific consensus on climate change tend to conflate risk assessment and risk management. For many, acknowledging climate change science means accepting a big government solution; because they oppose big government, they oppose the mainstream climate science. The failed Congressional effort to adopt cap-and-trade legislation in 2009-10 and EPA’s subsequent unsuccessful efforts to significantly reduce GHG emissions from electric generating facilities are the most commonly identified examples of a big government solution; both encountered significant political opposition.²⁴

A more complete understanding of the wide variety of public and private legal tools could yield different outcomes. Some polling data, for example, shows a public willingness to *support* efforts to reduce GHG emissions when preferred tools or approaches are employed.²⁵ According to polling data, there is greater public support for renewable energy and energy efficiency policies that can be justified based on economic development and climate security grounds than there is for the consensus scientific position on climate change.²⁶ Greater use of nuclear power and natural gas appeals even to many avowed climate skeptics.²⁷ And the many economic, environmental, security, and social “co-benefits” of GHG mitigation tools (called that because they are in addition to the benefits of GHG reduction) have provided an enduring foundation for state and local efforts.²⁸

19. *Id.*

20. *Id.*

21. Hari M. Osofsky & Jacqueline Peel, *Energy Partisanship*, 65 EMORY L. J. 695, 703-18 (2016).

22. Jim Norman, *Democrats Drive Rise in Concern about Global Warming*, GALLUP (Mar. 17, 2017), https://news.gallup.com/poll/206513/democrats-drive-rise-concern-global-warming.aspx?g_source=link_news9&g_campaign=item_234314&g_medium=copy.

23. Osofsky & Peel, *supra* note 21, at 704-06.

24. For an account of this effort, see ERIC POOLEY, *THE CLIMATE WAR: TRUE BELIEVERS, POWER BROKERS, AND THE FIGHT TO SAVE THE EARTH* (2010).

25. JOHN C. DERNBACH ET AL., *ACTING AS IF TOMORROW MATTERS: ACCELERATING THE TRANSITION TO SUSTAINABILITY* 132-39 (2012) [hereinafter *ACTING AS IF TOMORROW MATTERS*].

26. *Id.*

27. James Taylor, *Prominent Warmists, Skeptics Forge Common Ground at Energy Forum*, FORBES (Mar. 12, 2018), <https://www.forbes.com/sites/jamestaylor/2018/03/12/prominent-warmists-skeptics-forge-common-ground-at-energy-forum/#56e5feb1c403>.

28. Osofsky & Peel, *supra* note 21, at 729-35.

But it is difficult to develop a sophisticated understanding of how to actually achieve deep decarbonization in the real world—how to select and design legal tools that can command enough support to get adopted and implemented—unless we first understand what is in the deep decarbonization legal toolbox. That, in turn, is greatly assisted by knowing what types of tools there are.

C. Broadening and Deepening Risk Management Options

The typology set out in this article attempts to categorize these legal options, and in so doing to both simplify and provide additional clarity about the extraordinary number of choices that are available. Any typology, of course, involves grouping and labeling like items. Typologies can aid in understanding what kinds of legal choices are available to reduce GHG emissions. Typologies simplify because they translate the hundreds and even thousands of legal options into a smaller number of types or categories that are more easily understood and communicated. As in any grouping exercise, categories can be combined or split to emphasize or deemphasize particular points or options. They thus provide a kind of navigating device in the face of what may seem like an overwhelming amount of information.

But legal typologies can be both helpful and unhelpful. For policy experts and the general public, this simplification can constrain decision making by unduly narrowing the range of choices that are seen to be available.²⁹ On the other hand, typologies can also provide additional clarity by opening up conceptual space that may not previously have been recognized. Two examples from environmental law illustrate the latter point. The first involves the introduction of market-based instruments to reduce pollution.³⁰ From the late 1960s into the 1980s—the early years of modern environmental law—the primary legal instrument seen as available to decision makers was regulation, also known somewhat pejoratively as “command and control.”³¹ The development of a second category—market-based instruments such as pollutant taxation and cap-and-trade rules—demonstrated that other and cheaper ways are often available to achieve desired outcomes.³² Market-based instruments have sometimes helped to break the legislative “logjam” over environmental protection, leading to the enactment of measures that might not otherwise have been adopted.³³ Recognition of a particular category of legal tools, in

29. MICHAEL P. VANDENBERGH & JONATHAN M. GILLIGAN, *BEYOND POLITICS: THE PRIVATE GOVERNANCE RESPONSE TO CLIMATE CHANGE* 88-89 (2017).

30. Robert N. Stavins, *Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?*, 1997 U. CHICAGO L. FORUM 293, 297 (1997).

31. *Id.* at 297, 329.

32. *Id.* at 297-98, 329 (positing that there are essentially two choices at the national level—regulation or “so-called command and control instruments,” and market based instruments). The idea of taxing pollution is often attributed to Cambridge University economist Arthur Cecil Pigou. A.C. PIGOU, *THE ECONOMICS OF WELFARE* (1920). Stavins and others have developed this line of thinking for contemporary pollution control laws, and have articulated, advocated, and developed specific market-based laws.

33. Jonathan B. Wiener, *Radiative Forcing: Climate Policy to Break the Logjam in Environmental Law*, 17 N.Y.U. ENVTL. L. J. 210, 243 (2008). Perhaps the most prominent example is the cap-and-trade provisions of the 1990 Clean Air Act Amendments of 1990, 42 U.S.C. §§ 7651–7651o, which cut sulfur dioxide emissions from coal-fired power plants by 50% between 1990 and 2000 at a fraction of the cost of conventional regulation. Gabriel Chan et al., *The SO₂ Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections*

other words, has a value that is in addition to any specific proposal that might fit that category.

The second example involves the choice of actors employing the typology. When the federal government is friendly to environmental protection and reduction of GHG emissions, it is both easy and wrong to think entirely or primarily in terms of federal government action—whether it is regulatory, market-based, or something else. Even when the federal government is friendly, state and local governments have for decades played a significant role in environmental protection, including climate change mitigation.³⁴ And when the federal government is not friendly—or even hostile—state and local governments play a significant backstop role. Whatever the Trump Administration ultimately achieves in rolling back federal environmental and climate change law, for example, it is not likely to be able to generally roll back what state and local governments have put in place.³⁵

But even this broader range of governmental actors is unduly limiting. There is growing recognition of another category of action in law and governance—private environmental or climate change law and governance.³⁶ Legal pathways in private environmental governance include certification, auditing, labeling, and reporting programs, which tend to be enforced through a variety of contractual and related arrangements.³⁷ The function of many public climate change mitigation tools can be served—at least to some degree—by some form of private governance.³⁸ Put differently, the inclusion of private governance tends to help focus the decarbonization effort on what actions are needed rather than who requires or undertakes them. This does not mean that private governance is necessarily of equal effectiveness to public governance, but it does mean “that there are more options available to decision makers than traditionally believed.”³⁹ Private corporate GHG emission reductions could be as high as a half-billion tons of CO₂ equivalent, which is “equal to a regulatory approach that would reduce the emissions of the U.S. transportation sector by a third.”⁴⁰ These reductions are achievable regardless of what governments do or do not do, and provide another way of reducing GHG emissions. “The principal barrier to this approach is conceptual, not physical; it is the widespread view that climate mitigation is synonymous with government laws

on *Twenty Years of Policy Innovation* (2012), https://www.belfercenter.org/sites/default/files/legacy/files/so2-brief_digital4_final.pdf.

34. See, e.g., John Dernbach & Widener University Law School Seminar on Global Warming, *Moving the Climate Debate From Models to Proposed Legislation: Lessons From State Experience*, 30 ENVTL. L. REP. 10,933 (Nov. 2000).

35. William W. Buzbee, *Federalism Hedging, Entrenchment, and the Climate Challenge*, 2017 WIS. L. REV. 1037, 1088-92 (2017).

36. Michael P. Vandenbergh, *Private Environmental Governance*, 99 CORNELL L. REV. 129 (2013); Errol Meidinger, *Environmental Certification Systems and U.S. Environmental Law: Closer Than You May Think*, 31 ENVTL. L. REP. 10,162 (2001).

37. Vandenbergh & Gilligan, *supra* note 29, at 14-16, 121-23.

38. Sarah E. Light & Eric W. Orts, *Parallels in Public and Private Environmental Governance*, 5 MICH. J. ENVTL. & ADMIN. L. 1, 53-71 (2015).

39. *Id.* at 53.

40. Vandenbergh & Gilligan, *supra* note 29, at 224.

and policies.”⁴¹ Significantly, it appears that corporate sustainability efforts, including those to reduce GHG emissions, are not simply substitutes for public law; they may also change public opinion enough to make governmental action more acceptable.⁴²

Several different typologies of legal instruments for environmental protection or climate change mitigation have been articulated.⁴³ Over the last several decades, these typologies have evolved in two ways. More recent typologies tend to employ more categories than earlier typologies. Jim Salzman, for example, has organized public law instruments not into two categories, but five, which he describes as five Ps—Prescriptive regulation, Property rights, Penalties, Payments, and Persuasion.⁴⁴ A more recent typology posits seven different types of instruments: prescriptive rules (also known as command-and-control regulation); property rights or entitlements, market-leveraging approaches, tradable permits/allowances, informational governance, procurement/supply chain management, and insurance.⁴⁵

41. *Id.* at 13.

42. David A. Dana & Janice Nadler, *Regulation, Public Attitudes, and Private Governance*, J. EMPIRICAL STUD. (forthcoming 2018).

43. It is also possible to construct typologies of instruments for climate change adaptation, though that is beyond the scope of this article. *See, e.g.*, Sofia Yazykova & Carl Bruch, *Incorporating Climate Change Adaptation Into Framework Environmental Laws*, 48 ENVTL. L. REP. 10,334 (2018).

44. James Salzman, *Teaching Policy Instrument Choice in Environmental Law: The Five P's*, 23 DUKE ENVTL. L. & POL'Y F. 363, 363-64 (2013), *see also* James Salzman & Barton H. Thompson, Jr., *Environmental Law & Policy*, 52-60 (4th ed. 2013) (describing five P's). Many other typologies have been articulated, mostly but not entirely, for public law. *See, e.g.*, Dominic Stead, *Policy Preferences and the Diversity of Instrument Choice for Mitigating Climate Change Impacts in the Transport Sector*, 12 J. OF ENVTL. PLAN. & MGMT. 1 (2017), <https://www.tandfonline.com/doi/pdf/10.1080/09640568.2017.1397505?needAccess=true> (regulation, voluntary agreements, fiscal, information/education, infrastructure.); *OECD Policy Instruments for the Environment*, ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (2016) (taxes, fees or charges, tradable permits, deposit-refund schemes, environmentally motivated subsidies, voluntary approaches); Jonathan B. Wiener & Barak D. Richman, *Mechanism Choice*, RESEARCH HANDBOOK ON PUBLIC CHOICE AND PUBLIC LAW 363 (2010) (conduct rules, quantity/property rules, price/liability rules, information/disclosure rules, government ownership, private ordering); Jonathan B. Wiener, *Property and Prices to Protect the Planet*, 19 DUKE J. COMP. & INT'L L. 515 (2009) (regulation of conduct, property or quantity instruments, prices to limit access, information disclosure, geoengineering projects); Lawrence H. Goulder & Ian W. H. Parry, *Instrument Choice in Environmental Policy*, 2 REV. ENVTL. ECON. & POL'Y 152, 155-59 (2008) (incentive-based instruments (emissions taxes and tradable allowance systems, subsidies for pollution abatement, taxes on emissions or good associated with emissions) and direct regulatory instruments (technology mandates, performance standards)); Richard B. Stewart, *Instrument Choice*, THE OXFORD HANDBOOK OF INTERNATIONAL ENVIRONMENTAL LAW 147, 150-54 (2007) (explaining “basic types of environmental regulatory instruments” as command-and-control regulation, economic instruments, information-based approaches, hybrid regulatory approaches); Kenneth R. Richards, *Framing Environmental Policy Instrument Choice*, 10 DUKE ENVTL. L. & POL'Y F. 221 (2000) (subsidies, contracts, government production, zero-baseline taxes, auctioned marketable allowances, command-and-control regulation). Others have advocated that specific tools be added to the list of environmental policy instruments. *See, e.g.*, Adam D.K. Abelkop, *Tort Law as an Environmental Policy Instrument*, 92 OR. L. REV. 381 (2014). Some have advocated that tools employed for one purpose be used to address climate change. *See, e.g.*, Rick Reibstein, *Using the Tools of Pollution Prevention to Reduce Greenhouse Gas Emissions*, 39 ENVTL. L. REP. 10,851, 10,851 (2009) (arguing that the tools employed in pollution prevention—“assistance, planning, and expanded right to know reporting”—should be employed to address climate change).

45. Sarah E. Light & Michael P. Vandenberg, *Private Environmental Governance*, ELGAR ENCYCLOPEDIA OF ENVIRONMENTAL LAW: DECISION MAKING IN ENVIRONMENTAL LAW 253, 254-264 (2015); Light & Orts, *supra* note 38, at 23-53.

In addition, some more recent typologies include both public law and private law instruments.⁴⁶ For each of the seven types of instruments noted above, Sarah Light and Eric Orts explain there are both public and private governance options.⁴⁷ While a government could adopt a prescriptive rule requiring that a certain percentage of electricity in its jurisdiction be produced from renewable sources, for instance, a company could do the same for its own operations or a private certification system could include the same kind of prescriptive rule for those companies that wish to be certified.⁴⁸

The evolution of these typologies shows an expanding framework of options for decision makers and their lawyers. Beyond their value for decision makers, typologies can have political consequences for what they teach the public about available choices to address climate change. Climate change is politically polarizing in part because reducing GHG emissions has become synonymous not just with government laws and policies, but with a particular type of law—government regulation.⁴⁹ To be sure, it is likely to be difficult or even impossible to achieve deep decarbonization without any additional public law regulation. On the other hand, as the evolution of these typologies indicates, a wide variety of other tools and actors are also available.

Many of the typologies, particularly the more recent typologies, do not distinguish between environmental law instruments and climate change law instruments, effectively treating climate change as a form of environmental law.⁵⁰ In many ways, this is a reasonable view. Much climate change law grows out of environmental law, a point highlighted by the U.S. Supreme Court's 2007 decision in *Massachusetts v. EPA* that greenhouses gases are air pollutants under the Clean Air Act, and can be regulated as such.⁵¹ Yet climate change law is also different from environmental law. Because the great majority of GHG emissions are due to the use of fossil fuels for energy production, climate change law necessarily includes or is based on a good deal of energy law—a field of law that historically has been considered separate from environmental law.⁵² While environmental law regulates the environmental effects of energy extraction and production, energy law regulates the way in which energy is priced, marketed, and distributed. It is impossible to address climate change without also addressing those features of energy law. Of perhaps equal importance, environmental law has tended to focus on regulating existing forms of energy extraction and production, reducing pollution from those technologies based on cost and feasibility. Yet the climate change mitigation effort—and the developing law that supports it—is also focused on

46. See generally Light & Vandenberg, *supra* note 45; see generally Light & Orts, *supra* note 38.

47. Light & Orts, *supra* note 38, at 24-25.

48. *Id.* at 26-27.

49. A well-orchestrated and longstanding disinformation campaign also contributes to political polarization on this issue. Naomi Oreskes & Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (2010).

50. See, e.g., Salzman, *supra* note 44; see generally Light & Orts, *supra* note 38.

51. *Massachusetts v. EPA*, 549 U.S. 497 (2007).

52. Making environmental law work together with energy law to address climate change is no easy task. Jody Freeman, *The Uncomfortable Convergence of Energy and Environmental Law*, 41 HARV. ENVTL. L. REV. 339 (2017).

changing the way in which energy is produced and used. Achieving deep decarbonization will require a transition to low-carbon, zero-carbon, and even negative-carbon development—a task that requires more than environmental law.

Understanding the legal toolbox for climate change mitigation—and more precisely deep decarbonization—thus requires a focused evaluation on actual and potential legal tools for that issue alone. This article differs from most recent environmental typologies by focusing on climate change.⁵³ And it differs from all typologies, even those that are limited to climate change, by focusing on what is legally required for deep decarbonization. It also differs from other typologies because it draws from, and synthesizes, the comprehensive database of recommendations in *Legal Pathways*.

This is important because deep decarbonization can seem so challenging as to be impossible. *Legal Pathways* addresses part of this problem by demonstrating the availability of legal tools—tools currently being employed or that could be developed—to do the job. This article takes the next step by showing the categories into which these tools fit, providing a framework for thinking about, drafting, enacting, and implementing the legal pathways required for deep decarbonization.

III. LEGAL PATHWAYS TO DEEP DECARBONIZATION

The Deep Decarbonization Pathways Project (DDPP) provides the primary technical and policy foundation for an analysis of legal pathways to reducing U.S. GHG emissions by at least 80% from 1990 levels by 2050.⁵⁴ This section will explain the DDPP and then the *Legal Pathways* project.⁵⁵ These provide a basis for understanding the types of legal tools described in the next section, as well as the scale and significance of the deep decarbonization effort for which they could be employed.

A. Technical and Policy Foundation

Until as recently as 2012, there had “been little physically realistic modeling of the energy and economic transformations required” to substantially reduce GHG emissions by 2050.⁵⁶ Using California’s goal of reducing GHG emissions by 80% from 1990 levels by 2050 as a focal point, Jim Williams and others concluded that three different approaches together are needed: technically feasible energy efficiency, renewable electricity, and moving from liquid fuels in the transportation and building sectors to decarbonized electricity.⁵⁷ This analysis marks the beginning of the Deep Decarbonization Pathways Project (DDPP).⁵⁸

53. See generally Salzman, *supra* note 44 (environmental law); see also Light & Orts, *supra* note 38 (environmental law); but see also Light & Vandenberg, *supra* note 45 (typology for climate change, but same as typology for environmental law in Light & Orts).

54. LEGAL PATHWAYS, *supra* note 2, Introduction.

55. *Id.*

56. James H. Williams et al., *The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity*, 335 SCIENCE 53, 53 (2012).

57. *Id.*

58. See generally JIM WILLIAMS ET AL., PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES, U.S. REPORT OF THE DEEP DECARBONIZATION PATHWAYS PROJECT OF THE SUSTAINABLE DEV. SOLS. NETWORK AND THE INSTITUTE FOR SUSTAINABLE DEV. AND INT’L RELATIONS (Nov. 2014).

The DDPP, which is led by the Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations (IDDRI), is the principal international effort to devise pathways to decarbonize the global economy.⁵⁹ The DDPP is based on the work of research teams in sixteen countries, including the United States, that are responsible for 74% of the world's GHG emissions.⁶⁰ The overall objective of the project is to devise pathways that will “ensure a better-than-even chance of remaining below a 2°C (or 3.6°F) temperature rise,” which the international community regards as necessary to avoid dangerous levels of warming.⁶¹

The DDPP prepared two reports for the United States.⁶² The most important finding in those reports “is that it is technically feasible for the U.S. to reduce [carbon dioxide] emissions from fossil fuel combustion” by 85% from 1990 levels by 2050, which is “an order of magnitude decrease in per capita emissions compared to 2010.”⁶³ If the U.S. did that, it could reduce its overall GHG emissions by 80% below 1990 levels by 2050.⁶⁴

The U.S. DDPP reports are based on the same three pillars—energy efficiency, renewable energy, and decarbonization of liquid fuels—as the 2012 California report. Enormous changes would be required in the U.S. energy system to make those reductions happen. Because it is difficult to decarbonize gas and liquid fuels, the researchers said, meeting the 2050 objective would require almost complete decarbonization of electricity and, among other things, switching a “large share” of end uses that require gasoline and other liquid fuels over to electricity (such as electric cars).⁶⁵ It would also be necessary to produce fuel from electricity itself, they said, citing the production of hydrogen from hydrolysis as an example.⁶⁶ Overall, this transition would double electricity generation but reduce its

59. Sustainable Development Solutions Network, *Vision and Organization*, <http://www.unsdsn.org/about-us/vision-and-organization/> (last visited June 7, 2018); see also, DDPP, *About*, <http://deepdecarbonization.org/about/> (last visited June 7, 2018) (explaining the relationship between the Sustainable Development Solutions Network and the DDPP); Williams et al., *supra* note 58; see also, IDDRI, <https://www.iddri.org/en> (last visited June 20, 2018); *Pathways to Deep Decarbonization: 2014 Report*, SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK & INSTITUTE FOR SUSTAINABLE DEVELOPMENT AND INTERNATIONAL RELATIONS (2014), http://www.unsdsn.org/wp-content/uploads/2014/09/DDPP_Digit_updated.pdf [hereinafter DDPP 2014 REPORT].

60. *Pathways to Deep Decarbonization: 2015 Report*, SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK & INST. FOR SUSTAINABLE DEV. & INT'L RELATIONS, 3 (2015), http://deepdecarbonization.org/wp-content/uploads/2016/03/DDPP_2015_REPORT.pdf [hereinafter DDPP 2015 SYNTHESIS REPORT]. The other countries are —Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Africa, South Korea, and the United Kingdom. *Id.*

61. *Id.* at 3; see also CONFERENCE OF THE PARTIES, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, *Adoption of the Paris Agreement*, U.N. Doc. FCCC/CP/2015/L.9/Rev.1 (Dec. 12, 2015), <https://unfccc.int/resource/docs/2015/cop21/eng/109r01.pdf>.

62. JAMES H. WILLIAMS ET AL., *PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES*, U.S. 2050 REPORT, VOL. 1: TECHNICAL REPORT, ENERGY AND ENVIRONMENTAL ECONOMICS, INC. ET AL. (2015), http://www.deepdecarbonization.org/wp-content/uploads/2015/11/US_Deep_Decarbonization_Technical_Report.pdf [hereinafter DDPP U.S. TECHNICAL REPORT]; see also DDPP U.S. POLICY REPORT, *supra* note 1.

63. DDPP 2014 REPORT, *supra* note 59, at 204.

64. DDPP U.S. TECHNICAL REPORT, *supra* note 62, at xii.

65. *Id.* at xiv.

66. *Id.*

carbon intensity to 3% to 10% of current levels, requiring a vast increase in either renewable energy (as much as “2,500 gigawatts (GW) of wind and solar generation (30 times present capacity)” or carbon capture and sequestration (CCS)).⁶⁷ The average fuel economy for light duty vehicles such as cars would need to be over 100 miles per gallon, and these vehicles would need to be fueled almost entirely by electricity and hydrogen.⁶⁸ The overall cost of this effort would be roughly 1% of GDP, the researchers say.⁶⁹

The DDPP researchers developed four different decarbonization scenarios for the United States, which highlight the role of some of these critical elements, and also illustrate the variety of potential approaches. Because electricity is at the center of a decarbonized energy system, the scenarios highlight contrasting ways of providing it: High Nuclear, High Renewables, and fossil fuels with CCS (High CCS).⁷⁰ A fourth scenario—called “Mixed Case”—is based on “a balanced mix of all three primary energy resources.”⁷¹

In addition to the DDPP reports, *Legal Pathways* also relies to a lesser degree on two reports issued in 2016. The U.S. government issued the first of these reports, *United States Mid-century Strategy for Deep Decarbonization*, which sets out a deep decarbonization strategy for 2050.⁷² This report incorporates all three DDPP pillars previously described and includes two more. These are (1) forest and land use management for carbon sequestration, and (2) reduction of non-CO₂ GHG emissions.⁷³ This report was removed from the White House website shortly after President Trump was inaugurated.⁷⁴

The second non-DDPP report influencing *Legal Pathways* grew out of the Risky Business Project, which was founded by former New York City Mayor Michael Bloomberg, former U.S. Secretary of the Treasury Hank Paulson, and businessman and philanthropist Tom Steyer.⁷⁵ Entitled *From Risk to Return, Investing in a Clean Energy Economy*, this report also addresses the three DDPP pillars but focuses more on capital investment needs, expected monetary returns, and impacts on American jobs.⁷⁶

67. *Id.*

68. *Id.*

69. DDPP U.S. TECHNICAL REPORT, *supra* note 62, at xii.

70. *Id.* at 16.

71. *Id.*

72. THE WHITE HOUSE, UNITED STATES MID-CENTURY STRATEGY FOR DEEP DECARBONIZATION (Nov. 2016), http://www.unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf.

73. *Id.* at 10-12.

74. A handful of other countries have also developed mid-century decarbonization strategies, including Benin, Canada, the Czech Republic, France, Germany, and Mexico. *Communication of Long-term Strategies*, UNFCCC, http://www.unfccc.int/focus/long-term_strategies/items/9971.php (last visited June 7, 2018). The European Union has also published several deep decarbonization roadmaps. Claire Dupont & Sebastian Oberthür, *Decarbonization in the EU: Setting the Scene*, DECARBONIZATION IN THE EUROPEAN UNION: INTERNAL POLICIES AND EXTERNAL STRATEGIES 1, 7-8 (Claire Dupont & Sebastian Oberthür eds., Palgrave Macmillan 2015).

75. *About Us*, RISKY BUSINESS, <https://www.riskybusiness.org/about/> (last visited June 7, 2018).

76. *See generally* Tim Duane et al., RISKY BUSINESS, FROM RISK TO RETURN: INVESTING IN A CLEAN ENERGY ECONOMY 70 (2016), https://www.riskybusiness.org/site/assets/uploads/sites/5/2016/10/RiskyBusiness_FromRiskToReturn.pdf.

To be sure, there are other reports and studies on how to decarbonize the U.S. economy.⁷⁷ Perhaps the most publicly prominent and ambitious U.S. approach was developed by Stanford University professor Mark Jacobson and his team.⁷⁸ Their decarbonization concept relies exclusively on the use of wind, water, and sunlight (WWS) to provide energy for every sector in the United States. Without any reliance on nuclear, geothermal, or CCS technologies, they propose that a 100% reduction in GHG emissions from energy is conceivably attainable by 2050.⁷⁹ By contrast, the DDPP, *Mid-Century*, and *Risky Business* reports are premised on the view that deep decarbonization is more likely to occur if all technically and economically feasible options are on the table.⁸⁰ Excluding options up front precludes decision makers from considering or even knowing about those options, regardless of their potential merit in particular contexts or attractiveness to certain decision makers.

B. *Legal Pathways Book*

Legal Pathways identifies a wide range of legal approaches to deep decarbonization within the United States, casting the largest possible net consistent with producing a book of manageable length. This book is the source for nearly all of the legal tools described in the next section. While both the scale and complexity of deep decarbonization are enormous, this book has a simple message: deep decarbonization is achievable in the United States using laws that exist or could be enacted. These legal tools can be employed with significant economic, social, environmental, and national security benefits.

The seven major sections of the book, which include a total of 34 chapters, indicate its breadth. The book begins with a section on cross-cutting issues—issues that apply to multiple sectors.⁸¹ This section includes chapters on carbon pricing, behavior, law for technological innovation, financing utility-scale facilities, financing “at the grid edge,” materials consumption and solid waste, and international trade.⁸² The remaining sections focus on specific sectors or types of issues.

77. There are also reports on how to decarbonize specific U.S. jurisdictions. See, e.g., Gabriel Pacyniak et al., *An Examination of Policy Options for Achieving Greenhouse Gas Emissions Reductions in New Jersey*, GEORGETOWN CLIMATE CENTER, RUTGERS UNIVERSITY (Sept. 2017).

78. Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-sector Energy Roadmaps for the 50 United States*, 8 ENERGY & ENVTL. SCI. 2093 (2015).

79. While Jacobson’s WWS pathway has served as a cornerstone for many environmental groups advocating for clean energy reform, it has drawn controversy within the academic realm. In 2017, mathematician and research scholar Chris Clack, along with 20 other scientists, published a study that strongly questions the feasibility of the WWS pathway. Christopher T.M. Clack et al., *Evaluation of a Proposal for Reliable Low-cost Grid Power With 100% Wind, Water, and Solar*, 114 PROC. NAT’L ACAD. SCI. 6722 (2017). In response, Jacobson and his team issued a rebuttal that reaffirmed their original conclusions. Mark Z. Jacobson et al., *The United States Can Keep the Grid Stable at Low Cost With 100% Clean, Renewable Energy in All Sectors Despite Inaccurate Claims*, 114 PROC. NAT’L ACAD. SCI. E5021 (2017).

80. LEGAL PATHWAYS, *supra* note 2, Introduction.

81. *Id.*

82. *Id.* Introduction.

The second and third sections address energy efficiency, conservation, and fuel switching.⁸³ One of these focuses on buildings and industry, and includes chapters on lighting, appliances, and other equipment; new buildings; existing buildings; and the industrial sector.⁸⁴ The other addresses transportation, and includes chapters on transportation demand and mode shifting, light-duty vehicles, heavy-duty vehicles and freight, aviation, and shipping.⁸⁵

The fourth section, on electricity decarbonization, includes chapters on utility-scale renewable generating capacity; distributed renewable energy facilities; transmission, distribution, storage, and grid integration; nuclear energy; hydro-power; electricity charges, mandates, and subsidies; and phasing out fossil fuels in the electricity sector.⁸⁶ A fifth section addresses fuel decarbonization.⁸⁷ It has chapters on bioenergy feedstock, the production and delivery of non-carbon gaseous fuels, and the production and delivery of bioenergy fuels.⁸⁸

The sixth section addresses carbon capture and negative emissions.⁸⁹ It includes chapters on CCS, negative emissions technologies and direct air capture, agriculture, and forestry.⁹⁰ While the agriculture chapter also includes recommendations on reducing emissions, it seemed appropriate to include it in this section because of agriculture's potential to remove carbon dioxide from the atmosphere.⁹¹ The seventh and final section focuses on non-carbon dioxide climate pollutants, and has chapters on black carbon, methane, fluorinated gases, and nitrous oxide.⁹²

The breadth of topics addressed in these chapters is somewhat similar to the breadth of approaches addressed in other works. A 2004 paper by Stephen Pacala and Robert Socolow, for example, suggests that the problem of growing GHG emissions be addressed by dividing the growth curve into smaller parts or wedges, and addressing these wedges through fifteen different strategies, each of which can achieve significant carbon dioxide reductions.⁹³ These strategies range from efficient vehicles and buildings to nuclear power, carbon capture and storage, the substitution of solar and wind energy for coal, and conservation tillage.⁹⁴ A 2017 book edited by Paul Hawken, *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, describes 80 different policy options or solutions that can be employed around the world to reduce GHG emissions.⁹⁵ These options range from wind turbines and microgrids to a plant-rich diet, family

83. *Id.*

84. *Id.*

85. LEGAL PATHWAYS, *supra* note 2, Introduction.

86. *Id.*

87. *Id.*

88. *Id.*

89. *Id.*

90. LEGAL PATHWAYS, *supra* note 2, Introduction.

91. *Id.*

92. *Id.*

93. Stephen Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCI. 965 (2004).

94. *Id.*

95. DRAWDOWN: THE MOST COMPREHENSIVE PLAN EVER PROPOSED TO REVERSE GLOBAL WARMING (Paul Hawken ed., 2017).

planning, net zero energy buildings, forest protection, mass transit, and household recycling.⁹⁶ For each option, the book quantifies the reduction in GHG emissions that can be achieved, net costs, and net savings.⁹⁷

What makes *Legal Pathways* distinctive is its focus on the United States, the much greater detail with which policy options are analyzed, and, perhaps most importantly, the translation of the policy analysis into more than a thousand specific *legal* recommendations. The authors of each of the thirty-four substantive chapters were all asked to follow the same basic approach in writing their chapters. Each chapter explains the topic in enough detail to enable readers without a specialized background to understand it, including a discussion of its contribution to U.S. GHG emissions and its potential to reduce such emissions.⁹⁸ Each chapter also describes the needed reduction, by 2050, for that topic, according to the DDPP reports for the United States.⁹⁹ In some cases, the DDPP reports do not address that topic, in which case the chapter describes the contribution this topic can make to decarbonization, and explains how addressing this topic makes a somewhat less daunting glide slope for decarbonization.¹⁰⁰ Finally, and most significantly, each chapter also identifies the main legal issues involved in decarbonization, and describes and explains the main legal options or pathways for successfully addressing these legal issues.¹⁰¹ These options or pathways, as indicated earlier, involve federal, state, and local law, as well as private governance. Authors were asked to include options even if they do not now seem politically realistic or likely; the idea was to identify all significant legal pathways for deep decarbonization in the United States, recognizing that the book should also have value over time. In addition, authors were asked, where information is available, to identify environmental, social, and economic co-benefits of their suggested legal pathways. These chapters were peer reviewed.

While the overall objective of the book is to analyze and describe legal pathways needed to achieve an 80% reduction of U.S. GHG emissions from 1990 levels by 2050, the pathways described here are not precisely calibrated to achieve only that result. Because this is a playbook, the number, diversity, and ambitiousness of various legal tools described in the book could be modified to achieve more rapid and deeper reductions, and even negative overall emissions.

It is commonly said that climate change mitigation requires an “all hands on deck” approach that engages all sectors of society, all levels of government, and all citizens. The large number of legal tools described in *Legal Pathways* provide an understanding of what is likely to be legally necessary for deep decarbonization. Although not all will be used, a great many will need to be.

96. *Id.* at vii.

97. *Id.* at 222-23 (ranking options by amount of greenhouse gas reduction that can be achieved).

98. LEGAL PATHWAYS, *supra* note 2, ch. 7.

99. *Id.* ch. 18.

100. *Id.* ch. 7.

101. *Id.* ch. 12.

IV. TYPOLOGY OF LEGAL PATHWAYS

At least twelve different types of legal instruments are available to decarbonize the U.S. economy.¹⁰² For each of these, this section explains that type of pathway and describes and explains additional legal actions that federal, state, local, or private decision makers can make that further exemplify that pathway. The possible additional legal actions shown are illustrative of those described in *Legal Pathway*, not exhaustive.

A word of caution is in order about these pathways. In any given typology, some legal instruments do not fall neatly into one category. Professor Richard Stewart uses the term “hybrid” to describe instruments that fall into two or more categories at the same time.¹⁰³ It is also possible for legal instruments to have both public law and private law features, such as, in the European context, where private agreements to reduce emissions are sometimes used to implement public law requirements.¹⁰⁴ Another example is climate contracts, which are essentially agreements between government and businesses for businesses to reduce their GHG emissions.¹⁰⁵ What that means, in practical terms, is that there is some plasticity in the categorization process.

A. *Additional Regulation*

As indicated above, a commonly listed category of domestic climate change instrument in many typologies is regulation or command-and-control regulation, which ordinarily directly limits or prohibits certain emissions of GHGs, requires a certain level of performance in order to indirectly reduce emissions (e.g., energy efficiency), is needed to make such limits or prohibitions work effectively (e.g., permit requirement in order to emit), or imposes other similar requirements. This is almost certainly the category that is most publicly recognized. This category does not, however, distinguish between additional regulation or additional authority to regulate, on one hand, from reductions in regulatory or other legal burdens, on the other. Yet there are enormous political and practical differences between the two. One adds to the regulatory burden, and the other subtracts from it. Combining the two into a single category of regulation also renders the category imprecise and, to some degree, misleading. At the same time, the command-and-control or regulatory category is almost invariably used to mean additional regulation.¹⁰⁶ Renaming the category as additional regulation thus makes its intended meaning more clear.

Perhaps the most widely recognized federal examples are efforts by the Obama Administration to regulate GHG emissions from power plants and motor vehicles, and that the Trump Administration is proposing to roll back. In 2015, EPA adopted the Clean Power Plan, which was intended reduce greenhouse gases

102. *Id.* Introduction.

103. Stewart, *supra* note 44, at 154.

104. *Id.*

105. See generally Eric W. Orts, *Climate Contracts*, 29 VA. ENVTL. L. J. 127 (2011).

106. See, e.g., Stewart, *supra* note 44, at 150.

from electric generating facilities by 32% from 2005 levels by 2030.¹⁰⁷ But under President Trump, EPA proposed in 2017 to repeal the Clean Power Plan and proposed in 2018 to replace it.¹⁰⁸ Somewhat similarly, in 2012, under the Obama Administration, EPA and the National Highway Traffic Safety Administration, adopted more stringent combined standards for corporate average fuel efficiency (CAFE) and GHG emissions from light-duty motor vehicles (e.g., cars, sport utility vehicles, and light trucks).¹⁰⁹ These standards were projected to achieve, on an average industry fleet wide basis, at least 40.1 miles per gallon in vehicles produced in model year 2021 (first phase) and 49.6 miles per gallon in vehicles produced in model year 2025 (second phase).¹¹⁰ In 2018, under the Trump Administration, these agencies proposed to freeze these standards at the first phase level through 2026.¹¹¹

States, by contrast, have adopted a great number and wide variety of renewable energy and energy efficiency regulations, including but not limited to renewable electricity portfolio standards, often called renewable portfolio standards (RPS), which require that a specified percentage of electricity be from renewable or zero-emission sources by a particular date, and energy efficiency provisions in building codes, which require that buildings as well as appliances and equipment used in those buildings meet specific energy efficiency standards.¹¹²

The range of possible-but-not-yet-adopted public law tools for additional regulation is quite broad. Most obviously, the federal government, in a future administration, could reverse the Trump Administration's roll back efforts by adopting more stringent fuel economy and GHG emission standards for light-duty vehicles and a more stringent version of the Clean Power Plan for existing fossil fueled

107. *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, 80 Fed. Reg. 64,661, at 64,736 n.384 (Oct. 23, 2015) (to be codified at 40 C.F.R. pt. 60). The U.S. Supreme Court enjoined the regulation until all legal challenges are resolved. *West Virginia v. EPA*, 136 S. Ct. 1000, 1000 (2016).

108. *Repeal of Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, 82 Fed. Reg. 48,035 (Oct. 16, 2017) (to be codified at 40 C.F.R. pt. 60); *Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program*, 83 Fed. Reg. 44,746 (Aug. 31, 2018) (to be codified at 40 C.F.R. pts. 51, 52, 60).

109. *Final Rule, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards*, 77 Fed. Reg. 62,623 (Oct. 15, 2012) (codified at 40 C.F.R. Parts 85, 86, and 600, and 49 C.F.R. pts. 523, 531, 533, 600).

110. NHTSA and EPA Propose to Extend the National Program to Improve Fuel Economy and Greenhouse Gases for Passenger Cars and Light Trucks, NATIONAL HIGHWAY TRAFFIC SAFETY ADMIN. 1 (2009), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/2017-25_cafe_nprm_factsheet.pdf.

111. *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks*, 83 Fed. Reg. 42,817 (Aug. 24, 2018) (to be codified at 49 C.F.R. Parts 523, 531, 533, 536, and 537). They also proposed to eliminate the long-standing waiver that has enabled California to set more stringent fuel economy and greenhouse gas emission standards. Ryan Beene et al., *Trump to Seek Repeal of California's Smog-Fighting Power*, BLOOMBERG (July 23, 2018), <https://www.bloomberg.com/news/articles/2018-07-23/trump-is-said-to-seek-repeal-of-california-s-smog-fighting-power>.

112. David Hodas, *State Initiatives*, GLOBAL CLIMATE CHANGE AND U.S. LAW 303 (Michael B. Gerrard & Jody Freeman eds., 2d ed. 2014); NATIONAL CONFERENCE OF STATE LEGISLATURES, STATE RENEWABLE PORTFOLIO STANDARDS AND GOALS (2018), <http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx>; U.S. DEP'T OF ENERGY, BUILDING ENERGY CODES PROGRAM, STATUS OF ENERGY CODE ADOPTION (2018), <https://www.energycodes.gov/status-state-energy-code-adoption>.

power plants.¹¹³ The federal government could also adopt GHG emission limitations for industrial sources that produce a large share of carbon emissions, carbon dioxide emission limits for aircraft, more stringent standards for emissions of fine particulate matter to further reduce black carbon, new methane regulations for existing oil and gas facilities, more stringent GHG standards for heavy duty vehicles, and more stringent nitrous oxide emissions from a variety of sources.¹¹⁴

Other public law tools would explicitly require improved energy efficiency. These include more stringent state energy efficiency standards for new buildings or federal energy efficiency standards for these buildings, improved federal energy efficiency standards for household appliances and industrial equipment, new state or federal energy efficiency resource standards for electric and natural gas utilities, fuel efficiency standards for shipping, and energy efficiency standards for food processing.¹¹⁵

Some legal tools would add to the list of energy resources that qualify as renewable or “clean” under a RPS, thus requiring utilities to use or consider using more of these resources. Possible additional resources include thermal energy systems that can contribute to decarbonization, combined heat and power facilities that are fueled by biogas rather than natural gas, carbon removal technologies, “all duly licensed nonfederal hydropower,” and nuclear energy.¹¹⁶ More broadly, Congress could adopt a national clean energy standard that integrates renewable energy and energy efficiency mandates.¹¹⁷

Other new legal pathways involve the redesign of conventional regulation to achieve superior performance. For instance, states could design and implement “performance-based ratemaking designs” for electric utilities “that include incentives for superior utility energy efficiency performance,” including decoupling of revenues from the sale of energy.¹¹⁸

A variety of other tools are available. These include requirements for carbon sequestration; laws that ban the use of GHG-intensive materials and products; laws requiring existing building owners who presently use fossil fuels to retrofit their buildings by electrification in order to use renewable or zero-emissions electricity; a federal requirement that states consider regional and national electricity needs, including decarbonization, in making decisions on interstate transmission lines; new state requirements for carbon dioxide emission limits or CCS requirements for fossil fuel power plants; and a federal requirement that any bioenergy feedstock used in the United States be certified as sustainable by an independent organization.¹¹⁹

113. LEGAL PATHWAYS, *supra* note 2, chs. 14, 21.

114. *Id.* chs. 12, 15, 16, 32, 33, 35.

115. *Id.* chs. 9, 10, 16, 30.

116. *Id.* chs. 19, 21, 22, 27, 29.

117. *Id.* ch. 23.

118. LEGAL PATHWAYS, *supra* note 2, ch. 9. Some regulatory measures are less about additional regulation than the manner in which the regulation is imposed. Governments, for example, should avoid adopting local content requirements that would run afoul of international trade law. *Id.* ch. 8.

119. *Id.* chs. 4, 6, 11, 20, 24, 25, 28.

Private actors could also adopt new or more stringent standards. For example:

- “Accrediting agencies such as Moody’s and the International Capital Market Association should adopt improved green bond standards more closely tied to carbon performance.”¹²⁰
- “Private actors need to continue to adopt RPS... and ratchet up RPS beyond 50% targets.”¹²¹
- The Forest Stewardship Council and the American Forest and Paper Association should include in their sustainable forestry certification programs standards for maximizing the potential for forestry CCS.¹²²

B. *Reduction or Removal of Legal Barriers*

Any effort to reduce GHG emissions must confront the reality that existing laws often create a regulatory or other barrier to doing so. Many discussions of climate change mitigation seem to assume that there is a blank legal slate on climate change, and that any effort to reduce emissions must involve new law, but this is simply not factually accurate. It therefore makes sense to consider legal options that would lessen or remove existing legal barriers to deep decarbonization.¹²³

To some degree, these existing laws, particularly public laws concerning energy production, favor some sources of energy (e.g., fossil fuels), or some types of companies (e.g., utilities), over others. Intentionally or unintentionally, these laws establish barriers to market entry, making it harder, for example, for renewable energy and energy efficiency to compete with incumbent technologies and companies. Such laws also likely contribute to higher GHG emissions than would otherwise occur. A major category of such laws involves the regulatory burden imposed on specific types of facilities in order to obtain a license or permit to operate. The business community’s longstanding quest for permit streamlining, as it is often called, has historically contained two distinct threads—the reduction in environmental and public health protections embedded in the permit application review process, and the elimination or easing of unnecessary procedural and other burdens that are claimed to have no real effect on environmental and public health protection. The latter is particularly important to decarbonization.

Net metering laws are perhaps the most prominent example of laws that lessen or remove legal barriers. Essentially, these laws allow owners of residential or commercial buildings that generate renewable electricity to sell their excess

120. *Id.* ch. 6.

121. *Id.* ch. 23.

122. *Id.* ch. 31.

123. Michael P. Vandenbergh & Ben Raker, *Private Governance and the New Private Advocacy*, 32 NAT. RESOURCES & ENV’T J. 45, 46-47 (Fall 2007) (explaining importance of advocacy “to reduce the public regulatory barriers to private-sector demand for renewable power.”).

electricity to the grid.¹²⁴ In so doing, they permit something that was not previously allowed. While they also require utilities to buy this electricity, they nonetheless create options for building owners that did not previously exist.

Many new legal pathways involve removal of unnecessary or excessive permit or license requirements for utility-scale renewable energy, distributed renewable energy, hydropower, nuclear power, interstate transmission lines, the production and delivery of biofuels, the production and delivery of low-carbon gaseous fuels, CCS facilities, and direct air capture and negative emissions technology facilities.¹²⁵ Others new pathways that would eliminate or reduce barriers to decarbonization include a streamlined patenting program for decarbonization technologies, removal of caps on the number of households that can participate in net metering programs, exemption of utility customers and their suppliers from utility regulation when they own and operate their own generation and distribution system, amended state laws that “allow utilities to recover the prudently incurred costs of energy-efficiency programs,” amended state electrical or building codes that support on-site storage of electricity from renewable sources, and amended laws that would enable schools participating in child nutrition programs to give a preference to low-carbon agricultural products.¹²⁶ In addition, Congress could amend the Public Utility Regulatory Policies Act “to better encourage the integration of low-carbon resources into the grid.”¹²⁷

C. Market-leveraging Approaches

Market-leveraging approaches represent “a mode of governance that intends to affect market behavior by using prices, incentives, and other market signals within already-existing markets.”¹²⁸ These approaches leverage existing “markets by either adding penalties or providing subsidies in accordance with environmental objectives.”¹²⁹ Thus, one category of market-leveraging tools creates negative financial incentives, making disfavored actions more expensive.¹³⁰ They include pollution charges, taxes and fees.¹³¹ The other category of market-leveraging tools embraces positive financial incentives to engage in desired behavior. Subsidies, for example, “provide economic incentives for environmentally friendly behavior or investments.”¹³² Financial incentives also include tax credits, tax deductions, and other tax incentives. A variety of tax credits and other financial incentives exist for renewable energy, energy efficiency, and alternative fuel vehicles.¹³³

124. *Solar Energy and Net Metering*, EDISON ELECTRIC INSTITUTE, <http://www.eei.org/issuesand-policy/generation/netmetering/documents/straight%20talk%20about%20net%20metering.pdf>. (last visited Oct. 10, 2018).

125. LEGAL PATHWAYS, *supra* note 2, chs. 18, 19, 20, 21, 22, 26, 27, 28, 29.

126. *Id.* chs. 4, 5, 6, 9, 10, 30.

127. 16 U.S.C. §§ 2601-2645 (1978); LEGAL PATHWAYS, *supra* note 2, ch. 23.

128. Light & Orts, *supra* note 38, at 33 (emphasis omitted).

129. *Id.*

130. Salzman, *supra* note 44, at 370-71.

131. Light & Orts, *supra* note 38, at 33-34.

132. *Id.* at 35.

133. Roberta Mann, *Subsidies, Tax Policy, and Technological Innovation*, in GLOBAL CLIMATE CHANGE AND U.S. LAW, *supra* note 112, at 566-76.

Any list of market-leveraging legal pathways that create negative incentives needs to begin with a carbon tax. A carbon tax could begin at \$25 per metric ton and increase over time based on rising damage from climate change. Its revenues could be spent for some combination of economic efficiency, income redistribution, and climate policy purposes, or simply refunded to taxpayers.¹³⁴ A carbon tax also needs to be accompanied by border tax adjustments on imported goods from countries without such a tax, to ensure that trade competition does not lead to a race to the bottom on carbon emissions.¹³⁵ Other possible market-leveraging negative incentives include an increased federal tax on fuel used in domestic aviation, and differential port charges based on GHG emissions of particular ships.¹³⁶

New public market-leveraging legal pathways that create positive incentives include: (1) federal, state, and local laws that authorize the issuance of green bonds; (2) Congressional creation of an agency that can purchase loans and issue mortgage-backed securities for residential and small business energy efficiency and renewable energy loans; (3) tax incentives for companies that seek “to enter the [circular economy] market;” (4) local financing programs for energy efficiency; (5) federal tax incentives for the construction of zero emission buildings; (6) elimination of “preferential [federal] tax treatment for parking benefits and allow[ance of] a greater benefit for commuting using other modes” of transportation; (7) state or federal tax credits for purchase of new alternative-fuel vehicles (including electric vehicles); (8) new state subsidies for low-carbon infrastructure development; (9) residential solar tax credits that are the same as those provided to commercial or utility solar installations; (10) tax credits or access to low-cost financing for nuclear developers who use the same design as one that has already been licensed and deployed successfully; (11) tax incentives for agricultural practices that decrease GHG emissions; (12) development of a national climate friendly wood product certification program similar to that for organic produce; (13) development and funding of programs to allow owners of wood-burning stoves to replace them with low- or zero-emission stoves; and (14) development and funding of methane gas management programs at landfills.¹³⁷

Private market-leveraging approaches that create positive incentives are also available, either in the private sector alone or in a public-private partnership. These approaches include private funding of the cost of replacing older heavy-duty vehicles with newer and more fuel-efficient and aerodynamic vehicles, in partnership with state and federal governments.¹³⁸ Private parties can also use a variety of mechanisms to stabilize and subsidize prices for electricity generated by CCS, including power purchase agreements.¹³⁹

134. LEGAL PATHWAYS, *supra* note 2, ch. 2.

135. *Id.* ch. 8.

136. *Id.* chs. 16, 17.

137. *Id.* chs. 5, 6, 7, 9, 10, 13, 14, 19, 21, 23, 30, 31, 32, 33.

138. *Id.* ch. 15.

139. LEGAL PATHWAYS, *supra* note 2, ch. 28.

D. *Removal of Incentives for Fossil Fuel Use*

The market-leveraging approaches described immediately above are all directed toward the use of various economic and financial instruments on behalf of decarbonization. They do not address the problem of legal instruments that encourage or support GHG emissions. Nor does another category described above—removal or reduction of legal barriers—precisely capture the category of legal instruments that actually incentivize fossil fuel use. While laws that incentivize fossil fuel use are barriers, they are not simply barriers; they move behavior in the wrong direction.

For many years, the most commonly identified examples of such laws have been subsidies for fossil fuels, including direct spending and various tax expenditures.¹⁴⁰ These tax expenditures or incentives include an enhanced oil recovery credit.¹⁴¹ The removal or reduction of such subsidies is thus an obvious decarbonization tool.¹⁴² While different methodologies exist for what counts as a fossil fuel subsidy, “there is an emerging global consensus supporting fossil fuel subsidy reform in multiple areas.”¹⁴³ Other subsidies that support the use of fossil fuels could also be eliminated. For example, all levels of government could allow their employees to receive direct cash payments in lieu of parking subsidies, thus encouraging employees to use other forms of transportation.¹⁴⁴

E. *Tradable Permits or Allowances*

Tradable permits, or cap-and-trade laws, are also, in a sense, market-leveraging tools or pathways. Cap-and-trade laws impose a declining cap on overall emissions as well as on the emissions of specific facilities or actors, and authorize facilities or actors that achieve greater-than-required reductions to sell their excess reductions to facilities or actors that are achieving less-than-required reductions.¹⁴⁵ The price for these tradable permits or allowances effectively puts a price on carbon. Cap-and-trade laws are different from carbon taxes, however, and merit a separate category, because they impose a cap on emissions that all regulated facilities or actors must meet.¹⁴⁶ A carbon tax, by contrast, does not require a specified level of emissions reduction.¹⁴⁷ A cap-and-trade law sets the maximum level of allowable emissions, and allows the price to float; a carbon tax sets the price and allows the emissions levels to float.¹⁴⁸

140. Doug Koplow & John C. Dernbach, *Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study of Increasing Transparency for Fiscal Policy*, 26 ANN. REV. ENERGY & ENV'T 361, 368-71 (2001).

141. Mann, *supra* note 133, at 576-79.

142. LEGAL PATHWAYS, *supra* note 2, chs. 4, 8, 23.

143. Doug Koplow, *Defining and Measuring Fossil Fuel Subsidies*, in THE POLITICS OF FOSSIL FUEL SUBSIDIES AND THEIR REFORM 23, 41 (Jakob Skovgaard & Harro van Asselt eds. 2018).

144. LEGAL PATHWAYS, *supra* note 2, ch. 13.

145. *Id.* ch. 28.

146. Light & Orts, *supra* note 38, at 37-38. Cap-and-trade laws also have a regulatory component because they impose a cap on emissions by facilities or actors. But the authorization to trade allowances means that facilities or actors are not required to meet the cap through their own reductions. That makes a cap-and-trade law different from additional regulation. *Id.*

147. *Id.* at 32.

148. *Id.*

In current U.S. law, the most prominent example of a cap-and-trade law is California's Global Warming Solutions Act, which establishes a cap-and-trade program for GHG emissions from many sectors of the economy in that state.¹⁴⁹ Also prominent is the nine-state Regional Greenhouse Gas Initiative, "a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO₂ emissions from the power sector."¹⁵⁰

New tradable permit pathways include, of course, a federal cap-and-trade law or new state cap-and-trade programs.¹⁵¹ Many of these pathways also broaden the range of activities subject to trading, including new buildings and aircraft.¹⁵² They would, in addition, expand the range of pollutants subject to trading, including not only carbon dioxide but also methane and nitrous oxide.¹⁵³ The scope of these tradable permit pathways could be deepened or broadened to include, for example, material efficiency across a product's life cycle.¹⁵⁴ Cap-and-trade programs could also be designed or broadened to allow the sale of offsets from unregulated sources such as forests, farms, or ranches.¹⁵⁵ Of course, states and others would need to design offset programs to ensure that they actually reduce net GHG emissions.¹⁵⁶

F. Information/Persuasion

Persuasion ordinarily refers to laws "requiring information production and dissemination."¹⁵⁷ These laws are generally intended to change behavior, not by compelling particular outcomes, but by causing people to think about what they are doing and thus encouraging them to change their behavior. These laws tend to operate as "nudges"—changes in the ways that public and private choices are presented to people that alter their behavior "in a predictable way without forbidding any options or significantly changing their economic incentives."¹⁵⁸ For GHG emissions, nudges are no small thing. Behavioral nudges at the household level could reduce U.S. GHG emissions by 7.4% annually without any material

149. Cal. Health & Safety Code §§ 38500-38599 (West 2006); Cal. Code Regs., tit. 17, §§ 95801-96022 (2018).

150. THE REGIONAL GREENHOUSE GAS INITIATIVE, <https://www.rggi.org/> (last visited Aug. 24, 2018). New Jersey is preparing to rejoin RGGI and Virginia has proposed regulations that would allow trading with RGGI states. 9 Va. Admin. Code § 5-140. Regulation for Emissions Trading Programs (adding 9 Va. Admin. Code §§ 5-140-6010 through 5-140-6430), 34 Va. Reg. Regs. 924-59 (Jan. 8, 2018); see also Darrell Proctor, *Virginia Moves to Join RGGI Carbon-trading Market*, POWER (Nov. 15, 2017), <http://www.powermag.com/virginia-moves-to-join-rggi-carbon-trading-market/>.

151. LEGAL PATHWAYS, *supra* note 2, chs. 10, 21, 24.

152. *Id.* chs. 10, 16.

153. *Id.* ch. 30.

154. *Id.* ch. 12.

155. *Id.* chs. 25, 30, 31.

156. LEGAL PATHWAYS, *supra* note 2, ch. 30.

157. Salzman, *supra* note 44, at 373.

158. RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS 6 (2008). Nudges can be understood as a form of "libertarian paternalism." *Id.* at 4-6.

effect on household wellbeing.¹⁵⁹ At least three kinds of informational nudge tools are already being employed. The use of these could be expanded, and one additional type of informational tool could also be employed.

The first is required disclosure of information, particularly about GHG emissions.¹⁶⁰ A Congressionally required¹⁶¹ EPA regulation mandates that approximately 8,000 industrial facilities report their GHG emissions.¹⁶² EPA's website for this data enables users to easily identify major emitters by name, location, and amount of GHG emissions.¹⁶³ The law not only obliges companies to measure and publicly report their GHG emissions, it also allows them and the public to compare their performance with peers.¹⁶⁴ A variety of privately run public disclosure programs for corporate GHG efforts also exists. The Coalition for Environmentally Responsible Economies (CERES) maintains a database of companies that have publicly committed to reduce their GHG emissions as well as companies that have publicly committed to increase the energy they get from renewable sources.¹⁶⁵ CDP, once called the Carbon Disclosure Project, has "built the most comprehensive collection of self-reported environmental data in the world," including GHG emissions data, and uses these disclosures to enable "companies, cities, states and regions" to measure and manage their environmental impacts.¹⁶⁶

In addition to these, local governments could "require energy use disclosures for larger commercial buildings," and require benchmarking information about their energy performance "to be made publicly available in a format that is easy to understand so that it can be readily used in rental and purchase decisions."¹⁶⁷ Similarly, states or the federal government could require an energy audit upon the sale of existing homes.¹⁶⁸ States could establish that information about utility customer usage should be made promptly available to the customer at little or no expense.¹⁶⁹ All levels of government can provide information and incentives to private employers to adopt flexible and compressed work schedules in order to reduce driving.¹⁷⁰

Governments, corporations, and businesses can use a great many additional approaches to increase uptake of energy-efficient home equipment technologies. These include green leases and improved life-cycle cost information for retailers

159. Thomas Dietz et al., *Household Actions Can Provide a Behavioral Wedge to Rapidly Reduce US Carbon Emissions*, 106 PROC. NAT'L ACAD. SCI. 18452 (2009).

160. Light & Orts, *supra* note 38, at 42-44.

161. Consolidated Appropriations Act of 2008, Pub. L. No. 110-161, 121 Stat. 1844, 2128 (2008).

162. 40 C.F.R. § 98.1 (2018); *Fact Sheet: Greenhouse Gases Reporting Program Implementation*, EPA (2013), <https://www.epa.gov/sites/production/files/2014-09/documents/ghgrp-overview-factsheet.pdf>.

163. *Greenhouse Gas Reporting Program (GHGRP)*, EPA, <http://www.epa.gov/ghgreporting/index.html> (last updated Aug. 14, 2018).

164. Consolidated Appropriations Act, 121 Stat. 1844, 2128.

165. *Greenhouse Gas Emissions and Renewable Energy*, CERES, <https://www.ceres.org/resources/roadmap-for-sustainability/greenhouse-gas-emissions-and-renewable-energy> (last visited Aug. 24, 2018).

166. *About Us*, CDP, <https://www.cdp.net/en/info/about-us> (last visited Aug. 24, 2018).

167. LEGAL PATHWAYS, *supra* note 2, ch. 10.

168. *Id.* ch. 11.

169. *Id.* ch. 6.

170. *Id.* ch. 13.

and householders.¹⁷¹ Governments, corporations, and businesses can also test, and if successful, employ strategies such as energy audits of existing homes and energy rating systems for new homes to increase the uptake of energy-efficient buildings.¹⁷²

At the federal level, the Securities and Exchange Commission could modify its 2010 guidance on climate change disclosure to require an explicit statement in corporate reports that climate regulation could lead to the stranding of corporate assets, could require disclosure of how a transition to clean energy would affect the company, and could enforce the guidance.¹⁷³ The U.S. Department of Agriculture could compile and publicly disseminate information about methane emissions from meat production, and use that information in making recommendations on meat consumption.¹⁷⁴ Congress could also “require all ships to track and then report all greenhouse gases emitted from the last port of call to the U.S. port of call, require that information to be made public, and” use that data to “support the development of efficiency rankings.”¹⁷⁵

A second kind of informational/nudging tool is “eco-labeling.”¹⁷⁶ Automobile dealers are required to put a label on each new motor vehicle they make available for sale, stating the fuel economy and GHG emissions of that vehicle.¹⁷⁷ New eco-labeling requirements could require life-cycle assessment and disclosure of a product’s carbon footprint.¹⁷⁸

A third type of informational or nudge tool is rankings or awards, which provide public recognition of exemplary performance.¹⁷⁹ For example, The Climate

171. *Id.* ch. 3.

172. LEGAL PATHWAYS, *supra* note 2, ch. 3.

173. Commission Guidance Regarding Disclosure Related to Climate Change, 75 Fed. Reg. 6,290 (2010) (to be codified at 17 C.F.R. pts. 211, 231, 241); LEGAL PATHWAYS, *supra* note 2, ch. 24.

174. LEGAL PATHWAYS, *supra* note 2, ch. 33.

175. *Id.* ch. 17.

176. Light & Orts, *supra* note 38, at 44-45.

177. 49 C.F.R. § 575.401 (2011). For sample labels, *see generally* *Learn About the Label*, U.S. DEP’T OF ENERGY, <https://www.fueleconomy.gov/feg/Find.do?action=bt1> (last visited Aug. 24, 2018).

178. LEGAL PATHWAYS, *supra* note 2, ch. 6.

179. Light & Orts, *supra* note 38, at 45-46.

Registry and the Center for Climate and Energy Solutions co-sponsor annual Climate Leadership Awards.¹⁸⁰ Governments could also establish financial awards for specified achievements in reducing GHG emissions.¹⁸¹

A fourth approach is about development of appropriate information systems to facilitate use and comparison of data.¹⁸² For instance, Congress could direct the U.S. Energy Information Administration, which already collects and disseminates energy data, to be the default agency for sharing information about the decarbonization transition across the federal government and to the public.¹⁸³ Additionally, Congress could require the publication of data enabling comparison of life cycle GHG emission analyses by product.¹⁸⁴ This is not limited to governments. Non-profit organizations and land-grant universities could “develop and distribute cost-effective monitoring, measurement, and verification tools” for soil carbon, which are a necessary foundation for valuing and rewarding agricultural carbon storage efforts.¹⁸⁵

G. Facilities and Operations

The facilities and operations category focuses on the actors themselves—federal, state, and local governments as well as private entities. “[T]he federal government is the nation’s largest energy consumer,” with “more than 350,000 energy-using buildings and structures and 600,000 road vehicles.”¹⁸⁶ State and local governments also use considerable energy, as do corporations, businesses, universities, and nongovernmental organizations.¹⁸⁷ Thus, their facilities and operations provide a significant opportunity to reduce GHG emissions.

The federal government has been working for some decades to reduce its energy consumption. It has reduced the energy intensity (energy consumption per dollar of expenditure) of its facilities by almost half (49%) since 1975, which has

180. *2019 Climate Leadership Awards*, CLIMATE LEADERSHIP CONFERENCE, https://www.climateleadershipconference.org/clc_awards/ (last visited Aug. 24, 2018). EPA previously co-sponsored these awards but withdrew its participation in 2017. *Climate Leadership Awards*, EPA, <https://www.epa.gov/climateleadership/climate-leadership-awards> (last visited Aug. 24, 2018). The Climate Registry and the Center for Climate and Energy Solutions decided to continue the program without EPA. Ann McCabe & Bob Perciasepe, *Ann McCabe and Bob Perciasepe on the Climate Leadership Awards*, CTR. FOR ENERGY & CLIMATE SOLUTIONS (Aug. 25, 2017), <https://www.c2es.org/press-release/ann-mccabe-and-bob-perciasepe-on-the-climate-leadership-awards/>. Another program that provides recognition is the ABA-EPA Law Office Climate Challenge, which enables law organizations to gain recognition by taking at least one of four specified actions concerning paper management, renewable energy, and energy efficiency. *ABA-EPA Law Office Climate Challenge*, ABA (Nov. 9, 2016), https://www.americanbar.org/groups/environment_energy_resources/public_service/aba_epa_law_office_climate_challenge.html. More than 300 law organizations are recognized as leaders and partners on an ABA website. *Partners & Leaders*, ABA (Dec. 3, 2014), https://www.americanbar.org/groups/environment_energy_resources/public_service/aba_epa_law_office_climate_challenge/partners_leaders.html.

181. Jonathan H. Adler, *Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 HARV. ENVTL. L. REV. 1, 2 (2011).

182. LEGAL PATHWAYS, *supra* note 2, ch. 23.

183. *Id.*

184. *Id.* ch. 12.

185. *Id.* ch. 30.

186. *Government Energy Management*, U.S. DEP’T OF ENERGY, <https://www.energy.gov/eere/efficiency/government-energy-management> (last visited Aug. 24, 2018).

187. *Id.*

led to considerable cost savings and GHG reductions.¹⁸⁸ Presidential executive orders in 2007 (George W. Bush), and 2009 and 2015 (Barack Obama) required increasingly ambitious levels of environmental and energy performance at federal facilities.¹⁸⁹ The 2015 executive order required agencies to set goals for reduction of greenhouse gases from sources they own or control; from electricity, steam, or heat they purchase; and from vendors, suppliers, and agency travel.¹⁹⁰ Like an RPS, the 2015 executive order also required agencies to acquire increasing percentages of their electricity from clean or renewable sources by specified dates.¹⁹¹ In 2018, President Trump revoked this executive order, replacing it with an executive order that removes the required GHG reduction goals and RPS.¹⁹² The new order instead requires agencies to “[a]chieve and maintain annual reductions in building energy use and implement energy efficiency measures that reduce costs,” and to “[m]eet statutory requirements relating to the consumption of renewable energy and electricity.”¹⁹³

Somewhat similarly, as indicated above, many companies have already made public commitments to reduce their greenhouse gases or increase the percentage of electricity they obtain from renewable energy. More than one hundred major corporations, including 24 headquartered in the U.S., have established science-based GHG emissions reductions targets, and are working to achieve them.¹⁹⁴ In addition, 110 companies have publicly committed to acquiring 100% of their electricity from renewable sources by 2020.¹⁹⁵

Many of the relevant legal tools for decarbonizing public and private facilities and operations involve procurement.¹⁹⁶ The RPS part of the 2015 Obama executive order was, at least in part, about procuring renewable electricity, and a future administration may want to revive that approach.¹⁹⁷ Beyond that, federal, state, and local governments, as well as private companies, could adopt more aggressive GHG reduction and renewable energy acquisition goals for their own operations

188. *FEMP Assistance Helps Lead the Federal Government in Reducing the Energy Intensity of its Facilities by 49% Since 1975*, U.S. DEP’T OF ENERGY, <https://www.energy.gov/eere/femp/federal-energy-management-program> (last visited Aug. 24, 2018).

189. Exec. Order No. 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, 72 Fed. Reg. 3,919 (Jan. 26, 2007); Exec. Order No. 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, 74 Fed. Reg. 52,117 (Oct. 9, 2009); Exec. Order No. 13963, *Planning for Federal Sustainability in the Next Decade*, 80 Fed. Reg. 15,871 (Mar. 15, 2015).

190. Exec. Order No. 13963, *supra* note 189, § 2.

191. *Id.* § 3(b). These requirements applied only to the extent they were “life-cycle cost-effective.” *Id.* § 3.

192. Exec. Order No. 13834, *Efficient Federal Operations*, 83 Fed. Reg. 23,771 (May 17, 2018).

193. *Id.* § 2(a)-(b).

194. *Over 100 Global Corporations Using Science-based Targets to Align Strategies with Paris Agreement*, SCIENCE BASED TARGETS, <https://sciencebasedtargets.org/2018/04/17/over-100-global-corporations-using-science-based-targets-to-align-strategies-with-paris-agreement/> (last visited Sept. 1, 2018).

195. Emma Foehringer Merchant, *Corporations With 100% Renewable Energy Goals Now Account for 150 Terawatt-Hours per Year*, GREENTECH MEDIA (GTM) (Sept. 21, 2017), <https://www.greentechmedia.com/articles/read/corporations-with-100-percent-renewables-goals-make-up-150-terawatt-hours#gs.PqQrUAE>.

196. Light & Orts, *supra* note 38, at 46-50. Indeed, their title for this category is procurement. This article instead uses facilities and operations because it includes not only procurement but also the many ways in which public and private entities manage and use their own land.

197. Exec. Order No. 13696, *Planning for Federal Sustainability in the Next Decade*, 80 Fed. Reg. 57 (Mar. 25, 2015).

and facilities. In addition, governments and companies could continue and enhance their practice of procuring alternative fuel and hybrid light-duty vehicles as well as heavy-duty vehicles.¹⁹⁸ Somewhat similarly, procurement rules could require that goods requiring overseas shipping be transported in an energy-efficient manner.¹⁹⁹ Major federal coastal facilities, including naval bases, could commit to purchasing electricity from offshore wind facilities.²⁰⁰ By executive order, the President could require that a specified percentage of electricity procured by the federal government be from licensed nonfederal hydropower.²⁰¹ Federal, state, and local governments could adopt laws prioritizing the procurement of low-carbon agricultural products.²⁰²

Procurement can also work the other way—moving away from something rather than toward it. For instance, municipal utilities could divest ownership of their coal-fired generating facilities.²⁰³

Procurement of clean energy may have other advantages. Required government procurement of a locally produced clean energy product, rather than a regulatory obligation for all parties to use that product, could insulate a measure from successful attack under international trade law.²⁰⁴

Other legal pathways involve the management of government and private land. The Bureau of Land Management and the U.S. Forest Service, for example, could revise their policies to limit grazing to a level that would restore the range and increase soil carbon.²⁰⁵ Congress could amend the “organic legislation” for each federal public land system to require climate change mitigation and authorize geologic carbon sequestration.²⁰⁶ Congress and state legislatures could also authorize the acquisition and reforestation or afforestation of abandoned lands or lands rendered economically unproductive by climate change or other environmental degradation.²⁰⁷ State and federal land management agencies could “develop prescribed burn protocols and land management strategies to minimize the net warming caused by emissions” of black carbon and carbon dioxide.²⁰⁸

H. Infrastructure Development

Because deep decarbonization would transform the way in which energy is produced and used, it necessarily involves changes in infrastructure—the physical structures and systems for transportation, energy production and supply, and buildings. While infrastructure is threatened by climate change,²⁰⁹ it must also play a

198. LEGAL PATHWAYS, *supra* note 2, chs. 14, 15.

199. *Id.* ch. 17.

200. *Id.* ch. 18.

201. *Id.* ch. 22.

202. *Id.* ch. 30.

203. LEGAL PATHWAYS, *supra* note 2, ch. 24.

204. *Id.* ch. 8.

205. *Id.* ch. 30.

206. *Id.* ch. 31.

207. *Id.*

208. LEGAL PATHWAYS, *supra* note 2, ch. 32.

209. Sea level rise, intense precipitation events, and other aspects of a changing climate are having, and will continue to have, an adverse impact on infrastructure, including roads, buildings, ports, and coastal military

significant role in reducing GHG emissions. Aspects of law affecting infrastructure may fit into some of the other categories, but much of the relevant law fits nowhere else. Much of the U.S. transportation infrastructure, for example, is publicly owned, planned, and funded. Over the years, laws have been adopted and strengthened to increase energy efficiency in transportation, building, and other infrastructure, and thus to reduce its GHG emissions.²¹⁰ There is considerable room for improvement. For example, Congress as well as more state and local governments could add GHG emissions reduction, including greater efficiency, to the list of factors to consider in transportation planning.²¹¹ More ambitiously, states could develop transportation plans “that are designed to achieve zero emission transportation systems.”²¹²

Other options are also available. Congress could expand investment in rail infrastructure to reduce the advantage that heavy-duty trucks now have over rail.²¹³ Federal, state, and local governments could provide incentives to businesses to develop electricity infrastructure that is more conducive to distributed electricity generation.²¹⁴ States could create tax-free financing options and other incentives to encourage local governments to build clean energy infrastructure.²¹⁵ Congress and state legislatures could adopt incentives “to encourage the construction of pipelines that are dedicated to the delivery of ethanol and biofuels.”²¹⁶ States could also “form and fund agencies akin to public utilities to conduct siting analyses, acquire property access rights, and otherwise coordinate and facilitate expansion of the carbon dioxide pipeline network” required for carbon sequestration.²¹⁷

Many of these infrastructure tools would provide travelers with more practical transportation options. For example, federal, state, and local governments could consider modifying “laws, policies, and programs to devote a larger share of transportation funding to providing meaningful alternatives to driving, and to increase funding for projects that better connect various modes in order to expand transportation choices.”²¹⁸ These governments as well as the private sector could also consider expanding financial and other support for charging infrastructure to support greater use of electric vehicles.²¹⁹

installations. U.S. Global Change Research Program, *Infrastructure*, <https://nca2014.globalchange.gov/highlights/report-findings/infrastructure#intro-section-2> (last visited Aug. 25, 2018).

210. Trip Pollard, *Transportation: Challenges and Choices*, in AGENDA FOR A SUSTAINABLE AMERICA 365 (John C. Dernbach ed., 2009); F. Kaid Benfield & Michael Repogle, *Transportation*, in STUMBLING TOWARD SUSTAINABILITY 647 (John C. Dernbach ed., 2002).

211. LEGAL PATHWAYS, *supra* note 2, ch. 13.

212. *Id.* ch. 32.

213. *Id.* ch. 15.

214. *Id.* ch. 19.

215. *Id.* ch. 23.

216. LEGAL PATHWAYS, *supra* note 2, ch. 27.

217. *Id.* ch. 28.

218. *Id.* ch. 13.

219. *Id.* ch. 14.

I. *Research and Development*

Transformational technological research and its subsequent use are critical to deep decarbonization.²²⁰ Thus, research and development is an essential part of the legal toolbox.²²¹ When Congress or a state legislature appropriates funds for this purpose, it does so through legislation. If a government or company has someone else do the work, it accomplishes that through a contract. Sometimes, government agencies provide research and development funding through grants or loans, in which case research and development works to some degree like a financial incentive or market leveraging measure. But often government and private research and development is conducted internally. For a variety of reasons, then, it is useful to consider research and development independent of other legal instruments.

A great many research and development tools are available. Congress could directly fund research and development for any or all of the following:

- Low-carbon technologies.²²²
- Biomaterials.²²³
- “[M]ethods to calculate embodied carbon emissions by material and manufacturing process.”²²⁴
- Distribution network and smart grid issues.²²⁵
- Development and testing of new nuclear reactor technologies.²²⁶
- “[I]mproved equipment to harvest, store, and deliver feedstocks for biofuels.”²²⁷
- Negative emissions technologies.²²⁸

In addition, the federal government as well as state and local governments could conduct research and development to reduce battery costs.²²⁹ The U.S. Fish and Wildlife Service, as well as the scientific community and private sector, could “continue to develop techniques to reduce bird and bat mortality from wind turbines.”²³⁰ The federal and state governments could fund research and development on “low-global warming potential cooling and refrigeration technologies and equipment.”²³¹

220. See generally *ACTING AS IF TOMORROW MATTERS*, *supra* note 26, at 275-81 (explaining the importance of such research and development for sustainable development); see also NICHOLAS A. ASHFORD & RALPH P. HALL, *TECHNOLOGY, GLOBALIZATION, AND SUSTAINABLE DEVELOPMENT: TRANSFORMING THE INDUSTRIAL STATE* 275-86 (2011) (explaining importance of technological innovation for sustainable development).

221. Research and development, as used here, includes the widespread use of this research. See, e.g., EVERETT M. ROGERS, *DIFFUSION OF INNOVATIONS* (5th ed. 2003).

222. *LEGAL PATHWAYS*, *supra* note 2, ch. 4.

223. *Id.* ch. 27.

224. *Id.* ch. 12.

225. *Id.* ch. 20.

226. *Id.* ch. 21.

227. *LEGAL PATHWAYS*, *supra* note 2, ch. 27.

228. *Id.* ch. 29.

229. *Id.* ch. 14. State and local governments, as well as the private sector, could also do this. *Id.*

230. *Id.* ch. 18.

231. *LEGAL PATHWAYS*, *supra* note 2, ch. 34.

Many of these tools involve agriculture. Congress could, for example, increase funding for the U.S. Department of Agriculture to “quickly develop and disseminate climate-friendly practices and crop varieties.”²³² Somewhat similarly, states could “work with agricultural producers to maximize the revenue-generating potential of anaerobic digestion,” which can produce marketable biogas from manure.²³³

As with other types of tools, research and development is not for the government alone. The private sector could fund major research for a circular economy.²³⁴ Impact investors, philanthropists, and foundations could increase their investment in carbon farming practices, which reduce GHG emissions from farming, or by using farming methods to capture or hold carbon in the soil.²³⁵

J. Property Rights

Property rights are another potential legal tool to address climate change. They are often seen as a response to Garrett Hardin’s famous essay, *Tragedy of the Commons*, which explained how common pool resources could be overused because, while no one owns them, all have a financial incentive to overuse them.²³⁶ One response is to provide persons with limited property rights in these resources, and thus hopefully encourage better stewardship of the resources in question. Tradable permits or allowances, which create a limited property right in emissions, thus have a property rights aspect, even though they are assigned a separate category here. But there are other approaches as well. One is based on recognition that land provides a wide variety of climate-related “ecosystem services,” a term that refers to the many ways that natural ecosystems provides services that humans want and need.²³⁷ For climate change mitigation, these services include carbon sequestration and storage from trees and plants as well as local temperature control through shading by trees.²³⁸ One set of legal tools, still largely at the conceptual stage, would recognize property rights in those ecosystem services, thus discouraging the loss of these services and encouraging more landowners to provide them.²³⁹

Other property-related legal tools are further developed in existing law. Some would authorize greater use of property-assessed clean energy programs,

232. *Id.* ch. 30.

233. *Id.* ch. 33.

234. *Id.* ch. 7.

235. *Id.* ch. 30.

236. Garrett Hardin, *The Tragedy of the Commons*, 162 *SCI.* 1243, 1243-48 (1968).

237. Kalyani Robbins, *Allocating Property Rights in Ecosystem Services: From Chaos to Flowing Rivers*, 42 *HARV. ENVTL. L. REV.* 197, 200-01 (2018).

238. *Ecosystem Services: Regulating Services*, THE ECONOMICS OF ECOSYSTEM SERVICES & BIODIVERSITY (TEEB), <http://www.teebweb.org/resources/ecosystem-services/> (last visited Aug. 29, 2018).

239. See generally J. Sheehan & A. Kanas, *Carbon Property Rights in Soil* (2008), http://prres.net/Papers/Sheehan_Carbon_Property_Rights_in_Soil.pdf (discussing efforts in some Australian states to recognize a property right in soil carbon); Robbins, *supra* note 237, at 197 (arguing that “ecosystem services are definable as property,” that “they may be protected as a property right,” and that this protection “should be accomplished with an eye toward maximizing their social value.”); see also Steven A. Kennett, Arlene J. Kwasniak, & Alastair R. Lucas, *Property Rights and the Legal Framework for Carbon Sequestration on Agricultural Land*, 37 *OTTAWA L. REV.* 171 (2006), <https://ssrn.com/abstract=2712536>.

which enable funding of residential and commercial renewable energy and energy improvements on residential and commercial buildings to be paid over time through an increased property tax assessment against the property.²⁴⁰ Governments could be authorized to exercise the power of eminent domain to acquire land or property rights for carbon dioxide pipelines for carbon sequestration and for negative emissions technologies.²⁴¹ Changes in the way that landowners are paid under eminent domain laws could also reduce opposition to these and similar projects. For example, transmission line companies could consider “offering landowners annual payments instead of a one-time easement payment.”²⁴²

Governments and private actors could also expand their acquisition of easements for climate change mitigation. For example, Congress could modify the Agricultural Conservation Easement Program to better protect and enhance soil carbon storage in agriculture and forestry.²⁴³ The rapidly growing use of private land acquisition for conservation (not just in fee simple but also through conservation easements) provides another promising approach.²⁴⁴ Land trust and conservation organizations could incorporate climate change mitigation practices (e.g., forest management for carbon capture) into the terms of these easements.²⁴⁵

K. Insurance

Insurance provides a way of readjusting and reallocating risk as part of the transition to a decarbonized economy, and can encourage behavior that would reduce GHG emissions.²⁴⁶ It also does not fit neatly into any of the other categories of legal instruments.²⁴⁷

Insurance could be used to modify behavior in a wide variety of contexts. The Department of Agriculture’s Risk Management Agency could “ensure that its crop insurance policies do not interfere with cover cropping or other proven decarbonizing practices or conversely encourage less beneficial practices.”²⁴⁸ At the same time, the Federal Crop Insurance Corporation could require “publicly funded crop insurance policies [to] treat carbon-intensive practices as risk enhancing and

240. LEGAL PATHWAYS, *supra* note 2, chs. 9, 11.

241. *Id.* chs. 28, 29; *see also* Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change, Carbon Sequestration, and Property Rights*, 2010 U. ILL. L. REV. 363 (showing that the design and operation of carbon sequestration facilities also involve a wide range of property issues).

242. LEGAL PATHWAYS, *supra* note 2, ch. 20.

243. *Id.* chs. 30, 31.

244. Dan Tarlock & Andrew Zabel, *Biodiversity Conservation: An Unrealized Aspiration*, in *AGENDA FOR A SUSTAINABLE AMERICA* 269, 278 (John C. Dernbach ed., 2009).

245. LEGAL PATHWAYS, *supra* note 2, ch. 30; *see also* Marina Schaffler, *Looking to the Land to Mitigate Climate Change*, *SAVING LAND* (Spring 2018), <https://www.landtrustalliance.org/node/2718>.

246. Sean Hecht & Jessee Lueders, *Insurance*, in *CLIMATE CHANGE LAW* 661, 666 (Daniel A. Farber & Marjan Peeters eds., 2016); *see also* Gary Guzy, *Insurance and Climate Change*, in *GLOBAL CLIMATE CHANGE AND U.S. LAW*, *supra* note 112, at 541, 541. In September 2018, the California Department of Insurance issued a report recommending a wide variety of reforms in that state to address the changing risks created by climate change. CALIFORNIA DEP’T OF INSURANCE, *TRIAL BY FIRE: MANAGING CLIMATE RISKS FACING INSURERS IN THE GOLDEN STATE* (2018), <https://www.law.berkeley.edu/wp-content/uploads/2018/09/Trial-by-Fire-September-2018.pdf>.

247. Light & Orts, *supra* note 38, at 50-53.

248. LEGAL PATHWAYS, *supra* note 2, ch. 30.

reduce or eliminate their premium subsidies accordingly.”²⁴⁹ In the same vein, Congress or state legislatures could authorize or require pay-as-you-drive insurance for motor vehicles, which would reward those who find other ways of transportation.²⁵⁰

The availability of insurance can also help some technologies to get off the ground. One of the obstacles to greater use of CCS is the absence of widely available commercial insurance for the operation of such facilities. Existing insurers could expand their products, and new insurers could enter that market.²⁵¹ Somewhat similarly, the federal government or states could help enable more low-income energy projects by authorizing reinsurance to private bond insurers for pooled credits from those projects.²⁵²

Private governance also can play other roles on insurance. Across the globe, a growing number of insurance companies are refusing to insure coal mines or coal-fired electric generating facilities.²⁵³

L. Social Equity

Social equity is essential to deep decarbonization, not only to help ensure public and community acceptance for the changes that will occur but also as a fundamental tenet of justice and fairness. A great many of the legal tools available for deep decarbonization can be designed to foster social equity.²⁵⁴ But some social equity tools stand alone. Even if many of these tools do not directly reduce GHG emissions, they should be considered as part of the package or suite of tools that are needed for deep decarbonization. With them, deep decarbonization is politically more likely to be accomplished, and more likely to be fair; without them, deep decarbonization may be impossible.

Many of these are directed at coal miners, an occupational category that is especially hard hit by decarbonization. For example, Congress could adopt legislation to provide \$1 billion over five years to restore abandoned coal mines to something like their natural state, while also scaling up economic diversification efforts in coal country.²⁵⁵ State and local governments can also promote the creation of more clean energy jobs and businesses in these regions.²⁵⁶ Nor are these

249. *Id.*

250. *Id.* ch. 13.

251. *Id.* ch. 28.

252. *Id.* ch. 6.

253. Oliver Ralph & Olaf Storbeck, *Allianz to Stop Selling Insurance to Coal Companies*, FIN. TIMES (May 4, 2018), <https://www.ft.com/content/a23a6c3c-4eec-11e8-9471-a083af05aea7>; Oliver Ralph, *Insurers Go Cold on Coal Industry*, FIN. TIMES (Jan. 8, 2018), <https://www.ft.com/content/7ec63f34-f20c-11e7-ac08-07c3086a2625>.

254. For example, renewable energy tools can be designed so that economic benefits flow primarily to the community instead of distant investors. A carbon tax can be designed to avoid imposing higher costs on the poor, or not. Tools that have the effect of replacing fossil fuels with clean energy can be designed to maintain or improve the economic position of workers and communities that would otherwise be left behind.

255. H.R. 1731, 115 Cong. (2017); LEGAL PATHWAYS, *supra* note 2, ch. 24.

256. LEGAL PATHWAYS, *supra* note 2, ch. 24.

and similar actions limited to government. Renewable energy and energy efficiency companies could give a hiring preference to displaced fossil fuel workers.²⁵⁷

Social equity tools extend beyond coal country. As they seek to reduce GHG emissions, for instance, states could “include mechanisms and funding that provide low-income and minority communities meaningful access to clean energy, clean vehicles, and alternative fuels without increasing their energy and transportation burdens.”²⁵⁸ Where carbon dioxide pipelines are to be developed for carbon sequestration, states could “engage early and vigorously with citizens and other stakeholders” to work out their concerns.²⁵⁹ On the private governance side, parts of the global voluntary carbon offset market already include social justice as a factor in developing carbon credits.²⁶⁰

V. USING AND APPLYING THIS TYPOLOGY

This typology synthesizes the vast amount of information about available legal pathways. In so doing, it provides a structure for making decisions about legal tools for deep decarbonization. It also provides a structure for creative lawyering on decarbonization.

A. *Structure for Making Choices*

The table below provides an overview of the variety of types of legal instruments as well as the types of governance employing these instruments.

257. *Id.*

258. *Id.* ch. 32.

259. *Id.* ch. 28.

260. Vandenbergh & Gilligan, *supra* note 29, at 220-21.

prescriptive regulation in other typologies), market-leveraging approaches, tradable permits or allowances, information/persuasion, property rights, and insurance. But several are not contained in other typologies, at least in this form. Two, reduction or removal of regulatory barriers and removal of incentives for fossil fuel use, show that deep decarbonization may in many cases be assisted and encouraged by less law, not more. Three others—facilities and operations, infrastructure development, and research and development—are outside the boundaries of what many would consider politically controversial.²⁶² One other, social equity, can be designed into many individual measures, but also requires separate measures without which deep decarbonization cannot fairly be achieved. These additional categories contribute to a greater understanding of how to achieve deep decarbonization, and suggest pathways to accelerating the effort.

Most obviously, they suggest ways of moving forward in the United States at a time when the public is deeply polarized on climate change. Germany and California have made considerably more progress as a whole than the United States in reducing GHG emissions.²⁶³ A major reason is the much higher level of public acceptance and support for measures to reduce GHG emissions in those jurisdictions.²⁶⁴ But even in these jurisdictions, individual measures rise or fall based on their own perceived merit; there is no free pass for legal measures to mitigate climate change.

What this suggests is that a broad range of types of legal tools is more likely than a narrow range of types of tools to yield individual measures or suites of measures that can command enough support or acceptance to be adopted.²⁶⁵ To pick the most obvious example, measures that reduce or eliminate legal or regulatory barriers (but do not compromise environmental and public health protection) might be among those that could command broad support even in jurisdictions where the public is divided about climate change. More broadly, across the wide range of federal, state, local, and private decision makers, some types of legal tools will be more congenial than others; this typology could assist in identifying those tools.

262. The facilities and operations category, however, builds on the procurement category used by other authors. *See, e.g.,* Light & Orts, *supra* note 38, at 46-70.

263. John C. Dernbach, *Legal Pathways to Deep Decarbonization: Lessons from California and Germany*, 82 *BROOK. L. REV.* 825, 843-64 (2017).

264. *Id.* at 865-67.

265. *See, e.g.,* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE 1009-10 (Ottmar Edenhofer et al. eds., 2014), https://www.ipcc.ch/pdf/assessment-report/ar5wg3/ipcc_wg3_ar5_full.pdf (suggesting four criteria for evaluation of individual climate mitigation tools: (1) “environmental effectiveness,” which is measured, for climate change mitigation, by the extent to which a tool reduces human sources of GHG emissions or removes GHGs from the atmosphere; (2) “aggregate economic performance,” which is measured by both economic efficiency (the maximization of net benefits) and cost-effectiveness (the least cost strategy to achieve a given level of environmental performance); (3) “distributional and social impacts,” which relate “to burden- and benefit-sharing;” and (4) “institutional feasibility,” which, for domestic purposes, is strongly related to political feasibility.). In any given situation, these criteria may be mutually reinforcing or conflicting, in which case tradeoffs must be made. *Id.* at 1012; *see also* Goulder & Parry, *supra* note 44 (identifying cost, administrative costs, cost impacts from fiscal interactions, “the ability of the instrument to address uncertainty, and the nature of its distributional impacts” as considerations in choosing instruments).

B. *Structure for Creative Lawyering*

While *Legal Pathways* provides a comprehensive compilation of legal recommendations, many additional legal instruments exist or can be drafted and implemented. The boxes in the table exemplify the many kinds of legal pathways that can be developed, modified, and implemented, and provide a point of departure for creative legal problem solving. Indeed, one could apply the table, not just to GHGs in general, but to nearly all of the 34 topics represented by individual chapters in *Legal Pathways*. Put differently, for any given topic or client, each of the boxes in the table represents policy space that can be populated with new or amended laws.

I have argued elsewhere that a changing climate means all lawyers should consider becoming more engaged in this issue, and provided examples of lawyers who are doing just that in their law practice, using sustainable development as a lens for addressing legal problems.²⁶⁶ Essentially, sustainability in law practice tends to focus on 1) reducing adverse environmental and social impacts or even creating positive impacts and 2) maximizing environmental, social, and economic opportunities for clients.²⁶⁷ Sustainable development can provide more and better choices to clients—if clients are open to those choices.²⁶⁸

Similarly, understanding the many types of legal tools that are available for deep decarbonization can help lawyers provide additional legal options to clients—options that may be less expensive and easier to implement than more conventional legal options, or produce greater economic, social, and environmental co-benefits than conventional legal options. For lawyers representing nongovernmental organizations, this typology provides an expanded range of legal options that could be drafted and proposed. For lawyers in government, this typology suggests a broad range of non-regulatory legal actions that could supplement regulation or even be used in some instances as a substitute for regulation. For lawyers in private practice or working in-house for corporations, this typology suggests a wide range of private governance actions that corporate and business clients could adopt and implement on their own—including, for example, reducing their own GHG emissions, procuring a specified percentage of renewable or zero-emission electricity by a particular future date, establishing a shadow price for carbon in their own operations, or reducing internal legal barriers to decarbonization that may exist in standard contracts or other organizational rules. For private practice and in-house corporate lawyers, this typology also suggests the broad range of public law options available to all levels of government and may encourage constructive engagement with government decision makers about the most cost-effective and beneficial way to accomplish deep decarbonization. For all lawyers, as well as law students and even those considering law as a career, this typology makes clear the wide variety of actual or potential practice areas that deep decarbonization makes available.

266. John C. Dernbach, *Lawyering as if Tomorrow Matters*, 86 UMKC L. REV. 759 (2018); John C. Dernbach, *Sustainable Development in Law Practice: A Lens for Addressing All Legal Problems*, 95 DENV. L. REV. 123 (2017).

267. *Id.* at 151-63.

268. *Id.*

For lawyers who are not already engaged in climate change issues, but who are interested in becoming engaged in these issues, including retired lawyers, this typology provides a way of thinking about how they could use their existing skills and knowledge to do so without having to completely change their careers or their expertise. As the typology shows, lawyers whose practice includes (or included) insurance, procurement, contracting, real estate, corporate governance, or many other specialties outside of environmental or energy law can add significant value by applying their practice skills to deep decarbonization. This is perhaps especially important for lawyers in law firms that are directing more of the firm's pro bono efforts to sustainable development or climate change.²⁶⁹

Lawyers with skill, expertise, and knowledge to develop and communicate types of legal choices about decarbonization will be more helpful to their clients than other lawyers. Whatever one's practice area or interests, a clear understanding of the types of available decarbonization tools provides a stronger basis for effective lawyering.²⁷⁰

VI. CONCLUSION

This article has described twelve types or categories of legal tools or pathways that are available to reduce U.S. GHG emissions by at least 80% from 1990 levels by 2050. These are additional regulation, reduction or removal of legal barriers, market-leveraging approaches, removal of incentives for fossil fuel use, tradable permits or allowances, information/persuasion, facilities and operations, infrastructure development, research and development, insurance, property rights, and social equity.

In describing these types of tools, this article has attempted to clarify the wide range of types of legal actions that are available to decarbonize the U.S. economy. While this article does not endorse any particular legal pathways or combination of legal pathways, it is premised on the view that serious and continued legal action to address climate change is both necessary and inevitable. The costs of reducing GHG emissions and the risks of catastrophic climate change will only grow under a business-as-usual scenario.²⁷¹ Time, to put it bluntly, is not on our side. At the same time, we now know that we have a big legal toolbox for decarbonizing the U.S. economy, and we understand the types of tools in the toolbox. We also

269. See, e.g., Bobby Magill, *Big Law Firms Pledge Free Work for Sustainability Causes*, BIG LAW BUSINESS (Sept. 14, 2018), <https://biglawbusiness.com/big-law-firms-pledge-free-work-for-sustainability-causes/> (explaining that nine major law firms have committed \$15 million in free legal assistance on climate change and sustainable development).

270. To be sure, a shorter list is easier to remember than a longer list. Professor Salzman says “the Five P’s framework can strengthen students’ understanding of environmental law and policy in a simple manner they are likely to remember long after their final exam.” Salzman, *supra* note 44, at 376. My preference for a longer list is based on the view that it provides legal practitioners and policy makers with a more explicit statement of the choices.

271. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5 °C: SUMMARY FOR POLICYMAKERS (2018), http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf; Connor Nolan et al., *Past and Future Global Transformation of Terrestrial Ecosystems Under Climate Change*, 361 SCI. 920 (Aug. 31, 2018), <http://science.sciencemag.org/content/361/6405/920>; Will Steffen et al., *Trajectory of the Earth System in the Anthropocene*, PROC. NAT’L ACAD. SCI. (2018), <http://www.pnas.org/content/pnas/early/2018/07/31/1810141115.full.pdf>.

already have considerable experience using these tools. The only important remaining question is whether we have the will to use them—and to use them effectively.